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Analysis of the Potential Impacts on Surface Water Quality Resulting from the Proposed Use of the San Luis Drain to Transport Agricultural Drainage through the Northern Grasslands

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1. Background

1.1 Purpose of report and scope of study

An Environmental Assessment and Initial Study for the interim use of a portion of the San Luis Drain for conveyance water through the Grassland Water District and adjacent Grassland areas was conducted by Summers Engineering Inc. for a coalition of Grassland Drainage entities. These entities include the Panoche Drainage District, Firebaugh Canal Water District, Central California Irrigation District, Broadview Water District, Pacheco Water District, Charleston Drainage District and the City of Los Banos. The project proposes the use of 18 miles of the San Luis Drain for the conveyance of agricultural drainage water for a period of five years and the elimination of agricultural drainage discharges from 76 miles of existing channels in and adjacent to the Grassland Water District.

Review of the study document by the Natural Resources Defence Council, the Environmental Defence Fund and the Fish and Wildlife Service resulted in the request by these organizations for more detailed analysis of potential environmental impacts of the project and a more detailed accounting of project benefits. A report by Swain and Quinn (March,1991) was prepared to (a) quantify the potential project effects on surface water quality within Salt and Mud Sloughs and the San Joaquin River using currently available data, and (b) to improve the understanding of existing water supply and drainage operations within the Grassland area. After submission of the original report it was brought to the attention of one of the co-authors that the database on selenium and boron concentrations in drainage water, compiled by the Environmental Defence Fund (EDF), did not include the water quality data collected by the Regional Water Quality Control Board (CRWQCB). In addition, the US Bureau of Reclamation (USBR) requested further examination of Grasslands hydrology to estimate the quantity of supplemental water that would be needed to restore the San Joaquin River to the same TDS and trace element concentrations prior to implementation of the project. This report addresses these issues and incorporates additional analysis in response to some of the review comments of the March, 1991 (Swain and Quinn, 1991) report.

Some of the March 1991 report will be repeated in this report to produce a stand-alone document. Only two years of Grassland area hydrology are considered, however, as an expedient. These years are considered to be representative of wet (1986) and critically dry (1988) years. The years 1987 and 1989 were also considered critically dry - the 1988 results for monthly selenium and boron loads to the San Joaquin River appear to be intermediate between the 1987 and 1989 results. The updated database does not change the results significantly from those presented in the March, 1991 report. The reader is referred to the March, 1991 report for the analysis of with project and without project scenarios for hydrologies similar to the 1987, 1989 and 1990 water years.

1.2 Water supply and drainage in the Grassland area prior to 1985

A detailed description of the water resources of the Grassland area is contained in the Report on Water Supply Investigations (USBR,1989) and in the San Joaquin Valley Drainage Program Report on Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley (SJVDP, 1990a).

The Grassland area shown in Figure 1 is typically divided into two subareas, the northwestern Grassland and the Southwestern Grassland. The northwestern Grassland is approximately 130,000 acres in area and is bounded by State Highway 140 to the north, State Highway 152 to the south, the San Joaquin River to the east and Ingomar Grade to the west. The southwestern Grassland area covers a smaller area of approximately 50,000 acres and is bounded by State Highway 152 to the north, the Outside Canal to the south, State Highway 53 to the east and State Highway 165 to the west (SJVDP, 1990a).

The Grassland Resource Conservation District (RCD) covers an area of approximately 75,000 acres and is the largest institutional entity within the combined northeastern and southwestern Grassland areas (Figure 2). The lands contained within the Grassland area sustain multiple land uses including seasonally flooded inland marshes, permanent pasture, seasonally flooded native pasture and agricultural crops. The Grassland RCD includes 60,000 acres of privately owned duck clubs, 12,000 acres of land owned by the State and Federal governments and 3,000 acres of cropland. The Federal and State owned refuges include Kesterson National Wildlife refuge, Volta Wildlife Management Area and Los Banos Wildlife Management Area. The San Luis National Wildlife Refuge lies to the east of the northwestern Grassland area (USBR,1989).

Within the non-refuge areas of Grassland RCD 70 - 80 % of the acreage is managed to provide habitat for wintering waterfowl (USBR,1989). Most agricultural land with in the RCD is in permanent pasture or field crops such as sugar beets, alfalfa and cotton. Wetland areas which have been converted to agricultural uses are no longer eligible to receive Central Valley Project (CVP) water , which is made available through the Grassland Water District. Hence today, as well as prior to 1985, agricultural land is entitled only to drainage return flows as an irrigation water supply. The firm CVP allocation of 50,000 acre-ft per year has been insufficient to meet demand from the wetland areas within Grassland area - hence agricultural return flows and operational spills from agricultural areas outside the Grassland area and pumpage from groundwater wells within the Grassland area have been used to supplement water supplies in the Federal and State refuges and in the private duck clubs (USBR, 1989). The fraction of annual wetland water requirements met by groundwater pumping is difficult to assess owing to the lack of monitoring data and the variable water quality underlying the Grassland area. Private duck clubs, within the Grassland RCD, but outside the boundaries of the Grassland Water District, rely heavily upon alternative sources of water other than project deliveries, as well as on interim contracts for water with neighbouring water districts.

The Grassland area conveys agricultural drainage produced by entities known as the "exchange contractors" including the Central California Irrigation District (CCID), the San Luis Canal Company and the Firebaugh Canal Company and by water districts within the San Luis Unit which include the Panoche Water District, the Broadview Water District, the San Luis Water District and the Pacheco Water District. The mass load of selenium entering the Grassland area is mostly contributed by the Federal water contractors within the San Luis Unit. The channels contributing these contaminated flows enter the Grassland area from the south. These contaminated drainage return flows mix with return flows with lower selenium concentrations in transit through south and north Grasslands. Prior to 1985, these drainage return flows were utilized to supplement water deliveries to wetlands and refuges within the Grassland areas.

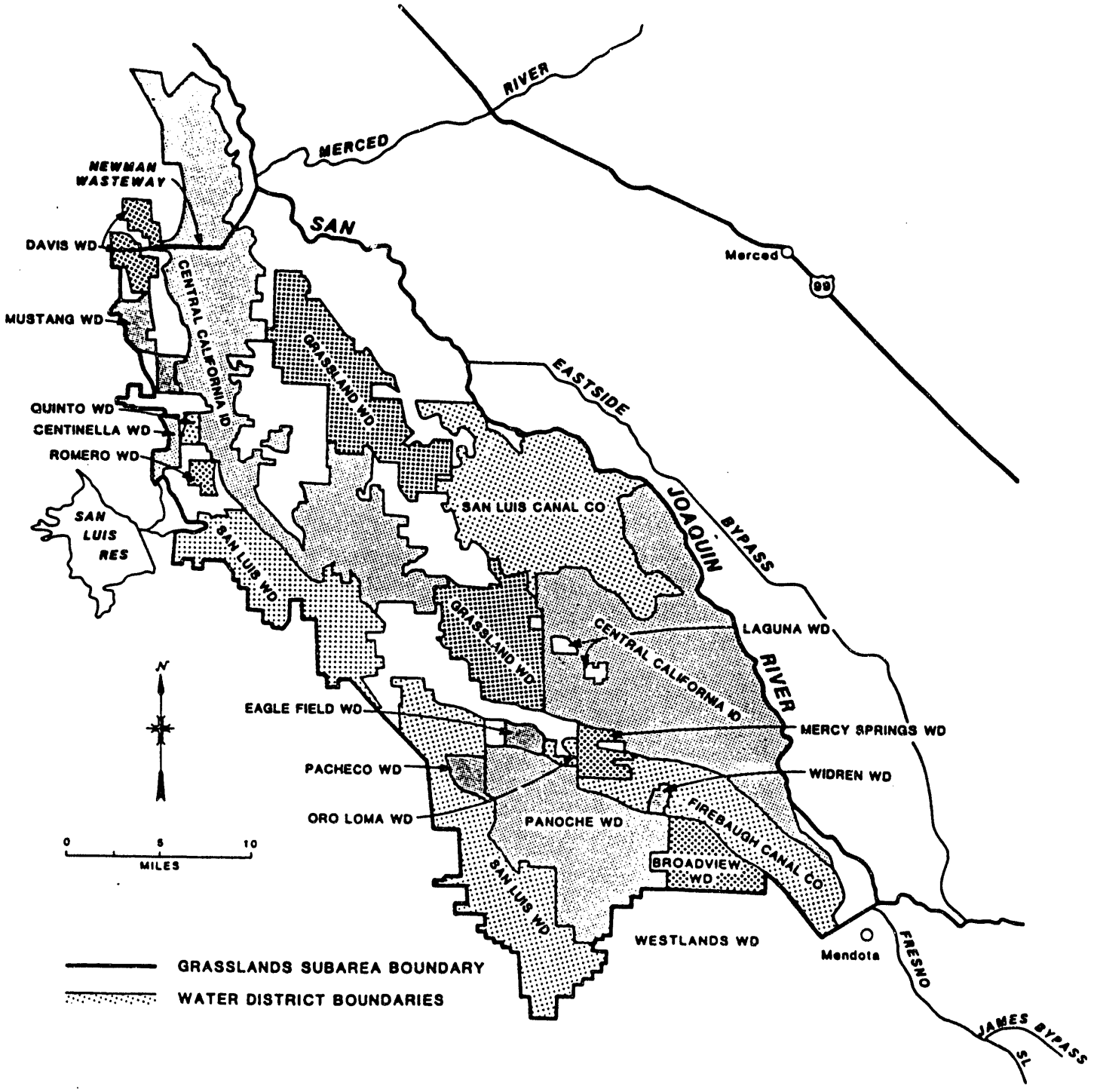


Figure 1. Location of Grassland area relative to west-side agricultural water districts

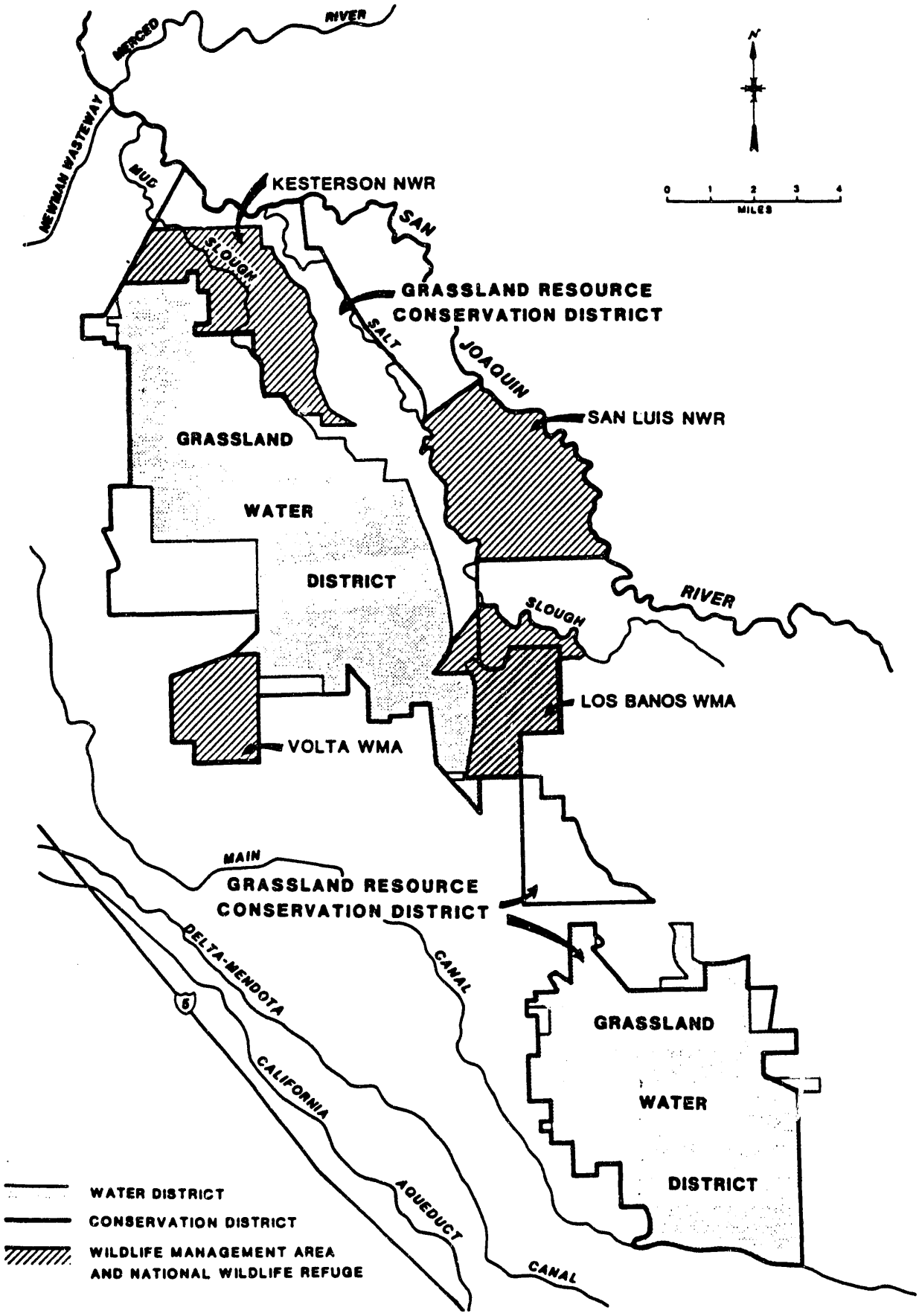


Figure 2. Location of state and federal refuges and the perimeter of the Grassland Resource Conservation District.

In 1985, after the closure of the twelve 100 acre ponds of Kesterson Reservoir due to selenium poisoning of waterfowl, use of tile drainage flows from the Westlands Water District was also discontinued. Westlands is located to the south and east of Broadview , San Luis and Panoche Water Districts in the San Luis Unit. To the Grassland area, this change in operation constituted a loss of approximately 90,000 acre-ft of firm water supply (USFWS, 1988). Although the Bureau of Reclamation has, since 1986, made available up to 100,000 acre-feet of interim project water, the cost of this water supply ($12/acre-ft) has precluded its widespread use (USBR,1989). In addition, capacity limitations within the Delta-Mendota canal have hampered efforts to deliver this water on a continuing basis.

1.3 Present use of Grassland channels for drainage conveyance

The major difference between pre-1985 and present use of the channels and drainage ditches for surface water conveyance within Grassland area, is the elimination of the use of turnouts along these channels to divert drainage return flows into the refuges. The non-availability of these drainage return flows for use in refuges has severely decreased operational flexibility related to delivery and distribution of fresh water supplies within the Grassland area. This has resulted in several of the channels, such as the Agatha Canal and Camp 13 ditch, within southern Grassland being alternately used to convey fresh water supplies and agricultural drainage flows at various times during the water year (Figures 3 and 4). Although field studies have determined minimum flushing flows necessary to minimize contamination of fresh water supplies by residual volumes of contaminated drainage water, such a practice creates scheduling difficulties and leads to a potential loss of water supply.

Water supplies to the northern area are delivered by Garzas Creek in the northwest, Volta Wasteway and San Luis Wasteway in the southwest, the Santa Fe Canal and Eagle Ditch in the central portion (Grassland Water District) and the San Luis Canal on the east side of the Grassland area (Figure 4). CVP water can be delivered from the Delta Mendota Canal, either through the Mendota Pool or Wolfsen Bypass to the CCID Main Canal which then flows into Garzas Creek, or from the Delta Mendota Canal directly into Volta Wasteway. Water supplies to the southern area are routed through the CCID Main Canal and CCID Helm Canal. The Camp 13 Ditch and the Agatha Canal/Geis Canal are the primary conveyances for delivering CVP water from the Delta Mendota Canal by way of the CCID Main Canal.

A number of control and diversion structures have been constructed in the Grassland area since 1985 to allow the separation of contaminated drainage flows from those flows of more suitable quality for use in refuges (Figure 4). These include :

1.3.1 Blake-Porter Bypass

This control structure was scheduled to be discontinued in 1990 by agreement with the San Luis Canal Company. The bypass diverts contaminated drainage flows, which passes through the Camp 13 and Agatha Canals, directly into Mud Slough (south) and hence to the San Joaquin River by way of Salt Slough. Use of the bypass has allowed freshwater deliveries to be made using the San Luis Canal to refuges in the northern Grassland RCD. The

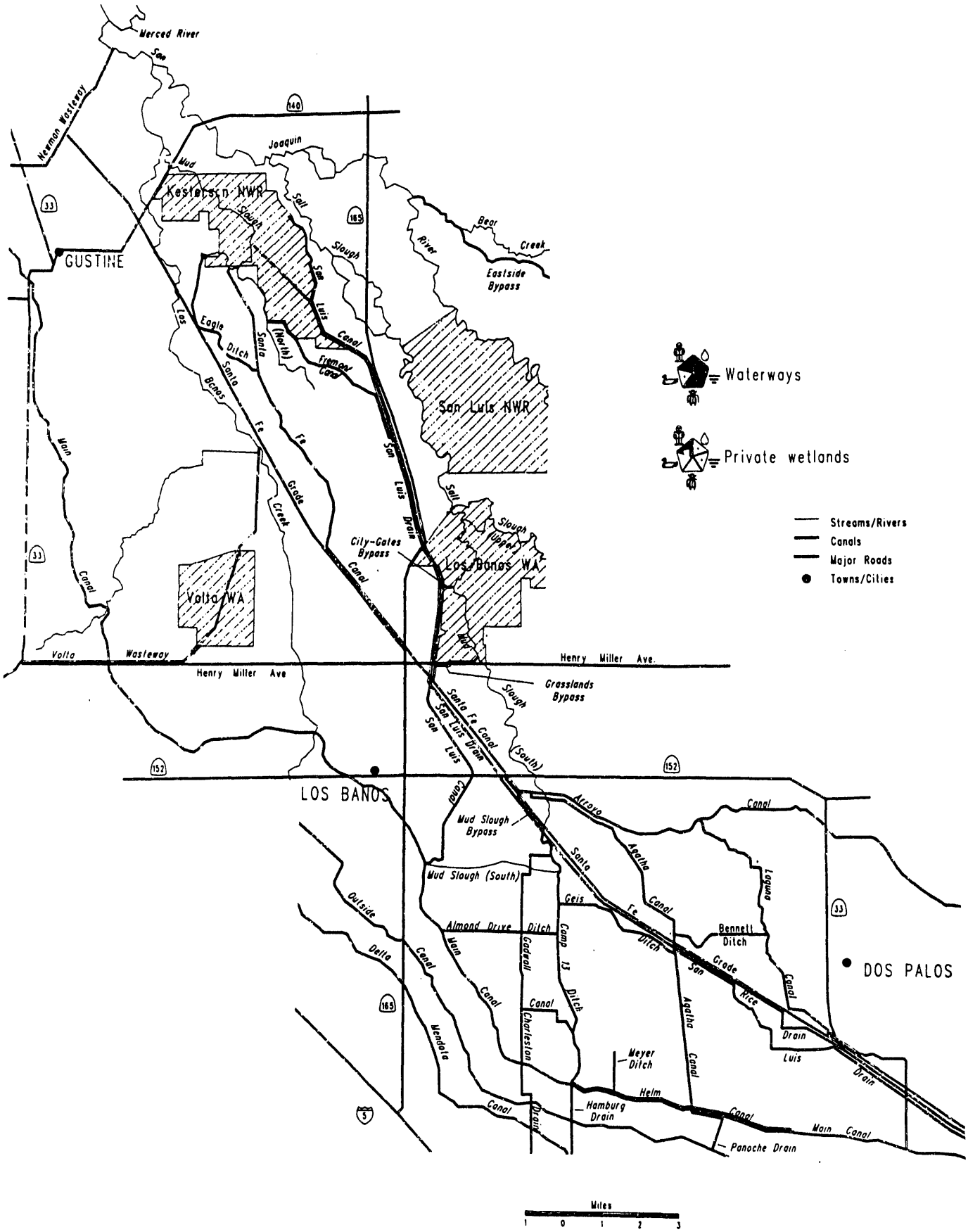


Figure 3. Canal network within the south-eastern and north-western Grassland areas.

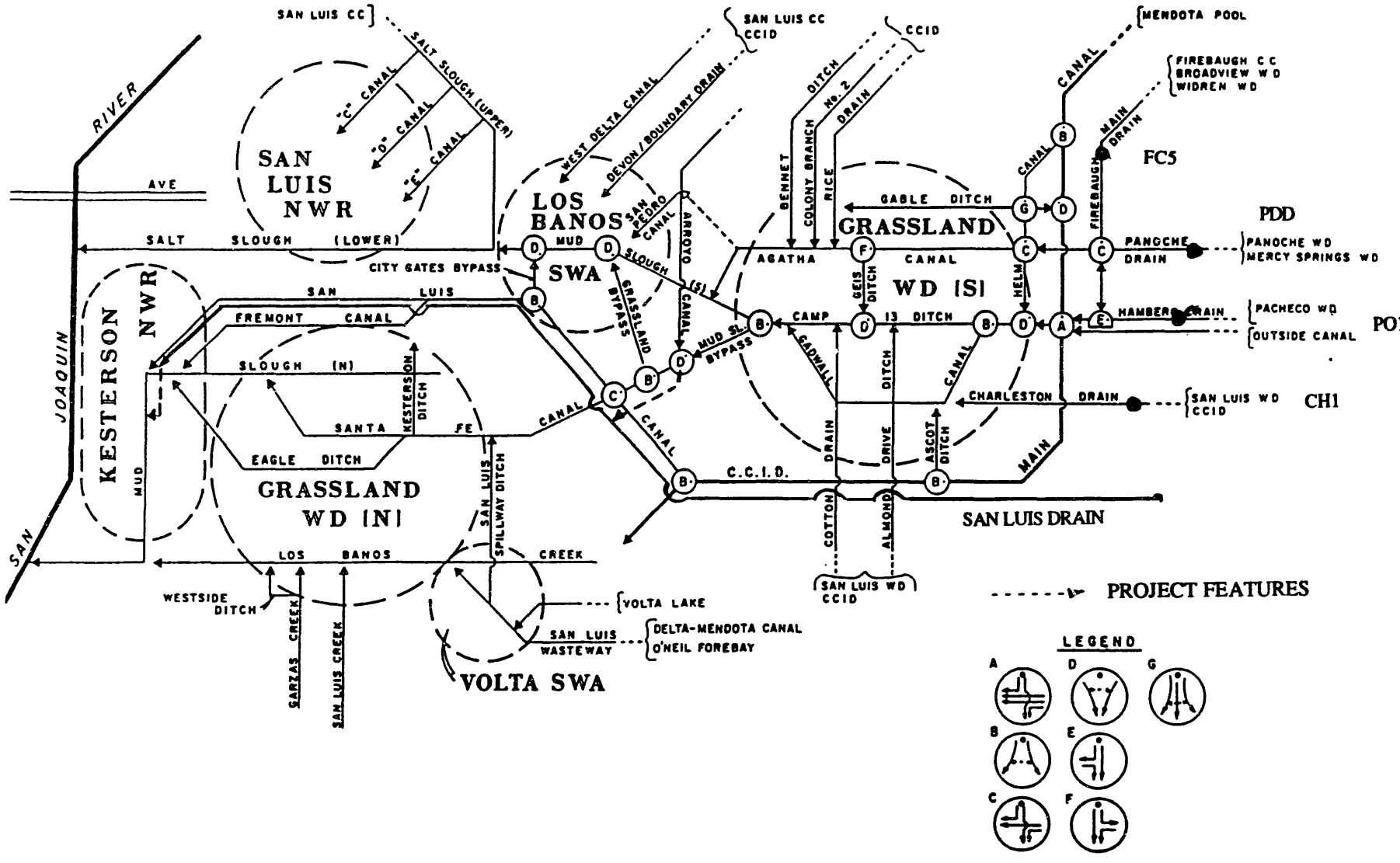


Figure 4. Schematic of the surface water conveyance system through the Grasslands sub-basin in the western San Joaquin Valley of California. Drainage monitoring sites (FC5, PDD, PO1, CH1) are shown to the left of the diagram.

potential effect of discontinuing use of this system, without use of an alternative means of flow separation, is the contamination of some portions of the northern Grassland RCD area (USBR, 1988). In this study an assumption is made that after August 1991 use of the bypass will continue, in the absence of the current proposed plan. Hence drainage from Camp 13 Ditch and Agatha Canal will be combined in Mud Slough (South) and will primarily be diverted through 23 miles of Salt Slough to the San Joaquin River. Some agricultural drainage flows would be carried to the San Joaquin River by Mud Slough (North). This is similar to the without project assumption, made in the Environmental Assessment study (Summers Engineering, 1990), which assumed that the Santa-Fe Canal / Mud Slough bypass would be continued to be operated in violation of the agreement with San Luis Canal Company.

1.3.2 Agatha / Camp 13 Flip-Flop

This system was designed to allow Grassland Water District to alternate the conveyance of fresh water between the Agatha and Camp 13 Canals. When fresh water is diverted along the Agatha Canal , adjacent marshlands can be flooded and irrigated, while agricultural drainage is diverted along the Camp 13 Canal to Mud Slough and vice-versa. By alternating (flip-flopping) fresh water and drain water in each of these canals, the southern portion of the Grassland RCD wetlands can receive water of acceptable quality. However, because some agricultural drainage is present within the system at all times, there is some potential degradation of water quality and possible water wastage, in particular if flushing flows are required prior to the delivery of refuge fresh water supply. The need for flushing can detract from the flexibility of conveyance operations and the ability to deliver water at the time it is needed.

1.4 Alternative water supplies

Groundwater pumping is used for supplemental water supply in as many as 15 of the 165 private duck clubs within the Grassland RCD. High pumping costs, poor groundwater quality and insufficient well yield preclude the use of these wells beyond use as a supplemental supply. Pump yields range from 675 - 2,100 gallons per minute and confined aquifer pumpage has an average TDS of 2000 ppm (USBR, 1989; USFWS, 1978). Safe yield for areas outside the State and Federal refuges has been estimated by the USBR at 71,500 acre-ft - however actual groundwater pumping within the Grassland area is typically less than 2000 acre-ft/year.

1.5 Grassland drainers proposed use of the San Luis Drain

Several variations of the Zahm-Sansoni-Nelson plan have been considered by the Grassland entities. Previous versions of the plan included use of segments of the San Luis Drain for separate conveyance of CVP water and agricultural drainage. The current proposed action is to use the San Luis Drain to convey agricultural drainage from a point approximately 1.3 miles south of Highway 152 to the terminus of the San Luis Drain at the north of Kesterson Reservoir, a distance of 18 miles (Summers Eng., 1990). Agricultural drainage would continue to be routed through the southern Grassland Water District via the existing Camp 13/Agatha Canal system and discharge

into the San Luis Drain at the point of intersection with Mud Slough. Structural changes would be necessary in Mud Slough (south) to permit gravity discharge into the San Luis Drain. At the terminus of the San Luis Drain an existing short channel would be enlarged to allow the agricultural drain flows to enter Mud Slough (North) and then be conveyed a short distance to the San Joaquin River (Figure 4).

The effect of the project would be to divert contaminated agricultural drainage flows (drainage high in TDS, selenium and boron), which currently flow into both Mud and Salt Sloughs, entirely into Mud Slough. Eliminating these discharges would reduce the flow in Salt Slough. Flows in Salt Slough would derive from seepage, runoff and reservoir releases from adjacent refuges and agricultural drainage flows from water quality zone A, as described by the SJVDP plan (SJVDP, 1990b). It is assumed that San Luis NWR and Los Banos WA contribute flow mainly to channels tributary to Salt Slough and that Kesterson NWR and Volta WA contribute flow mainly to channels tributary to Mud Slough. Grassland RCD contributes to both Salt and Mud Sloughs.

The most important potential beneficial features of the project as stated by Summers Engineering (1990) are as follows :

(a) Isolation of unusable agricultural drainage water from usable and fresh water supplies in the Northern Grassland area.

(b) Improvement in the operational flexibility of existing facilities and improvements in the efficiency of water delivery to wetland areas.

(c) Improvement in water quality in many of the existing channels within Grassland RCD and in Salt Slough.

(d) Reduction in selenium and boron uptake by aquatic vegetation and invertebrates in the channels no longer carrying contaminated agricultural drainage.

(e) Improved habitat quality for warm-water resident fish in Salt Slough.

The significant potential environmental consequences of the project and important potential negative impacts, as noted by Summers Engineering (1990) and reviewers of the Environmental Assessment and Initial Study document, are the following :

(a) Increased flows in Mud Slough reducing the habitat available for fish species such as sunfish, bass and carp which prefer low velocity water.

(b) Increased contaminant load in Mud Slough and increases in the concentrations of TDS, selenium and boron.

(c) Necessity for regulation of agricultural drainage discharges to meet SWRCB and CRWQCB objectives for selenium, boron and TDS in Mud and Salt Sloughs and in the San Joaquin River (although this may come to pass with or without the proposed action).

(d) Potential negative impacts on fish and invertebrates due to increased duration of exposure and higher ambient concentrations in the six mile segment of Mud Slough from the point of discharge to the point of discharge into the San Joaquin River.

(e) Possible disturbance of contaminated sediments in Mud Slough due to an increase in flow within Mud Slough.

(f) Likelihood of increased sediment deposition in Salt Slough because of reduced discharges.

(g) Potential increase in selenium, boron and TDS loading to the San Joaquin River if there is no reduction in drainage discharges from Grassland drainers.

1.6 Water quality objectives for the San Joaquin River, Mud and Salt Sloughs

Water quality objectives have been established for selenium and boron by the State Water Resources Control Board (SWRCB) and the California Regional Water Quality Control Board (CRWQCB), for Mud and Salt Sloughs, for the San Joaquin River near the mouth of the Merced River at Newman and by the USBR for TDS downstream of the Stanislaus River near Vernalis. Since less than 50% of the TDS load to the San Joaquin River is conveyed through the project study area, adherence to the TDS objective at Vernalis is an issue that concerns a much larger contributing area . Monitoring and regulation of TDS loading from Mud and Salt Sloughs is still important, however, because of the large total mass of salts added to the San Joaquin River by these sources. Selenium and boron are more important elements of concern, because more than 70% of the total load of these constituents in the San Joaquin River during a normal or dry year are contributed by Mud and Salt Sloughs (SWRCB, 1987). Analyses performed by the SWRCB (1987) have shown that the selenium objective of 2 ppb in Mud and Salt Sloughs is the most difficult to meet and hence the limiting constituent in these tributaries to the San Joaquin River. At Newman, the CVRWQCB boron objective of 0.8 ppm from March 15 - September 14 and 1.0 ppm from September 15 to March 14 (1.3 ppm in a critical year) limits drainage discharge to the San Joaquin River. At Vernalis, the limiting TDS water quality objective is 450 ppm, the result of an agreement between the US Bureau of Reclamation and the South Delta Water Agency. The SWRCB objective is 500 mg/l. Both objectives have been difficult to meet in dry and critically dry water years, even with releases from New Melones Reservoir. The SWRCB has adopted new objectives for Vernalis, which should go into effect in 1996. The new objectives are 0.7 mmhos/cm (April through August) and 1.0 mmhos/cm (September - March) and assume an TDS /EC conversion factor of 590 mg/l TDS per unit of EC) (EC is measured in mmhos/cm).

Of direct relevance to this study and to the environmental assessment of the impacts of the proposed use of the San Luis Drain are the objectives for selenium and boron for Mud and Salt Sloughs and for the San Joaquin River. These are as follows :

Mud and Salt Slough Objectives :

boron	2 ppm	(CVRWQCB 88-195)
	2 ppm	(SWRCB, 1987)
selenium	10 ppb	(CVRWQCB 88-195)

San Joaquin River Objectives near Newman (CVRWQCB 88-195):

boron	0.8 ppm	March 15 - September 15
	1.0 ppm	September 16 - March 14
	1.3 ppm	critical year
selenium	5 ppb	
	8 ppb	critical year

2. Study design

2.1 Conceptual framework

The Grassland area contains complex and diverse terrestrial and aquatic ecosystems. Any change in the inputs to these ecosystems, either in the quantity or quality of water deliveries can have impacts on the suitability of the ecosystem to support biota at each level of the food chain. Assessing the impacts of these seasonal changes cannot be performed adequately without intensive study and the collection of field-level data, neither of which are currently available. The approach that has been taken in this study is limited in scope to conservation of mass with respect to flows of water and contaminants. Contaminants are defined as those dissolved constituents in water that have been shown to cause damage to the aquatic and terrestrial ecosystems through the processes of bioaccumulation and that degrade the utility of the surface water resource as an irrigation supply for agricultural uses downstream. Selenium, boron and total dissolved solids (TDS) have been chosen as the primary contaminants of concern.

It is important to note that the analysis which follows utilizes historical data and hence treats surface and subsurface drainage flows within the Grassland area as substantially unregulated flows. In this sense the analysis is conservative and portrays a worse case scenario for the two years considered (1986,1988). It is envisaged that any use of the drain through authorization of the project would require considerable monitoring and regulation of discharges from each of the upslope agricultural water and drainage districts. Current monitoring sites have been chosen by Summers Engineering Inc. and the Grasslands Water District to allow the flow and contaminant load from each of these five entities to be individually estimated. Figure G-1 (Appendix G) shows the location of current monitoring sites within the Grassland area (Summers Engineering, 1991). Aslo contained in Appendix G is a table which describes the location of the monitoring sites shown in Figure G-1 and which also lists the sampling frequency of the major constituents EC, selenium and boron.

A current effort, spearheaded by the Water Quality Subcommittee of the San Joaquin River Management Program, is investigating the telemetering of electrical conductivity (EC) of flows at Newman and at other stations along the San Joaquin River. Once in place, this would provide real-time TDS concentrations along various reaches of the river, allowing east-side reservoir releases to be scheduled at times when TDS concentrations exceeded the SWRCB water quality objectives. Telemetering of drainage flows and TDS at each of the monitoring sites and the development of regression equations, relating seasonal TDS to selenium and boron concentrations at these sites, would allow greater water district control over drainage discharges. Additional research will be required to develop better predictors of selenium concentrations from flow and TDS data. Use of the San Luis Drain for conveyance of subsurface drainage would enhance the ability to control releases of contaminated drainage water to Mud Slough and the San Joaquin River. With water district co-operation and involvement of State and Federal agencies in data acquisition, analysis and dissemination the project could play a significant role in helping to improve water quality for TDS, selenium and boron in the San Joaquin River.

2.2 Data requirements

As previously noted, there is a paucity of historical data that provide concurrent records of flow and contaminant concentrations within the network of channels and ponds that make up the Grassland RCD. To perform a mass balance analysis, concurrent measurements of flow and concentration data are necessary at a sampling frequency that allows short term fluctuations in these levels to be observed. A weekly and sometimes even a daily sampling frequency would be required to perform realistic mass balances.

2.3 Data sources and limitations

Monitoring of flows and contaminants within the Grassland area has been undertaken by a number of State and Federal Agencies, as well as local agencies. The most comprehensive database has been compiled by Summers Engineering, a local engineering consulting firm, under contract with the Department of Water Resources and the Grassland drainage entities (Figure G-1 and Appendix G). The USGS has been monitoring flows and a wide range of common salts and trace elements between June,1984 and October, 1988 within Salt and Mud Sloughs and the San Joaquin River. Data collected on contaminant loading entering the Grassland area is limited in its accuracy by virtue of the fact that the flow and concentration measurements are grab samples, taken once or twice per month. Flow volumes along the Grassland channels are subject to considerable variation, especially during the pre-irrigation and regular irrigation seasons when drainage flows in the channels can change dramatically in the space of a few days. The USGS monitoring stations utilize continuous recorders - hence the flow measurements are likely to provide an accurate accounting of monthly flow volume. Data from three of these stations were used to analyse the effect of the proposed actions. These include Salt Slough at Highway 165, Mud Slough at Highway 140 and the San Joaquin River near Newman.

Analysis of monthly selenium and boron concentrations show significant correlation between monthly values of successive years - giving some confidence that grab samples of contaminant concentrations in channels within the Grassland area may be somewhat indicative of mean monthly contaminant concentrations. However, grab samples taken within the San Joaquin River may vary more markedly from the mean monthly average concentration of selenium, boron or TDS.

At the outset of this study there was some confusion regarding the use of the contaminant data from the Newman gauging station. The station is located on the west bank of the San Joaquin River, a short distance downstream of the confluence with the Merced River. This distance is not considered sufficient to allow adequate mixing of discharges from Salt and Mud Slough and the high quality Merced River flow. Crows Landing monitoring station is located approximately 6 miles downstream from the Newman gauge and is presently used to estimate TDS, selenium and boron concentrations in the San Joaquin River at the Newman site. Although Orestimba Creek occasionally discharges into the River between these two sites, these flows are not considered to be significantly large to invalidate the assumption that the flows at Newman and Crow Landing are equal. The Crows Landing data is used in this study for 1989 and 1990 river hydrology. These data were obtained from the California Regional Water Quality Control Board (CRWQCB,1990, 1991).

During the period 1986 - 1988, the USGS monitoring program was active. The USGS used a sampling technique that allowed contaminant concentrations to be measured at various depths and at several locations across the river. Using a flow weighting technique, the USGS was able to obtain a more realistic measurement of contaminant loading within the river. These samples were taken between two and six times per month. In this study, the USGS data for the period 1986 - 1988 was considered to be the most reliable, and hence was used in preference to other published data.

3. Analysis of operations and impacts on flow and water quality

3.1 Land use and water requirements

Land use practices within the wetlands and wildlife refuges, managed by the Departments of Fish and Game and the Fish and Wildlife Service, have been surveyed - hence it is relatively simple to determine water requirements within these areas. In the predominantly privately owned areas (southwestern Grassland), data on land use practices are harder to obtain, and there is a greater variety of land use, making estimation of water requirements considerably more difficult. The Report on Water Supply Investigations (USBR, 1989) was used to obtain the annual estimates of available water supply and the initial estimates of the monthly distribution of wetland water requirements.

In a previous SJVDP study an attempt was made to subdivide the area in to land units according to the source of water supply for the 1988 water year (Quinn, 1990, Phillips and Quinn, 1990). The Grassland area was divided into a number of subareas according to maps provided by F. Paveglio of the Fish and Wildlife Service, which delineated areas that were serviced with water supply through common turnouts and managed as units by the District Watermaster. The State and Federal wildlife areas were each considered as single subareas for water budgeting purposes. A map of these delineated subareas is provided in F-1 (Appendix F). The database of agricultural crops, pasture and managed wetlands for the 1988 water year, obtained from a survey of land use within each of the subareas, is included in Appendix A1. These land use estimates were used to estimate the wetland area drainage contribution to Salt and Mud Sloughs.

3.2 Wetland water management practices

Management practices differ between the subareas as a function of land use and refuge operation in those subareas with substantial areas of seasonal and permanent wetland. The most important impact of these practices from the standpoint of water quality in Grassland channels is :

(a) the timing of water deliveries to seasonal and permanent wetlands during the fall flooding period; (b) the timing of spring-time wetland releases to the channels (typically during March or April) in preparation for emergence of vegetation within the wetland areas and irrigation of these areas for wildlife food supply.

The schedule of wetland make-up water deliveries to offset direct evaporation and seepage losses can also affect the periods during which the channels contain water of good quality. The complicated schedule of water deliveries to wetlands and water releases from wetlands at different times of the year make a determination of monthly operations difficult to ascertain with confidence. Average monthly estimates of water deliveries have been determined for the

State and Federal refuges and private lands, based on historic operations and on perceived management strategies (USBR,1989; SJVDP, 1990b). These data are presented in Tables 1- 5.

3.3 Water budget and mass balances on salts and trace elements

Water budgets and trace element balances are also presented in Tables 1 - 5 for San Luis National Wildlife Refuge, Kesterson National Wildlife Refuge, Los Banos Wildlife Area, Volta Wildlife Area and Grassland RCD Wildlife Area. In each of these Tables the budgets and balances are performed for scenarios without the proposed action (without-project) and with the proposed action (with-project). These tables contain some small changes, which differ from the numbers tabulated in the March, 1991 report (Swain and Quinn, 1991), mostly to correct minor inconsistencies between the methodology described to calculate remaining wetland storage and the tabular values.

Refuge water supply quantities for the without-project scenario are based on current firm annual water supplies to these refuges, obtained from data complied by the SJVDP and Reclamation (SJVDP, 1990a and USBR, 1989). The with-project scenario is more complicated because of the large number of different State and Federal Agency estimates of water supplies required for optimal operation of these wetland areas.

The total water supply assumed available to each management area includes:

(a) the existing firm annual water supply (SJVDP, 1990a, 1990b)

(b) the surface return flows from wetland areas and agricultural drainage from operational spills of usable quality, made available as a result of the proposed action.

3.4 Scenarios

With-project scenarios can be developed with different sets of assumptions. Three scenarios are analyzed in this report which consider different operations utilizing three combinations of these sources of wetland water supply. These are as follows :

(a) Contaminated agricultural return flows are diverted to the San Luis Drain. Existing fresh water supplies to wetlands are supplemented by use of useable quality water in Salt Slough, improved in quality as a result of the project. Annual wetland drainage flows are increased by 27,000 acre-ft to 65,300 acre-ft. - (Scenario 1)

(b) Contaminated agricultural return flows are diverted to the San Luis Drain. Existing fresh water supplies to wetlands are not supplemented by use of useable quality water in Salt Slough due to a moratorium on increased diversions. A portion (80%) of the surface return flows and operational spills are routed directly to the San Joaquin River via Salt Slough. Total annual wetland drainage flows remain at approximately 38,300 acre-ft similar to the current condition. - (Scenario 2).

Table 1

SAN LUIS NWR - WATER BUDGET AND CONTAMINANT LOAD-FLOW FACTORS

(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	FUTURE WITHOUT PROPOSED ACTION											FUTURE WITH PROPOSED ACTION										
Year/ Mon	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (3.0K Ac Max) (c) Ac-Ft	Wetland End of Month Storage (d) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (h) ppm-Ac-Ft	Boron (i) ppm-Ac-Ft	Se (j) ppb-Ac-Ft	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (3.0k Ac Max) (k) Ac-Ft	Wetland End of Month Storage (l) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (m) ppm-Ac-Ft	Boron (n) ppm-Ac-Ft	Se (o) ppb-Ac-Ft
Oct	0.0	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	3.4	0.25	2.5	2.1	0.9	0.0	0.4	0.0	640	0.8	0.4
Nov	0.0	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	2.5	0.19	1.6	3.2	0.9	0.0	0.5	0.0	800	1.0	0.5
Dec	0.0	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.9	0.07	0.0	3.2	0.9	0.0	0.5	0.0	800	1.0	0.5
Jan	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.5	0.04	0.0	3.2	0.5	0.0	0.4	0.0	640	0.8	0.4
Feb	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.7	0.05	0.0	3.2	0.7	0.0	0.4	0.0	640	0.8	0.4
Mar	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.9	0.07	0.0	3.2	0.9	0.0	0.4	0.0	640	0.8	0.4
Apr	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.5	0.04	0.0	1.1	0.5	0.0	0.2	2.2	3,792	4.7	2.4
May	0.0	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.5	0.04	0.0	0.0	0.0	0.5	0.2	1.1	1,990	2.5	1.2
Jun	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	1.7	0.13	0.0	0.0	0.0	1.7	0.6	0.0	952	1.2	0.6
Jul	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.4	0.03	0.0	0.0	0.0	0.4	0.1	0.0	224	0.3	0.1
Aug	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.3	0.02	0.0	0.0	0.0	0.3	0.0	0.0	0	0.0	0.0
Sep	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.9	0.07	0.7	0.5	0.2	0.0	0.3	0.0	480	0.6	0.3
Total	0.0	1.00	0.0		0.0	0.0	0.0	0.0	0	0.0	0.0	13.4	1.00	4.8		5.5	2.9	4.0	3.2	11,598	14.5	7.2

(a) Moore et al, 1990, Present firm supply included in Vol. I "Fish and Wildlife Resources and Agricultural Drainage", Table 2-14.
(b) USBR, 1988, Table IV K-2 "Report on Refuge Water supply Investigations", Central Valley Hydrologic Basin, California.
(c) An average depth of water would be 1.0 feet and 0.5 feet per acre would be required to raise the water table to the land surface. No lands would be flooded with a firm water supply.
(d) Equals Col (2) minus Col (6) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(e) Wetland make-up water volume equals seepage and evaporation losses.
(f) Applied water volume generally equals the available water supply during the months of May thur August.
(g) Assumed releases from wetlands would be 67 and 33 percent in April and May, respectivily.
(h) Calculated as [Col. (8) + Col. (9)] x 1600 ppm (USBR wetland discharge data).
(i) Calculated as [Col. (8) + Col. (9)] x 2.0 ppm (USBR wetland discharge data).
(j) Calculated as [Col. (8) + Col. (9)] x 1 ppb (USBR wetland discharge data).
(k) Assumed an ave. depth of water of 1.0 feet and 0.5 ac-ft per ac would be required to raise the water table to the land surface. The flooded area equals 3,000 acres.
(l) Equals Col (13) minus col (17) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(m) Calculated as [Col. (19) + Col. (20)] x 1600 ppm (USBR wetland discharge data).

Table 2

KESTERSON NWR - WATER BUDGET AND CONTAMINANT LOAD-FLOW FACTORS

(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	FUTURE WITHOUT PROPOSED ACTION											FUTURE WITH PROPOSED ACTION										
Year/ Mon	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (1.4K Ac Max) (c) Ac-Ft	Wetland End of Month Storage (d) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (h) ppm-Ac-Ft	Boron (i) ppm-Ac-Ft	Se (j) ppb-Ac-Ft	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (1.4k Ac Max) (k) Ac-Ft	Wetland End of Month Storage (l) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (m) ppm-Ac-Ft	Boron (n) ppm-Ac-Ft	Se (o) ppb-Ac-Ft
Oct	1.5	0.43	1.2	1.1	0.3	0.0	0.1	0.0	160	0.2	0.1	1.5	0.43	1.2	1.1	0.3	0.0	0.1	0.0	160	0.2	0.1
Nov	1.5	0.43	1.1	1.9	0.4	0.0	0.1	0.0	160	0.2	0.1	1.5	0.43	1.1	1.9	0.4	0.0	0.1	0.0	160	0.2	0.1
Dec	0.0	0.00	0.0	1.7	0.0	0.0	0.1	0.0	160	0.2	0.1	0.0	0.00	0.0	1.7	0.0	0.0	0.1	0.0	160	0.2	0.1
Jan	0.0	0.00	0.0	1.6	0.0	0.0	0.1	0.0	160	0.2	0.1	0.0	0.00	0.0	1.6	0.0	0.0	0.1	0.0	160	0.2	0.1
Feb	0.0	0.00	0.0	1.6	0.0	0.0	0.1	0.0	160	0.2	0.1	0.0	0.00	0.0	1.6	0.0	0.0	0.1	0.0	160	0.2	0.1
Mar	0.0	0.00	0.0	1.5	0.0	0.0	0.1	0.8	1,440	1.8	0.9	0.0	0.00	0.0	1.5	0.0	0.0	0.1	0.8	1,440	1.8	0.9
Apr	0.0	0.00	0.0	0.5	0.0	0.0	0.0	0.4	640	0.8	0.4	0.0	0.00	0.0	0.5	0.0	0.0	0.0	0.4	640	0.8	0.4
May	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Jun	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Jul	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Aug	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Sep	0.5	0.14	0.5	0.3	0.0	0.0	0.0	0.0	0	0.0	0.0	0.5	0.14	0.5	0.3	0.0	0.0	0.0	0.0	0	0.0	0.0
Total	3.5	1.00	2.8		0.7	0.0	0.6	1.2	2,880	3.6	1.8	3.5	1.00	2.8		0.7	0.0	0.6	1.2	2,880	3.6	1.8

(a) Moore et al, 1990, Present firm supply included in Vol. I "Fish and Wildlife Resources and Agricultural Drainage", Table 2-14.
(b) USBR, 1988, Table IV J-2 "Report on Refuge Water supply Investigations", Central Valley Hydrologic Basin, California.
(c) An average depth of water would be 1.0 feet and 0.5 feet per acre would be required to raise the water table to the land surface. Available water restricts the flooded area to 1,400 acres.
(d) Equals Col (2) minus Col (6) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(e) Wetland make-up water volume equals seepage and evaporation losses.
(f) Applied water volume generally equals the available water supply during the months of May thur August.
(g) Assumed releases from wetlands would be 67 and 33 percent in April and May, respectivily.
(h) Calculated as [Col. (8) + Col. (9)] x 1600 ppm (USBR wetland discharge data).
(i) Calculated as [Col. (8) + Col. (9)] x 2.0 ppm (USBR wetland discharge data).
(j) Calculated as [Col. (8) + Col. (9)] x 1 ppb (USBR wetland discharge data).
(k) Assumed an ave. depth of water of 1.0 feet and 0.5 ac-ft per ac would be required to raise the water table to the land surface. The flooded area equals 1,400 acres.
(l) Equals Col (13) minus col (17) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(m) Calculated as [Col. (19) + Col. (20)] x 1600 ppm (USBR wetland discharge data).
(n) Calculated as [Col. (19) + Col. (20)] x 2.0 ppm (USBR wetland discharge data).
(o) Calculated as [Col. (19) + Col. (20)] x 1 ppb (USBR wetland discharge data).

Table 3

LOS BANOS WILDLIFE AREA - WATER BUDGET AND CONTAMINANT LOAD-FLOW FACTORS

(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	FUTURE WITHOUT PROPOSED ACTION											FUTURE WITH PROPOSED ACTION										
Year/ Mon	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (3.8K Ac Max) (c) Ac-Ft	Wetland End of Month Storage (d) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (h) ppm- Ac-Ft	Boron (i) ppm- Ac-Ft	Se (j) ppb- Ac-Ft	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (3.8k Ac Max) (k) Ac-Ft	Wetland End of Month Storage (l) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (m) ppm- Ac-Ft	Boron (n) ppm- Ac-Ft	Se (o) ppb- Ac-Ft
Oct	2.1	0.33	2.0	2.4	0.1	0.0	0.1	0.0	160	0.2	0.1	3.6	0.13	2.4	4.8	1.2	0.0	0.6	0.0	960	1.2	0.6
Nov	1.0	0.16	0.7	2.9	0.3	0.0	0.1	0.0	160	0.2	0.1	1.9	0.07	0.7	5.3	1.2	0.0	0.5	0.0	800	1.0	0.5
Dec	0.3	0.05	0.0	2.9	0.3	0.0	0.2	0.0	320	0.4	0.2	1.1	0.04	0.0	5.3	0.9	0.0	0.5	0.0	800	1.0	0.5
Jan	0.2	0.03	0.0	2.9	0.2	0.0	0.1	0.0	160	0.2	0.1	0.6	0.02	0.0	5.3	0.4	0.0	0.4	0.0	640	0.8	0.4
Feb	0.0	0.00	0.0	2.7	0.0	0.0	0.0	0.0	0	0.0	0.0	0.6	0.02	0.0	5.3	0.4	0.0	0.4	0.0	640	0.8	0.4
Mar	0.0	0.00	0.0	2.4	0.0	0.0	0.0	0.0	0	0.0	0.0	1.1	0.04	0.0	5.3	0.9	0.0	0.4	0.0	640	0.8	0.4
Apr	0.0	0.00	0.0	0.8	0.0	0.0	0.0	1.6	2,547	3.2	1.6	1.1	0.04	0.0	1.7	0.9	0.0	0.4	3.5	6,300	7.9	3.9
May	0.7	0.11	0.0	0.0	0.0	0.7	0.3	0.8	1,734	2.2	1.1	3.6	0.13	0.0	0.0	0.0	2.8	1.0	1.7	4,356	5.4	2.7
Jun	0.5	0.08	0.0	0.0	0.0	0.5	0.2	0.0	320	0.4	0.2	5.0	0.18	0.0	0.0	0.0	3.9	1.4	0.0	2,184	2.7	1.4
Jul	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	3.6	0.13	0.0	0.0	0.0	2.8	1.0	0.0	1,568	2.0	1.0
Aug	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	2.8	0.10	2.5	1.7	0.3	0.0	0.0	0.0	0	0.0	0.0
Sep	1.5	0.24	1.5	1.0	0.0	0.0	0.0	0.0	0	0.0	0.0	2.8	0.10	2.3	3.2	0.5	0.0	0.3	0.0	480	0.6	0.3
Total	6.4	1.00	4.2		0.9	1.2	1.0	2.4	5,401	6.8	3.4	27.7	1.00	7.9		6.7	9.5	6.8	5.3	19,367	24.2	12.1

(a) Moore et al, 1990, Present firm supply included in Vol. I "Fish and Wildlife Resources and Agricultural Drainage", Table 2-14.
(b) USBR, 1988, Table IV I-2 "Report on Refuge Water supply Investigations", Central Valley Hydrologic Basin, California.
(c) An average depth of water would be 1.0 feet and 0.5 feet per acre would be required to raise the water table to the land surface. Available water restricts the flooded area to 2,900 acres.
(d) Equals Col (2) minus Col (6) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(e) Wetland make-up water volume equals seepage and evaporation losses.
(f) Applied water volume generally equals the available water supply during the months of May thur August.
(g) Assumed releases from wetlands would be 67 and 33 percent in April and May, respectivily.
(h) Calculated as [Col. (8) + Col. (9)] x 1600 ppm (USBR wetland discharge data).
(i) Calculated as [Col. (8) + Col. (9)] x 2.0 ppm (USBR wetland discharge data).
(j) Calculated as [Col. (8) + Col. (9)] x 1 ppb (USBR wetland discharge data).
(k) Assumed an ave. depth of water of 1.0 feet and 0.5 ac-ft per ac would be required to raise the water table to the land surface. The flooded area equals 3,800 acres.
(l) Equals Col (13) minus col (17) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(m) Calculated as [Col. (19) + Col. (20)] x 1600 ppm (USBR wetland discharge data).

Table 4

VOLTA WILDLIFE AREA - WATER BUDGET AND CONTAMINANT LOAD-FLOW FACTORS

(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	FUTURE WITHOUT PROPOSED ACTION											FUTURE WITH PROPOSED ACTION										
Year/ Mon	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (2.7K Ac Max) (c) Ac-Ft	Wetland End of Month Storage (d) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (h) ppm-Ac-Ft	Boron (i) ppm-Ac-Ft	Se (j) ppb-Ac-Ft	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (2.7k Ac Max) (k) Ac-Ft	Wetland End of Month Storage (l) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (m) ppm-Ac-Ft	Boron (n) ppm-Ac-Ft	Se (o) ppb-Ac-Ft
Oct	2.0	0.20	1.0	2.6	0.5	0.0	0.3	0.0	400	0.5	0.3	2.0	0.20	1.0	2.6	0.5	0.0	0.3	0.0	400	0.5	0.3
Nov	0.6	0.06	0.0	2.6	0.6	0.0	0.3	0.0	480	0.6	0.3	0.6	0.06	0.0	2.6	0.6	0.0	0.3	0.0	480	0.6	0.3
Dec	0.6	0.06	0.0	2.6	0.6	0.0	0.3	0.0	480	0.6	0.3	0.6	0.06	0.0	2.6	0.6	0.0	0.3	0.0	480	0.6	0.3
Jan	0.2	0.02	0.0	2.6	0.2	0.0	0.2	0.0	320	0.4	0.2	0.2	0.02	0.0	2.6	0.2	0.0	0.2	0.0	320	0.4	0.2
Feb	0.2	0.02	0.0	2.6	0.2	0.0	0.2	0.0	320	0.4	0.2	0.2	0.02	0.0	2.6	0.2	0.0	0.2	0.0	320	0.4	0.2
Mar	0.2	0.02	0.0	2.6	0.2	0.0	0.1	0.0	160	0.2	0.1	0.2	0.02	0.0	2.6	0.2	0.0	0.1	0.0	160	0.2	0.1
Apr	0.2	0.02	0.0	0.9	0.2	0.0	0.0	1.8	2,805	3.5	1.8	0.2	0.02	0.0	0.9	0.2	0.0	0.0	1.8	2,805	3.5	1.8
May	1.0	0.10	0.0	0.0	0.0	1.0	0.4	0.9	1,941	2.4	1.2	1.0	0.10	0.0	0.0	0.0	1.0	0.4	0.9	1,941	2.4	1.2
Jun	1.2	0.12	0.0	0.0	0.0	1.2	0.4	0.0	672	0.8	0.4	1.2	0.12	0.0	0.0	0.0	1.2	0.4	0.0	672	0.8	0.4
Jul	0.6	0.06	0.0	0.0	0.0	0.6	0.2	0.0	336	0.4	0.2	0.6	0.06	0.0	0.0	0.0	0.6	0.2	0.0	336	0.4	0.2
Aug	1.4	0.14	1.1	0.7	0.3	0.0	0.0	0.0	0	0.0	0.0	1.4	0.14	1.1	0.7	0.3	0.0	0.0	0.0	0	0.0	0.0
Sep	1.8	0.18	1.4	1.9	0.4	0.0	0.2	0.0	320	0.4	0.2	1.8	0.18	1.4	1.9	0.4	0.0	0.2	0.0	320	0.4	0.2
Total	10.0	1.00	3.5		3.2	2.8	2.5	2.6	8,234	10.3	5.1	10.0	1.00	3.5		3.2	2.8	2.5	2.6	8,234	10.3	5.1

(a) Moore et al, 1990, Present firm supply included in Vol. I "Fish and Wildlife Resources and Agricultural Drainage", Table 2-14.
(b) USBR, 1988, Table IV H-2 "Report on Refuge Water supply Investigations", Central Valley Hydrologic Basin, California.
(c) An average depth of water would be 1.0 feet and 0.5 feet per acre would be required to raise the water table to the land surface.
(d) Equals Col (2) minus Col (6) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(e) Wetland make-up water volume equals seepage and evaporation losses.
(f) Applied water volume generally equals the available water supply during the months of May thur August.
(g) Assumed releases from wetlands would be 67 and 33 percent in April and May, respectivily.
(h) Calculated as [Col. (8) + Col. (9)] x 1600 ppm (USBR wetland discharge data).
(i) Calculated as [Col. (8) + Col. (9)] x 2.0 ppm (USBR wetland discharge data).
(j) Calculated as [Col. (8) + Col. (9)] x 1 ppb (USBR wetland discharge data).
(k) Assumed an ave. depth of water of 1.0 feet and 0.5 ac-ft per ac would be required to raise the water table to the land surface.
(l) Equals Col (13) minus col (17) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(m) Calculated as [Col. (19) + Col. (20)] x 1600 ppm (USBR wetland discharge data).
(n) Calculated as [Col. (19) + Col. (20)] x 2.0 ppm (USBR wetland discharge data).
(o) Calculated as [Col. (19) + Col. (20)] x 1 ppb (USBR wetland discharge data).

Table 5

GRASSLANDS RESOURCE CONSERVATION DISTRICT WILDLIFE AREA - WATER BUDGET AND CONTAMINANT LOAD-FLOW FACTORS

(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	FUTURE WITHOUT PROPOSED ACTION											FUTURE WITH PROPOSED ACTION										
Year/ Mon	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (49K Ac Max) (c) Ac-Ft	Wetland End of Month Storage (d) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (h) x1000 ppm- Ac-Ft	Boron (i) ppm- Ac-Ft	Se (j) ppb- Ac-Ft	Available Water Supply (a) Ac-Ft	Monthly Distrib. (b)	Flood Wetland (49k Ac Max) (k) Ac-Ft	Wetland End of Month Storage (l) Ac-Ft	Wetland Make-up Water (e) Ac-Ft	Applied Irr. Water (f) Ac-Ft	Seep. and Runoff Ac-Ft	Reser. Relea. (g) Ac-Ft	Load-Flow Factor TDS (m) x1000 ppm- Ac-Ft	Boron (n) ppm- Ac-Ft	Se (o) ppb- Ac-Ft
Oct	28.8	0.60	22.8	21.7	6.0	0.0	2.0	0.0	3.2	4.0	2.0	17.1	0.25	11.1	16.6	6.0	0.0	2.0	0.0	3.2	4.0	3.2
Nov	9.6	0.20	5.6	25.5	4.0	0.0	2.0	0.0	3.2	4.0	2.0	3.4	0.05	0.0	16.6	3.4	0.0	2.0	0.0	3.2	4.0	3.2
Dec	0.0	0.00	0.0	22.5	0.0	0.0	2.0	0.0	3.2	4.0	2.0	2.0	0.03	0.0	16.7	2.0	0.0	2.0	0.0	3.2	4.0	3.2
Jan	0.0	0.00	0.0	20.5	0.0	0.0	2.0	0.0	3.2	4.0	2.0	2.0	0.03	0.0	16.7	2.0	0.0	2.0	0.0	3.2	4.0	3.2
Feb	0.0	0.00	0.0	17.5	0.0	0.0	2.0	0.0	3.2	4.0	2.0	2.0	0.03	0.0	16.8	2.0	0.0	2.0	0.0	3.2	4.0	3.2
Mar	0.0	0.00	0.0	13.5	0.0	0.0	2.0	0.0	3.2	4.0	2.0	2.7	0.04	0.0	16.8	2.7	0.0	2.0	0.0	3.2	4.0	3.2
Apr	0.0	0.00	0.0	5.8	0.0	0.0	1.0	7.7	13.9	17.4	8.7	3.4	0.05	0.0	5.6	2.0	1.4	2.0	11.2	21.2	26.5	21.2
May	0.0	0.00	0.0	0.0	0.0	0.0	0.0	5.8	9.3	11.6	5.8	6.1	0.09	0.0	0.0	0.0	6.1	2.2	5.6	12.3	15.4	12.3
Jun	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.09	0.0	0.0	0.0	6.1	2.2	0.0	3.4	4.3	3.4
Jul	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.11	0.0	0.0	0.0	7.5	2.6	0.0	4.2	5.3	4.2
Aug	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.06	4.1	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	9.6	0.20	9.6	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6	0.17	9.6	9.2	2.0	0.0	1.0	0.0	1.6	2.0	1.6
Total	48.0	1.00	38.0		10.0	0.0	13.0	13.5	42.3	52.9	26.5	68.3	1.00	24.8		22.1	21.2	21.9	16.8	61.9	77.4	61.9

(a) Moore et al, 1990, Present firm supply included in Vol. I "Fish and Wildlife Resources and Agricultural Drainage", Table 2-14.
(b) USBR, 1988, Table IV G-2 "Report on Refuge Water supply Investigations", Central Valley Hydrologic Basin, California.
(c) An average depth of water would be 1.0 feet and 0.5 feet per acre would be required to raise the water table to the land surface. Available water restricts the flooded area to 22,700 acres.
(d) Equals Col (2) minus Col (6) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(e) Wetland make-up water volume equals seepage and evaporation losses.
(f) Applied water volume generally equals the available water supply during the months of May thur August.
(g) Assumed releases from wetlands would be 67 and 33 percent in April and May, respectivily.
(h) Calculated as [Col. (8) + Col. (9)] x 1600 ppm (USBR wetland discharge data).
(i) Calculated as [Col. (8) + Col. (9)] x 2.0 ppm (USBR wetland discharge data).
(j) Calculated as [Col. (8) + Col. (9)] x 1 ppb (USBR wetland discharge data).
(k) Assumed an ave. depth of water of 1.0 feet and 0.5 ac-ft per ac would be required to raise the water table to the land surface. The flooded area equals 22,700 ac of improved habitat.
(l) Equals Col (13) minus col (17) times 0.67. One third of the wetland inflow will raise the water table to the land surface.
(m) Calculated as [Col. (19) + Col. (20)] x 1600 ppm (USBR wetland discharge data).
(n) Calculated as [Col. (19) + Col. (20)] x 2.0 ppm (USBR wetland discharge data).
(o) Calculated as [Col. (19) + Col. (20)] x 1 ppb (USBR wetland discharge data).

Table 6

GRASSLANDS WETLAND RETURN FLOW AND CONTAMINANT DISCHARGE
FUTURE WITHOUT PROPOSED ACTION
(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	SAN LUIS NWR (Table 1)				KESTERSON NWR (Table 2)				LOS BANOS WA (Table 3)				VOLTA WA (Table 4)			
Year/ Mon	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft
Oct	0.0	0	0.0	0.0	0.1	160	0.2	0.1	0.1	160	0.2	0.1	0.3	400	0.5	0.3
Nov	0.0	0	0.0	0.0	0.1	160	0.2	0.1	0.1	160	0.2	0.1	0.3	480	0.6	0.3
Dec	0.0	0	0.0	0.0	0.1	160	0.2	0.1	0.2	320	0.4	0.2	0.3	480	0.6	0.3
Jan	0.0	0	0.0	0.0	0.1	160	0.2	0.1	0.1	160	0.2	0.1	0.2	320	0.4	0.2
Feb	0.0	0	0.0	0.0	0.1	160	0.2	0.1	0.0	0	0.0	0.0	0.2	320	0.4	0.2
Mar	0.0	0	0.0	0.0	0.9	1,440	1.8	0.9	0.0	0	0.0	0.0	0.1	160	0.2	0.1
Apr	0.0	0	0.0	0.0	0.4	640	0.8	0.4	1.6	2,547	3.2	1.6	1.8	2,805	3.5	1.8
May	0.0	0	0.0	0.0	0.0	0	0.0	0.0	1.1	1,734	2.2	1.1	1.3	1,941	2.4	1.2
Jun	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.2	320	0.4	0.2	0.4	672	0.8	0.4
Jul	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.2	336	0.4	0.2
Aug	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0
Sep	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.2	320	0.4	0.2
Total	0.0	0	0.0	0.0	1.8	2,880	3.6	1.8	3.4	5,401	6.8	3.4	5.3	8,234	10.3	5.2

(a) Salinity load calculated as drainage volume times 1600 ppm TDS [assumed salinity of the wetland releases and seepage (USBR Offstream Storage Study data)].
(a) Boron load calculated as drainage volume times 2 ppm [assumed boron concentration of the wetland releases and seepage (USBR Offstream Storage Study data)].
(a) Selenium load calculated as drainage volume times 1 ppm [assumed selenium concentration of the wetland releases and seepage (USBR Offstream Storage Study data)].

Table 6 (Continued)

GRASSLANDS WETLAND RETURN FLOW AND CONTAMINANT DISCHARGE
FUTURE WITHOUT PROPOSED ACTION
(Acre-Feet in 1000s)

1	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	GRASSLANDS RCD (Table 5)				TOTAL				MUD SLOUGH DISCHARGE				SALT SLOUGH DISCHARGE			
Year/ Mon	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft
Oct	2.0	3,200	4.0	2.0	2.5	3,920	4.9	2.5	1.1	1,712	2.1	1.1	1.4	2,208	2.8	1.4
Nov	2.0	3,200	4.0	2.0	2.5	4,000	5.0	2.5	1.1	1,792	2.2	1.1	1.4	2,208	2.8	1.4
Dec	2.0	3,200	4.0	2.0	2.6	4,160	5.2	2.6	1.1	1,792	2.2	1.1	1.5	2,368	3.0	1.5
Jan	2.0	3,200	4.0	2.0	2.4	3,840	4.8	2.4	1.0	1,632	2.0	1.0	1.4	2,208	2.8	1.4
Feb	2.0	3,200	4.0	2.0	2.3	3,680	4.6	2.3	1.0	1,632	2.0	1.0	1.3	2,048	2.6	1.3
Mar	2.0	3,200	4.0	2.0	3.0	4,800	6.0	3.0	1.7	2,752	3.4	1.7	1.3	2,048	2.6	1.3
Apr	9.6	13,900	17.4	8.7	13.4	19,892	24.9	12.5	5.7	8,449	10.6	5.3	7.7	11,443	14.3	7.2
May	6.2	9,300	11.6	5.8	8.6	12,975	16.2	8.1	3.5	5,289	6.6	3.3	5.1	7,686	9.6	4.8
Jun	0.0	0	0.0	0.0	0.6	992	1.2	0.6	0.4	672	0.8	0.4	0.2	320	0.4	0.2
Jul	0.0	0	0.0	0.0	0.2	336	0.4	0.2	0.2	336	0.4	0.2	0.0	0	0.0	0.0
Aug	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0
Sep	0.0	0	0.0	0.0	0.2	320	0.4	0.2	0.2	320	0.4	0.2	0.0	0	0.0	0.0
Total	27.8	42,300	52.9	26.5	38.3	58,915	73.6	36.9	17.1	26,378	32.9	16.5	21.2	32,537	40.7	20.4

(d) Drainage discharge to Mud Slough at Hwy 140 equals Col(6) + Col(14) + 0.36 x Col(18).
(e) Salinity load - flow discharged to Mud Slough at Hwy 140 equals Col(7) + Col(15) + 0.36 x Col(19).
(f) Boron load - flow discharged to Mud Slough at Hwy 140 equals Col(8) + Col(16) + 0.36 x Col(20).
(g) Selenium load - flow discharged to Mud Slough at Hwy 140 equals Col(9) + Col(17) + 0.36 x Col(21).
(h) Drainage discharge to Salt Slough at Hwy 165 equals Col(2) + Col(10) + 0.64 x Col(18).
(i) Salinity load - flow discharged to Salt Slough at Hwy 165 equals Col(3) + Col(11) + 0.64 x Col(19).
(j) Boron load - flow discharged to Salt Slough at Hwy 165 equals Col(4) + Col(12) + 0.64 x Col(20).
(k) Selenium load - flow discharged to Salt Slough at Hwy 140 equals Col(5) + Col(13) + 0.64 x Col(21).

Table 7

GRASSLANDS WETLAND RETURN FLOW AND CONTAMINANT DISCHARGE
FUTURE WITH PROPOSED ACTION
(Acre-Feet in 1000s)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	SAN LUIS NWR (Table 1)				KESTERSON NWR (Table 2)				LOS BANOS WA (Table 3)				VOLTA WA (Table 4)			
Year/ Mon	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft
Oct	0.4	640	0.8	0.4	0.1	160	0.2	0.1	0.6	960	1.2	0.6	0.3	400	0.5	0.3
Nov	0.5	800	1.0	0.5	0.1	160	0.2	0.1	0.5	800	1.0	0.5	0.3	480	0.6	0.3
Dec	0.5	800	1.0	0.5	0.1	160	0.2	0.1	0.5	800	1.0	0.5	0.2	480	0.6	0.3
Jan	0.4	640	0.8	0.4	0.1	160	0.2	0.1	0.4	640	0.8	0.4	0.2	320	0.4	0.2
Feb	0.4	640	0.8	0.4	0.1	160	0.2	0.1	0.4	640	0.8	0.4	0.2	320	0.4	0.2
Mar	0.4	640	0.8	0.4	0.9	1,440	1.8	0.9	0.4	640	0.8	0.4	0.1	160	0.2	0.1
Apr	2.4	3,792	4.7	2.4	0.4	640	0.8	0.4	3.9	6,300	7.9	3.9	1.8	2,805	3.5	1.8
May	1.3	1,990	2.5	1.2	0.0	0	0.0	0.0	2.7	4,356	5.4	2.7	1.3	1,941	2.4	1.2
Jun	0.6	952	1.2	0.6	0.0	0	0.0	0.0	1.4	2,184	2.7	1.4	0.4	672	0.8	0.4
Jul	0.1	224	0.3	0.1	0.0	0	0.0	0.0	1.0	1,568	2.0	1.0	0.2	336	0.4	0.2
Aug	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0
Sep	0.3	480	0.6	0.3	0.0	0	0.0	0.0	0.3	480	0.6	0.3	0.2	320	0.4	0.2
Total	7.3	11,598	14.5	7.2	1.8	2,880	3.6	1.8	12.1	19,368	24.2	12.1	5.2	8,234	10.2	5.2

(a) Salinity load calculated as drainage volume times 1600 ppm TDS [assumed salinity of the wetland releases and seepage (USBR Offstream Storage Study data)].
(a) Boron load calculated as drainage volume times 2 ppm [assumed boron concentration of the wetland releases and seepage (USBR Offstream Storage Study data)].
(a) Selenium load calculated as drainage volume times 1 ppm [assumed selenium concentration of the wetland releases and seepage (USBR Offstream Storage Study data)].

Table 7 (Continued)

GRASSLANDS WETLAND RETURN FLOW AND CONTAMINANT DISCHARGE
FUTURE WITH PROPOSED ACTION
(Acre-Feet in 1000s)

1	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	GRASSLANDS RCD (Table 5)				TOTAL				MUD SLOUGH DISCHARGE				SALT SLOUGH DISCHARGE			
Year/ Mon	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) (a) ppm-Ac-Ft	Boron load (B x Vol) (b) ppm-Ac-Ft	Se load (Se x Vol) (c) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft	Drainage Volume Ac-Ft	Salinity load (TDS x Vol) ppm-Ac-Ft	Boron load (B x Vol) ppm-Ac-Ft	Se load (Se x Vol) ppb-Ac-Ft
Oct	2.0	3,200	4.0	3.2	3.4	5,360	6.7	4.6	1.1	1712	2.1	1.6	2.3	3,648	4.6	3.0
Nov	2.0	3,200	4.0	3.2	3.4	5,440	6.8	3.9	1.1	1792	2.2	1.6	2.3	3,648	4.6	3.0
Dec	2.0	3,200	4.0	3.2	3.3	5,440	6.8	3.9	1.0	1792	2.2	1.6	2.3	3,648	4.6	3.0
Jan	2.0	3,200	4.0	3.2	3.1	4,960	6.2	3.5	1.0	1632	2.0	1.5	2.1	3,328	4.2	2.8
Feb	2.0	3,200	4.0	3.2	3.1	4,960	6.2	3.5	1.0	1632	2.0	1.5	2.1	3,328	4.2	2.8
Mar	2.0	3,200	4.0	3.2	3.0	6,080	7.6	4.2	0.9	2752	3.4	2.2	2.1	3,328	4.2	2.8
Apr	13.2	21,164	26.5	21.2	22.2	34,701	43.4	24.0	7.5	11064	13.8	9.8	14.7	23,637	29.6	19.9
May	7.8	12,334	15.4	12.3	13.5	20,621	25.7	14.1	4.5	6381	7.9	5.6	9.0	14,240	17.8	11.8
Jun	2.2	3,442	4.3	3.4	4.6	7,250	9.0	5.2	1.2	1911	2.3	1.6	3.4	5,339	6.7	4.2
Jul	2.6	4,207	5.3	4.2	3.9	6,335	8.0	4.1	1.1	1851	2.3	1.7	2.8	4,484	5.7	3.8
Aug	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0
Sep	1.0	1,600	2.0	1.6	1.8	2,880	3.6	2.1	0.6	896	1.1	0.8	1.2	1,984	2.5	1.6
0.0	38.8	61,947	77.5	61.9	65.3	104,027	130.0	73.1	21.1	33,415	41.7	29.3	44.2	70,612	88.3	58.9

(d) Drainage discharge to Mud Slough at Hwy 140 equals Col(6) + Col(14) + 0.36 x Col(18).
(e) Salinity load - flow discharged to Mud Slough at Hwy 140 equals Col(7) + Col(15) + 0.36 x Col(19).
(f) Boron load - flow discharged to Mud Slough at Hwy 140 equals Col(8) + Col(16) + 0.36 x Col(20).
(g) Selenium load - flow discharged to Mud Slough at Hwy 140 equals Col(9) + Col(17) + 0.36 x Col(21).
(h) Drainage discharge to Salt Slough at Hwy 165 equals Col(2) + Col(10) + 0.64 x Col(18).
(i) Salinity load - flow discharged to Salt Slough at Hwy 165 equals Col(3) + Col(11) + 0.64 x Col(19).
(j) Boron load - flow discharged to Salt Slough at Hwy 165 equals Col(4) + Col(12) + 0.64 x Col(20).
(k) Selenium load - flow discharged to Salt Slough at Hwy 140 equals Col(5) + Col(13) + 0.64 x Col(21).

(c) Contaminated agricultural return flows are diverted to the San Luis Drain. Wetland water supply is supplemented with an additional 55,000 acre-ft of interim supply due to increased operational flexibility in the Grassland basin. Wetland drainage flows are identical to those in (a) and 80% of the surface return flows and operational spills are routed directly to the San Joaquin River via Salt Slough as in (b). - (Scenario 3).

3.5 Assumptions in wetland return flow analysis

Moore et al. (1990) describe the historical use of surface and subsurface return flows in the Grassland area. The annual volume of these return flows made available for wetland use was estimated by the SJVDP (SJVDP, 1990b) to be 55,000 acre-ft. Estimates of likely increases in wetland water supplies, the volume of wetland return flows and constituent loads in these return flows, resulting from the proposed action, are shown in Tables 1 - 5. The average water use for these wetlands was assumed to be 4.2 acre-ft / acre. Allowance was also made for seepage losses from these wetland areas. Seepage losses were assumed to account for up to 30% of the annual surface applied irrigation water.

The monthly supply was obtained, as previously noted, by multiplying the annual total available water supply by the monthly distribution percentage, as described for each wetland management area (USBR, 1988). This monthly distribution of water requirements varies from area to area because of differences in management objectives and in the mix of seasonal pasture, permanent pasture and agricultural crops in each refuge (Tables 1- 5 : column 3). The wetland flood - up period typically occurs between the months of September and November each year. To raise the water table to shooting depth, approximately one and one half feet of water were assumed necessary (Tables 1-5 : column 4). This would provide 0.5 feet of water to raise the water table to the land surface. This estimate is based on a water table at 5.0 ft and a specific yield of the shallow groundwater aquifer of 0.1 ft/ft.

In months when water supply is available for flooding wetland, make-up water is supplied to the wetland to keep the water table at shooting depth. Make-up water is generally the sum of evaporation losses and seepage losses throughout the hunting season and until April when the seasonal wetlands are de-watered. The amount of water available to flood wetland is the difference between the available supply and the required volume of make-up water. During the months of May through August the applied irrigation water is generally equal to the available monthly water supply as estimated by the USBR and the Fish and Wildlife Service (USBR, 1989). Seasonal wetlands and a portion of the permanent ponds are dewatered in anticipation of emergence of plants preferred by water fowl as a food supply. Releases from wetlands into the drainage channels within the Grassland area are assumed to be 67% and 33% of the total reservoir release in the months of April and May respectively.

Drainage releases from these ponds are calculated according to the following algebraic equation where :

$$REL_i = STOR_{i-1} - EVAP_i + AIW_i - SP_i - RO_i - STOR_i$$

Where : AIW_i - applied irrigation water in month i

$EVAP_i$	-	evaporation loss during the month i
REL_i	-	monthly wetland return flow in month i
RO_i	-	runoff in month i
SP_i	-	seepage losses in month i
$STOR_{i-1}$	-	previous month wetland storage month (i-1)
$STOR_i$	-	storage in month i
MUW_i	-	wetland make-up water in month i (equal to $EVAP_i + SP_i$)

In the case of the San Luis NWR, the refuge currently has no firm fresh water supply, hence the available water supply numbers in column 2 are shown equal to zero. Both the Volta WA and Kesterson NWR are limited in the firm water supply and were assumed to have access to surface drainage water of usable quality. Hence the available water supply to these refuges, with the project, is assumed to equal the firm water deliveries available under existing conditions.

3.6 Contaminants in wetland return flows

The load- flow factor, calculated in Tables 1- 5, is the product of (a) the volume of seepage, runoff and drainage releases from managed wetlands into channels within Grasslands and (b) the concentration of the chemical contaminants dissolved in these flows. The load-flow factor is a parameter used to compare mass loading of contaminants. This parameter is expressed in units of acre-ft - ppm (TDS and boron) or acre-ft - ppb (selenium) for ease of analysis (flow x contaminant concentration).

Direct evaporation from wetland channels and from the ponded wetlands do not affect the mass of contaminants in the Grasslands but can have a significant effect on contaminant concentrations at various points within the system. Even though evaporation losses are lower in the winter months (when water is ponded) than in the summer months (when the seasonal wetlands are drained) evaporative concentration of the salts and trace elements dissolved in the influent water supply takes place. During the summer months evaporative concentration and precipitation of salts in the near surface soils occurs as water is drawn to the soil surface through capillarity and strong matric gradients. Salts are also concentrated in the root zone due to evapo-transpiration losses from native vegetation, during the growing season. Some of the salts precipitated in surface soils are resolubilized during the flooding period. Data collected during an off-stream storage experiment conducted by the Boyle Engineering Corp. for the USBR (Boyle, 1987) shows effluent concentrations of approximately 1600 ppm for TDS, 2.6 ppm for boron and less than 1 ppb for selenium. These concentrations were assumed for the combined runoff, seepage and wetland reservoir releases during the flooding and irrigation seasons. It is likely that seepage into the network of shallow surface channels would contain high concentrations of salts and certain trace elements due to the high concentrations of these contaminants in the shallow groundwater. The mean TDS concentrations of these flows were estimated to be 3200 ppm.

3.7 Agricultural return flows and contaminant loads

Mass loadings of return flows from the wetland areas co-mingle with agricultural drainage return flows from the upslope water and drainage districts. The total mass loading of boron, selenium and TDS from each of the wetland areas is summarized for the without project scenario in Table 6 and for the with project scenario in Table 7. Monthly flow and concentration data of agricultural drainage discharged from several upslope water and drainage districts have been collected by Summer's Engineering Inc., the CRWQCB and local entities. The monitoring sites were chosen such that each site could be assumed to represent the flow and loading originating from certain water or drainage districts (Figure G-1, Appendix G)). The assignment of these monitoring sites to the districts is shown schematically in Figure 4 using the symbols FC5, PDD, PO1 and CH1. The flow and water quality monitoring data are grab samples, taken once or twice a month, and are used to represent the average contaminant level of drainage outflow from each entity for that month. There has been little analysis to check the validity of this sampling frequency to estimate monthly loads of TDS, boron and selenium to the San Joaquin River.

USGS water quality and flow monitoring sites on Mud and Salt Sloughs and the San Joaquin River were used to determine the impact of the proposed action. The Mud and Salt Slough monitoring sites located at Highways 140 and 165, respectively, generally correspond to the lower boundary of the wetland area and the San Joaquin River, near the Newman site, coincides with the Hills Ferry Basin Plan control station. Tables C1 through C11 in Appendix C include the mean monthly flow and water quality data for electrical conductivity, TDS, boron and selenium. Data in Appendix C : Tables C1 - C5 for the years 1986 - 1988 include USGS published monthly flow data and calculated mean monthly water quality data from unpublished USGS grab sample data. Tables C6 - C11 for the years 1989 and 1990 represents published USGS flow data and mean monthly water quality data calculated from the California Water Quality Control Board water quality grab sample data.

In the previous report (Swain and Quinn, 1991) monthly TDS concentrations were estimated using boron data and a regression equation. The regression equation was developed by the SJVDP from field data, collected during the period the Water Districts were freely discharging their drainage water through the Grassland area. In this report, actual TDS data was obtained from CRWQCB records and substituted for the estimates based on boron concentrations, except for the period October - December, 1986, for which no records were obtained and for which the boron-based estimates were retained. In most cases the measured TDS concentrations, used as monthly averages, were greater than those estimated from boron concentrations. As noted in Section1, the previous database, compiled by the Environmental Defence Fund (EDF) did not include the selenium and boron data collected by the CRWQCB. These data were compiled and a simple mean was taken of the mean concentration values from both data sets.

The monthly flow data for the period October 1985 - December 1989 is graphed in Figure 5. Monthly concentrations of boron and selenium for the same period are graphed in Figures 6 through 9. It should be noted that the monthly concentration values in these graphs are arranged according to calendar year - the spreadsheets, described in the next section , have the monthly sequence organized by water year (October 1 - September 30). The drainage flow, selenium and boron loading are recorded at each of four drains flowing into the Grassland area . The

CDD : Charleston Water District
FCWD : Firebaugh, CCID and Broadview Water Districts
PWD : Pacheco Water District
PDD : Panoche Drainage District

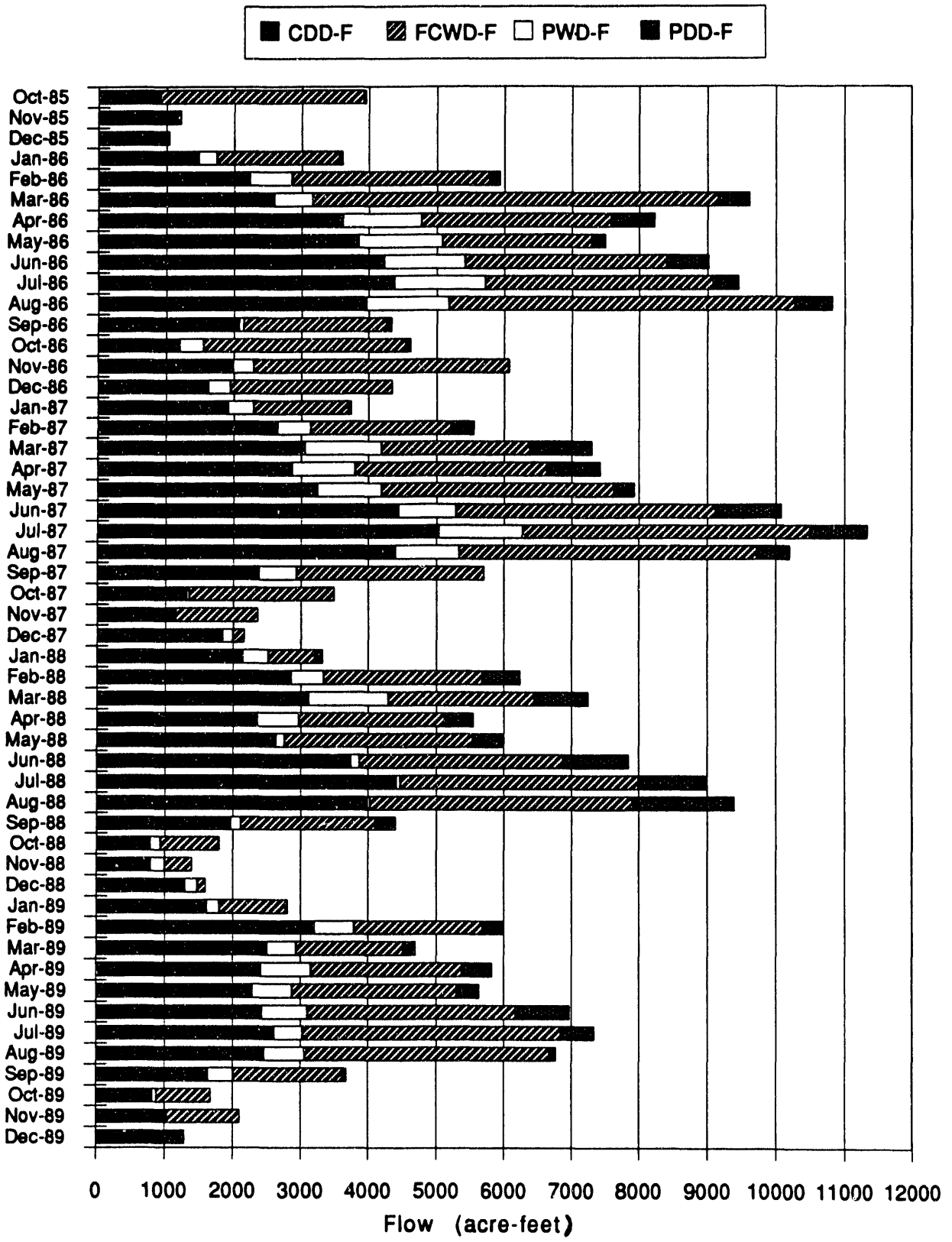
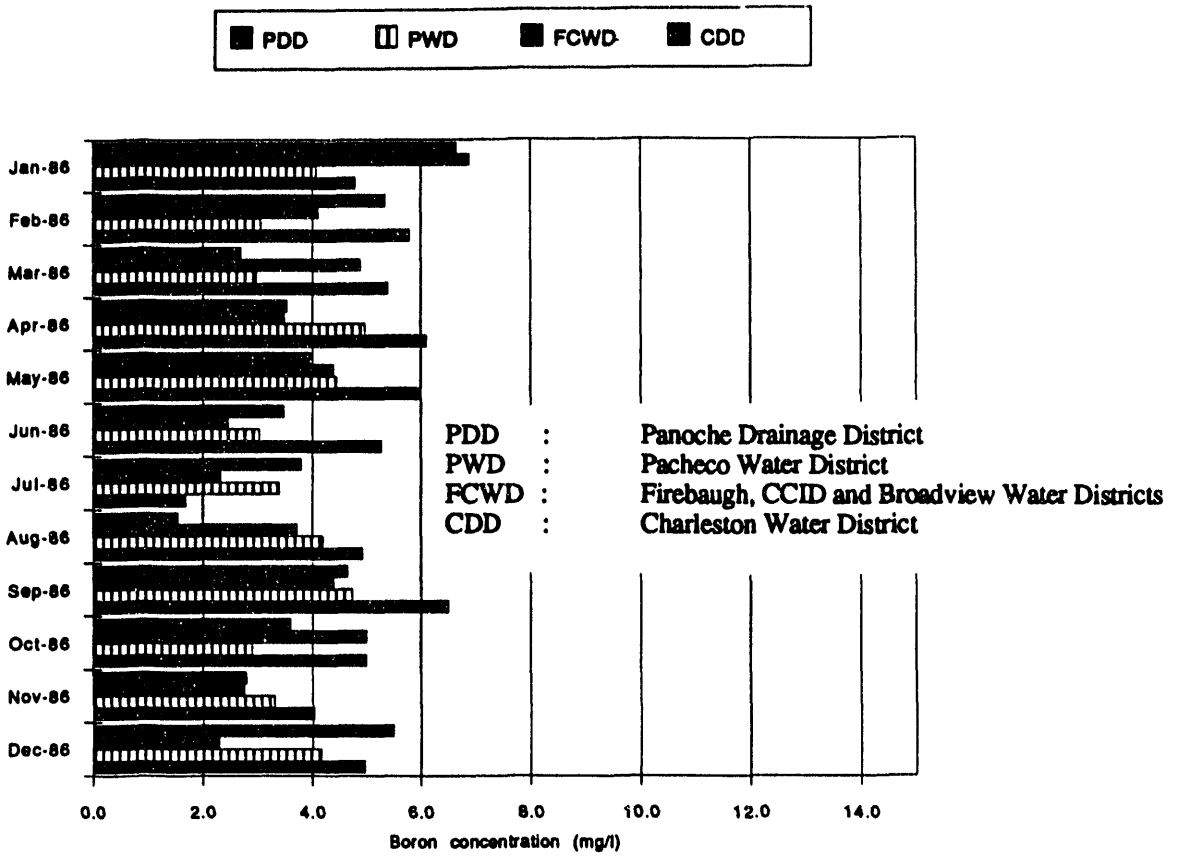


Figure 5. **Monthly drainage flows from agricultural and water districts measured at four monitoring sites in South Grasslands for the period 1985 - 1989.**



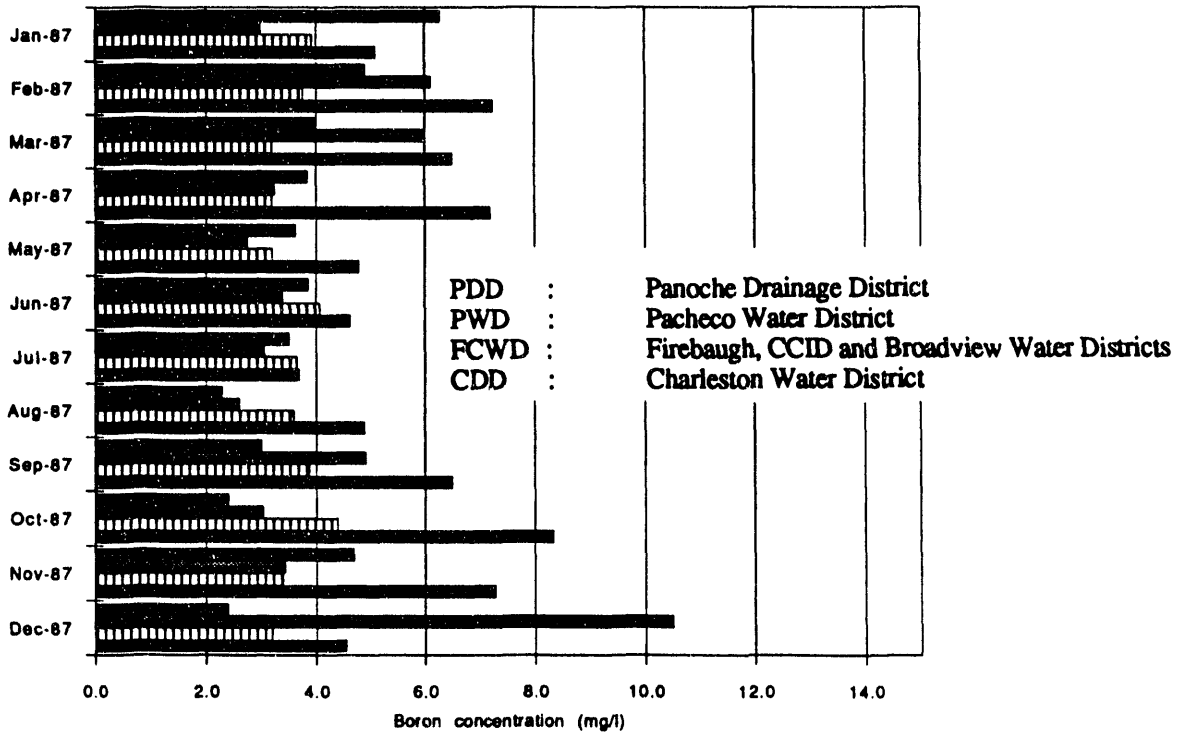
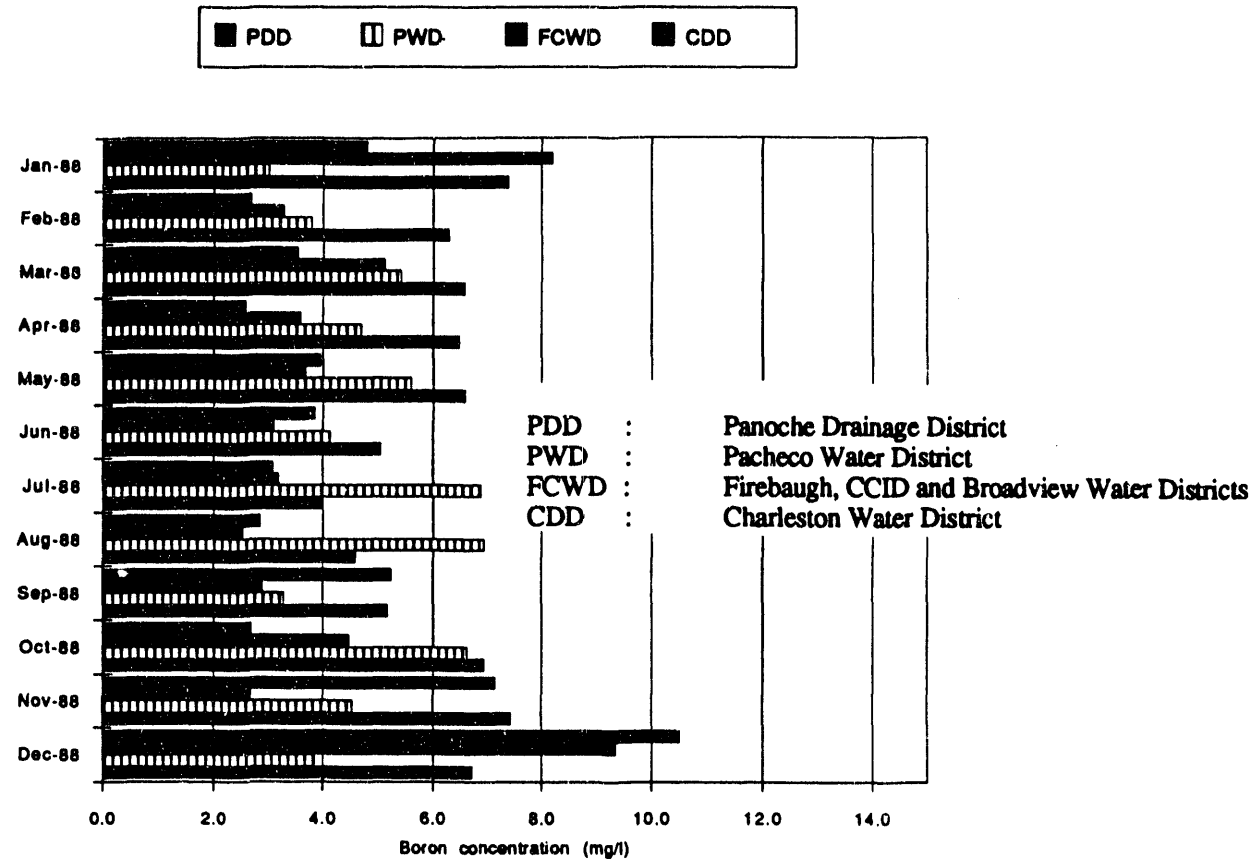


Figure 6. **Boron concentrations in monthly drainage flows from agricultural and water districts measured at four monitoring sites in South Grasslands for the period 1986 - 1987.**



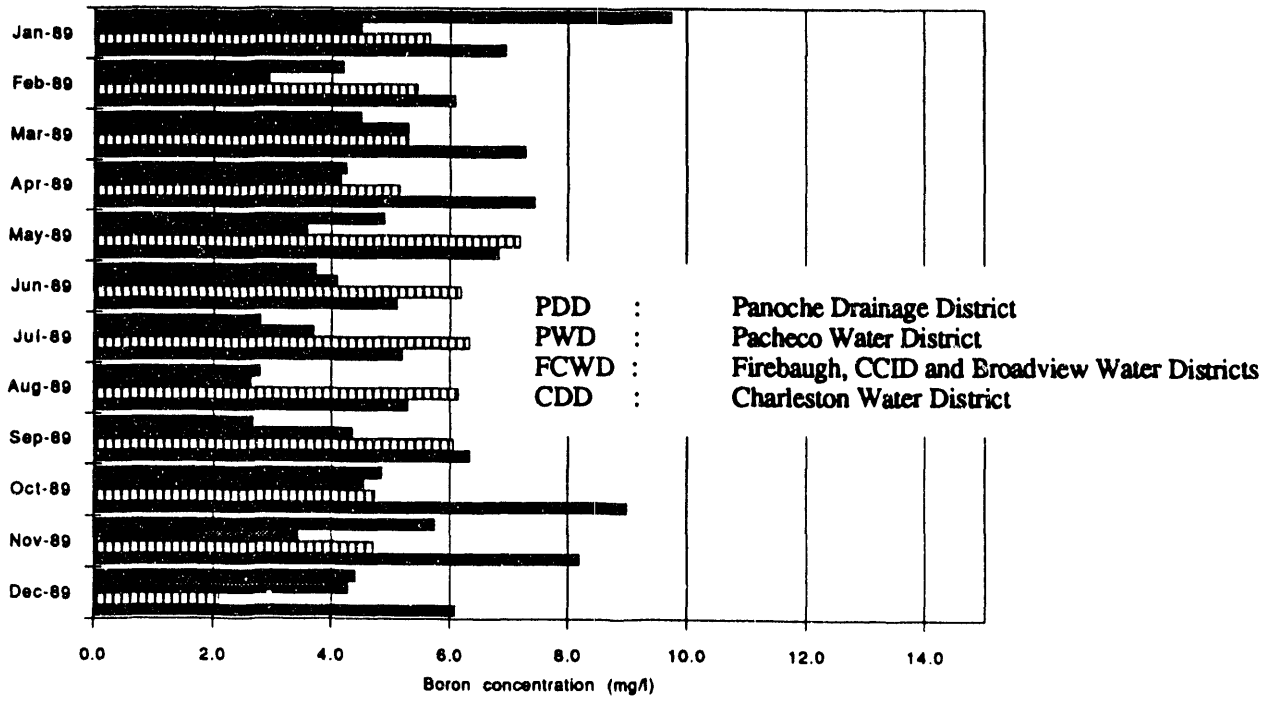
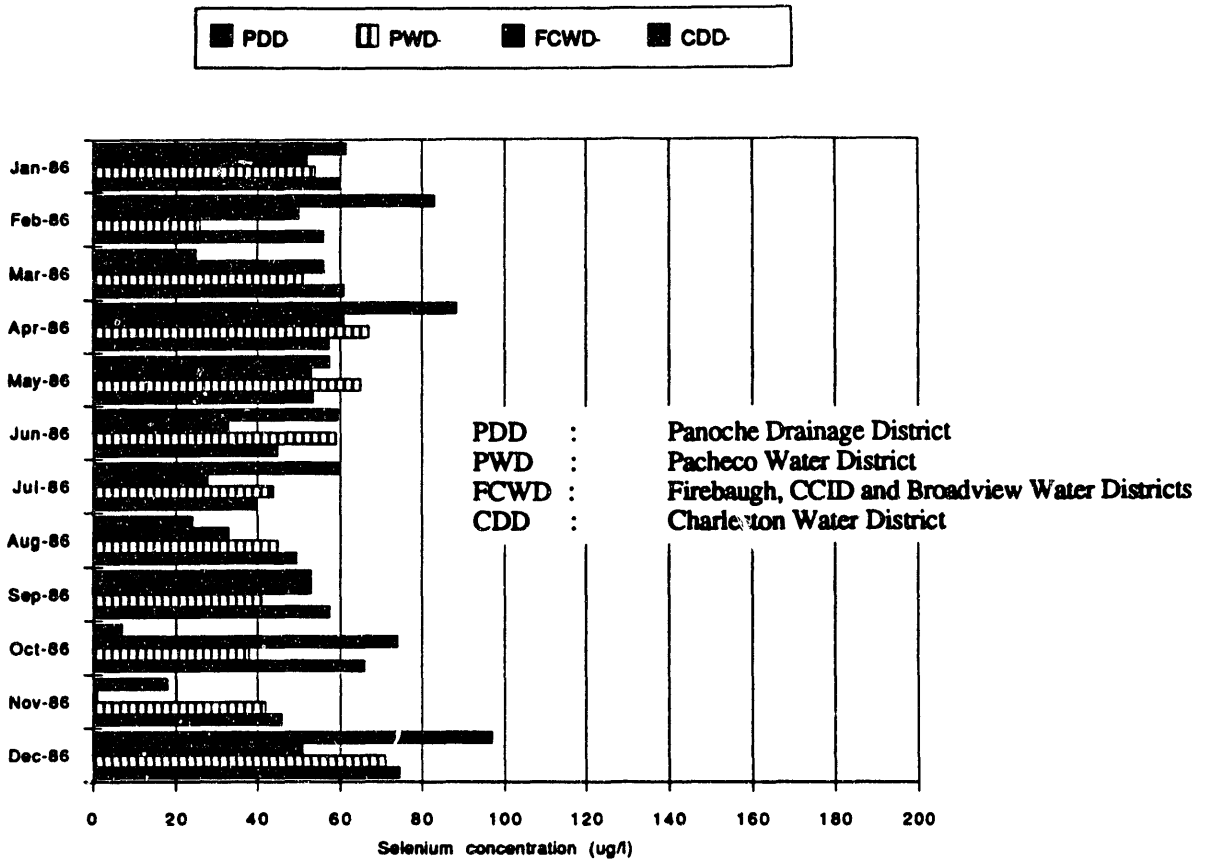


Figure 7. **Boron concentrations in monthly drainage flows from agricultural and water districts measured at four monitoring sites in South Grasslands for the period 1988 - 1989.**



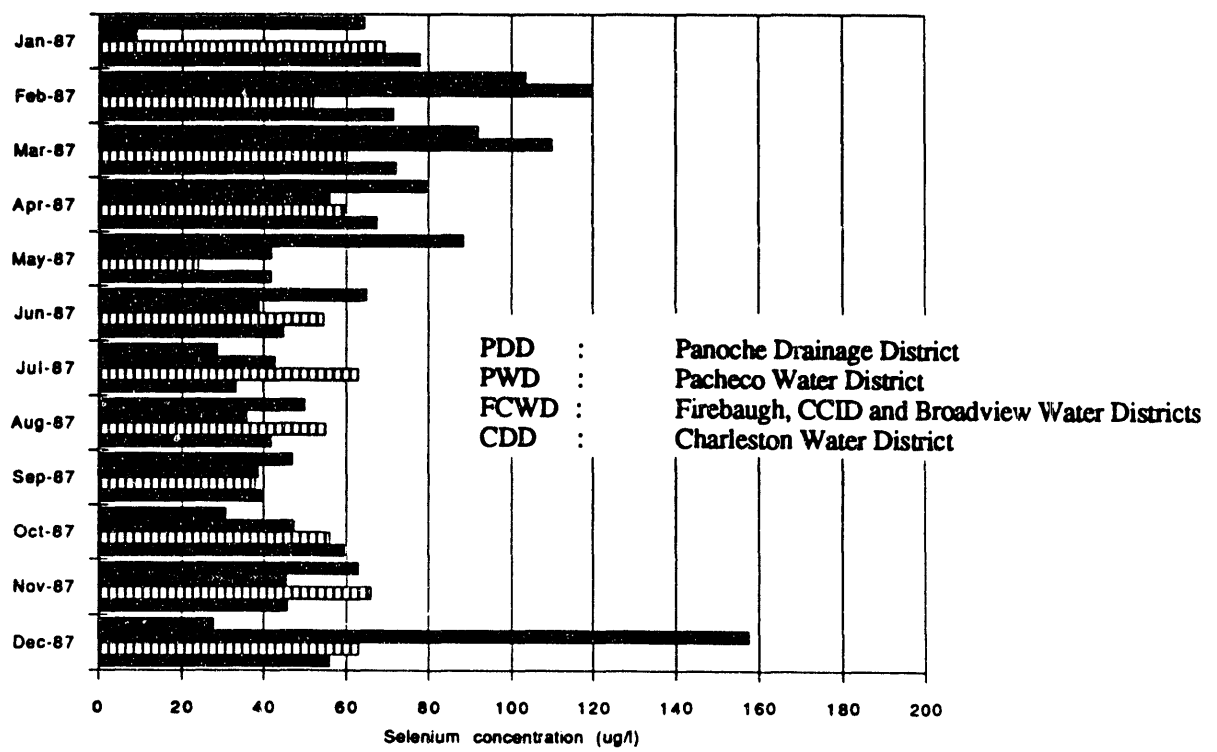
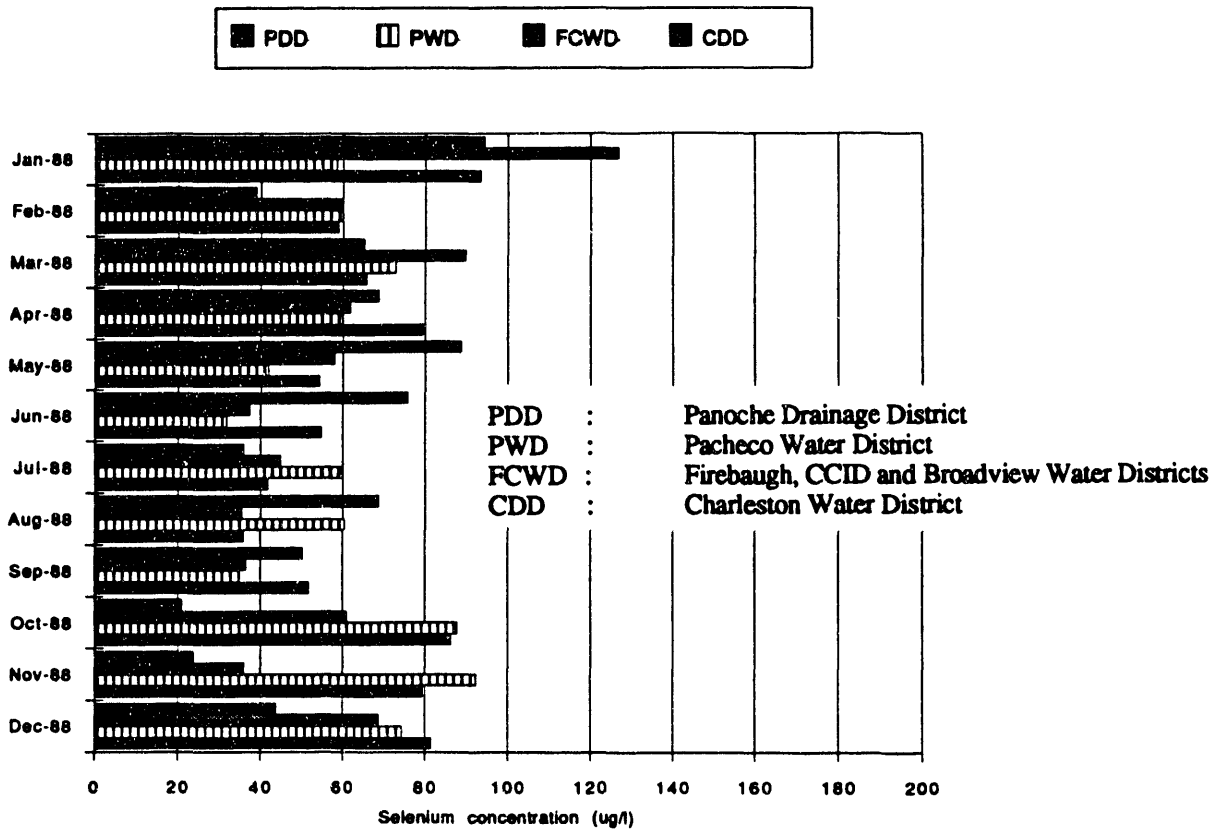


Figure 8. Selenium concentrations in monthly drainage flows from agricultural and water districts measured at four monitoring sites in South Grasslands for the period 1986 - 1987.



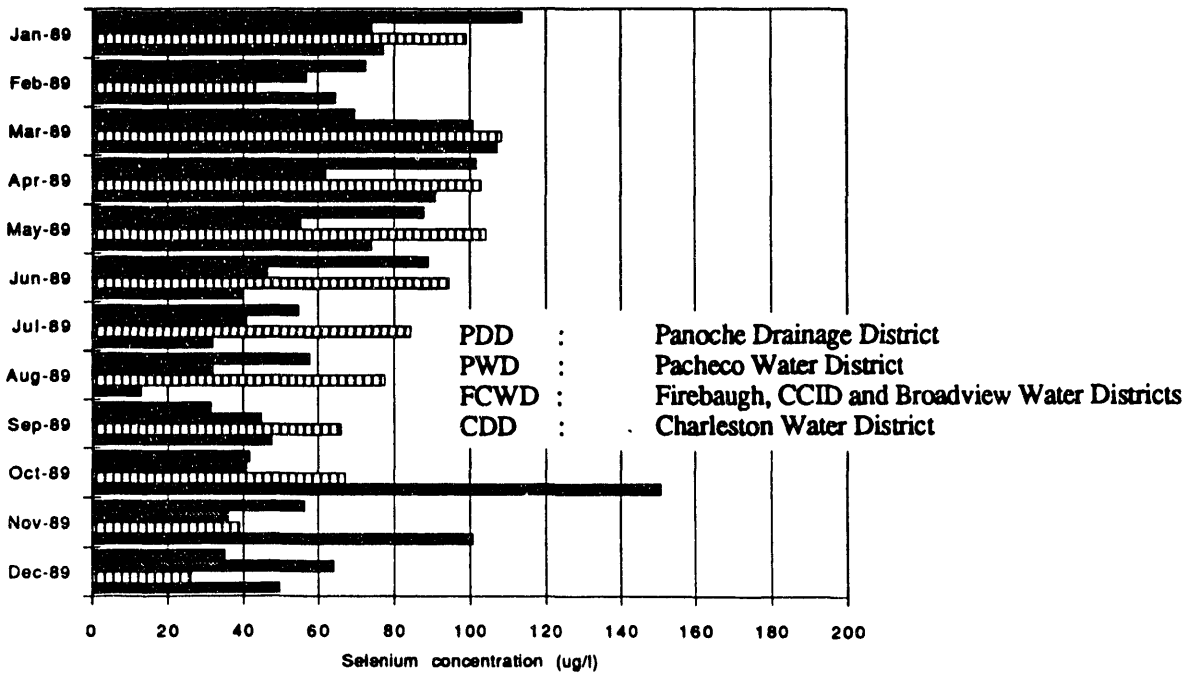


Figure 9. Selenium concentrations in monthly drainage flows from agricultural and water districts measured at four monitoring sites in South Grasslands for the period 1988 - 1989.

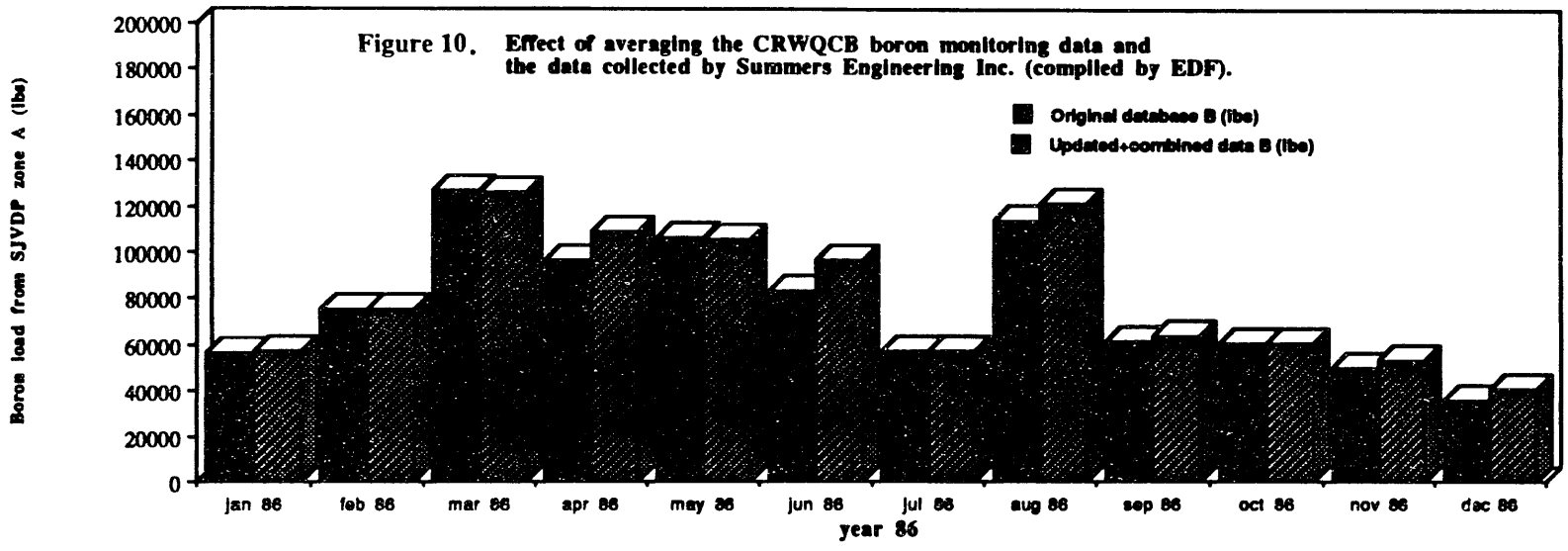


Figure 10. **Effect of averaging the CRWQCB boron monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).**

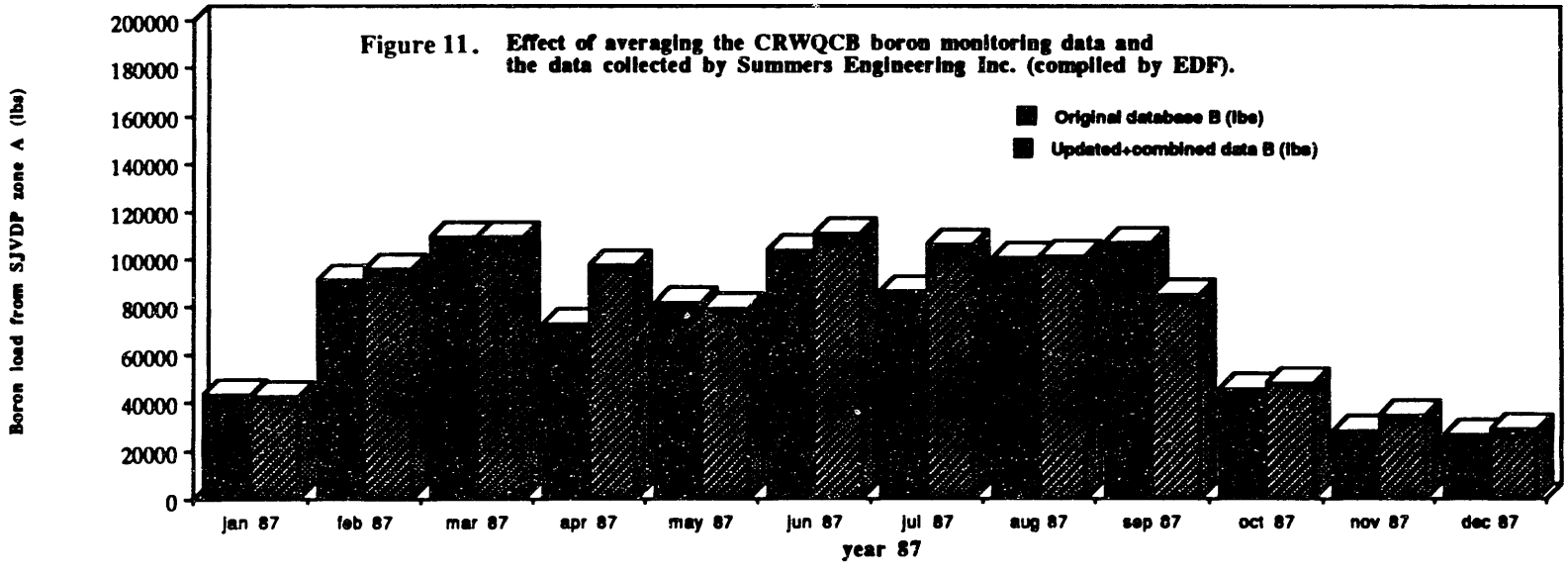


Figure 11. **Effect of averaging the CRWQCB boron monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).**

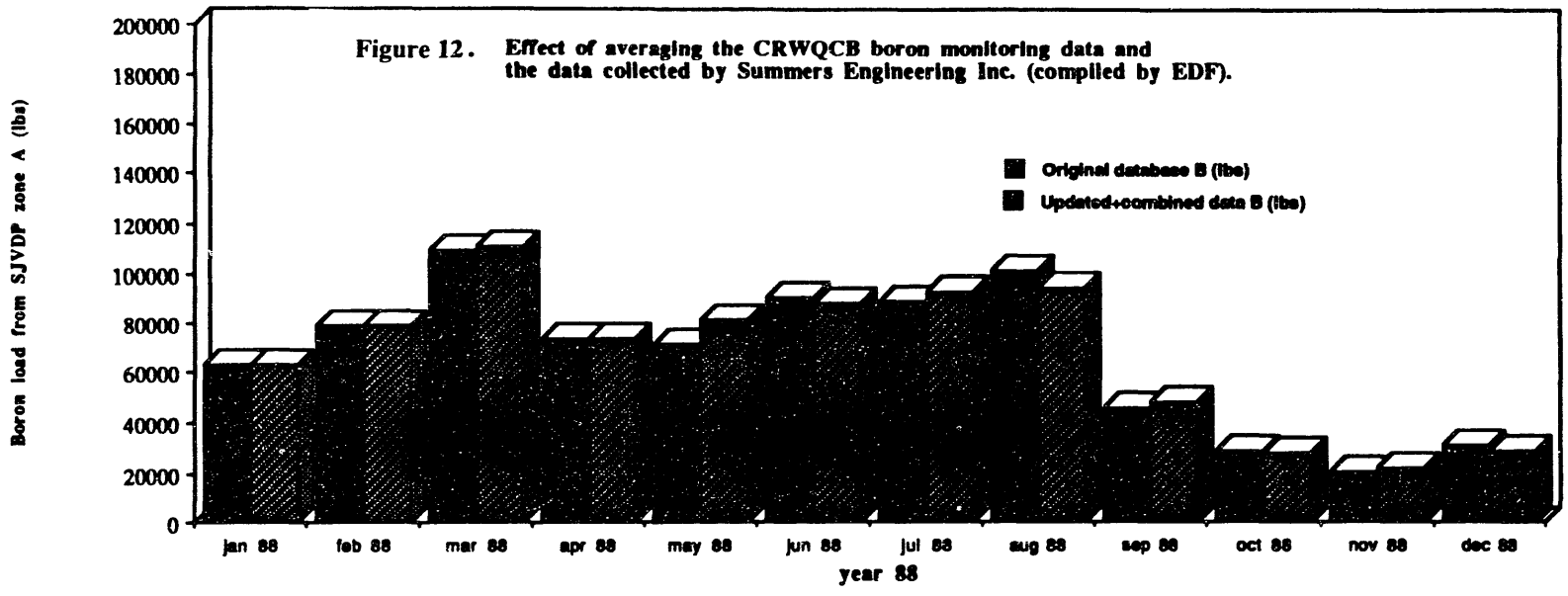


Figure 12. Effect of averaging the CRWQCB boron monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).

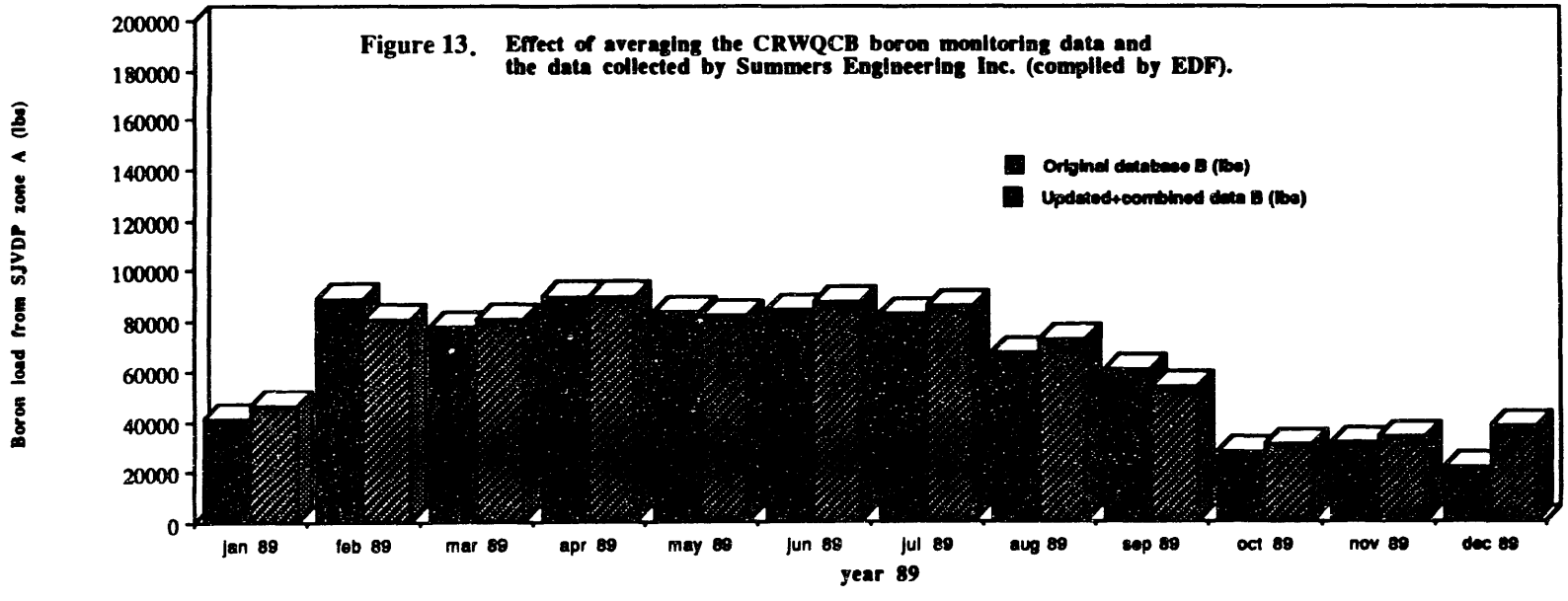


Figure 13. Effect of averaging the CRWQCB boron monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).

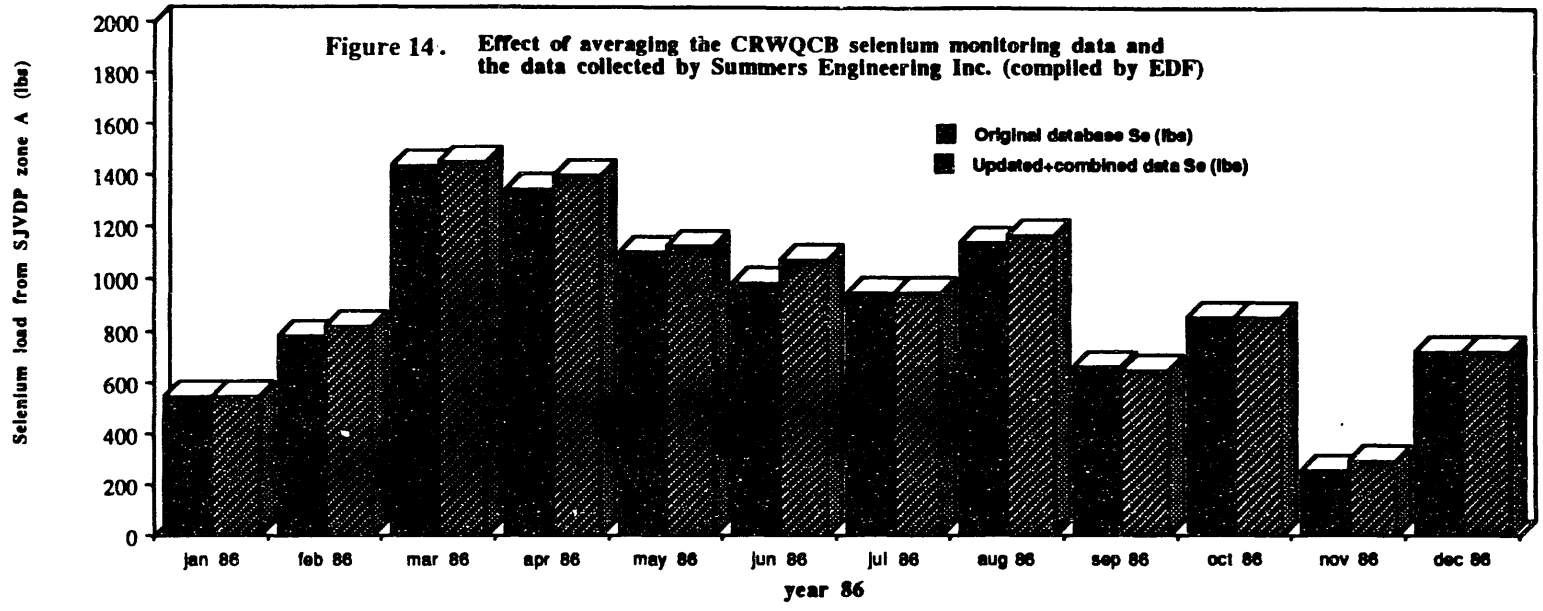


Figure 14. Effect of averaging the CRWQCB selenium monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF)

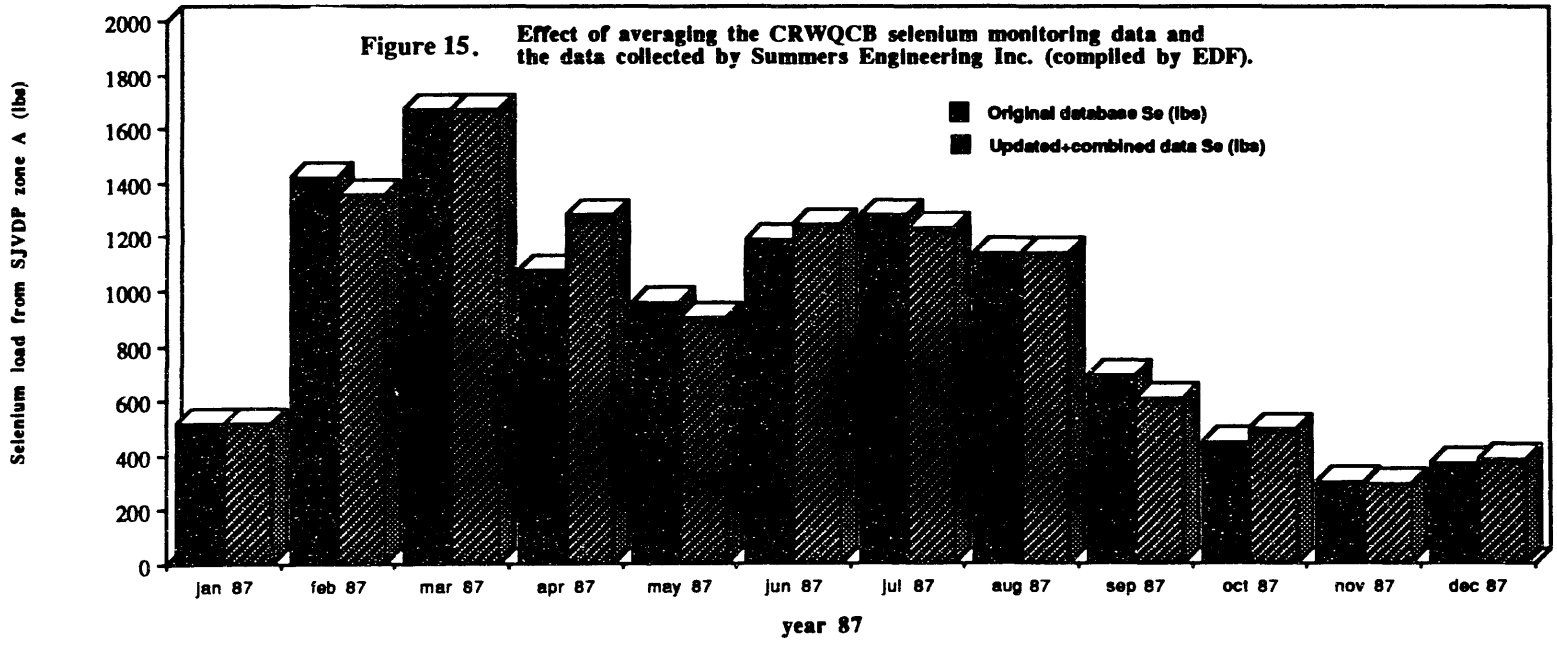


Figure 15. Effect of averaging the CRWQCB selenium monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).

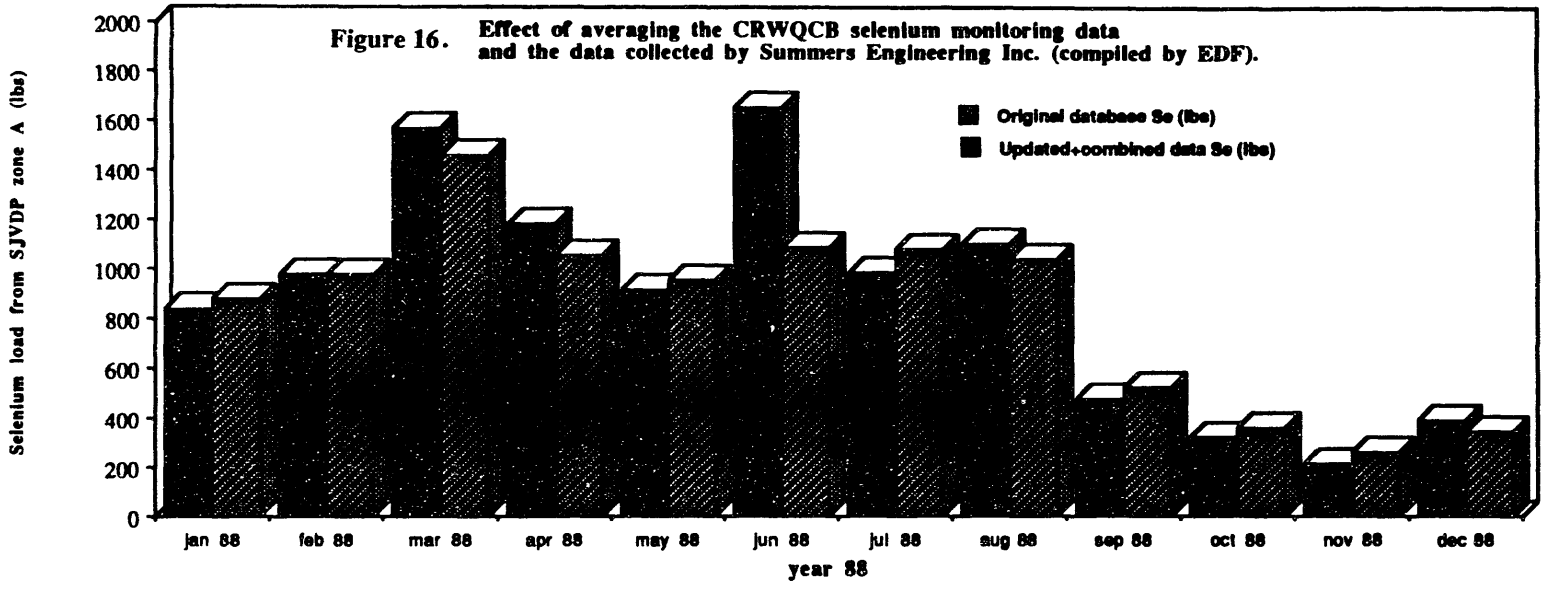


Figure 16. **Effect of averaging the CRWQCB selenium monitoring data and the data collected by Summers Engineering Inc. (compiled by EDF).**

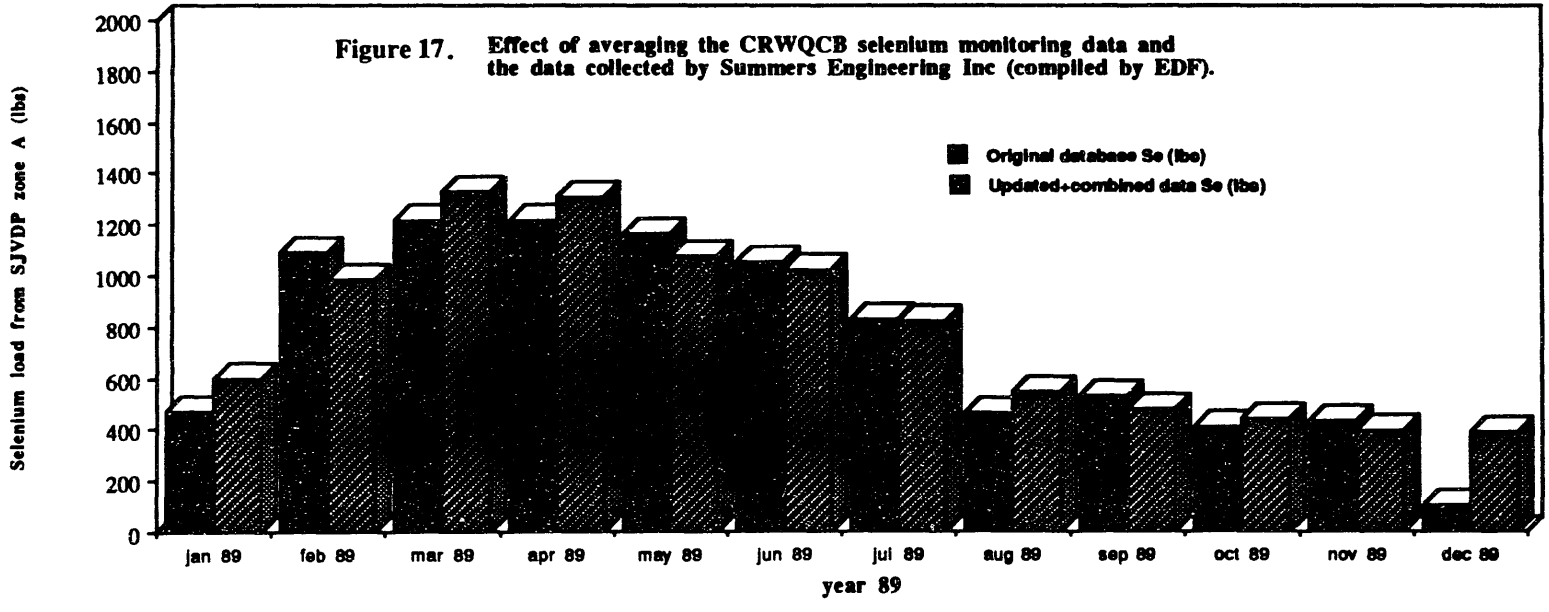
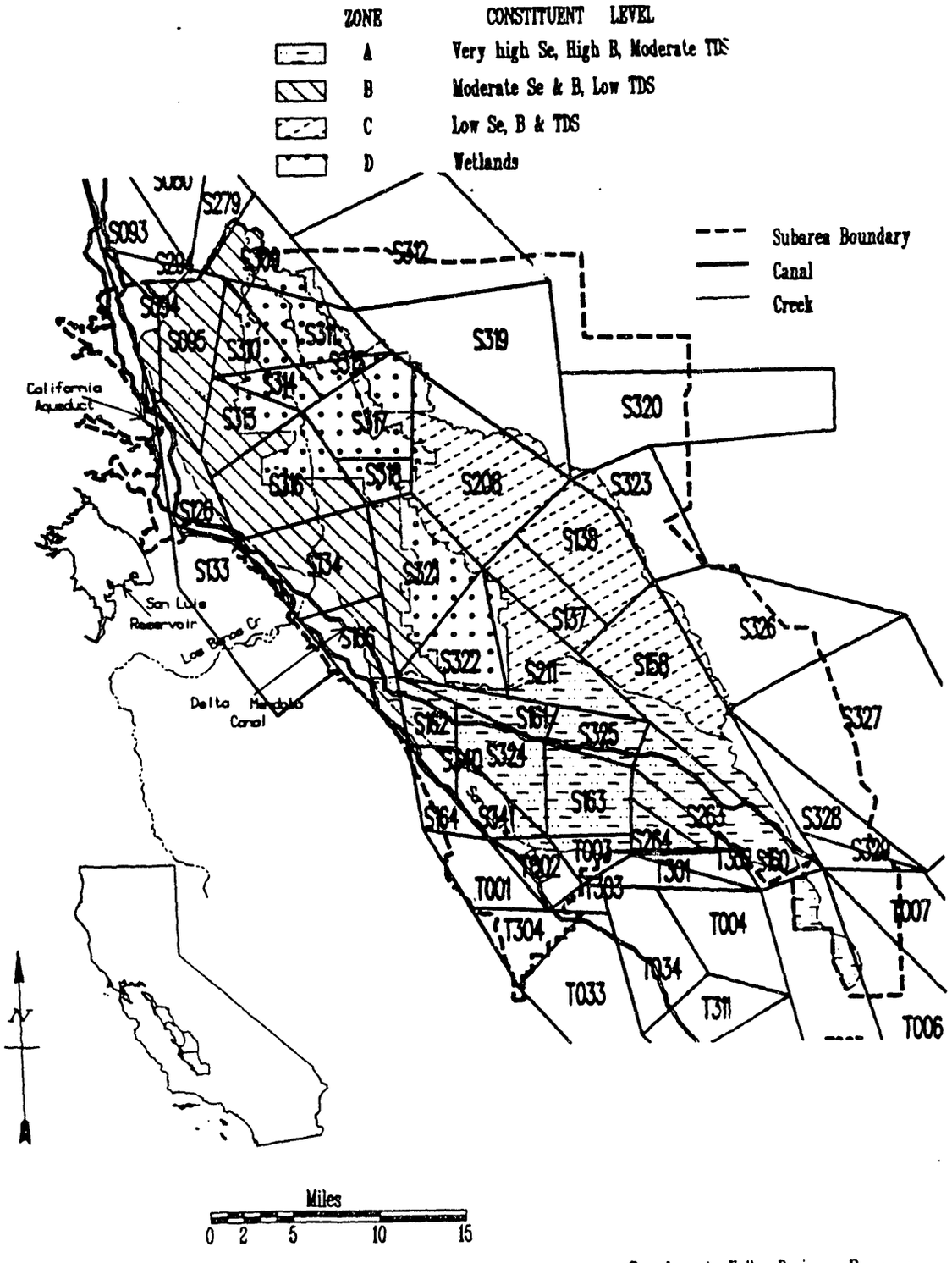


Figure 17. **Effect of averaging the CRWQCB selenium monitoring data and the data collected by Summers Engineering Inc (compiled by EDF).**

Figure 18. Shallow groundwater quality zones in Grassland area.



San Joaquin Valley Drainage Program

Table 8. **Input-output analysis of boron loading in the Grasslands area.**

(flow factors in 1,000's)

MONTH	Boron 1988 load-flow factors: drainage LOAD FLOW FACTOR (in) AFXppm	(salt slough) LOAD FLOW FACTOR (out) AFXppm	(mud slough) LOAD FLOW FACTOR (out) AFXppm	NET BORON LOAD FLOW FACTOR (out-in) AF-ppm	NET BORON LOAD (out-in) tons	Boron 1986 load-flow factors: drainage LOAD FLOW FACTOR (in) AFXppm	(salt slough) LOAD FLOW FACTOR (out) AFXppm	(mud slough) LOAD FLOW FACTOR (out) AFXppm	NET BORON LOAD FLOW FACTOR (out-in) AF-ppm	NET BORON LOAD (out-in) tons
Oct	17.7	13.8	1.6	-2.3	-3.1	17.9	12.1	3.4	2.4	3.3
Nov	12.6	25.7	5.7	18.8	25.6	6.9	11.7	6.5	11.3	15.4
Dec	10.8	20.0	5.0	14.3	19.4	8.2	12.3	20.4	24.5	33.3
Jan	23.2	34.4	12.2	23.4	31.8	21.1	20.1	21.0	20.0	27.2
Feb	29.1	51.1	10.6	32.5	44.2	27.7	56.7	20.9	49.9	67.9
Mar	40.9	46.9	21.3	27.4	37.3	46.3	41.6	28.8	24.1	32.8
Apr	27.1	44.9	6.9	24.7	33.6	39.9	47.3	46.6	54.0	73.4
May	30.1	31.6	10.9	12.4	16.9	39.0	21.8	33.5	16.3	22.2
Jun	32.6	32.1	14.3	13.9	18.9	35.4	10.6	27.7	2.9	3.9
Jul	34.3	46.8	4.1	16.6	22.6	21.2	21.1	18.8	18.7	25.4
Aug	34.8	35.0	1.7	1.9	2.5	44.5	28.1	13.9	-2.5	-3.4
Sep	17.8	26.1	1.0	9.3	12.7	23.5	13.7	1.4	-8.4	-11.4
	310.8	408.3	95.4	192.9	262.4	331.6	297.1	242.9	213.2	290.0

Table 9. **Input-output analysis of selenium loading in the Grasslands area.**

(flow factors in 1,000's)

	Selenium 1988 load-flow factors					Selenium 1986 load-flow factors				
MONTH	drainage LOAD FLOW FACTOR (in) AFXppb	(salt slough) LOAD FLOW FACTOR (out) AFXppb	(mud slough) LOAD FLOW FACTOR (out) AFXppb	NET SELENIUM LOAD FLOW FACTOR (out-in) AF-ppb	NET SELENIUM LOAD (LOSSES) (out-in) lbs	drainage LOAD FLOW FACTOR (in) AFXppb	(salt slough) LOAD FLOW FACTOR (out) AFXppb	(mud slough) LOAD FLOW FACTOR (out) AFXppb	NET SELENIUM LOAD FLOW FACTOR (out-in) AF-ppb	NET SELENIUM LOAD (LOSSES) (out-in) lbs
Oct	182.4	74.8	2.0	-105.6	-287.2	230.1	51.0	3.0	-176.1	-479.0
Nov	108.1	71.6	4.1	-32.4	-88.1	72.4	45.0	9.0	-18.4	-50.0
Dec	140.8	75.9	1.8	-63.1	-171.6	58.1	46.0	63.0	50.9	138.4
Jan	321.7	215.8	20.4	-85.5	-232.6	201.1	107.0	54.0	-40.1	-109.1
Feb	360.3	467.8	13.0	120.5	327.8	300.7	360.0	26.0	85.3	232.0
Mar	538.6	308.8	110.6	-119.2	-324.2	534.6	310.0	95.0	-129.6	-352.5
Apr	387.5	263.7	26.1	-97.7	-265.7	514.3	326.0	336.0	147.7	401.7
May	349.6	238.6	23.4	-87.6	-238.3	415.8	172.0	19.0	-224.8	-611.5
Jun	397.4	173.9	78.7	-144.8	-393.9	395.6	26.0	223.0	-146.6	-398.8
Jul	394.9	288.6	19.7	-86.6	-235.6	351.1	49.0	155.0	-147.1	-400.1
Aug	382.7	233.0	10.2	-139.5	-379.4	432.0	181.0	103.0	-148.0	-402.6
Sep	193.4	179.3	4.0	-10.1	-27.5	239.0	63.0	4.0	-172.0	-467.8
	3757.4	2591.8	314.0	-851.6	-2316.4	3744.8	1736.0	1090.0	-918.8	-2499.1

Table 10. **Input-output analysis of TDS loading in the Grasslands area.**

(flow factors in 1,000's)

MONTH	TDS 1988 load-flow factors					TDS 1986 load-flow factors				
	drainage LOAD FLOW FACTOR (in) AFXppm	(salt slough) LOAD FLOW FACTOR (out) AFXppm	(mud slough) LOAD FLOW FACTOR (out) AFXppm	NET TDS LOAD FLOW FACTOR (out-in) AFXppm	NET TDS LOAD (LOSSES) (out-in) lbs	drainage LOAD FLOW FACTOR (in) AFXppm	(salt slough) LOAD FLOW FACTOR (out) AFXppm	(mud slough) LOAD FLOW FACTOR (out) AFXppm	NET TDS LOAD FLOW FACTOR (out-in) AFXppm	NET TDS LOAD (LOSSES) (out-in) tons
Oct	8.1	11.9	1.5	5.3	7.2	14.1	9.1	2.7	-2.3	-3.1
Nov	6.2	17.2	4.5	15.5	21.1	5.0	9.8	4.9	9.7	13.2
Dec	5.5	13.9	3.9	12.3	16.7	5.6	9.6	12.6	16.6	22.6
Jan	12.4	20.9	8.5	17.0	23.1	12.3	13.1	14.1	14.9	20.3
Feb	16.6	30.2	7.9	21.5	29.2	20.1	33.9	9.4	23.2	31.6
Mar	21.0	33.3	12.9	25.2	34.3	30.7	26.1	16.2	11.6	15.8
Apr	15.9	26.4	4.7	15.2	20.7	26.1	28.0	24.7	26.6	36.2
May	16.3	21.6	8.0	13.3	18.1	23.7	15.6	35.5	27.4	37.3
Jun	18.6	20.4	7.1	8.9	12.1	23.5	9.7	13.1	-0.7	-1.0
Jul	19.2	26.8	2.4	10.0	13.6	24.3	16.3	9.5	1.5	2.0
Aug	20.3	24.5	0.9	5.1	6.9	26.7	18.8	3.9	-4.0	-5.4
Sep	9.3	17.9	0.6	9.2	12.5	13.1	12.4	0.8	0.1	0.1
	169.4	265.0	62.9	158.5	215.6	225.2	202.4	147.4	124.6	169.5

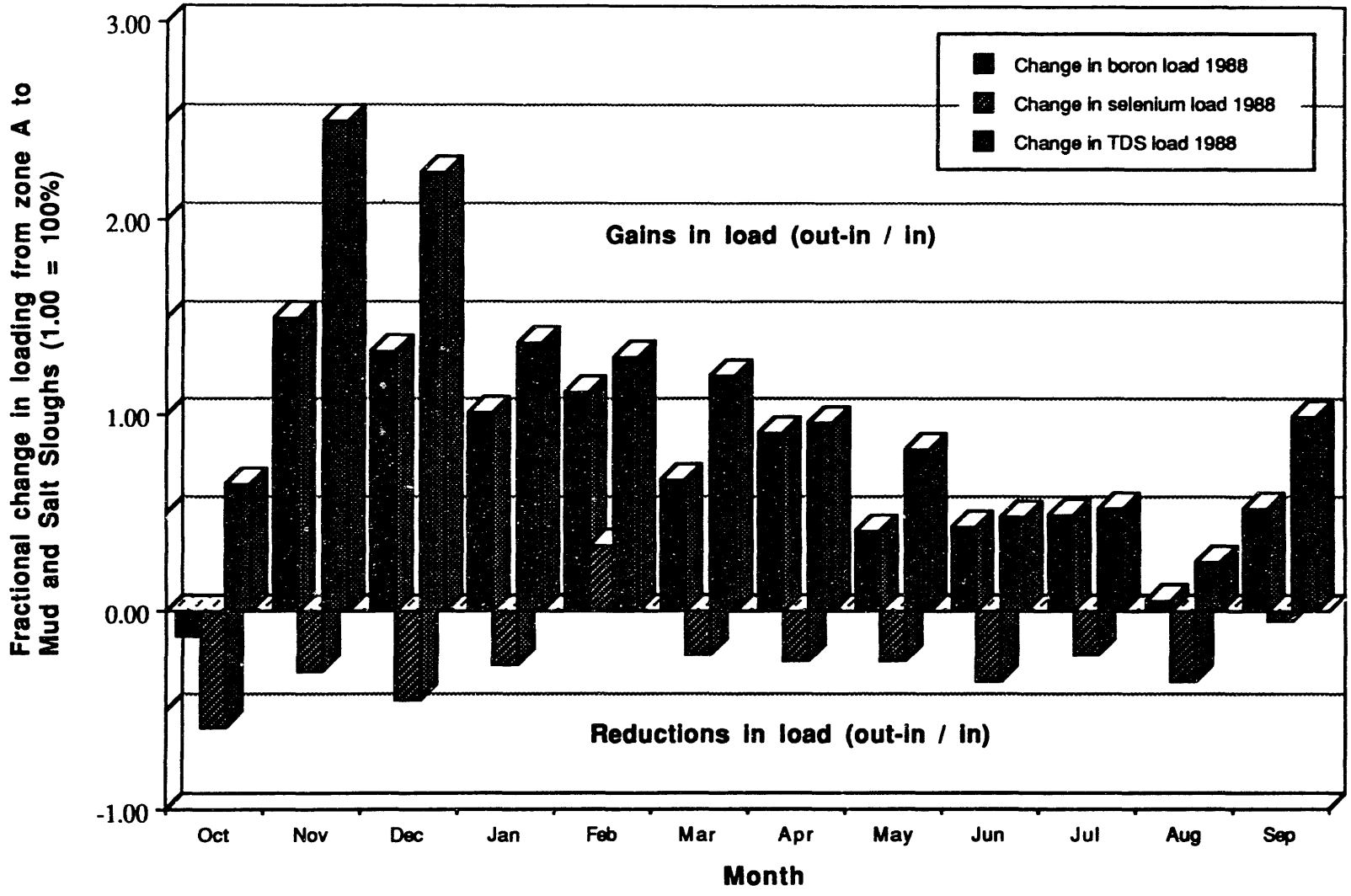


Figure 19 Input - output analysis showing the percent gain in boron and TDS load and the percent reduction in selenium load between the drainage monitoring sites and Mud and Salt Sloughs (1988 data)

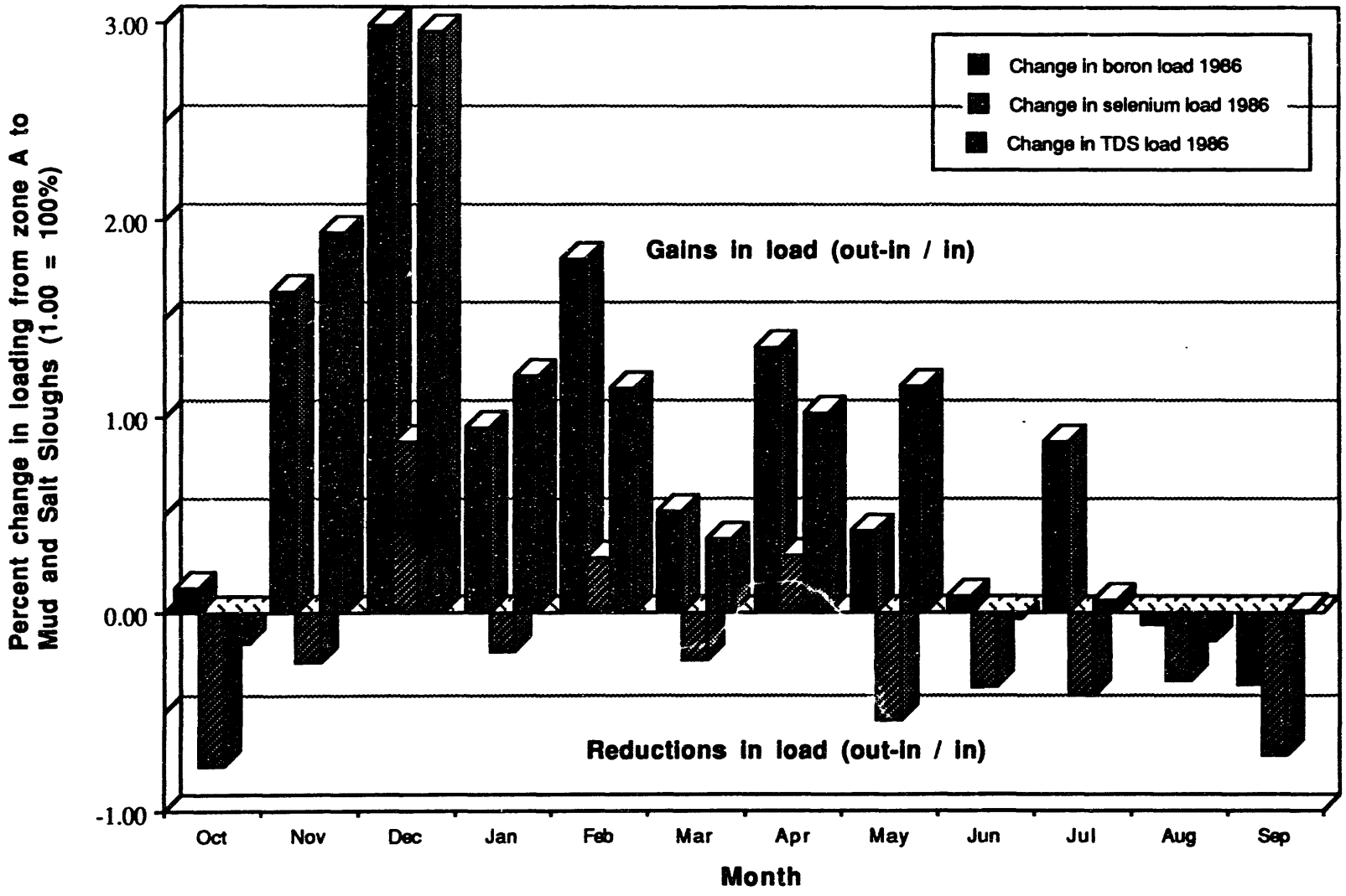


Figure 20 Input-output analysis showing the percent monthly gain in boron and TDS load and the monthly percent reduction in selenium load between the drainage monitoring sites and Mud and Salt Sloughs (1986 data)

four drains (CCD, FCWD, PWD and PDD) correspond to the the four drainage monitoring sites shown in Figure 4. Each histogram is labelled according to the relative contribution from each source. The total flow shown in Figure 5 is equal to the total agricultural drainage flow into the Grassland area.

Examination of Figure 5 reveals that monthly flows from the agricultural water and drainage districts (SJVDP water quality zone A) have decreased by as much as 20% between 1985 and 1989. Since contaminant concentrations in these flows have not changed to the same extent (Figure 6), with the exception of San Luis Water District (SLWD) and Central California Irrigation District (CCID), contaminant loads of TDS, selenium and boron passing into the Grassland area would appear to have decreased correspondingly. If analyzed by calendar year ; boron loads decreased from 514,132 lbs in 1987 to 432,904 lbs in 1989 (16% reduction); selenium loads decreased from 4,835 lbs in 1987 to 4253 lbs in 1989 (12% reduction) ; and TDS decreased from 113,891 tons in 1987 to 96230 tons in 1989 (16% reduction). This decrease in load may be attributed to increased subsurface drainage recycling and improvements in on-farm water management practices. The year 1988 is intermediate in boron, selenium and TDS drainage loads compared to years 1987 and 1989, which were also designated as critically dry .

To gauge the significance of enlarging the database by inclusion of the CRWCB data and the effect on the conclusions drawn in the March 1991 report (Swain and Quinn, 1991), the EDF and the combined EDF and CRWCB datasets are contrasted in Figures 10 - 17. These figures are for boron and selenium concentrations and cover the period 1986 - 1989. The differences in mean values are small and not very significant for the boron data . In the case of the selenium data there appears to be more variability in the data. This may be ascribed to differences in laboratory protocols responsible for analyzing the samples - and inherent difficulties in measurement of concentrations in the parts per billion range in the case of selenium. Major discrepancies in the data were only evident in 1988, where the mean of the two data sets reduced the June mean monthly concentration by approximately 30%.

3.8 Losses of boron, selenium and TDS in ponds and channels

Agricultural return flows pass though vegetated and earth-lined channels in their passage through the Grasslands area. Mass balance analyses of input loads and export loads from the Grassland area have revealed substantial selenium losses between the points of entry into the Grassland area and the USGS monitoring sites in Salt and Mud Sloughs and along the San Joaquin River (Figures 19 and 20 ; Table 9). In Figures 19 and 20 the combined mass loadings of boron, selenium and TDS at Mud and Salt Sloughs are subtracted from the combined agricultural drainage mass loading of these constituents, as measured at the four previously described monitoring sites. In this report the mass loadings at these import and export sites were chosen without including the estimated return flows and loads from SJVDP zones B and C (as was perfomed by Swain and Quinn, March, 1991) so as to utilize only measured data. SJVDP zones B and C include those areas which moderate and low levels of boron, selenium and TDS in the Grassland area and are delineated in Figure 18. The tables and graphs in Figures 19 and 20 show that both boron and TDS loads increase in transit through Grasslands, resulting from the co-mingling of surface and subsurface return flows from SJVDP zones B and C and wetland return flows from within Grasslands itself. This

increase in load also results in a decrease in boron and TDS concentrations, since the mixing flows contain lower concentrations of TDS and boron than the agricultural drainage discharge from SJVDP zone A (Figure 18).

Selenium loads , conversely, decrease in most months for both 1988 and 1986 water years. The observation that selenium loads do not increase can be explained by the low concentrations of selenium (typically less than 1ppb) in return flows from SJVDP zones B and C and the wetland return flows. Selenium losses may result from activity by a variety of biochemical mechanisms including uptake by vegetation, invertebrates, algae and other biota within the Grassland ecosystem. Volatilization may take place along channels and within earth-lined canals that support fungi and other microbes capable of reducing selenium into volatile organic compounds such as dimethylselenide. Selenium reduction to Se(IV), Se(0) and Se (- I I) in bottom sediments may also contribute to decreases in selenium load (Tokunaga, 1991, personal communication).

Although some boron uptake may occur in vegetation growing within and along the sides of channels both boron and TDS loads are expected to be largely conserved during passage through the Grassland area. In the scenarios examined in Section 4 of this report, surface return flows from SJVDP zones B and C are utilized by wetlands to supplement water supply and hence some reduction in boron and TDS load may occur due to precipitation of salts and deposition in the pond sediments. Mass balances of all three contaminants of concern will be examined in more detail in Section 4.

4. Analysis of Impacts

An analysis of project impacts must consider both the within and between season variations in contaminant loads and flows entering the Grassland area from the upslope drainage districts as well as the within and between season seepage flows, runoff and refuges and agricultural drainage discharges within the Grassland area. Return flows from CCID, SLCC and other drainers adjacent to the Grassland area (SJVDP zones B and C) are of sufficient quality for wetland use and are considered to be a water resource, which presently is used either to blend with and dilute agricultural drain flows before discharging into the San Joaquin River, or is used as a supplemental water supply for re-use in the wetlands themselves. With the proposed action, more of this water is likely to become available for other uses.

Return flows from wetlands, which include seepage, uncontrolled runoff and drainage releases are returned to the natural and man-made system of channels, ultimately reaching the San Joaquin River by way of Salt and Mud Sloughs. The geographic proximity of San Luis NWR and Los Banos WA to Salt Slough suggests that most of the return flows from these refuges discharge into Salt Slough. Likewise, Kesterson NWR and Volta WA are closest to Mud Slough (North) which is likely to receive the most of the return flows produced by these wildlife management areas. Grassland RCD, including the Grassland WD and the private duck clubs in southwest Grassland, is a large contiguous area and likely contributes to both Sloughs. To determine the distribution of flow and contaminant load from the privately operated wetland to each of the Sloughs, an area weighting procedure was used. The areas of permanent and seasonal wetlands (land uses 20 and 21 in Appendix A) were summed and the acreages within the Grassland subareas shown in Figure 5 were allocated as tributary either to Salt Slough or Mud Slough (see the following tabulation).

Salt Slough		
Subarea		Area (acres)
206	(50%)	1.5
207		1.5
209		1.7
201		6.3
200		2.6
215		5.3
216		0.9
218		3.1
219		3.0
220		2.2
221		1.1
222		0.8
TOTAL		**30.0**

Mud Slough		
Subarea		Area (acres)
203		3.8
204		1.5
205		8.1
206	(50%)	1.5
223		1.1
TOTAL		**16.0**

The ratio of wetland areas contributing to Salt and Mud Sloughs flows is approximately 2 : 1. Therefore the return flow volume discharged to Salt Slough is assumed to be approximately twice as large as that discharged to Mud Slough. Wetland return flows to these two sloughs with and without the proposed action are illustrated in Figure 20.

4.1 Scenario development

The analysis which follows considers the with project scenarios outlined in the previous section. The first and most likely scenario (**scenario 1**) is that wetland managers take advantage of the improved water quality in Salt Slough and divert surface return flows and water district operational spills to supplement the firm water supply delivered from the Federal CVP. This will reduce the average annual volume of flow along Salt Slough as well as change the monthly schedule of flow and mass loading of TDS, selenium and boron to the San Joaquin River. Releases from wetlands during the spring will generally be larger and contain higher salt loads. The analysis which follows (4.2) attempts to quantify the volume and mass loading of these discharges.

The second scenario (**scenario 2**) assumes that no diversions into the adjacent wetlands will occur. In this scenario the hydrologic analysis is comparatively simple since the major impact of the project would be to divert the existing agricultural drainage flows into the San Luis Drain and then to Mud Slough (North). In this scenario boron and TDS loads to the river will be largely unchanged and should closely match the monthly distribution of contaminant load from the water districts. The only impact will be on selenium, which is not expected to experience the same losses due to plant and microbial uptake in the Drain that occurred within the Grassland channels. A comparison is made of these scenarios in Section 4.3.

A third scenario, which is not part of the proposed project, is analyzed nevertheless. In this scenario (scenario 3) the amount of water that is diverted by wetlands and refuges in scenario 1 is supplied from other sources. The rationale for this scenario is both practical and political. In order to ensure that no Salt Slough diversions occur to wetlands, with implementation of the project, additional water , equivalent in volume and quality to the zone B and C drainage is assumed to be found. This supply could as easily be supplied from groundwater pumpage. The USBR has estimated safe yield within the Grassland area of greater than 55,000 acre-ft/year. Water quality considerations, however, may account for the small annual amount of groundwater pumped within the Grassland area. The surface return flows and operational spills from SJVDP designated zones B and C continue to be diverted mostly (80%) down Salt Slough. The wetland releases continue to be discharged down both Mud and Salt Sloughs in the ratio of approximately 1 : 2 (i.e. 33% into Mud Slough and 66% into Salt Slough) as in the other with-project scenarios. Hence, in this scenario, the total flow leaving Mud and Salt Sloughs is increased by a volume equal to the additional discharge from wetlands.

4.2 Development of the with-project scenarios

Tables 6 and 7 showed the return flow volumes and contaminant loads from each of the wetland management areas. The flow volumes were obtained by combining the volumes of seepage and runoff and the volume of reservoir release expected from each of the five refuges and wetland areas (Tables 1-5). The major differences between the without -project (Table 6) and the with-project scenarios (Table 7) are in the flow volumes assumed for San Luis NWR, Los Banos WA and Grassland RCD. The increase in the estimated return flows from each area is in direct proportion to the increased water supplies assumed to be available to these refuges resulting from the capability of separating usable return flows from contaminated agricultural return flows. Summing the volume of return flows for the with-project scenario, and subtracting these from the summed flow volumes for the without-project scenario, yields the total increased return flow volume from the wetlands of approximately 27,000 acre-ft. Additional inflow to these areas was approximately 55,000 acre-ft. Of these increased return flows it is assumed that approximately 23,000 acre-ft would be directed down Salt Slough and the remaining 4,000 acre-ft down Mud Slough.

To determine the effects of the proposed action on the loads of boron, selenium and TDS at Mud and Salt Sloughs, the refuge return flows are combined with agricultural drainage flows from the upslope water and drainage districts. These agricultural drainage flows are from two main sources as recognized in the SJVDP Final Report (SJVDP, 1990) and in the Technical Appendix to the SJVDP Final Report (Swain, 1991). SJVDP zones B and C (Figure 18) are sources of relatively good quality return flows and include agricultural drainage from parts of CCID and San Luis Canal Company. Zone A is the source of agricultural drainage, identified by the SJVDP as problem water, which derives from Firebaugh Water District (Canal Company), Broadview Water District, Panoche Water District, Pacheco Water District and San Luis Water District.

Tables B1 - B27 and C1 - C27 in Appendices B and C describe the effect of the combined flows (measured or estimated) on the concentrations of boron, selenium and TDS, with and without the proposed action for hydrologic years 1988 and 1986 . The with-project analysis contrasts scenarios 1, 2 and 3. The logic of the spreadsheet format

is discussed for one example, contrasting the without project and the with project cases (scenario 1) using Tables B1 and B2 in Appendix B (hydrologic year 1988). The same logic used to construct Tables B1 and B2 apply to all other tables in this report. The following assumptions apply to the construction of these tables:

(a) The USGS continuous flow recorded in Salt and Mud Sloughs can be used as a standard against which the hydrology upstream of these gauges can be calibrated.

(b) The USGS TDS, boron and selenium grab sample data are representative of average monthly concentrations and can be used to estimate mean monthly loads of constituents for 1986 and 1988.

(c) There are flows and contaminant loads unaccounted for in the mass balance analysis. These flows may be greater or lower than the annual figures calculated for each year of the 1986 and 1988 hydrology database used in the analysis. Adjustments were made to these flows, and to the loads of contaminants carried by these flows, in order to calibrate against the contaminant loads in Mud and Salt Sloughs for the existing or no-action condition. These adjustments can also be applied to the hydrology of the with project scenario.

(d) Adjustments should be made to flows first, given the greater reliability of the data.

(e) Grab samples taken by the CVRWQCB on the west bank of the San Joaquin River at Newman, tends to underestimate the effect of the Merced River. For this reason, the CVRWQCB water quality measurements at Crows Landing for TDS, boron and selenium taken during 1989 and 1990 were used to estimate the mean monthly load at Newman. For the years 1986 and 1988 which are the subject of this analysis the Newman data were used, complete CRWQCB data not having been available. (The San Joaquin River is assumed to be completely mixed at Crows Landing.) The flow measured at Newman is assumed to be similar that measured at Crow Landing, since both are downstream of the Merced River and there are no major tributary inflows or river accretions between these sites. An adjustment factor could be applied between these sites to correct contaminant concentrations for the small differences in flow, if the data were available.

4.3 Calibration of contaminant flows and loads (without project)

4.3.1 Contaminant flow and concentration data

Monthly flows and boron concentrations for the gauging station near Newman are shown in each of the water and contaminant budgets (Table B1: columns 2 and 3). The integrated flow weighted water sampling procedure used by the USGS from October 1985 through September 1988 was assumed to improve data reliability at the Newman site. Boron load, expressed as a boron load-flow factor, is determined by multiplying the figures in columns 2 and 3. This is equivalent to multiplying the monthly averaged flow and concentration data as described by the following equation :

$$\underline{C} = 1/t \int_0^m C(t)\, dt \qquad 1.$$

$$Q = \int_0^m Q^* \, dt \qquad 2.$$

$$L = \underline{C} \, Q \qquad 3.$$

Where :

$\underline{C}$	=	time averaged concentration
C	=	sampled concentration at time t
Q	=	monthly flow volume
Q^*	=	flow rate at time t
m	=	month index
dt	=	delta time (t expressed in days or weeks)
L	=	constituent load (expressed in load-flow units)

Tokunaga (Tetsu Tokunaga, LBL : personal communication, 1991) has questioned the validity of this procedure, in the case where C and/or Q^* vary with time. Unfortunately, flow and concentration data for constituents other than TDS, are not collected concurrently , as part of the current Grassland and San Joaquin River monitoring programs. Neither boron or selenium can be determined directly, except by chemical analysis in the laboratory. Regression relationships between TDS (or EC) and the trace elements selenium and boron, as previously noted, are not entirely reliable. The regression coefficient for the relationship between TDS and boron is typically higher than that for TDS and selenium. The time averaged concentration data was considered more accurate than the regression derived concentration data and was therefore utilized in this study.

The flows and estimated loads (load-flow factors), contributed by Salt and Mud Sloughs were subtracted from the flow and estimated boron load-flow factor near Newman(columns 11 and 12) to estimate the concentration of boron in river accretions between the Mud and Salt Slough monitoring stations and the San Joaquin River monitoring station near Newman. The calculated monthly value of boron concentration, obtained by dividing the boron load-flow factor by the flow, should be a positive number. However, most of the load-flow factors values are negative indicating a reduction in boron load somewhere between Salt and Mud Sloughs and the San Joaquin River monitoring station. If these monthly residuals are compared for water years 1986 through 1990, it appears that the error in the calculated mass balance is not systematic. The error does not appear to be consistent between months of different years or for a particular water year type (i.e wet or critically dry). It is possible that random error, associated with the water quality sampling procedure at Newman and in Mud and Salt Sloughs, is rather large and that the sample values are not good estimators of the monthly mean.

A calibration procedure was adopted to distribute the error in this load-flow factor by adjusting first the flows, then the contaminant load-flow factors in Mud and Salt Sloughs, so that the total of the flows and loads from each of the source areas balances with the flow and load measured at the Newman monitoring station. These source areas include the wetlands and refuges (columns 14 and 15), SJVDP agricultural drainage discharge zones B and C

(columns 16 and 17) and agricultural discharge zone A (columns 18 and 19), the source of most of the high boron, selenium and TDS.

The wetland return flows are all assumed to have a boron concentration of 1 ppm, a selenium concentration of 1ppb and a TDS concentration of 1600 ppm. The boron, selenium and TDS concentration assumptions are based on limited data, obtained during the USBR's offstream storage study, conducted in the Northern Grassland area, and from the USBR agricultural drainage monitoring data from SJVDP zones B and C (Appendix D), obtained during the period 1984 - 1987.

In columns 20 to 23 the flows and load-flow factor numbers are calculated from the wetland return flows and the agricultural drainage monitoring data from SJVDP water quality zones A, B and C, including that collected by Summers Engineering. In all years, and for most months the load-flow factors for the reconstructed data exceed the monitored data load-flow factors at the Salt and Mud Slough, USGS stream gauging sites. However, the calculated flows are less than those recorded by the USGS. The calculated values were adjusted by increasing or decreasing the accretion sufficiently to match the recorded value. This adjustment factor was assumed to be independent of the proposed action and was used to adjust the predicted flows both with and without the proposed action. In columns 24 -27, the flow discrepancy between the measured and the calculated values was determined for both Salt and Mud Sloughs and the contaminant concentration of these accretions assumed to be equal to the surface drainage water quality from the San Luis Canal Company which is : TDS - 1000 ppm; boron - 1.0 ppm; selenium - 1.0 ppb. In columns 28 -31 the reconstructed load-flow factors (boron load in wetland releases + boron load agricultural return flows from zones A, B and C) were added to the adjusted low boron load-flow estimates and from this sum was subtracted the load flow factors estimated from the records at Mud and Salt Sloughs. The calculated difference is the in-transit boron adjustment, which when added to the reconstructed Mud and Salt Slough load-flow factors produces the figure in column 33, the load flow factor for boron in the San Joaquin river. If the load flow factor in column 33 is divided by the recorded flow at Newman monitoring station, the monthly boron concentrations in column 2 are reproduced. These same adjustments are then applied to each of the with project scenarios.

The calibration procedure, that has just been described, was duplicated for both the without project and with project analyses for the 1986 and 1988 water year hydrologies and for the three contaminants. In evaluating the impact of the proposed project, the calibrated TDS, selenium and boron loading data were used as base conditions for the impact analysis.

4.3.2 Selenium uptake and effect of using San Luis Drain

The conclusions drawn from analysis of Figures 19 and 20 were that, whereas boron and TDS mass loads appeared to be largely conserved in transit through Grassland channels, selenium experienced a significant loss. Mechanisms responsible for the reduction in selenium mass loading between the drainage monitoring sites and the points of discharge into the San Joaquin River along Mud and Salt Sloughs may include the following :

(a) Uptake by vegetation in unlined canals.

(b) Direct volatilization of selenate and selenite from wetted soils.

(c) Uptake by algae and other biota and immobilization in channel sediments.

In Swain and Quinn (1991) the assumption made was that the selenium losses, which were calculated for the no-action condition, would be reduced by a certain percentage due to the diversion of highly contaminated drainage water from Salt and Mud Sloughs to the San Luis Drain. This percentage reduction was correlated with the residence time that the drainage contaminants had to interact with vegetation and biota. This reduction was assumed to correlate directly with the length of earth lined channel through which the drainage would pass - since the length of earth lined channel is reduced with the use of the San Luis Drain, the selenium uptake would likely decrease. To obtain an estimate of the percentage change in residence time, the reduction in the length of vegetated channel was measured and used as a weighting factor. This weighting factor was applied to correct for selenium accumulation in vegetation and biota that would no longer take place with the proposed action. This simple weighting factor was used as a first approximation and is not based on field concentration data or from a detailed knowledge of channel cross - sections or velocities. More intensive study of selenium transformations within the Grassland basin will be necessary to address this deficiency.

In Tables B9, B11 and B13 the effect of the project on selenium loading in Salt and Mud Sloughs is calculated in columns 28 - 31. Column 29 contains the selenium load in-transit adjustment adjusted for the assumed reduction in selenium losses and/or uptake due to diverting the drain flows from the Grassland channels into the San Luis Drain. By adjusting the in-transit adjustment load factor downward - the net effect is an increase in net selenium load compared to the without project scenario. The reduction in selenium losses and/or uptake within the Grassland distribution system was calculated to be 49% in the report by Swain and Quinn (1991) since conveyance along the San Luis Drain was assumed to reduce the vegetated channel residence time by 49%. Selenium losses were assumed to be primarily due to uptake by vegetation growing in the channels. Hence the selenium load increase due to the proposed action was estimated in Table B9, B11, B13 and B15 as 49% of the selenium load adjustment necessary to reconstruct the San Joaquin River selenium concentrations (Table B8).

During a field trip organized by the Grassland Water District, after the completion of the report by Swain and Quinn (March, 1991), it was observed that water flowing along the Camp 13 and Agatha Canals did not contact aquatic and terrestrial vegetation to the extent initially assumed. During this tour it was also learned that channels were cleared and sediments were removed from the channels every 2 - 3 years as part of routine maintenance by the Grassland Water District (Don Marchioci; personal communication, 1991). Although no data exists to verify selenium uptake or removal mechanisms, it may more reasonable to assume that the majority of the selenium loss may be through uptake by algae and phytoplankton than by vegetal uptake (Alex Horne, U.C. Berkeley : personal communication, 1991). Selenium taken up in this fashion would likely eventually end up in channel sediments, where it could become immobilized in the reducing environment of the detrital layer. Deposition and immobilization of selenium could occur equally in the San Luis Drain as in Grassland channels. The intial estimate of selenium in-transit loss adjustment of 51% was decreased to

10% - resulting in a smaller net increase in selenium load entering Mud Slough as a result of the project, compared to the without project scenario. The 10% in transit loss adjustment assumption of 10% may be conservative if algal uptake, deposition and immobilization are the primary mechansims for selenium losses from the Grassland system. However, because this assumption has no scientific basis, a range of in-transit selenium reduction (uptake) assumptions were made - 0%, 10%, 20% and 51%. The spreadsheet analysis performed for scenario 1 is made using each of these four assumptions. Scenarios 2 and 3 were analyzed using only the 10% uptake assumption.

The importance of this assumption of selenium uptake mechanism will be evident in the analysis that follows. Field research to verify this assumption should be undertaken as a matter of some urgency.

4.3.3 Projected mass loading of boron, selenium and TDS

After calibrating flows in both Salt and Mud Sloughs to match measured data, a separate mass balance analysis was performed to estimate the effect of the project on concentrations of the contaminants in Mud Slough, Salt Slough and in the San Joaquin River.

The effect of the proposed project on selenium flows and loads at Salt Slough, Mud Slough and the San Joaquin River near Newman are presented in Columns 35 - 43. In each case, since the majority of the agricultural drainage flows containing high loads of contaminants are routed and discharged into Mud Slough (north), above the monitoring site at Highway 140, the contaminant concentrations increase within Mud Slough (north) and decrease along Salt Slough. The volume of flow within Salt Slough is significantly depleted by virtue of the redirection of contaminated drainage and the increased diversions from the Slough of good quality drainage return flows to adjacent wetlands. The general effect of the proposed action is described in Figures 21 through 26 for contaminants boron, selenium and TDS and for the years 1988 and 1986. In the graphs which follow the 1988 results (crtitically dry year) are presented before 1986 results (wet year) to remain consistent with the previous report by Swain and Quinn (1991). The three graphs on each page, labelled (a), (b) and (c), describe the effects on Salt Slough, Mud Slough and the San Joaquin River at Newman respectively. In order to make the graphs easy to interpret, only **scenario 1** (with increased use of Salt Slough flows by wetlands - **S1**) and **scenario 2** (without increased use of Salt Slough flows by wetlands - **S2**) were compared with the without project scenario.

4.4 Effect of proposed project on boron concentrations

4.4.1 1988 data

The effect of the proposed project on monthly boron concentrations is similar to the effect of the project on TDS. This is expected, since both boron and TDS appear to be conserved in transit through the Grassland area. In 1988, boron concentrations are most elevated above the without project scenario concentrations in Mud Slough for the months of November through April (Figure 22), and may be close to 100% higher in the months of December, January and February for both Scenarios 1 and 2. Conversely, in Salt Slough, boron loads are reduced throughout the year with the greatest improvement occurring in January and February when most of the high boron loads are being diverted to Mud Slough. There does not appear to be much difference in boron concentrations between

scenarios 1 and 2 (with and without wetland use of Salt Slough flows, respectively), although in every month, wetland diversions cause slightly higher concentrations of boron in both sloughs. Wetland releases during April and May do not add significantly to the total boron load - hence concentrations change very little.

Boron concentrations in the San Joaquin River at Newman are elevated only slightly, in Scenario 1, over the without project scenario. As expected, since Scenario 2 involves only re-routing of agricultural drainage flows along Salt and Mud Sloughs, there is little discernable difference in San Joaquin River concentrations.

4.4.2 1986 data

Figures 30 and 31 show the same general pattern of lower boron concentrations, in the months December through April in Salt Slough, compared to the without project scenario. The converse is true of Mud Slough, which exhibits higher concentrations of boron, during the same period, as a result of the project, and lower concentrations of boron between the months April and September. Boron concentrations are always higher in Salt Slough under scenario 1, where wetland return flows to Salt Slough contain higher concentrations of boron than the return flows within Salt Slough. There appears to be little effect of the project on boron concentrations in the San Joaquin River. The major difference between the wet year and critically dry year hydrologies for boron is manifested in lower boron concentrations in both Mud and Salt Sloughs, with the greatest percentage reduction, during the summer months. This is probably a result of improved quality of subsurface returns from the upslope agricultural areas due to a higher proportions of tailwater in the combined flow.

4.5 Effect of proposed project on selenium concentrations

The monitoring data for the 1986 - 1989 period suggest that under the existing operation of the Grassland system significant losses of selenium occur in transit through the vegetated channels and unlined ditches. The precise magnitude of these losses have been difficult to quantify, because the monitoring program that has been conducted since 1985 has been more concerned with assessing compliance with water quality objectives and less with analysis of selenium losses through the Grassland system. An attempt has been made in the analysis, previously described, to correct for ungaged flows into the Grassland system and for errors in loads, resulting from using grab sample data as average monthly selenium concentration values.

In Salt Slough the selenium concentration was assumed to remain at 1ppb or less for the entire year. This assumption was based on monthly monitoring of Wetland return flows during the Reclamation's Offstream storage study, the assumed quality of fresh water delivered and/or spilled through Salt Slough and monthly monitoring of subsurface and surface drainage from agricultural lands east of Salt Slough by Reclamation and state and local agencies. For example the offstream storage monitoring program indicated that wetland releases did not contain selenium concentrations greater than 5ppb during three years of water quality sampling and were typically lower than 1ppb.

4.5.1 1988 data

In Figure 24 the analysis suggests a dramatic increase in selenium concentrations in Mud Slough as a result of the project. During the year, selenium levels could increase from less than 5ppb to over 40 ppb in the months of October,

Figure 21. Estimated effect of project on boron concentrations in Salt Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

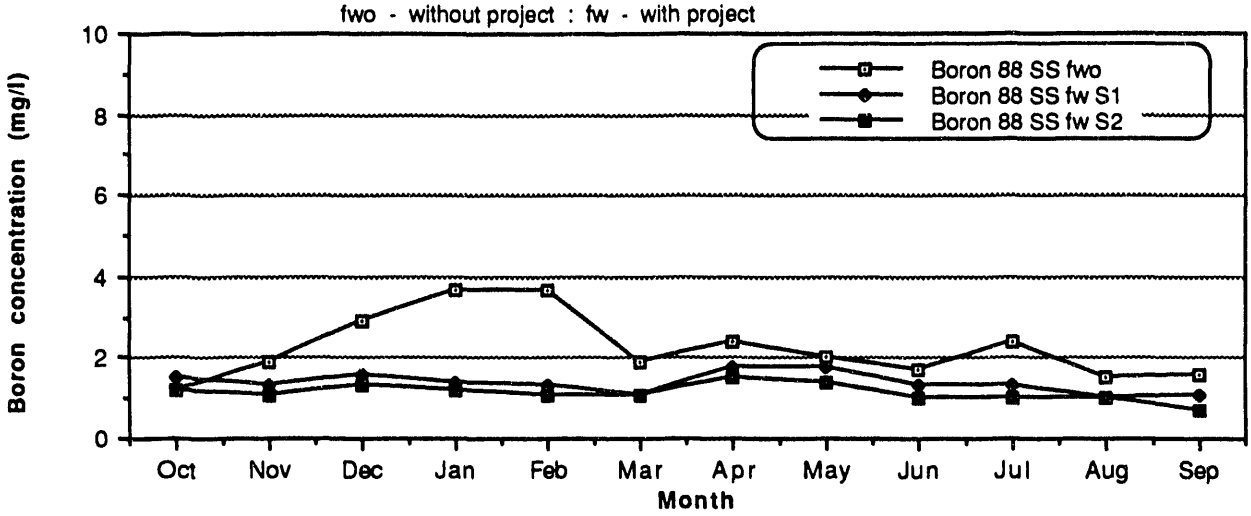


Figure 22. Estimated effect of project on boron concentrations in Mud Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

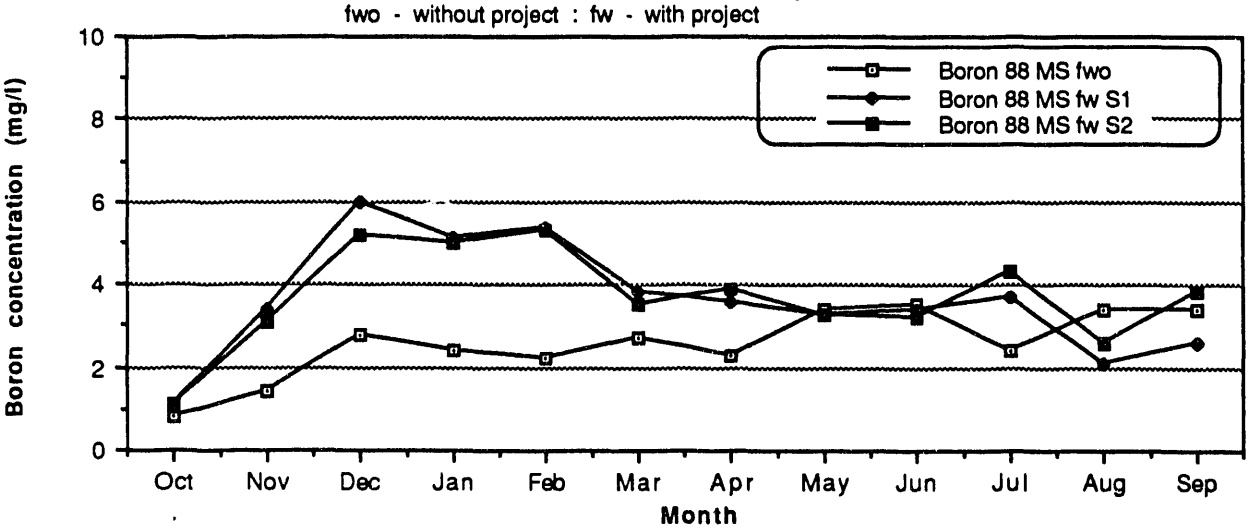


Figure 23. Estimated effect of project on boron concentrations in the San Joaquin River.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

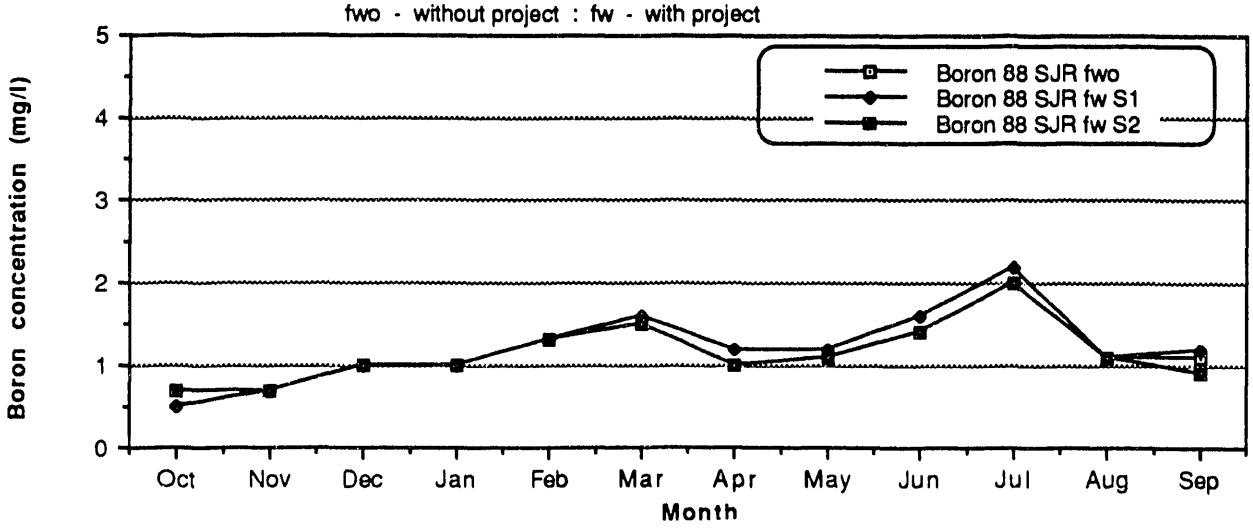


Figure 24. Estimated effect of the project on selenium concentrations in Salt Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

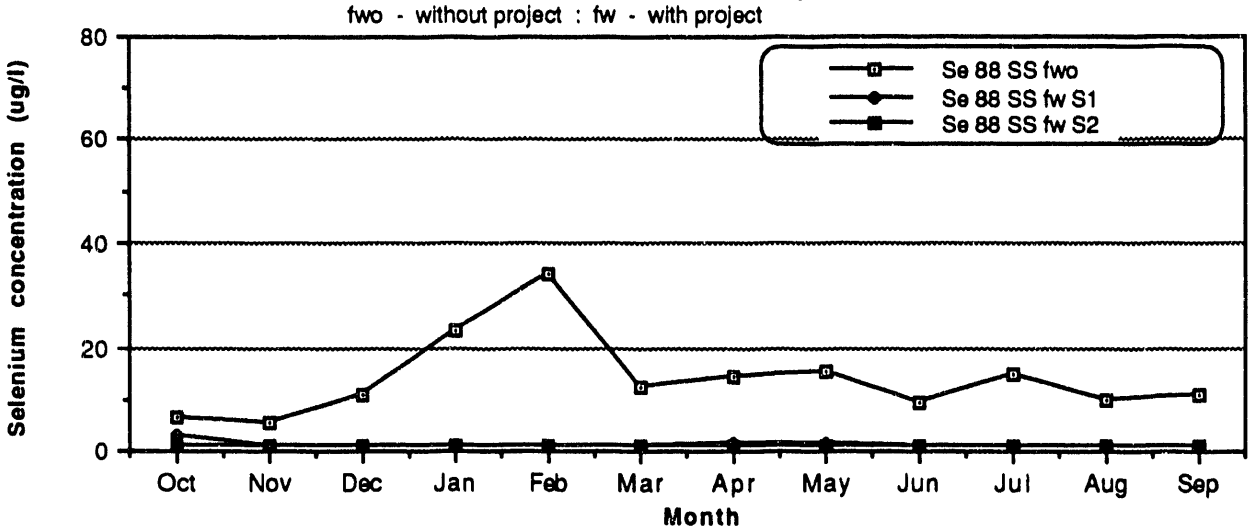


Figure 25. Estimated effect of the project on selenium concentrations in Mud Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

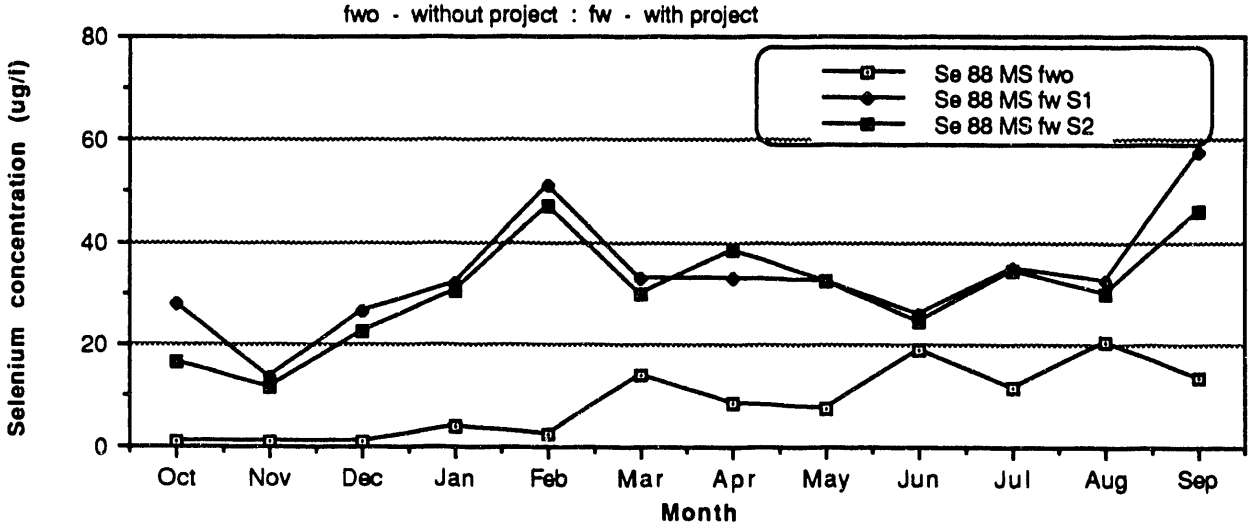


Figure 26. Estimated effect of the project on selenium in the San Joaquin River.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

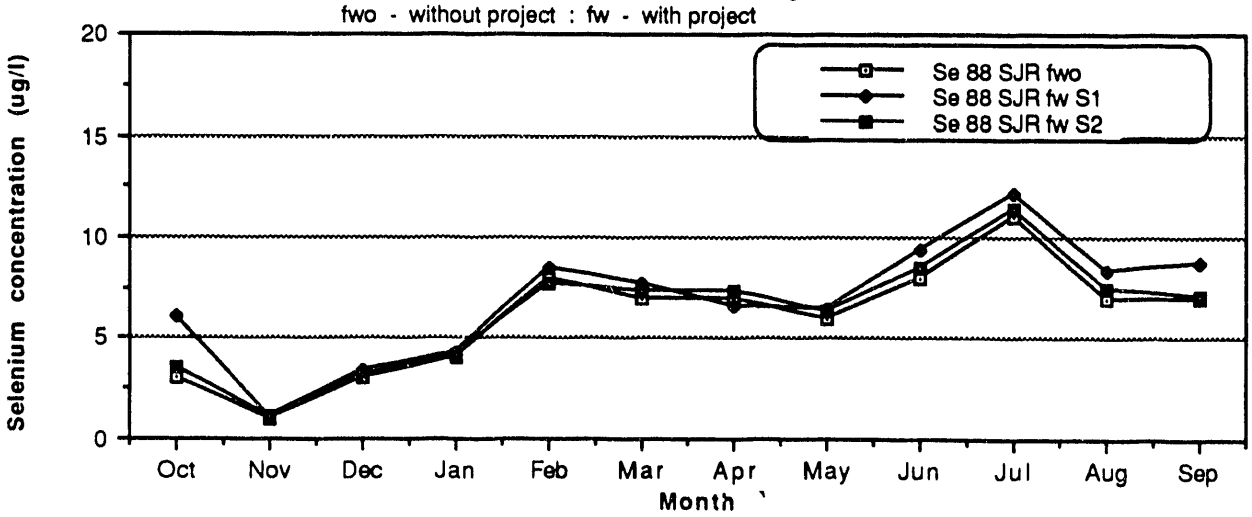


Figure 27. Estimated effect of project on TDS concentrations in Salt Slough

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

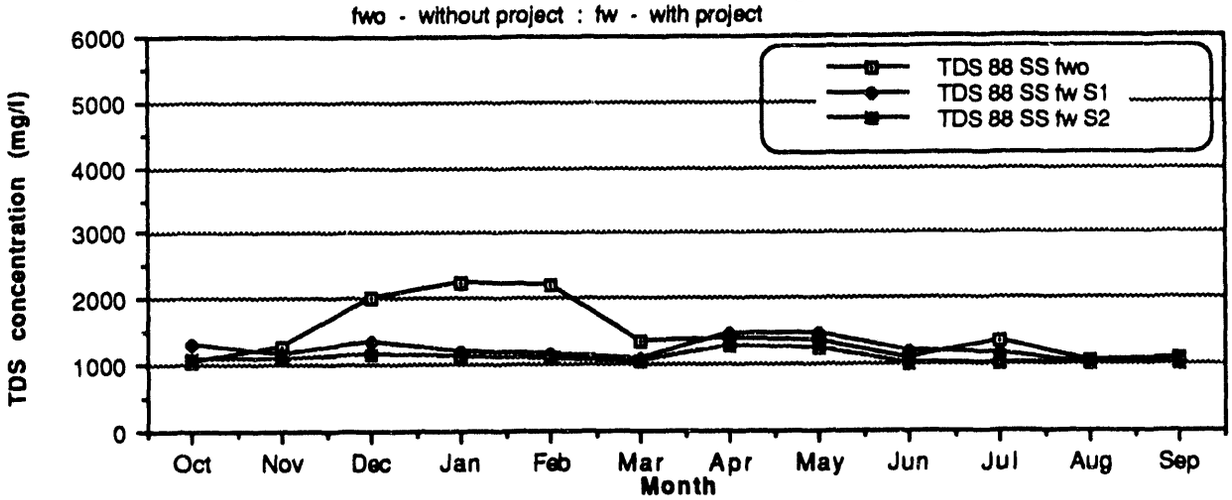


Figure 28. Estimated effect of project on TDS concentration in Mud Slough.

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

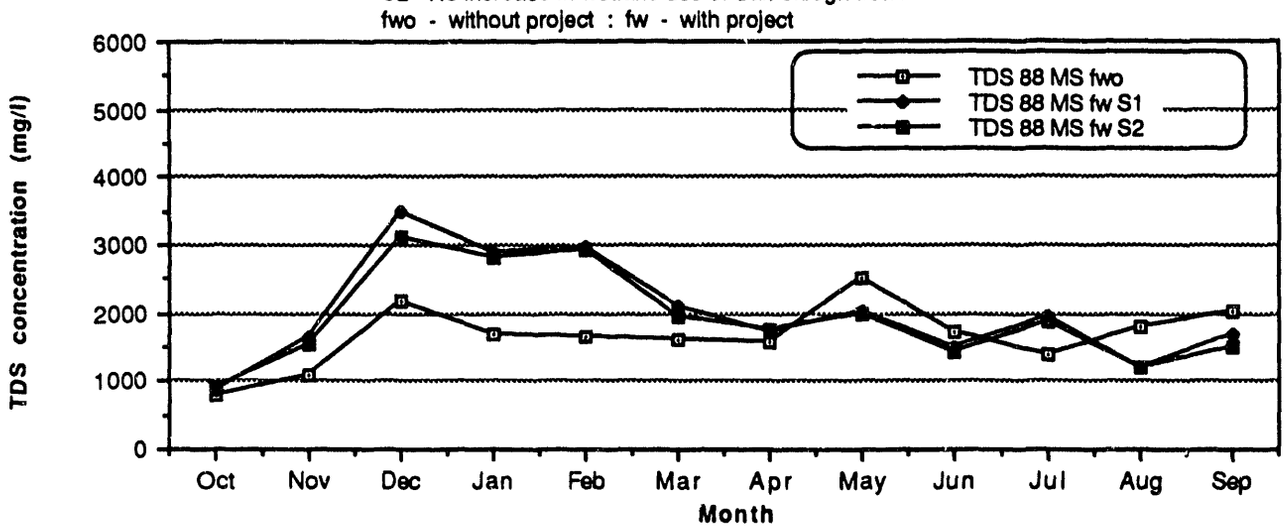


Figure 29. Estimated effect of project on TDS concentrations in the San Joaquin River.

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

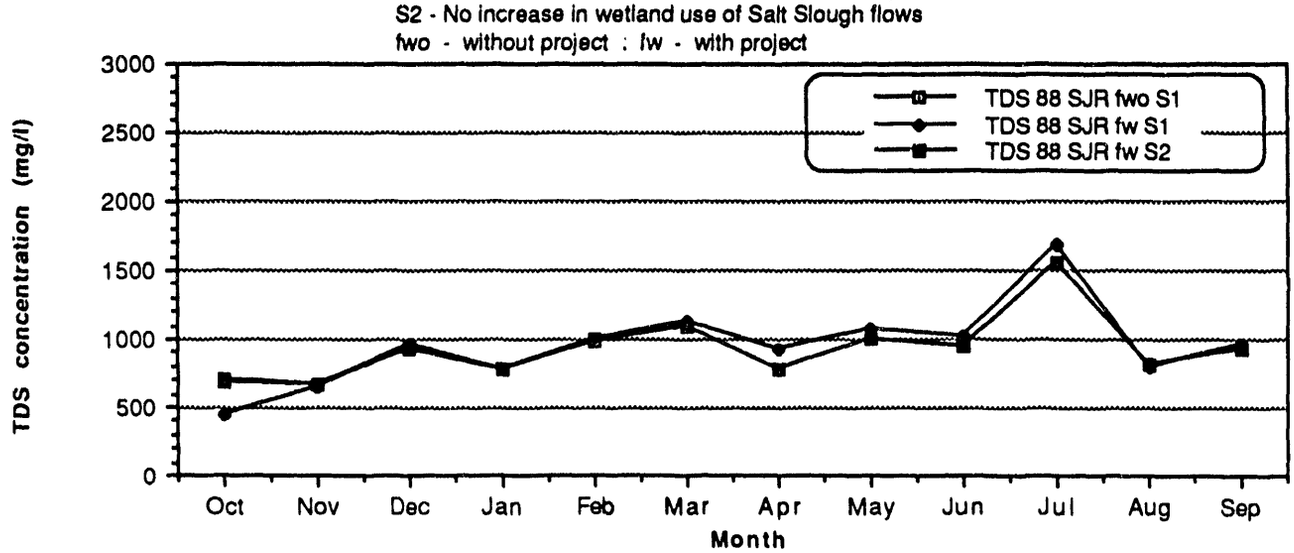


Figure 30. Estimated effect of project on boron concentrations in Salt Slough

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

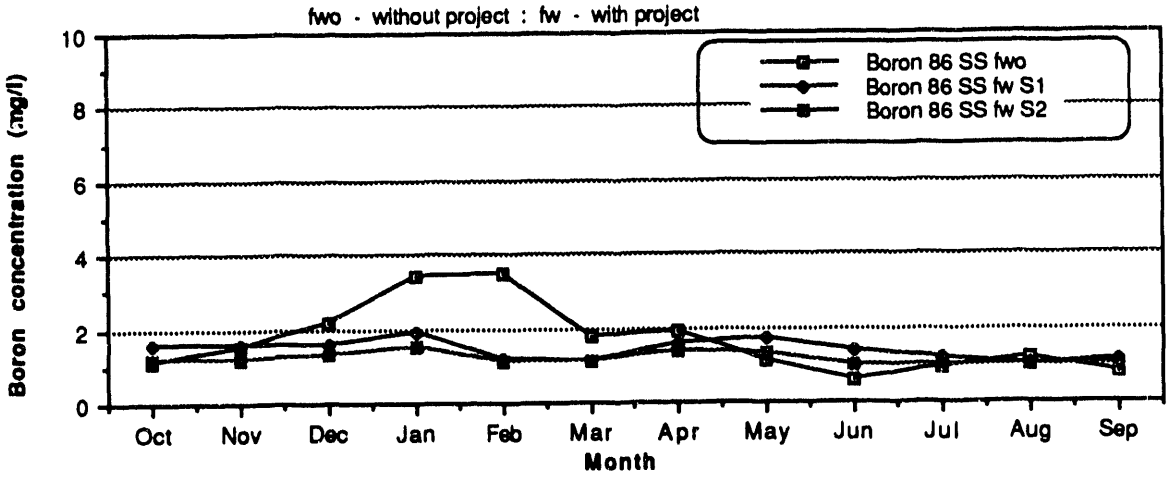


Figure 31. Estimated effect of the project on boron concentrations in Mud Slough

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

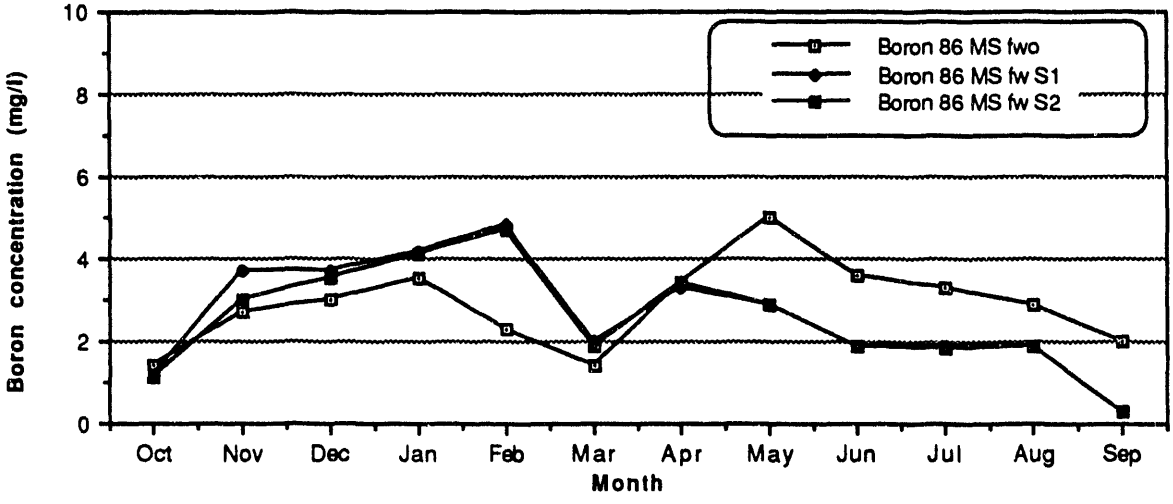


Figure 32. Estimated effect of the project on boron concentrations in the San Joaquin River

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

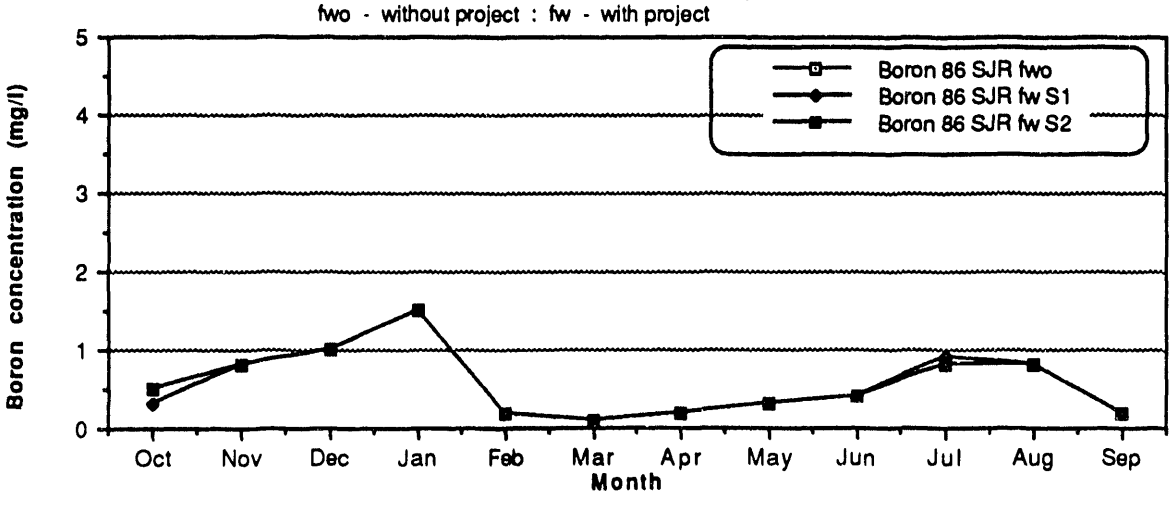


Figure 33. Estimated effect of the project on selenium concentrations in Salt Slough

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

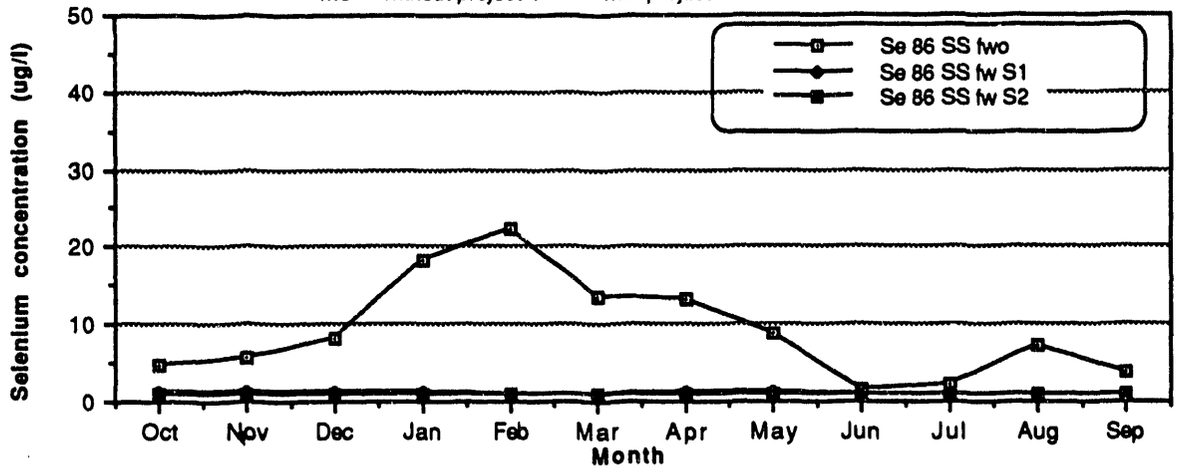


Figure 34. Estimated effect of the project on selenium concentrations in Mud Slough

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

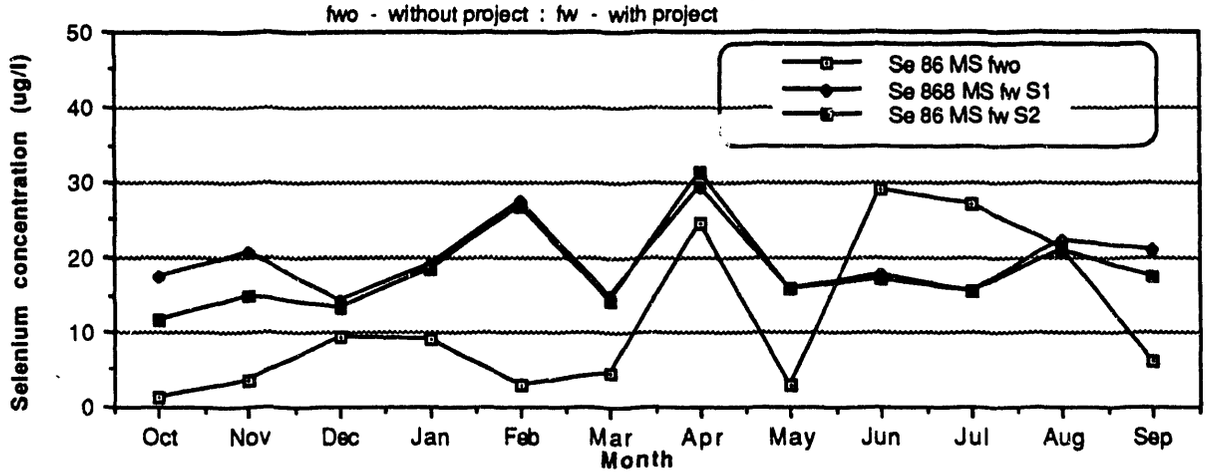


Figure 35. Estimated effect of the project on selenium concentrations in the San Joaquin River.

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

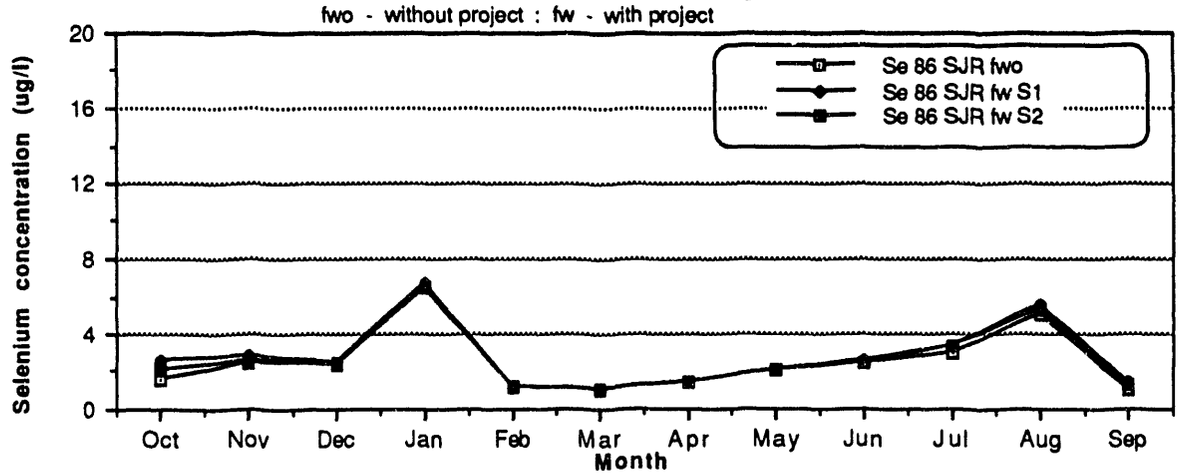


Figure 36. Estimated effect of project on TDS concentrations in Salt Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

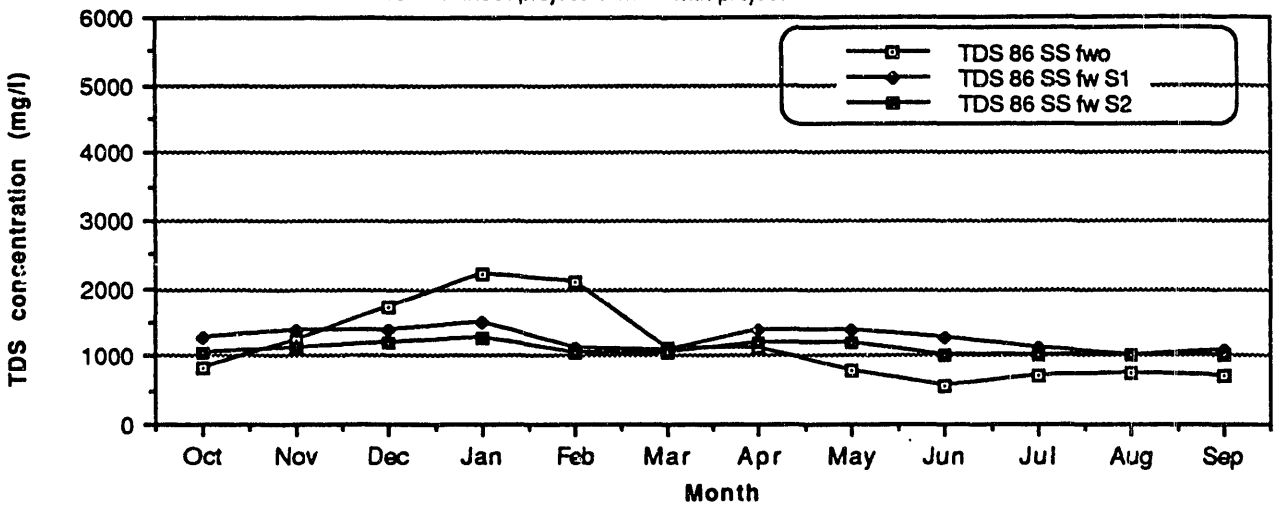


Figure 37. Estimated effect of project on TDS concentrations in Mud Slough.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project

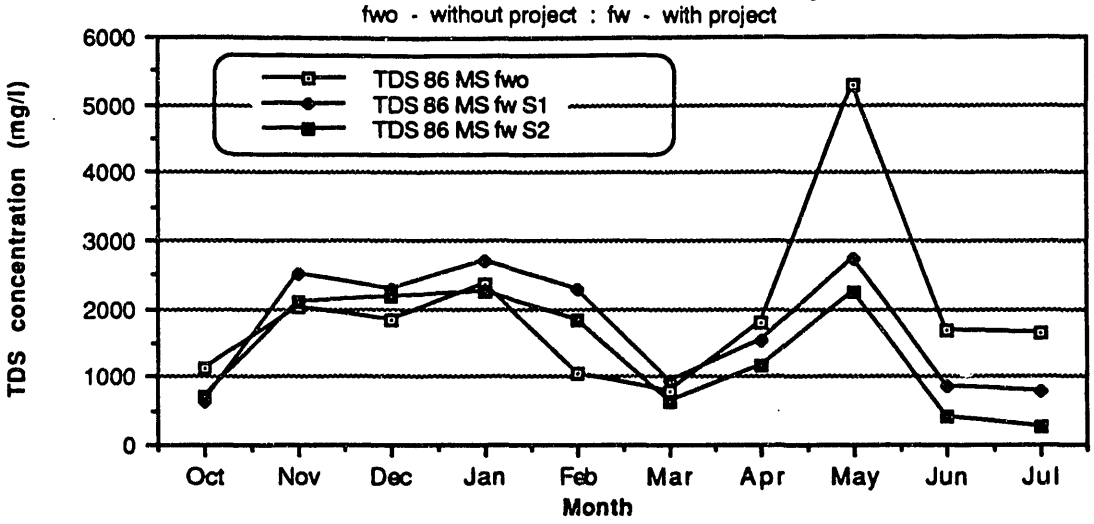
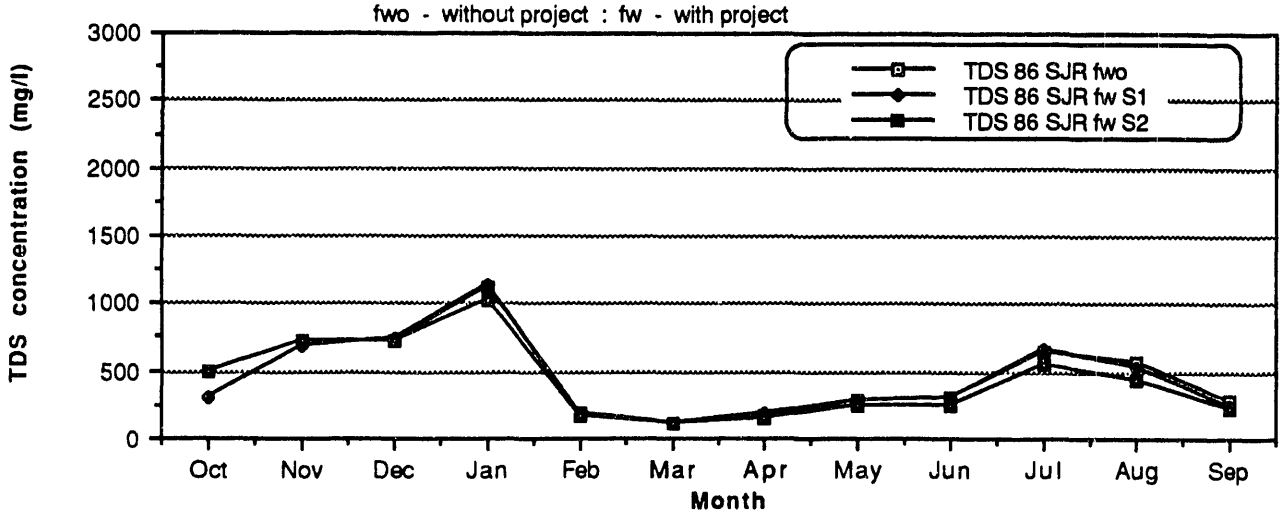


Figure 38. Estimated effect of project on TDS concentrations in the San Joaquin River.
S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
fwo - without project : fw - with project



December, January and February and by more than 50% in the months of March through October. The peak concentrations between January and March in Mud Slough, that result from the project, appear to offset the high concentrations of selenium in the without project scenario, in Salt Slough. Mud Slough concentrations resulting from Scenario 1 are, in most months, elevated over selenium concentrations for Scenario2, due to evaporative concentration of selenium in the ponded wetlands. In the San Joaquin River selenium concentrations are slightly higher for each month with the project than without the project. This is, in part, due to the assumption that 10% of the in-transit losses (uptake) of selenium, in the without project scenario, were added to the selenium load for the with-project scenarios. A n uptake assumption of 0% for selenium would result in a smaller increase in San Joaquin River selenium concentrations. A 51% uptake assumption for selenium, on the other hand, would result in much higher San Joaquin River selenium concentrations, relative to the without project scenario and the other with-project scenarios.

4.5.2 1986 data

The 1986 data presented in Figure 34 shows a marked difference from the 1988 data in the concentration of selenium in Mud Slough as a result of the project. In 1988, the peak concentrations in February and September are 50.8 ug/l and 57.4 ug/l - in 1986, the February and September selenium concentrations are 27.3 ug/l and 21.1 ug/l respectively. The unusually high runoff in March and April of 1986 , combined with the high selenium load in wetland releases during April and May may help to explain the sawtooth nature of Figure 34 between February and June. In contrast to 1988, selenium concentrations are lower in June and July in Mud Slough, with the project, than without the project. Inspection of the San Joaquin River selenium concentration at Newman for these two months shows little difference between the without and the with project scenarios. The likely result of the lower Mud Slough selenium concentrations associated with the project is therefore the wetland releases of 4600 acre-ft and 3900 acre-ft during the months of June and July, which helped to dilute selenium levels in Mud Slough flows.

In 1986, a wet year, the effect of the project scenarios 1 and 2 on selenium concentrations in the San Joaquin River is smaller than experienced during 1988, a critically dry year. As for boron, the lower selenium concentrations in the combined agricultural return flows entering the Grassland area during 1986 helps to reduce the overall water quality impact of the project.

4.6 Effect of proposed project on TDS concentrations

The analysis of mass loading in to and out of the Grassland area suggests that there was no significant net accumulation of salts in the Grassland. Hence the major impact of the project would be a reapportioning of the TDS loads to Mud and Salt Sloughs, with a resulting change in the average monthly TDS concentrations and loads in the Sloughs. In the case of Salt Slough this is due to increased wetland diversions of Salt Slough flows.

4.6.1 1988 data

Figure 28 shows that TDS concentrations in Mud Slough could increase by as much as 80% in December, to approximately 3500 ppm, and increase by between 30% and 80% between the months of November through March.

The salinity of the flows generally are reduced after April due to the increased volume of water released from wetlands storage into Mud Slough.

The major benefit of the project in Salt Slough would appear between the months of December and March, when the TDS concentrations are reduced by between 25% and 50% of those levels representative of conditions without the project. This period corresponds with the highest expected increase in Mud Slough TDS concentration. One of the effects of the project on contaminant levels in the San Joaquin River near Newman would be an average annual increase in TDS concentrations. In Figure 29, the average estimated increase in TDS concentration is 3.5%, from a mean value of 928 ppm without the proposed project, to 960 ppm with the project. This small increase in concentration is a direct effect of increased consumptive use of water and storage of salts within the wetlands in the Grassland area. These return flows typically have concentrations of 1000 ppm TDS when diverted to the wetland areas and 1600 ppm when they are returned as drainage flows in the spring. The timing of these releases has a direct bearing on their TDS upon discharge to Mud and Salt Sloughs. Increasing levels of evaporation from the wetlands, as mean daily temperatures rise during the early Spring, can elevate concentrations of TDS, boron and selenium. Although the increase in TDS concentrations of return flows from these wetlands can be largely explained by the process of evapoconcentration of salts, part of this increase could also result from increased levels of organic materials suspended in the return flows, a fraction of which would be salts.

4.6.2 1986 data

Figures 36 and 37 summarize the effect of the project on TDS in Salt and Mud Sloughs respectively. Figure 36 shows the same trend as Figure 27, with lower TDS concentrations in Salt Slough in the October - March period offset by higher TDS concentrations during the same period in Mud Slough. The last two months of data are not included in Figure 37 - since both were negative and hence unrealistic. Hence the August and September numbers in Figure 38 may also be in error. The negative numbers result from the calibration procedure and may arise from either (a) unreliable monthly TDS estimates from monitoring data or (b) a poor assumption for the TDS concentration of the flows used in the flow adjustment procedure during calibration. Scenario 1 produces higher TDS concentrations in both Salt and Mud Sloughs than in the case of Scenario 2.

As expected, and consistent with the boron analysis, the effect of the project on TDS in the San Joaquin River is less marked in the wet year (1986) than in the critically dry year (1988).

4.7 Effect of the proposed project on the maintenance of water quality objectives

Figures 39, 40, 41 and 42 show monthly variations in boron and selenium concentrations in the San Joaquin River for the years 1986 and 1988 for the without and the with project conditions. The wet and critically dry year objectives for Mud and Salt Sloughs and the San Joaquin River were previously described in Section 1.6.

Mud and Salt Slough Objectives :

boron	2 ppm monthly mean	5.8 ppm maximum	(CVRWQCB 88-195)

selenium	10 ppb monthly mean	26.0 ppb maximum	(CVRWQCB 88-195)

San Joaquin River Objectives near Newman (CVRWQCB 88-195):

boron	0.8 ppm monthly mean	March 15 - September 15
	1.0 ppm monthly mean	September 16 - March 14
	1.3 ppm monthly mean	critically dry year
selenium	5 ppb monthly mean	
	8 ppb monthly mean	critically dry year

For 1988 the boron objective of 1.3 ppm for the San Joaquin River (critically dry years) is violated in March, June and July both with the project, under scenarios 1, 2 and 3 and without the project. In all cases scenario 2, in which Salt Slough flows are diverted for use on wetlands, shows the highest boron concentrations. The selenium objective for the San Joaquin River of 8 ppb (critically dry year) is exceeded once without the project and five times under scenario 2. For Scenario 2, in which Salt Slough is not utilized, the objective is violated twice, in both June and July. For Scenario 3, which allows for the provision of additional tailwater return flows, equal to the volume that would be taken from Salt Slough and used in wetlands, only one violation of the SWRCB objective occurs. Although there is a large difference in the number of monthly violations between the with (Scenario 1) and without project scenarios, inspection of Figure 40 shows that the objective for selenium concentrations is very close to being violated without the project in both February and June.

In 1986 the boron and selenium objectives for the San Joaquin River at Newman are lower and are violated only once without the project, in January, and twice with the project (Scenario 1) - in January and July for boron, and in January and August for boron (Figures 41 and 42). Both Scenario 2 and Scenario 3 result in a lower frequency of exceeding the boron and selenium objectives than Scenario 1. Unlike the 1988 hydrologic year there are very small differences between the scenarios in the case of boron and only small differences in the case of selenium. The large volume of San Joaquin River flow in the spring months tends to dampen the effect of the much smaller volume of boron and selenium contaminated return flows.

Table 11. is a summary of the frequency of exceeding the SWRCB objectives for both selenium and boron for both 1988 and 1986 hydrologic years. This table should be used with Figures 21 - 40 to assess the magnitude by which the objective was exceeded or how the close the objective was to being exceeded in any one month. Inspection of the monthly frequency of exceeding the objectives for Salt and Mud Sloughs shows that the sum of monthly violations for both Sloughs actually decreases for each of the with-project Scenarios. The water quality data for 1988 and 1986 for Salt Slough shows that the SWRCB objectives were violated five times in 1988 and three times in 1986 for boron; the objectives were violated eight times in 1988 and four times in 1986 for selenium. By diverting most of the subsurface agricultural drainage flows to Mud Slough, in each of the with-project scenarios, violations of the SWRCB objectives in Salt Slough are largely eliminated. However, as was shown in Figures 21 - 38, the resulting Mud Slough concentrations of boron and selenium not only violate the objectives with greater

Figure 39. Estimated effect of boron concentration in the San Joaquin River (1988 - critically dry year)

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
S3 - No increase in wetland use of Salt Slough flows : Additional water supply supplied.
fwo - without project : fw - future-with project

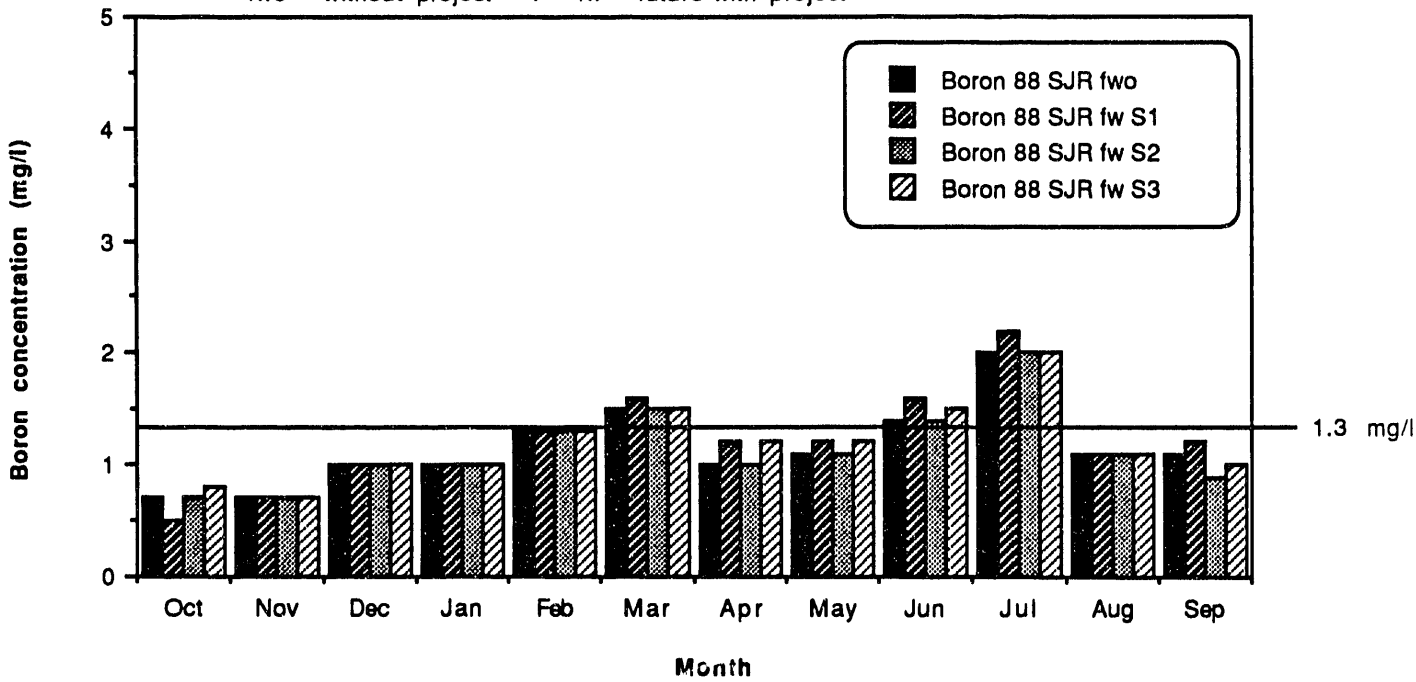


Figure 40. Estimated effect of project on selenium concentrations in the San Joaquin River. (1988 - critically dry year)

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
S3 - No increase in wetland use of Salt Slough flows : Additional water supply supplied.
fwo - without project : fw - future-with project

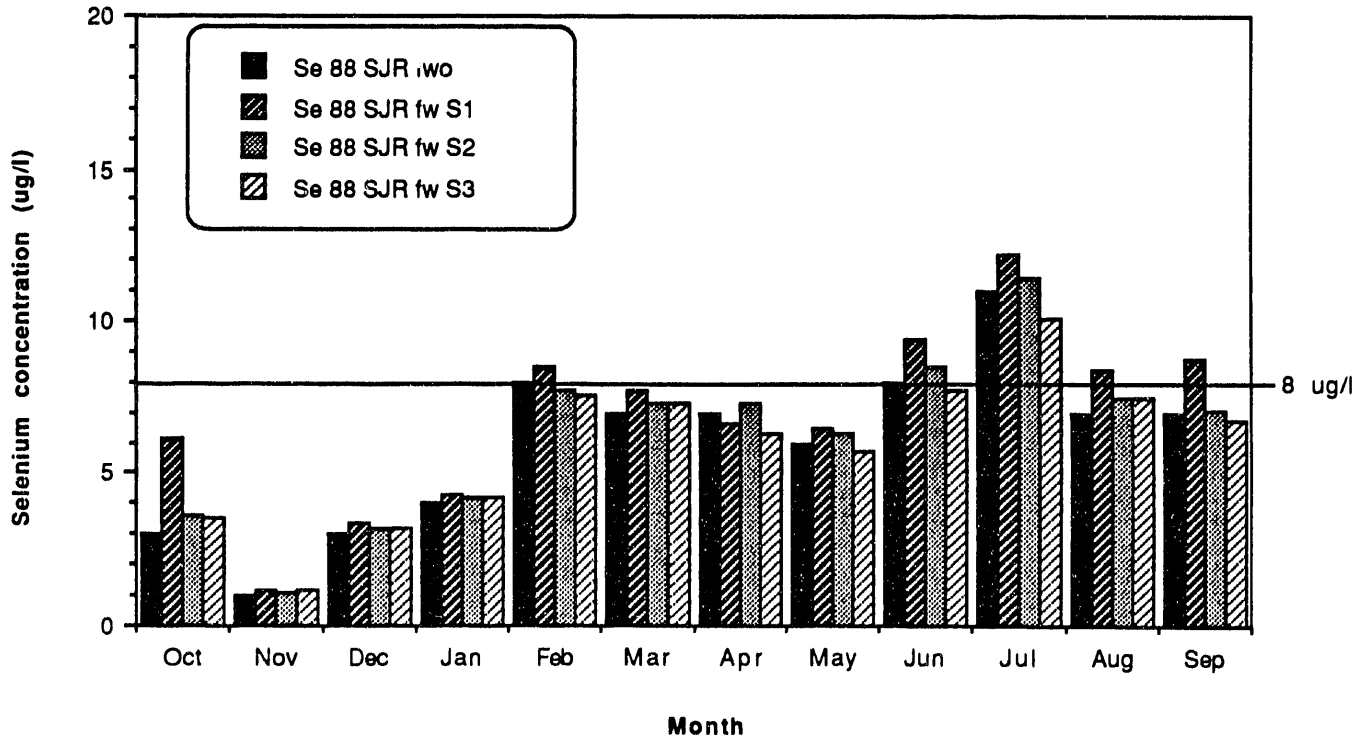


Figure 41. Estimated effect of boron concentration in the San Joaquin River. (1986 - wet year)

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
S3 - No increase in wetland use of Salt Slough flows : Additional water supply supplied.
fwo - without project : fw - future-with project

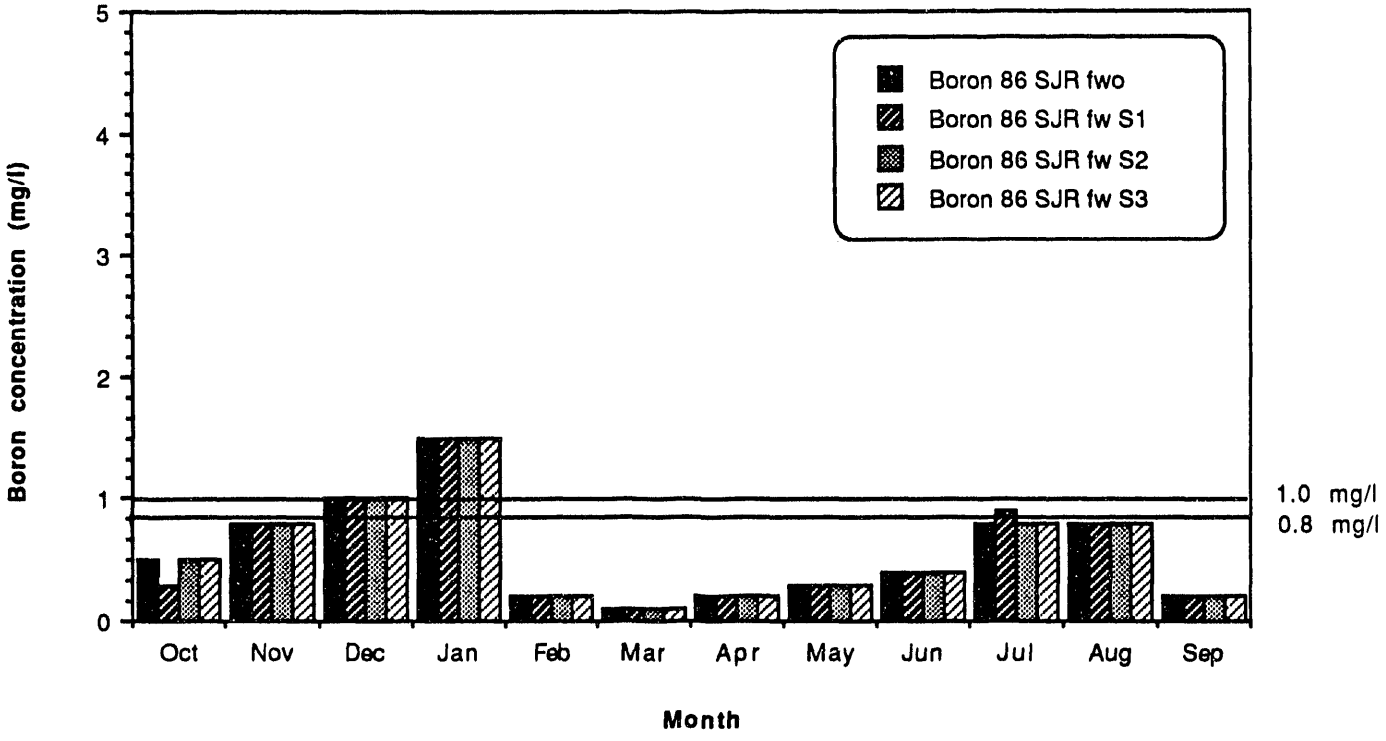
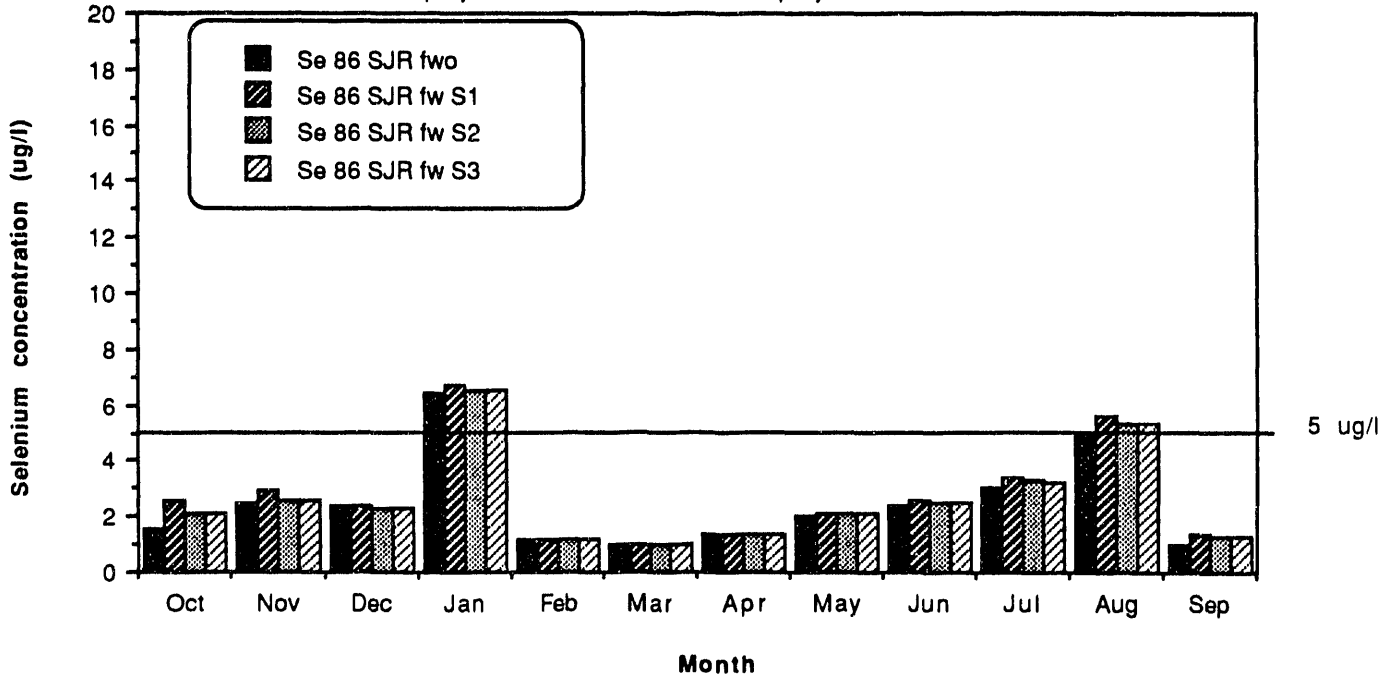


Figure 42. Estimated effect of project on selenium concentrations in the San Joaquin River. (1986 - wet year)

S1 - Increased wetland use of Salt Slough flows permitted
S2 - No increase in wetland use of Salt Slough flows
S3 - No increase in wetland use of Salt Slough flows : Additional water supply supplied.
fwo - without project : fw - future-with project



frequency, but also exceed more frequently the 5.8 ppm and 26.0 ppb maximum concentration limits, set by the CRWQCB for boron and selenium respectively. The maximum boron concentration of 5.8 ppm was not exceeded in either 1988 or 1986, in the without project scenario, whereas it is exceeded once in Mud Slough, in Scenario 1. The maximum selenium concentration of 26.0 ppb was exceeded once in 1988 (Salt Slough) and twice in 1986 (Mud Slough) for the without project scenario. In Scenario 1 this maximum concentration was exceeded in Mud Slough ten times in 1988 and twice in 1986.

4.8 Effect of the proposed project on boron and selenium loads

The major difference between each of the project scenarios 1, 2 and 3 is in the use of Salt Slough flows and in the release pattern of wetland return flows. Table 12. is a summary of the boron and selenium loads for the San Joaquin River at Newman expressed as load-flow factors and taken from column 33 of the spreadsheet analysis. The conversion factor to change load flow factors to tons of boron and to pounds of selenium appears below Table 12.

Inspection of Table 12. shows that boron loads generated by the project are not significantly different between Scenarios 1 and 2 and the without project scenario. The largest difference of 2700 AF-ppm between Scenario 2 and the without project scenario in 1988 is equivalent to an annual difference of 3.7 tons of boron. A larger difference occurs between Scenario 3 and the without project scenario - in this case 53,800 AF-ppm, which is equivalent to 73.2 tons of boron annually. In Scenario 3, the boron load contained in the additional water supply supplied to wetlands, accounts for the higher boron load. It should be noted that the assumption was made that this water was of the same quality as the return flows from SJVDP water quality zones B and C. However, since this increased load is associated with higher return flows down Mud and Salt Slough, the overall effect on boron, selenium and TDS concentrations in the San Joaquin River was very small, as was shown in Figures 39 - 42 The higher runoff and return flows generated in 1986 account for the approximately 25 %- 30% difference in annual boron loading between the two years.

The assumption that was made regarding selenium uptake in the Grassland area account, in large part for the differences between the project scenarios 1, 2 and 3 and the without project scenario. Again, the increased selenium load contained in the additional water supply accounts for the differences in total annual load between Scenario 3 and Scenarios 1 and 2. The largest difference in selenium loading between the Scenarios 1 and 3 in 1988 (90.8 lbs) is smaller than the difference between Scenario 1 and the without - project scenario for 1988 (415.8lbs). This contrasts with 149.6 lbs between Scenarios 1 and 3 and 445.8 lbs for the without - project scenario in 1986.

4.9 Options for restoring the San Joaquin River to pre-project conditions for boron, selenium and TDS

A number of options exist to mitigate the effect of the project on the San Joaquin River. These options fall into two major categories : (a) those options that reduce the load of contaminants in agricultural return flows from SJVDP water quality zone A; and (b) those options which provide supplemental flows of fresh water for blending

Table 11. Frequency of exceeding SWRCB water quality objectives

WATER YEAR WATER QUALITY CONTROL POINT	FREQUENCY OF EXCEEDING WATER QUALITY OBJECTIVES									
	BORON CONCENTRATION					SELENIUM CONCENTRATION				
	WATER QUALITY OBJECTIVE ppm	NUMBER OF MONTHS EXCEEDING MEAN MONTHLY OBJECTIVE				WATER QUALITY OBJECTIVE ppb	NUMBER OF MONTHS EXCEEDING MEAN MONTHLY OBJECTIVE			
		WITHOUT PROJECT	WITH PROJECT SCENARIO 1	WITH PROJECT SCENARIO 2	WITH PROJECT SCENARIO 3		WITHOUT PROJECT	WITH PROJECT SCENARIO 1	WITH PROJECT SCENARIO 2	WITH PROJECT SCENARIO 3
1988										
Salt Slough at Hwy 165	2.0	5	0	0	0	10	8	0	0	0
Mud Slough at Hwy 140	2.0	10	9	10	11	10	5	12	12	12
San Joaquin River near Newman	1.3	3	3	3	3	8	1	5	2	1
1986										
Salt Slough at Hwy 165	2.0	3	0	0	0	10	4	0	0	0
Mud Slough at Hwy 140	2.0	5	6	6	6	10	2	12	12	12
San Joaquin River near Newman	0.8 / 1.0	1	2	1	1	5	1	2	2	1

Table 12. **Summary of boron and selenium loads in the San Joaquin River with and without the project for 1988 and 1986. Loads expressed as load-flow factor (flow x concentration).**

	MONTHLY BORON LOAD-FLOW IN THE SAN JOAQUIN RIVER				MONTHLY SELENIUM LOAD-FLOW IN THE SAN JOAQUIN RIVER			
	WITHOUT PROJECT KAF - ppm	WITH PROJECT SCENARIO 1 KAF - ppm	WITH PROJECT SCENARIO 2 KAF - ppm	WITH PROJECT SCENARIO 3 KAF - ppm	WITHOUT PROJECT KAF - ppb	WITH PROJECT SCENARIO 1 KAF - ppb	WITH PROJECT SCENARIO 2 KAF - ppb	WITH PROJECT SCENARIO 3 KAF - ppb
1988								
Oct	14.6	5.2	14.6	16.4	62.7	65.2	74.3	76.4
Nov	23.9	20.6	23.9	25.7	34.1	35.9	38.9	41.0
Dec	27.9	27.1	27.9	29.5	83.7	90.3	90.7	92.7
Jan	42.8	42.5	42.7	44.1	171.2	181.2	180.9	182.8
Feb	49.3	49.2	49.3	50.9	303.2	314.3	292.4	294.4
Mar	74.3	73.2	74.2	75.9	346.5	360.4	361.0	363.0
Apr	39.4	53.6	37.6	56.1	275.8	301.9	287.6	304.3
May	36.6	40.3	35.9	45.4	199.8	214.0	210.1	219.1
Jun	44.5	45.0	44.6	52.4	254.4	268.2	270.4	275.6
Jul	49.8	52.0	49.7	57.3	273.9	283.7	283.8	289.1
Aug	34.1	30.5	34.1	34.1	217.0	228.8	232.4	232.4
Sep	25.9	22.6	25.9	29.1	164.5	162.4	166.7	168.9
Total	463.1	461.8	460.4	516.9	2386.8	2506.3	2489.2	2539.7
1986								
Oct	18.1	8.7	18.1	18.1	57.8	67.2	76.3	78.4
Nov	21.6	18.3	21.6	21.6	67.5	67.2	70.2	72.3
Dec	39.8	39.0	39.8	39.8	95.5	91.2	91.6	93.6
Jan	52.1	51.9	52.1	52.1	222.1	227.2	226.9	228.8
Feb	56.6	56.4	56.6	56.6	339.5	333.2	332.9	334.9
Mar	85.2	84.2	85.2	85.2	851.9	867.7	868.3	870.3
Apr	121.4	137.5	121.4	124.6	849.9	853.0	838.2	855.4
May	61.2	65.6	61.2	62.5	408.0	436.4	432.2	441.5
Jun	48.2	48.7	48.3	49.8	289.4	303.4	305.6	310.8
Jul	50.8	53.0	50.8	52.7	190.5	207.1	207.2	212.5
Aug	47.2	43.5	47.1	47.1	295.0	308.2	311.8	311.8
Sep	11.7	8.4	11.6	12.3	58.4	72.6	76.9	79.1
Total	613.9	615.2	613.8	622.4	3725.5	3834.4	3838.1	3889.4

Note : tabular values are in thousands.

To convert tabular values of boron to tons of boron multiply by 1000 x 0.00136 e.g 39.4 KAF-ppm x 1000 x 0.00136 = 53.6 tons boron

To convert tabular values of selenium to lbs of selenium multiply by 2000 x 0.00136 e.g 275.8 KAF-ppm x 2000 x 0.00136 = 750.2 lbs selenium

purposes during those periods when water quality either exceeds the without-project concentration or exceeds the State Water Resources Control Board objectives for selenium and boron.

(a) On-farm water management options for controlling drainage at its source include water conservation through adoption of improved irrigation and drainage technologies, tailwater and subsurface drainage recycling and changes in agronomic practices. Some of these options may result in little change in contaminant load, such as can happen with subsurface drainage recycling, whereby a reduction in subsurface agricultural drainage flows is associated with an increase in the contaminant concentration of these flows. Improved management practices, aided by the current proposed project, could increase flexibility of water delivery and discharge operations and hence enhance the ability to control the timing of contaminated subsurface drainage discharges to Salt and Mud Sloughs and to the San Joaquin River. Current inititiatives by the SWRCB, the CRWQCB and the San Joaquin River Management Program to measure real-time flow and water quality data at designated monitoring stations along the San Joaquin River should substantially enhance information flow between river managers and the upslope agricultural water districts, making it easier to meet San Joaquin River water quality objectives.

(b) Supplemental flows, provided for blending with contaminated flows within Mud Slough to improve water quality in the San Joaquin River, could potentially be aquired from a number of sources depending on the availability of water supplies, the ability to pay for the water and the ability to convey water from the diversion point to the place of delivery. The Federal and State Project facilities to the west of the Grassland area can provide Delta water through the Delta Mendota,Canal or the California Aqueduct or by transfer along the Main or Outside Canals, water supplies can also be made available along the San Joaquin River, either through releases from Mendota Pool or through some future reoperation of Friant Dam. Additional surface return flows from SJVDP water quality zones B and C, which currently return to the river via Orestimba Creek, if available, could also be used for blending purposes, though the higher boron and TDS concentrations in these return flows would increase the volume of this supply that would be needed for blending purposes. Timing of supplemental water supplies for blending would rely heavily on a real-time monitoring system for provision of water quality information and flexible and coordinated water supply management by the State and Federal Water Purveyors and the Grasslands Water Master.

4.10 Supplemental water supply requirements to match without-project water quality concentrations and meet SWRCB objectives.

One means of mitigating the impact of the project is to attempt to restore the San Joaquin River to the same water quality prior to implementation of the project. This is only feasible where the quality of the water used for blending purposes is lower in TDS, boron or selenium concentration than the without project, San Joaquin River concentration. If the water supply has a higher concentration than the target concentration this option would not be feasible, since, theoretically, even an infinite volume of water would fail to exactly satisfy the criterion. In practical

terms, a very large volume of water could concievably provide sufficient dilution to meet the criterion, owing to numerical round-off, since the SWRCB objective is an integer number in the case of selenium and rounded to the first decimal place in the case of boron .

In Appendices B and C, the supplemental water requirements have been determined for each with-project scenario, for boron, selenium and TDS and for 1988 and 1986 hydrologies. The volume of supplemental (dilution) water was calculated using the following algorithm :

$$V_s = V_{fw} \left((C_{fw} - C_{fw+s}) / (C_{fw+s} - C_s) \right)$$

Where :

V_s	-	volume of supplemental water required to match without project conc.
V_{fw}	-	flow in the San Joaquin River with the project
C_{fw+s}	-	concentration of the San Joaquin River without the project
C_{fw}	-	concentration of the San Joaquin River with the project
C_s	-	concentration of the supplemental water supply

Tables 13 - 24 and Figures 43 - 54 show the monthly supplemental water supply needed to (a) restore the San Joaquin River to pre-project concentrations and; (b) meet SWRCB objectives for the San Joaquin River. Pre-project conditions are the concentrations reported in column 3 of the spreadsheets. In the case of boron, Scenario 1 and 1988 hydrology, meeting the SWRCB objectives requires a greater volume of supplemental water supply (39,518 acre-ft/year) than the volume required to restore the San Joaquin River to the without-project boron concentration (28,113 acre-ft/yr). Tables 13 - 15 and Figure 43 also show that only in Scenarios 1 and 3 is supplemental water needed to restore boron concentrations to pre-project concentrations. This result is also true of the 1986 hydrology.

In Figure 44 both the supplemental water requirement and the assimilative capacity of the San Joaquin River is shown. Assimilative capacity is a concept that was utilized by the San Joaquin Valley Drainage Program to describe the maximum contaminant load that the river can accept and still meet the existing Basin Plan water quality objectives for selenium and boron, developed to protect beneficial uses of the San Joaquin River. The assimilative capacity of the San Joaquin River at Newman can be calculated by first reconstructing the flow and calculating the load-flow factor within the San Joaquin River without the contaminated flows from zone A. The reconstructed San Joaquin River flow is multiplied by the Basin plan objectives which produces the maximum allowable load-flow factor. Finally the reconstructed load-flow factor at Newman is subtracted from the maximum allowable load-flow factor to obtain the assimilative capacity. The allowable discharge by drainers is calculated by dividing the allowable load-flow factor by the concentration of each of the contaminants, selenium and boron, for the with-project condition.

The allowable discharge can be calculated using the following algorithm :

$$V_d = V_{fw} \left((C_{fw} - C_{SWRCB}) / (C_{SWRCB} - C_d) \right)$$

Where :

V_d	-	volume of discharge allowed without exceeding SWRCB objectives.
V_{fw}	-	volume of flow in the San Joaquin River
C_{SWRCB}	-	SWRCB objective for the San Joaquin River at Newman
C_{fw}	-	existing concentration of the San Joaquin River
C_d	-	concentration of the discharge into San Joaquin River

The assimilative capacity of the river can vary widely between months and between years depending on the flow volume. In the past four years the drought has caused significant reductions in monthly flow volume in the San Joaquin River - hence the assimilative capacity of the river has been relatively low (Figure 44), whereas during 1986, high river flow volumes during the months of February, March and April provided a very large assimilative capacity (Figure 46).

Only by making use of the assimilative capacity of the river can the requirement for supplemental water supply to meet SWRCB water quality objectives be reduced, since, for boron the SWRCB objectives are more restrictive than the requirement to recreate pre-project boron concentrations. To make use of the river assimilative capacity , temporary storage of subsurface agricultural drainage is necessary to permit these drainage discharges to enter the river during those times when flows are high relative to boron loads.

In contrast to boron, the volume of supplemental water required for selenium to restore the San Joaquin River to pre-project conditions is, in most cases, greater than the volume required to meet SWRCB objectives. The magnitude of the supplemental flows are highly dependent on the assumptions made of selenium uptake within the Grassland system. Figure 47 and Tables B10 -B16 and C10-C16 in the Appendix show the magnitude of the differences in monthly supplemental water requirement, if the assumption varies between a minimum of 0% uptake to a maximum of 51% uptake, using 1988 hydrology. In Figure 47 scenario 1 and scenario 2 are compared as far as the monthly volume of supplemental water supply required to return the river to pre-project selenium concentrations. Five different levels of selenium uptake are assumed in scenario in the analysis of supplemental water requirements to meet SWRCB objectives. Only the 10% selenium uptake level is considered in scenario 2. The reader is reminded that "uptake" refers to the total selenium system losses assumed in the without-project scenario that are due to conveyance in the vegetated Grassland channels. It is assumed that these losses do not occur when the project is implemented, hence these losses must be added to selenium load that occurs in the no-action scenario.

In Figure 50 the same range of selenium uptake assumption values is applied to 1986 San Joaquin River hydrology. The high flows in the San Joaquin River during the spring months make it more difficult to match pre-project selenium concentrations - hence a much larger volume of supplemental water is required. In several cases where the San Joaquin River selenium concentrations were equal or lower than the assumed selenium concentration of the supplemental water - an infinite volume of supplemental water would be required - an infeasible solution.

Table 13.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 1 : (1988 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	5.2	10.6	0.5	0.7	1.3	0	0
Nov	20.6	29.9	0.7	0.7	1.3	0	0
Dec	27.1	26.2	1.0	1.0	1.3	0	0
Jan	42.5	41.9	1.0	1.0	1.3	0	0
Feb	49.2	37.0	1.3	1.3	1.3	0	0
Mar	73.2	46.9	1.6	1.5	1.3	3,608	12,791
Apr	53.6	45.8	1.2	1.0	1.3	11,450	0
May	40.3	33.1	1.2	1.1	1.3	3,678	0
Jun	45.0	28.4	1.6	1.4	1.3	4,733	7,745
Jul	52.0	23.2	2.2	2.0	1.3	2,578	18,982
Aug	30.5	27.4	1.1	1.1	1.3	0	0
Sep	22.6	18.6	1.2	1.1	1.3	2,067	0
TOTALS	461.8	369.0				28,113	39,518

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix B-3)
1988 was a critically dry year - hence SWRCB B objective of 1.3 ppm applies.
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

Table 14.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 2 : (1988 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	14.6	20.9	0.7	0.7	1.3	0	0
Nov	23.9	34.1	0.7	0.7	1.3	0	0
Dec	27.9	27.9	1.0	1.0	1.3	0	0
Jan	42.7	42.8	1.0	1.0	1.3	0	0
Feb	49.3	37.9	1.3	1.3	1.3	0	0
Mar	74.2	49.5	1.5	1.5	1.3	0	9,000
Apr	37.6	39.4	1.0	1.0	1.3	0	0
May	35.9	33.3	1.1	1.1	1.3	0	0
Jun	44.6	31.8	1.4	1.4	1.3	0	2,891
Jul	49.7	24.9	2.0	2.0	1.3	0	15,845
Aug	34.1	31.0	1.1	1.1	1.3	0	0
Sep	25.9	28.8	0.9	1.1	1.3	0	0
TOTALS	460.4	402.3				0	27,736

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix B-5)
1988 was a critically dry year - hence SWRCB B objective of 1.3 ppm applies.
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

Table 15.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 3 : (1988 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	16.4	21.8	0.8	0.7	1.3	4,360	0
Nov	25.7	35.0	0.7	0.7	1.3	0	0
Dec	29.5	28.6	1.0	1.0	1.3	0	0
Jan	44.1	43.5	1.0	1.0	1.3	0	0
Feb	50.9	38.7	1.3	1.3	1.3	0	0
Mar	75.9	49.5	1.5	1.5	1.3	0	9,000
Apr	56.1	48.2	1.2	1.0	1.3	12,050	0
May	45.4	38.2	1.2	1.1	1.3	4,244	0
Jun	52.4	35.8	1.5	1.4	1.3	2,983	6,509
Jul	57.3	28.6	2.0	2.0	1.3	0	18,200
Aug	34.1	31.0	1.1	1.1	1.3	0	0
Sep	29.1	29.2	1.0	1.1	1.3	0	0
TOTALS	516.9	428.1				23,638	33,709

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix B-7)
1988 was a critically dry year - hence SWRCB B objective of 1.3 ppm applies.
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

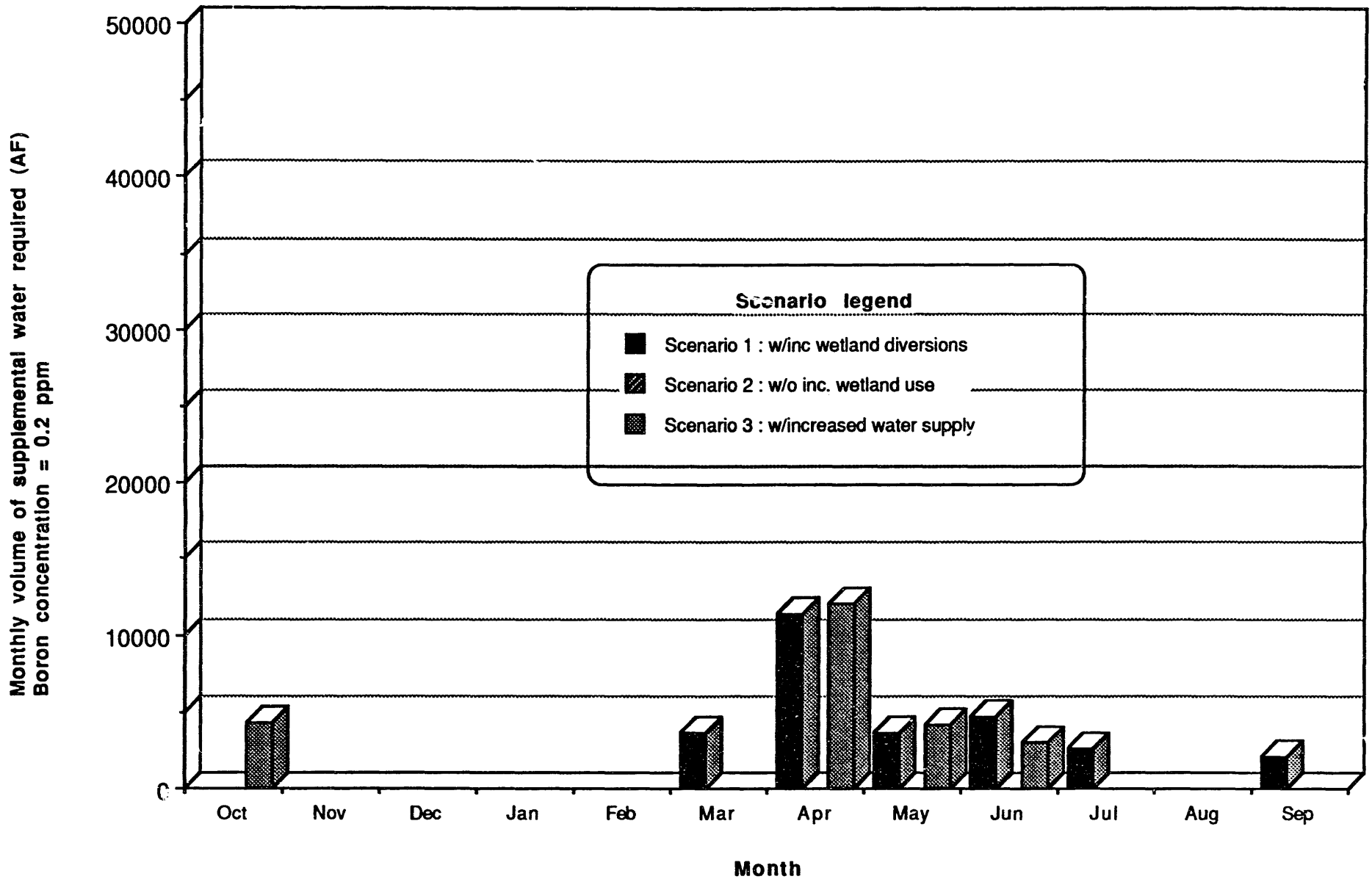


Figure 43 Monthly supplemental flows required to restore the San Joaquin River at Newman to pre-project boron concentrations (1988 hydrology)

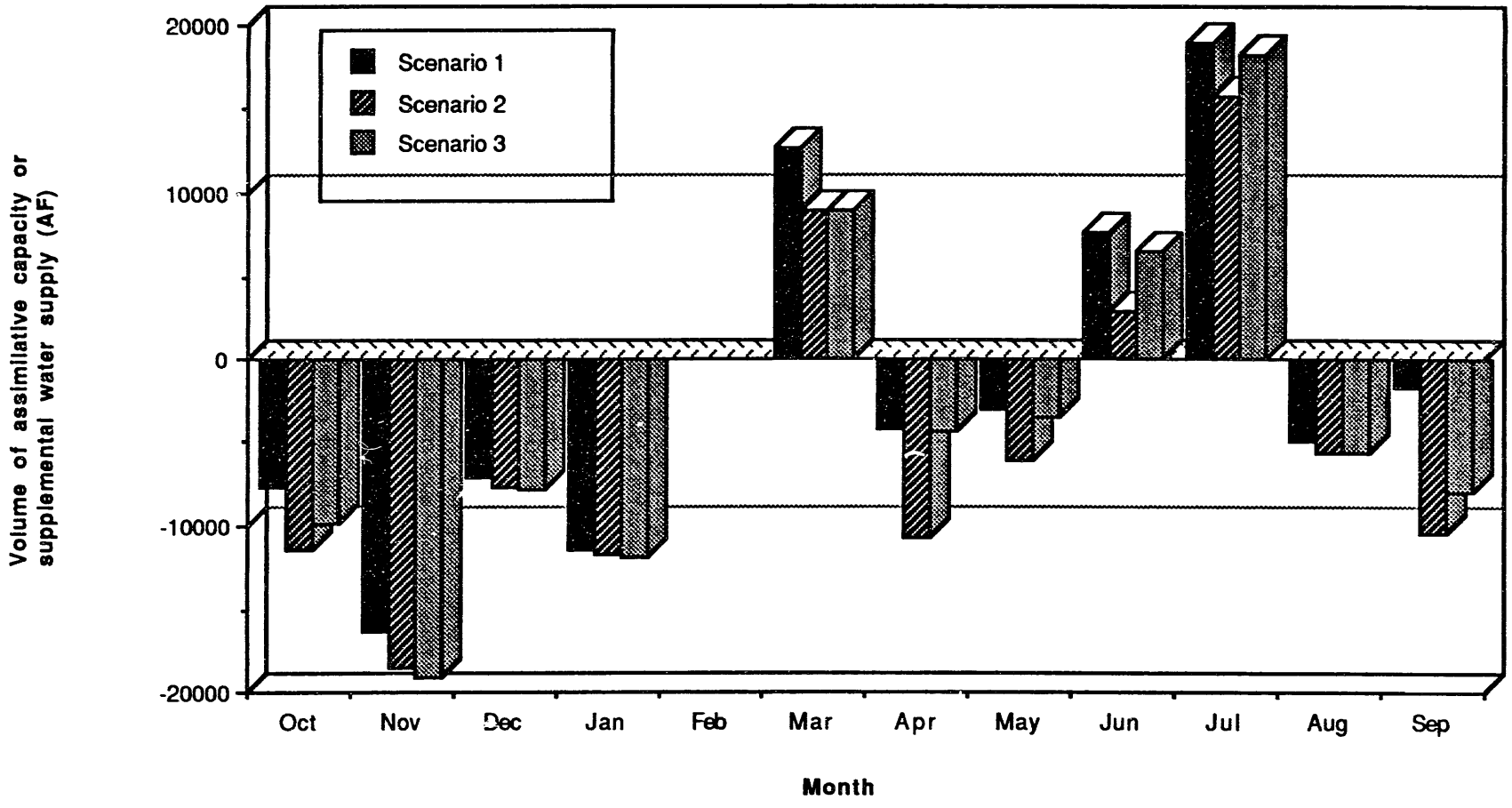


Figure 44. **Monthly assimilative capacity of the San Joaquin River or monthly volume of supplemental water required to meet SWRCB boron objective : 1988 hydrology.**

Table 16.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 1 : (1986 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	8.7	25.8	0.3	0.5	1.0	0	0
Nov	18.3	22.8	0.8	0.8	1.0	0	0
Dec	39.0	38.1	1.0	1.0	1.0	0	0
Jan	51.9	33.8	1.5	1.5	1.0	0	21,125
Feb	56.4	281.9	0.2	0.2	1.0	0	0
Mar	84.2	849.3	0.1	0.1	0.8	0	0
Apr	137.5	613.5	0.2	0.2	0.8	0	0
May	65.6	203.8	0.3	0.3	0.8	0	0
Jun	48.7	117.2	0.4	0.4	0.8	0	0
Jul	53.0	61.8	0.9	0.8	0.8	10,300	10,300
Aug	43.5	55.4	0.8	0.8	0.8	0	0
Sep	8.4	53.6	0.2	0.2	0.8	0	0
TOTALS	615.2	2357.0				10,300	31,425

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix C-3)
1986 was a wet year - hence SWRCB B objective of 0.8 ppm applies (Mar 15- Sep15); 1.0 ppm (Sep16- Mar1
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

Table 17.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 2 : (1986 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	18.1	36.1	0.5	0.5	1.0	0	0
Nov	21.6	27.0	0.8	0.8	1.0	0	0
Dec	39.8	39.8	1.0	1.0	1.0	0	0
Jan	52.1	34.7	1.5	1.5	1.0	0	21,688
Feb	56.6	282.9	0.2	0.2	1.0	0	0
Mar	85.2	851.9	0.1	0.1	0.8	0	0
Apr	121.4	607.1	0.2	0.2	0.8	0	0
May	61.2	204.0	0.3	0.3	0.8	0	0
Jun	48.3	120.6	0.4	0.4	0.8	0	0
Jul	50.8	63.5	0.8	0.8	0.8	0	0
Aug	47.1	59.0	0.8	0.8	0.8	0	0
Sep	11.6	58.4	0.2	0.2	0.8	0	0
TOTALS	613.8	2385.0				0	21,688

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix C-5)
1986 was a wet year - hence SWRCB B objective of 0.8 ppm applies (Mar 15- Sep15); 1.0 ppm (Sep16- Mar1
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

Table 18.

Volume of supplemental water supply required to meet SWRCB boron objectives for the San Joaquin River at Newman with the project : Scenario 3 : (1986 hydrology)

MONTH	1 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	2 FLOW NEWMAN KAF	3 BORON CONC WITH PROJECT ppm	4 BORON CONC W/O PROJECT ppm	5 SWRCB OBJECTIVE FOR BORON ppm	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	18.1	37.0	0.5	0.5	1.0	0	0
Nov	21.6	27.9	0.8	0.8	1.0	0	0
Dec	39.8	40.5	1.0	1.0	1.0	0	0
Jan	52.1	35.4	1.5	1.5	1.0	0	22,125
Feb	56.6	283.7	0.2	0.2	1.0	0	0
Mar	85.2	851.9	0.1	0.1	0.8	0	0
Apr	124.6	615.9	0.2	0.2	0.8	0	0
May	62.5	208.9	0.3	0.3	0.8	0	0
Jun	49.8	124.6	0.4	0.4	0.8	0	0
Jul	52.7	67.2	0.8	0.8	0.8	0	0
Aug	47.1	59.0	0.8	0.8	0.8	0	0
Sep	12.3	60.0	0.2	0.2	0.8	0	0
TOTALS	622.4	2412.0				0	22,125

(a) & (b) assume the B concentration of supplemental water supply is 0.2 ppm. (see Appendix C-7)
1986 was a wet year - hence SWRCB B objective of 0.8 ppm applies (Mar 15- Sep15); 1.0 ppm (Sep16- Mar1
NF - Infeasible since an infinite volume of supplemental water supply at 0.2 ppm would be required

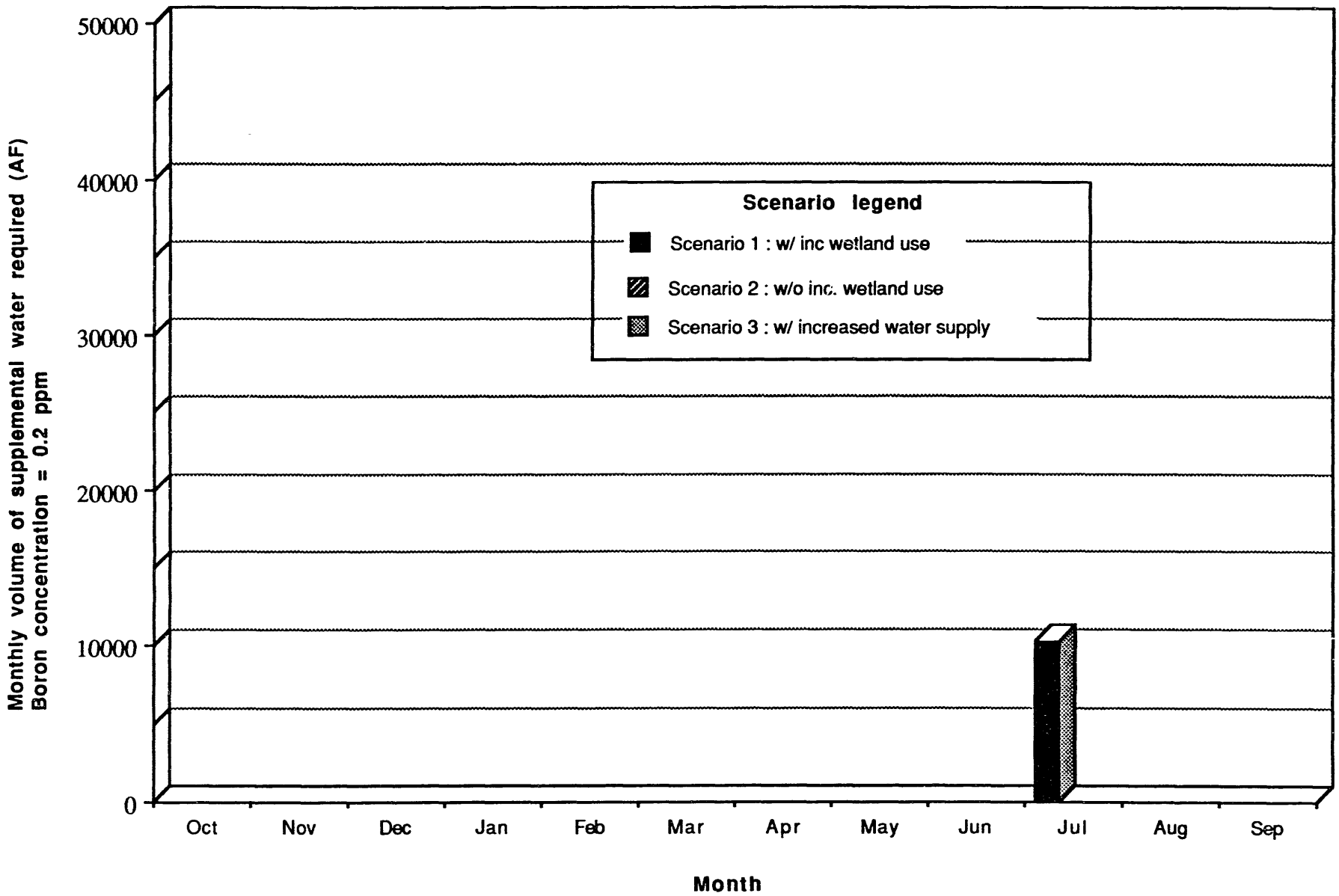


Figure 45 **Monthly supplemental flows required to return San Joaquin River at Newman to pre-project boron concentrations (1986 hydrology)**

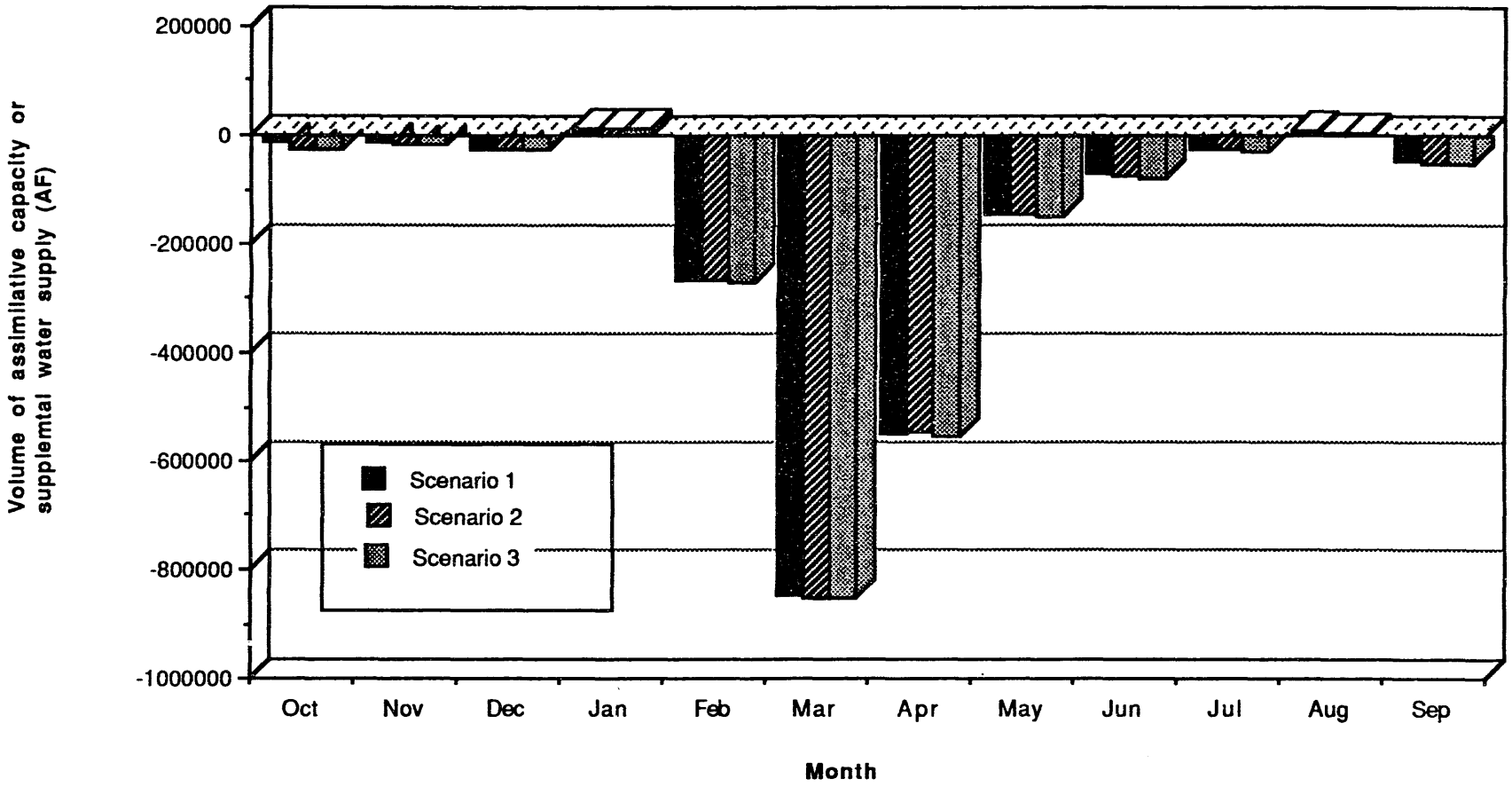


Figure 46. **Monthly assimilative capacity of the San Joaquin River or monthly volume of supplemental water required to meet SWRCB boron objective : 1986 hydrology.**

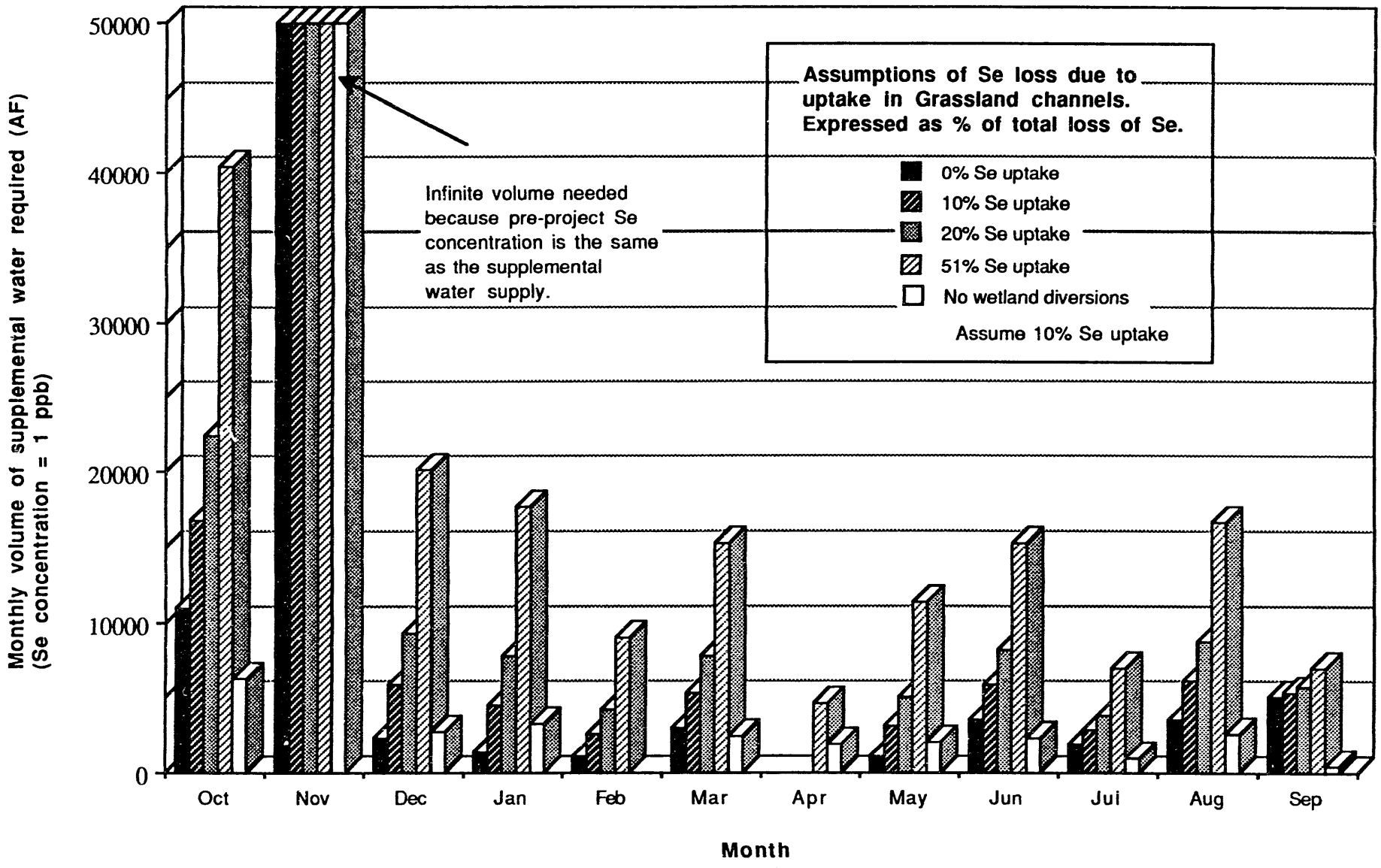


Figure 47 Monthly supplemental flows required to return San Joaquin River at Newman to pre-project selenium concentrations (1988 hydrology).

Table 19.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 1 : (1988 hydrology) (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	65.2	10.6	6.2	3.0	8.0	16,700	0
Nov	35.9	29.9	1.2	1.0	8.0	NF	0
Dec	90.3	26.2	3.4	3.0	8.0	5,850	0
Jan	181.2	41.9	4.3	4.0	8.0	4,533	0
Feb	314.3	37.0	8.5	8.0	8.0	2,614	2,614
Mar	360.4	46.9	7.7	7.0	8.0	5,350	0
Apr	301.9	45.8	6.6	7.0	8.0	0	0
May	214.0	33.1	6.5	6.0	8.0	3,080	0
Jun	268.2	28.4	9.4	8.0	8.0	5,857	5,857
Jul	283.7	23.2	12.2	11.0	8.0	2,850	14,014
Aug	228.8	27.4	8.4	7.0	8.0	6,167	1,371
Sep	162.4	18.6	8.7	7.0	8.0	5,367	1,943
TOTALS	2506.3	369.0				58,368	25,800

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix B-12)
1988 was a critically dry year - hence SWRCB Se objective of 0.8 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

Table 20.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 2 : (1988 hydrology) (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	74.3	20.9	3.6	3.0	8.0	5,800	0
Nov	38.9	34.1	1.1	1.0	8.0	NF	0
Dec	90.7	27.9	3.2	3.0	8.0	2,790	0
Jan	180.9	42.8	4.2	4.0	8.0	3,233	0
Feb	292.4	37.9	7.7	8.0	8.0	0	0
Mar	361.0	49.5	7.3	7.0	8.0	2,417	0
Apr	287.6	39.4	7.3	7.0	8.0	1,967	0
May	210.1	33.3	6.3	6.0	8.0	2,060	0
Jun	270.4	31.8	8.5	8.0	8.0	2,286	2,286
Jul	283.8	24.9	11.4	11.0	8.0	990	12,086
Aug	232.4	31.0	7.5	7.0	8.0	2,567	0
Sep	166.7	23.5	7.1	7.0	8.0	367	0
TOTALS	2489.2	397.0				24,476	14,371

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix B-18)
1988 was a critically dry year - hence SWRCB Se objective of 0.8 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

Table 21.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 3 : (1988 hydrology) (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	76.4	21.8	3.5	3.0	8.0	5,450	0
Nov	41.0	35.0	1.2	1.0	8.0	NF	0
Dec	92.7	28.6	3.2	3.0	8.0	2,860	0
Jan	182.8	43.5	4.2	4.0	8.0	2,900	0
Feb	294.4	38.7	7.6	8.0	8.0	0	0
Mar	363.0	49.5	7.3	7.0	8.0	2,475	0
Apr	304.3	48.2	6.3	7.0	8.0	0	0
May	219.1	38.2	5.7	6.0	8.0	0	0
Jun	275.6	35.8	7.7	8.0	8.0	0	0
Jul	289.1	28.6	10.1	11.0	8.0	0	8,580
Aug	232.4	31.0	7.5	7.0	8.0	2,583	0
Sep	168.9	25.1	6.7	7.0	8.0	0	0
TOTALS	2539.7	424.0				16,268	8,580

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix B-20)
1988 was a critically dry year - hence SWRCB Se objective of 0.8 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

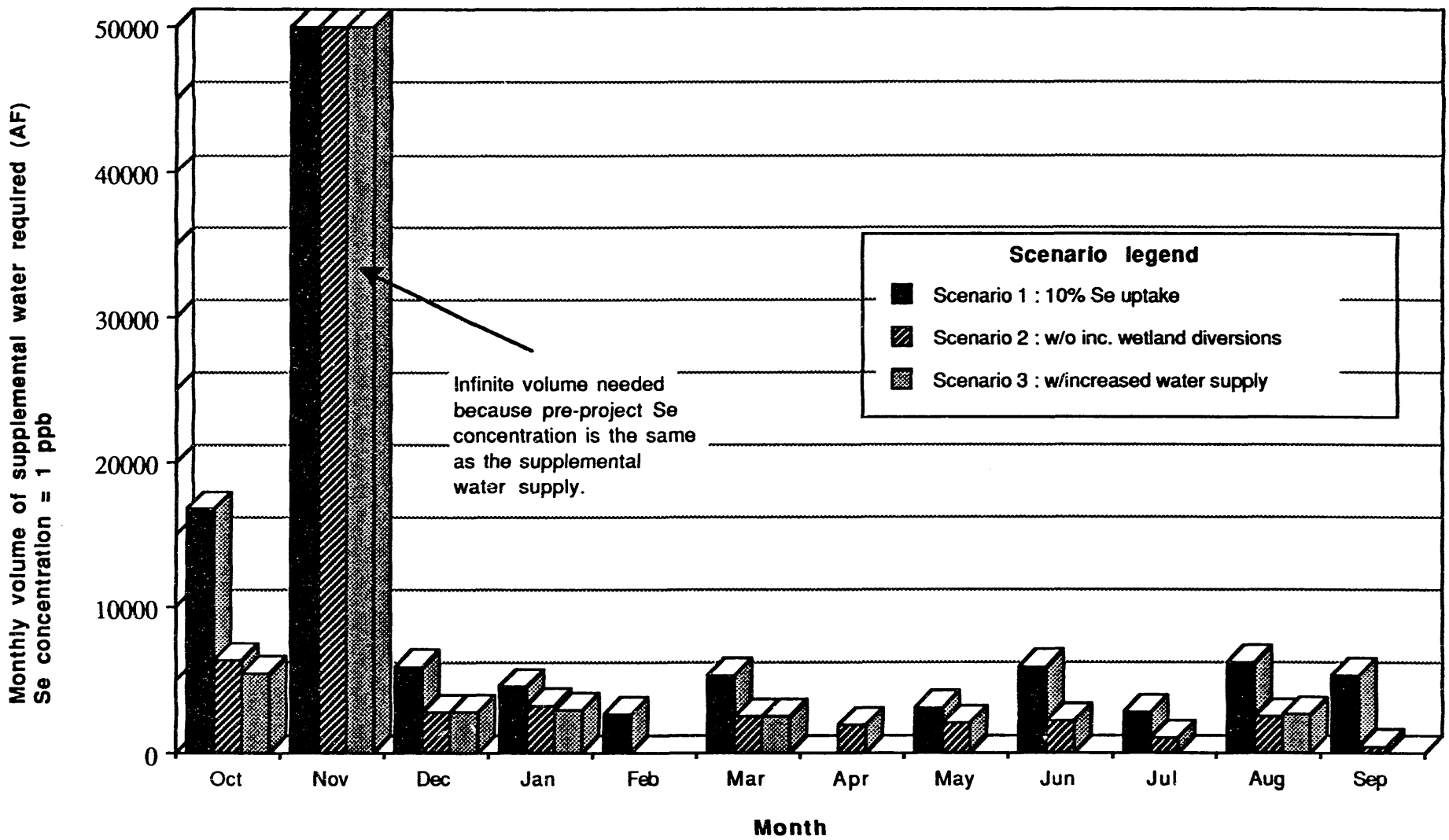


Figure 48 Monthly supplemental flows required to return the San Joaquin River at Newman to pre-project selenium concentrations (1988 hydrology).

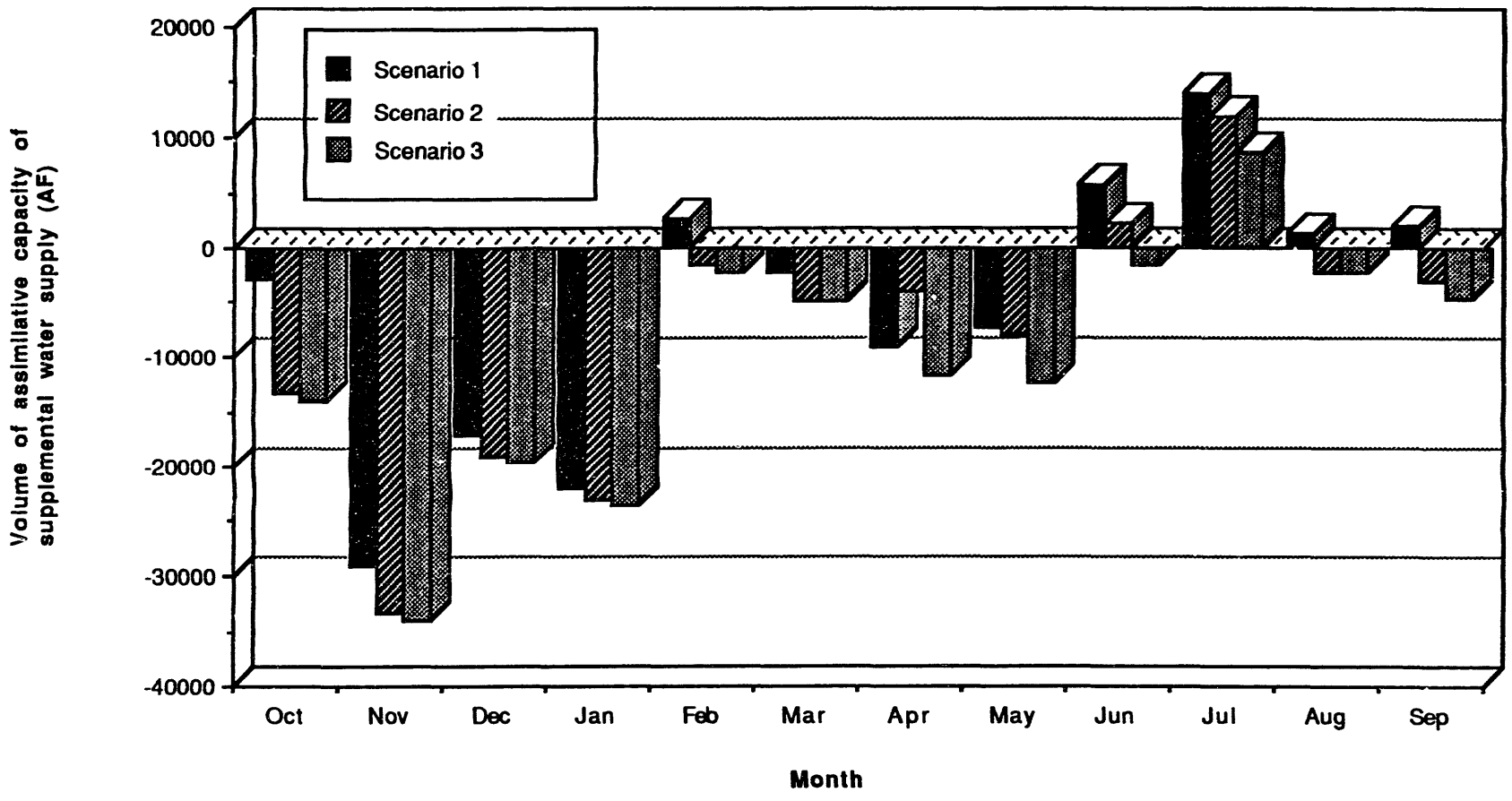


Figure 49. **Monthly assimilative capacity of the San Joaquin River or monthly volume of supplemental water required to meet SWRCB selenium objective : 1988 hydrology.**

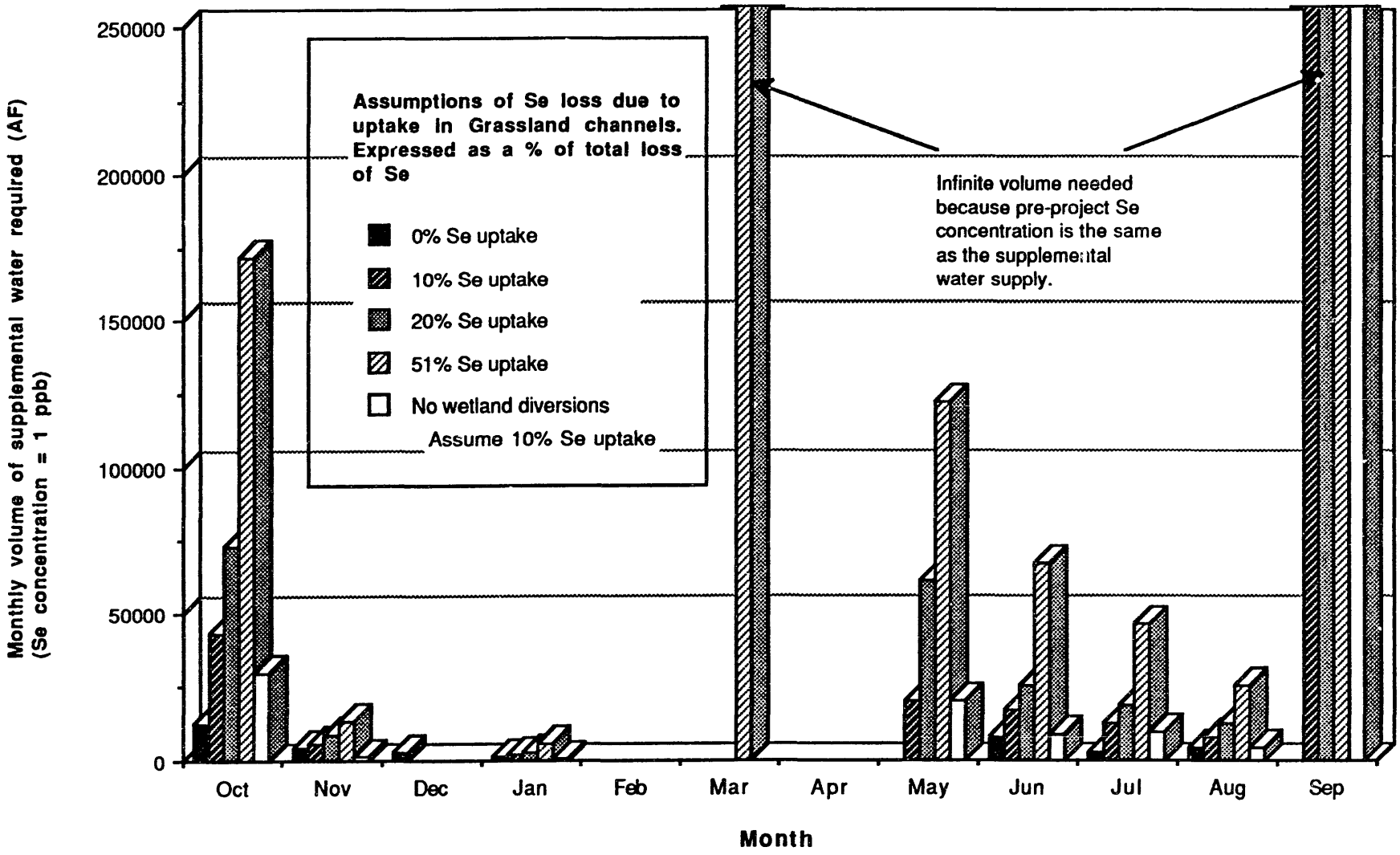


Figure 50 Monthly supplemental flows required to return San Joaquin River at Newman to pre-project selenium concentrations (1986 hydrology).

Table 22.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 1 : (1986 hydrology). (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	67.2	25.8	2.6	1.6	5.0	43,000	0
Nov	67.2	22.8	2.9	2.5	5.0	6,080	0
Dec	91.2	38.1	2.4	2.4	5.0	0	0
Jan	227.2	33.8	6.7	6.4	5.0	1,878	14,365
Feb	333.2	282.0	1.2	1.2	5.0	0	0
Mar	867.7	849.3	1.0	1.0	5.0	0	0
Apr	853.0	613.5	1.4	1.4	5.0	0	0
May	436.4	203.8	2.1	2.0	5.0	20,380	0
Jun	303.4	117.2	2.6	2.4	5.0	16,743	0
Jul	207.1	61.8	3.4	3.0	5.0	12,360	0
Aug	30.8	55.4	5.6	5.0	5.0	8,310	8,310
Sep	72.6	53.5	1.4	1.0	5.0	NF	0
TOTALS	3557.0	2357.0				108,751	22,675

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix C-12)
1986 was a wet year - hence SWRCB Se objective of 0.5 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

Table 23.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 2 : (1986 hydrology). (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	76.3	36.1	2.1	1.6	5.0	30,083	0
Nov	70.2	27.0	2.6	2.5	5.0	1,800	0
Dec	91.6	39.8	2.3	2.4	5.0	0	0
Jan	226.9	34.7	6.5	6.4	5.0	643	13,013
Feb	332.9	282.9	1.2	1.2	5.0	0	0
Mar	868.3	851.9	1.0	1.0	5.0	0	0
Apr	838.2	607.1	1.4	1.4	5.0	0	0
May	432.2	204.0	2.1	2.0	5.0	20,400	0
Jun	305.6	120.6	2.5	2.4	5.0	8,614	0
Jul	207.2	63.5	3.3	3.0	5.0	9,525	0
Aug	311.8	59.0	5.3	5.0	5.0	4,425	4,425
Sep	76.9	58.4	1.3	1.0	5.0	NF	0
TOTALS	3838.1	2385.0				75,490	17,438

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix C-18)
1986 was a wet year - hence SWRCB Se objective of 0.5 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

Table 24.

Volume of supplemental water supply required to meet SWRCB selenium objectives for the San Joaquin River at Newman with the project : Scenario 3 : (1986 hydrology). (assume Grassland Se losses of 10%).

MONTH	1 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	2 FLOW NEWMAN KAF	3 SELENIUM CONC WITH PROJECT ppb	4 SELENIUM CONC W/O PROJECT ppb	5 SWRCB OBJECTIVE FOR SELENIUM ppb	6 SUPPLEMENTAL VOLUME TO MATCH FWO CONC. (a) AF	7 SUPPLEMENTAL VOLUME TO MEET SWRCB OBJ. (b) AF
Oct	78.4	37.0	2.1	1.6	5.0	30,833	0
Nov	72.3	27.9	2.6	2.5	5.0	1,860	0
Dec	93.6	40.5	2.3	2.4	5.0	0	0
Jan	228.8	35.4	6.5	6.4	5.0	656	13,275
Feb	334.9	283.7	1.2	1.2	5.0	0	0
Mar	870.3	851.9	1.0	1.0	5.0	0	0
Apr	855.4	615.9	1.4	1.4	5.0	0	0
May	441.5	208.9	2.1	2.0	5.0	20,890	0
Jun	310.8	124.6	2.5	2.4	5.0	8,900	0
Jul	212.5	67.2	3.2	3.0	5.0	6,720	0
Aug	311.8	59.0	5.3	5.0	5.0	4,425	4,425
Sep	79.1	60.0	1.3	1.0	5.0	NF	0
TOTALS	3889.4	2412.0				74,284	17,700

(a) & (b) assume the Se concentration of supplemental water supply is 1ppb. (See Appendix C-20)
1986 was a wet year - hence SWRCB Se objective of 0.5 ppb applies.
NF - Infeasible since an infinite volume of supplemental water supply at 1ppb would be required

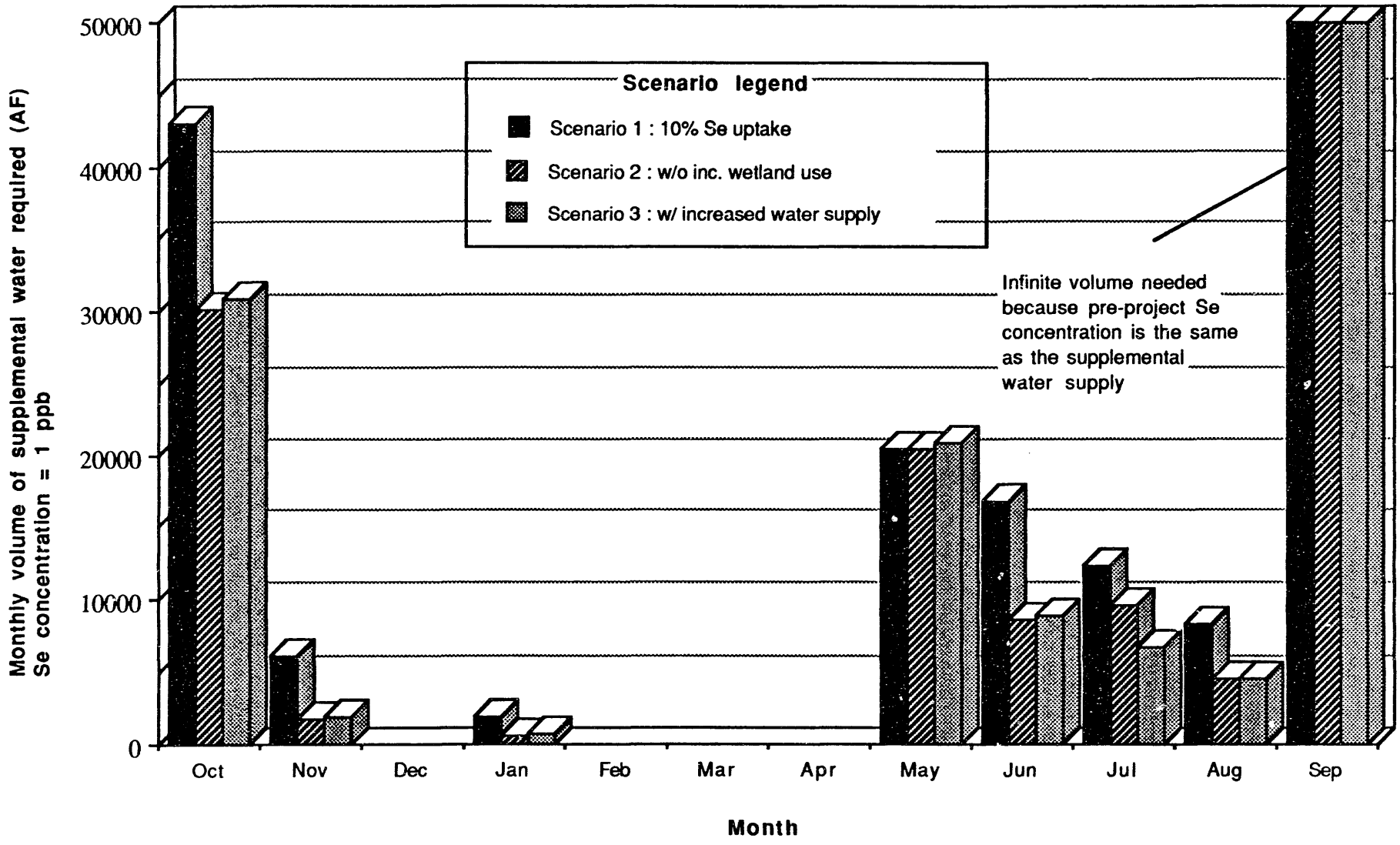


Figure 51 **Monthly supplemental flows required to return the San Joaquin River at Newman to pre-project selenium conditions (1986 hydrology).**

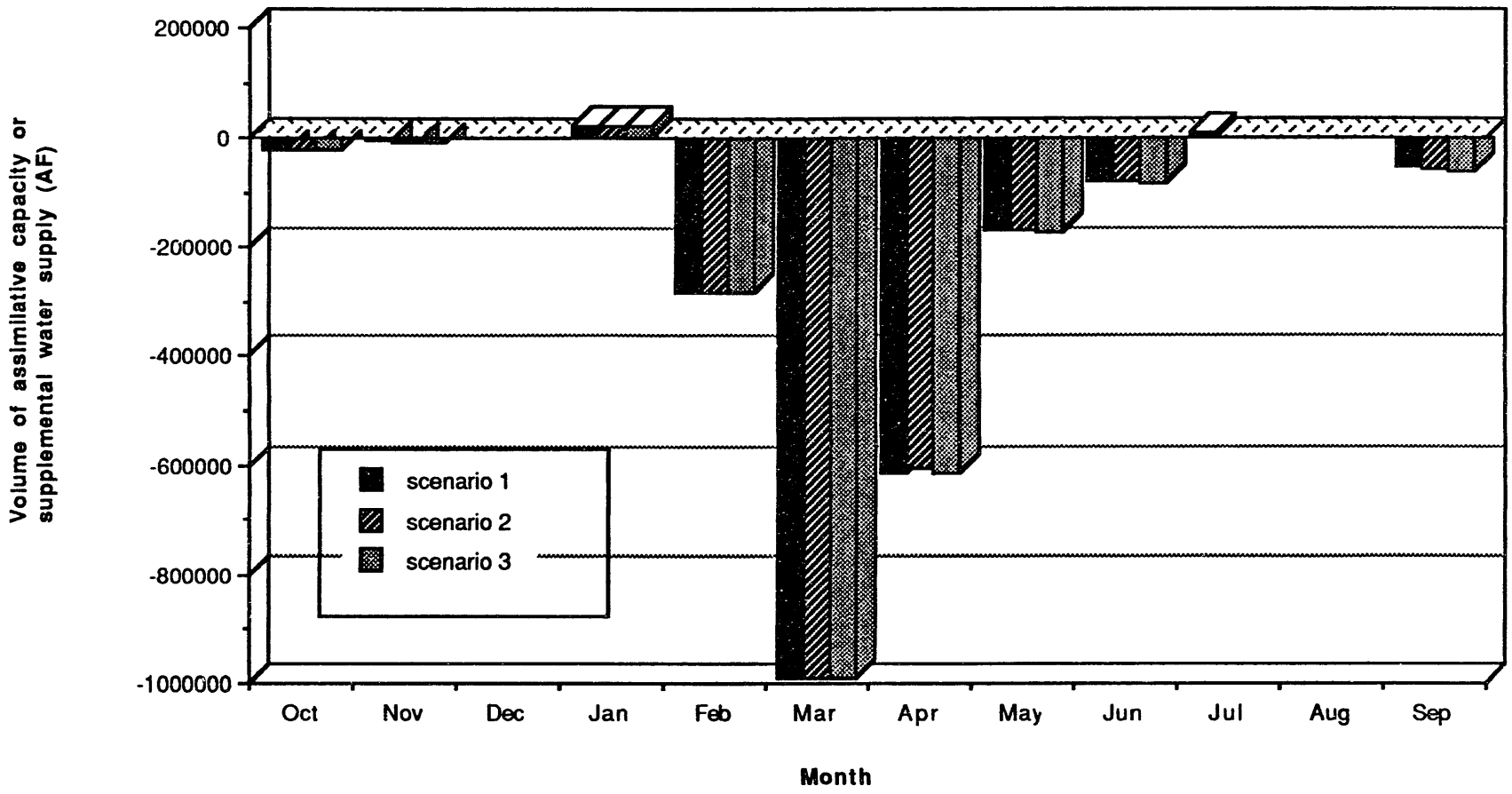


Figure 52. Monthly assimilative capacity of the San Joaquin River or monthly volume of supplemental water required to meet SWRCB selenium objective : 1986 hydrology.

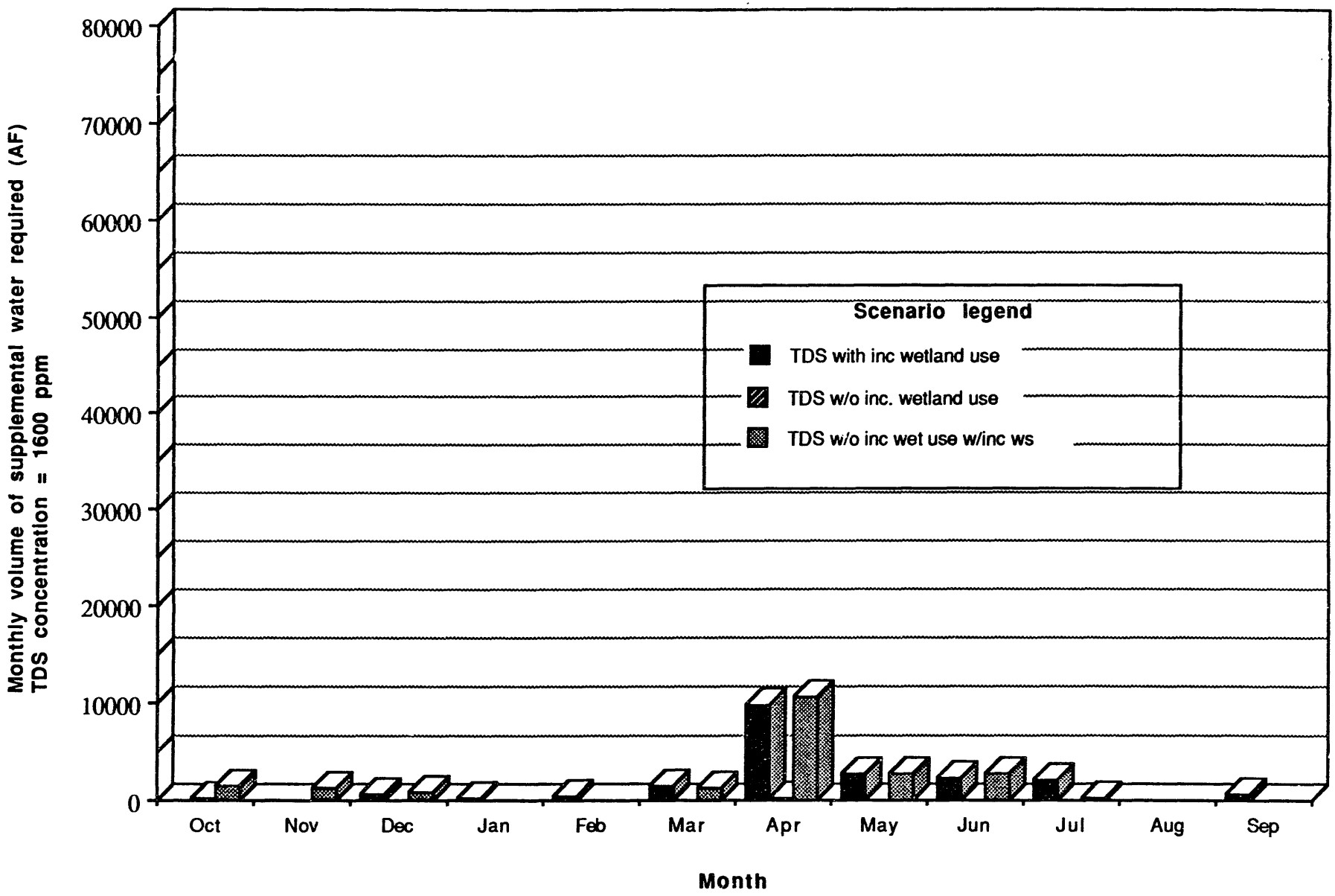


Figure 53 **Monthly supplemental flows required to return San Joaquin River at Newman to pre-project TDS concentrations (1988 hydrology)**

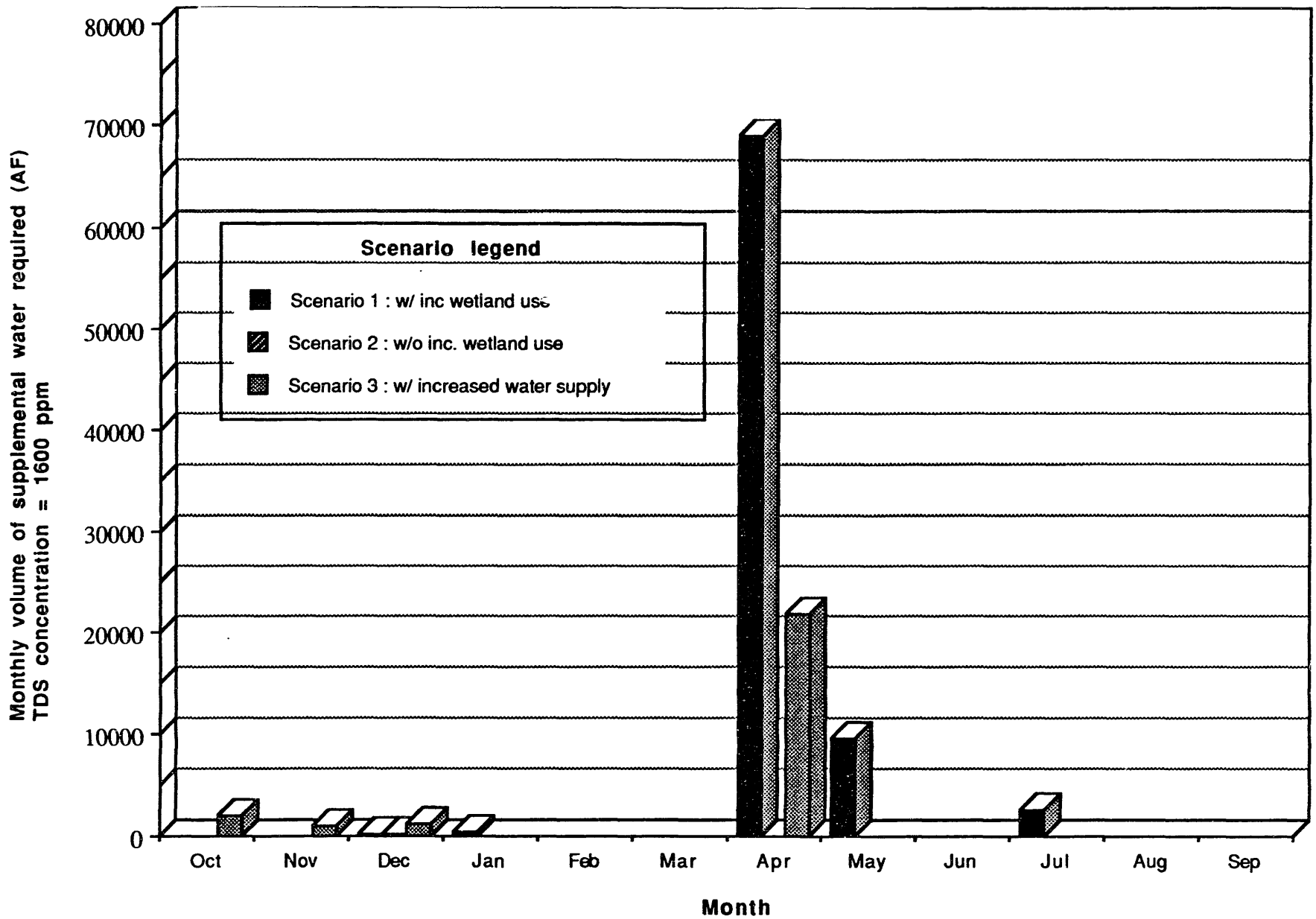


Figure 54 **Monthly supplemental flows required to return San Joaquin River at Newman to pre-project TDS concentrations (1986 hydrology)**

Although a greater volume of supplemental water appears to be required using the 1986 hydrology, the number of months for which supplemental flows are needed is reduced.

Figures 49 and 52 and Tables 18 - 23 can be used to contrast the monthly supplemental flows required to meet SWRCB objectives for selenium in 1988 and 1986 respectively. Figure 49 shows that total supplemental water requirements of 25,800 AF/yr , 14,371 AF/yr and 8,580 AF/yr are needed in Scenarios 1, 2 and 3 respectively (assuming a 10% selenium uptake). In a wet year (1986) these requirements are 22,675 AF/yr , 17,438 AF/yr and 17,700 AF/yr. In 1988 the highest supplemental water requirements occurred in the months of June and July, whereas for 1986 the highest requirement occurred in January. Although not apparent from Figure 52 because of the scale of the ordinate, substantial assimilative capacity occurs in the river during the months October through December for all three project scenarios in 1986. Similarly in 1988 the months October through January combined produce an assimilative capacity ranging from more than 75,000 AF for Scenario 1 to more than 95,000 AF for Scenario 2. In all cases, considering only these months, the total assimilative capacity of the river exceeds the volume of supplemental water required - unfortunately this assimilative capacity does not coincide with the period of greatest selenium load to the river, which typically runs from February through July.

In Figure 52, the high volumes of spring runoff produced exceptionally high river assimilative capacities in the months February through June, as high as 1 MAF in March of 1988 , when applied to all three of the potential project scenarios. Hildebrand (personal communication, 1990) and others have advocated the utilization of this assimilative capacity in wet years by pumping shallow groundwater - hence reducing shallow groundwater tables and the annual production of tile drainage high in toxic trace elements in succeeding years. Recent work by Swain (personal communication, 1991) and CH2M-Hill (Grant Davids, personal communication, 1991) has shown that a system of improved irrigation management, combined with drainage recycling and temporary storage of subsurface drainage, can be developed to take better advantage of river assimilative capacity for boron and selenium in the San Joaquin River.

Figures 53 and 54 and Tables B21-B28 and C21 - C28 show the supplemental flows required to restore the San Joaquin River to pre-project TDS concentrations for 1988 and 1986 respectively. Since there is no SWRCB objective for TDS at Newman, and meeting the Vernalis objective is outside the scope of this study this was the only analysis performed. Total supplemental water requirements for 1988 range from 20,227 AF/yr for Scenario 1, 590 AF/yr for Scenario 2 and 20,864 AF/yr for Scenario3. In Scenarios 1 and 3 wetland return flows add TDS load to Mud Slough, which require dilution to return them to the pre-project TDS concentrations. In 1986, the high volumes of stream flow during the spring months tended to damp out the effect of the wetland return flows - hence only 50% of the 1988 Scenario 1 supplemental flows were required to restore the San Joaquin River to pre-project conditions. No supplemental water was required for either Scenario 2 or Scenario 3 in 1986.

5. Conclusions

5.1 Summary of findings

The major effects of the proposed action under scenarios 1, 2 and 3 were summarized in Tables 11 and 12. The major effect of the project under each of the three scenarios described in this document are to increase the load and concentration of boron , selenium and TDS in Mud Slough while reducing the load and concentration of these contaminants in Salt Slough. Other observations are as follows :

- o Violations of the SWRCB mean monthly concentration objectives for boron in Salt Slough, which currently occur, and which would continue to occur in the future, under the without - project scenario, would likely be eliminated with implementation of the project. Violation of the SWRCB monthly maximum concentrations for selenium, which occur infrequently in Salt Slough in dry years, such as 1988, are also likely to be eliminated with implementation of the project.

- o SWRCB mean monthly boron concentration objectives for boron in Mud Slough which are currently violated in both critically dry and wet years would continue to be violated in both the without project and with project scenarios. The monthly maximum boron concentration level of 5.8 ppm was violated once using the 1988 hydrology in Scenario 1, whereas no violations occurred in the without-project scenario. Selenium concentrations in Mud Slough, which currently exceed the mean monthly objective for more than one third of the year in both critically dry and wet years, would violate the objective throughout the year with implementation of the project. Maximum monthly selenium concentrations were violated in June and July of the wet year,1986, in Mud Slough but not in the critically dry year,1988. It would be more likely that these SWRCB maximum monthly selenium concentrations would be violated with implementation of the project, especially in critically dry years.

- o Implementation of the project causes boron, selenium and TDS loads and flows to decrease during every month of the year in Salt Slough and increase for every month of the year in Mud Slough. During the spring and late summer months these changes can be greater or smaller by a factor of greater than 100%.

  In every scenario the water quality for TDS, boron and selenium improves in Salt Slough and deteriorates in Mud Slough. The timing of the highest loads in Salt Slough in the without project scenario generally corresponds to the timing of the highest flows - these occur during preirrigation and the regular season irrigations within the upslope water districts. Diversion of these high loads by the project into Mud Slough, during the high flow months of February - April and July - August, produces a corresponding bimodal load distribution. The concentrations of contaminants tend to be highest between December and February for TDS and boron in Salt Slough in the without project scenario and in Mud Slough in the with-project scenarios, when

flows are low. Selenium concentrations, on the other hand are influenced, not only by the timing of wetland releases, but also by opportunities for uptake by aquatic vegetation and biota.

- The water years 1986 - 1990 show a trend of decreased flows of agricultural drainage water from the upslope agricultural water districts. This reduction in flow is the result of improvements in water conservation and irrigation practices and an increase in tailwater and subsurface drainage recycling. As a result, the concentrations of TDS, boron and selenium within the drainage water from these water districts have increased during the same period. If the flows and the concentrations are multiplied together, a small reduction in contaminant loading to the Grassland area appears to be taking place for TDS, boron and selenium. The encouragement of water conservation and drainage reduction practices in the upslope agricultural areas would appear to make it more difficult for these entities to comply with water quality objectives for selenium and boron in Mud and Salt Sloughs. However, the reductions in boron and selenium loads should make it easier to comply with SWRCB water quality objectives for the San Joaquin River at Newman. During drought periods such as the present one, smaller volumes of Merced River water may be available to dilute the discharges from Mud and Salt Sloughs. Tailwater drainage flows and operational spills are also substantially reduced, diminishing the available water supply for dilution purposes.

- The boron objective is generally more restrictive than the selenium objective in the San Joaquin River at Newman for the with-project scenarios. This occurs even though selenium concentrations are expected to increase by a greater percentage than boron concentrations as a result of the project. The ramification of this finding is that selenium levels would be expected to fall below the objective during those months where the assimilative capacity of the river with respect to boron was met but not exceeded.

- Annual supplemental water requirements are generally higher for boron than they are for selenium for both 1988 and 1986 hydrologies to meet SWRCB objectives for the San Joaquin River at Newman. Conversely, supplemental water requirements are greater for selenium than they are for either boron or TDS in order to restore the San Joaquin River to pre-project concentrations.

- Wetland return flows often have boron concentrations exceeding the SWRCB objectives for Mud and Salt Sloughs. Delivering additional water to wetlands, such as was analyzed in Scenario 3 to discourage use of Salt Slough flows, increases total boron loading to the San Joaquin River but does not have a significant affect on boron concentrations in the river for either 1988 or 1986 hydrologies. Although boron and selenium loading to the San Joaquin River is similar in Scenarios 1 and 2, boron and selenium concentrations are almost always higher in Scenario 1 because of the use of Salt Slough to provide supplemental wetland water supply .

- Considerable opportunity exists to make use of the assimilative capacity of the San Joaquin River through creative management of subsurface agricultural drainage that contains high levels of potentially toxic trace elements. Pumping of the shallow semi-confined aquifer and discharge of contaminated water high in these trace elements during wet years and times of large river assimilative capacity can help to lower water tables and thus reduce the flow and load of contaminated agricultural return flows during nomal and dry years. Changes in drainage management practices to accomodate this strategy would be made easier with the implementation of the proposed project.

5.2 Study Limitations

Besides the data limitations, which were discussed in Section 2, the major weakness of this study lies in the use of recent hydrology data to represent the without-project scenario pre-1985 conditions before the development of the Blake-Porter bypass and its use to divert contaminated drainage flows from Camp 13 and Agatha Canals directly into Mud Slough (South) and Salt Sough for eventual delivery to the San Joaquin River. A calibration procedure was devised to allow reconstruction of the monthly flow records, so as to account for the effects of these diversions and on the conditions manifested without the proposed action. The paucity of data, especially replicate data, makes it impossible to test some of the assumptions made in this analysis or to develop confidence intervals for the flow, load and concentration data. As a result, there are unexplained gains and losses of TDS, boron and selenium within the study area.

The mechanisms responsible for selenium losses that have been shown to occur within the Grassland area are not well understood. Hence, there is no means to predict with confidence the effect of diverting the contaminated agricultural drainage flows into the San Luis Drain - hence reducing the total residence time in the vegetated channels within the Grassland area. If uptake by vegetation is the primary mechanism responsible for selenium uptake then the net gain in selenium load with implementation of the project could be as large as 51% of the total annual system losses of selenium. On the other hand, if algae and phytoplankton are the responsible agents for the loss of selenium in the system, then the losses experienced by the current routing of contaminated drainage flows could quite easily be replicated in the San Luis Drain. The long - term effects of selenium immobilization and accumulation within Mud Slough are also unknown. This research question deserves to be examined in more detail.

6. References

Boyle Engineering Corporation, 1987. An Evaluation of Wetland Habitat for Offstream Storage : Final Report. US Buraeu of reclamation, CA. November, 1987.

CRWCB, 1990. Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California. October 1988 through September 1989. Water Year 1989. November 1990.

CRWCB, 1991. Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California. October 1989 through September 1990. Water Year 1990. November 1991.

Phillips A. and N.W.T. Quinn. 1989. Grassland Fresh Water Supply and Drainage Model Preliminary Draft Report. September, 1989.

Quinn, N.W.T. et al. 1990. Overview of the Use of the Westside Agricultural Drainage Economics Model (WADE) for Plan Evaluation. Technical Information Record. August, 1990.

SJVDP, 1990a. Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California. October 1990.

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

State Water Resources Control Board, 1987. Regulation of Agricultural Drainage to the San Joaquin River. Final Report. August, 1987.

Summers Engineering, 1990. Environmental Assessment and Initial Study. Proposed Use of the San Luis Drain for Conveyance of Drainage Water through the Grassland Water District and Adjacent Grassland Areas.

Summers Engineering, 1991. Monitoring Program Map, 1991.

Swain D.G., 1990. Documentation of the Use of Data, Analysis and Evaluation Process that Resulted in the SJVDP Recommended Plan. Technical Information Record. September, 1990.

Swain D.G. and N.W.T. Quinn, 1991. Analysis of the Potential Water Quality Impacts Resulting from the Proposed Use of the San Luis Drain by Grassland Drainers. In : Supplemental Environmental assessment and Draft Finding of No Significant Impact. USBR, April, 1991.

USBR, 1989. Report on Refuge Water Supply Investigations. Central Valley Hydrologic Basin, California. March 1989.

USGS Watstore database.

Appendix A

Monthly water quality data
Concentrations and load-flow factor

San Joaquin River, Mud Slough, Salt Slough

1986 - 1990

A1 - A11

Table A-1

SAN JOAQUIN RIVER nr NEWMAN AVERAGE MONTHLY WATER QUALITY (a)
(Flows and Salt Loads in 1000s)

MONTH	YEAR 1986								
		CONCENTRATION				LOAD-FLOW FACTOR			
	FLOWS (b) AF or cfs	Salinity EC	TDS ppm	B ppm	Se ppb	EC-FLOW AF-ppm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	36.1	0.8	492	0.5	1.6	28.3	17,743	18.3	58.3
7	455	0.6	365	0.2	1.0	273	166,075	91	455
23	724	0.9	571	0.7	2.0	651.6	413,404	506.8	1448
Total	1179					924.6	579,479	597.8	1903
Nov - Ave.	27	1.2	721	0.8	2.5	32.2	19,472	21.6	68.7
6	497	1.1	668	0.8	3.0	546.7	331,996	397.6	1491
18	414	1.3	785	0.8	2.0	538.2	324,990	331.2	828
Total	911					1084.9	656,986	728.8	2319
Dec - Ave.	39.8	1.2	728	1.0	2.4	48.6	28,958	38.3	95.7
4	876	1.1	571	0.8	2.0	963.6	500,196	700.8	1752
18	598	1.4	957	1.2	3.0	837.2	572,286	717.6	1794
Total	1474					1800.8	1,072,482	1418.4	3546
Jan - Ave.	34.7	1.7	1,127	1.5	6.4	59.8	39,097	51.0	223.4
8	508	1.5	1,020	1.3	7.0	762	518,160	660.4	3556
23	651	1.9	1,210	1.6	6.0	1236.9	787,710	1041.6	3906
Total	1159					1998.9	1,305,870	1702	7462
Feb - Ave.	282.9	0.4	194	0.2	1.2	103.7	54,991	47.1	339.5
5	971	1.3	802	1.1	4.0	1262.3	778,742	1068.1	3884
20	13600	0.3	151	0.1	1.0	4080	2,053,600	1360	13600
Total	14571					5342.3	2,832,342	2428.1	17484
Mar-Ave.	851.9	0.2	121	0.1	1.0	134.9	103,306	118.3	851.9
4	5580	0.4	230	0.3	1.0	2232	1,283,400	1674	5580
18	23100	0.1	95	0.1	1.0	2310	2,194,500	2310	23100
Total	28680					4542	3,477,900	3984	28680
Apr-Ave.	607.1	2.0	170	0.2	1.4	1214.2	103,143	121.4	869.6
2	15100	0.3	182	0.2	1.0	4530	2,748,200	3020	15100
15	11500	0.3	154	0.2	2.0	3450	1,771,000	2300	23000
Total	26600					7980	4,519,200	5320	38100
May - Ave.	204	1.7	277	0.3	2.0	346.8	56,595	68.2	408.0
6	4440	0.4	216	0.3	2.0	1776	959,040	1332	8880
21	2300	0.7	396	0.4	2.0	1610	910,800	920	4600
Total	6740					3386	1,869,840	2252	13480
Jun - Ave.	120.6	1.7	301	0.4	2.4	205.0	36,325	50.4	288.8
3	2380	0.4	231	0.3	2.0	952	549,780	714	4760
17	1550	0.7	409	0.6	3.0	1085	633,950	930	4650
Total	3930					2037	1,183,730	1644	9410
Jul-Ave.	63.5	1.6	646	0.8	3.0	101.6	41,021	50.8	190.5
15	920	1.1	646	0.8	3.0	1012	594,320	736	2760
						0	0	0	0
Total	920					1012	594,320	736	2760
Aug-Ave.	59	1.4	564	0.8	5.0	82.6	33,276	47.2	295.0
26	974	0.9	564	0.8	5.0	876.6	549,336	779.2	4870
						0	0	0	0
Total	974					876.6	549,336	779.2	4870
Sep-Ave.	58.4	1.6	288	0.2	1.0	93.4	16,819	11.7	58.4
24	971	0.5	288	0.2	1.0	485.5	279,648	194.2	971
						0	0	0	0
Total	971					485.5	279,648	194.2	971
	2385.0								

(a) USGS published and unpublished data.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-2

SAN JOAQUIN RIVER nr NEWMAN AVERAGE MONTHLY WATER QUALITY (a)
(Flows and Salt Loads in 1000s)

MONTH	YEAR 1987									MONTH	YEAR 1988								
		CONCENTRATION				LOAD-FLOW FACTOR						CONCENTRATION				LOAD-FLOW FACTOR			
	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-ppm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb		FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	56.2	0.4	270	0.2	2.0	22.5	15,174	11.2	112.4	Oct - Ave.	20.9	1.1	689	0.7	2.0	23.0	14,400	14.6	41.8
23	1120	0.4	270	0.2	2.0	448	302,400	224	2240	21	322	1.1	689	0.7	2.0	354.2	221,858	225.4	644
Total	1120					448	302,400	224	2240	Total	322					354.2	221,858	225.4	644
Nov - Ave.	32.9	1.2	749	0.9	4.0	39.5	24,642	29.6	131.6	Nov - Ave.	34.1	1.1	670	0.7	1.0	37.5	22,847	23.9	34.1
20	534	1.2	749	0.9	4.0	640.8	399,966	480.6	2136	18	553	1.1	670	0.7	1.0	608.3	370,510	387.1	553
Total	534					640.8	399,966	480.6	2136	Total	553					608.3	370,510	387.1	553
Dec - Ave.	30.8	1.5	899	1.0	7.0	46.2	27,689	30.8	215.6	Dec - Ave.	27.9	1.5	934	1.0	3.0	41.9	26,059	27.9	83.7
16	490	1.5	899	1.0	7.0	735	440,510	490	3430	16	448	1.5	934	1.0	3.0	672	418,432	448	1344
Total	490					735	440,510	490	3430	Total	448					672	418,432	448	1344
Jan - Ave.	36.6	1.7	1,090	1.4	7.0	62.2	39,894	51.2	256.2	Jan - Ave.	42.8	1.3	779	1.0	3.0	55.6	33,341	42.8	128.4
22	626	1.7	1,090	1.4	7.0	1064.2	682,340	876.4	4382	21	944	1.3	779	1.0	3.0	1227.2	735,376	944	2832
Total	626					1064.2	682,340	876.4	4382	Total	944					1227.2	735,376	944	2832
Feb - Ave.	43.6	1.6	966	0.6	7.0	69.8	42,118	26.2	305.2	Feb - Ave.	37.9	1.5	992	1.3	8.0	56.9	37,597	49.3	303.2
19	1060	1.6	966	0.6	7.0	1696	1,023,960	636	7420	18	612	1.5	992	1.3	8.0	918	607,104	795.6	4896
Total	1060					1696	1,023,960	636	7420	Total	612					918	607,104	795.6	4896
Mar-Ave.	68.7	1.9	1,140	1.6	8.0	130.5	78,318	109.9	549.6	Mar-Ave.	49.5	1.7	1,100	1.5	7.0	84.2	54,450	74.3	346.5
25	1050	1.9	1,140	1.6	8.0	1995	1,197,000	1680	8400	15	864	1.7	1,100	1.5	7.0	1468.8	950,400	1296	6048
Total	1050					1995	1,197,000	1680	8400	Total	864					1468.8	950,400	1296	6046
Apr-Ave.	43.9	1.4	903	0.9	3.5	59.3	39,642	39.6	154.1	Apr-Ave.	39.4	1.2	770	1.0	7.0	47.3	30,338	39.4	275.8
22	665	1.4	903	1.0	4.0	931	600,495	665	2660	2									
30	637	1.3		0.8	3.0	828.1		509.6	1911	20	765	1.2	770	1.0	7.0	918	589,050	765	5355
Total	1302					1759.1	600,495	1174.6	4571	Total	765					918	589,050	765	5355
May - Ave.	41.2	1.4	866	1.2	1.0	57.7	35,679	49.4	41.2	May - Ave.	33.3	1.4	993	1.1	6.0	46.6	33,067	36.6	199.8
20	665	1.4	866	1.2	1.0	931	575,890	798	665	19	472	1.4	993	1.1	6.0	660.8	468,696	519.2	2832
Total	665					931	575,890	798	665	Total	472					660.8	468,696	519.2	2832
Jun - Ave.	37.8	1.5	964	1.4	4.0	56.7	36,439	52.9	151.2	Jun - Ave.	31.8	1.5	950	1.4	8.0	47.7	30,210	44.5	254.4
17	576	1.5	964	1.4	4.0	864	555,264	806.4	2304	23	490	1.5	950	1.4	8.0	735	465,500	686	3920
Total	576					864	555,264	806.4	2304	Total	490					735	465,500	686	3920
Jul-Ave.	36.2	1.4	922	1.4	8.0	50.7	33,376	50.7	289.6	Jul-Ave.	24.9	1.8	1,550	2.0	11.0	44.8	38,595	49.8	273.9
20	564	1.4	922	1.4	8.0	789.6	520,008	789.6	4512	20	316	1.8	1,550	2.0	11.0	568.8	489,800	632	3476
Total	564					789.6	520008	789.6	4512	Total	316					568.8	489800	632	3476
Aug-Ave.	33.4	1.3	700	1.0	6.0	43.4	23,380	33.4	200.4	Aug-Ave.	31	1.3	824	1.1	8.0	40.3	25,544	34.1	248.0
19	508	1.3	700	1.0	6.0	660.4	355,600	508	3048	25	560	1.3	824	1.1	8.0	728	461,440	616	4480
Total	508					660.4	355600	508	3048	Total	560					728	461440	616	4480
Sep-Ave.	26	1.4	668	0.7	3.0	36.4	17,368	18.2	78.0	Sep-Ave.	23.5	1.5	929	1.1	7.0	35.3	21,832	25.9	164.5
23	350	1.4	668	0.7	3.0	490	233,800	245	1050	28	357	1.5	929	1.1	7.0	535.5	331,653	392.7	2499
Total	350					490	233800	245	1050	Total	357					535.5	331653	392.7	2499
	487.3										397.0								

(a) USGS published and unpublished data.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-3

DEVELOPMENT OF AVERAGE MONTHLY WATER QUALITY - WATER YEAR 1986 (a)

(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	SALT SLOUGH @ HWY 165									MUD SLOUGH @ HWY 140								
		CONCENTRATION				LOAD-FLOW FACTOR					CONCENTRATION				LOAD-FLOW FACTOR			
	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	11.0	1.4	829	1.1	4.6	15.0	9,121	12.0	50.4	2.4	9.8	1,126	1.4	1.3	23.6	2,703	3.4	3.2
11	152.0	1.3	784	0.7	2.0	197.6	119,168	106.4	304.0	31.0	27.8	1,810	2.5	2.0	861.8	56,110	77.5	62.0
24	276.0	1.4	854	1.3	6.0	386.4	235,704	358.8	1656.0	66.0	1.4	805	0.9	1.0	92.4	53,130	59.4	66.0
Total	428.0					584.0	354,872	465.2	1960.0	97.0					954.2	109,240	136.9	128.0
Nov - Ave.	7.8	2.0	1,256	1.5	5.8	15.2	9,793	12.0	45.6	2.4	2.9	2,039	2.7	3.6	7.1	4,895	6.4	8.7
7	144.0	1.7	1,070	1.2	5.0	244.8	154,080	172.8	720.0	38.0	2.2	1,570	2.2	5.0	83.6	59,660	83.6	190.0
19	105.0	2.3	1,510	2.0	7.0	241.5	158,550	210.0	735.0	33.0	3.8	2,580	3.2	2.0	125.4	85,140	105.6	66.0
Total	249.0					486.3	312,630	382.8	1455.0	71.0					209.0	144,800	189.2	256.0
Dec - Ave.	5.6	2.5	1,717	2.2	8.3	14.2	9,617	12.5	46.3	6.8	2.7	1,846	3.0	9.2	18.1	12,556	20.3	62.6
5	160.0	2.5	1,700	2.5	10.0	400.0	272,000	400.0	1600.0	96.0	2.2	1,420	2.2	4.0	211.2	136,320	211.2	384.0
19	65.0	2.6	1,760	1.6	4.0	169.0	114,400	104.0	260.0	104.0	3.1	2,240	3.7	14.0	322.4	232,960	384.8	1456.0
Total	225.0					569.0	386,400	504.0	1860.0	200.0					533.6	369,280	596.0	1840.0
Jan - Ave.	5.9	3.1	2,225	3.4	18.2	18.6	13,130	19.8	107.3	6.0	3.2	2,346	3.5	9.0	19.2	14,076	20.9	53.8
9	100.0	3.2	2,340	3.3	16.0	320.0	234,000	330.0	1600.0	62.0	3.2	2,340	3.3	6.0	198.4	145,080	204.6	372.0
24	120.0	3.1	2,130	3.4	20.0	372.0	255,600	408.0	2400.0	90.0	3.2	2,350	3.6	11.0	288.0	211,500	324.0	990.0
Total	220.0					692.0	489,600	738.0	4000.0	152.0					486.4	356,580	528.6	1362.0
Feb - Ave.	16.2	3.0	2,091	3.5	22.2	48.1	33,875	56.0	359.6	9.1	1.5	1,036	2.3	2.9	13.6	9,424	20.6	26.1
6	150.0	2.9	2,070	3.6	25.0	435.0	310,500	540.0	3750.0	55.0	2.8	2,290	1.3	2.0	154.0	125,950	71.5	110.0
21	352.0	3.0	2,100	3.4	21.0	1056.0	739,200	1196.8	7392.0	380.0	1.3	854	2.4	3.0	494.0	324,520	912.0	1140.0
Total	502.0					1491.0	1,049,700	1736.8	11142.0	435.0					648.0	450,470	983.5	1250.0
Mar-Ave.	23.1	1.8	1,131	1.8	13.4	42.3	26,123	42.1	309.9	20.6	1.3	787	1.4	4.6	27.8	16,206	28.1	93.8
5	314.0	2.3	1,530	2.7	21.0	722.2	480,420	847.8	6594.0	108.0	2.0	1,220	2.1	7.0	216.0	131,760	226.8	756.0
18	440.0	1.5	846	1.2	8.0	660.0	372,240	528.0	3520.0	479.0	1.2	689	1.2	4.0	574.8	330,031	574.8	1916.0
Total	754.0					1382.2	852,660	1375.8	10114.0	587.0					790.8	461,791	801.6	2672.0
Apr-Ave.	24.9	1.6	1,125	1.9	13.1	40.2	28,025	47.1	327.2	13.7	2.9	1,805	3.4	24.5	39.0	24,729	45.9	335.7
2	370.0	2.0	1,420	2.5	17.0	740.0	525,400	925.0	6290.0	323.0	2.9	1,740	3.4	17.0	936.7	562,020	1098.2	5491.0
16	455.0	1.3	886	1.4	10.0	591.5	403,130	637.0	4550.0	323.0	2.8	1,870	3.3	32.0	904.4	604,010	1065.9	10336.0
Total	825.0					1331.5	928,530	1562.0	10840.0	646.0					1841.1	1,166,030	2164.1	15827.0
May - Ave.	19.8	1.2	789	1.1	8.7	23.1	15,626	20.8	172.5	6.7	2.4	5,303	5.0	7.6	16.1	35,530	33.5	51.2
7	450.0	1.2	821	1.3	13.0	540.0	369,450	585.0	5850.0	134.0	2.4	6,390	8.2	3.0	321.6	856,260	1098.8	402.0
21	250.0	1.1	732	0.6	1.0	275.0	183,000	150.0	250.0	38.0	2.4	1,470	3.0	24.0	91.2	55,860	114.0	912.0
Total	700.0					815.0	552,450	735.0	6100.0	172.0					412.8	912,120	1212.8	1314.0
Jun - Ave.	17.6	0.9	549	0.6	1.5	15.8	9,664	11.4	26.1	7.7	2.5	1,705	3.6	29.0	19.5	13,130	28.0	223.3
3	320.0	0.8	491	0.5	1.0	256.0	157,120	160.0	320.0	127.0	2.8	1,880	3.9	29.0	355.6	238,760	495.3	3683.0
18	300.0	1.0	611	0.8	2.0	300.0	183,300	240.0	600.0	143.0	2.3	1,550	3.4	29.0	328.9	221,650	486.2	4147.0
Total	620.0					556.0	340,420	400.0	920.0	270.0					684.5	460,410	981.5	7830.0
Jul-Ave.	23.4	1.2	698	0.9	2.1	27.0	16,344	20.0	48.4	5.7	2.4	1,664	3.3	27.2	13.6	9,486	18.7	155.2
1	354.0	1.2	732	0.9	3.0	424.8	259,128	318.6	1062.0	132.0	2.3	1,590	3.1	26.0	303.6	209,880	409.2	3432.0
16	309.0	1.1	660	0.8	1.0	339.9	203,940	247.2	309.0	59.0	2.6	1,830	3.7	30.0	153.4	107,970	218.3	1770.0
Total	663.0					764.7	463,068	565.8	1371.0	191.0					457.0	317,850	627.5	5202.0
Aug-Ave.	25.5	1.3	739	1.1	7.1	32.0	18,833	28.2	180.3	4.8	2.1	813	2.9	21.4	10.3	3,901	14.1	102.5
6	410.0	1.1	620	0.9	5.0	451.0	254,200	369.0	2050.0	109.0	2.1	1,260	3.0	21.0	228.9	137,340	327.0	2289.0
27	440.0	1.4	849	1.3	9.0	616.0	373,560	572.0	3960.0	60.0	2.2		2.8	22.0	132.0	0	168.0	1320.0
Total	850.0					1067.0	627,760	941.0	6010.0	169.0					360.9	137,340	495.0	3609.0
Sep-Ave.	17.1	1.1	726	0.8	3.7	18.8	12,408	13.9	63.4	0.7	2.0	1,158	2.0	6.0	1.4	811	1.4	4.2
8	351.0	1.1	720	0.9	5.0	386.1	252,720	315.9	1755.0	15.0	2.0	1,160	2.0	6.0	30.0	17,400	30.0	90.0
25	266.0	1.1	733	0.7	2.0	292.6	194,978	186.2	532.0	3.0	2.1	1,150	1.8	6.0	6.3	3,450	5.4	18.0
Total	617.0					678.7	447,698	502.1	2287.0	18.0					36.3	20,850	35.4	108.0
Total Annual (AF	197.9									86.6								

(a) USGS published and unpublished data.

(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-4

DEVELOPMENT OF AVERAGE MONTHLY WATER QUALITY - WATER YEAR 1987 (a)

(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	SALT SLOUGH @ HWY 165									MUD SLOUGH @ HWY 140								
		CONCENTRATION				LOAD-FLOW FACTOR					CONCENTRATION				LOAD-FLOW FACTOR			
	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	11.5	1.3	763	1.0	6.9	15.2	8,776	11.0	79.8	1.0	1.2	804	0.9	1.6	1.2	804	0.9	1.6
7	133	1.7	920	1.4	12	226.1	122,360	186.2	1596	26	0.8	483	0.6	1	20.8	12,558	15.6	26
22	229	1.1	672	0.7	4	251.9	153,888	160.3	916	10	2.1	1,640	1.7	3	21	16,400	17	30
Total	362					478	276,248	346.5	2512	36					41.8	28,958	32.6	56
Nov - Ave.	12.9	1.4	944	1.3	10.6	18.7	12,177	16.8	136.8	1.5	2.4	1,530	2.1	4.3	3.6	2,295	3.1	6.5
5	274	1.4	895	1.3	12	383.6	245,230	356.2	3288	17	2.6	1,610	2	1	44.2	27,370	34	17
19	239	1.5	1,000	1.3	9	358.5	239,000	310.7	2151	34	2.3	1,490	2.1	6	78.2	50,660	71.4	204
Total	513					742.1	484,230	666.9	5439	51					122.4	78,030	105.4	221
Dec - Ave.	9.6	2.1	1,361	1.9	16.7	20.6	13,066	18.1	160.8	1.5	3.8	2,564	3.3	3.9	5.7	3,846	5.0	5.9
4	205	2.1	1,290	1.8	18	430.5	264,450	369	3690	19	4.3	2,840	3.4	1	81.7	53,960	64.6	19
15	147	2.2	1,460	2	15	323.4	214,620	294	2205	27	3.4	2,370	3.3	6	91.8	63,990	89.1	162
Total	352					753.9	479,070	663	5895	46					173.5	117,950	153.7	181
Jan - Ave.	9.1	2.7	1,986	3.2	20.0	24.6	18,077	29.0	181.6	3.0	3.4	2,182	3.3	8.6	10.1	6,545	10.0	25.8
6	144	2.7	1,740	2.6	17	388.8	250,560	374.4	2448	36	3.3	2,170	3.2	8	118.8	78,120	115.2	288
21	140	2.7	2,240	3.8	23	378	313,600	532	3220	52	3.4	2,190	3.4	9	176.8	113,880	176.8	468
Total	284					766.8	564,160	906.4	5668	88					295.6	192,000	292	756
Feb - Ave.	13.7	2.2	1,471	1.8	14.9	30.2	20,159	24.9	204.5	7.0	2.6	1,789	3.3	11.0	18.5	12,520	23.4	77.2
5	238	2.1	1,380	2.3	16	499.8	328,440	547.4	3808	129	2.7	1,770	3.1	3	348.3	228,330	399.9	387
18	277	2.3	1,550	1.4	14	637.1	429,350	387.8	3878	208	2.6	1,800	3.5	16	540.8	374,400	728	3328
Total	515					1136.9	757,790	935.2	7686	337					889.1	602,730	1127.9	3715
Mar-Ave.	28.6	2.2	1,336	2.0	12.2	63.5	38,208	56.6	348.7	8.6	3.0	2,005	3.5	14.4	26.1	17,246	30.0	124.0
10	734	2.3	1,340	2.1	13	1688.2	983,560	1541.4	9542	94	3.1	1,670	2.5	2	291.4	156,980	235	188
24	499	2.1	1,330	1.8	11	1047.9	663,670	898.2	5489	154	3	2,210	4.1	22	462	340,340	631.4	3388
Total	1233					2736.1	1,647,230	2439.6	15031	248					753.4	497,320	866.4	3576
Apr-Ave.	16.7	2.0	1,205	1.5	8.0	33.4	20,121	25.5	133.6	4.6	3.4	1,976	3.7	17.0	15.6	9,090	16.8	78.2
9	339	2	1,320	1.7	8	678	447,480	576.3	2712	127	2.7	1,880	3.6	17	342.9	238,760	457.2	2159
21	252	1.6	1,050	1.3	8	403.2	264,600	327.6	2016	43	3.2	2,260	3.8	17	137.6	97,180	163.4	731
Total	591					1081.2	712,080	903.9	4728	170					480.5	335,940	620.6	2890
May - Ave.	21.8	1.7	1,153	1.7	10.1	37.1	25,136	37.7	221.2	1.7	3.7	1,450	2.6	14.0	6.3	2,465	4.4	23.8
7	252	1.9	1,290	1.9	13	478.8	325,080	478.8	3276	0				0	0	0	0	0
20	335	1.7	1,050	1.6	8	569.5	351,750	536	2680	38	2.2	1,450	2.6	14	83.6	55,100	98.8	532
Total	587					1048.3	676,830	1014.8	5956	38					83.6	55,100	98.8	532
Jun - Ave.	20.2	1.7	1,036	1.5	9.6	34.3	20,932	31.1	193.9	2.1	2.5	1,971	3.9	24.1	5.3	4,139	8.2	50.7
3	482	1.6	1,000	1.5	10	771.2	482,000	723	4820	42	2.6	1,820	3.5	16	109.2	76,440	147	672
16	325	1.6	1,090	1.6	9	520	354,250	520	2925	58	2.8	2,080	4.2	30	162.4	120,640	243.6	1740
Total	807					1291.2	836,250	1243	7745	100					271.6	197,080	390.6	2412
Jul-Ave.	19.2	1.6	1,039	1.6	7.4	30.7	19,950	31.6	143.0	3.7	2.1	1,505	2.9	19.2	7.8	5,569	10.6	70.9
8	298	1.9	1,280	2.2	8	566.2	381,440	655.6	2384	23	1.8	1,120	1.7	3	41.4	25,760	39.1	69
22	368	1.3	844	1.2	7	478.4	310,592	441.6	2576	77	2.3	1,620	3.2	24	177.1	124,740	246.4	1848
Total	666					1044.6	692,032	1097.2	4960	100					218.5	150,500	285.5	1917
Aug-Ave.	15.6	1.4	816	0.9	5.2	21.8	12,724	14.3	80.4	6.2	2.3	1,597	3.4	14.5	14.3	9,900	20.9	90.1
5	241	1.4	884	1.1	7	337.4	213,044	265.1	1687	109	2.1	1,450	3	15	228.9	158,050	327	1635
18	207	1.3	736	0.7	3	269.1	152,352	144.9	621	98	2.5	1,760	3.8	14	245	172,480	372.4	1372
Total	448					606.5	365,396	410	2308	207					473.9	330,530	699.4	3007
Sep-Ave.	13.1	1.6	972	1.3	6.4	21.0	12,728	17.0	83.7	0.9	1.6	808	1.2	6.9	1.4	727	1.1	6.2
9	275	1.5	883	1.1	6	412.5	242,825	302.5	1650	18	1.5	979	1.7	11	27	17,622	30.6	198
22	176	1.7	1,110	1.6	7	299.2	195,360	281.6	1232	15	1	603	0.7	2	15	9,045	10.5	30
Total	451					711.7	438,185	584.1	2882	33					42	26,667	41.1	228
Total Annual (AF)	192.0									41.8								

(a) USGS published and unpublished data.

(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-5

DEVELOPMENT OF AVERAGE MONTHLY WATER QUALITY - WATER YEAR 1988 (a)

(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	SALT SLOUGH @ HWY 165									MUD SLOUGH @ HWY 140								
		CONCENTRATION				LOAD-FLOW FACTOR					CONCENTRATION				LOAD-FLOW FACTOR			
	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb	FLOWS (b) AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	11.5	1.6	1,036	1.2	6.5	18.4	11,910	14.3	74.3	2.0	1.3	773	0.8	1.0	2.5	1,546	1.6	2.0
7	152	1.8	1,110	1.4	8	273.6	168,720	212.8	1216	10	1.5	928	1.1	1	15	9,280	11	10
20	160	1.5	965	1.1	5	240	154,400	176	800	39	1.2	733	0.7	1	46.8	28,587	27.3	39
Total	312					513.6	323,120	388.8	2016	49					61.8	37,867	38.3	49
Nov - Ave.	13.5	2.0	1,271	1.9	5.3	27.0	17,154	25.0	71.0	4.1	1.8	1,091	1.4	1.0	7.4	4,471	5.9	4.1
4	269	1.8	1,230	1.9	3	484.2	330,870	511.1	807	82	1.7	977	1.3	1	139.4	80,114	106.6	82
17	222	1.8	1,320	1.8	8	399.6	293,040	399.6	1776	78	1.9	1,210	1.6	1	148.2	94,380	124.8	78
Total	491					883.8	623,910	910.7	2583	160					287.6	174,494	231.4	160
Dec - Ave.	6.9	3.0	2,017	2.9	11.0	20.7	13,919	20.3	75.9	1.8	3.3	2,176	2.8	1.0	5.9	3,916	5.0	1.8
2	136	2.8	1,940	2.9	11	380.8	263,840	394.4	1496	29	2.9	1,870	2.4	1	84.1	54,230	69.6	29
15	127	3	2,100	3	11	381	266,700	381	1397	16	3.9	2,730	3.4	1	62.4	43,680	54.4	16
Total	263					761.8	530,540	775.4	2893	45					146.5	97,910	124	45
Jan - Ave.	9.3	3.2	2,251	3.7	23.2	29.8	20,938	34.2	215.5	5.1	2.6	1,669	2.4	4.0	13.3	8,513	12.3	20.4
7	108	3.4	2,360	3.8	27	367.2	254,880	410.4	2916	67	3	1,920	2.8	4	201	128,640	187.6	268
20	191	3.1	2,190	3.6	21	592.1	418,290	687.6	4011	130	2.4	1,540	2.2	4	312	200,200	286	520
Total	299					959.3	673,170	1098	6927	197					513	328,840	473.6	788
Feb - Ave.	13.8	2.8	2,190	3.7	33.9	38.6	30,216	50.9	467.9	4.8	2.5	1,645	2.2	2.7	11.9	7,895	10.6	13.0
3	167	3.3	2,450	4.2	39	551.1	409,150	701.4	6513	115	2.1	1,350	1.7	1	241.5	155,250	195.5	115
17	218	2.8	1,990	3.3	30	610.4	433,820	719.4	6540	60	3.2	2,210	3.2	6	192	132,600	192	360
Total	385					1161.5	842,970	1420.8	13053	175					433.5	287,850	387.5	475
Mar-Ave.	24.7	2.2	1,349	1.9	12.5	54.3	33,325	47.0	309.1	7.9	2.4	1,629	2.7	14.0	18.8	12,865	21.3	110.6
3	492	1.9	1,320	2	13	934.8	649,440	984	6396	163	2.3	1,590	2.7	14	374.9	259,170	440.1	2282
14	466	2.1	1,380	1.8	12	978.6	643,080	838.8	5592	122	2.5	1,680	2.7	14	305	204,960	329.4	1708
Total	958					1913.4	1,292,520	1822.8	11988	285					679.9	464,130	769.5	3990
Apr-Ave.	18.7	2.2	1,410	2.4	14.1	41.1	26,361	44.9	262.8	3.0	2.4	1,570	2.3	8.7	7.2	4,710	6.9	26.0
5	281	2.4	1,610	1.8	17	674.4	452,410	505.8	4777	36	3.2	2,190	3.1	4	115.2	78,840	111.6	144
19	403	1.9	1,270	1.1	12	765.7	511,810	443.3	4836	72	2	1,260	1.9	11	144	90,720	136.8	792
Total	684					1440.1	964,220	949.1	9613	108					259.2	169,560	248.4	936
May - Ave.	15.8	1.9	1,366	2.0	15.1	30.0	21,585	31.0	239.2	3.2	3.6	2,513	3.4	7.3	11.6	8,043	10.8	23.5
2	272	2.3	1,540	2.3	19	625.6	418,880	625.6	5168	11	4.9	3,480	4.3	2	53.9	38,280	47.3	22
18	254	1.8	1,180	1.6	11	457.2	299,720	406.4	2794	22	3	2,030	2.9	10	66	44,660	63.8	220
Total	526					1082.8	718,600	1032	7962	33					119.9	82,940	111.1	242
Jun - Ave.	18.9	1.7	1,081	1.7	9.2	32.1	20,422	31.6	173.8	4.1	2.5	1,735	3.5	19.2	10.2	7,112	14.4	78.7
10	323	1.5	933	1.3	6	484.5	301,359	419.9	1938	113	2.7	1,900	4	22	305.1	214,700	452	2486
22	368	1.8	1,210	2	12	662.4	445,280	736	4416	44	1.9	1,310	2.3	12	83.6	57,640	101.2	528
Total	691					1146.9	746,639	1155.9	6354	157					388.7	272,340	553.2	3014
Jul-Ave.	19.5	2.0	1,372	2.4	14.8	39.0	26,745	46.0	288.5	1.7	2.0	1,390	2.4	11.6	3.5	2,362	4.1	19.8
7	408	1.9	1,300	2.2	14	775.2	530,400	897.6	5712	34	1.6	1,030	1.6	5	54.4	35,020	54.4	170
19	269	2.2	1,480	2.6	16	591.8	398,120	699.4	4304	13	3.2	2,330	4.5	29	41.6	30,290	58.5	377
Total	677					1367	928,520	1597	10016	47					96	65,310	112.9	547
Aug-Ave.	23.3	1.7	1,051	1.5	10.0	38.5	24,479	35.0	233.9	0.5	2.6	1,799	3.4	20.3	1.3	900	1.7	10.2
9	379	1.6	1,020	1.4	8	606.4	386,580	530.6	3032	22	2.5	1,720	3.4	19	55	37,840	74.8	418
24	394	1.7	1,080	1.6	12	669.8	425,520	630.4	4728	3	3.4	2,380	3.7	30	10.2	7,140	11.1	90
Total	773					1276.2	812,100	1161	7760	25					65.2	44,980	85.9	508
Sep-Ave.	16.3	1.7	1,099	1.6	11.0	27.7	17,914	26.1	179.7	0.3	2.9	2,023	3.4	13.3	0.9	607	1.0	4.0
8	270	1.9	1,250	1.9	13	513	337,500	513	3510	7	2.7	1,930	3.7	16	18.9	13,510	25.9	112
27	263	1.5	944	1.3	9	394.5	248,272	341.9	2367	2	3.4	2,350	2.5	4	6.8	4,700	5	8
Total	533					907.5	585,772	854.9	5877	9					25.7	18,210	30.9	120
Total Annual (AF	192.2									38.5								

(a) USGS published and unpublished data.

(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-6

SAN JOAQUIN RIVER nr NEWMAN AVERAGE MONTHLY WATER QUALITY - WATER YEAR 1989(a)
(Flows and Salt Loads in 1000s)

MONTH	FLOWS (b)	CONCENTRATION				LOAD-FLOW FACTOR			
	AF or cfs	EC us/cm	TDS (c) ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	21.5	1.4	902	0.8	5.3	30.8	19,390	17.6	114.1
4	275	1.6	1,008	0.9	6.9	440.0	277,200	247.5	1,897.5
11	345	1.4	882	0.7	4.6	483.0	304,290	241.5	1,587.0
17	329	1.5	945	0.9	5.8	493.5	310,905	296.1	1,908.2
25	441	1.3	819	0.8	4.5	573.3	361,179	352.8	1,984.5
Total	1,390					1,989.8	1,253,574	1,137.9	7,377.2
Nov - Ave.	20.5	1.5	960	0.9	4.2	16.3	10,270	10.1	44.9
1	376	1.5	945	0.9	3.5	564.0	355,320	338.4	1,316.0
10	321	1.5	945	0.9	3.4	481.5	303,345	288.9	1,091.4
15	314	1.6	1,008	1.0	5.0	502.4	316,512	314.0	1,570.0
22	323	1.5	945	1.0	5.0	484.5	305,235	323.0	1,615.0
Total	1,334					2,032.4	1,280,412	1,264.3	5,592.4
Dec - Ave.	26.4	1.6	984	1.1	4.5	41.2	25,987	29.3	118.2
8	468	1.4	882	1.0	4.1	655.2	412,776	468.0	1,918.8
28	553	1.7	1,071	1.2	4.8	940.1	592,263	663.6	2,654.4
Total	1,021					1,595.3	1,005,039	1,131.6	4,573.2
Jan - Ave.	31.4	1.8	1,129	1.3	7.0	56.3	35,438	41.5	219.6
11	596	1.7	1,071	1.2	4.5	1,013.2	638,316	715.2	2,682.0
26	465	1.9	1,197	1.4	7.4	883.5	556,605	651.0	3,441.0
31	463	1.8	1,134	1.4	9.8	833.4	525,042	648.2	4,537.4
Total	1,524					2,730.1	1,719,963	2,014.4	10,660.4
Feb - Ave.	31.9	1.8	1,128	1.3	9.6	57.1	35,995	42.4	305.5
7	596	1.7	1,071	1.2	7.7	1,013.2	638,316	715.2	4,589.2
14	728	1.7	1,071	1.3	8.4	1,237.6	779,688	946.4	6,115.2
21	577	2.0	1,260	1.5	13.0	1,154.0	727,020	865.5	7,501.0
Total	1,901					3,404.8	2,145,024	2,527.1	18,205.4
Mar-Ave.	42	1.7	1,073	1.3	10.3	70.7	44,530	53.1	427.0
1	492	2.2	1,386	1.9	17.0	1,082.4	681,912	934.8	8,364.0
7	711	1.5	945	1.1	6.9	1,066.5	671,895	782.1	4,905.9
15	640	1.9	1,197	1.4	11.0	1,216.0	766,080	896.0	7,040.0
21	612	1.9	1,197	1.4	12.0	1,162.8	732,564	856.8	7,344.0
29	859	1.3	819	0.9	7.5	1,116.7	703,521	773.1	6,442.5
Total	3,314					5,644.4	3,555,972	4,242.8	34,096.4
Apr-Ave.	44.7		1,014	1.3	6.6	0.0	45,333	59.5	293.8
12	620	1.8	1,134	1.1	9.5	1,116.0	703,080	682.0	5,890.0
20	1,000	1.5	945	1.5	5.4	1,500.0	945,000	1,500.0	5,400.0
26	831	1.6	1,008	1.3	5.8	1,329.6	837,648	1,080.3	4,819.8
Total	2451					3,945.6	2,485,728	3,262.3	16,109.8
May - Ave.	36.2		820	1.0	7.0	0.0	29,688	37.2	252.7
1	1,270	1.0	630	0.8	4.5	1,270.0	800,100	1,016.0	5,715.0
10	448	1.6	1,008	1.2	9.7	716.8	451,584	537.6	4,345.6
17	479	1.6	1,008	1.3	9.1	766.4	482,832	622.7	4,358.9
24	522	1.4	882	1.0	7.1	730.8	460,404	522.0	3,706.2
30	565	1.4	882	1.2	8.5	791.0	498,330	678.0	4,802.5
Total	3,284					4,275.0	2,693,250	3,376.3	22,928.2
Jun - Ave.	28.9	1.7	936	1.5	8.8	49.1	27,038	42.2	254.8
7	435	1.6	1,008	1.3	10.0	696.0	438,480	565.5	4,350.0
14	499	1.6	1,008	1.4	9.5	798.4	502,992	698.6	4,740.5
21	484	1.6	1,008	1.5	9.2	774.4	487,872	726.0	4,452.8
27	572	1.2	756	1.6	7.0	686.4	432,432	915.2	4,004.0
Total	1,990					2,955.2	1,861,776	2,905.3	17,547.3
Jul-Ave.	25.2	1.6	967	1.3	7.4	40.3	24,367	31.8	187.2
2	530	1.5	945	1.2	7.9	795.0	500,850	636.0	4,187.0
12	374	1.9	1,197	1.6	10.0	710.6	447,678	598.4	3,740.0
19	471	1.4	882	1.2	6.0	659.4	415,422	565.2	2,826.0
25	405	1.4	882	1.1	6.1	567.0	357,210	445.5	2,470.5
Total	1,780					2,732.0	1,721,160	2,245.1	13,223.5
Aug-Ave.	26.1	1.5	883	1.2	6.4	39.2	23,051	30.7	166.7
1	468	1.4	882	1.1	6.3	655.2	412,776	514.8	2,948.4
9	394	1.4	882	1.1	5.9	551.6	347,508	433.4	2,324.6
16	426	1.4	882	1.2	6.6	596.4	375,732	511.2	2,811.6
24	472	1.3	819	1.2	6.2	613.6	386,568	566.4	2,926.4
Total	1,724					2,416.8	1,522,584	2,025.8	11,011.0
Sep-Ave.	22.8		906	1.0	5.5	0.0	20,652	23.7	125.2
1	396	1.5	945	1.2	5.8	594.0	374,220	475.2	2,296.8
6	451	1.5	945	1.2	7.2	676.5	426,195	541.2	3,247.2
13	339	1.4	882	1.0	5.3	474.6	298,998	339.0	1,796.7
21	466	1.3	819	0.9	3.8	605.8	381,654	419.4	1,770.8
29	391	1.5	945	0.9	5.4	586.5	369,495	351.9	2,111.4
Total	2,043					2,937.4	1,850,562	2,126.7	11,222.9
Total Annual (AF)	347.3								

(a) USGS flow data near Newman and Calif. RWQCB water quality data at Crows Landing from their December 1990 report on the lower San Joaquin River.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.
(c) Daily TDS values calculated as 0.63 times the recorded EC values measured at the Crows Landing CVRWQCB monitoring station. The 0.64 EC to TDS conversion factor was determined from the 1987 and 1988 USGS data obtained at the Newman station.

Table A-7

SALT SLOUGH AT HWY 165 AVERAGE MONTHLY WATER QUALITY - WATER YEAR1989 (a)
(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	FLOWS (b) AF or cfs	CONCENTRATION EC us/cm	TDS ppm	B ppm	Se ppb	LOAD-FLOW FACTOR EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	15.6	1.5	958	1.0	7.9	23.0	14,945	15.7	122.8
4	236	1.7	1,105	1.3	15.0	401.2	260,780	306.8	3,540.0
11	245	1.4	910	0.8	7.5	343.0	222,950	196.0	1,837.5
17	247	1.3	845	0.7	2.7	321.1	208,715	172.9	666.9
25	295	1.5	975	1.2	6.8	442.5	287,625	354.0	2,006.0
Total	1023					1,507.8	980,070	1,029.7	8,050.4
Nov - Ave.	10.7	2.0	1,264	1.5	7.6	21.1	13,521	15.8	81.6
1	272	1.6	1,024	1.1	6.2	435.2	278,528	299.2	1,686.4
10	162	2.1	1,344	1.6	7.0	340.2	217,728	259.2	1,134.0
15	167	2.0	1,280	1.5	6.7	334.0	213,760	250.5	1,118.9
22	147	2.5	1,600	2.0	12.0	367.5	235,200	294.0	1,764.0
Total	748					1,476.9	945,216	1,102.9	5,703.3
Dec - Ave.	9.7	2.4	1,634	2.1	9.1	23.7	15,854	20.7	88.4
8	174	2.0	1,340	1.6	5.4	348.0	233,160	278.4	939.6
28	166	2.9	1,943	2.7	13.0	481.4	322,538	448.2	2,158.0
Total	340					829.4	555,698	726.6	3,097.6
Jan - Ave.	8.6	3.0	1,965	3.1	25.5	25.6	16,898	26.9	219.3
11	140	2.8	1,960	2.8	15.0	392.0	274,400	392.0	2,100.0
26	126	3.4	2,176	3.4	33.0	428.4	274,176	428.4	4,158.0
31	150	2.8	1,792	3.2	29.0	420.0	268,800	480.0	4,350.0
Total	416					1,240.4	817,376	1,300.4	10,608.0
Feb - Ave.	13.2	2.7	2,097	2.5	22.2	35.5	27,679	33.2	293.3
7	224	2.8	2,184	2.7	23.0	627.2	489,216	604.8	5,152.0
14	293	2.4	1,872	2.2	18.0	703.2	548,496	644.6	5,274.0
21	281	2.9	2,262	2.7	26.0	814.9	635,622	758.7	7,306.0
Total	798					2,145.3	1,673,334	2,008.1	17,732.0
Mar-Ave.	18.0	2.7	1,630	2.5	24.1	48.1	29,341	44.8	434.4
1	195.0	3.4	2,074	3.9	38.0	663.0	404,430	760.5	7,410.0
7	228.0	2.9	1,769	2.7	24.0	661.2	403,332	615.6	5,472.0
15	269.0	2.9	1,769	2.5	20.0	780.1	475,861	672.5	5,380.0
21	287	2.8	1,708	2.7	31.0	803.6	490,196	774.9	8,897.0
29	434	2.0	1,220	1.6	16.0	868.0	529,480	694.4	6,944.0
Total	1413					3,775.9	2,303,299	3,517.9	34,103.0
Apr-Ave.	18.7	2.3	1,490	2.4	19.9	43.5	27,870	44.9	372.8
5	251	2.9	1,856	2.5	30.0	727.9	465,856	627.5	7,530.0
12	370	2.1	1,344	1.8	17.0	777.0	497,280	666.0	6,290.0
20	371	2.3	1,472	2.5	18.0	853.3	546,112	927.5	6,678.0
26	374	2.2	1,408	1.9	18.0	822.8	526,592	710.6	6,732.0
Total	1366					3,181.0	2,035,840	2,931.6	27,230.0
May - Ave.	17.0	2.1	1,508	2.2	19.1	35.6	25,634	37.2	324.4
1	266.0	2.5	1,800	2.7	28.0	665.0	478,800	718.2	7,448.0
10	235.0	2.2	1,584	2.4	22.0	517.0	372,240	564.0	5,170.0
17	277.0	2.2	1,584	2.2	18.0	609.4	438,768	609.4	4,986.0
24	326	1.7	1,224	1.6	14.0	554.2	399,024	521.6	4,564.0
30	356	2.0	1,440	2.2	16.0	712.0	512,640	783.2	5,696.0
Total	1460					3,057.6	2,201,472	3,196.4	27,864.0
Jun - Ave.	19.9	1.9	1,235	2.1	19.1	38.4	24,574	42.1	380.0
7	257	2.5	1,600	2.6	27.0	642.5	411,200	668.2	6,939.0
14	290	2.1	1,344	2.2	19.0	609.0	389,760	638.0	5,510.0
21	347	2.1	1,344	2.4	19.0	728.7	466,368	832.8	6,593.0
27	482	1.4	896	1.6	15.0	674.8	431,872	771.2	7,230.0
Total	1376					2,655.0	1,699,200	2,910.2	26,272.0
Jul-Ave.	20.5	1.7	1,200	1.8	12.4	35.7	24,600	37.6	254.1
5	308	1.9	1,311	2.0	13.0	585.2	403,788	616.0	4,004.0
12	314	2.0	1,380	2.2	16.0	628.0	433,320	690.8	5,024.0
19	363	1.5	1,035	1.5	10.0	544.5	375,705	544.5	3,630.0
25	321	1.6	1,104	1.7	11.0	513.6	354,384	545.7	3,531.0
Total	1306					2,271.3	1,567,197	2,397.0	16,189.0
Aug-Ave.	22.5	1.5	960	1.5	9.0	33.8	21,605	34.6	203.6
1	495	1.3	832	1.2	7.4	643.5	411,840	594.0	3,663.0
9	322	1.7	1,088	1.8	11.0	547.4	350,336	579.6	3,542.0
16	351	1.6	1,024	1.7	9.4	561.6	359,424	596.7	3,299.4
24	431	1.5	960	1.6	9.2	646.5	413,760	689.6	3,965.2
Total	1599					2,399.0	1,535,360	2,459.9	14,469.6
Sep-Ave.	15.7	1.6	1,065	1.6	12.9	25.7	16,713	24.5	201.8
1	312	1.6	1,040	1.6	11.0	499.2	324,480	499.2	3,432.0
6	323	1.6	1,040	1.5	10.0	516.8	335,920	484.5	3,230.0
13	269	1.5	975	1.4	12.0	403.5	262,275	376.6	3,228.0
21	250	1.7	1,105	1.6	14	425.0	276,250	400.0	3,500.0
29	280	1.8	1,170	1.7	18	504.0	327,600	476.0	5,040.0
Total	1434					2,348.5	1,526,525	2,236.3	18,430.0
Total Annual (AF)	190.1								

(a) USGS published and unpublished data and Calif. Reg. Water quality Control Board data from December 1990 report on the lower San Joaquin River.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-8

MUD SLOUGH AT HWY 140 AVERAGE MONTHLY WATER QUALITY - WATER YEAR1989 (a)
(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	FLOWS (b) AF or cfs	CONCENTRATION EC us/cm	TDS ppm	B ppm	Se ppb	LOAD-FLOW FACTOR EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	1.4	1.4	859	0.8	2.4	2.0	1,202	1.1	3.4
4	10	1.4	854	0.8	4.5	14.0	8,540	8.1	45.0
11	7	1.4	854	0.7	3.5	9.8	5,978	4.9	24.5
17	32	1.3	793	0.7	1.9	41.6	25,376	22.4	60.8
25	39	1.5	915	0.9	2.1	58.5	35,685	35.1	81.9
Total	88					123.9	75,579	70.5	212.2
Nov - Ave.	1.1	2.8	1,679	1.7	1.7	3.0	1,847	1.9	1.9
1	22	2.0	1,220	1.2	1.8	44.0	26,840	26.4	39.6
10	14	2.5	1,525	1.6	1.6	35.0	21,350	22.4	22.4
15	11	3.2	1,952	2.0	1.6	35.2	21,472	22.0	17.6
22	16	3.7	2,257	2.4	1.9	59.2	36,112	38.4	30.4
Total	63					173.4	105,774	109.2	110
Dec - Ave.	3.5	2.0	1,361	1.3	1.0	7.1	4,763	4.7	3.5
8	85	1.8	1,206	1.2	0.9	153.0	102,510	102.0	76.5
28	73	2.3	1,541	1.5	1.1	167.9	112,493	109.5	80.3
Total	158					320.9	215,003	211.5	156.8
Jan - Ave.	2.9	3.1	1,987	2.3	2.5	9.0	5,761	6.7	7.3
11	47	2.7	1,728	1.9	0.7	126.9	81,216	89.3	32.9
26	41	3.4	2,176	2.4	2.5	139.4	89,216	98.4	102.5
31	35	3.3	2,112	2.8	5.0	115.5	73,920	98.0	175.0
Total	123					381.8	244,352	285.7	310.4
Feb - Ave.	2.5	3.0	2,012	2.2	1.1	7.6	5,030	5.5	2.8
7	39	3.1	2,046	2.2	1.1	120.9	79,794	85.8	42.9
14	76	3.0	1,980	2.2	1.1	228.0	150,480	167.2	83.6
21	32	3.1	2,046	2.2	1.1	99.2	65,472	70.4	35.2
Total	147					448.1	295,746	323.4	161.7
Mar-Ave.	1.7	3.7	2,527	2.8	3.8	6.3	4,296	4.8	6.5
1	27	3.8	2,584	2.8	5.0	102.6	69,768	75.6	135.0
7	33	3.5	2,380	2.6	3.7	115.5	78,540	85.8	122.1
15	25	3.7	2,516	2.8	2.1	92.5	62,900	70.0	52.5
21	24	3.6	2,448	2.7	1.9	86.4	58,752	64.8	45.6
29	21	4.1	2,788	3.2	6.9	86.1	58,548	67.2	144.9
Total	130					483.1	328,508	363.4	500.1
Apr-Ave.	3.2	3.4	2,230	3.0	1.8	11.0	7,137	9.6	5.8
5	14	5.0	3,250	3.3	1.9	70.0	45,500	46.2	26.6
12	11	6.4	4,160	4.5	2.1	70.4	45,760	49.5	23.1
20	127	3.2	2,080	3.0	1.6	406.4	264,160	381.0	203 2
26	109	3.2	2,080	2.8	2.0	348.8	226,720	305.2	218.0
Total	261					895.6	582,140	781.9	470.9
May - Ave.	1.2	3.3	2,289	2.8	2.5	4.0	2,747	3.4	3.1
1	84.0	2.8	1,932	2.5	1.7	235.2	162,288	210.0	142.8
10	7	3.8	2,622	2.8	2.3	26.6	18,354	19.6	16.1
17	5	6.3	4,347	4.8	5.0	31.5	21,735	24.0	25.0
24	9	6.8	4,692	5.4	8.8	61.2	42,228	48.6	79.2
30	10	2.7	1,863	2.1	3.0	27.0	18,630	21.0	30.0
Total	115					381.5	263,235	323.2	293.1
Jun - Ave.	0.5	3.4	2,396	2.8	2.5	1.7	1,198	1.4	1.3
7	[illegible]	3.5	2,450	2.5	2.4	14.0	9,800	10.0	9.6
14	11	1.9	1,330	1.5	2.2	20.9	14,630	16.5	24.2
21	6	4.1	2,870	2.9	2.0	24.6	17,220	17.4	12.0
27	9	4.8	3,360	4.4	3.3	43.2	30,240	39.6	29.7
Total	30					102.7	71,890	83.5	75.5
Jul-Ave.	1.1	2.1	1,460	1.8	3.3	2.4	1,606	2.0	3.6
5	11	5.0	3,400	4.1	5.7	55.0	37,400	45.1	62.7
12	19	1.9	1,292	1.5	2.0	36.1	24,548	28.5	38.0
19	18	1.7	1,156	1.4	1.9	30.6	20,808	25.2	34.2
25	25	1.4	952	1.4	4.2	35.0	23,800	35.0	105.0
Total	73					156.7	106,556	133.8	239.9
Aug-Ave.	1.1	2.7	1,852	2.8	9.5	3.0	2,037	3.1	10.4
1	15	2.1	1,449	1.9	6.1	31.5	21,735	28.5	91.5
9	19	3.2	2,208	3.0	7.4	60.8	41,952	57.0	140.6
16	18	2.8	1,932	3.2	13.0	50.4	34,776	57.6	234.0
24	17	2.5	1,725	3.1	11.0	42.5	29,325	52.7	187.0
Total	69					185.2	127,788	195.8	653.1
Sep-Ave.	1.0	1.5	1,058	1.1	3.1	1.5	1,058	1.1	3.1
1	11	3.1	2,201	3.3	9.6	34.1	24,211	36.3	105.6
6	18	1.1	781	0.8	3.6	19.8	14,058	14.4	64.8
13	19	1.6	1,136	1.1	2.6	30.4	21,584	20.9	49.4
21	20	1.2	852	0.7	1.4	24.0	17,040	14.0	28.0
29	24	1.2	852	0.7	1.6	28.8	20,448	16.8	38.4
Total	92					137.1	97,341	102.4	286.2
Total Annual (AF)	21.2								

(a) USGS published and unpublished data and Calif. Reg. Water quality Control Board data from December 1990 report on the lower San Joaquin River.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-9

SAN JOAQUIN RIVER nr NEWMAN AVERAGE MONTHLY WATER QUALITY - WATER YEAR 1990(a)
(Flows and Salt Loads in 1000s)

MONTH	FLOWS (b)	CONCENTRATION				LOAD-FLOW FACTOR			
		EC	TDS (c)	B	Se	EC-FLOW	TDS-FLOW	B-FLOW	Se-FLOW
	AF or cfs	us/cm	ppm	ppm	ppb	AF-us/cm	AF-ppm	AF-ppm	AF-ppb
Oct - Ave.	27.8	1.3	811	0.9	3.6	35.8	22,537	23.9	98.8
6	378	1.6	1,008	1.0	5.9	604.8	381,024	378.0	2,230.2
13	348	1.2	756	0.7	4.0	417.6	263,088	243.6	1,392.0
20	395	1.2	756	0.8	2.1	474.0	298,620	316.0	829.5
30	621	1.2	756	0.9	2.8	745.2	469,476	558.9	1,738.8
Total	1742					2,241.6	1,412,208	1,496.5	6,190.5
Nov - Ave.	35.8	1.3	819	0.9	3.5	46.5	29,320	31.3	126.7
6	568	1.3	819	0.9	3.9	738.4	465,192	511.2	2,215.2
13	613	1.3	819	0.8	2.9	796.9	502,047	490.4	1,777.7
20	584	1.3	819	0.9	3.9	759.2	478,296	525.6	2,277.6
30	652	1.3	819	0.9	3.5	847.6	533,988	586.8	2,282.0
Total	2417					3,142.1	1,979,523	2,114.0	8,552.5
Dec - Ave.	36.2	1.5	943	1.0	5.7	54.2	34,130	37.0	207.1
8	614	1.3	819	0.9	3.9	798.2	502,866	552.6	2,394.6
15	604	1.5	945	1.0	5.5	906.0	570,780	604.0	3,322.0
21	593	1.6	1,008	1.1	5.8	948.8	597,744	652.3	3,439.4
29	553	1.6	1,008	1.1	7.9	884.8	557,424	608.3	4,368.7
Total	2364					3,537.8	2,228,814	2,417.2	13,524.7
Jan - Ave.	34.8	1.8	1,163	1.3	8.9	64.2	40,462	45.2	310.5
5	530	1.8	1,134	1.2	8.4	954.0	601,020	636.0	4,452.0
11	540	1.9	1,197	1.3	9.3	1,026.0	646,380	702.0	5,022.0
19	622	1.7	1,071	1.2	7.2	1,057.4	666,162	746.4	4,478.4
26	552	2.0	1,260	1.5	11.0	1,104.0	695,520	828.0	6,072.0
Total	2244					4,141.4	2,609,082	2,912.4	20,024.4
Feb - Ave.	37.4	1.8	1,148	1.5	12.0	68.2	42,953	57.1	447.2
2	575	1.8	1,134	1.4	13.0	1,035.0	652,050	805.0	7,475.0
9	625	1.9	1,197	1.6	12.0	1,187.5	748,125	1,000.0	7,500.0
19	827	1.8	1,134	1.5	12.0	1,488.6	937,818	1,240.5	9,924.0
26	693	1.8	1,134	1.6	11.0	1,247.4	785,862	1,108.8	7,623.0
Total	2720					4,958.5	3,123,855	4,154.3	32,522.0
Mar-Ave.	38.1	2.0	1,233	1.5	11.0	74.6	46,975	55.7	420.9
5	677	1.9	1,197	1.7	12.0	1,286.3	810,369	1,150.9	8,124.0
9	637	1.9	1,197	1.4	12.0	1,210.3	762,489	891.8	7,644.0
16	634	2.0	1,260	1.3	11.0	1,268.0	798,840	824.2	6,974.0
23	609	2.0	1,260	1.4	9.9	1,218.0	767,340	852.6	6,029.1
30	503	2.0	1,260	1.5	10.0	1,006.0	633,780	754.5	5,030.0
Total	3060					5,988.6	3,772,818	4,474.0	33,801.1
Apr-Ave.	30.1	2.0	1,245	1.4	7.9	59.5	37,479	43.3	239.0
6	454	2.0	1,260	1.4	8.8	908.0	572,040	635.6	3,995.2
12	465	1.9	1,197	1.3	7.8	883.5	556,605	604.5	3,627.0
20	567	2.0	1,260	1.7	8.6	1,134.0	714,420	963.9	4,876.2
27	487	2.0	1,260	1.3	6.5	974.0	613,620	633.1	3,165.5
Total	1973					3,899.5	2,456,685	2,837.1	15,663.9
May - Ave.	25.6	1.7	1,089	1.3	9.4	44.3	27,886	33.0	240.4
4	397.0	1.8	1,134	1.3	9.4	714.6	450,198	516.1	3,731.8
11	306.0	1.8	1,134	1.4	10.0	550.8	347,004	428.4	3,060.0
18	306.0	1.9	1,197	1.6	12.0	581.4	366,282	489.6	3,672.0
25	384	1.9	1,197	1.5	11.0	729.6	459,648	576.0	4,224.0
31	733	1.5	945	1.0	7.2	1,099.5	692,685	733.0	5,277.6
Total	2126					3,675.9	2,315,817	2,743.1	19,965.4
Jun - Ave.	21.5	1.7	1,093	1.4	7.4	37.3	23,493	29.6	158.8
8	313	1.8	1,134	1.1	8.4	563.4	354,942	344.3	2,629.2
15	294	1.8	1,134	1.5	7.6	529.2	333,396	441.0	2,234.4
22	303	1.9	1,197	1.7	9.4	575.7	362,691	515.1	2,848.2
28	269	1.4	882	1.2	3.7	376.6	237,258	322.8	995.3
Total	1179					2,044.9	1,288,287	1,623.2	8,707.1
Jul-Ave.	20.1	1.5	965	1.3	5.9	30.8	19,401	25.9	119.0
6	384	1.6	1,008	1.4	6.8	614.4	387,072	537.6	2,611.2
13	225	1.8	1,134	1.5	6.1	405.0	255,150	337.5	1,372.5
20	289	1.5	945	1.2	6.2	433.5	273,105	346.8	1,791.8
27	332	1.3	819	1.1	4.5	431.6	271,908	365.2	1,507.3
Total	1230					1,884.5	1,187,235	1,587.1	7,282.8
Aug-Ave.	20.6	1.5	965	1.1	6.1	31.5	19,875	22.9	125.8
3	299	1.9	1,197	1.3	7.4	568.1	357,903	388.7	2,212.6
9	317	1.5	945	1.3	6.3	475.5	299,565	412.1	1,997.1
16	333	1.3	819	0.9	4.8	432.9	272,727	299.7	1,598.4
24	311	1.4	882	0.9	5.5	435.4	274,302	279.9	1,710.5
31	258	1.6	1,008	1.2	6.8	412.8	260,064	309.6	1,754.4
Total	1518					2,324.7	1,464,561	1,690	9,273
Sep-Ave.	13.6	1.3	790	0.8	3.4	17.1	10,745	10.6	46.8
7	264	1.3	819	0.8	3.5	343.2	216,216	211.2	924.0
14	249	1.3	819	0.8	2.8	323.7	203,931	199.2	697.2
21	180	1.2	756	0.7	1.6	216.0	136,080	126.0	288.0
28	255	1.2	756	0.8	5.3	306.0	192,780	204.0	1,351.5
Total	948					1,188.9	749,007	740.4	3,260.7
Total Annual (AF)	341.6								

(a) USGS flow data near Newman and Calif. RWQCB water quality data at Crows Landing from their December 1990 report on the lower San Joaquin River.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.
(c) Daily TDS values calculated as 0.63 times the recorded EC values measured at the Crows Landing CVRWQCB monitoring station. The 0.64 EC to TDS conversion factor was determined from the 1987 and 1988 USGS data obtained at the Newman station.

Table A-10

SALT SLOUGH AT HWY 165 AVERAGE MONTHLY WATER QUALITY - WATER YEAR1990 (a)
(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	FLOWS (b)	CONCENTRATION				LOAD-FLOW FACTOR			
	AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	15.8	1.6	1,014	1.3	6.7	24.6	16,019	20.6	105.8
6	246	1.6	1,040	1.3	8.7	393.6	255,840	319.8	2,140.2
13	193	1.4	910	1.1	5.4	270.2	175,630	212.3	1,042.2
20	212	1.6	1,040	1.5	9.2	339.2	220,480	318.0	1,950.4
30	309	1.6	1,040	1.3	4.2	494.4	321,360	401.7	1,297.8
Total	960					1,497.4	973,310	1,251.8	6,430.6
Nov - Ave.	16.4	1.8	1,131	1.4	8.5	29.0	18,554	23.5	139.8
6	286	1.7	1,088	1.4	9.4	486.2	311,168	400.4	2,688.4
13	286	1.7	1,088	1.2	7.2	486.2	311,168	343.2	2,059.2
20	235	1.9	1,216	1.7	9.9	446.5	285,760	399.5	2,326.5
30	237	1.8	1,152	1.5	7.7	426.6	273,024	355.5	1,824.9
Total	1044					1,845.5	1,181,120	1,498.6	8,899.0
Dec - Ave.	12	2.3	1,569	2.0	14.1	28.1	18,828	24.4	169.2
8	212	2.1	1,407	1.7	7.2	445.2	298,284	360.4	1,526.4
15	224	2.1	1,407		11.0	470.4	315,168		2,464.0
21	178	2.6	1,742	2.1	17.0	462.8	310,076	373.8	3,026.0
29	166	2.7	1,809	2.4	24.0	448.2	300,294	398.4	3,984.0
Total	780					1,826.6	1,223,822	1,133	11,000
Jan - Ave.	10.9	3.2	2,106	2.8	27.3	35.2	22,960	30.7	297.5
5	175	2.8	1,960	2.3	22.0	490.0	343,000	402.5	3,850.0
11	183	3.1	1,984	3.0	26.0	567.3	363,072	549.0	4,758.0
19	181	3.0	1,920	2.9	27.0	543.0	347,520	524.9	4,887.0
26	158	4.1	2,624	3.1	35.0	647.8	414,592	489.8	5,530.0
Total	697					2,248.1	1,468,184	1,966.2	19,025.0
Feb - Ave.	15	2.6	2,049	2.6	28.1	39.4	30,728	39.6	421.3
2	211	3.0	2,340	2.9	36.0	633.0	493,740	611.9	7,596.0
19	306	2.5	1,950	2.6	30.0	765.0	596,700	795.6	9,180.0
26	318	2.5	1,950	2.5	21.0	795.0	620,100	795.0	6,678.0
Total	835					2,193.0	1,710,540	2,202.5	23,454.0
Mar-Ave.	19.1	2.6	1,611	2.6	22.3	50.5	30,776	48.9	426.8
5	366	2.3	1,403	2.1	19.0	841.8	513,498	768.6	6,954.0
9	293	2.8	1,708	2.6	29.0	820.4	500,444	761.8	8,497.0
16	278	2.8	1,708	3.1	24.0	778.4	474,824	861.8	6,672.0
23	306	2.5	1,525	2.2	18.0	765.0	466,650	673.2	5,508.0
30	217	3.0	1,830	3.1	23.0	651.0	397,110	672.7	4,991.0
Total	1460					3,856.6	2,352,526	3,738.1	32,622.0
Apr-Ave.	18.8	2.7	1,696	2.4	18.2	49.8	31,885	45.1	342.4
6	214	3.0	1,920	2.6	24.0	642.0	410,880	556.4	5,136.0
12	199	2.7	1,728	2.2	16.0	537.3	343,872	437.8	3,184.0
20	269	2.3	1,472	2.4	14.0	618.7	395,968	645.6	3,766.0
27	187	2.7	1,728	2.6	20.0	504.9	323,136	486.2	3,740.0
Total	869					2,302.9	1,473,856	2,126.0	15,826.0
May - Ave.	12.9	2.5	1,767	2.4	21.4	31.7	22,789	30.9	275.9
4	165	2.7	1,944	2.7	28.0	445.5	320,760	445.5	4,620.0
11	175	2.7	1,944	2.8	31.0	472.5	340,200	490.0	5,425.0
18	153	2.9	2,088	3.0	25.0	443.7	319,464	459.0	3,825.0
25	236	2.0	1,440	1.6	14.0	472.0	339,840	377.6	3,304.0
31	293	2.3	1,656	2.3	16.0	673.9	485,208	673.9	4,688.0
Total	1022					2,507.6	1,805,472	2,446.0	21,862.0
Jun - Ave.	10.9	2.7	1,699	3.0	17.3	28.9	18,518	32.4	188.1
8	151	2.9	1,856	2.3	21.0	437.9	280,256	347.3	3,171.0
15	185	2.8	1,792	3.4	18.0	518.0	331,520	629.0	3,330.0
22	178	2.8	1,792	3.7	19.0	498.4	318,976	658.6	3,382.0
28	162	2.1	1,344	2.3	11.0	340.2	217,728	372.6	1,782.0
Total	676					1,794.5	1,148,480	2,007.5	11,665.0
Jul-Ave.	16.1	2.0	1,373	2.2	10.6	32.0	22,100	35.1	171.3
6	273	2.0	1,380	2.2	12.0	546.0	376,740	600.6	3,276.0
13	157	2.4	1,656	3.0	13.0	376.8	259,992	471.0	2,041.0
20	240	1.8	1,242	1.8	8.2	432.0	298,080	432.0	1,968.0
27	245	1.9	1,311	2.0	10.0	465.5	321,195	490.0	2,450.0
Total	915					1,820.3	1,256,007	1,993.6	9,735.0
Aug-Ave.	18.4	1.6	995	1.5	8.4	28.6	18,300	28.0	154.1
3	237	1.9	1,216	2.4	10.0	450.3	288,192	568.8	2,370.0
9	274	1.7	1,088	1.7	9.6	465.8	298,112	465.8	2,630.4
16	298	1.4	896	1.1	6.3	417.2	267,008	327.8	1,877.4
31	215	1.2	768	0.9	7.9	258.0	165,120	193.5	1,698.5
Total	1024					1,591.3	1,018,432	1,555.9	8,576.3
Sep-Ave.	12.2	1.8	1,202	1.5	11.8	22.6	14,668	18.5	143.9
2	245	2.9	1,885	2.8	27.0	710.5	461,825	686.0	6,615.0
7	201	2.0	1,300	1.1	6.3	402.0	261,300	221.1	1,266.3
14	133	1.2	780	0.8	3.6	159.6	103,740	106.4	478.8
21	165	1.3	845	1.2	9.1	214.5	139,425	198.0	1,501.5
28	201	1.3	845	1.1	6.4	261.3	169,845	221.1	1,286.4
Total	945					1,747.9	1,136,135	1,432.6	11,148.0
Total Annual (AF)	178.5								

(a) USGS published and unpublished data and Calif. Reg. Water quality Control Board data from December 1990 report on the lower San Joaquin River.

(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Table A-11

MUD SLOUGH AT HWY 140 AVERAGE MONTHLY WATER QUALITY - WATER YEAR1990 (a)
(Average Monthly Flows, Load Flow Factors and EC Values in 1,000s)

MONTH	FLOWS (b)	CONCENTRATION				LOAD-FLOW FACTOR			
	AF or cfs	EC us/cm	TDS ppm	B ppm	Se ppb	EC-FLOW AF-us/cm	TDS-FLOW AF-ppm	B-FLOW AF-ppm	Se-FLOW AF-ppb
Oct - Ave.	3.5	1.2	728	0.8	1.1	4.2	2,548	2.7	3.9
6	21.0	1.5	915	0.9	1.9	31.5	19,215	18.9	39.9
13	20.0	1.9	1,159	1.1	1.2	38.0	23,180	22.0	24.0
20	75.0	1.1	671	0.8	1.0	82.5	50,325	60.0	75.0
30	70.0	1.0	610	0.6	1.0	70.0	42,700	42.0	70.0
Total	186.0					222.0	135,420	142.9	208.9
Nov - Ave.	3.6	1.5	886	1.0	1.5	5.2	3,190	3.5	5.5
6	58.0	1.5	915		1.7	87.0	53,070		98.6
13	56.0	1.4	854	0.9	1.1	78.4	47,824	50.4	61.6
20	52.0	1.4	854	0.9	1.4	72.8	44,408	46.8	72.8
30	61.0	1.5	915	1.1	1.9	91.5	55,815	67.1	115.9
Total	227.0					329.7	201,117	164.3	348.9
Dec - Ave.	4.5	1.9	1,253	1.2	1.2	8.4	5,636	5.4	5.5
8	65.0	1.9	1,273	1.2	1.4	123.5	82,745	78.0	91.0
15	64.0	1.9	1,273	1.2	1.1	121.6	81,472	76.8	70.4
21	109.0	1.7	1,139	1.1	1.1	185.3	124,151	119.9	119.9
29	63.0	2.1	1,407	1.4	1.4	132.3	88,641	88.2	88.2
Total	301.0					562.7	377,009	362.9	369.5
Jan - Ave.	3.2	2.5	1,620	1.9	2.6	8.1	5,185	6.2	8.3
5	51.0	2.6	1,664	1.7	1.4	132.6	84,864	86.7	71.4
11	51.0	2.5	1,600	1.7	0.9	127.5	81,600	86.7	45.9
19	59.0	2.5	1,600	2.0	7.0	147.5	94,400	118.0	413.0
26	49.0			2.3	7.2			112.7	16.6
Total	210.0					407.6	260,864	404.1	546.9
Feb - Ave.	2.2	3.0	2,008	3.0	8.9	6.7	4,418	6.5	19.6
2	37.0	3.1	2,046	2.2	5.5	114.7	75,702	81.4	203.5
19	48.0			3.4	20.0			163.2	960.0
26	50.0	3.0	1,980	3.1	12.0	150.0	99,000	155.0	37.2
Total	135.0					264.7	174,702	399.6	1,200.7
Mar-Ave.	1.7	3.8	2,600	3.3	10.8	6.5	4,420	5.6	18.4
5	47.0	3.2	2,176	3.0	14.0	150.4	102,272	141.0	658.0
9	35.0	3.6	2,448	3.1	12.0	126.0	85,680	108.5	420.0
16	23.0	4.1	2,788	3.6	11.0	94.3	64,124	82.8	253.0
23	15.0	4.4	2,992	3.4	3.8	66.0	44,880	51.0	57.0
30	15.0	5.3	3,604	4.1	4.7	79.5	54,060	61.5	70.5
Total	135.0					516.2	351,016	444.8	1,458.5
Apr-Ave.	1.4	4.2	2,728	3.6	1.7	5.9	3,819	5.0	2.4
6	9.0	5.6	3,640	3.8	2.8	50.4	32,760	34.2	25.2
12	10.0	6.3	4,095	4.5	3.1	63.0	40,950	45.0	31.0
20	34.0	4.4	2,860	4.1	1.7	149.6	97,240	139.4	57.8
27	51.0	3.4	2,210	3.0	1.3	173.4	112,710	153.0	66.3
Total	104.0					436.4	283,660	371.6	180.3
May - Ave.	0.5	5.4	3,693	4.3	13.5	2.7	1,846	2.1	6.8
4	7.3	5.4	3,726	3.8	1.6	39.4	27,200	27.7	11.7
11	5.4	7.6	5,244	5.3	1.4	41.0	28,318	28.6	7.6
18	6.3	8.9	6,141	5.8	1.1	56.1	38,688	36.5	6.9
25	12.0	5.2	3,588	3.8	8.7	62.4	43,056	45.6	104.4
31	20.0	3.7	2,553	4.0	28.0	74.0	51,060	80.0	560.0
Total	51.0					272.9	188,322	218.5	690.6
Jun - Ave.	0.7	4.6	3,238	4.0	14.5	3.2	2,267	2.8	10.2
8	4.4	5.5	3,850	4.2	3.7	24.2	16,940	18.5	16.3
15	13.0	4.6	3,220	5.6	28.0	59.8	41,860	72.8	364.0
22	14.0	9.0	6,300	1.7	4.9	126.0	88,200	23.8	68.6
28	14.0			4.9	15.0			68.6	210.0
Total	45.4					210.0	147,000	183.7	658.9
Jul-Ave.	0.7	3.5	2,385	5.0	19.4	2.5	1,669	3.5	13.6
6	11.0	3.5	2,380	4.8	22.0	38.5	26,180	52.8	242.0
13	6.8	4.5	3,060	5.5	13.0	30.6	20,808	37.4	88.4
20	10.0	3.3	2,244	4.7	20.0	33.0	22,440	47.0	200.0
27	15.0	3.2	2,176	5.0	20.0	48.0	32,640	75.0	300.0
Total	42.8					150.1	102,068	212.2	830.4
Aug-Ave.	0.4	2.4	1,635	4.3	21.2	0.9	654	1.7	8.5
3	8.6	1.7	1,173	4.4	21.0	14.6	10,088	37.8	180.6
9	2.3	2.9	2,001	4.0	15.0	6.7	4,602	9.2	34.5
16	4.1	3.2	2,208	4.2	23.0	13.1	9,053	17.2	94.3
31	1.8	3.0	2,070	4.0	26.0	5.4	3,726	7.2	46.8
Total	16.8					39.8	27,469	71.5	356.2
Sep-Ave.	0.2	2.8	2,015	3.2	10.5	0.6	403	0.6	2.1
2	1.2	3.0	2,130	2.0	1.9	3.6	2,556	2.4	2.3
7	1.2	3.4	2,414	4.7	31.0	4.1	2,897	5.6	37.2
14	1.4	3.8	2,698	4.9	10.0	5.3	3,777	6.9	14.0
21	2.3	2.8	1,988	3.2	7.8	6.4	4,572	7.4	17.9
28	1.3	1.2	852	1.0	5.1	1.6	1,108	1.3	6.6
Total	7.4					21.0	14,910	23.6	78.0
Total Annual (AF)	22.6								

(a) USGS published and unpublished data and Calif. Reg. Water quality Control Board data from December 1990 report on the lower San Joaquin River.
(b) Monthly average values are in thousands of acre-feet and the daily values are in cubic feet per second.

Appendix B

Mass balance analysis for boron, selenium and TDS

1988 hydrology

B1 - B28

Table B1. Boron mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	20.9	0.7	14.6	11.5	1.2	13.8	2.0	0.8	1.6	7.4	-0.8	1.0	2.5	4.9	11.2	11.2	3.5	17.7	13.4	26.1	3.8	7.7
Nov	34.1	0.7	23.9	13.5	1.9	25.7	4.1	1.4	5.7	16.5	-7.5	1.0	2.5	5.0	5.1	5.1	2.4	12.6	7.5	17.1	2.5	5.6
Dec	27.9	1.0	27.9	6.9	2.9	20.0	1.8	2.8	5.0	19.2	2.8	1.0	2.6	5.2	2.4	2.4	2.2	10.8	5.2	13.6	2.0	4.8
JAn	42.8	1.0	42.8	9.3	3.7	34.4	5.1	2.4	12.2	28.4	-3.9	1.0	2.4	4.8	1.6	1.6	3.3	23.2	5.4	22.7	1.9	6.9
Feb	37.9	1.3	49.3	13.8	3.7	51.1	4.8	2.2	10.6	19.3	-12.4	1.0	2.3	4.6	1.7	1.7	6.2	29.1	7.7	27.3	2.5	8.1
Mar	49.5	1.5	74.3	24.7	1.9	46.9	7.9	2.7	21.3	16.9	6.0	1.0	3.0	6.0	2.6	2.6	7.3	40.9	9.3	37.4	3.6	12.0
Apr	39.4	1.0	39.4	18.7	2.4	44.9	3.0	2.3	6.9	17.7	-12.4	1.0	13.4	24.9	2.4	2.4	5.6	27.1	14.1	39.1	7.3	17.0
May	33.3	1.1	36.6	15.8	2.0	31.6	3.2	3.4	10.9	14.3	-5.9	1.0	8.6	16.2	5.1	5.1	6.0	30.1	14.1	38.4	5.6	13.8
Jun	31.8	1.4	44.5	18.9	1.7	32.1	4.1	3.5	14.3	8.8	-2.0	1.0	0.6	1.2	7.4	7.4	7.9	32.6	12.6	32.5	3.3	8.6
Jul	24.9	2.0	49.8	19.5	2.4	46.8	1.7	2.4	4.1	3.7	-1.1	1.0	0.2	0.4	5.4	5.4	9.0	34.3	11.6	31.8	3.0	8.2
Aug	31.0	1.1	34.1	23.3	1.5	35.0	0.5	3.4	1.7	7.2	-2.6	1.0	0.0	0.0	3.6	3.6	9.4	34.8	10.5	30.8	2.5	7.6
Sep	23.5	1.1	25.9	16.3	1.6	26.1	0.3	3.4	1.0	6.9	-1.3	1.0	0.2	0.4	6.5	6.5	4.4	17.8	8.9	19.5	2.3	5.1
TOTAL	397.0	1.2	463.0	192.2	2.1	408.3	38.5	2.5	95.4	166.3	-40.7		38.3	73.6	55.0	55.0	67.2	310.8	120.2	336.4	40.3	105.7

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and organized by EDF.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (32) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (28) of table 6.

Table B1. (cont). Boron mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY
WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 BORON LOAD-FLOW FACTOR (21)+(25)-(7) AFXppm	29 BORON LOAD (28)x0.00136 x1000 Tons	30 BORON LOAD-FLOW FACTOR (23)+(27)-(10) AFXppm	31 BORON LOAD (28)x0.00136 x1000 Tons	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (29)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (28)]-(7) AFXppm	38 FLOW [22]+ (26)]-(8) AF	39 BORON CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] Tons
-1.9	-1.9	-1.8	-1.8	10.4	14.2	4.2	5.8	20.9	14.6	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.0	6.0	1.6	1.6	-2.6	-3.5	1.5	2.0	34.1	23.9	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-0.2	-0.2	-4.8	-6.5	-0.4	-0.6	27.9	27.9	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	3.9	3.2	3.2	-7.8	-10.5	-2.2	-2.9	42.8	42.8	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.1	6.1	2.3	2.3	-17.6	-24.0	-0.2	-0.2	37.9	49.3	1.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
15.4	15.4	4.3	4.3	5.9	8.1	-5.0	-6.8	49.5	74.3	1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.6	4.6	-4.3	-4.3	-1.2	-1.6	5.9	8.0	39.4	39.4	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-2.4	-2.4	8.5	11.5	0.5	0.7	33.3	36.6	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.3	6.3	0.8	0.8	6.7	9.1	-4.9	-6.7	31.8	44.5	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.9	7.9	-1.3	-1.3	-7.1	-9.7	2.9	3.9	24.9	49.8	2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.8	12.8	-2.0	-2.0	8.7	11.8	3.9	5.3	31.0	34.1	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.5	7.5	-2.0	-2.0	0.9	1.2	2.2	2.9	23.5	25.9	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
72.0	72.0	-1.8	-1.8	0.1	0.1	8.4	11.4	397.0	463.0	1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B2. Boron mass balance analysis : 1988 hydrology : Scenario 1.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR (14)x2.0 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	20.9	0.7	14.6	11.5	1.2	13.8	2.0	0.8	1.6	7.4	-0.8	1.0	3.4	6.8	0.0	0.0	3.5	17.7	2.3	4.6	4.6	19.8
Nov	34.1	0.7	23.9	13.5	1.9	25.7	4.1	1.4	5.7	16.5	-7.5	1.0	3.4	6.8	0.0	0.0	2.4	12.6	2.3	4.6	3.5	14.8
Dec	27.9	1.0	27.9	6.9	2.9	20.0	1.8	2.8	5.0	19.2	2.8	1.0	3.4	6.8	0.0	0.0	2.2	10.8	2.3	4.6	3.2	13.0
JAn	42.8	1.0	42.8	9.3	3.7	34.4	5.1	2.4	12.2	28.4	-3.9	1.0	3.1	6.2	0.0	0.0	3.3	23.2	2.1	4.2	4.3	25.2
Feb	37.9	1.3	49.3	13.8	3.7	51.1	4.8	2.2	10.6	19.3	-12.4	1.0	3.1	6.2	0.0	0.0	6.2	29.1	2.1	4.2	7.2	31.1
Mar	49.5	1.5	74.3	24.7	1.9	46.9	7.9	2.7	21.3	16.9	6.0	1.0	3.0	6.0	0.0	0.0	7.3	40.9	2.1	4.2	8.2	44.3
Apr	39.4	1.0	39.4	18.7	2.4	44.9	3.0	2.3	6.9	17.7	-12.4	1.0	22.2	44.4	0.0	0.0	5.6	27.1	14.7	29.6	13.1	40.9
May	33.3	1.1	36.6	15.8	2.0	31.6	3.2	3.4	10.9	14.3	-5.9	1.0	13.5	27.0	0.0	0.0	6.0	30.1	9.0	17.8	10.5	38.0
Jun	31.8	1.4	44.5	18.9	1.7	32.1	4.1	3.5	14.3	8.8	-2.0	1.0	4.6	9.2	0.0	0.0	7.9	32.6	3.4	6.7	9.1	34.9
Jul	24.9	2.0	49.8	19.5	2.4	46.8	1.7	2.4	4.1	3.7	-1.1	1.0	3.9	7.8	0.0	0.0	9.0	34.3	2.8	5.7	10.1	36.6
Aug	31.0	1.1	34.1	23.3	1.5	35.0	0.5	3.4	1.7	7.2	-2.6	1.0	0.0	0.0	0.0	0.0	9.4	34.8	0.0	0.0	9.4	34.8
Sep	23.5	1.1	25.9	16.3	1.6	26.1	0.3	3.4	1.0	6.9	-1.3	1.0	1.8	3.6	0.0	0.0	4.4	17.8	1.2	2.5	5.0	18.9
TOTAL	397.0	1.2	463.0	192.2	2.1	408.3	38.5	2.5	95.4	166.3	-40.7		65.4	130.8	0.0	0.0	67.2	310.8	44.3	88.7	88.2	352.1

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (26) of table 7.

Table B2 (cont.). Boron mass balance analysis : 1988 hydrology : Scenario 1.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table B1 AF	BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	FLOWS [24] Table B1 AF	BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	B LOAD (Future without condition (Col(29) +(31) of Table B2) Tons	B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	Boron LOAD-FACTOR AFXppm	B LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	BORON CONC. (33)/(32) ppm	FLOW [(20)+ (24)]-(5) AF	BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	FLOW [22)+ (26)]-(8) AF	BORON CONC. [(23)+(27) (31)]+ [(22)+(26) ppm	LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppm	BORON LOAD [(42)x1000 x0.00136] Tons
-1.9	-1.9	-1.8	-1.8	20.0	0.0	0.0	14.7	10.6	5.2	0.5	-11.1	1.5	-11.1	0.8	1.1	1.7	-10.3	-9.4	-12.8
6.0	6.0	1.6	1.6	-1.5	0.0	0.0	-1.1	29.9	20.6	0.7	-5.2	1.3	-15.1	1.0	3.4	11.8	-4.2	-3.3	-4.5
1.7	1.7	-0.2	-0.2	-7.1	0.0	0.0	-5.2	26.2	27.1	1.0	-2.9	1.6	-13.7	1.2	6.0	12.9	-1.7	-0.8	-1.1
3.9	3.9	3.2	3.2	-13.4	0.0	0.0	-9.9	41.9	42.5	1.0	-3.3	1.4	-26.3	2.4	5.1	26.1	-0.9	-0.3	-0.3
6.1	6.1	2.3	2.3	-24.2	0.0	0.0	-17.8	37.0	49.2	1.3	-5.6	1.3	-40.8	4.7	5.4	40.6	-0.9	-0.1	-0.2
15.4	15.4	4.3	4.3	1.3	0.0	0.0	1.0	46.9	73.2	1.6	-7.2	1.1	-27.3	4.6	3.8	26.3	-2.6	-1.1	-1.4
4.6	4.6	-4.3	-4.3	6.4	0.0	0.0	4.7	45.8	53.7	1.2	0.6	1.8	-10.7	5.8	3.6	25.0	6.4	14.3	19.4
1.7	1.7	-2.4	-2.4	12.2	0.0	0.0	9.0	33.1	40.3	1.2	-5.1	1.8	-12.1	4.9	3.3	15.7	-0.2	3.6	4.9
6.3	6.3	0.8	0.8	2.4	0.0	0.0	1.8	28.4	45.0	1.6	-9.2	1.3	-19.1	5.8	3.4	19.6	-3.4	0.4	0.6
7.9	7.9	-1.3	-1.3	-5.6	0.0	0.0	-4.1	23.2	51.9	2.2	-8.8	1.3	-33.2	7.1	3.7	35.3	-1.7	2.1	2.8
12.8	12.8	-2.0	-2.0	17.1	0.0	0.0	12.6	27.4	30.5	1.1	-10.5	1.0	-22.2	6.9	2.1	18.5	-3.6	-3.6	-4.9
7.5	7.5	-2.0	-2.0	4.1	0.0	0.0	3.0	18.6	22.6	1.2	-7.6	1.1	-16.1	2.7	2.6	12.8	-4.9	-3.2	-4.4
72.0	72.0	-1.8	-1.8	11.7	0.0	0.0	8.6	369.0	461.7	1.3	-75.9		-247.6	47.9		246.3	-28.0	-1.3	-1.8

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B3. Boron dilution requirements : 1988 hydrology : Scenario 1.

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) lbs	2 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	3 FLOW NEWMAN KAF	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	5.2	10.6	0.5	0.7	-4.2	0
Nov	0.0	20.6	29.9	0.7	0.7	0.0	0
Dec	0.0	27.1	26.2	1.0	1.0	0.0	0
Jan	0.0	42.5	41.9	1.0	1.0	0.0	0
Feb	0.0	49.2	37.0	1.3	1.3	0.0	0
Mar	0.0	73.2	46.9	1.6	1.5	3.6	3,608
Apr	0.0	53.6	45.8	1.2	1.0	11.4	11,450
May	0.0	40.3	33.1	1.2	1.1	3.7	3,678
Jun	0.0	45.0	28.4	1.6	1.4	4.7	4,733
Jul	0.0	52.0	23.2	2.2	2.0	2.6	2,578
Aug	0.0	30.5	27.4	1.1	1.1	0.0	0
Sep	0.0	22.6	18.6	1.2	1.1	2.1	2,067
TOTALS	0.0	461.8	369.0			23.9	28,113

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table B4. Boron mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ [18]+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	20.9	0.7	14.6	11.5	1.2	13.8	2.0	0.8	1.6	7.4	-0.8	1.0	2.5	4.9	11.2	11.2	3.5	17.7	10.6	12.0	6.6	21.8
Nov	34.1	0.7	23.9	13.5	1.9	25.7	4.1	1.4	5.7	16.5	-7.5	1.0	2.5	5.0	5.1	5.1	2.4	12.6	5.6	7.0	4.4	15.7
Dec	27.9	1.0	27.9	6.9	2.9	20.0	1.8	2.8	5.0	19.2	2.8	1.0	2.6	5.2	2.4	2.4	2.2	10.8	3.5	5.0	3.7	13.4
JAn	42.8	1.0	42.8	9.3	3.7	34.4	5.1	2.4	12.2	28.4	-3.9	1.0	2.4	4.8	1.6	1.6	3.3	23.2	2.7	4.1	4.6	25.5
Feb	37.9	1.3	49.3	13.8	3.7	51.1	4.8	2.2	10.6	19.3	-12.4	1.0	2.3	4.6	1.7	1.7	6.2	29.1	2.7	4.0	7.5	31.4
Mar	49.5	1.5	74.3	24.7	1.9	46.9	7.9	2.7	21.3	16.9	6.0	1.0	3.0	6.0	2.6	2.6	7.3	40.9	3.4	4.7	9.5	44.7
Apr	39.4	1.0	39.4	18.7	2.4	44.9	3.0	2.3	6.9	17.7	-12.4	1.0	13.4	24.9	2.4	2.4	5.6	27.1	9.7	16.3	11.7	38.1
May	33.3	1.1	36.6	15.8	2.0	31.6	3.2	3.4	10.9	14.3	-5.9	1.0	8.6	16.2	5.1	5.1	6.0	30.1	9.3	13.8	10.4	37.6
Jun	31.8	1.4	44.5	18.9	1.7	32.1	4.1	3.5	14.3	8.8	-2.0	1.0	0.6	1.2	7.4	7.4	7.9	32.6	6.3	6.5	9.6	34.7
Jul	24.9	2.0	49.8	19.5	2.4	46.8	1.7	2.4	4.1	3.7	-1.1	1.0	0.2	0.4	5.4	5.4	9.0	34.3	4.4	4.4	10.2	35.6
Aug	31.0	1.1	34.1	23.3	1.5	35.0	0.5	3.4	1.7	7.2	-2.6	1.0	0.0	0.0	3.6	3.6	9.4	34.8	3.0	3.0	10.0	35.4
Sep	23.5	1.1	25.9	16.3	1.6	26.1	0.3	3.4	1.0	6.9	-1.3	1.0	0.2	0.4	6.5	6.5	4.4	17.8	10.6	5.3	5.8	19.3
TOTAL	397.0	1.2	463.0	192.2	2.1	408.3	38.5	2.5	95.4	166.3	-40.7		38.3	73.6	55.0	55.0	67.2	310.8	71.7	86.0	94.1	353.4

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of Table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (28) of Table 6.

Table B4. (cont.). Boron mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table B1 AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [24] Table B1 AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 B LOAD (Future without condition (Col(29) +(31) of Table B1 Tons	29 B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 Boron LOAD-FACTOR AFXppm	31 B LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 BORON CONC. [(23)+(27) (31)]+ [(22)+(26) ppm	40 LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] Tons
-1.9	-1.9	-1.8	-1.8	20.0	0.0	0.0	14.7	20.9	14.6	0.7	-2.8	1.2	-3.7	2.8	1.1	3.7	0.0	0.0	0.0
6.0	6.0	1.6	1.6	-1.5	0.0	0.0	-1.1	34.1	23.9	0.7	-1.9	1.1	-12.7	1.9	3.1	12.7	0.0	0.0	0.0
1.7	1.7	-0.2	-0.2	-7.1	0.0	0.0	-5.2	27.9	27.9	1.0	-1.7	1.3	-13.3	1.7	5.2	13.4	0.0	0.0	0.0
3.9	3.9	3.2	3.2	-13.4	0.0	0.0	-9.9	42.8	42.7	1.0	-2.7	1.2	-26.4	2.7	5.0	26.3	0.0	-0.1	-0.1
6.1	6.1	2.3	2.3	-24.2	0.0	0.0	-17.8	37.9	49.3	1.3	-5.0	1.1	-41.0	5.0	5.3	41.0	0.0	0.0	0.0
15.4	15.4	4.3	4.3	1.3	0.0	0.0	1.0	49.5	74.2	1.5	-5.9	1.1	-26.8	5.9	3.5	26.7	0.0	-0.1	-0.1
4.6	4.6	-4.3	-4.3	6.4	0.0	0.0	4.7	39.4	37.6	1.0	-4.4	1.5	-24.0	4.4	3.9	22.2	0.0	-1.8	-2.4
1.7	1.7	-2.4	-2.4	12.2	0.0	0.0	9.0	33.3	35.9	1.1	-4.8	1.4	-16.1	4.8	3.3	15.4	0.0	-0.8	-1.0
6.3	6.3	0.8	0.8	2.4	0.0	0.0	1.8	31.8	44.6	1.4	-6.3	1.0	-19.4	6.3	3.2	19.4	0.0	0.0	0.0
7.9	7.9	-1.3	-1.3	-5.6	0.0	0.0	-4.1	24.9	49.7	2.0	-7.2	1.0	-34.5	7.2	4.3	34.4	0.0	-0.1	-0.2
12.8	12.8	-2.0	-2.0	17.1	0.0	0.0	12.6	31.0	34.1	1.1	-7.5	1.0	-19.2	7.5	2.6	19.2	0.0	0.0	0.0
7.5	7.5	-2.0	-2.0	4.1	0.0	0.0	3.0	28.8	25.9	0.9	1.8	0.7	-13.3	3.5	3.8	13.3	5.3	0.1	0.1
72.0	72.0	-1.8	-1.8	11.7	0.0	0.0	8.6	402.3	460.3	1.1	-48.5		-250.3	53.8		247.6	5.3	-2.7	-3.7

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B5. Boron dilution requirements : 1988 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project assuming no increased wetland use

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) lbs	2 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	3 FLOW NEWMAN KAF	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	14.6	20.9	0.7	0.7	0.0	0
Nov	0.0	23.9	34.1	0.7	0.7	0.0	0
Dec	0.0	27.9	27.9	1.0	1.0	0.0	0
Jan	0.0	42.7	42.8	1.0	1.0	0.0	0
Feb	0.0	49.3	37.9	1.3	1.3	0.0	0
Mar	0.0	74.2	49.5	1.5	1.5	0.0	0
Apr	0.0	37.6	39.4	1.0	1.0	0.0	0
May	0.0	35.9	33.3	1.1	1.1	0.0	0
Jun	0.0	44.6	31.8	1.4	1.4	0.0	0
Jul	0.0	49.7	24.9	2.0	2.0	0.0	0
Aug	0.0	34.1	31.0	1.1	1.1	0.0	0
Sep	0.0	25.9	28.8	0.9	1.1	-6.4	0
TOTALS	0.0	460.4	402.3			-6.4	0

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table B6. Boron mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ BORON	LOAD FLOW FACTOR (2)x(3)	FLOW	WQ BORON	LOAD FLOW FACTOR (5)x(6)	FLOW	WQ BORON	LOAD FLOW FACTOR (8)x(9)	FLOW (2)-(5)-[8]	LOAD FLOW FACTOR (4)-(7)-[10] (e)	Ass. WQ BORON	DRAINAGE VOLUME	LOAD FLOW FACTOR Table 7	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR (16)x1.0	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS (16)x0.82+ (18)x0+ (30)Table 7	LOAD FLOW FACTOR (f)	FLOWS (16)x0.18+ [18]+ (26)Table 7	LOAD FLOW FACTOR (g)
	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	AFXppm	ppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm
Oct	20.9	0.7	14.6	11.5	1.2	13.8	2.0	0.8	1.6	7.4	-0.8	1.0	3.4	6.7	11.2	11.2	3.5	17.7	11.5	13.8	6.6	21.8
Nov	34.1	0.7	23.9	13.5	1.9	25.7	4.1	1.4	5.7	16.5	-7.5	1.0	3.4	6.8	5.1	5.1	2.4	12.6	6.5	8.8	4.4	15.7
Dec	27.9	1.0	27.9	6.9	2.9	20.0	1.8	2.8	5.0	19.2	2.8	1.0	3.3	6.8	2.4	2.4	2.2	10.8	4.3	6.6	3.6	13.4
JAn	42.8	1.0	42.8	9.3	3.7	34.4	5.1	2.4	12.2	28.4	-3.9	1.0	3.1	6.2	1.6	1.6	3.3	23.2	3.4	5.5	4.6	25.5
Feb	37.9	1.3	49.3	13.8	3.7	51.1	4.8	2.2	10.6	19.3	-12.4	1.0	3.1	6.2	1.7	1.7	6.2	29.1	3.5	5.6	7.5	31.4
Mar	49.5	1.5	74.3	24.7	1.9	46.9	7.9	2.7	21.3	16.9	6.0	1.0	3.0	7.6	2.6	2.6	7.3	40.9	4.2	6.3	8.7	44.7
Apr	39.4	1.0	39.4	18.7	2.4	44.9	3.0	2.3	6.9	17.7	-12.4	1.0	22.2	43.4	2.4	2.4	5.6	27.1	16.7	31.6	13.5	41.3
May	33.3	1.1	36.6	15.8	2.0	31.6	3.2	3.4	10.9	14.3	-5.9	1.0	13.5	25.7	5.1	5.1	6.0	30.1	13.2	22.0	11.4	38.9
Jun	31.8	1.4	44.5	18.9	1.7	32.1	4.1	3.5	14.3	8.8	-2.0	1.0	4.6	9.0	7.4	7.4	7.9	32.6	9.5	12.8	10.4	36.2
Jul	24.9	2.0	49.8	19.5	2.4	46.8	1.7	2.4	4.1	3.7	-1.1	1.0	3.9	8.0	5.4	5.4	9.0	34.3	7.2	10.1	11.1	37.5
Aug	31.0	1.1	34.1	23.3	1.5	35.0	0.5	3.4	1.7	7.2	-2.6	1.0	0.0	0.0	3.6	3.6	9.4	34.8	3.0	3.0	10.0	35.4
Sep	23.5	1.1	25.9	16.3	1.6	26.1	0.3	3.4	1.0	6.9	-1.3	1.0	1.8	3.6	6.5	6.5	4.4	17.8	10.6	7.8	6.2	20.0
TOTAL	397.0	1.2	463.0	192.2	2.1	408.3	38.5	2.5	95.4	166.3	-40.7		65.3	130.0	55.0	55.0	67.2	310.8	93.5	133.8	98.1	362.0

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of Table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (28) of Table 7.

Table B6 (cont.). Boron mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table 51 AF	BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	FLOWS [24] Table 51 AF	BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	B LOAD (Future without condition (Col(29) +(31) of Table 51 Tons	B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	Boron LOAD-FACTOR AFXppm	B LOAD-FLOW FACTOR (28)÷1000 ÷0.00136 AFXppm	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	BORON CONC. (33)/(32) ppm	FLOW [(20)+ (24)]-(5) AF	BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	FLOW [22)+ (26)]-(8) AF	BORON CONC. [(23)+(27) (31)]+ [(22)+(26) ppm	LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppm	BORON LOAD [(42)x1000 x0.00136] Tons
-1.9	-1.9	-1.8	-1.8	20.0	0.0	0.0	14.7	21.8	16.4	0.8	-1.9	1.2	-1.9	2.8	1.1	3.7	0.9	1.8	2.4
6.0	6.0	1.6	1.6	-1.5	0.0	0.0	-1.1	35.0	25.7	0.7	-1.0	1.2	-10.9	1.9	3.1	12.7	0.9	1.8	2.5
1.7	1.7	-0.2	-0.2	-7.1	0.0	0.0	-5.2	28.6	29.5	1.0	-0.9	1.4	-11.7	1.6	5.4	13.4	0.7	1.6	2.2
3.9	3.9	3.2	3.2	-13.4	0.0	0.0	-9.9	43.5	44.1	1.0	-2.0	1.3	-25.0	2.7	5.0	26.3	0.7	1.3	1.8
6.1	6.1	2.3	2.3	-24.2	0.0	0.0	-17.8	38.7	50.9	1.3	-4.2	1.2	-39.4	5.0	5.3	41.0	0.8	1.6	2.2
15.4	15.4	4.3	4.3	1.3	0.0	0.0	1.0	49.5	75.8	1.5	-5.1	1.1	-25.2	5.1	3.7	26.7	0.0	1.5	2.1
4.6	4.6	-4.3	-4.3	6.4	0.0	0.0	4.7	48.2	56.1	1.2	2.6	1.7	-8.7	6.2	3.5	25.4	8.8	16.7	22.7
1.7	1.7	-2.4	-2.4	12.2	0.0	0.0	9.0	38.2	45.4	1.2	-0.9	1.6	-7.9	5.8	3.1	16.7	4.9	8.7	11.9
6.3	6.3	0.8	0.8	2.4	0.0	0.0	1.8	35.8	52.4	1.5	-3.1	1.2	-13.1	7.1	3.1	20.9	4.0	7.8	10.7
7.9	7.9	-1.3	-1.3	-5.6	0.0	0.0	-4.1	28.6	57.3	2.0	-4.4	1.2	-28.8	8.1	4.1	36.3	3.7	7.5	10.2
12.8	12.8	-2.0	-2.0	17.1	0.0	0.0	12.6	31.0	34.1	1.1	-7.5	1.0	-19.2	7.5	2.6	19.2	0.0	0.0	0.0
7.5	7.5	-2.0	-2.0	4.1	0.0	0.0	3.0	29.2	29.1	1.0	1.8	0.8	-10.8	3.9	3.6	14.0	5.7	3.3	4.4
72.0	72.0	-1.8	-1.8	11.7	0.0	0.0	8.6	428.1	516.7	1.2	-26.7		-202.5	57.8		256.2	31.1	53.7	73.0

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B7. Boron dilution requirements : 1988 hydrology : Scenario 3.

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project assuming no increased wetland use
Assume increased water supply to wetlands.

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) lbs	2 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	3 FLOW NEWMAN KAF	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	16.4	21.8	0.8	0.7	4.4	4,360
Nov	0.0	25.7	35.0	0.7	0.7	0.0	0
Dec	0.0	29.5	28.6	1.0	1.0	0.0	0
Jan	0.0	44.1	43.5	1.0	1.0	0.0	0
Feb	0.0	50.9	38.7	1.3	1.3	0.0	0
Mar	0.0	75.9	49.5	1.5	1.5	0.0	0
Apr	0.0	56.1	48.2	1.2	1.0	12.1	12,050
May	0.0	45.4	38.2	1.2	1.1	4.2	4,244
Jun	0.0	52.4	35.8	1.5	1.4	3.0	2,983
Jul	0.0	57.3	28.6	2.0	2.0	0.0	0
Aug	0.0	34.1	31.0	1.1	1.1	0.0	0
Sep	0.0	29.1	29.2	1.0	1.1	-3.2	0
TOTALS	0.0	516.9	428.1			20.4	23,638

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table B8. Selenium mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 WQ Se ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 WQ Se ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	2.5	2.5	11.2	11.2	3.5	182.4	13.4	156.5	3.8	39.6
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	2.5	2.5	5.1	5.1	2.4	108.1	7.5	92.1	2.5	23.6
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	2.6	2.6	2.4	2.4	2.2	140.8	5.2	116.1	2.0	29.7
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	2.4	2.4	1.6	1.6	3.3	321.7	5.4	260.1	1.9	65.6
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	2.3	2.3	1.7	1.7	6.2	360.3	7.7	290.9	2.5	73.4
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	3.0	2.6	2.6	7.3	538.6	9.3	434.3	3.6	109.9
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	13.4	12.5	2.4	2.4	5.6	387.5	14.1	319.2	7.3	83.2
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	8.6	8.1	5.1	5.1	6.0	349.6	14.1	288.7	5.6	74.1
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	0.6	0.6	7.4	7.4	7.9	397.4	12.6	324.2	3.3	81.2
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	0.2	0.2	5.4	5.4	9.0	394.9	11.6	320.3	3.0	80.1
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	3.6	3.6	9.4	382.7	10.5	309.1	2.5	77.2
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	0.2	0.2	6.5	6.5	4.4	193.4	6.9	160.0	2.3	40.0
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		38.3	36.9	55.0	55.0	67.2	3757.4	120.2	3071.5	40.3	777.8

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (33) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (29) of table 6.

Table B8 (cont). Selenium mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS (5)-(20) AF	Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	FLOWS (8)-(22) AF	Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	Se LOAD-FLOW FACTOR (21)+(25)-(7) AFXppb	Se LOAD (x1000) (28)x0.00136 x2000 lbs	Se LOAD-FLOW FACTOR (23)+(27)-(10) AFXppb	Se LOAD (x1000) (28)x0.00136 x2000 lbs	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppb	Se CONC. (33)/(32) ppb	FLOW [(20)+(24)]-(5) AF	Se CONC. [(21)+(25)-(29)]+[(20)+(24)] ppb	LOAD FLOW FACTOR [(21)+(25)(28)]-(7) AFXppb	FLOW [22)+(26)]-(8) AF	Se CONC. [(23)+(27)-(31)]+[(22)+(26)] ppb	LOAD FLOW FACTOR [(23)+(27)-(30)]-(10) AFXppb	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) ppb	Se LOAD [(42)x2000 x0.00136] AFXppb
-1.9	-1.9	-1.8	-1.8	79.8	217.1	35.8	97.3	20.9	62.7	3.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.0	6.0	1.6	1.6	26.5	72.1	21.1	57.5	34.1	34.1	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-0.2	-0.2	41.9	113.9	27.7	75.4	27.9	83.7	3.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	3.9	3.2	3.2	48.3	131.2	48.4	131.6	42.8	171.2	4.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.1	6.1	2.3	2.3	-170.7	-464.4	62.7	170.4	37.9	303.2	8.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
15.4	15.4	4.3	4.3	141.0	383.5	3.6	9.7	49.5	346.5	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.6	4.6	-4.3	-4.3	60.1	163.3	52.9	143.8	39.4	275.8	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-2.4	-2.4	51.8	141.0	48.4	131.6	33.3	199.8	6.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.3	6.3	0.8	0.8	156.6	426.1	3.3	8.9	31.8	254.4	8.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.9	7.9	-1.3	-1.3	39.6	107.7	59.2	160.9	24.9	273.9	11.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.8	12.8	-2.0	-2.0	89.0	242.0	65.0	176.8	31.0	217.0	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.5	7.5	-2.0	-2.0	-11.8	-32.1	34.1	92.8	23.5	164.5	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
72.0	72.0	-1.8	-1.8	552.0	1501.3	462.0	1256.7	397.0	2386.8	6.0	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B9. Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 0% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION (Assume selenium system losses reduced by 0%)

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 WQ Se ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 WQ Se ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)x+ (28)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	3.4	4.6	0.0	0.0	3.5	182.4	2.3	3.0	4.6	184.0
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	3.4	3.9	0.0	0.0	2.4	108.1	2.3	3.0	3.5	109.7
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	3.3	3.9	0.0	0.0	2.2	140.8	2.3	3.0	3.2	142.4
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	3.1	3.5	0.0	0.0	3.3	321.7	2.1	2.8	4.3	323.2
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	3.1	3.5	0.0	0.0	6.2	360.3	2.1	2.8	7.2	361.8
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	4.2	0.0	0.0	7.3	538.6	2.1	2.8	8.2	540.8
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	22.2	24.0	0.0	0.0	5.6	387.5	14.7	19.9	13.1	397.3
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	13.5	14.1	0.0	0.0	6.0	349.6	9.0	11.8	10.5	355.2
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	4.6	5.2	0.0	0.0	7.9	397.4	3.4	4.2	9.1	399.0
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	3.9	4.1	0.0	0.0	9.0	394.9	2.8	3.8	10.1	396.6
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	0.0	0.0	9.4	382.7	0.0	0.0	9.4	382.7
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	1.8	2.1	0.0	0.0	4.4	193.4	1.2	1.6	5.0	194.2
TOTAL	397.0	6.0	2386.6	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		65.3	73.1	0.0	0.0	67.2	3757.4	44.3	58.7	88.2	3786.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table B9 (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 0% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION (Assume selenium system losses reduced by 0%)

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table 8C AF	Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	FLOWS [24] Table 8C AF	Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	Se LOAD (Future without condition (Col(29) +(31) of Table 8C lbs	Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.0) lbs	Se LOAD-FLOW FACTOR AFXppb	Se LOAD-FLOW FACTOR (29)÷2000 +0.00136 AFXppb	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	Se CONC. (33)/(32) ppb	FLOW [(20)+ (24)]-(5) AF	Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	FLOW [22)+ (26)]-(8) AF	Se CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppb	LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppb	Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	314.4	0.0	115.6	10.6	53.6	5.1	-11.1	2.8	-73.7	0.8	23.8	64.6	-10.3	-9.1	-24.7
6.0	6.0	1.6	1.6	129.6	129.6	0.0	47.6	29.9	31.1	1.0	-5.2	1.1	-62.6	1.0	12.5	59.5	-4.2	-3.0	-8.2
1.7	1.7	-0.2	-0.2	189.3	189.3	0.0	69.6	26.2	83.3	3.2	-2.9	1.2	-71.2	1.2	24.2	70.8	-1.7	-0.4	-1.1
3.9	3.9	3.2	3.2	262.8	262.8	0.0	96.6	41.9	171.5	4.1	-3.3	1.1	-209.1	2.4	30.6	209.4	-0.9	0.3	0.9
6.1	6.1	2.3	2.3	-294.0	-294.0	0.0	-108.1	37.0	303.5	8.2	-5.6	1.1	-458.9	4.7	49.7	459.2	-0.9	0.3	0.8
15.4	15.4	4.3	4.3	393.2	393.2	0.0	144.6	46.9	345.9	7.4	-7.2	1.0	-290.6	4.6	32.0	289.9	-2.6	-0.6	-1.6
4.6	4.6	-4.3	-4.3	307.1	307.1	0.0	112.9	45.8	290.6	6.3	0.6	1.3	-239.2	5.8	31.8	254.0	6.4	14.8	40.3
1.7	1.7	-2.4	-2.4	272.6	272.6	0.0	100.2	33.1	204.0	6.2	-5.1	1.3	-225.1	4.9	31.2	229.3	-0.2	4.2	11.3
6.3	6.3	0.8	0.8	435.0	435.0	0.0	159.9	28.4	252.2	8.9	-9.2	1.1	-163.4	5.8	24.2	161.2	-3.4	-2.2	-6.0
7.9	7.9	-1.3	-1.3	268.6	268.6	0.0	98.8	23.2	273.8	11.8	-8.8	1.1	-276.9	7.1	33.7	276.8	-1.7	-0.1	-0.3
12.8	12.8	-2.0	-2.0	418.8	418.8	0.0	154.0	27.4	213.4	7.8	-10.5	1.0	-220.2	6.9	30.6	216.6	-3.6	-3.6	-9.8
7.5	7.5	-2.0	-2.0	60.7	60.7	0.0	22.3	18.6	160.2	8.6	-7.6	1.0	-170.2	2.7	56.6	165.9	-4.9	-4.3	-11.8
72.0	72.0	-1.8	-1.8	2,758.1	2,758.1	0.0	1,014.0	369.0	2,383.1	6.5	-75.9		-2,460.9	47.9		2,457.1	-28.0	-3.7	-10.1

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B10. Selenium dilution requirements : 1988 hydrology : Scenario 1 : 0% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 0%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	53.6	10.6	5.1	3.0	10.9	10,900
Nov	0.0	31.1	29.9	1.0	1.0	0.0	0
Dec	0.0	83.3	26.2	3.2	3.0	2.4	2,350
Jan	0.0	171.5	41.9	4.1	4.0	1.3	1,300
Feb	0.0	303.5	37.0	8.2	8.0	1.1	1,071
Mar	0.0	345.9	46.9	7.4	7.0	2.9	2,933
Apr	0.0	290.6	45.8	6.3	7.0	-5.0	0
May	0.0	204.0	33.1	6.2	6.0	1.1	1,080
Jun	0.0	252.2	28.4	8.9	8.0	3.6	3,571
Jul	0.0	273.8	23.2	11.8	11.0	1.9	1,860
Aug	0.0	213.4	27.4	7.8	7.0	3.6	3,600
Sep	0.0	160.2	18.6	8.6	7.0	5.0	5,000
TOTALS	0.0	2383.1	369.0			28.7	33,666

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B11. Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 10% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION (Assume selenium system losses reduced by 10%)

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ Se	LOAD FLOW FACTOR	FLOW	WQ Se	LOAD FLOW FACTOR	FLOW	WQ Se	LOAD FLOW FACTOR	FLOW	LOAD FLOW FACTOR	Ass. WQ Se	DRAINAGE VOLUME	LOAD FLOW FACTOR	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS	LOAD FLOW FACTOR	FLOWS	LOAD FLOW FACTOR
			(2)x(3)			(5)x(6)			(8)x(9)	(2)-(5)-[8]	(4)-(7)-[10] (e)			Table 7		(16)x1.0			(16)x0.82+ (18)x0+ (30)Table 7	(f)	(16)x0.18+ (18)x+ (26)Table 7	(g)
	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	AFXppb	ppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	3.4	4.6	0.0	0.0	3.5	182.4	2.3	3.0	4.6	184.0
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	3.4	3.9	0.0	0.0	2.4	108.1	2.3	3.0	3.5	109.7
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	3.3	3.9	0.0	0.0	2.2	140.8	2.3	3.0	3.2	142.4
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	3.1	3.5	0.0	0.0	3.3	321.7	2.1	2.8	4.3	323.2
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	3.1	3.5	0.0	0.0	6.2	360.3	2.1	2.8	7.2	361.8
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	4.2	0.0	0.0	7.3	538.6	2.1	2.8	8.2	540.8
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	22.2	24.0	0.0	0.0	5.6	387.5	14.7	19.9	13.1	397.3
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	13.5	14.1	0.0	0.0	6.0	349.6	9.0	11.8	10.5	355.2
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	4.6	5.2	0.0	0.0	7.9	397.4	3.4	4.2	9.1	399.0
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	3.9	4.1	0.0	0.0	9.0	394.9	2.8	3.8	10.1	396.6
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	0.0	0.0	9.4	382.7	0.0	0.0	9.4	382.7
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	1.8	2.1	0.0	0.0	4.4	193.4	1.2	1.6	5.0	194.2
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		65.3	73.1	0.0	0.0	67.2	3757.4	44.3	58.7	88.2	3786.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table B11. (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 10% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION (Assume selenium system losses reduced by 10%)

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table 8 AF	Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	FLOWS [24] Table 8 AF	Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	Se LOAD (Future without condition (Col(29) +(31) of Table 8 lbs	Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.10) lbs	Se LOAD-FLOW FACTOR AFXppb	Se LOAD-FLOW FACTOR (29)+2000 +0.00136 AFXppb	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	Se CONC. (33)/(32) ppb	FLOW [(20)+ (24)]-(5) AF	Se CONC. [(21)+(25)-(30)]+ [(20)+(24)] ppb	LOAD FLOW FACTOR [(21)+(25)-(30)]-(7) AFXppb	FLOW [22]+ (26)]-(8) AF	Se CONC. [(23)+(27)-(31)]+ [(22)+(26)] ppb	LOAD FLOW FACTOR [(23)+(27)-(31)]-(10) AFXppb	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppb	Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	283.0	0.0	104.0	10.6	65.2	6.1	-11.1	2.8	-73.7	0.8	27.9	76.1	-10.3	2.5	6.7
6.0	6.0	1.6	1.6	129.6	116.6	0.0	42.9	29.9	35.9	1.2	-5.2	1.1	-62.6	1.0	13.4	64.3	-4.2	1.8	4.8
1.7	1.7	-0.2	-0.2	189.3	170.4	0.0	62.6	26.2	90.3	3.4	-2.9	1.2	-71.2	1.2	26.5	77.8	-1.7	6.6	17.9
3.9	3.9	3.2	3.2	262.8	236.5	0.0	87.0	41.9	181.2	4.3	-3.3	1.1	-209.1	2.4	31.9	219.0	-0.9	10.0	27.1
6.1	6.1	2.3	2.3	-294.0	-323.4	0.0	-118.9	37.0	314.3	8.5	-5.6	1.1	-458.9	4.7	50.8	470.0	-0.9	11.1	30.2
15.4	15.4	4.3	4.3	393.2	353.9	0.0	130.1	46.9	360.4	7.7	-7.2	1.0	-290.6	4.6	33.2	304.4	-2.6	13.9	37.7
4.6	4.6	-4.3	-4.3	307.1	276.4	0.0	101.6	45.8	301.9	6.6	0.6	1.3	-239.2	5.8	33.1	265.3	6.4	26.1	71.0
1.7	1.7	-2.4	-2.4	272.6	245.3	0.0	90.2	33.1	214.0	6.5	-5.1	1.3	-225.1	4.9	32.4	239.3	-0.2	14.2	38.6
6.3	6.3	0.8	0.8	435.0	391.5	0.0	143.9	28.4	268.2	9.4	-9.2	1.1	-163.4	5.8	25.8	177.2	-3.4	13.8	37.5
7.9	7.9	-1.3	-1.3	268.6	241.7	0.0	88.9	23.2	283.7	12.2	-8.8	1.1	-276.9	7.1	34.8	286.7	-1.7	9.8	26.5
12.8	12.8	-2.0	-2.0	418.8	376.9	0.0	138.6	27.4	228.8	8.4	-10.5	1.0	-220.2	6.9	32.7	232.0	-3.6	11.8	32.1
7.5	7.5	-2.0	-2.0	60.7	54.6	0.0	20.1	18.6	162.4	8.7	-7.6	1.0	-170.2	2.7	57.4	168.1	-4.9	-2.1	-5.7
72.0	72.0	-1.8	-1.8	2,758.1	2,423.5	0.0	891.0	369.0	2,506.1	6.8	-75.9		-2,460.9	47.9		2,580.2	-28.0	119.3	324.5

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B12. Selenium dilution requirements : 1988 hydrology : Scenario 1 : 10% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	31.4	65.2	10.6	6.2	3.0	16.7	16,700
Nov	13.0	35.9	29.9	1.2	1.0	NF	NF
Dec	18.9	90.3	26.2	3.4	3.0	5.9	5,850
Jan	26.3	181.2	41.9	4.3	4.0	4.5	4,533
Feb	29.4	314.3	37.0	8.5	8.0	2.6	2,614
Mar	39.3	360.4	46.9	7.7	7.0	5.3	5,350
Apr	30.7	301.9	45.8	6.6	7.0	-3.1	0
May	27.3	214.0	33.1	6.5	6.0	3.1	3,080
Jun	43.5	268.2	28.4	9.4	8.0	5.9	5,857
Jul	26.9	283.7	23.2	12.2	11.0	2.9	2,850
Aug	41.9	228.8	27.4	8.4	7.0	6.2	6,167
Sep	61.0	162.4	18.6	8.7	7.0	5.4	5,367
TOTALS	389.6	2506.3	369.0			55.3	58,368

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B13. Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 20% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION (Assume selenium system losses reduced by 20%)

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ Se	LOAD FLOW FACTOR (2)x(3)	FLOW	WQ Se	LOAD FLOW FACTOR (5)x(6)	FLOW	WQ Se	LOAD FLOW FACTOR (8)x(9)	FLOW (2)-(5)-[8]	LOAD FLOW FACTOR (4)-(7)-[10] (e)	Ass. WQ Se	DRAINAGE VOLUME	LOAD FLOW FACTOR Table 7	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR (16)x1.0	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS (16)x0.82+ (18)x0+ (30)Table 7	LOAD FLOW FACTOR (f)	FLOWS (16)x0.18+ (18)x+ (26)Table 7	LOAD FLOW FACTOR (g)
	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	AFXppb	ppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	3.4	4.6	0.0	0.0	3.5	182.4	2.3	3.0	4.6	184.0
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	3.4	3.9	0.0	0.0	2.4	108.1	2.3	3.0	3.5	109.7
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	3.3	3.9	0.0	0.0	2.2	140.8	2.3	3.0	3.2	142.4
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	3.1	3.5	0.0	0.0	3.3	321.7	2.1	2.8	4.3	323.2
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	3.1	3.5	0.0	0.0	6.2	360.3	2.1	2.8	7.2	361.8
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	4.2	0.0	0.0	7.3	538.6	2.1	2.8	8.2	540.8
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	22.2	24.0	0.0	0.0	5.6	387.5	14.7	19.9	13.1	397.3
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	13.5	14.1	0.0	0.0	6.0	349.6	9.0	11.8	10.5	355.2
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	4.6	5.2	0.0	0.0	7.9	397.4	3.4	4.2	9.1	399.0
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	3.9	4.1	0.0	0.0	9.0	394.9	2.8	3.8	10.1	396.6
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	0.0	0.0	9.4	382.7	0.0	0.0	9.4	382.7
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	1.8	2.1	0.0	0.0	4.4	193.4	1.2	1.6	5.0	194.2
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		65.3	73.1	0.0	0.0	67.2	3757.4	44.3	58.7	88.2	3786.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table B13. (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 20% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION (Assume selenium system losses reduced by 20%)

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table B5 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table B5 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table B5 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.2) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)÷2000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]÷ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27)- (31)]÷ [(22)+(26)] ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	251.5	0.0	92.5	10.6	76.7	7.2	-11.1	2.8	-73.7	0.8	32.0	87.7	-10.3	14.0	38.2
6.0	6.0	1.6	1.6	129.6	103.7	0.0	38.1	29.9	40.6	1.4	-5.2	1.1	-62.6	1.0	14.3	69.1	-4.2	6.5	17.7
1.7	1.7	-0.2	-0.2	189.3	151.4	0.0	55.7	26.2	97.2	3.7	-2.9	1.2	-71.2	1.2	28.8	84.7	-1.7	13.5	36.8
3.9	3.9	3.2	3.2	262.8	210.2	0.0	77.3	41.9	190.8	4.6	-3.3	1.1	-209.1	2.4	33.2	228.7	-0.9	19.6	53.4
6.1	6.1	2.3	2.3	-294.0	-352.8	0.0	-129.7	37.0	325.1	8.8	-5.6	1.1	-458.9	4.7	52.0	480.8	-0.9	21.9	59.6
15.4	15.4	4.3	4.3	393.2	314.6	0.0	115.6	46.9	374.8	8.0	-7.2	1.0	-290.6	4.6	34.4	318.9	-2.6	28.3	77.0
4.6	4.6	-4.3	-4.3	307.1	245.7	0.0	90.3	45.8	313.2	6.8	0.6	1.3	-239.2	5.8	34.4	276.6	6.4	37.4	101.7
1.7	1.7	-2.4	-2.4	272.6	218.1	0.0	80.2	33.1	224.0	6.8	-5.1	1.3	-225.1	4.9	33.7	249.3	-0.2	24.2	65.9
6.3	6.3	0.8	0.8	435.0	348.0	0.0	127.9	28.4	284.2	10.0	-9.2	1.1	-163.4	5.8	27.5	193.2	-3.4	29.8	81.0
7.9	7.9	-1.3	-1.3	268.6	214.9	0.0	79.0	23.2	293.5	12.7	-8.8	1.1	-276.9	7.1	35.9	296.5	-1.7	19.6	53.4
12.8	12.8	-2.0	-2.0	418.8	335.0	0.0	123.2	27.4	244.2	8.9	-10.5	1.0	-220.2	6.9	34.8	247.4	-3.6	27.2	74.0
7.5	7.5	-2.0	-2.0	60.7	48.6	0.0	17.9	18.6	164.6	8.9	-7.6	1.0	-170.2	2.7	58.1	170.3	-4.9	0.1	0.4
72.0	72.0	-1.8	-1.8	2,758.1	2,088.9	0.0	768.0	369.0	2,629.1	7.1	-75.9		-2,460.9	47.9		2,703.2	-28.0	242.3	659.1

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B14. Selenium dilution requirements : 1988 hydrology : Scenario 1 : 20% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 20%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	62.8	76.7	10.6	7.2	3.0	22.5	22,450
Nov	26.0	40.6	29.9	1.4	1.0	NF	NF
Dec	37.8	97.2	26.2	3.7	3.0	9.3	9,300
Jan	52.6	190.8	41.9	4.6	4.0	7.7	7,733
Feb	58.8	325.1	37.0	8.8	8.0	4.2	4,157
Mar	78.6	374.8	46.9	8.0	7.0	7.8	7,750
Apr	61.4	313.2	45.8	6.8	7.0	-1.2	0
May	54.6	224.0	33.1	6.8	6.0	5.1	5,080
Jun	87.0	284.2	28.4	10.0	8.0	8.1	8,143
Jul	53.8	293.5	23.2	12.7	11.0	3.8	3,830
Aug	83.8	244.2	27.4	8.9	7.0	8.7	8,733
Sep	12.2	164.6	18.6	8.8	7.0	5.7	5,733
TOTALS	669.4	2628.9	369.0			81.7	82,910

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B15. Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 51% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION (Assume selenium system losses reduced by 51%)

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ Se	LOAD FLOW FACTOR (2)x(3)	FLOW	WQ Se	LOAD FLOW FACTOR (5)x(6)	FLOW	WQ Se	LOAD FLOW FACTOR (8)x(9)	FLOW (2)-(5)-[8]	LOAD FLOW FACTOR (4)-(7)-[10] (e)	Ass. WQ Se	DRAINAGE VOLUME	LOAD FLOW FACTOR Table 7	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR (16)x1.0	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS (16)x0.82+ (18)x0+ (30)Table 7	LOAD FLOW FACTOR (f)	FLOWS (16)x0.18+ (18)x+ (26)Table 7	LOAD FLOW FACTOR (g)
	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	AFXppb	ppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	3.4	4.6	0.0	0.0	3.5	182.4	2.3	3.0	4.6	184.0
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	3.4	3.9	0.0	0.0	2.4	108.1	2.3	3.0	3.5	109.7
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	3.3	3.9	0.0	0.0	2.2	140.8	2.3	3.0	3.2	142.4
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	3.1	3.5	0.0	0.0	3.3	321.7	2.1	2.8	4.3	323.2
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	3.1	3.5	0.0	0.0	6.2	360.3	2.1	2.8	7.2	361.8
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	4.2	0.0	0.0	7.3	538.6	2.1	2.8	8.2	540.8
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	22.2	24.0	0.0	0.0	5.6	387.5	14.7	19.9	13.1	397.3
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	13.5	14.1	0.0	0.0	6.0	349.6	9.0	11.8	10.5	355.2
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	4.6	5.2	0.0	0.0	7.9	397.4	3.4	4.2	9.1	399.0
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	3.9	4.1	0.0	0.0	9.0	394.9	2.8	3.8	10.1	396.6
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	0.0	0.0	9.4	382.7	0.0	0.0	9.4	382.7
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	1.8	2.1	0.0	0.0	4.4	193.4	1.2	1.6	5.0	194.2
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		65.3	73.1	0.0	0.0	67.2	3757.4	44.3	58.7	88.2	3786.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table B15. (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 1 : 51% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION (Assume selenium system losses reduced by 51%)
(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table 8E AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table 8E AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table 8E lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.51) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)÷2000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]÷ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27)- (31)]÷ [(22)+(26)] ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	154.1	0.0	56.6	10.6	112.6	10.6	-11.1	2.8	-73.7	0.8	44.8	123.5	-10.3	49.9	135.6
6.0	6.0	1.6	1.6	129.6	63.5	0.0	23.3	29.9	55.4	1.9	-5.2	1.1	-62.6	1.0	17.2	83.8	-4.2	21.3	57.9
1.7	1.7	-0.2	-0.2	189.3	92.8	0.0	34.1	26.2	118.8	4.5	-2.9	1.2	-71.2	1.2	36.0	106.3	-1.7	35.1	95.5
3.9	3.9	3.2	3.2	262.8	128.8	0.0	47.3	41.9	220.8	5.3	-3.3	1.1	-209.1	2.4	37.2	258.6	-0.9	49.6	134.9
6.1	6.1	2.3	2.3	-294.0	-443.9	0.0	-163.2	37.0	358.6	9.7	-5.6	1.1	-458.9	4.7	55.5	514.3	-0.9	55.4	150.8
15.4	15.4	4.3	4.3	393.2	192.7	0.0	70.8	46.9	419.6	8.9	-7.2	1.0	-290.6	4.6	37.9	363.7	-2.6	73.1	198.9
4.6	4.6	-4.3	-4.3	307.1	150.5	0.0	55.3	45.8	348.2	7.6	0.6	1.3	-239.2	5.8	38.4	311.6	6.4	72.4	196.9
1.7	1.7	-2.4	-2.4	272.6	133.6	0.0	49.1	33.1	255.1	7.7	-5.1	1.3	-225.1	4.9	37.5	280.4	-0.2	55.3	150.4
6.3	6.3	0.8	0.8	435.0	213.2	0.0	78.4	28.4	333.8	11.8	-9.2	1.1	-163.4	5.8	32.5	242.7	-3.4	79.4	215.9
7.9	7.9	-1.3	-1.3	268.6	131.6	0.0	48.4	23.2	324.1	14.0	-8.8	1.1	-276.9	7.1	39.4	327.1	-1.7	50.2	136.7
12.8	12.8	-2.0	-2.0	418.8	205.2	0.0	75.4	27.4	291.9	10.7	-10.5	1.0	-220.2	6.9	41.3	295.1	-3.6	74.9	203.8
7.5	7.5	-2.0	-2.0	60.7	29.7	0.0	10.9	18.6	171.6	9.2	-7.6	1.0	-170.2	2.7	60.4	177.3	-4.9	7.1	19.2
72.0	72.0	-1.8	-1.8	2,758.1	1,051.6	0.0	386.6	369.0	3,010.5	8.2	-75.9		-2,460.9	47.9		3,084.5	-28.0	623.7	1,696.4

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B16. Selenium dilution requirements : 1988 hydrology : Scenario 1 : 51% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 51%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	160.1	112.6	10.6	10.6	3.0	40.4	40,400
Nov	66.3	55.4	29.9	1.9	1.0	NF	NF
Dec	96.4	118.8	26.2	4.5	3.0	20.1	20,100
Jan	134.1	220.8	41.9	5.3	4.0	17.7	17,733
Feb	149.9	358.6	37.0	9.7	8.0	8.9	8,943
Mar	200.4	419.6	46.9	8.9	7.0	15.2	15,217
Apr	156.6	348.2	45.8	7.6	7.0	4.6	4,600
May	139.2	255.1	33.1	7.7	6.0	11.3	11,300
Jun	221.9	333.8	28.4	11.8	8.0	15.2	15,229
Jul	137.2	324.1	23.2	14.0	11.0	6.9	6,890
Aug	213.7	291.9	27.4	10.7	7.0	16.7	16,683
Sep	31.1	171.6	18.6	9.2	7.0	6.9	6,900
TOTALS	1707.0	3010.5	369.0			164.0	163,995

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B17. Selenium mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ Se	LOAD FLOW FACTOR	FLOW	Se BORON	LOAD FLOW FACTOR	FLOW	Se BORON	LOAD FLOW FACTOR	FLOW	LOAD FLOW FACTOR	Ass. WQ Se	DRAINAGE VOLUME	LOAD FLOW FACTOR	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS	LOAD FLOW FACTOR	FLOWS	LOAD FLOW FACTOR
			(2)x(3)			(5)x(6)			(8)x(9)	(2)-(5)-[8]	(4)-(7)-[10] (e)			Table 6		(16)x1.0			(16)x0.82+ (18)x0+ (30)Table 6		(16)x0.18+ (18)+ (26)Table 6	
	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	ppb	AFXppb	AF	AFXppb	ppb	AF	AFXppm	AF	AFxppb	AF	AFxppb	AF	AFxppb	AF	AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	2.5	2.5	11.2	11.2	3.5	182.4	10.6	10.6	6.6	185.5
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	2.5	2.5	5.1	5.1	2.4	108.1	5.6	5.6	4.4	110.1
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	2.6	2.6	2.4	2.4	2.2	140.8	3.5	3.5	3.7	142.3
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	2.4	2.4	1.6	1.6	3.3	321.7	2.7	2.7	4.6	323.0
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	2.3	2.3	1.7	1.7	6.2	360.3	2.7	2.7	7.5	361.6
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	3.0	2.6	2.6	7.3	538.6	3.4	3.4	9.5	540.8
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	13.4	12.5	2.4	2.4	5.6	387.5	9.7	9.7	11.7	393.2
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	8.6	8.1	5.1	5.1	6.0	349.6	9.3	9.3	10.4	353.9
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	0.6	0.6	7.4	7.4	7.9	397.4	6.3	6.3	9.6	399.2
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	0.2	0.2	5.4	5.4	9.0	394.9	4.4	4.4	10.2	396.0
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	3.6	3.6	9.4	382.7	3.0	3.0	10.0	383.4
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	0.2	0.2	6.5	6.5	4.4	193.4	5.3	5.3	5.8	194.8
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		38.3	36.9	55.0	55.0	67.2	3757.4	66.4	66.4	94.1	3763.7

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of Table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of Table 6.

Table B17. (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table 6B AF	Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	FLOWS [26] Table 6C AF	Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	Se LOAD (Future without condition (Col(29) +(31) of Table B9 lbs	Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.1) lbs	Se LOAD-FLOW FACTOR AFXppb	Se LOAD-FLOW FACTOR (29)÷1000 ÷0.00136 AFXppb	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	Se CONC. (33)/(32) ppb	FLOW [(20)+(24)]-(5) AF	Se CONC. [(21)+(25)-(30)]÷[(20)+(24)] ppb	LOAD FLOW FACTOR [(21)+(25)-(30)]-(7) AFXppb	FLOW [22)+(26)]-(8) AF	Se CONC. [(23)+(27)-(31)]÷[(22)+(26)] ppb	LOAD FLOW FACTOR [(23)+(27)-(31)]-(10) AFXppb	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppb	Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	283.0	0.0	104.0	20.9	74.3	3.6	-2.8	1.0	-66.1	2.8	16.5	77.6	0.0	11.6	31.5
6.0	6.0	1.6	1.6	129.6	116.6	0.0	42.9	34.1	38.9	1.1	-1.9	1.0	-60.0	1.9	11.4	64.7	0.0	4.8	12.9
1.7	1.7	-0.2	-0.2	189.3	170.4	0.0	62.6	27.9	90.7	3.2	-1.7	1.0	-70.7	1.7	22.5	77.7	0.0	7.0	19.0
3.9	3.9	3.2	3.2	262.8	236.5	0.0	87.0	42.8	180.9	4.2	-2.7	1.0	-209.1	2.7	30.7	218.8	0.0	9.7	26.3
6.1	6.1	2.3	2.3	-294.0	-264.6	0.0	-97.3	37.9	292.4	7.7	-5.0	1.0	-459.0	5.0	47.0	448.2	0.0	-10.8	-29.4
15.4	15.4	4.3	4.3	393.2	353.9	0.0	130.1	49.5	361.0	7.3	-5.9	1.0	-289.9	5.9	30.1	304.4	0.0	14.5	39.3
4.6	4.6	-4.3	-4.3	307.1	276.4	0.0	101.6	39.4	287.6	7.3	-4.4	1.0	-249.4	4.4	38.7	261.2	0.0	11.8	32.1
1.7	1.7	-2.4	-2.4	272.6	245.3	0.0	90.2	33.3	210.1	6.3	-4.8	1.0	-227.6	4.8	32.6	237.9	0.0	10.3	28.0
6.3	6.3	0.8	0.8	435.0	391.5	0.0	143.9	31.8	270.4	8.5	-6.3	1.0	-161.3	6.3	24.5	177.3	0.0	16.0	43.5
7.9	7.9	-1.3	-1.3	268.6	241.7	0.0	88.9	24.9	283.8	11.4	-7.2	1.0	-276.3	7.2	34.5	286.1	0.0	9.9	26.8
12.8	12.8	-2.0	-2.0	418.8	376.9	0.0	138.6	31.0	232.4	7.5	-7.5	1.0	-217.2	7.5	30.2	232.6	0.0	15.4	41.9
7.5	7.5	-2.0	-2.0	60.7	54.6	0.0	20.1	23.5	166.7	7.1	-3.5	1.0	-166.5	3.5	45.8	168.7	0.0	2.2	6.0
72.0	72.0	-1.8	-1.8	2,758.1	2,482.3	0.0	912.6	397.0	2,489.0	6.3	-53.8		-2,453.2	53.8		2,555.3	0.0	102.2	277.9

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B18. Selenium dilution requirements : 1988 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10% and assume no Salt Slough diversions to wetlands.

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	31.4	74.3	20.9	3.6	3.0	6.3	6,270
Nov	13.0	38.9	34.1	1.1	1.0	NF	NF
Dec	18.9	90.7	27.9	3.2	3.0	2.8	2,790
Jan	26.3	180.9	42.8	4.2	4.0	3.2	3,233
Feb	29.4	292.4	37.9	7.7	8.0	-1.6	0
Mar	39.3	361.0	49.5	7.3	7.0	2.5	2,475
Apr	30.7	287.6	39.4	7.3	7.0	2.0	1,970
May	27.3	210.1	33.3	6.3	6.0	2.0	1,998
Jun	43.5	270.4	31.8	8.5	8.0	2.3	2,271
Jul	26.9	283.8	24.9	11.4	11.0	1.0	996
Aug	41.9	232.4	31.0	7.5	7.0	2.6	2,567
Sep	6.1	166.7	23.5	7.1	7.0	0.4	392
TOTALS	334.7	2489.2	397.0			23.3	24,962

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of diiution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B19. Selenium mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (18)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (18)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	20.9	3.0	62.7	11.5	6.5	74.8	2.0	1.0	2.0	7.4	-14.1	1.0	3.4	4.6	11.2	11.2	3.5	182.4	11.5	12.2	6.6	186.0
Nov	34.1	1.0	34.1	13.5	5.3	71.6	4.1	1.0	4.1	16.5	-41.6	1.0	3.4	3.9	5.1	5.1	2.4	108.1	6.5	7.2	4.4	110.6
Dec	27.9	3.0	83.7	6.9	11.0	75.9	1.8	1.0	1.8	19.2	6.0	1.0	3.3	3.9	2.4	2.4	2.2	140.8	4.3	5.0	3.6	142.8
JAn	42.8	4.0	171.2	9.3	23.2	215.8	5.1	4.0	20.4	28.4	-65.0	1.0	3.1	3.5	1.6	1.6	3.3	321.7	3.4	4.1	4.6	323.5
Feb	37.9	8.0	303.2	13.8	33.9	467.8	4.8	2.7	13.0	19.3	-177.6	1.0	3.1	3.5	1.7	1.7	6.2	360.3	3.5	4.2	7.5	362.1
Mar	49.5	7.0	346.5	24.7	12.5	308.8	7.9	14.0	110.6	16.9	-72.9	1.0	3.0	4.2	2.6	2.6	7.3	538.6	4.2	4.9	8.7	541.3
Apr	39.4	7.0	275.8	18.7	14.1	263.7	3.0	8.7	26.1	17.7	-14.0	1.0	22.2	24.0	2.4	2.4	5.6	387.5	16.7	21.9	13.5	397.7
May	33.3	6.0	199.8	15.8	15.1	238.6	3.2	7.3	23.4	14.3	-62.1	1.0	13.5	14.1	5.1	5.1	6.0	349.6	13.2	16.0	11.4	356.2
Jun	31.8	8.0	254.4	18.9	9.2	173.9	4.1	19.2	78.7	8.8	1.8	1.0	4.6	5.2	7.4	7.4	7.9	397.4	9.5	10.3	10.4	400.4
Jul	24.9	11.0	273.9	19.5	14.8	288.6	1.7	11.6	19.7	3.7	-34.4	1.0	3.9	4.1	5.4	5.4	9.0	394.9	7.2	8.2	11.1	397.5
Aug	31.0	7.0	217.0	23.3	10.0	233.0	0.5	20.3	10.2	7.2	-26.2	1.0	0.0	0.0	3.6	3.6	9.4	382.7	3.0	3.0	10.0	383.4
Sep	23.5	7.0	164.5	16.3	11.0	179.3	0.3	13.3	4.0	6.9	-18.8	1.0	1.8	2.1	6.5	6.5	4.4	193.4	6.5	6.9	6.2	195.4
TOTAL	397.0	6.0	2386.8	192.2	13.5	2591.6	38.5	8.2	313.9	166.3	-518.7		65.3	73.1	55.0	55.0	67.2	3757.4	89.4	103.8	98.1	3796.8

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and supplemented with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of Table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of Table 7.

Table B19. (cont.). Selenium mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
FLOWS [24] Table 8S AF	Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	FLOWS [26] Table 8S AF	Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	Se LOAD (Future without condition (Col(29) +(31) of Table 8S lbs	Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.1) lbs	Se LOAD-FLOW FACTOR AFXppb	Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	FLOW (11)+(20)+(22) (24)+(26) AF	LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	Se CONC. (33)/(32) ppb	FLOW [(20)+ (24)]-(5) AF	Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	FLOW [22)+ (26)]-(8) AF	Se CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppb	LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	FLOW (32)-(2) AF	LOAD FLOW FACTOR (33)-(4) AFXppb	Se LOAD [(42)x2000 x0.00136] lbs
-1.9	-1.9	-1.8	-1.8	314.4	283.0	0.0	104.0	21.8	76.4	3.5	-1.9	1.1	-64.5	2.8	16.6	78.1	0.9	13.7	37.2
6.0	6.0	1.6	1.6	129.6	116.6	0.0	42.9	35.0	41.0	1.2	-1.0	1.1	-58.4	1.9	11.5	65.2	0.9	6.9	18.6
1.7	1.7	-0.2	-0.2	189.3	170.4	0.0	62.6	28.6	92.7	3.2	-0.9	1.1	-69.2	1.6	23.3	78.2	0.7	9.0	24.4
3.9	3.9	3.2	3.2	262.8	236.5	0.0	87.0	43.5	182.8	4.2	-2.0	1.1	-207.7	2.7	30.8	219.3	0.7	11.6	31.5
6.1	6.1	2.3	2.3	-294.0	-264.6	0.0	-97.3	38.7	294.4	7.6	-4.2	1.1	-457.5	5.0	47.1	448.7	0.8	-8.8	-24.0
15.4	15.4	4.3	4.3	393.2	353.9	0.0	130.1	49.5	363.0	7.3	-5.1	1.0	-288.4	5.1	32.0	304.9	0.0	16.5	44.7
4.6	4.6	-4.3	-4.3	307.1	276.4	0.0	101.6	48.2	304.3	6.3	2.6	1.2	-237.2	6.2	31.6	265.7	8.8	28.5	77.6
1.7	1.7	-2.4	-2.4	272.6	245.3	0.0	90.2	38.2	219.1	5.7	-0.9	1.2	-220.9	5.8	29.2	240.2	4.9	19.3	52.5
6.3	6.3	0.8	0.8	435.0	391.5	0.0	143.9	35.8	275.6	7.7	-3.1	1.1	-157.3	7.1	22.9	178.5	4.0	21.2	57.6
7.9	7.9	-1.3	-1.3	268.6	241.7	0.0	88.9	28.6	289.1	10.1	-4.4	1.1	-272.5	8.1	31.5	287.6	3.7	15.2	41.2
12.8	12.8	-2.0	-2.0	418.8	376.9	0.0	138.6	31.0	232.4	7.5	-7.5	1.0	-217.2	7.5	30.2	232.6	0.0	15.4	41.9
7.5	7.5	-2.0	-2.0	60.7	54.6	0.0	20.1	25.1	168.9	6.7	-2.3	1.0	-164.9	3.9	41.6	169.3	1.6	4.4	12.0
72.0	72.0	-1.8	-1.8	2,758.1	2,482.3	0.0	912.6	424.0	2,539.5	6.0	-30.8		-2,415.8	57.8		2,568.4	27.0	152.7	415.3

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B20. Selenium dilution requirements : 1988 hydrology : Scenario 3.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10% and assume no Salt Slough diversions to wetlands. Assume additional wetland water supply.

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	31.4	76.4	21.8	3.5	3.0	5.4	5,450
Nov	13.0	41.0	35.0	1.2	1.0	NF	NF
Dec	18.9	92.7	28.6	3.2	3.0	2.9	2,860
Jan	26.3	182.8	43.5	4.2	4.0	2.9	2,900
Feb	29.4	294.4	38.7	7.6	8.0	-2.2	0
Mar	39.3	363.0	49.5	7.3	7.0	2.5	2,475
Apr	30.7	304.3	48.2	6.3	7.0	-5.6	0
May	27.3	219.1	38.2	5.7	6.0	-2.3	0
Jun	43.5	275.6	35.8	7.7	8.0	-1.5	0
Jul	26.9	289.1	28.6	10.1	11.0	-2.6	0
Aug	41.9	232.4	31.0	7.5	7.0	2.6	2,583
Sep	6.1	168.9	25.1	6.7	7.0	-1.3	0
TOTALS	334.7	2539.7	424.0			0.8	16,268

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table B21. TDS mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY WITHOUT PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	20.9	689	14.4	11.5	1,036	11.9	2.0	773	1.5	7.4	0.9	1,000	2.5	3.9	11.2	11.2	3.5	8.1	13.4	17.9	3.8	5.4
Nov	34.1	670	22.8	13.5	1,271	17.2	4.1	1,091	4.5	16.5	1.2	1,000	2.5	4.0	5.1	5.1	2.4	6.2	7.5	11.4	2.5	4.0
Dec	27.9	934	26.1	6.9	2,017	13.9	1.8	2,175	3.9	19.2	8.2	1,000	2.6	4.2	2.4	2.4	2.2	5.5	5.2	8.7	2.0	3.3
JAn	42.8	779	33.3	9.3	2,251	20.9	5.1	1,669	8.5	28.4	3.9	1,000	2.4	3.8	1.6	1.6	3.3	12.4	5.4	13.4	2.0	4.4
Feb	37.9	992	37.6	13.8	2,190	30.2	4.8	1,645	7.9	19.3	-0.5	1,000	2.3	3.7	1.7	1.7	6.2	16.6	7.7	16.7	2.6	5.2
Mar	49.5	1,100	54.5	24.7	1,349	33.3	7.9	1,629	12.9	16.9	8.3	1,000	3.0	4.8	2.6	2.6	7.3	21.0	9.2	20.9	3.6	7.4
Apr	39.4	770	30.3	18.7	1,410	26.4	3.0	1,570	4.7	17.7	-0.7	1,000	13.4	19.9	2.4	2.4	5.6	15.9	14.1	26.2	7.2	12.1
May	33.3	993	33.1	15.8	1,366	21.6	3.2	2,513	8.0	14.3	3.4	1,000	8.6	13.0	5.1	5.1	6.0	16.3	14.1	24.9	5.6	9.5
Jun	31.8	950	30.2	18.9	1,081	20.4	4.1	1,735	7.1	8.8	2.7	1,000	0.6	1.0	7.4	7.4	7.9	18.6	12.6	21.2	3.3	5.7
Jul	24.9	1,550	38.6	19.5	1,372	26.8	1.7	1,390	2.4	3.7	9.5	1,000	0.2	0.3	5.4	5.4	9.0	19.2	11.6	19.8	3.0	5.1
Aug	31.0	824	25.5	23.3	1,051	24.5	0.5	1,799	0.9	7.2	0.2	1,000	0.0	0.0	3.6	3.6	9.4	20.3	10.5	19.2	2.5	4.7
Sep	23.5	929	21.8	16.3	1,099	17.9	0.3	2,023	0.6	6.9	3.3	1,000	0.2	0.3	6.5	6.5	4.4	9.3	8.9	12.8	2.3	3.4
TOTAL	397.0	928	368.3	192.2	1,379	265.0	38.5	1,635	62.9	166.3	40.3		38.3	58.9	55.0	55.0	67.1	169.3	120.1	213.1	40.3	70.1

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the Grasslands area from the drainage districts was collected by Summers Engineering and the CRWQCB.
(e) TDS Load - Flow estimates were estimated from EC data collected by Summers Engineering Inc. and the CRWQCB.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (31) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (27) of table 6.

Table B21. (cont). TDS mass balance analysis : 1988 hydrology : Future without scenario.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY
WITHOUT PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD-FLOW FACTOR (21)+(25)-(7) AFXppm	29 TDS LOAD (x1000) (28)x0.00136 Tons	30 TDS LOAD-FLOW FACTOR (23)+(27)-(10) AFXppm	31 TDS LOAD (28)x0.00136 x1000 Tons	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)- (29)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (28)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-1.9	-1.9	-1.8	-1.8	4.1	5.6	2.0	2.7	20.9	14.4	689	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.0	6.0	1.6	1.6	0.2	0.3	1.1	1.5	34.1	22.8	670	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-0.2	-0.2	-3.5	-4.8	-0.8	-1.0	27.9	26.1	934	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	3.9	3.1	3.1	-3.6	-4.9	-1.0	-1.3	42.8	33.3	779	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.1	6.1	2.2	2.2	-7.4	-10.1	-0.4	-0.5	37.9	37.6	992	NA	NA	NA	NA	NA	NA	NA	NA	NA
15.5	15.5	4.3	4.3	3.1	4.2	-1.2	-1.6	49.5	54.5	1,100	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.6	4.6	-4.2	-4.2	4.4	6.0	3.1	4.2	39.4	30.3	770	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	1.7	-2.4	-2.4	5.1	6.9	-1.0	-1.3	33.3	33.1	993	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.3	6.3	0.8	0.8	7.2	9.7	-0.6	-0.8	31.8	30.2	950	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.9	7.9	-1.3	-1.3	0.9	1.2	1.5	2.1	24.9	38.6	1,550	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.8	12.8	-2.0	-2.0	7.5	10.2	1.8	2.4	31.0	25.5	824	NA	NA	NA	NA	NA	NA	NA	NA	NA
7.4	7.4	-2.0	-2.0	2.3	3.1	0.8	1.1	23.5	21.8	929	NA	NA	NA	NA	NA	NA	NA	NA	NA
72.1	72.1	-1.8	-1.8	20.2	27.5	5.4	7.3	397.0	368.3	928	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B22. TDS mass balance analysis : 1988 hydrology : Scenario 1.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30) Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26) Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	20.9	689	14.4	11.5	1,036	11.9	2.0	773	1.5	7.4	0.9	1,000	3.4	5.4	0.0	0.0	3.5	8.1	2.3	3.6	4.6	9.9
Nov	34.1	670	22.8	13.5	1,271	17.2	4.1	1,091	4.5	16.5	1.2	1,000	3.4	5.4	0.0	0.0	2.4	6.3	2.3	3.6	3.5	8.1
Dec	27.9	934	26.1	6.9	2,017	13.9	1.8	2,175	3.9	19.2	8.2	1,000	3.4	5.4	0.0	0.0	2.2	5.6	2.3	3.6	3.2	7.4
Jan	42.8	779	33.3	9.3	2,251	20.9	5.1	1,669	8.5	28.4	3.9	1,000	3.1	5.0	0.0	0.0	3.3	12.3	2.1	3.3	4.3	13.9
Feb	37.9	992	37.6	13.8	2,190	30.2	4.8	1,645	7.9	19.3	-0.5	1,000	3.1	5.0	0.0	0.0	6.2	16.4	2.1	3.3	7.2	18.1
Mar	49.5	1,100	54.5	24.7	1,349	33.3	7.9	1,629	12.9	16.9	8.3	1,000	3.0	6.1	0.0	0.0	7.3	21.1	2.1	3.3	8.2	23.8
Apr	39.4	770	30.3	18.7	1,410	26.4	3.0	1,570	4.7	17.7	-0.7	1,000	22.2	34.7	0.0	0.0	5.6	16.1	14.7	23.6	13.1	27.1
May	33.3	993	33.1	15.8	1,366	21.6	3.2	2,513	8.0	14.3	3.4	1,000	13.5	20.6	0.0	0.0	6.0	16.4	9.0	14.2	10.5	22.8
Jun	31.8	950	30.2	18.9	1,081	20.4	4.1	1,735	7.1	8.8	2.7	1,000	4.6	7.3	0.0	0.0	7.9	18.7	3.4	5.3	9.1	20.6
Jul	24.9	1,550	38.6	19.5	1,372	26.8	1.7	1,390	2.4	3.7	9.5	1,000	3.9	6.3	0.0	0.0	9.0	19.2	2.8	4.5	10.1	21.1
Aug	31.0	824	25.5	23.3	1,051	24.5	0.5	1,799	0.9	7.2	0.2	1,000	0.0	0.0	0.0	0.0	9.4	20.3	0.0	0.0	9.4	20.3
Sep	23.5	929	21.8	16.3	1,099	17.9	0.3	2,023	0.6	6.9	3.3	1,000	1.8	2.9	0.0	0.0	4.4	9.3	1.2	2.0	5.0	10.2
TOTAL	397.0	928	368.3	192.2	1,379	265.0	38.5	1,635	62.9	166.3	40.3		65.4	104.0	0.0	0.0	67.2	169.6	44.3	70.6	88.2	203.1

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and the CRWQCB.
(e) TDS Load - Flow estimates were estimated from EC data collected by Summers Engineering Inc. and the CRWQCB.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of Table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0 + Col (27) of table 7.

Table B23. (cont.). TDS mass balance analysis : 1988 hydrology : Scenario 1.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table 21 AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [26] Table 21 AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table 21 Tonsx1000	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tonsx1000	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22]+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)- (31)]+ [(22)+(26) ppm	40 LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-1.9	-1.9	-1.8	-1.8	8.3	0.0	0.0	6.1	10.6	4.6	438	-11.1	1,326	-10.2	0.8	871	0.4	-10.3	-9.8	-13.3
6.0	6.0	1.6	1.6	1.8	0.0	0.0	1.3	29.9	19.3	644	-5.2	1,162	-7.5	1.0	1,643	3.9	-4.2	-3.6	-4.8
1.7	1.7	-0.2	-0.2	-5.8	0.0	0.0	-4.3	26.2	25.0	954	-2.9	1,337	-8.6	1.2	3,498	7.5	-1.7	-1.0	-1.4
3.9	3.9	3.1	3.1	-6.2	0.0	0.0	-4.6	41.9	32.7	782	-3.3	1,204	-13.7	2.3	2,900	13.1	-0.9	-0.6	-0.8
6.1	6.1	2.2	2.2	-10.6	0.0	0.0	-7.8	37.0	37.1	1,003	-5.6	1,150	-20.8	4.6	2,979	20.2	-0.9	-0.5	-0.7
15.5	15.5	4.3	4.3	2.6	0.0	0.0	1.9	46.9	53.3	1,134	-7.1	1,070	-14.5	4.6	2,099	13.3	-2.6	-1.2	-1.6
4.6	4.6	-4.2	-4.2	10.2	0.0	0.0	7.5	45.8	42.9	935	0.6	1,463	1.9	5.9	1,738	10.7	6.4	12.5	17.1
1.7	1.7	-2.4	-2.4	5.6	0.0	0.0	4.1	33.1	35.7	1,077	-5.1	1,488	-5.6	4.9	2,009	8.2	-0.2	2.6	3.5
6.3	6.3	0.8	0.8	8.9	0.0	0.0	6.6	28.4	29.2	1,026	-9.2	1,199	-8.7	5.8	1,497	7.7	-3.4	-1.0	-1.4
7.9	7.9	-1.3	-1.3	3.3	0.0	0.0	2.4	23.2	39.2	1,690	-8.8	1,158	-14.4	7.1	1,967	15.0	-1.7	0.6	0.8
12.8	12.8	-2.0	-2.0	12.6	0.0	0.0	9.3	27.4	21.9	801	-10.5	1,000	-11.7	6.9	1,215	8.1	-3.6	-3.6	-4.9
7.4	7.4	-2.0	-2.0	4.2	0.0	0.0	3.1	18.6	17.9	961	-7.7	1,091	-8.5	2.7	1,684	4.5	-4.9	-4.0	-5.4
72.1	72.1	-1.8	-1.8	34.8	0.0	0.0	25.6	369.1	358.7	972	-75.8		-122.3	47.9		112.7	-27.9	-9.6	-13.0

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B24. TDS dilution requirements : 1988 hydrology : Scenario 1.

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	4.6	10.6	438	689	-3.867	0
Nov	0.0	19.3	29.9	644	670	-1.162	0
Dec	0.0	25.0	26.2	954	934	0.562	562
Jan	0.0	32.7	41.9	782	779	0.162	162
Feb	0.0	37.1	37.0	1,003	992	0.411	411
Mar	0.0	53.3	46.9	1,134	1,100	1.451	1,451
Apr	0.0	42.9	45.8	935	770	9.827	9,827
May	0.0	35.7	33.1	1,077	993	2.803	2,803
Jun	0.0	29.2	28.4	1,026	950	2.274	2,274
Jul	0.0	39.2	23.2	1,690	1,550	2.097	2,097
Aug	0.0	21.9	27.4	801	824	-0.766	0
Sep	0.0	17.9	18.6	961	929	0.641	641
TOTALS	0.0	358.8	369.0			14.432	20,227

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Table B25. TDS mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ TDS	LOAD FLOW FACTOR (2)x(3)	FLOW	WQ TDS	LOAD FLOW FACTOR (5)x(6)	FLOW	WQ TDS	LOAD FLOW FACTOR (8)x(9)	FLOW (2)-(5)-[8]	LOAD FLOW FACTOR (4)-(7)-[10] (e)	Ass. WQ TDS	DRAINAGE VOLUME	LOAD FLOW FACTOR Table 6	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR (16)x1.0	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS (16)x0.82+ (18)x0+ (30) Table 6	LOAD FLOW FACTOR (f)	FLOWS (16)x0.18+ (18)+ (26) Table 6	LOAD FLOW FACTOR (g)
	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	AFXppm	ppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm
Oct	20.9	689	14.4	11.5	1,036	11.9	2.0	773	1.5	7.4	0.9	1,000	2.5	3.9	11.2	11.2	3.5	8.1	10.6	11.4	6.6	11.9
Nov	34.1	670	22.8	13.5	1,271	17.2	4.1	1,091	4.5	16.5	1.2	1,000	2.5	4.0	5.1	5.1	2.4	6.3	5.6	6.4	4.4	9.0
Dec	27.9	934	26.1	6.9	2,017	13.9	1.8	2,175	3.9	19.2	8.2	1,000	2.6	4.2	2.4	2.4	2.2	5.6	3.5	4.3	3.7	7.8
JAn	42.8	779	33.3	9.3	2,251	20.9	5.1	1,669	8.5	28.4	3.9	1,000	2.4	3.8	1.6	1.6	3.3	12.3	2.7	3.5	4.6	14.2
Feb	37.9	992	37.6	13.8	2,190	30.2	4.8	1,645	7.9	19.3	-0.5	1,000	2.3	3.7	1.7	1.7	6.2	16.4	2.7	3.4	7.5	18.4
Mar	49.5	1,100	54.5	24.7	1,349	33.3	7.9	1,629	12.9	16.9	8.3	1,000	3.0	4.8	2.6	2.6	7.3	21.1	3.4	4.2	9.5	24.3
Apr	39.4	770	30.3	18.7	1,410	26.4	3.0	1,570	4.7	17.7	-0.7	1,000	13.4	19.9	2.4	2.4	5.6	16.1	9.7	13.4	11.7	24.9
May	33.3	993	33.1	15.8	1,366	21.6	3.2	2,513	8.0	14.3	3.4	1,000	8.6	13.0	5.1	5.1	6.0	16.4	9.3	11.9	10.4	22.6
Jun	31.8	950	30.2	18.9	1,081	20.4	4.1	1,735	7.1	8.8	2.7	1,000	0.6	1.0	7.4	7.4	7.9	18.7	6.3	6.4	9.6	20.7
Jul	24.9	1,550	38.6	19.5	1,372	26.8	1.7	1,390	2.4	3.7	9.5	1,000	0.2	0.3	5.4	5.4	9.0	19.2	4.4	4.4	10.2	20.5
Aug	31.0	824	25.5	23.3	1,051	24.5	0.5	1,799	0.9	7.2	0.2	1,000	0.0	0.0	3.6	3.6	9.4	20.3	3.0	3.0	10.0	20.9
Sep	23.5	929	21.8	16.3	1,099	17.9	0.3	2,023	0.6	6.9	3.3	1,000	0.2	0.3	6.5	6.5	4.4	9.3	5.3	5.3	5.8	10.8
TOTAL	397.0	928	368.3	192.2	1,379	265.0	38.5	1,635	62.9	166.3	40.3		38.3	58.9	55.0	55.0	67.2	169.6	66.4	77.6	94.1	205.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp{[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387} x Col (18).
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of Table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (27) of Table 6.

Table B25. (cont.). TDS mass balance analysis : 1988 hydrology : Scenario 2.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table 2(AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [26] Table 2(AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table 2(Tonsx1000	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tonsx1000	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)- (31)]+ [(22)+(26) ppm	40 LOAD FLOW FACTOR [(23)+(27)- (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-1.9	-1.9	-1.8	-1.8	8.1	0.0	0.0	6.0	20.9	14.5	696	-2.8	1,065	-2.4	2.8	917	2.6	0.0	0.1	0.2
6.0	6.0	1.6	1.6	1.8	0.0	0.0	1.3	34.1	22.9	671	-1.9	1,070	-4.8	1.9	1,543	4.8	0.0	0.0	0.0
1.7	1.7	-0.2	-0.2	-5.8	0.0	0.0	-4.3	27.9	26.1	936	-1.7	1,168	-7.9	1.7	3,116	7.9	0.0	0.1	0.1
3.9	3.9	3.1	3.1	-6.1	0.0	0.0	-4.5	42.7	33.1	775	-2.7	1,122	-13.5	2.6	2,831	13.2	-0.1	0.0	0.0
6.1	6.1	2.2	2.2	-10.6	0.0	0.0	-7.8	37.8	37.4	989	-5.0	1,085	-20.7	4.9	2,923	20.5	-0.1	-0.2	-0.3
15.5	15.5	4.3	4.3	2.6	0.0	0.0	1.9	49.6	54.6	1,101	-5.8	1,040	-13.6	5.9	1,939	13.8	0.1	0.2	0.2
4.6	4.6	-4.2	-4.2	10.2	0.0	0.0	7.5	39.5	30.5	773	-4.4	1,262	-8.4	4.5	1,759	8.5	0.1	0.2	0.2
1.7	1.7	-2.4	-2.4	5.6	0.0	0.0	4.1	33.3	33.1	993	-4.8	1,235	-8.0	4.8	2,003	8.0	0.0	0.0	0.0
6.3	6.3	0.8	0.8	8.9	0.0	0.0	6.5	31.8	30.3	952	-6.3	1,010	-7.7	6.3	1,431	7.8	0.0	0.1	0.1
7.9	7.9	-1.3	-1.3	3.3	0.0	0.0	2.4	24.9	38.6	1,550	-7.2	1,000	-14.4	7.2	1,893	14.4	0.0	0.0	0.0
12.8	12.8	-2.0	-2.0	12.6	0.0	0.0	9.3	31.0	25.5	824	-7.5	1,000	-8.7	7.5	1,198	8.7	0.0	0.0	0.0
7.4	7.4	-2.0	-2.0	4.2	0.0	0.0	3.1	23.4	21.7	928	-3.6	1,000	-5.2	3.5	1,506	5.1	-0.1	-0.1	-0.2
72.0	72.0	-1.9	-1.9	34.8	0.0	0.0	25.6	396.9	368.4	928	-53.8		-115.4	53.7		115.5	-0.1	0.0	0.0

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B26. TDS dilution requirements : 1988 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project, assuming no Salt Slough diversions to wetlands.

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	14.5	20.9	696	689	0.213	213
Nov	0.0	22.9	34.1	671	670	0.051	51
Dec	0.0	26.1	27.9	936	934	0.060	60
Jan	0.0	33.1	42.7	775	779	-0.220	0
Feb	0.0	37.4	37.8	989	992	-0.114	0
Mar	0.0	54.6	49.6	1,101	1,100	0.045	45
Apr	0.0	30.5	39.5	773	770	0.154	154
May	0.0	33.1	33.3	993	993	0.000	0
Jun	0.0	30.3	31.8	952	950	0.067	67
Jul	0.0	38.6	24.9	1,550	1,550	0.000	0
Aug	0.0	25.5	31.0	824	824	0.000	0
Sep	0.0	21.7	23.4	928	929	-0.025	0
TOTALS	0.0	368.3	396.9			0.230	590

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Table B27. TDS mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MO.	FLOW	WQ TDS	LOAD FLOW FACTOR (2)x(3)	FLOW	WQ TDS	LOAD FLOW FACTOR (5)x(6)	FLOW	WQ TDS	LOAD FLOW FACTOR (8)x(9)	FLOW (2)-(5)-[8]	LOAD FLOW FACTOR (4)-(7)-[10] (e)	Ass. WQ TDS	DRAINAGE VOLUME	LOAD FLOW FACTOR Table 7	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR (16)x1.0	SURFACE AND SUBSURFACE DRAINAGE DISCHARGE	LOAD FLOW FACTOR	FLOWS (16)x0.82+ (18)x0+ (30) Table 7	LOAD FLOW FACTOR (f)	FLOWS (16)x0.18+ (18)+ (26) Table 7	LOAD FLOW FACTOR (g)
	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	ppm	AFXppm	AF	AFXppm	ppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm	AF	AFXppm
Oct	20.9	689	14.4	11.5	1,036	11.9	2.0	773	1.5	7.4	0.9	1,000	3.4	5.4	11.2	11.2	3.5	8.1	11.5	12.8	6.6	11.9
Nov	34.1	670	22.8	13.5	1,271	17.2	4.1	1,091	4.5	16.5	1.2	1,000	3.4	5.4	5.1	5.1	2.4	6.3	6.5	7.8	4.4	9.0
Dec	27.9	934	26.1	6.9	2,017	13.9	1.8	2,175	3.9	19.2	8.2	1,000	3.3	5.4	2.4	2.4	2.2	5.6	4.3	5.6	3.6	7.8
JAn	42.8	779	33.3	9.3	2,251	20.9	5.1	1,669	8.5	28.4	3.9	1,000	3.1	5.0	1.6	1.6	3.3	12.3	3.4	4.6	4.6	14.2
Feb	37.9	992	37.6	13.8	2,190	30.2	4.8	1,645	7.9	19.3	-0.5	1,000	3.1	5.0	1.7	1.7	6.2	16.4	3.5	4.7	7.5	18.4
Mar	49.5	1,100	54.5	24.7	1,349	33.3	7.9	1,629	12.9	16.9	8.3	1,000	3.0	6.1	2.6	2.6	7.3	21.1	4.2	5.5	8.7	24.3
Apr	39.4	770	30.3	18.7	1,410	26.4	3.0	1,570	4.7	17.7	-0.7	1,000	22.2	34.7	2.4	2.4	5.6	16.1	16.7	25.6	13.5	27.6
May	33.3	993	33.1	15.8	1,366	21.6	3.2	2,513	8.0	14.3	3.4	1,000	13.5	20.6	5.1	5.1	6.0	16.4	13.2	18.4	11.4	23.7
Jun	31.8	950	30.2	18.9	1,081	20.4	4.1	1,735	7.1	8.8	2.7	1,000	4.6	7.3	7.4	7.4	7.9	18.7	9.5	11.4	10.4	21.9
Jul	24.9	1,550	38.6	19.5	1,372	26.8	1.7	1,390	2.4	3.7	9.5	1,000	3.9	6.3	5.4	5.4	9.0	19.2	7.2	8.9	11.1	22.0
Aug	31.0	824	25.5	23.3	1,051	24.5	0.5	1,799	0.9	7.2	0.2	1,000	0.0	0.0	3.6	3.6	9.4	20.3	3.0	3.0	10.0	20.9
Sep	23.5	929	21.8	16.3	1,099	17.9	0.3	2,023	0.6	6.9	3.3	1,000	1.8	2.9	6.5	6.5	4.4	9.3	6.5	7.3	6.2	11.3
TOTAL	397.0	928	368.3	192.2	1,379	265.0	38.5	1,635	62.9	166.3	40.3		65.3	104.0	55.0	55.0	67.2	169.6	89.4	115.7	98.1	213.0

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-2 and Table A-5, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp[[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387] x Col (18).
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of Table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (27) of Table 7.

Table B27 (cont.). TDS mass balance analysis : 1988 hydrology : Scenario 3.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1988 HYDROLOGY
WITH PROPOSED ACTION WITHOUT INCREASED WETLAND WATER USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table 2.1 AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [26] Table 2.1 AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table 2.1 Tonsx1000	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tonsx1000	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(30)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)-(30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)-(30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)-(31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)-(30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-1.9	-1.9	-1.8	-1.8	8.1	0.0	0.0	6.0	21.8	16.0	733	-1.9	1,101	-1.0	2.8	917	2.6	0.9	1.6	2.2
6.0	6.0	1.6	1.6	1.8	0.0	0.0	1.3	35.0	24.3	695	-1.0	1,108	-3.3	1.9	1,543	4.8	0.9	0.0	0.0
1.7	1.7	-0.2	-0.2	-5.8	0.0	0.0	-4.3	28.6	27.4	958	-0.9	1,226	-6.6	1.6	3,197	7.9	0.7	1.3	1.8
3.9	3.9	3.1	3.1	-6.1	0.0	0.0	-4.5	43.4	34.2	788	-2.0	1,168	-12.4	2.6	2,831	13.2	0.6	0.0	0.0
6.1	6.1	2.2	2.2	-10.6	0.0	0.0	-7.8	38.6	38.7	1,002	-4.2	1,128	-19.4	4.9	2,923	20.5	0.7	1.1	1.5
15.5	15.5	4.3	4.3	2.6	0.0	0.0	1.9	49.6	55.9	1,127	-5.0	1,062	-12.4	5.1	2,058	13.8	0.1	1.5	2.0
4.6	4.6	-4.2	-4.2	10.2	0.0	0.0	7.5	48.3	45.3	938	2.6	1,420	3.8	6.3	1,700	11.2	8.9	15.0	20.4
1.7	1.7	-2.4	-2.4	5.6	0.0	0.0	4.1	38.2	40.7	1,066	-0.9	1,352	-1.5	5.8	1,902	9.1	4.9	7.7	10.4
6.3	6.3	0.8	0.8	8.9	0.0	0.0	6.5	35.8	36.5	1,021	-3.1	1,123	-2.7	7.1	1,439	9.1	4.0	6.3	8.6
7.9	7.9	-1.3	-1.3	3.3	0.0	0.0	2.4	28.6	44.6	1,559	-4.4	1,111	-9.9	8.1	1,874	15.9	3.7	6.0	8.2
12.8	12.8	-2.0	-2.0	12.6	0.0	0.0	9.3	31.0	25.5	824	-7.5	1,000	-8.7	7.5	1,198	8.7	0.0	0.0	0.0
7.4	7.4	-2.0	-2.0	4.2	0.0	0.0	3.1	25.0	24.3	971	-2.4	1,056	-3.2	3.9	1,500	5.6	1.5	2.4	3.3
72.0	72.0	-1.9	-1.9	34.8	0.0	0.0	25.6	423.9	413.5	975	-30.8		-77.3	57.7		122.5	26.9	0.0	0.0

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table B28. TDS dilution requirements : 1988 hydrology : Scenario 3

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project, assuming no Salt Slough diversions to wetlands. Assume additional wetland water supply.

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	16.0	21.8	733	689	1.394	1,394
Nov	0.0	24.3	35.0	695	670	1.308	1,308
Dec	0.0	27.4	28.6	958	934	0.736	736
Jan	0.0	34.2	43.4	788	779	0.502	0
Feb	0.0	38.7	38.6	1,002	992	0.390	0
Mar	0.0	55.9	49.6	1,127	1,100	1.219	1,219
Apr	0.0	45.3	48.3	938	770	10.552	10,552
May	0.0	40.7	38.2	1,066	993	2.811	2,811
Jun	0.0	36.5	35.8	1,021	950	2.678	2,678
Jul	0.0	44.6	28.6	1,559	1,550	0.166	166
Aug	0.0	25.5	31.0	824	824	0.000	0
Sep	0.0	24.3	25.0	971	929	1.131	0
TOTALS	0.0	413.4	423.9			22.9	20,864

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Appendix C

Mass balance analysis for boron, selenium and TDS

1986 hydrology

C1 - C28

Table C1. Boron mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY
WITHOUT PROPOSED ACTION
(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	0.5	18.1	11.0	1.1	12.1	2.4	1.4	3.4	22.7	2.6	1.0	2.5	4.9	11.2	11.2	4.0	17.9	13.8	26.3	3.9	7.7
Nov	27.0	0.8	21.6	7.8	1.5	11.7	2.4	2.7	6.5	16.8	3.4	1.0	2.5	5.0	5.1	5.1	1.2	6.9	6.5	12.5	2.3	4.5
Dec	39.8	1.0	39.8	5.6	2.2	12.3	6.8	3.0	20.4	27.4	7.1	1.0	2.6	5.2	2.4	2.4	1.1	8.2	4.3	11.6	1.8	4.3
Jan	34.7	1.5	52.1	5.9	3.4	20.1	6.0	3.5	21.0	22.8	11.0	1.0	2.4	4.8	1.6	1.6	3.6	21.1	5.6	21.0	2.0	6.5
Feb	282.9	0.2	56.6	16.2	3.5	56.7	9.1	2.3	20.9	257.6	-21.0	1.0	2.3	4.6	1.7	1.7	5.9	27.7	7.4	26.2	2.5	7.9
Mar	851.9	0.1	85.2	23.1	1.8	41.6	20.6	1.4	28.8	808.2	14.8	1.0	3.0	6.0	2.6	2.6	9.6	46.3	11.1	41.7	4.1	13.1
Apr	607.1	0.2	121.4	24.9	1.9	47.3	13.7	3.4	46.6	568.5	27.5	1.0	13.4	24.9	2.4	2.4	8.2	39.9	16.2	48.2	7.8	19.0
May	204.0	0.3	61.2	19.8	1.1	21.8	6.7	5.0	33.5	177.5	5.9	1.0	8.6	16.2	5.1	5.1	7.5	39.0	15.3	45.0	5.9	15.3
Jun	120.6	0.4	48.2	17.6	0.6	10.6	7.7	3.6	27.7	95.3	10.0	1.0	0.6	1.2	7.4	7.4	9.0	35.4	13.5	34.8	3.5	9.2
Jul	63.5	0.8	50.8	23.4	0.9	21.1	5.7	3.3	18.8	34.4	10.9	1.0	0.2	0.4	5.4	5.4	9.5	21.2	12.0	21.4	3.1	5.6
Aug	59.0	0.8	47.2	25.5	1.1	28.1	4.8	2.9	13.9	28.7	5.2	1.0	0.0	0.0	3.6	3.6	10.8	44.5	11.6	38.5	2.8	9.5
Sep	58.4	0.2	11.7	17.1	0.8	13.7	0.7	2.0	1.4	40.6	-3.4	1.0	0.2	0.4	6.5	6.5	4.3	23.5	8.8	24.2	2.2	6.3
TOTAL	2,385.0	0.3	613.8	197.9	1.5	296.9	86.6	2.8	242.9	2,100.5	74.0	0.0	38.3	73.6	55.0	55.0	74.7	331.7	126.2	351.3	41.8	108.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (32) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (28) of table 6.

Table C1 (cont). Boron mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY
WITHOUT PROPOSED ACTION
(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 BORON LOAD-FLOW FACTOR (21)+(25)-(7) AFXppm	29 BORON LOAD (28)x0.00136 x1000 Tons	30 BORON LOAD-FLOW FACTOR (23)+(27)-(10) AFXppm	31 BORON LOAD (30)x0.00136 x1000 Tons	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (29)]+ [(20)+(24) ppm	37 LOAD FLOW FACTOR [(21)+(25)+ (28)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 BORON CONC. [(23)+(27)- (31)]+ [(22)+(26) ppm	40 LOAD FLOW FACTOR [(23)+(27)+ (30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] Tons
-2.8	-2.8	-1.5	-1.5	11.4	15.5	2.8	3.8	36.1	18.1	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	0.1	0.1	2.0	2.8	-1.8	-2.5	27.0	21.6	0.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	5.0	5.0	0.5	0.7	-11.1	-15.1	39.8	39.8	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.3	0.3	4.0	4.0	1.2	1.6	-10.5	-14.3	34.7	52.1	1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.8	8.8	6.6	6.6	-21.7	-29.6	-6.5	-8.8	282.9	56.6	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.0	12.0	16.5	16.5	12.1	16.5	0.8	1.1	851.9	85.2	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.7	8.7	5.9	5.9	9.6	13.0	-21.6	-29.4	607.1	121.4	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.5	4.5	0.8	0.8	27.7	37.7	-17.4	-23.7	204.0	61.2	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.1	4.1	4.2	4.2	28.4	38.6	-14.3	-19.5	120.6	48.2	0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
11.4	11.4	2.6	2.6	11.7	16.0	-10.6	-14.4	63.5	50.8	0.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
13.9	13.9	2.0	2.0	24.4	33.2	-2.4	-3.2	59.0	47.2	0.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.3	8.3	-1.5	-1.5	18.8	25.6	3.3	4.6	58.4	11.7	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
71.7	71.7	44.8	44.8	126.2	171.6	-89.2	-121.4	2,385.0	613.8	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C2. Boron mass balance analysis : 1986 hydrology : Scenario 1.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	0.5	18.1	11.0	1.1	12.1	2.4	1.4	3.4	22.7	2.6	1.0	3.4	6.7	0.0	0.0	4.0	17.9	2.3	4.6	5.1	20.0
Nov	27.0	0.8	21.6	7.8	1.5	11.7	2.4	2.7	6.5	16.8	3.4	1.0	3.4	6.8	0.0	0.0	1.2	6.9	2.3	4.6	2.3	9.1
Dec	39.8	1.0	39.8	5.6	2.2	12.3	6.8	3.0	20.4	27.4	7.1	1.0	3.4	6.8	0.0	0.0	1.1	8.2	2.3	4.6	2.1	10.4
Jan	34.7	1.5	52.1	5.9	3.4	20.1	6.0	3.5	21.0	22.8	11.0	1.0	3.1	6.2	0.0	0.0	3.6	21.1	2.1	4.2	4.6	23.1
Feb	282.9	0.2	56.6	16.2	3.5	56.7	9.1	2.3	20.9	257.6	-21.0	1.0	3.1	6.2	0.0	0.0	5.9	27.7	2.1	4.2	6.9	29.7
Mar	851.9	0.1	85.2	23.1	1.8	41.6	20.6	1.4	28.8	808.2	14.8	1.0	3.0	7.6	0.0	0.0	9.6	46.3	2.1	4.2	10.5	49.7
Apr	607.1	0.2	121.4	24.9	1.9	47.3	13.7	3.4	46.6	568.5	27.5	1.0	22.2	43.4	0.0	0.0	8.2	39.9	14.7	29.6	15.7	53.7
May	204.0	0.3	61.2	19.8	1.1	21.8	6.7	5.0	33.5	177.5	5.9	1.0	13.5	25.7	0.0	0.0	7.5	39.0	9.0	17.8	12.0	46.9
Jun	120.6	0.4	48.2	17.6	0.6	10.6	7.7	3.6	27.7	95.3	10.0	1.0	4.6	9.0	0.0	0.0	9.0	35.4	3.4	6.7	10.2	37.7
Jul	63.5	0.8	50.8	23.4	0.9	21.1	5.7	3.3	18.8	34.4	10.9	1.0	3.9	8.0	0.0	0.0	9.5	21.2	2.8	5.7	10.6	23.5
Aug	59.0	0.8	47.2	25.5	1.1	28.1	4.8	2.9	13.9	28.7	5.2	1.0	0.0	0.0	0.0	0.0	10.8	44.5	0.0	0.0	10.8	44.5
Sep	58.4	0.2	11.7	17.1	0.8	13.7	0.7	2.0	1.4	40.6	-3.4	1.0	1.8	3.6	0.0	0.0	4.3	23.5	1.2	2.5	4.9	24.6
TOTAL	2,385.0	0.3	613.8	197.9	1.5	296.9	86.6	2.8	242.9	2,100.5	74.0	0.0	65.4	130.0	0.0	0.0	74.7	331.7	44.3	88.7	95.7	373.0

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (28) of table 7.

Table C2 (cont.). Boron mass balance analysis : 1986 hydrology : Scenario 1.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C1 AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [24] Table C1 AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 B LOAD (Future without condition (Col(29) +(31) of Table C1 Tons	29 B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 Boron LOAD-FLOW FACTOR AFXppm	31 B LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 BORON CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] Tons
-2.8	-2.8	-1.5	-1.5	19.3	0.0	0.0	14.2	25.8	8.7	0.3	-11.5	-3.6	-10.3	1.2	1.2	0.9	-10.3	-9.4	-12.7
1.3	1.3	0.1	0.1	0.3	0.0	0.0	0.2	22.8	18.3	0.8	-4.2	1.6	-5.8	0.0	3.7	2.5	-4.2	-3.3	-4.5
1.3	1.3	5.0	5.0	-14.4	0.0	0.0	-10.6	38.1	39.0	1.0	-2.0	1.6	-6.4	0.3	3.7	5.6	-1.7	-0.8	-1.1
0.3	0.3	4.0	4.0	-12.7	0.0	0.0	-9.3	33.8	51.9	1.5	-3.5	1.9	-15.6	2.6	4.2	15.4	-0.9	-0.2	-0.2
8.8	8.8	6.5	6.5	-38.4	0.0	0.0	-28.2	281.9	56.4	0.2	-5.3	1.2	-43.7	4.3	4.8	43.5	-1.0	-0.2	-0.2
12.0	12.0	16.5	16.5	17.6	0.0	0.0	12.9	849.3	84.2	0.1	-9.0	1.1	-25.4	6.4	2.0	24.4	-2.6	-1.0	-1.4
8.7	8.7	5.9	5.9	-16.4	0.0	0.0	-12.1	613.5	137.5	0.2	-1.5	1.6	-9.0	7.9	3.3	25.1	6.4	16.1	21.9
4.5	4.5	0.8	0.8	14.0	0.0	0.0	10.3	203.8	65.6	0.3	-6.3	1.7	0.5	6.1	2.9	3.9	-0.2	4.4	6.0
4.1	4.1	4.2	4.2	19.1	0.0	0.0	14.0	117.2	48.7	0.4	-10.1	1.4	0.2	6.7	1.9	0.2	-3.4	0.4	0.6
11.4	11.4	2.6	2.6	1.6	0.0	0.0	1.2	61.8	53.0	0.9	-9.2	1.2	-4.0	7.5	1.9	6.2	-1.7	2.2	3.0
13.9	13.9	2.0	2.0	30.0	0.0	0.0	22.1	55.4	43.5	0.8	-11.6	1.0	-14.2	8.0	1.9	10.5	-3.6	-3.7	-5.0
8.3	8.3	-1.4	-1.4	30.2	0.0	0.0	22.2	53.6	8.4	0.2	-7.6	1.1	-2.9	2.8	0.3	-0.4	-4.8	-3.3	-4.4
71.8	71.8	44.7	44.7	50.2	0.0	0.0	36.9	2,357.0	615.2	0.3	-81.8		-136.4	53.8		137.8	-28.0	1.4	1.9

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C3. Boron dilution requirements : 1986 hydrology : Scenario 1.

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) lbs	2 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	3 FLOW NEWMAN KAF	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	8.7	25.8	0.3	0.5	-17.2	0
Nov	0.0	18.3	22.8	0.8	0.8	0.0	0
Dec	0.0	39.0	38.1	1.0	1.0	0.0	0
Jan	0.0	51.9	33.8	1.5	1.5	0.0	0
Feb	0.0	56.4	281.9	0.2	0.2	0.0	0
Mar	0.0	84.2	849.3	0.1	0.1	0.0	0
Apr	0.0	137.5	613.5	0.2	0.2	0.0	0
May	0.0	65.6	203.8	0.3	0.3	0.0	0
Jun	0.0	48.7	117.2	0.4	0.4	0.0	0
Jul	0.0	53.0	61.8	0.9	0.8	10.3	10,300
Aug	0.0	43.5	55.4	0.8	0.8	0.0	0
Sep	0.0	8.4	53.6	0.2	0.2	0.0	0
TOTALS	0.0	615.2	2357.0			-6.9	10,300

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table C4. Boron mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	0.5	18.1	11.0	1.1	12.1	2.4	1.4	3.4	22.7	2.6	1.0	2.5	4.9	11.2	11.2	4.0	17.9	10.6	12.0	7.1	22.0
Nov	27.0	0.8	21.6	7.8	1.5	11.7	2.4	2.7	6.5	16.8	3.4	1.0	2.5	5.0	5.1	5.1	1.2	6.9	5.6	7.0	3.2	10.0
Dec	39.8	1.0	39.8	5.6	2.2	12.3	6.8	3.0	20.4	27.4	7.1	1.0	2.6	5.2	2.4	2.4	1.1	8.2	3.5	5.0	2.6	10.9
Jan	34.7	1.5	52.1	5.9	3.4	20.1	6.0	3.5	21.0	22.8	11.0	1.0	2.4	4.8	1.6	1.6	3.6	21.1	2.7	4.1	4.9	23.3
Feb	282.9	0.2	56.6	16.2	3.5	56.7	9.1	2.3	20.9	257.6	-21.0	1.0	2.3	4.6	1.7	1.7	5.9	27.7	2.7	4.0	7.2	30.0
Mar	851.9	0.1	85.2	23.1	1.8	41.6	20.6	1.4	28.8	808.2	14.8	1.0	3.0	6.0	2.6	2.6	9.6	46.3	3.4	4.7	11.8	50.1
Apr	607.1	0.2	121.4	24.9	1.9	47.3	13.7	3.4	46.6	568.5	27.5	1.0	13.4	24.9	2.4	2.4	8.2	39.9	9.7	16.3	14.3	51.0
May	204.0	0.3	61.2	19.8	1.1	21.8	6.7	5.0	33.5	177.5	5.9	1.0	8.6	16.2	5.1	5.1	7.5	39.0	9.3	13.8	11.9	46.5
Jun	120.6	0.4	48.2	17.6	0.6	10.6	7.7	3.6	27.7	95.3	10.0	1.0	0.6	1.2	7.4	7.4	9.0	35.4	6.3	6.5	10.7	37.6
Jul	63.5	0.8	50.8	23.4	0.9	21.1	5.7	3.3	18.8	34.4	10.9	1.0	0.2	0.4	5.4	5.4	9.5	21.2	4.4	4.4	10.7	22.6
Aug	59.0	0.8	47.2	25.5	1.1	28.1	4.8	2.9	13.9	28.7	5.2	1.0	0.0	0.0	3.6	3.6	10.8	44.5	3.0	3.0	11.4	45.1
Sep	58.4	0.2	11.7	17.1	0.8	13.7	0.7	2.0	1.4	40.6	-3.4	1.0	0.2	0.4	6.5	6.5	4.3	23.5	5.3	5.3	5.7	25.1
TOTAL	2,385.0	0.3	613.8	197.9	1.5	296.9	86.6	2.8	242.9	2,100.5	74.0	0.0	38.3	73.6	55.0	55.0	74.7	331.7	66.4	86.0	101.6	374.3

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (28) of table 6.

Table C4 (cont.). Boron mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 B LOAD (Future without condition (Col(29) +(31) of Table c1 Tons	29 B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 Boron LOAD-FLOW FACTOR AFXppm	31 B LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 BORON CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	19.3	0.0	0.0	14.2	36.1	18.1	0.5	-3.2	1.2	-2.9	3.2	1.1	3.0	0.0	0.0	0.1
1.3	1.3	0.1	0.1	0.3	0.0	0.0	0.2	27.0	21.6	0.8	-0.9	1.2	-3.4	0.9	3.0	3.4	0.0	0.0	-0.1
1.3	1.3	5.0	5.0	-14.4	0.0	0.0	-10.6	39.8	39.8	1.0	-0.8	1.3	-6.1	0.8	3.5	6.0	0.0	0.0	0.0
0.3	0.3	4.0	4.0	-12.7	0.0	0.0	-9.3	34.7	52.1	1.5	-2.9	1.5	-15.6	2.9	4.1	15.7	0.0	0.0	0.1
8.8	8.8	6.6	6.6	-38.4	0.0	0.0	-28.2	282.9	56.6	0.2	-4.7	1.1	-43.9	4.7	4.7	43.9	0.0	0.0	0.0
12.0	12.0	16.5	16.5	17.6	0.0	0.0	12.9	851.9	85.2	0.1	-7.7	1.1	-24.8	7.7	1.9	24.8	0.0	0.0	0.0
8.7	8.7	5.9	5.9	-16.4	0.0	0.0	-12.1	607.1	121.4	0.2	-6.5	1.4	-22.3	6.5	3.4	22.4	0.0	0.0	0.0
4.5	4.5	0.8	0.8	14.0	0.0	0.0	10.3	204.0	61.2	0.3	-6.0	1.3	-3.5	6.0	2.9	3.5	0.0	0.0	0.0
4.1	4.1	4.2	4.2	19.1	0.0	0.0	14.0	120.6	48.3	0.4	-7.2	1.0	0.0	7.2	1.9	0.0	0.0	0.0	0.0
11.4	11.4	2.6	2.6	1.6	0.0	0.0	1.2	63.5	50.8	0.8	-7.6	1.0	-5.2	7.6	1.8	5.2	0.0	0.0	0.0
13.9	13.9	2.0	2.0	30.0	0.0	0.0	22.1	59.0	47.1	0.8	-8.6	1.0	-11.2	8.6	1.9	11.1	0.0	-0.1	-0.1
8.3	8.3	-1.5	-1.5	30.2	0.0	0.0	22.2	58.4	11.6	0.2	-3.5	1.0	-0.1	3.5	0.3	0.0	0.0	-0.1	-0.1
71.8	71.8	44.7	44.7	50.2	0.0	0.0	36.9	2,385.0	613.8	0.3	-59.7		-139.1	59.7		139.1	0.0	0.0	0.0

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C5. Boron dilution requirements : 1986 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project, assuming no Salt Slough diversions to wetlands

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) lbs	2 BORON LOAD FLOW FACTOR (col 33) KAF x ppm	3 FLOW NEWMAN KAF	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	18.1	36.1	0.5	0.5	0.0	0
Nov	0.0	21.6	27.0	0.8	0.8	0.0	0
Dec	0.0	39.8	39.8	1.0	1.0	0.0	0
Jan	0.0	52.1	34.7	1.5	1.5	0.0	0
Feb	0.0	56.6	282.9	0.2	0.2	0.0	0
Mar	0.0	85.2	851.9	0.1	0.1	0.0	0
Apr	0.0	121.4	607.1	0.2	0.2	0.0	0
May	0.0	61.2	204.0	0.3	0.3	0.0	0
Jun	0.0	48.3	120.6	0.4	0.4	0.0	0
Jul	0.0	50.8	63.5	0.8	0.8	0.0	0
Aug	0.0	47.1	59.0	0.8	0.8	0.0	0
Sep	0.0	11.6	58.4	0.2	0.2	0.0	0
TOTALS	0.0	613.8	2385.0			0.0	0

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table C6. Boron mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ BORON ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ BORON ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ BORON ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ BORON ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	0.5	18.1	11.0	1.1	12.1	2.4	1.4	3.4	22.7	2.6	1.0	3.4	6.7	11.2	11.2	4.0	17.9	11.5	12.0	7.1	22.0
Nov	27.0	0.8	21.6	7.8	1.5	11.7	2.4	2.7	6.5	16.8	3.4	1.0	3.4	6.8	5.1	5.1	1.2	6.9	6.5	7.0	3.2	10.0
Dec	39.8	1.0	39.8	5.6	2.2	12.3	6.8	3.0	20.4	27.4	7.1	1.0	3.3	6.8	2.4	2.4	1.1	8.2	4.3	5.0	2.5	10.9
Jan	34.7	1.5	52.1	5.9	3.4	20.1	6.0	3.5	21.0	22.8	11.0	1.0	3.1	6.2	1.6	1.6	3.6	21.1	3.4	4.1	4.9	23.3
Feb	282.9	0.2	56.6	16.2	3.5	56.7	9.1	2.3	20.9	257.6	-21.0	1.0	3.1	6.2	1.7	1.7	5.9	27.7	3.5	4.0	7.2	30.0
Mar	851.9	0.1	85.2	23.1	1.8	41.6	20.6	1.4	28.8	808.2	14.8	1.0	3.0	7.6	2.6	2.6	9.6	46.3	4.2	4.7	11.0	50.1
Apr	607.1	0.2	121.4	24.9	1.9	47.3	13.7	3.4	46.6	568.5	27.5	1.0	22.2	43.4	2.4	2.4	8.2	39.9	16.7	16.3	16.1	54.2
May	204.0	0.3	61.2	19.8	1.1	21.8	6.7	5.0	33.5	177.5	5.9	1.0	13.5	25.7	5.1	5.1	7.5	39.0	13.2	13.8	12.9	47.8
Jun	120.6	0.4	48.2	17.6	0.6	10.6	7.7	3.6	27.7	95.3	10.0	1.0	4.6	9.0	7.4	7.4	9.0	35.4	9.5	6.5	11.5	39.1
Jul	63.5	0.8	50.8	23.4	0.9	21.1	5.7	3.3	18.8	34.4	10.9	1.0	3.9	8.0	5.4	5.4	9.5	21.2	7.2	4.4	11.6	24.5
Aug	59.0	0.8	47.2	25.5	1.1	28.1	4.8	2.9	13.9	28.7	5.2	1.0	0.0	0.0	3.6	3.6	10.8	44.5	3.0	3.0	11.4	45.1
Sep	58.4	0.2	11.7	17.1	0.8	13.7	0.7	2.0	1.4	40.6	-3.4	1.0	1.8	3.6	6.5	6.5	4.3	23.5	6.5	5.3	6.1	25.8
TOTAL	2,385.0	0.3	613.8	197.9	1.5	296.9	86.6	2.8	242.9	2,100.5	74.0	0.0	65.3	130.0	55.0	55.0	74.7	331.7	89.4	86.0	105.6	382.9

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Boron Load - Flow estimates were calculated as Boron Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (32) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (28) of table 7.

Table C6 (cont.). Boron mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER BORON CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW B FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT BORON ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 BORON LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 BORON LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 B LOAD (Future without condition (Col(29) +(31) of Table C1 Tons	29 B LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 Boron LOAD-FLOW FACTOR AFXppm	31 B LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 BORON CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 BORON CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22]+ (26)]-(8) AF	39 BORON CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 BORON LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	19.3	0.0	0.0	14.2	37.0	18.1	0.5	-2.3	1.1	-2.9	3.2	1.1	3.0	0.9	0.0	0.1
1.3	1.3	0.1	0.1	0.3	0.0	0.0	0.2	27.9	21.5	0.8	0.0	1.1	-3.4	0.9	3.0	3.4	0.9	0.0	-0.1
1.3	1.3	5.0	5.0	-14.4	0.0	0.0	-10.6	40.5	39.8	1.0	0.0	1.1	-6.1	0.7	3.5	6.0	0.7	0.0	0.0
0.3	0.3	4.0	4.0	-12.7	0.0	0.0	-9.3	35.4	52.1	1.5	-2.2	1.2	-15.6	2.9	4.1	15.7	0.7	0.0	0.1
8.8	8.8	6.6	6.6	-38.4	0.0	0.0	-28.2	283.7	56.6	0.2	-3.9	1.0	-43.9	4.7	4.7	43.9	0.8	0.0	0.0
12.0	12.0	16.5	16.5	17.6	0.0	0.0	12.9	851.9	85.2	0.1	-6.9	1.0	-24.8	6.9	2.0	24.8	0.0	0.0	0.0
8.7	8.7	5.9	5.9	-16.4	0.0	0.0	-12.1	615.9	124.6	0.2	0.5	1.0	-22.3	8.3	3.3	25.6	8.8	3.2	4.4
4.5	4.5	0.8	0.8	14.0	0.0	0.0	10.3	208.9	62.5	0.3	-2.1	1.0	-3.5	7.0	2.8	4.8	4.9	1.3	1.8
4.1	4.1	4.2	4.2	19.1	0.0	0.0	14.0	124.6	49.8	0.4	-4.0	0.8	0.0	8.0	1.9	1.5	4.0	1.5	2.1
11.4	11.4	2.6	2.6	1.6	0.0	0.0	1.2	67.2	52.7	0.8	-4.8	0.8	-5.2	8.5	1.8	7.1	3.7	1.9	2.6
13.9	13.9	2.0	2.0	30.0	0.0	0.0	22.1	59.0	47.1	0.8	-8.6	1.0	-11.2	8.6	1.9	11.1	0.0	-0.1	-0.1
8.3	8.3	-1.5	-1.5	30.2	0.0	0.0	22.2	60.0	12.3	0.2	-2.3	0.9	-0.1	3.9	0.5	0.7	1.6	0.6	0.9
71.8	71.8	44.7	44.7	50.2	0.0	0.0	36.9	2,412.0	622.4	0.3	-36.7		-139.1	63.7		147.7	27.0	8.6	11.7

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C7. Boron dilution requirements : 1986 hydrology : Scenario 3

Dilution volume required to restore the SJR at Newman to the same boron concentration without the project, assuming no Salt Slough diversions to wetlands Assume additional wetland water supply.

MONTH	1 INCREASED BORON LOAD DUE TO USE OF DRAIN (col 29) KAF x ppm	2 BORON LOAD FLOW FACTOR (col 33) KAF	3 FLOW NEWMAN ppm	4 BORON CONC WITH PROJECT ppm	5 BORON CONC W/O PROJECT mg/l	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	18.1	37.0	0.5	0.5	0.0	0
Nov	0.0	21.6	27.9	0.8	0.8	0.0	0
Dec	0.0	39.8	40.5	1.0	1.0	0.0	0
Jan	0.0	52.1	35.4	1.5	1.5	0.0	0
Feb	0.0	56.6	283.7	0.2	0.2	0.0	0
Mar	0.0	85.2	851.9	0.1	0.1	0.0	0
Apr	0.0	124.6	615.9	0.2	0.2	0.0	0
May	0.0	62.5	208.9	0.3	0.3	0.0	0
Jun	0.0	49.8	124.6	0.4	0.4	0.0	0
Jul	0.0	52.7	67.2	0.8	0.8	0.0	0
Aug	0.0	47.1	59.0	0.8	0.8	0.0	0
Sep	0.0	12.3	60.0	0.2	0.2	0.0	0
TOTALS	0.0	622.4	2412.0			0.0	0

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 0.2 ppm boron.

Table C8. Selenium mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 WQ Se ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 WQ Se ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	58	11.0	4.6	51	2.4	1.3	3	22.7	4.0	1.0	2.5	2.5	11.2	11.2	4.0	230.1	13.8	194.7	3.9	49.1
Nov	27.0	2.5	68	7.8	5.8	45	2.4	3.6	9	16.8	13.6	1.0	2.5	2.5	5.1	5.1	1.2	72.4	6.5	63.5	2.3	16.5
Dec	39.8	2.4	96	5.6	8.3	46	6.8	9.2	63	27.4	-13.5	1.0	2.6	2.6	2.4	2.4	1.1	58.1	4.3	49.9	1.8	13.1
Jan	34.7	6.4	222	5.9	18.2	107	6.0	9.0	54	22.8	60.7	1.0	2.4	2.4	1.6	1.6	3.6	201.1	5.6	163.6	2.0	41.5
Feb	282.9	1.2	339	16.2	22.2	360	9.1	2.9	26	257.6	-46.6	1.0	2.3	2.3	1.7	1.7	5.9	300.7	7.4	243.3	2.5	61.5
Mar	851.9	1.0	852	23.1	13.4	310	20.6	4.6	95	808.2	447.6	1.0	3.0	3.0	2.6	2.6	9.6	534.6	11.1	431.1	4.1	109.1
Apr	607.1	1.4	850	24.9	13.1	326	13.7	24.5	336	568.5	188.1	1.0	13.4	12.5	2.4	2.4	8.2	514.3	16.2	420.6	7.8	108.6
May	204.0	2.0	408	19.8	8.7	172	6.7	2.9	19	177.5	216.3	1.0	8.6	8.1	5.1	5.1	7.5	415.8	15.3	341.6	5.9	87.4
Jun	120.6	2.4	289	17.6	1.5	26	7.7	29.0	223	95.3	39.7	1.0	0.6	0.6	7.4	7.4	9.0	395.6	13.5	322.7	3.5	80.8
Jul	63.5	3.0	191	23.4	2.1	49	5.7	27.2	155	34.4	-13.7	1.0	0.2	0.2	5.4	5.4	9.5	351.1	12.0	285.3	3.1	71.4
Aug	59.0	5.0	295	25.5	7.1	181	4.8	21.4	103	28.7	11.2	1.0	0.0	0.0	3.6	3.6	10.8	432.0	11.6	348.5	2.8	87.0
Sep	58.4	1.0	58	17.1	3.7	63	0.7	6.0	4	40.6	-9.1	1.0	0.2	0.2	6.5	6.5	4.3	239.0	8.8	196.5	2.2	49.2
OTA	2,385.0	1.6	3,726	197.9	8.8	1737	86.6	12.6	1090	2,100.5	898.5	0.4	38.3	36.9	55.0	55.0	74.7	3744.9	126.2	3061.5	41.8	775.3

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (33) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (29) of table 6.

Table C8. (cont). Selenium mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITHOUT PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS (8)-(22) AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD-FLOW FACTOR (21)+(25)-(7) AFXppb	29 Se LOAD (x1000) (28)x0.00136 x2000 lbs	30 Se LOAD-FLOW FACTOR (23)+(27)-(10) AFXppb	31 Se LOAD (x1000) (28)x0.00136 x2000 lbs	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+(24)]-(5) AF	36 Se CONC. [(21)+(25)-(28)]+[(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)-(28)]-(7) AFXppb	38 FLOW [22)+(26)]-(8) AF	39 Se CONC. [(23)+(27)-(30)]+[(22)+(26)] ppb	40 LOAD FLOW FACTOR [(23)+(27)-(30)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) ppb	43 Se LOAD [(42)x2000 x0.00136] AFXppb
-2.8	-2.8	-1.5	-1.5	141.3	384.4	44.5	121.1	36.1	57.8	1.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	0.1	0.1	19.5	53.2	8.0	21.8	27.0	67.5	2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	5.0	5.0	4.7	12.8	-44.4	-120.7	39.8	95.5	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.3	0.3	4.0	4.0	56.5	153.7	-8.5	-23.1	34.7	222.1	6.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.8	8.8	6.6	6.6	-107.6	-292.6	41.7	113.4	282.9	339.5	1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.0	12.0	16.5	16.5	133.5	363.2	30.8	83.9	851.9	851.9	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.7	8.7	5.9	5.9	103.1	280.5	-221.1	-601.5	607.1	849.9	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.5	4.5	0.8	0.8	173.9	473.0	68.7	187.0	204.0	408.0	2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.1	4.1	4.2	4.2	300.5	817.3	-138.3	-376.1	120.6	289.4	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
11.4	11.4	2.6	2.6	247.5	673.3	-81.0	-220.4	63.5	190.5	3.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
13.9	13.9	2.0	2.0	181.4	493.4	-13.7	-37.2	59.0	295.0	5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.3	8.3	-1.5	-1.5	141.6	385.1	43.4	118.1	58.4	58.4	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
71.7	71.7	44.8	44.8	1,396.0	3,797.2	-269.8	-733.8	2,385.0	3,725.5	1.6	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C9. Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 0% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	2.5	2.5	0.0	0.0	4.0	230.1	2.3	3.0	5.1	231.7
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	2.5	2.5	0.0	0.0	1.2	72.4	2.3	3.0	2.3	74.0
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	2.6	2.6	0.0	0.0	1.1	58.1	2.3	3.0	2.1	59.7
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	2.4	2.4	0.0	0.0	3.6	201.1	2.1	2.8	4.6	202.6
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	2.3	2.3	0.0	0.0	5.9	300.7	2.1	2.8	6.9	302.2
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	3.0	0.0	0.0	9.6	534.6	2.1	2.8	10.5	536.8
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	13.4	13.4	0.0	0.0	8.2	514.3	14.7	19.9	15.7	524.1
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	8.6	8.6	0.0	0.0	7.5	415.8	9.0	11.8	12.0	421.4
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	0.6	0.6	0.0	0.0	9.0	395.6	3.4	4.2	10.2	397.2
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	0.2	0.2	0.0	0.0	9.5	351.1	2.8	3.8	10.6	352.8
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	0.0	0.0	10.8	432.0	0.0	0.0	10.8	432.0
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	1.0	1.0	0.0	0.0	4.3	239.0	1.2	1.6	4.9	239.8
TOTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	39.1	39.1	0.0	0.0	74.7	3744.9	44.3	58.7	95.7	3774.4

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table C9. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 0% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C8 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C5 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table C8 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.0) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22]+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ [(22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	505.5	0.0	185.8	25.8	48.6	1.9	-11.5	-0.4	-50.4	1.2	12.3	41.3	-10.3	-9.1	-24.8
1.3	1.3	0.1	0.1	75.0	75.0	0.0	27.6	22.8	64.5	2.8	-4.2	1.2	-40.9	0.0	19.4	37.9	-4.2	-3.0	-8.2
1.3	1.3	5.0	5.0	-107.9	-107.9	0.0	-39.7	38.1	95.1	2.5	-3.0	1.2	-42.2	0.3	14.7	41.8	-1.7	-0.4	-1.0
0.3	0.3	4.0	4.0	130.6	130.6	0.0	48.0	33.8	222.4	6.6	5.0	1.3	-104.3	2.6	18.4	104.6	-0.9	0.3	0.8
8.8	8.8	6.6	6.6	-179.2	-179.2	0.0	-65.9	282.0	339.8	1.2	-2.1	1.1	-348.0	4.4	27.8	348.3	-0.9	0.3	0.8
12.0	12.0	16.5	16.5	447.1	447.1	0.0	164.4	849.3	851.3	1.0	-12.3	1.0	-294.7	6.4	14.4	294.1	-2.6	-0.6	-1.7
8.7	8.7	5.9	5.9	-321.0	-321.0	0.0	-118.0	613.5	864.8	1.4	-5.7	1.2	-297.6	7.9	30.0	312.4	6.4	14.8	40.3
4.5	4.5	0.8	0.8	660.0	660.0	0.0	242.6	203.8	412.2	2.0	-6.7	1.2	-156.0	6.1	14.0	160.1	-0.2	4.2	11.3
4.1	4.1	4.2	4.2	441.2	441.2	0.0	162.2	117.2	287.2	2.5	-2.8	1.1	-18.1	6.7	16.6	15.9	-3.4	-2.2	-6.0
11.4	11.4	2.6	2.6	452.9	452.9	0.0	166.5	61.8	190.4	3.1	-6.7	1.1	-33.9	7.5	14.3	33.9	-1.7	-0.1	-0.2
13.9	13.9	2.0	2.0	456.2	456.2	0.0	167.7	55.4	291.4	5.3	-17.2	1.0	-167.2	8.0	20.8	163.5	-3.6	-3.6	-9.8
8.3	8.3	-1.5	-1.5	503.2	503.2	0.0	185.0	53.5	54.1	1.0	-7.6	1.0	-53.4	2.7	15.7	49.1	-4.9	-4.3	-11.7
71.8	71.8	44.7	44.7	3,063.6	3,063.6	0.0	1,126.3	2,357.0	3,721.7	1.6	-74.8		-1,606.7	53.8		1,602.9	-28.0	-3.8	-10.3

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C10. Selenium dilution requirements : 1986 hydrology : Scenario 1 : 0% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 0%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	48.6	25.8	1.9	1.6	12.9	12,900
Nov	0.0	64.5	22.8	2.8	2.5	4.6	4,560
Dec	0.0	95.1	38.1	2.5	2.4	2.7	2,721
Jan	0.0	222.4	33.8	6.6	6.4	1.3	1,252
Feb	0.0	339.8	282.0	1.2	1.2	0.0	0
Mar	0.0	851.3	849.3	1.0	1.0	0.0	0
Apr	0.0	864.8	613.5	1.4	1.4	0.0	0
May	0.0	412.2	203.8	2.0	2.0	0.0	0
Jun	0.0	287.2	117.2	2.5	2.4	8.4	8,371
Jul	0.0	190.4	61.8	3.1	3.0	3.1	3,090
Aug	0.0	291.4	55.4	5.3	5.0	4.2	4,155
Sep	0.0	54.1	53.5	1.0	1.0	0.0	0
TOTALS	0.0	3721.8	2357.0			37.0	37,050

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C11. Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 10% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	3.4	4.6	0.0	0.0	4.0	230.1	2.3	3.0	5.1	231.7
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	3.4	3.9	0.0	0.0	1.2	72.4	2.3	3.0	2.3	74.0
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	3.3	3.9	0.0	0.0	1.1	58.1	2.3	3.0	2.1	59.7
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	3.1	3.5	0.0	0.0	3.6	201.1	2.1	2.8	4.6	202.6
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	3.1	3.5	0.0	0.0	5.9	300.7	2.1	2.8	6.9	302.2
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	4.2	0.0	0.0	9.6	534.6	2.1	2.8	10 5	536.8
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	22.2	24.0	0.0	0.0	8.2	514.3	14.7	19.9	15.7	524.1
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	13.5	14.1	0.0	0.0	7.5	415.8	9.0	11.8	12.0	421.4
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	4.6	5.2	0.0	0.0	9.0	395.6	3.4	4.2	10.2	397.2
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	3.9	4.1	0.0	0.0	9.5	351.1	2.8	3.8	10.6	352.8
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	0.0	0.0	10.8	432.0	0.0	0.0	10.8	432.0
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	1.8	2.1	0.0	0.0	4.3	239.0	1.2	1.6	4.9	239.8
OTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	65.3	73.1	0.0	0.0	74.7	3744.9	44.3	58.7	95.7	3774.4

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table C11. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 10% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C8 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C8 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table C8 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-.10) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)÷1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)-(30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)-(30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ (22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)-(31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	455.0	0.0	167.3	25.8	67.2	2.6	-11.5	-0.4	-50.4	1.2	17.5	59.9	-10.3	9.5	25.7
1.3	1.3	0.1	0.1	75.0	67.5	0.0	24.8	22.8	67.2	2.9	-4.2	1.2	-40.9	0.0	20.5	40.7	-4.2	-0.3	-0.7
1.3	1.3	5.0	5.0	-107.9	-97.1	0.0	-35.7	38.1	91.2	2.4	-3.0	1.2	-42.2	0.3	14.1	37.8	-1.7	-4.3	-11.8
0.3	0.3	4.0	4.0	130.6	117.5	0.0	43.2	33.8	227.2	6.7	5.0	1.3	-104.3	2.6	19.0	109.4	-0.9	5.1	13.9
8.8	8.8	6.6	6.6	-179.2	-161.3	0.0	-59.3	282.0	333.2	1.2	-2.1	1.1	-348.0	4.4	27.3	341.7	-0.9	-6.3	-17.1
12.0	12.0	16.5	16.5	447.1	402.4	0.0	147.9	849.3	867.7	1.0	-12.3	1.0	-294.7	6.4	15.0	310.6	-2.6	15.8	43.0
8.7	8.7	5.9	5.9	-321.0	-288.9	0.0	-106.2	613.5	853.0	1.4	-5.7	1.2	-297.6	7.9	29.5	300.6	6.4	3.0	8.2
4.5	4.5	0.8	0.8	660.0	594.0	0.0	218.4	203.8	436.4	2.1	-6.7	1.2	-156.0	6.1	15.9	184.4	-0.2	28.4	77.3
4.1	4.1	4.2	4.2	441.2	397.1	0.0	146.0	117.2	303.4	2.6	-2.8	1.1	-18.1	6.7	17.7	32.1	-3.4	14.0	38.1
11.4	11.4	2.6	2.6	452.9	407.6	0.0	149.9	61.8	207.1	3.4	-6.7	1.1	-33.9	7.5	15.6	50.5	-1.7	16.6	45.1
13.9	13.9	2.0	2.0	456.2	410.6	0.0	150.9	55.4	308.2	5.6	-17.2	1.0	-167.2	8.0	22.1	180.3	-3.6	13.2	35.8
8.3	8.3	-1.5	-1.5	503.2	452.9	0.0	166.5	53.5	72.6	1.4	-7.6	1.0	-53.4	2.7	21.1	67.6	-4.9	14.2	38.6
71.8	71.8	44.7	44.7	3,063.6	2,757.2	0.0	1,013.7	2,357.0	3,834.4	1.6	-74.8		-1,606.7	53.8		1,715.6	-28.0	108.9	296.1

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area .ior should their be any significant salt load flushed from these channels over an annual period.

Table C12. Selenium dilution requirements : 1986 hydrology : Scenario 1 : 10% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	50.5	67.2	25.8	2.6	1.6	43.0	43,000
Nov	7.5	67.2	22.8	2.9	2.5	6.1	6,080
Dec	10.8	91.2	38.1	2.4	2.4	0.0	0
Jan	13.1	227.2	33.8	6.7	6.4	1.9	1,878
Feb	17.9	333.2	282.0	1.2	1.2	0.0	0
Mar	44.7	867.7	849.3	1.0	1.0	0.0	0
Apr	32.1	853.0	613.5	1.4	1.4	0.0	0
May	66.0	436.4	203.8	2.1	2.0	20.4	20,380
Jun	44.1	303.4	117.2	2.6	2.4	16.7	16,743
Jul	45.3	207.1	61.8	3.4	3.0	12.4	12,360
Aug	45.6	30.8	55.4	5.6	5.0	8.3	8,310
Sep	50.3	72.6	53.5	1.4	1.0	NF	NF
TOTALS	427.9	3557.0	2357.0			108.8	108,751

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C13. Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 20% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	2.5	2.5	0.0	0.0	4.0	230.1	2.3	3.0	5.1	231.7
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	2.5	2.5	0.0	0.0	1.2	72.4	2.3	3.0	2.3	74.0
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	2.6	2.6	0.0	0.0	1.1	58.1	2.3	3.0	2.1	59.7
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	2.4	2.4	0.0	0.0	3.6	201.1	2.1	2.8	4.6	202.6
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	2.3	2.3	0.0	0.0	5.9	300.7	2.1	2.8	6.9	302.2
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	3.0	0.0	0.0	9.6	534.6	2.1	2.8	10.5	536.8
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	13.4	13.4	0.0	0.0	8.2	514.3	14.7	19.9	15.7	524.1
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	8.6	8.6	0.0	0.0	7.5	415.8	9.0	11.8	12.0	421.4
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	0.6	0.6	0.0	0.0	9.0	395.6	3.4	4.2	10.2	397.2
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	0.2	0.2	0.0	0.0	9.5	351.1	2.8	3.8	10.6	352.8
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	0.0	0.0	10.8	432.0	0.0	0.0	10.8	432.0
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	1.0	1.0	0.0	0.0	4.3	239.0	1.2	1.6	4.9	239.8
OTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	39.1	39.1	0.0	0.0	74.7	3744.9	44.3	58.7	95.7	3774.4

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table C13. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 20% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C8 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C8 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table C8 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.2) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ (22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	404.4	0.0	148.7	25.8	85.8	3.3	-11.5	-0.4	-50.4	1.2	22.7	78.5	-10.3	28.1	76.3
1.3	1.3	0.1	0.1	75.0	60.0	0.0	22.1	22.8	70.0	3.1	-4.2	1.2	-40.9	0.0	21.7	43.4	-4.2	2.5	6.8
1.3	1.3	5.0	5.0	-107.9	-86.3	0.0	-31.7	38.1	87.2	2.3	-3.0	1.2	-42.2	0.3	13.6	33.9	-1.7	-8.3	-22.6
0.3	0.3	4.0	4.0	130.6	104.5	0.0	38.4	33.8	232.0	6.9	5.0	1.3	-104.3	2.6	19.6	114.2	-0.9	9.9	27.0
8.8	8.8	6.6	6.6	-179.2	-143.4	0.0	-52.7	282.0	326.6	1.2	-2.1	1.1	-348.0	4.4	26.8	335.2	-0.9	-12.9	-35.1
12.0	12.0	16.5	16.5	447.1	357.7	0.0	131.5	849.3	884.2	1.0	-12.3	1.0	-294.7	6.4	15.6	327.0	-2.6	32.3	87.7
8.7	8.7	5.9	5.9	-321.0	-256.8	0.0	-94.4	613.5	841.1	1.4	-5.7	1.2	-297.6	7.9	28.9	288.8	6.4	-8.8	-23.9
4.5	4.5	0.8	0.8	660.0	528.0	0.0	194.1	203.8	460.7	2.3	-6.7	1.2	-156.0	6.1	17.8	208.7	-0.2	52.7	143.3
4.1	4.1	4.2	4.2	441.2	353.0	0.0	129.8	117.2	319.7	2.7	-2.8	1.1	-18.1	6.7	18.9	48.3	-3.4	30.2	82.2
11.4	11.4	2.6	2.6	452.9	362.3	0.0	133.2	61.8	223.7	3.6	-6.7	1.1	-33.9	7.5	16.8	67.2	-1.7	33.2	90.4
13.9	13.9	[illegible]	2.0	456.2	365.0	0.0	134.2	55.4	324.9	5.9	-17.2	1.0	-167.2	8.0	23.4	197.1	-3.6	29.9	81.4
8.3	8.3	-1.5	-1.5	503.2	402.6	0.0	148.0	53.5	91.1	1.7	-7.6	1.0	-53.4	2.7	26.6	86.1	-4.9	32.7	88.9
71.8	71.8	44.7	44.7	3,063.6	2,450.9	0.0	901.1	2,357.0	3,947.0	1.7	-74.8		-1,606.7	53.8		1,828.2	-28.0	221.5	602.5

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C14. Selenium dilution requirements : 1986 hydrology : Scenario 1 : 20% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 20%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	101.1	85.8	25.8	3.3	1.6	73.1	73,100
Nov	15.0	70.0	22.8	3.1	2.5	9.1	9,120
Dec	21.6	87.2	38.1	2.3	2.4	-2.7	0
Jan	26.1	232.0	33.8	6.9	6.4	3.1	3,130
Feb	35.8	326.6	282.0	1.2	1.2	0.0	0
Mar	89.4	884.2	849.3	1.0	1.0	0.0	0
Apr	64.2	841.1	613.5	1.4	1.4	0.0	0
May	132.0	460.7	203.8	2.3	2.0	61.1	61,140
Jun	88.2	319.7	117.2	2.7	2.4	25.1	25,114
Jul	90.6	223.7	61.8	3.6	3.0	18.5	18,540
Aug	91.2	324.9	55.4	5.9	5.0	12.5	12,465
Sep	100.6	91.1	53.5	1.7	1.0	NF	NF
TOTALS	855.8	3947.0	2357.0			199.9	202,609

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C15. Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 51% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	2.5	2.5	0.0	0.0	4.0	230.1	2.3	3.0	5.1	231.7
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	2.5	2.5	0.0	0.0	1.2	72.4	2.3	3.0	2.3	74.0
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	2.6	2.6	0.0	0.0	1.1	58.1	2.3	3.0	2.1	59.7
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	2.4	2.4	0.0	0.0	3.6	201.1	2.1	2.8	4.6	202.6
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	2.3	2.3	0.0	0.0	5.9	300.7	2.1	2.8	6.9	302.2
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	3.0	0.0	0.0	9.6	534.6	2.1	2.8	10.5	536.8
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	13.4	13.4	0.0	0.0	8.2	514.3	14.7	19.9	15.7	524.1
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	8.6	8.6	0.0	0.0	7.5	415.8	9.0	11.8	12.0	421.4
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	0.6	0.6	0.0	0.0	9.0	395.6	3.4	4.2	10.2	397.2
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	0.2	0.2	0.0	0.0	9.5	351.1	2.8	3.8	10.6	352.8
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	0.0	0.0	10.8	432.0	0.0	0.0	10.8	432.0
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	1.0	1.0	0.0	0.0	4.3	239.0	1.2	1.6	4.9	239.8
TOTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	39.1	39.1	0.0	0.0	74.7	3744.9	44.3	58.7	95.7	3774.4

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table C15. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 1 : 51% uptake.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C8 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C8 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table C8 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.51) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ (22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	247.7	0.0	91.1	25.8	143.4	5.6	-11.5	-0.4	-50.4	1.2	38.7	136.1	-10.3	85.7	233.0
1.3	1.3	0.1	0.1	75.0	36.8	0.0	13.5	22.8	78.5	3.4	-4.2	1.2	-40.9	0.0	25.3	52.0	-4.2	11.0	30.0
1.3	1.3	5.0	5.0	-107.9	-52.9	0.0	-19.4	38.1	74.9	2.0	-3.0	1.2	-42.2	0.3	11.8	21.6	-1.7	-20.6	-56.1
0.3	0.3	4.0	4.0	130.6	64.0	0.0	23.5	33.8	246.9	7.3	5.0	1.3	-104.3	2.6	21.3	129.1	-0.9	24.8	67.4
8.8	8.8	6.6	6.6	-179.2	-87.8	0.0	-32.3	282.0	306.2	1.1	-2.1	1.1	-348.0	4.4	25.3	314.7	-0.9	-33.3	-90.6
12.0	12.0	16.5	16.5	447.1	219.1	0.0	80.5	849.3	935.1	1.1	-12.3	1.0	-294.7	6.4	17.5	378.0	-2.6	83.2	226.3
8.7	8.7	5.9	5.9	-321.0	-157.3	0.0	-57.8	613.5	804.6	1.3	-5.7	1.2	-297.6	7.9	27.2	252.2	6.4	-45.4	-123.4
4.5	4.5	0.8	0.8	660.0	323.4	0.0	118.9	203.8	535.9	2.6	-6.7	1.2	-156.0	6.1	23.7	283.9	-0.2	127.9	347.9
4.1	4.1	4.2	4.2	441.2	216.2	0.0	79.5	117.2	369.9	3.2	-2.8	1.1	-18.1	6.7	22.4	98.6	-3.4	80.5	219.0
11.4	11.4	2.6	2.6	452.9	221.9	0.0	81.6	61.8	275.3	4.5	-6.7	1.1	-33.9	7.5	20.7	118.8	-1.7	84.8	230.7
13.9	13.9	2.0	2.0	456.2	223.5	0.0	82.2	55.4	376.9	6.8	-17.2	1.0	-167.2	8.0	27.5	249.1	-3.6	81.9	222.9
8.3	8.3	-1.5	-1.5	503.2	246.6	0.0	90.7	53.5	148.5	2.8	-7.6	1.0	-53.4	2.7	43.4	143.4	-4.9	90.1	244.9
71.8	71.8	44.7	44.7	3,063.6	1,501.2	0.0	551.9	2,357.0	4,296.2	1.8	-74.8		-1,606.7	53.8		2,177.3	-28.0	570.7	1,552.2

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C16. Selenium dilution requirements : 1986 hydrology : Scenario 1 : 51% uptake.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 51%)

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	257.8	143.4	25.8	5.6	1.6	172.0	172,000
Nov	38.2	78.5	22.8	3.4	2.5	13.7	13,680
Dec	55.0	74.9	38.1	2.0	2.4	-10.9	0
Jan	66.6	246.9	33.8	7.3	6.4	5.6	5,633
Feb	91.4	306.2	282.0	1.1	1.2	-141.0	0
Mar	228.0	935.1	849.3	1.1	1.0	NF	NF
Apr	163.7	804.6	613.5	1.3	1.4	-153.4	0
May	336.6	535.9	203.8	2.6	2.0	122.3	122,280
Jun	225.0	369.9	117.2	3.2	2.4	67.0	66,971
Jul	231.0	275.3	61.8	4.5	3.0	46.4	46,350
Aug	232.7	376.9	55.4	6.8	5.0	24.9	24,930
Sep	256.6	148.5	53.5	2.8	1.0	NF	NF
TOTALS	2182.6	4296.1	2357.0			146.6	451,845

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C17. Selenium mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (28)Table 6 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	2.5	2.5	11.2	11.2	4.0	230.1	10.6	10.6	7.1	233.3
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	2.5	2.5	5.1	5.1	1.2	72.4	5.6	5.6	3.2	74.4
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	2.6	2.6	2.4	2.4	1.1	58.1	3.5	3.5	2.6	59.6
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	2.4	2.4	1.6	1.6	3.6	201.1	2.7	2.7	4.9	202.4
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	2.3	2.3	1.7	1.7	5.9	300.7	2.7	2.7	7.2	302.0
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	3.0	2.6	2.6	9.6	534.6	3.4	3.4	11.8	536.7
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	13.4	12.5	2.4	2.4	8.2	514.3	9.7	9.2	14.3	520.1
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	8.6	8.1	5.1	5.1	7.5	415.8	9.3	9.0	11.9	420.0
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	0.6	0.6	7.4	7.4	9.0	395.6	6.3	6.3	10.7	397.3
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	0.2	0.2	5.4	5.4	9.5	351.1	4.4	4.4	10.7	352.3
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	3.6	3.6	10.8	432.0	3.0	3.0	11.4	432.6
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	0.2	0.2	6.5	6.5	4.3	239.0	5.3	5.3	5.7	240.3
TOTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	38.3	36.9	55.0	55.0	74.7	3744.9	66.4	65.6	101.6	3771.2

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbr ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 6.

Table C17. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C8 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C8 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) of Table C8 lbs	29 Se LOAD REDUCTION DUE TO USE OF SLD (28)x(1-0.1) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22)+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ (22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	455.0	0.0	167.3	36.1	76.3	2.1	-3.2	1.0	-42.8	3.2	11.5	61.4	0.0	18.6	50.5
1.3	1.3	0.1	0.1	75.0	67.5	0.0	24.8	27.0	70.2	2.6	-0.9	1.0	-38.4	0.9	15.0	41.1	0.0	2.7	7.4
1.3	1.3	5.0	5.0	-107.9	-97.1	0.0	-35.7	39.8	91.6	2.3	-1.8	1.0	-41.7	0.8	13.1	37.8	0.0	-3.9	-10.7
0.3	0.3	4.0	4.0	130.6	117.5	0.0	43.2	34.7	226.9	6.5	5.6	1.0	-104.4	2.9	18.4	109.2	0.0	4.8	13.1
8.8	8.8	6.6	6.6	-179.2	-161.3	0.0	-59.3	282.9	332.9	1.2	-1.5	1.0	-348.1	4.7	26.7	341.5	0.0	-6.6	-18.0
12.0	12.0	16.5	16.5	447.1	402.4	0.0	147.9	851.9	868.3	1.0	-11.0	1.0	-294.1	7.7	14.3	310.5	0.0	16.4	44.7
8.7	8.7	5.9	5.9	-321.0	-288.9	0.0	-106.2	607.1	838.2	1.4	-10.7	1.0	-308.3	6.5	31.2	296.5	0.0	-11.8	-32.1
4.5	4.5	0.8	0.8	660.0	594.0	0.0	218.4	204.0	432.2	2.1	-6.4	1.0	-158.8	6.0	15.9	183.0	0.0	24.2	65.9
4.1	4.1	4.2	4.2	441.2	397.1	0.0	146.0	120.6	305.6	2.5	0.1	1.0	-16.0	7.2	17.1	32.2	0.0	16.2	44.1
11.4	11.4	2.6	2.6	452.9	407.6	0.0	149.9	63.5	207.2	3.3	-5.1	1.0	-33.3	7.6	15.4	50.0	0.0	16.7	45.3
13.9	13.9	2.0	2.0	456.2	410.6	0.0	150.9	59.0	311.8	5.3	-14.2	1.0	-164.2	8.6	21.1	181.0	0.0	16.8	45.6
8.3	8.3	-1.5	-1.5	503.2	452.9	0.0	166.5	58.4	76.9	1.3	-3.5	1.0	-49.6	3.5	17.3	68.1	0.0	18.5	50.3
71.8	71.8	44.7	44.7	3,063.6	2,757.2	0.0	1,013.7	2,385.0	3,838.1	1.6	-52.7		-1,599.8	59.7		1,712.4	0.0	112.6	306.2

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C18. Selenium dilution requirements : 1986 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10% and assume no Salt Slough diversions to wetlands.

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	50.5	76.3	36.1	2.1	1.6	30.1	30,083
Nov	7.5	70.2	27.0	2.6	2.5	1.8	1,800
Dec	10.8	91.6	39.8	2.3	2.4	-2.8	0
Jan	13.1	226.9	34.7	6.5	6.4	0.6	643
Feb	17.9	332.9	282.9	1.2	1.2	0.0	0
Mar	44.7	868.3	851.9	1.0	1.0	0.0	0
Apr	32.1	838.2	607.1	1.4	1.4	0.0	0
May	66.0	432.2	204.0	2.1	2.0	20.4	20,400
Jun	44.1	305.6	120.6	2.5	2.4	8.6	8,614
Jul	45.3	207.2	63.5	3.3	3.0	9.5	9,525
Aug	45.6	311.8	59.0	5.3	5.0	4.4	4,425
Sep	50.3	76.9	58.4	1.3	1.0	NF	NF
TOTALS	427.9	3838.1	2385.0			72.6	75,490

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C19. Selenium mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ Se ppb	4 LOAD FLOW FACTOR (2)x(3) AFXppb	5 FLOW AF	6 Se BORON ppb	7 LOAD FLOW FACTOR (5)x(6) AFXppb	8 FLOW AF	9 Se BORON ppb	10 LOAD FLOW FACTOR (8)x(9) AFXppb	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppb	13 Ass. WQ Se ppb	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFxppb	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFxppb	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFxppb	20 FLOWS (16)x0.82+ (18)x0+ (30)Table 7 AF	21 LOAD FLOW FACTOR (f) AFxppb	22 FLOWS (16)x0.18+ (18)+ (26)Table 7 AF	23 LOAD FLOW FACTOR (g) AFxppb
Oct	36.1	1.6	57.8	11.0	4.6	50.6	2.4	1.3	3.1	22.7	4.0	0.2	3.4	4.6	11.2	11.2	4.0	230.1	11.5	12.2	7.1	233.8
Nov	27.0	2.5	67.5	7.8	5.8	45.2	2.4	3.6	8.6	16.8	13.6	0.8	3.4	3.9	5.1	5.1	1.2	72.4	6.5	7.2	3.2	74.9
Dec	39.8	2.4	95.5	5.6	8.3	46.5	6.8	9.2	62.6	27.4	-13.5	-0.5	3.3	3.9	2.4	2.4	1.1	58.1	4.3	5.0	2.5	60.1
Jan	34.7	6.4	222.1	5.9	18.2	107.4	6.0	9.0	54.0	22.8	60.7	2.7	3.1	3.5	1.6	1.6	3.6	201.1	3.4	4.1	4.9	202.9
Feb	282.9	1.2	339.5	16.2	22.2	359.6	9.1	2.9	26.4	257.6	-46.6	-0.2	3.1	3.5	1.7	1.7	5.9	300.7	3.5	4.2	7.2	302.5
Mar	851.9	1.0	851.9	23.1	13.4	309.5	20.6	4.6	94.8	808.2	447.6	0.6	3.0	4.2	2.6	2.6	9.6	534.6	4.2	4.9	11.0	537.2
Apr	607.1	1.4	849.9	24.9	13.1	326.2	13.7	24.5	335.7	568.5	188.1	0.3	22.2	24.0	2.4	2.4	8.2	514.3	16.7	21.9	16.1	524.6
May	204.0	2.0	408.0	19.8	8.7	172.3	6.7	2.9	19.4	177.5	216.3	1.2	13.5	14.1	5.1	5.1	7.5	415.8	13.2	16.0	12.9	422.3
Jun	120.6	2.4	289.4	17.6	1.5	26.4	7.7	29.0	223.3	95.3	39.7	0.4	4.6	5.2	7.4	7.4	9.0	395.6	9.5	10.3	11.5	398.5
Jul	63.5	3.0	190.5	23.4	2.1	49.1	5.7	27.2	155.0	34.4	-13.7	-0.4	3.9	4.1	5.4	5.4	9.5	351.1	7.2	8.2	11.6	353.8
Aug	59.0	5.0	295.0	25.5	7.1	181.1	4.8	21.4	102.7	28.7	11.2	0.4	0.0	0.0	3.6	3.6	10.8	432.0	3.0	3.0	11.4	432.6
Sep	58.4	1.0	58.4	17.1	3.7	63.3	0.7	6.0	4.2	40.6	-9.1	-0.2	1.8	2.1	6.5	6.5	4.3	239.0	6.5	6.9	6.1	240.9
TOTA	2,385.0	1.6	3,725.5	197.9	8.8	1,737.2	86.6	12.6	1,089.8	2,100.5	898.5	0.4	65.3	73.1	55.0	55.0	74.7	3744.9	89.4	103.8	105.6	3784.3

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) Selenium Load - Flow estimates were calculated as Selenium Load in lbs ÷ 2000lbs/ton ÷ 0.00136 tons/AF-ppm ÷ 1000.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (33) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19) + Col (29) of table 7.

Table C19. (cont.). Selenium mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER SELENIUM CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows and Load-Flow Factors in 1,000s)

ADJUSTED LOW Se FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT Se ADJUSTMENTS (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Change in flows and load flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and Mud SLOUGH		MUD SLOUGH	SALT SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C.6 AF	25 Se LOAD-FLOW FACTOR (24) X 1.0 AFXppb	26 FLOWS [24] Table C.6 AF	27 Se LOAD-FLOW FACTOR (26) X 1.0 AFXppb	28 Se LOAD (Future without condition (Col(29) +(31) = Table C.6 lbs	29 Se LOAD ADJUSTED FOR GAINS IN SLD (28)x(1-0.1) lbs	30 Se LOAD-FLOW FACTOR AFXppb	31 Se LOAD-FLOW FACTOR (29)+1000 +0.00136 AFXppb	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppb	34 Se CONC. (33)/(32) ppb	35 FLOW [(20)+ (24)]-(5) AF	36 Se CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppb	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppb	38 FLOW [22]+ (26)]-(8) AF	39 Se CONC. [(23)+(27) (31)]+ (22)+(26) ppb	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppb	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 Se LOAD [(42)x2000 x0.00136] lbs
-2.8	-2.8	-1.5	-1.5	505.5	455.0	0.0	167.3	37.0	78.4	2.1	-2.3	1.1	-41.2	3.2	11.6	61.9	0.9	20.7	56.2
1.3	1.3	0.1	0.1	75.0	67.5	0.0	24.8	27.9	72.3	2.6	0.0	1.1	-36.8	0.9	15.1	41.6	0.9	4.8	13.1
1.3	1.3	5.0	5.0	-107.9	-97.1	0.0	-35.7	40.5	93.6	2.3	-1.0	1.1	-40.2	0.7	13.4	38.3	0.7	-1.9	-5.3
0.3	0.3	4.0	4.0	130.6	117.5	0.0	43.2	35.4	228.8	6.5	6.3	1.2	-103.0	2.9	18.4	109.7	0.7	6.7	18.3
8.8	8.8	6.6	6.6	-179.2	-161.3	0.0	-59.3	283.7	334.9	1.2	-0.7	1.1	-346.6	4.7	26.7	342.0	0.8	-4.6	-12.5
12.0	12.0	16.5	16.5	447.1	402.4	0.0	147.9	851.9	870.3	1.0	-10.2	1.0	-292.6	6.9	14.8	311.0	0.0	18.4	50.1
8.7	8.7	5.9	5.9	-321.0	-288.9	0.0	-106.2	615.9	855.4	1.4	-3.7	1.2	-295.6	8.3	28.9	301.0	8.8	5.4	14.7
4.5	4.5	0.8	0.8	660.0	594.0	0.0	218.4	208.9	441.5	2.1	-2.5	1.2	-151.8	7.0	14.9	185.3	4.9	33.5	91.2
4.1	4.1	4.2	4.2	441.2	397.1	0.0	146.0	124.6	310.8	2.5	3.3	1.1	-12.0	8.0	16.3	33.4	4.0	21.4	58.2
11.4	11.4	2.6	2.6	452.9	407.6	0.0	149.9	67.2	212.5	3.2	-2.3	1.1	-29.5	8.5	14.6	51.5	3.7	22.0	59.7
13.9	13.9	2.0	2.0	456.2	410.6	0.0	150.9	59.0	311.8	5.3	-14.2	1.0	-164.2	8.6	21.1	181.0	0.0	16.8	45.6
8.3	8.3	-1.5	-1.5	503.2	452.9	0.0	166.5	60.0	79.1	1.3	-2.3	1.0	-48.0	3.9	16.0	68.7	1.6	20.7	56.3
71.8	71.8	44.7	44.7	3,063.6	2,757.2	0.0	1,013.7	2,412.0	3,889.4	1.6	-29.7		-1,561.6	63.7		1,725.5	27.0	163.9	445.7

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C20. Selenium dilution requirements : 1986 hydrology : Scenario 3.

Dilution volume required to restore the SJR at Newman to the same selenium concentration without the project (assume Grassland Se losses of 10% and assume no Salt Slough diversions to wetlands. Assume additional wetland water supply

MONTH	1 INCREASED SELENIUM LOAD DUE TO USE OF DRAIN (C28-C29) lbs	2 SELENIUM LOAD FLOW FACTOR (col 33) KAF x ppb	3 FLOW NEWMAN KAF	4 SELENIUM CONC WITH PROJECT ppb	5 SELENIUM CONC W/O PROJECT ppb	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	50.5	78.4	37.0	2.1	1.6	30.8	30,833
Nov	7.5	72.3	27.9	2.6	2.5	1.9	1,860
Dec	10.8	93.6	40.5	2.3	2.4	-2.9	0
Jan	13.1	228.8	35.4	6.5	6.4	0.7	656
Feb	17.9	334.9	283.7	1.2	1.2	0.0	0
Mar	44.7	870.3	851.9	1.0	1.0	0.0	0
Apr	32.1	855.4	615.9	1.4	1.4	0.0	0
May	66.0	441.5	208.9	2.1	2.0	20.9	20,890
Jun	44.1	310.8	124.6	2.5	2.4	8.9	8,900
Jul	45.3	212.5	67.2	3.2	3.0	6.7	6,720
Aug	45.6	311.8	59.0	5.3	5.0	4.4	4,425
Sep	50.3	79.1	60.0	1.3	1.0	NF	NF
TOTALS	427.9	3889.4	2412.0			71.4	74,284

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF
NF - Infeasible since an infinite volume of dilution water at 1ppb would be required
Assume dilution water contains 1ppb selenium.

Table C21. TDS mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY
WITHOUT PROPOSED ACTION
(Flows and Load-Flow Factors in 1,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0.80+ (30)Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)x0.20+ (26)Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	492	17.8	11.0	829	9.1	2.4	1,126	2.7	22.7	5.9	1,000	2.5	3.9	11.2	11.2	4.0	14.1	13.8	22.7	3.9	6.6
Nov	27.0	721	19.5	7.8	1,256	9.8	2.4	2,039	4.9	16.8	4.8	1,000	2.5	4.0	5.1	5.1	1.2	5.0	6.5	10.4	2.3	3.7
Dec	39.8	728	29.0	5.6	1,717	9.6	6.8	1,846	12.6	27.4	6.8	1,000	2.6	4.2	2.4	2.4	1.1	5.6	4.3	8.8	1.8	3.3
Jan	34.7	1,127	39.1	5.9	2,225	13.1	6.0	2,346	14.1	22.8	11.9	1,000	2.4	3.8	1.6	1.6	3.6	12.3	5.6	13.4	2.0	4.4
Feb	282.9	194	54.9	16.2	2,091	33.9	9.1	1,036	9.4	257.6	11.6	1,000	2.3	3.7	1.7	1.7	5.9	20.1	7.4	19.5	2.5	6.0
Mar	851.9	121	103.1	23.1	1,131	26.1	20.6	787	16.2	808.2	60.7	1,000	3.0	4.8	2.6	2.6	9.6	30.7	11.1	28.8	4.1	9.4
Apr	607.1	170	103.2	24.9	1,125	28.0	13.7	1,805	24.7	568.5	50.5	1,000	13.4	19.9	2.4	2.4	8.2	26.1	16.2	34.3	7.8	14.1
May	204.0	277	56.5	19.8	789	15.6	6.7	5,303	35.5	177.5	5.4	1,000	8.6	13.0	5.1	5.1	7.5	23.7	15.3	30.8	5.9	11.0
Jun	120.6	301	36.3	17.6	549	9.7	7.7	1,705	13.1	95.3	13.5	1,000	0.6	1.0	7.4	7.4	9.0	23.5	13.5	25.2	3.5	6.7
Jul	63.5	646	41.0	23.4	698	16.3	5.7	1,664	9.5	34.4	15.2	1,000	0.2	0.3	5.4	5.4	9.5	24.3	12.0	23.9	3.1	6.2
Aug	59.0	564	33.3	25.5	739	18.8	4.8	813	3.9	28.7	10.5	1,000	0.0	0.0	3.6	3.6	10.8	26.7	11.6	24.3	2.8	6.0
Sep	58.4	288	16.8	17.1	726	12.4	0.7	1,158	0.8	40.6	3.6	1,000	0.2	0.3	6.5	6.5	4.3	13.1	8.8	15.8	2.2	4.1
TOTAL	2,385.0	231	550.4	197.9	1,023	202.5	86.6	1,703	147.4	2,100.5	200.4		38.3	58.9	55.0	55.0	74.7	225.4	126.2	257.9	41.8	81.3

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp{[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387} x Col (18) for Oct-Dec. TDS data used for Jan -Sep 1986.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0.8 + Col (31) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19) x 0.2 + Col (27) of table 6.

Table C21. (cont). TDS mass balance analysis : 1986 hydrology : Future without scenario.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY
WITHOUT PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS ADJUSTMENTS (h) NECESSARY TO MATCH MEASURED VALUES				RECONSTRUCTED SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION								
SALT SLOUGH		MUD SLOUGH		SALT SLOUGH		MUD SLOUGH					SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS (5)-(20) AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS (8)-(22) AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD-FLOW FACTOR (21)+(25)-(7) AFXppm	29 TDS LOAD (x1000) (28)x0.00136 Tons	30 TDS LOAD-FLOW FACTOR (23)+(27)-(10) AFXppm	31 TDS LOAD (x1000) (30)x0.00136 Tons	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(28)-(30) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+(24)]-(5) AF	36 TDS CONC. [(21)+(25)+(29)]+[(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)+(28)]-(7) AFXppm	38 FLOW [22]+(26)]-(8) AF	39 TDS CONC. [(23)+(27)+(31)]+[(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)+(30)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppb	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	10.8	14.7	2.3	3.2	36.1	17.8	492	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	0.1	0.1	1.9	2.6	-1.0	-1.4	27.0	19.5	721	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.3	1.3	5.0	5.0	0.5	0.6	-4.2	-5.7	39.8	29.0	728	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.3	0.3	4.0	4.0	0.6	0.8	-5.7	-7.8	34.7	39.1	1,127	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.8	8.8	6.6	6.6	-5.6	-7.6	3.1	4.3	282.9	54.9	194	NA	NA	NA	NA	NA	NA	NA	NA	NA
12.0	12.0	16.5	16.5	14.6	19.9	9.7	13.1	851.9	103.1	121	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.7	8.7	5.9	5.9	15.0	20.3	-4.7	-6.4	607.1	103.2	170	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.5	4.5	0.8	0.8	19.7	26.8	-23.8	-32.4	204.0	56.5	277	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.1	4.1	4.2	4.2	19.6	26.7	-2.3	-3.1	120.6	36.3	301	NA	NA	NA	NA	NA	NA	NA	NA	NA
11.4	11.4	2.6	2.6	18.9	25.7	-0.7	-0.9	63.5	41.0	646	NA	NA	NA	NA	NA	NA	NA	NA	NA
13.9	13.9	2.0	2.0	19.4	26.4	4.1	5.6	59.0	33.3	564	NA	NA	NA	NA	NA	NA	NA	NA	NA
8.3	8.3	-1.5	-1.5	11.7	16.0	1.8	2.4	58.4	16.8	288	NA	NA	NA	NA	NA	NA	NA	NA	NA
71.7	71.7	44.8	44.8	127.1	172.9	-21.3	-29.0	2,385.0	550.4	231	NA	NA	NA	NA	NA	NA	NA	NA	NA

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C22. TDS mass balance analysis : 1986 hydrology : Scenario 1.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30) Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26) Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	492	17.8	11.0	829	9.1	2.4	1,126	2.7	22.7	5.9	1,000	3.4	5.4	0.0	0.0	4.0	14.1	2.3	3.6	5.1	15.8
Nov	27.0	721	19.5	7.8	1,256	9.8	2.4	2,039	4.9	16.8	4.8	1,000	3.4	5.4	0.0	0.0	1.2	5.0	2.3	3.6	2.3	6.8
Dec	39.8	728	29.0	5.6	1,717	9.6	6.8	1,846	12.6	27.4	6.8	1,000	3.4	5.4	0.0	0.0	1.1	5.6	2.3	3.6	2.1	7.4
Jan	34.7	1,127	39.1	5.9	2,225	13.1	6.0	2,346	14.1	22.8	11.9	1,000	3.1	5.0	0.0	0.0	3.6	12.3	2.1	3.3	4.6	14.0
Feb	282.9	194	54.9	16.2	2,091	33.9	9.1	1,036	9.4	257.6	11.6	1,000	3.1	5.0	0.0	0.0	5.9	20.1	2.1	3.3	6.9	21.7
Mar	851.9	121	103.1	23.1	1,131	26.1	20.6	787	16.2	808.2	60.7	1,000	3.0	6.1	0.0	0.0	9.6	30.7	2.1	3.3	10.5	33.5
Apr	607.1	170	103.2	24.9	1,125	28.0	13.7	1,805	24.7	568.5	50.5	1,000	22.2	34.7	0.0	0.0	8.2	26.1	14.7	23.6	15.7	37.2
May	204.0	277	56.5	19.8	789	15.6	6.7	5,303	35.5	177.5	5.4	1,000	13.5	20.6	0.0	0.0	7.5	23.7	9.0	14.2	12.0	30.1
Jun	120.6	301	36.3	17.6	549	9.7	7.7	1,705	13.1	95.3	13.5	1,000	4.6	7.3	0.0	0.0	9.0	23.5	3.4	5.3	10.2	25.4
Jul	63.5	646	41.0	23.4	698	16.3	5.7	1,664	9.5	34.4	15.2	1,000	3.9	6.3	0.0	0.0	9.5	24.3	2.8	4.5	10.6	26.1
Aug	59.0	564	33.3	25.5	739	18.8	4.8	813	3.9	28.7	10.5	1,000	0.0	0.0	0.0	0.0	10.8	26.7	0.0	0.0	10.8	26.7
Sep	58.4	288	16.8	17.1	726	12.4	0.7	1,158	0.8	40.6	3.6	1,000	1.8	2.9	0.0	0.0	4.3	13.1	1.2	2.0	4.9	14.0
TOTAL	2,385.0	231	550.4	197.9	1,023	202.5	86.6	1,702	147.4	2,100.5	200.4		65.4	104.0	0.0	0.0	74.7	225.4	44.3	70.6	95.7	258.8

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp[[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387] x Col (18) for Oct-Dec. TDS data used for Jan -Sep 1986.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19)+ Col (27) of table 7.

Table C23. (cont.). TDS mass balance analysis : 1986 hydrology : Scenario 1.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C22 AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [24] Table C22 AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table C22 Tons	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	17.9	0.0	0.0	13.2	25.8	8.0	309	-11.5	1,264	-8.3	1.2	633	-1.5	-10.3	-9.8	-13.3
1.3	1.3	0.1	0.1	1.2	0.0	0.0	0.9	22.8	15.8	692	-4.2	1,374	-4.8	0.0	2,522	1.2	-4.2	-3.7	-5.0
1.3	1.3	5.0	5.0	-5.1	0.0	0.0	-3.8	38.1	27.9	733	-2.0	1,374	-4.7	0.3	2,276	3.6	-1.7	-1.1	-1.4
0.3	0.3	4.0	4.0	-7.0	0.0	0.0	-5.1	33.8	38.6	1,143	-3.5	1,512	-9.5	2.6	2,686	9.0	-0.9	-0.5	-0.6
8.8	8.8	6.6	6.6	-3.3	0.0	0.0	-2.4	282.0	54.4	193	-5.3	1,113	-21.7	4.4	2,277	21.3	-0.9	-0.4	-0.6
12.0	12.0	16.5	16.5	33.0	0.0	0.0	24.3	849.3	101.8	120	-9.0	1,087	-10.8	6.4	952	9.5	-2.6	-1.3	-1.8
8.7	8.7	5.9	5.9	13.9	0.0	0.0	10.2	613.5	115.6	189	-1.5	1,382	4.3	7.9	1,521	8.1	6.4	12.4	16.9
4.5	4.5	0.8	0.8	-5.6	0.0	0.0	-4.1	203.8	59.1	290	-6.3	1,388	3.1	6.1	2,736	-0.5	-0.2	2.6	3.6
4.1	4.1	4.2	4.2	23.6	0.0	0.0	17.4	117.2	35.2	300	-10.1	1,259	-0.2	6.7	849	-0.9	-3.4	-1.1	-1.5
11.4	11.4	2.6	2.6	24.8	0.0	0.0	18.2	61.8	41.6	673	-9.2	1,119	-0.4	7.5	795	1.0	-1.7	0.6	0.8
13.9	13.9	2.0	2.0	32.0	0.0	0.0	23.5	55.4	29.6	535	-11.6	1,000	-4.9	8.0	406	1.3	-3.6	-3.7	-5.0
8.3	8.3	-1.5	-1.5	18.4	0.0	0.0	13.5	53.5	12.9	241	-7.6	1,083	-2.1	2.7	-295	-1.8	-4.9	-3.9	-5.4
71.8	71.8	44.7	44.7	143.8	0.0	0.0	105.7	2,357.0	540.6	229	-81.8		-60.1	53.8		50.3	-28.0	-9.8	-13.4

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C24. TDS dilution requirements : 1986 hydrology : Scenario 1.

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	8.0	25.8	309	492	-9.616	0
Nov	0.0	15.8	22.8	692	721	-0.918	0
Dec	0.0	27.9	38.1	733	728	0.262	262
Jan	0.0	38.6	33.8	1,143	1,127	0.480	480
Feb	0.0	54.4	282.0	193	194	-1.461	0
Mar	0.0	101.8	849.3	120	121	-7.077	0
Apr	0.0	115.6	613.5	189	170	68.973	68,973
May	0.0	59.1	203.8	290	277	9.599	9,599
Jun	0.0	35.2	117.2	300	301	-0.391	0
Jul	0.0	41.6	61.8	673	646	2.587	2,587
Aug	0.0	29.6	55.4	535	564	-2.854	0
Sep	0.0	12.9	53.5	241	288	-8.761	0
TOTALS	0.0	540.5	2357.0			50.823	81,902

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Table C25. TDS mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 6 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30) Table 6 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26) Table 6 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	492	17.8	11.0	829	9.1	2.4	1,126	2.7	22.7	5.9	1,000	2.5	3.9	11.2	11.2	4.0	14.1	10.6	11.4	7.1	17.9
Nov	27.0	721	19.5	7.8	1,256	9.8	2.4	2,039	4.9	16.8	4.8	1,000	2.5	4.0	5.1	5.1	1.2	5.0	5.6	6.4	3.2	7.8
Dec	39.8	728	29.0	5.6	1,717	9.6	6.8	1,846	12.6	27.4	6.8	1,000	2.6	4.2	2.4	2.4	1.1	5.6	3.5	4.3	2.6	7.8
Jan	34.7	1,127	39.1	5.9	2,225	13.1	6.0	2,346	14.1	22.8	11.9	1,000	2.4	3.8	1.6	1.6	3.6	9.0	2.7	3.5	4.9	10.9
Feb	282.9	194	54.9	16.2	2,091	33.9	9.1	1,036	9.4	257.6	11.6	1,000	2.3	3.7	1.7	1.7	5.9	14.7	2.7	3.4	7.2	16.6
Mar	851.9	121	103.1	23.1	1,131	26.1	20.6	787	16.2	808.2	60.7	1,000	3.0	4.8	2.6	2.6	9.6	22.6	3.4	4.2	11.8	25.8
Apr	607.1	170	103.2	24.9	1,125	28.0	13.7	1,805	24.7	568.5	50.5	1,000	13.4	19.9	2.4	2.4	8.2	19.1	9.7	13.4	14.3	28.0
May	204.0	277	56.5	19.8	789	15.6	6.7	5,303	35.5	177.5	5.4	1,000	8.6	13.0	5.1	5.1	7.5	17.4	9.3	11.9	11.9	23.6
Jun	120.6	301	36.3	17.6	549	9.7	7.7	1,705	13.1	95.3	13.5	1,000	0.6	1.0	7.4	7.4	9.0	17.2	6.3	6.4	10.7	19.2
Jul	63.5	646	41.0	23.4	698	16.3	5.7	1,664	9.5	34.4	15.2	1,000	0.2	0.3	5.4	5.4	9.5	17.9	4.4	4.4	10.7	19.2
Aug	59.0	564	33.3	25.5	739	18.8	4.8	813	3.9	28.7	10.5	1,000	0.0	0.0	3.6	3.6	10.8	19.6	3.0	3.0	11.4	20.3
Sep	58.4	288	16.8	17.1	726	12.4	0.7	1,158	0.8	40.6	3.6	1,000	0.2	0.3	6.5	6.5	4.3	9.6	5.3	5.3	5.7	11.0
TOTAL	2,385.0	231	550.4	197.9	1,023	202.5	86.6	1,702	147.4	2,100.5	200.4		38.3	58.9	55.0	55.0	74.7	171.9	66.4	77.6	101.6	208.1

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 6.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp{[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387} x Col (18) for months Oct - Dec. Combined CRWRCB and SEI data was used for the months Jan - Sept.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of table 6.
(g) Calculated as Col (17) x 0.18 + Col (19)+ Col (27) of table 6.

Table C25. (cont.). TDS mass balance analysis : 1986 hydrology : Scenario 2.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C21 AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [24] Table C22 AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table C22 Tons	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)÷1000 ÷0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25) (30)]÷ [(20)+(24) ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27) (31)]÷ [(22)+(26) ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	17.9	0.0	0.0	13.2	36.1	17.7	491	-3.2	1,060	-0.5	3.2	719	0.5	0.0	0.0	-0.1
1.3	1.3	0.1	0.1	1.2	0.0	0.0	0.9	27.0	19.4	720	-0.9	1,116	-2.1	0.9	2,101	2.1	0.0	0.0	-0.1
1.3	1.3	5.0	5.0	-5.1	0.0	0.0	-3.8	39.8	29.0	730	-0.8	1,182	-4.0	0.8	2,174	4.0	0.0	0.1	0.1
0.3	0.3	4.0	4.0	-7.0	0.0	0.0	-5.1	34.7	35.8	1,032	-2.9	1,268	-9.3	2.9	2,259	6.0	0.0	-3.3	-4.5
8.8	8.8	6.6	6.6	-3.3	0.0	0.0	-2.4	282.9	49.4	175	-4.7	1,065	-21.6	4.7	1,856	16.2	0.0	-5.4	-7.4
12.0	12.0	16.5	16.5	33.0	0.0	0.0	24.3	851.9	94.9	111	-7.7	1,048	-9.9	7.7	637	1.8	0.0	-8.2	-11.1
8.7	8.7	5.9	5.9	13.9	0.0	0.0	10.2	6[illegible].1	96.3	159	-6.5	1,204	-5.9	6.5	1,170	-1.1	0.0	-7.0	-9.5
4.5	4.5	0.8	0.8	-5.6	0.0	0.0	-4.1	204.0	50.3	247	-6.0	1,188	0.7	6.0	2,244	-7.0	0.0	-6.2	-8.5
4.1	4.1	4.2	4.2	23.6	0.0	0.0	17.4	120.6	30.1	249	-7.2	1,012	0.8	7.2	407	-7.1	0.0	-6.2	-8.5
11.4	11.4	2.6	2.6	24.8	0.0	0.0	18.2	63.5	34.6	546	-7.6	1,000	-0.5	7.6	272	-5.9	0.0	-6.4	-8.7
13.9	13.9	2.0	2.0	32.0	0.0	0.0	23.5	59.0	26.1	443	-8.6	1,000	-2.0	8.6	-94	-5.2	0.0	-7.2	-9.7
8.3	8.3	-1.5	-1.5	18.4	0.0	0.0	13.5	58.4	13.2	227	-3.5	1,000	1.2	3.5	-957	-4.8	0.0	-3.6	-4.9
71.8	71.8	44.7	44.7	143.8	0.0	0.0	105.7	2,385.0	497.0	208	-59.7		-53.1	59.7		-0.3	0.0	-53.4	-72.7

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C26. TDS dilution requirements : 1986 hydrology : Scenario 2.

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project, assuming no Salt Slough diversions to wetlands.

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	17.7	36.1	491	492	-0.074	0
Nov	0.0	19.4	27.0	720	721	-0.038	0
Dec	0.0	29.0	39.8	730	728	0.109	109
Jan	0.0	35.8	34.7	1,032	1,127	-2.928	0
Feb	0.0	49.4	282.9	175	194	-27.850	0
Mar	0.0	94.9	851.9	111	121	-70.992	0
Apr	0.0	96.3	607.1	159	170	-39.515	0
May	0.0	50.3	204.0	247	277	-22.174	0
Jun	0.0	30.1	120.6	249	301	-20.904	0
Jul	0.0	34.6	63.5	546	646	-9.845	0
Aug	0.0	26.1	59.0	443	564	-12.680	0
Sep	0.0	13.2	58.4	227	288	-12.413	0
TOTALS	0.0	496.8	2385.0			-219.302	109

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Table C27. TDS mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

	SAN JOAQUIN R nr NEWMAN (a)			SALT SLOUGH at HWY 165 (a)			MUD SLOUGH at HWY 140 (a)			SJR nr NEWMAN Minus MUD & SALT SLOUGH			WETLAND RELEASES (b)		ZONE B AND C AGRICULTURAL DRAINAGE (c)		ZONE A AGRICULTURAL DRAINAGE (d)		RECONSTRUCTED SALT SLOUGH FLOWS and LOAD		RECONSTRUCTED MUD SLOUGH FLOWS and LOAD	
1 MO.	2 FLOW AF	3 WQ TDS ppm	4 LOAD FLOW FACTOR (2)x(3) AFXppm	5 FLOW AF	6 WQ TDS ppm	7 LOAD FLOW FACTOR (5)x(6) AFXppm	8 FLOW AF	9 WQ TDS ppm	10 LOAD FLOW FACTOR (8)x(9) AFXppm	11 FLOW (2)-(5)-[8] AF	12 LOAD FLOW FACTOR (4)-(7)-[10] (e) AFXppm	13 Ass. WQ TDS ppm	14 DRAINAGE VOLUME AF	15 LOAD FLOW FACTOR Table 7 AFXppm	16 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	17 LOAD FLOW FACTOR (16)x1.0 AFXppm	18 SURFACE AND SUBSURFACE DRAINAGE DISCHARGE AF	19 LOAD FLOW FACTOR AFXppm	20 FLOWS (16)x0.82+ (18)x0+ (30) Table 7 AF	21 LOAD FLOW FACTOR (f) AFXppm	22 FLOWS (16)x0.18+ (18)+ (26) Table 7 AF	23 LOAD FLOW FACTOR (g) AFXppm
Oct	36.1	492	17.8	11.0	829	9.1	2.4	1,126	2.7	22.7	5.9	1,000	3.4	5.4	11.2	11.2	4.0	14.1	11.5	12.8	7.1	17.9
Nov	27.0	721	19.5	7.8	1,256	9.8	2.4	2,039	4.9	16.8	4.8	1,000	3.4	5.4	5.1	5.1	1.2	5.0	6.5	7.8	3.2	7.8
Dec	39.8	728	29.0	5.6	1,717	9.6	6.8	1,846	12.6	27.4	6.8	1,000	3.3	5.4	2.4	2.4	1.1	5.6	4.3	5.6	2.5	7.8
Jan	34.7	1,127	39.1	5.9	2,225	13.1	6.0	2,346	14.1	22.8	11.9	1,000	3.1	5.0	1.6	1.6	3.6	9.0	3.4	4.6	4.9	10.9
Feb	282.9	194	54.9	16.2	2,091	33.9	9.1	1,036	9.4	257.6	11.6	1,000	3.1	5.0	1.7	1.7	5.9	14.7	3.5	4.7	7.2	16.6
Mar	851.9	121	103.1	23.1	1,131	26.1	20.6	787	16.2	808.2	60.7	1,000	3.0	6.1	2.6	2.6	9.6	22.6	4.2	5.5	11.0	25.8
Apr	607.1	170	103.2	24.9	1,125	28.0	13.7	1,805	24.7	568.5	50.5	1,000	22.2	34.7	2.4	2.4	8.2	19.1	16.7	25.6	16.1	28.0
May	204.0	277	56.5	19.8	789	15.6	6.7	5,303	35.5	177.5	5.4	1,000	13.5	20.6	5.1	5.1	7.5	17.4	13.2	18.4	12.9	23.6
Jun	120.6	301	36.3	17.6	549	9.7	7.7	1,705	13.1	95.3	13.5	1,000	4.6	7.3	7.4	7.4	9.0	17.2	9.5	11.4	11.5	19.2
Jul	63.5	646	41.0	23.4	698	16.3	5.7	1,664	9.5	34.4	15.2	1,000	3.9	6.3	5.4	5.4	9.5	17.9	7.2	8.9	11.6	19.2
Aug	59.0	564	33.3	25.5	739	18.8	4.8	813	3.9	28.7	10.5	1,000	0.0	0.0	3.6	3.6	10.8	19.6	3.0	3.0	11.4	20.3
Sep	58.4	288	16.8	17.1	726	12.4	0.7	1,158	0.8	40.6	3.6	1,000	1.8	2.9	6.5	6.5	4.3	9.6	6.5	7.3	6.1	11.0
TOTAL	2,385.0	231	550.4	197.9	1,023	202.5	86.6	1,702	147.4	2,100.5	200.4		65.3	104.0	55.0	55.0	74.7	171.9	89.4	115.7	105.6	208.1

(a) Stream flow and water quality data for the San Joaquin River and Salt and Mud Slough were obtained from Table A-1 and Table A-3, respectively.
(b) Wetland releases were obtained from Table 7.
(c) Agricultural drainage volume available for wetland use was assumed to be identical to those quantities identified in the SJVDP Final Report of Sept 1990. Monthly distribution was calculated as Col(13)-Col(2) of Tables 1-5.
(d) The volume and quality agricultural drainage discharged to the grasslands area from the drainage districts was collected by Summers Engineering and updated with CRWQCB data.
(e) TDS Load - Flow estimates were calculated as Exp{[Ln(Boron Load in lbs ÷ Col (18) ÷ 2000 ÷ 0.00136 ÷ 2.926] ÷ 1.387} x Col (18) for months Oct - Dec. Combined CRWRCB and SEI data was used for the months Jan - Sept.
(f) Calculated as Col (17) x 0.82 + Col (19) x 0 + Col (31) of table 7.
(g) Calculated as Col (17) x 0.18 + Col (19)+ Col (27) of table 7.

Table C27 (cont.). TDS mass balance analysis : 1986 hydrology : Scenario 3.

SAN JOAQUIN RIVER TDS CONCENTRATIONS - 1986 HYDROLOGY WITH PROPOSED ACTION WITHOUT INCREASED WETLAND USE

(Flows in 1,000s and Load-Flow Factors in 1,000,000s)

ADJUSTED LOW TDS FLOWS REQ. TO MATCH MEASURED VALUES				ASSUMED IN TRANSIT TDS REDUCTION (h)				SAN JOAQUIN RIVER nr NEWMAN CONDITIONS			EFFECT OF PROPOSED ACTION (Changes in flows and load-flow factors)								
SALT SLOUGH		MUD SLOUGH		SALT and MUD SLOUGH		SALT SLOUGH	MUD SLOUGH				SALT SLOUGH			MUD SLOUGH			SJR nr NEWMAN		
24 FLOWS [24] Table C22 AF	25 TDS LOAD-FLOW FACTOR (24) X 1.0 AFXppm	26 FLOWS [24] Table C22 AF	27 TDS LOAD-FLOW FACTOR (26) X 1.0 AFXppm	28 TDS LOAD (Future without condition (Col(29) +(31) of Table C22 Tons	29 TDS LOAD REDUCTION DUE TO USE OF SLD (28)x(1-1) Tons	30 TDS LOAD-FLOW FACTOR AFXppm	31 TDS LOAD-FLOW FACTOR (28)+1000 +0.00136 AFXppm	32 FLOW (11)+(20)+(22) (24)+(26) AF	33 LOAD FLOW FACTOR (12)+(21)+(23)+(25) (27)-(31) AFXppm	34 TDS CONC. (33)/(32) ppm	35 FLOW [(20)+ (24)]-(5) AF	36 TDS CONC. [(21)+(25)- (30)]+ [(20)+(24)] ppm	37 LOAD FLOW FACTOR [(21)+(25)- (30)]-(7) AFXppm	38 FLOW [22)+ (26)]-(8) AF	39 TDS CONC. [(23)+(27)- (31)]+ [(22)+(26)] ppm	40 LOAD FLOW FACTOR [(23)+(27)- (31)]-(10) AFXppm	41 FLOW (32)-(2) AF	42 LOAD FLOW FACTOR (33)-(4) AFXppm	43 TDS LOAD [(42)x1000 x0.00136] (x1000) Tons
-2.8	-2.8	-1.5	-1.5	17.9	0.0	0.0	13.2	37.0	19.2	518	-2.3	1,094	0.9	3.2	719	0.5	0.9	1.4	1.9
1.3	1.3	0.1	0.1	1.2	0.0	0.0	0.9	27.9	20.9	748	0.0	1,173	-0.7	0.9	2,101	2.1	0.9	1.4	1.9
1.3	1.3	5.0	5.0	-5.1	0.0	0.0	-3.8	40.5	30.3	749	0.0	1,242	-2.7	0.7	2,203	4.0	0.7	1.3	1.8
0.3	0.3	4.0	4.0	-7.0	0.0	0.0	-5.1	35.4	36.9	1,043	-2.2	1,331	-8.2	2.9	2,259	6.0	0.7	-2.2	-3.0
8.8	8.8	6.6	6.6	-3.3	0.0	0.0	-2.4	283.7	50.7	179	-3.9	1,100	-20.4	4.7	1,856	16.2	0.8	-4.2	-5.6
12.0	12.0	16.5	16.5	33.0	0.0	0.0	24.3	851.9	96.2	113	-6.9	1,076	-8.7	6.9	656	1.8	0.0	-6.9	-9.3
8.7	8.7	5.9	5.9	13.9	0.0	0.0	10.2	615.9	108.4	176	0.5	1,352	6.3	8.3	1,075	-1.1	8.8	5.2	7.1
4.5	4.5	0.8	0.8	-5.6	0.0	0.0	-4.1	208.9	56.8	272	-2.1	1,296	7.3	7.0	2,080	-7.0	4.9	0.3	0.5
4.1	4.1	4.2	4.2	23.6	0.0	0.0	17.4	124.6	35.1	282	-4.0	1,143	5.8	8.0	386	-7.1	4.0	-1.2	-1.6
11.4	11.4	2.6	2.6	24.8	0.0	0.0	18.2	67.2	39.1	582	-4.8	1,090	4.0	8.5	255	-5.9	3.7	-1.9	-2.6
13.9	13.9	2.0	2.0	32.0	0.0	0.0	23.5	59.0	26.1	443	-8.6	1,000	-2.0	8.6	-94	-5.2	0.0	-7.2	-9.7
8.3	8.3	-1.5	-1.5	18.4	0.0	0.0	13.5	60.0	15.2	254	-2.3	1,053	3.2	3.9	-873	-4.8	1.6	-1.6	-2.2
71.8	71.8	44.7	44.7	143.8	0.0	0.0	105.7	2,412.0	535.1	222	-36.7		-15.0	63.7		-0.3	27.0	-15.3	-20.9

(h) Theoretically salinity should not accumulate within the channels conveying drainage through the wetland area nor should their be any significant salt load flushed from these channels over an annual period.

Table C28. TDS dilution requirements : 1986 hydrology : Scenario 3

Dilution volume required to restore the SJR at Newman to the same TDS concentration without the project, assuming no Salt Slough diversions to wetlands. Assume additional wetland water supply.

MONTH	1 INCREASED TDS LOAD DUE TO USE OF THE S.L. DRAIN (col 29) tons	2 TDS LOAD FLOW FACTOR (col 33) (x 1000) KAF x ppm	3 FLOW NEWMAN KAF	4 TDS CONC WITH PROJECT ppm	5 TDS CONC W/O PROJECT ppm	6 DILUTION VOLUME TO MATCH FWO CONC.(a) AF x1000	7 DILUTION VOLUME TO MATCH FWO CONC.(b) AF
Oct	0.0	19.2	37.0	518	492	1.959	1,959
Nov	0.0	20.9	27.9	748	721	1.046	1,046
Dec	0.0	30.3	40.5	749	728	1.170	1,170
Jan	0.0	36.9	35.4	1,043	1,127	-2.641	0
Feb	0.0	50.7	283.7	179	194	-22.049	0
Mar	0.0	96.2	851.9	113	121	-56.793	0
Apr	0.0	108.4	615.9	176	170	21.866	21,866
May	0.0	56.8	208.9	272	277	-3.784	0
Jun	0.0	35.1	124.6	282	301	-7.891	0
Jul	0.0	39.1	67.2	582	646	-6.668	0
Aug	0.0	26.1	59.0	443	564	-12.680	0
Sep	0.0	15.2	60.0	254	288	-7.108	0
TOTALS	0.0	534.9	2412.0			-93.6	26,042

(a) annual dilution volume (including months with negative dilution volumes) - AF x 1000
(b) annual dilution volume (only those months where dilution is required) - AF

Assume dilution water contains 1600 ppm TDS

Appendix D

Flow, boron, selenium and TDS data collected by Summers Eng. Inc. and supplemented with CRWQCB data.

D1 - D2

Combi 9 Nov 90		Panoche Drainage District												Firebaugh, CCID and Broadview water districts										Pacheco Water District					
		flow SEI Total	Se SEI Avg	Se CRWQCB Avg	Se Avg. SEI + CRWQCB	Se SEI Avg	Se Avg. SEI + CRWQCB	B SEI Avg	B CRWQCB Avg	B Avg. SEI + CRWQCB	B SEI Avg	B Avg. SEI + CRWQCB	flow SEI Total	Se SEI Avg	Se CRWQCB Avg	Se Avg. SEI + CRWQCB	Se SEI Avg	Se Avg. SEI + CRWQCB	B SEI Avg	B CRWQCB Avg	B Avg. SEI + CRWQCB	B SEI Avg	B Avg. SEI + CRWQCB	flow SEI Total	Se SEI Avg	Se CRWQCB Avg	Se Avg. SEI + CRWQCB	Se SEI Avg	Se Avg. SEI + CRWQCB
		AF	ug/l	ug/l	ug/l	lbs	lbs	mg/l	mg/l	mg/l	lbs	lbs	AF	ug/l	ug/l	ug/l	lbs	lbs	mg/l	mg/l	mg/l	lbs	lbs	AF	ug/l	ug/l	ug/l	lbs	lbs
1985	Oct	920	63		63	158	158	3.0		3.0	7457	7507	3008	57		57	466	466	5.0		5.0	40909	40909	incomplete data					0
	Nov	1168	60		60	191	191	5.7		5.7	18013	18109	50	44		44	6	6	3.8		3.8	522	522						0
	Dec	1055	55		55	158	158	7.8		7.8	22325	22383																	0
1986	Jan	1478	60		60	241	241	4.8		4.8	19297	19297	1821	52		52	257	258	6.9		6.9	34077	34077	267	60	48	54	44	39
	Feb	2233	56		56	340	340	5.8		5.8	35349	35228	2926	50		50	398	398	4.1		4.1	32710	32710	626	7	45	26	12	44
	Mar	2594	61		61	430	430	5.4		5.4	38383	38101	5994	56		56	913	913	4.9		4.9	79725	79725	570	51	51	51	79	79
	Apr	3618	53	62	58	521	566	5.1	7.1	6.1	50090	59981	2818	61		61	467	468	3.5		3.5	26827	26827	1154	70	64	67	220	210
	May	3852	51	56	54	534	561	5.9	6.0	6.0	61922	62393	2219	53		53	320	320	4.4		4.4	26557	26557	1230	74	56	65	247	217
	Jun	4225	39	51	45	448	517	4.4	6.2	5.3	50220	60735	2987	33		33	268	268	2.5		2.5	19987	19987	1194	61	57	59	198	192
	Jul	4378	40		40	478	478	1.7		1.7	20244	20244	3360	28		28	256	256	2.3		2.3	21203	21203	1343	44		44	161	161
	Aug	3973	44	55	50	475	535	4.2	5.7	4.9	44847	53222	5094	33		33	457	457	3.7		3.7	51682	51682	1204	53	37	45	173	147
	Sep	2079	60	55	58	339	325	6.0	7.0	6.5	33929	36757	2117	53		53	305	305	4.4		4.4	25336	25336	68	55	27	41	10	8
	Oct	1210	66		66	217	217	5.0		5.0	16357	16456	3008	74		74	605	605	5.0		5.0	40909	40909	340	38		38	35	35
	Nov	1993	40	52	46	217	249	3.5	4.6	4.0	18865	21901	3785	1		1	10	10	2.8		2.8	28415	28415	296	42	42	42	34	34
	Dec	1624	75	74	75	331	329	4.0	6.0	5.0	17446	21976	2400	51		51	333	333	2.3		2.3	14949	14949	326	65	77	71	58	63
	CYr	33257				4570	4787				406952	446290	38529				4589	4591				402377	402377	8618				1270	1230
	WYr	31573				4311	4498				402078	433956	32394				4113	4115				359536	359536					1144	1098
	Tld																												
1987	Jan	1922	78		78	405	408	5.1		5.1	26662	26662	1412	9		9	35	35	3.0		3.0	11484	11484	369	74	65	70	74	70
	Feb	2648	83	80	72	598	515	6.7	7.8	7.3	48257	52219	2077	120		120	678	678	6.1		6.1	34462	34462	492	43	61	52	58	70
	Mar	3062	72		72	599	600	6.5		6.5	53720	54136	2200	110		110	658	658	6.0		6.0	35844	35844	1127	60		60	184	184
	Apr	2874	52	83	68	408	528	5.0	9.4	7.2	39086	56284	2833	45	67	56	347	432	2.5	4.0	3.3	19264	25044	928	61	58	60	154	150
	May	3244	40	44	42	353	371	4.6	5.0	4.8	40412	42265	3442	46	38	42	430	393	3.2	2.3	2.8	29959	25746	948	43	5	24	111	62
	Jun	4443	40	50	45	483	544	3.5	5.8	4.6	41935	56014	3832	38	40	39	396	406	3.9	2.9	3.4	40546	35386	847	60	49	55	138	126
	Jul	5042	29	38	34	398	459	2.5	4.9	3.7	34286	50743	4219	46	40	43	528	493	3.1	3.0	3.1	35689	35058	1237	70	56	63	235	212
	Aug	4399	42		42	502	503	4.9		4.9	58032	58630	4390	36		36	430	430	2.6		2.6	30927	31046	939	55		55	140	140
	Sep	2380	41	39	40	265	259	7.5	5.5	6.5	48552	42078	2773	43	35	39	320	292	6.9	2.9	4.9	52345	37109	558	70	6	38	106	58
	Oct	1321	50	69	60	180	214	8.0	8.7	8.4	28745	30003	2142	45	50	48	262	277	2.8	3.3	3.0	16080	17654	36		56	56	9	5
	Nov	1158	50	42	46	157	145	5.8	8.8	7.3	18269	22993	1204	44	47	46	144	149	3.1	3.8	3.4	10087	11266	0	66		66	0	0
	Dec	1843	57	55	56	288	281	3.9	5.2	4.6	19601	22834	179	128	187	158	62	77	11.8	9.2	10.5	57.5	5112	149	63		63	26	26
	CYr	34336				4632	4825				457556	514861	30703				4289	4320				322432	305210	7630				1236	1102
	WYr	34841				4774	4981				443612	499364	36371				4769	4766				374793	355452	8407				1327	1203
	Tld																												
1988	Jan	2146	78	109	94	455	546	6.3	8.5	7.4	36774	43195	687	152	102	127	284	237	11.7	4.7	8.2	21863	15323	377	61	56	59	63	60
	Feb	2866	59		59	460	460	6.3		6.3	49112	49112	2344	60		60	382	383	3.3		3.3	21040	21040	476	60		60	78	78
	Mar	3120	72	60	66	611	560	6.5	6.8	6.6	54737	56010	2165	98	82	90	577	530	5.2	5.0	5.1	30857	30151	1169	72	74	73	229	232
	Apr	2356	100	59	80	641	509	6.5		6.5	41654	41654	2151	62		62	363	363	3.6		3.6	21297	21063	620	60		60	101	101
	May	2634	55	54	55	394	390	5.8	7.4	6.6	41554	47286	2778	52	64	58	393	438	3.1	4.3	3.7	23197	27844	126	42		42	26	14
	Jun	3753	65	45	55	663	561	4.7	5.4	5.1	47978	51551	3001	35	40	38	286	306	3.1	3.1	3.1	25468	25386	120	35	29	32	11	10
	Jul	4413	38	46	42	456	504	4.0		4.0	48013	48013	3525	45		45	431	431	3.2		3.2	30298	30682	540	60		60	10	88
	Aug	3991	38	34	36	412	391	5.3	3.9	4.6	57426	49881	3874	35	38	36	369	374	2.6	2.5	2.6	27397	26870	532	100	21	61	11	88
	Sep	1974	55	49	52	295	279	5.5	4.9	5.2	29263	27786	1991	25	48	37	135	198	2.3	3.5	2.9	12510	15732	295	35		35	14	28
	Oct	789	55	118	87	118	186	6.3	7.6	7.0	13520	14915	856	70	52	61	163	142	5.2	3.7	4.5	12200	10408	150	95	81	88	39	36
	Nov	801	55	104	80	120	173	6.5	8.4	7.5	14162	18231	402	45	27	36	49	39	3.6	1.8	2.7	3925	2947	203	90	95	93	50	51
	Dec	1301	95	68	82	336	288	7.1	6.4	6.7	25054	23851	125	70	68	69	24	23	12.0	6.7	9.4	4080	3179	182	65	84	75	32	37
	CYr	30144				4961	4849				459247	469486	23899				3455	3465				234133	230624	3669				663	823
	WYr	31575				5009	4841				473125	490318	26041				3688	3763				245839	248121	3319				578	731
	Tld																												
1989	Jan	1617	75	79	77	330	339	7.4	6.5	7.0	32547	30568	988	29	119	74	78	199	2.0	7.0	4.5	5375	12093	186	100	98	99	51	50
	Feb	3209	60	69	65	523	563	6.2	6.0	6.1	54117	53244	1897	70	44	57	361	294	3.7	2.2	3.0	19091	15222	583	80	7	44	127	69
	Mar	2507	110	105	108	750	733	7.1	7.5	7.3	48415	49779	1578	75	127	101	322	434	5.0	5.6	5.3	21461	22748	432	100	117	109	117	127
	Apr	2414	90	92	91	591	598	7.7	7.2	7.5	50559	48917	2228	50	74	62	303	376	3.8	4.5	4.2	23029	25150	745	110	96	103	223	209
	May	2293	95	53	74	592	462	6.9	6.8	6.9	43035	42723	2429	50	61	56	330	367	3.7	3.5	3.6	24445	23765	585	110	99	105	175	166
	Jun	2430	40		40	284	264	5.1		5.1	33709	33709	3075	55	38	47	460	389	4.2	4.0	4.1	35129	34292	672	75	114	95	137	173
	Jul	2616	40	24	32	285	228	5.1	5.3	5.2	36289	37001	3809	35	47	41	362	425	3.4	4.0	3.7	35228	38334	419	100	69	85	114	96
	Aug	2458	12	14	13	80	87	4.9	5.7	5.3	32760	35435	3616	29	35	32	285	315	2.8	2.5	2.7	27539	26064	601	50	105	78	82	127
	Sep	1640	46	49	48	205	212	6.6	6.1	6.4	29441	28326	1623	60	30	45	265	199	5.5	3.2	4.4	24280	19203	364	60	72	66	59	65
	Oct	827	150	152	151	337	340	8.3	9.7	9.0	18670	20245	799	30	52	41	65	[illegible]	3.7	5.4	4.6	8041	9888	60	67	67	67	11	11
	Nov	1042	120	82	101	340	286	8.6	7.8	8.2	24374	23241	1097	31	41	36	90	107	2.4	4.5	3.5	6965	10294	0	0	39	39	0	0
	Dec	1822	30	69	50	106	245	6.1	6.1	6.1	21586	30231	678	50	78	64	0	118	4.3	4.3	4.3	0	7884	0	0	26	26	0	0
	CYr	24354				4403	4356				425503	433418	23109				2921	3311				230581	244958	4647				1096	1094
	WYr	24075				4194	4132				413608	414699	22626				3002	3201				235781	233425	5122				1205	1206
	Tld																												

Conversion factor - 2.179 x 10**-3 AF - ug/l to lbs Se

ug/l * 0.0027 = lbs/AF
mg/l * 2.72 = lbs/AF

All flow SEI Total	All EC SEI Avg	Updated TDS EC CRWQCB Avg	All EC Avg. SEI + CRWQCB	Updated TDS TDS Avg. SEI + CRWQCB	TDS Avg. SEI + CRWQCB
AF	mmho	mmho	mmho	tons	ppm
3964					
1220					
1055					
3619	3.15		3.15	12321	2503
5941	3.65		3.65	20080	2485
9620	3.79		3.79	30728	2349
8234	3.40	3.60	3.50	26100	2331
7511	3.48	3.70	3.59	23720	2322
9019	2.82	3.30	3.06	23474	1914
9459	3.22		3.22	24282	1888
10821	2.79	3.20	3.00	26726	1816
4346	3.74	3.60	3.67	13129	2221
4626	3.09		3.09	13313	2116
6077	2.28		2.28	11985	1450
4350	3.52		3.52	11534	1950
83623				237392	
74809				200560	
3748	3.40		3.40	12359	2425
5557	4.52	3.97	4.25	23411	3098
7308	4.12		4.12	31627	3182
7436	3.71	4.31	4.01	25449	2516
7942	3.15	2.93	3.04	22107	2047
10084	3.01	3.40	3.21	29427	2146
11343	3.04	3.05	3.05	31355	2033
10206	2.90		2.90	25927	1868
5711	3.43	3.12	3.28	15633	2013
3499	3.96	4.75	4.36	11073	2327
2362	3.82	4.55	4.19	8433	2625
2171	3.03	3.46	3.25	7468	2529
77367				244269	
84388				254127	
3333		5.30	5.30	16833	3714
6246	4.30		4.30	22523	2651
7258	4.20	3.92	4.06	28504	2888
5555	4.65		4.65	21672	2869
5982		4.25	4.25	22198	2729
7857	4.00	3.28	3.64	25245	2363
8992	2.93		2.93	26108	2135
9404	3.29	2.90	3.10	27562	2155
4412	3.51	3.38	3.45	12646	2108
1803	3.53	5.09	4.31	6734	2746
1406	3.66	4.84	4.25	4986	2608
1608	4.49	3.89	4.19	6540	2991
63856				221551	
67071				230265	
2821	4.60	4.18	4.39	11055	2881
6004	3.90	4.22	4.06	22545	2761
4704	4.80	4.70	4.75	21444	3352
5838	5.10	4.46	4.78	24534	3090
5642	5.00	3.92	4.46	21760	2836
6983	3.40		3.40	23492	2474
7348	3.60	3.02	3.31	22018	2203
6777	3.70	3.22	3.46	18346	1991
3688	3.50	3.65	3.58	11503	2293
1686	4.70	5.76	5.23	6756	2946
2143	4.70	4.75	4.73	7361	2526
2726	3.30	4.15	3.73	9925	2677
56360				200739	
54622				194957	

comb1
9-Nov-90

Panoche Drainage District

Year	Month	flow SEI Total (AF)	EC SEI Avg (mmho)	EC CRWQCB Avg (mmho)	EC Avg. SEI + CRWQCB (mmho)	TDS Avg. SEI + CRWQCB (tons)	TDS (ppm)
1985	Oct	920					
	Nov	1168					
	Dec	1055					
1986	Jan	1478	3.15		3.15	4430	2204
	Feb	2233	3.65		3.65	7756	2554
	Mar	2594	3.79		3.79	9355	2652
	Apr	3618	3.40	3.60	3.50	12050	2449
	May	3852	3.48	3.70	3.59	13159	2512
	Jun	4225	2.82	3.30	3.06	12303	2141
	Jul	4378	3.22		3.22	13415	2253
	Aug	3973	2.79	3.20	3.00	11323	2096
	Sep	2079	3.74	3.60	3.67	7261	2568
	Oct	1210	3.09		3.09	3558	2162
	Nov	1993	2.28		2.28	4324	1595
	Dec	1624	3.52		3.52	5440	2463
	CYr	33257				104374	
	WYr	31573				91052	
1987	Jan	1922	3.40		3.40	6219	2379
	Feb	2648	4.52	3.97	4.25	10697	2970
	Mar	3062	4.12		4.12	12005	2883
	Apr	2874	3.71	4.31	4.01	10967	2808
	May	3244	3.15	2.93	3.04	10507	2382
	Jun	4443	3.01	3.40	3.21	13551	2243
	Jul	5042	3.04	3.05	3.05	14810	2131
	Aug	4399	2.90		2.90	12140	2029
	Sep	2380	3.43	3.12	3.28	7417	2291
	Oct	1321	3.96	4.75	4.36	5475	3047
	Nov	1158	3.82	4.55	4.19	4612	2928
	Dec	1843	3.03	3.46	3.25	5691	2271
	CYr	34336				113891	
	WYr	34841				111435	
1988	Jan	2146		5.30	5.30	10823	3708
	Feb	2866	4.30		4.30	11727	3009
	Mar	3120	4.20	3.92	4.06	12054	2841
	Apr	2356	4.65		4.65	10425	3254
	May	2634		4.25	4.25	10653	2974
	Jun	3753	4.00	3.28	3.64	13000	2547
	Jul	4413	2.93		2.93	12304	2050
	Aug	3991	3.29	2.90	3.10	11754	2166
	Sep	1974	3.51	3.38	3.45	6471	2410
	Oct	789	3.53	5.09	4.31	3236	3016
	Nov	801	3.66	4.84	4.25	3239	2973
	Dec	1301	4.49	3.89	4.19	5187	2932
	CYr	30144				110873	
	WYr	31575				114989	
1989	Jan	1617	4.60	4.16	4.39	6755	3072
	Feb	3209	3.90	4.22	4.06	12398	2841
	Mar	2507	4.80	4.70	4.75	11332	3324
	Apr	2414	5.10	4.46	4.78	10980	3344
	May	2293	5.00	3.92	4.46	9732	3121
	Jun	2430	3.40		3.40	7862	2379
	Jul	2616	3.60	3.02	3.31	8240	2316
	Aug	2458	3.70	3.22	3.46	8093	2421
	Sep	1640	3.50	3.65	3.58	5579	2501
	Oct	827	4.70	5.76	5.23	4116	3660
	Nov	1042	4.70	4.75	4.73	4685	3306
	Dec	1822	3.30	4.15	3.73	6458	2606
	CYr	24875				96230	
	WYr	24075				92633	

Firebaugh, CCID

Year	Month	flow SEI Total (AF)	EC SEI Avg (mmho)	EC CRWQCB Avg (mmho)	EC Avg. SEI + CRWQCB (mmho)	TDS Avg. SEI + CRWQCB (tons)	TDS Avg. SEI + CRWQCB (ppm)
1985	Oct	3008					
	Nov	50					
	Dec	0					
1986	Jan	1821	3.87		3.87	6706	2708
	Feb	2926	3.52		3.52	9801	2463
	Mar	5994	3.24		3.24	18481	2267
	Apr	2818	2.72		2.72	7294	1903
	May	2219	2.57		2.57	5427	1798
	Jun	2987	1.96		1.96	5571	1371
	Jul	3360	1.83		1.83	5851	1280
	Aug	5094	2.26		2.26	10955	1581
	Sep	2117	2.65		2.65	5339	1854
	Oct	3008	3.04		3.04	8702	2127
	Nov	3785	1.91		1.91	6879	1336
	Dec	2400	2.19		2.19	5002	1532
	CYr	38529				96008	
	WYr	32394				75425	
1987	Jan	1412	3.46		3.46	4649	2421
	Feb	2077	4.69		4.69	9270	3282
	Mar	2200	5.15		5.15	10782	3604
	Apr	2833	2.87	3.08	2.98	8020	2082
	May	3442	2.55	2.14	2.35	7681	1641
	Jun	3832	2.84	2.32	2.58	9408	1805
	Jul	4219	2.63	2.35	2.49	9997	1742
	Aug	4390	2.23		2.23	9316	1560
	Sep	2773	2.43	2.31	2.37	6254	1658
	Oct	2142	2.61	2.76	2.69	5473	1879
	Nov	1204	3.07	3.60	3.34	3821	2334
	Dec	179	7.49	7.51	7.50	1278	5250
	CYr	30703				85949	
	WYr	36371				95960	
1988	Jan	687	7.79	4.73	6.26	4091	4379
	Feb	2344	3.22		3.22	7182	2253
	Mar	2165	4.28	3.60	3.94	8117	2757
	Apr	2151	3.47		3.47	7103	2428
	May	2778	2.93	3.85	3.39	8982	2372
	Jun	3001	2.76	2.63	2.69	7689	1884
	Jul	3525	2.92		2.92	9795	2043
	Aug	3874	2.52	2.45	2.49	9161	1739
	Sep	1991	2.00	2.86	2.43	4604	1700
	Oct	856	3.59	3.06	3.33	2708	2326
	Nov	402		2.05	2.05	784	1434
	Dec	125	6.50	4.77	5.64	670	3941
	CYr	23899				70866	
	WYr	26041				77276	
1989	Jan	988	1.90	4.90	3.40	3197	2379
	Feb	1897	3.90	2.70	3.30	5957	2309
	Mar	1578	4.20	5.10	4.65	6983	3254
	Apr	2228	3.50	3.65	3.58	7580	2502
	May	2429	3.10	3.11	3.11	7177	2173
	Jun	3075	3.20	2.86	3.03	8866	2120
	Jul	3809	2.70	2.90	2.80	10149	1959
	Aug	3616	2.10	2.06	2.08	7157	1455
	Sep	1623	3.00	2.40	2.70	4170	1889
	Oct	799	2.60	3.73	3.17	2406	2214
	Nov	1097	1.90	3.19	2.55	2657	1781
	Dec	678	3.80	4.26	4.03	2598	2818
	CYr	23817				68897	
	WYr	22628				65398	

Pacheco Water District

Year	Month	flow SEI Total (AF)	EC SEI Avg (mmho)	EC CRWQCB Avg (mmho)	EC Avg. SEI + CRWQCB (mmho)	TDS Avg. SEI + CRWQCB (tons)	TDS Avg. SEI + CRWQCB (ppm)
1985	Oct						
	Nov						
	Dec						
1986	Jan	267	3.22	3.65	3.44	873	2404
	Feb	626	3.03	2.80	2.92	1736	2039
	Mar	570	2.99	3.10	3.05	1652	2131
	Apr	1154	3.90	3.80	3.85	4228	2694
	May	1230	3.87	3.50	3.69	4313	2578
	Jun	1194	2.96	2.98	2.97	3375	2078
	Jul	1343	2.88		2.88	3681	2015
	Aug	1204	3.17	2.80	2.99	3420	2089
	Sep	68	2.91	3.28	3.10	200	2163
	Oct	340	2.64		2.64	854	1847
	Nov	296	2.70		2.70	761	1890
	Dec	326	3.52		3.52	1092	2463
	CYr	8618				26185	
	WYr	7656				23478	
1987	Jan	369	3.19	3.70	3.45	1210	2411
	Feb	492	3.52	3.70	3.61	1690	2528
	Mar	1127	3.97		3.97	4258	2778
	Apr	928	3.20	3.39	3.30	2910	2306
	May	948	3.04	2.90	2.97	2679	2078
	Jun	847	4.02	3.18	3.60	2902	2519
	Jul	1237	4.08	3.30	3.69	4344	2582
	Aug	939	3.41		3.41	3047	2386
	Sep	558	3.86	3.53	3.70	1962	2585
	Oct	36		3.65	1.83	125	2553
	Nov	0	3.63		3.63	0	
	Dec	149	3.52		3.52	499	2462
	CYr	7630				25626	
	WYr	8407				27709	
1988	Jan	377	3.40	3.50	3.45	1238	2415
	Feb	476	3.85		3.85	1744	2694
	Mar	1169	4.44	4.62	4.53	5039	3170
	Apr	620	4.45		4.45	2625	3113
	May	126	4.28		4.28	513	2994
	Jun	120	4.11	3.50	3.81	435	2665
	Jul	540	4.66		4.66	2395	3261
	Aug	532	6.45	3.25	4.85	2455	3393
	Sep	295	3.10		3.10	870	2168
	Oct	150	5.38	5.37	5.38	767	3760
	Nov	203	4.88	5.09	4.99	963	3488
	Dec	182	3.00	4.89	3.95	683	2759
	CYr	4790				19727	
	WYr	4440				17938	
1989	Jan	186	4.70	5.42	5.06	896	3542
	Feb	583	5.80	4.15	4.98	2760	3481
	Mar	432	5.10	5.82	5.46	2245	3821
	Apr	745	5.60	5.12	5.36	3800	3750
	May	585	6.00	5.47	5.74	3193	4013
	Jun	672	4.20	6.28	5.24	3351	3667
	Jul	419	5.10	4.42	4.76	1898	3331
	Aug	601	3.40	6.15	4.78	2731	3341
	Sep	364	4.20	4.91	4.56	1578	3188
	Oct	60	4.00	4.19	4.10	234	2868
	Nov	0		3.90	3.90	0	
	Dec	0		3.06	3.06	0	
	CYr	4647				22686	
	WYr	5122				24865	

Charleston Water District

Year	Month	flow SEI Total (AF)	EC SEI Avg (mmho)	EC CRWQCB Avg (mmho)	EC Avg. SEI + CRWQCB (mmho)	TDS Avg. SEI + CRWQCB (tons)	TDS Avg. SEI + CRWQCB (ppm)
1985	Oct	36					
	Nov	2					
	Dec	0					
1986	Jan	53	6.37	6.00	6.19	312	4329
	Feb	156	5.30	5.30	5.30	787	3709
	Mar	462	3.44	2.20	2.82	1240	1974
	Apr	644	4.45	3.80	4.13	2528	2886
	May	210	2.82	5.40	4.11	821	2875
	Jun	613	4.03	3.60	3.82	2225	2669
	Jul	378	3.71		3.71	1335	2597
	Aug	550	2.23	1.70	1.97	1028	1374
	Sep	82	4.02	4.40	4.21	329	2950
	Oct	68	3.07		3.07	199	2152
	Nov	3	7.20		7.20	21	5147
	Dec	0	7.00		7.00	0	
	CYr	3219				10825	
	WYr	3186				10605	
1987	Jan	45	6.57		6.57	281	4592
	Feb	340	5.49	5.35	5.42	1754	3793
	Mar	919	5.24		5.24	4582	3666
	Apr	801		4.66	4.66	3552	3261
	May	308	3.85	4.61	4.23	1240	2960
	Jun	962	4.18	3.61	3.90	3566	2726
	Jul	845	2.53	3.45	2.99	2404	2092
	Aug	478	3.13		3.13	1424	2190
	Sep	0		3.32	3.32	0	
	Oct	0		2.73	2.73	0	
	Nov	0		4.55	4.55	0	
	Dec	0		10.22	10.22	0	
	CYr	4698				18803	
	WYr	4769				19023	
1988	Jan	123	6.03	5.60	5.82	681	4071
	Feb	560	3.51		3.51	1870	2455
	Mar	804	4.31	4.30	4.31	3294	3013
	Apr	428	3.73		3.73	1519	2610
	May	444	4.80	5.00	4.90	2070	3428
	Jun	983	4.61	4.20	4.41	4121	3083
	Jul	514	3.30		3.30	1614	2309
	Aug	1007	4.30	4.45	4.38	4192	3061
	Sep	152	4.49	5.20	4.85	701	3391
	Oct	8	3.06	2.94	3.00	23	2114
	Nov	0	7.30	3.55	5.43	0	
	Dec	0	9.27	5.33	7.30	0	
	CYr	5023				20085	
	WYr	5015				20062	
1989	Jan	30	8.70	5.81	7.25	207	5074
	Feb	315	4.64	4.90	4.77	1430	3338
	Mar	187	5.61	4.33	4.97	884	3476
	Apr	451	5.00	5.13	5.07	2174	3544
	May	335	4.94	5.46	5.20	1658	3639
	Jun	806	4.50	4.40	3.40	3413	3114
	Jul	504	4.04	3.18	3.61	1731	2525
	Aug	102		3.76	1.88	365	2631
	Sep	61	2.68	3.40	3.04	176	2122
	Oct	0	4.78	4.72	4.75	0	
	Nov	4	5.19	4.70	4.95	19	3493
	Dec	226	5.20	2.88	4.04	869	2827
	CYr	3021				12926	
	WYr	2799				12061	

Conversion factor - ppm TDS = tons/AF * 2000 lbs/ton / 2.72

B SEI Avg	B CRWCCB Avg	B Avg. SEI + CRWCCB	B SEI Avg	B Avg. SEI + CRWCCB	########### Flow SEI Total	Se SEI Avg	Se CRWCCB Avg	Charleston Se Avg. SEI + CRWCCB	Water District Se SEI Avg	Se Avg. SEI + CRWCCB	########### B SEI Avg	B CRWCCB Avg	B Avg. SEI + CRWCCB	B SEI Avg	B Avg. SEI + CRWCCB	All Flow	All Se	Updated Se total load CRWCCB + SEI data	All B	Updated B total load CRWCCB + SEI data
mg/l	mg/l	mg/l	lbs	lbs	AF	ug/l	ug/l	ug/l	lbs	lbs	mg/l	mg/l	mg/l	lbs	lbs	AF	lbs	lbs	lbs	lbs
	incomplete data			0	36	21		21	2	2	2.8		2.8	269	274	####	626	626	48635	48690
				0	2	4		4	0	0	6.8		6.8	37	37	1220	197	197	18572	18668
				0	0	0			0	0				0	0	1055	158	158	22325	22383
3.4	4.7	4.1	2498	2956	53	9	114	62	1	9	6.9	6.4	6.6	992	957	3619	543	547	56864	57287
2.9	3.2	3.1	4972	5210	156	74	92	83	31	35	5.0	5.7	5.4	2122	2270	5941	781	818	75153	75419
2.8	3.2	3.0	4264	4612	462	13	36	25	16	31	3.6	1.8	2.7	4524	3393	9620	1438	1454	126895	125831
4.5	5.5	5.0	14125	15616	644	80	97	89	140	155	3.3	3.8	3.6	5781	6218	8234	1348	1399	96823	108642
4.9	4.0	4.5	16393	14888	210	15	100	58	9	33	2.9	5.0	4.0	1679	2268	7511	1110	1131	106551	106106
2.6	3.5	3.0	8347	9857	613	44	75	60	73	99	3.2	3.8	3.5	5302	5819	9019	987	1076	83855	96398
3.4		3.4	12420	12420	378	60		60	62	62	3.8		3.8	3866	3907	9459	954	955	57733	57774
4.5	3.9	4.2	14704	13738	550	25	23	24	37	36	1.6	1.5	1.6	2424	2334	10821	1143	1175	113657	120976
4.5	5.0	4.7	838	877	82	39	65	53	9	12	4.4	4.9	4.7	984	1038	4346	663	650	61087	64008
2.9		2.9	2719	2682	68	7		7	1	1	3.6		3.6	673	666	4626	859	859	60658	60713
3.0	3.6	3.3	2431	2665	3	4	32	18	0	0	3.7	1.9	2.8	30	23	6077	261	294	49741	53003
4.2	4.1	4.2	3751	3693	0	0	97	97	0	0		5.5	5.5	0	0	4350	722	725	36148	40618
			87462	89214	3219				380	473				28376	28893	83623	10810	11081	925167	966774
			78561	80174	3186				381	474				27978	28516	67153	9949	10184	868153	902181
4.0	3.9	3.9	3975	3944	45	5	124	65	1	8	6.6	6.0	6.3	803	769	3748	514	520	42923	42859
3.1	4.4	3.8	4149	5018	340	93	114	104	86	96	4.6	5.2	4.9	4263	4536	5557	1419	1358	91131	96235
3.2		3.2	9871	9809	919	92		92	230	230	4.0		4.0	10024	9999	7308	1671	1672	109458	109788
2.9	3.5	3.2	7320	8077	801	77	82	80	168	173	3.4	4.3	3.9	7408	8388	7436	1075	1283	73079	97794
3.4	3.0	3.2	8793	8264	308	75	102	89	63	74	3.2	4.1	3.6	2656	3045	7942	957	900	81820	79321
4.5	3.6	4.1	10459	9377	962	65	65	65	170	170	4.2	3.5	3.9	11095	10126	10084	1187	1246	104034	110903
3.8	3.5	3.6	12752	12264	845	52	6	29	119	67	1.8	5.2	3.5	4229	8090	11343	1280	1232	86956	106155
3.6		3.6	9169	9195	478	50		50	65	65	2.3		2.3	2925	2990	10206	1137	1138	101053	101861
3.9	3.9	3.9	5889	5904	0		47	47	0	0		3.0	3.0	0	0	5711	692	609	106786	85092
	4.4	4.4	683	431	0		31	31	0	0		2.4	2.4	0	0	3499	451	496	45509	48087
3.4		3.4	0	0	0		63	63	0	0		4.7	4.7	0	0	2362	301	294	28355	34259
3.2		3.2	1216	1297	0		28	28	0	0		2.4	2.4	0	0	2171	374	383	26562	29243
			74276	73581	4698				901	883				43402	47944	77367	11059	11130	897666	941597
			81277	80893	4769				903	884				44106	48633	84388	11774	11834	943788	984342
2.9	3.1	3.0	3015	3097	123	104	85	95	35	32	5.1	4.5	4.8	1706	1606	3333	836	875	63358	63220
3.8		3.8	4946	4920	560	39		39	59	59	2.7		2.7	4082	4113	6246	979	980	79180	79184
4.6	6.3	5.4	14627	17250	804	69	92	66	150	143	3.4	3.7	3.5	8944	7742	7258	1566	1465	109165	111152
4.7		4.7	7926	7926	428	69		69	80	80	2.6		2.6	3219	3027	5555	1184	1054	74096	73670
5.6		5.6	1902	1919	444	85	93	89	102	107	3.9	4.0	4.0	5193	4782	5982	915	951	71847	81632
4.5	3.8	4.1	1466	1353	983	77	76	76	694	203	4.0	3.8	3.9	16002	10321	7857	1654	1081	90914	88611
6.9		6.9	1118	10135	514	36		36	89	50	3.1		3.1	9693	4334	8992	986	1074	89122	93164
11.0	2.9	7.0	1227	10057	1007	71	68	69	310	189	1.1	4.6	2.9	14933	7847	9404	1102	1041	100983	94655
3.3		3.3	1305	2648	152	30	71	51	34	21	4.8	5.7	5.3	3286	2171	4412	479	526	46364	48337
7.0	6.3	6.6	2848	2709	8	10	32	21		0	3.1	2.3	2.7	71	59	1803	320	364	28639	28091
4.5	4.6	4.5	2468	2504	0	4	44	24		0	11.3	3.0	7.2			1406	219	264	20555	21682
3.0	4.7	3.9	1485	1906	0	7	81	44		0	15.8	5.2	10.5			1608	392	349	30619	28936
			44332	66423	6144				1553	886				67130	46001	63856	10631	10023	804841	812533
			39430	61032	6136				1552	885				67059	45942	67071	10827	10219	825453	845413
5.3	6.0	5.7	2681	2858	30	129	99	114	12	9	13.5	6.0	9.8	751	796	2821	470	597	41354	46315
7.3	3.6	5.5	11576	8642	315	92	53	73	78	62	4.6	3.8	4.2	4541	3599	6004	1090	988	89325	80706
4.7	5.9	5.3	5523	6228	187	52	87	70	26	35	5.9	3.1	4.5	2619	2289	4704	1215	1329	78018	81044
5.3	5.0	5.2	10740	10436	451	79	125	102	96	125	4.5	4.0	4.3	5214	5214	5838	1213	1307	89541	89716
7.7	6.7	7.2	12252	11457	335	76	100	88	69	80	5.2	4.6	4.9	4192	4465	5642	1167	1075	83924	82429
4.5	7.9	6.2	8225	11333	806	87	91	89	191	195	3.7	3.8	3.8	7454	8221	6983	1052	1021	84517	87555
7.4	5.3	6.4	8434	7237	504	52	58	55	71	75	2.8	2.8	2.8	3084	3838	7348	831	824	83033	86410
3.8	8.5	6.2	6212	10054	102	50	66	58	14	16		2.8	2.8	694	777	6777	461	544	67205	72329
6.4	5.7	6.1	6337	5990	61	15	48	32	2	5	2.4	3.0	2.7	556	444	3688	532	481	60614	53963
5.0	4.5	4.7	809	772	0	14	70	42	0	0	4.8	4.9	4.9			1686	413	440	27521	30905
	4.7	4.7	0	0	4	44	69	57	0	1	7.1	4.4	5.8			2143	430	394	31340	33535
	2.1	2.1	0	0	226	31	39	35	0	22	6.3	2.5	4.4			2726	106	385	21586	38114
			72789	75006					559	625				29104	29642	52110	8979	9385	757978	783023
			78781	81353	2799				560	604				29175	29701	54622	8960	9143	757345	759177

Appendix E

Detailed maps of water supply facilities in State and Federal Refuges and Management Areas

E1 - E4

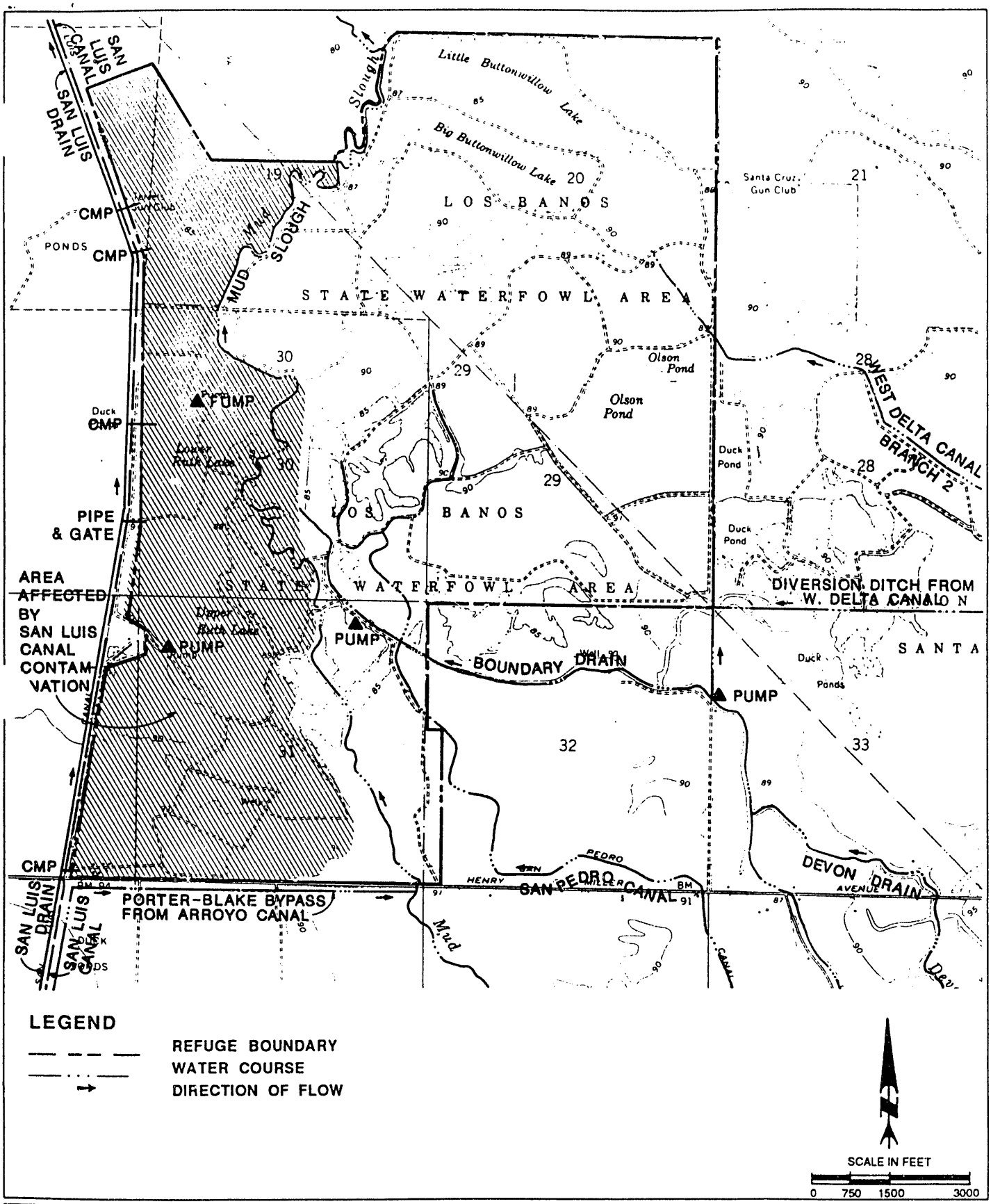


Figure E-1

LOS BANOS WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

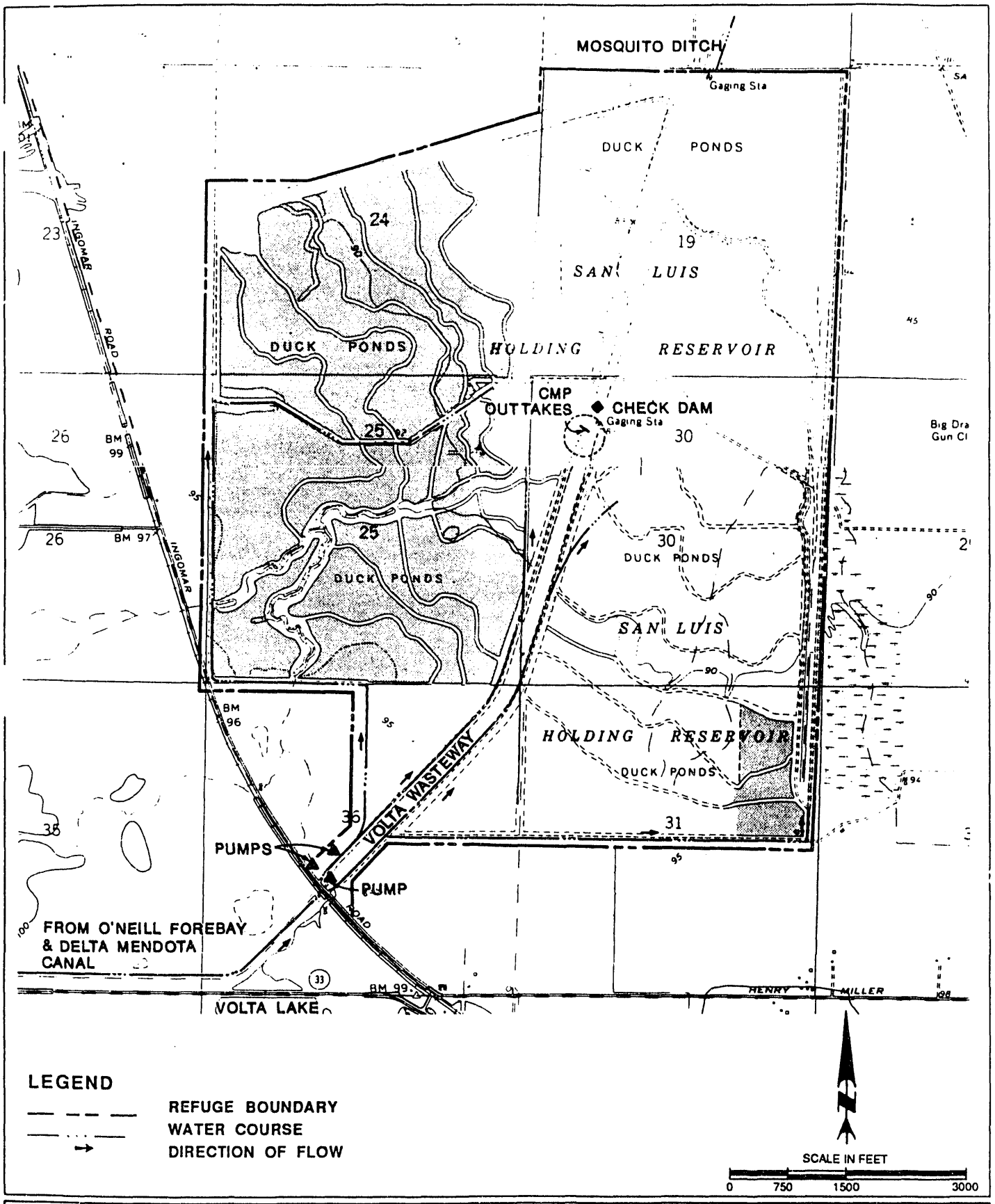


Figure E-2

VOLTA WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

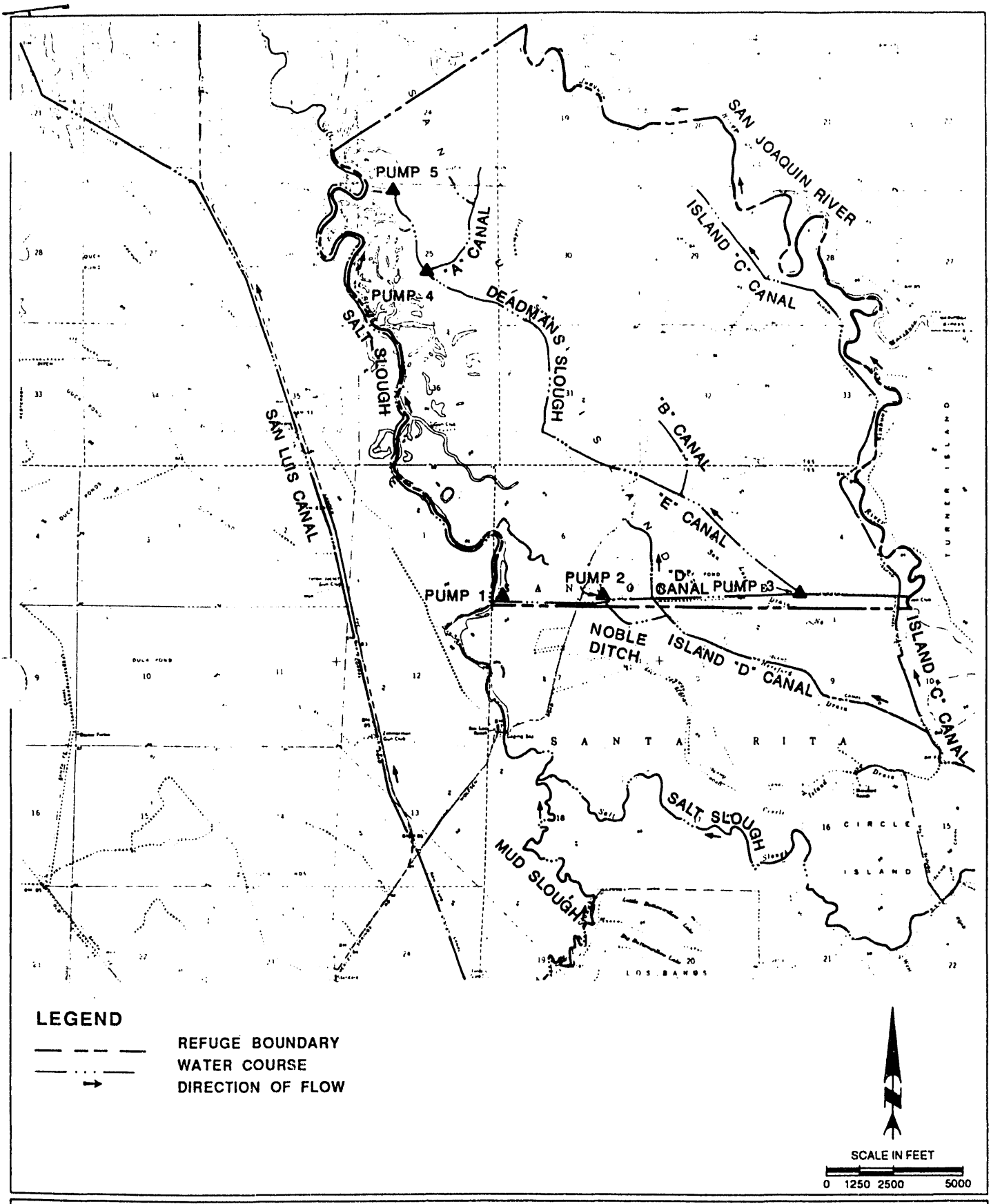


Figure E-3

SAN LUIS NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

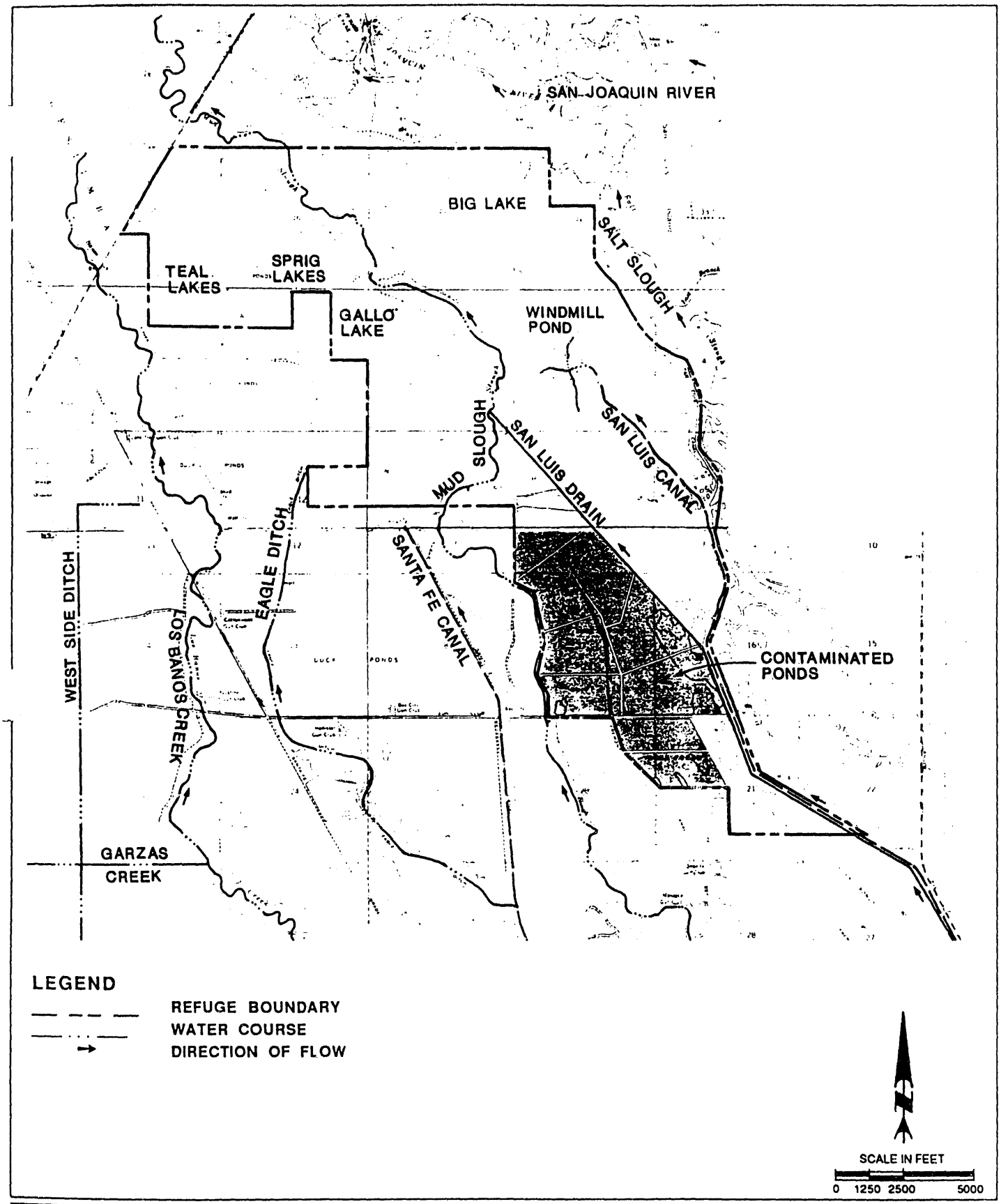


Figure E-4

KESTERSON NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

Appendix F

Land use data for management areas defined in GRASDIN model (Philips and Quinn, 1988)

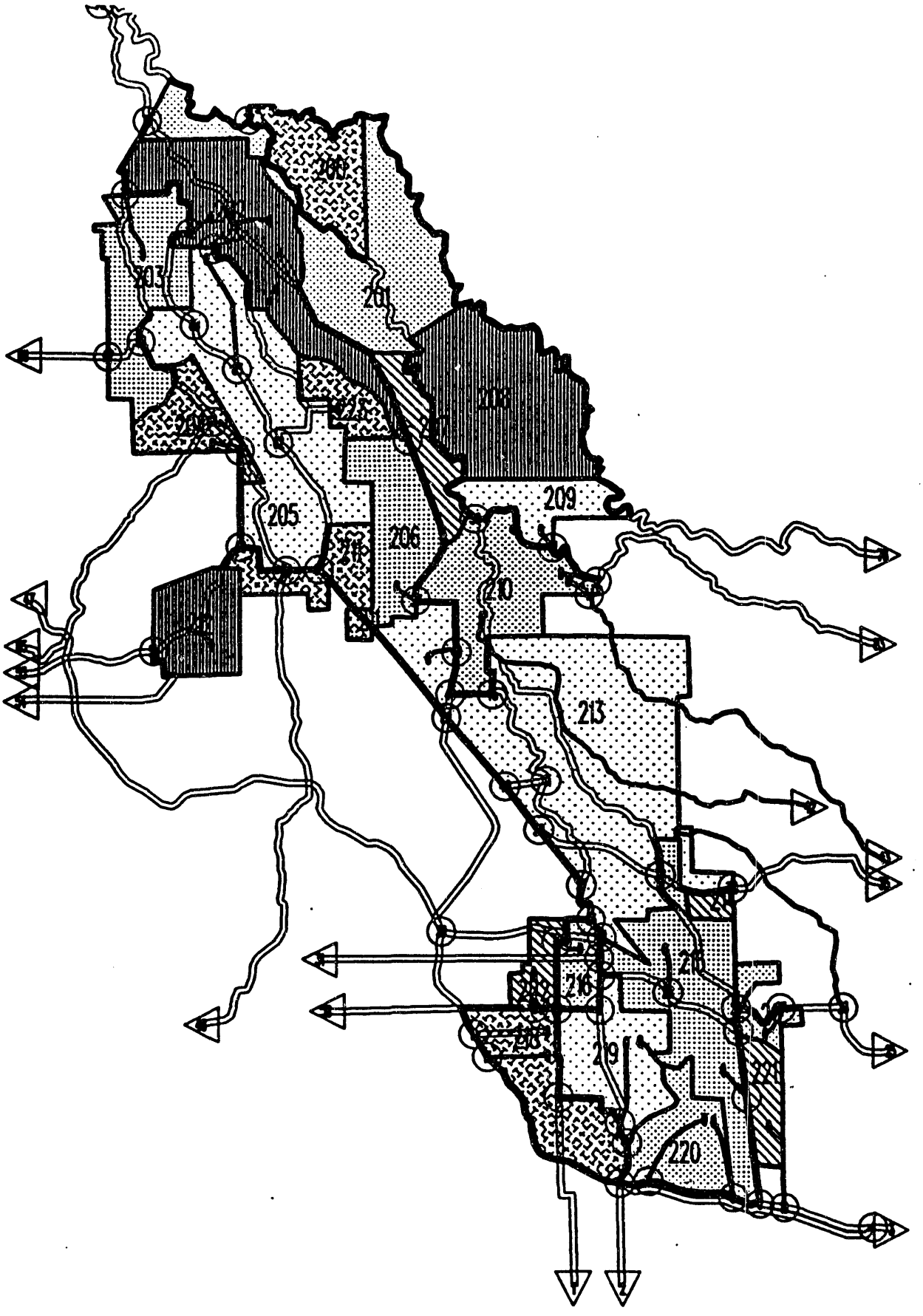


Figure F-1 Map showing the breakdown of the Grassland area into water service subareas (Phillips and Quinn, 1990). The land use data appears in Appendix F.

TYPE H - WDU 200

200	1988	
1	.95	17
7	.95	40.
8	.95	18.
12	.95	29.
15	1.00	32.
20	1.00	2160.
21	1.00	437.
22	1.00	581.

TYPE H - WDU 201

201	1988	
1	.95	41.
5	.95	18.
7	.95	96.
8	.95	42.
12	.95	33.
15	.95	95.
19	.95	13.
20	1.00	5221.
21	1.00	1058.
22	1.00	1403.

TYPE H - WDU 202

202	1988	
20	1.00	4919.
21	1.00	982.
22	1.00	1348.

TYPE H - WDU 203

203	1988	
1	.96	24.
5	.95	11.
7	.95	58.
8	.95	25.
12	.95	41.
15	.95	35.
19	.95	8.
20	1.00	3130.
21	1.00	635.
22	1.00	841.

TYPE H - WDU 204

204	1988	
7	.95	27.
8	.95	12.
12	.95	56.
20	1.00	1461.
21	1.00	296.
22	1.00	392.

TYPE H - WDU 205

205	1988	
1	.96	52.
5	.95	24.
7	.95	125.
8	.95	55.
9	.95	16.
12	.95	44.
15	.95	76.
17	.95	14
18	.95	3.
19	.95	17.
20	1.00	6758.
21	1.00	1370.
22	1.00	1816.
23	1.00	10.

TYPE H - WDU 206

206	1988	
1	.96	19.

```
  5  .95        9.
  7  .95       46.
  8  .95       20.
 12  .95       61.
 20 1.00     2412.
 21 1.00      489.
 22 1.00      649.
                                                    TYPE H - WDU 207
207 1988
  7  .95       40.
  8  .95       11.
 20 1.00     1275.
 21 1.00      258.
 22 1.00      345.
 25 1.00       30.
                                                    TYPE H - WDU 208
208 1988
 20 1.00     2942.
 21 1.00       80.
 22 1.00     4400.
                                                    TYPE H - WDU 209
209 1988
  5  .95        5.
  7  .95       32.
  8  .95        8.
 20 1.00     1460.
 21 1.00      296.
 22 1.00      392.
                                                    TYPE H - WDU 210
210 1988
 20 1.00     3069.
 21 1.00      850.
 22 1.00      970.
                                                    TYPE H - WDU 211
211 1988
  1  .96       10.
  7  .95       40.
  8  .95       11.
 12  .95       22.
 20 1.00     1589.
 21 1.00      371.
 22 1.00      396.
                                                    TYPE H - WDU 212
212 1988
 20 1.00     2400.
 21 1.00      415.
                                                    TYPE H - WDU 213
213 1988
  1  .96       87.
  5  .95       39.
  7  .95      208.
  8  .95       91.
  9  .95       26.
 12  .95       73.
 15  .95      127.
 17  .95       23.
 18  .95        5.
 19  .95       29.
 20 1.00    11223.
 21 1.00     2275.
 22 1.00     3017.
 23 1.00       17.
                                                    TYPE H - WDU 214
214 1988
  7  .95        5.
  8  .95        4.
```

12	.95	9.
20	1.00	263.
21	1.00	53.
22	1.00	70.

TYPE H - WDU 215

215	1988	
1	.96	35.
5	.95	15.
7	.95	82.
8	.95	32.
9	.95	9.
12	.95	76.
18	.95	9.
19	.95	20.
20	1.00	4430.
21	1.00	868.
22	1.00	1190.

TYPE H - WDU 216

216	1988	
2	.95	2.
7	.95	23.
3	.95	23.
20	1.00	760.
21	1.00	154.
22	1.00	207.

TYPE H - WDU 217

217	1988	
7	.95	20.
17	.95	20
20	1.00	600.
21	1.00	121.
22	1.00	161.

TYPE H - WDU 218

218	1988	
7	.95	77.
17	.95	91.
20	1.00	2597.
21	1.00	526.
22	1.00	698.

TYPE H - WDU 219

219	1988	
1	.96	5.
5	.95	9.
7	.95	69.
8	.95	20.
9	.95	6.
12	.95	17.
17	.95	10
19	.95	13
20	1.00	2477.
21	1.00	513.
22	1.00	666.

TYPE H - WDU 220

220	1988	
7	.95	57.
8	.95	16.
12	.95	45.
20	1.00	1866.
21	1.00	378.
22	1.00	504.

TYPE H - WDU 221

221	1988	
7	.95	27.
8	.95	8.
12	.95	11.
17	.95	5.

```
 19  .95        8.
 20 1.00      937.
 21 1.00      190.
 22 1.00      252.
                                                    TYPE H - WDU 222
222 1982
  7  .95       18.
 17  .95       22.
 19  .95        7.
 20 1.00      703.
 21 1.00      142.
 22 1.00      188.
                                                    TYPE H - WDU 223
223 1982
  3  .95        7.
  7  .95       25.
 12  .95       10.
 17  .95        8.
 19  .95       10.
 20 1.00      926.
 21 1.00      188.
 22 1.00      249.
                                                    TYPE H - END OF DATA
                                                    TYPE I - CROP CODES
ALFALFA                    1      0.96
ALF SEED                   2      0.95
BARLEY                     3      0.95
BEANS                      4      0.95
BEETS                      5      0.95
CORN                       6      0.95
COTTON                     7      0.95
GRAIN                      8      0.96
MELONS                     9      0.95
MILO                      10      0.95
MISC FLD                  11      0.95
MISC TRK                  12      0.95
NATIVE                    13      1.00
NURSERY                   14      0.96
PASTURE                   15      0.96
POTATOES                  16      0.95
RICE                      17      0.96
SAFFLOWER                 18      0.95
TOMATOES                  19      1.00
SEASONAL WETLANDS         20      1.00
PERMANENT WETLANDS        21      1.00
MANAGED UPLANDS           22      1.00
OTHER UPLANDS             23      1.00
UNIRRIGATED CROPLANDS     24      1.00
NO CROP                   25      1.00
```

Appendix G

Monitoring stations within the Grassland area and frequency of measurement (Summers Engineeering, 1991)

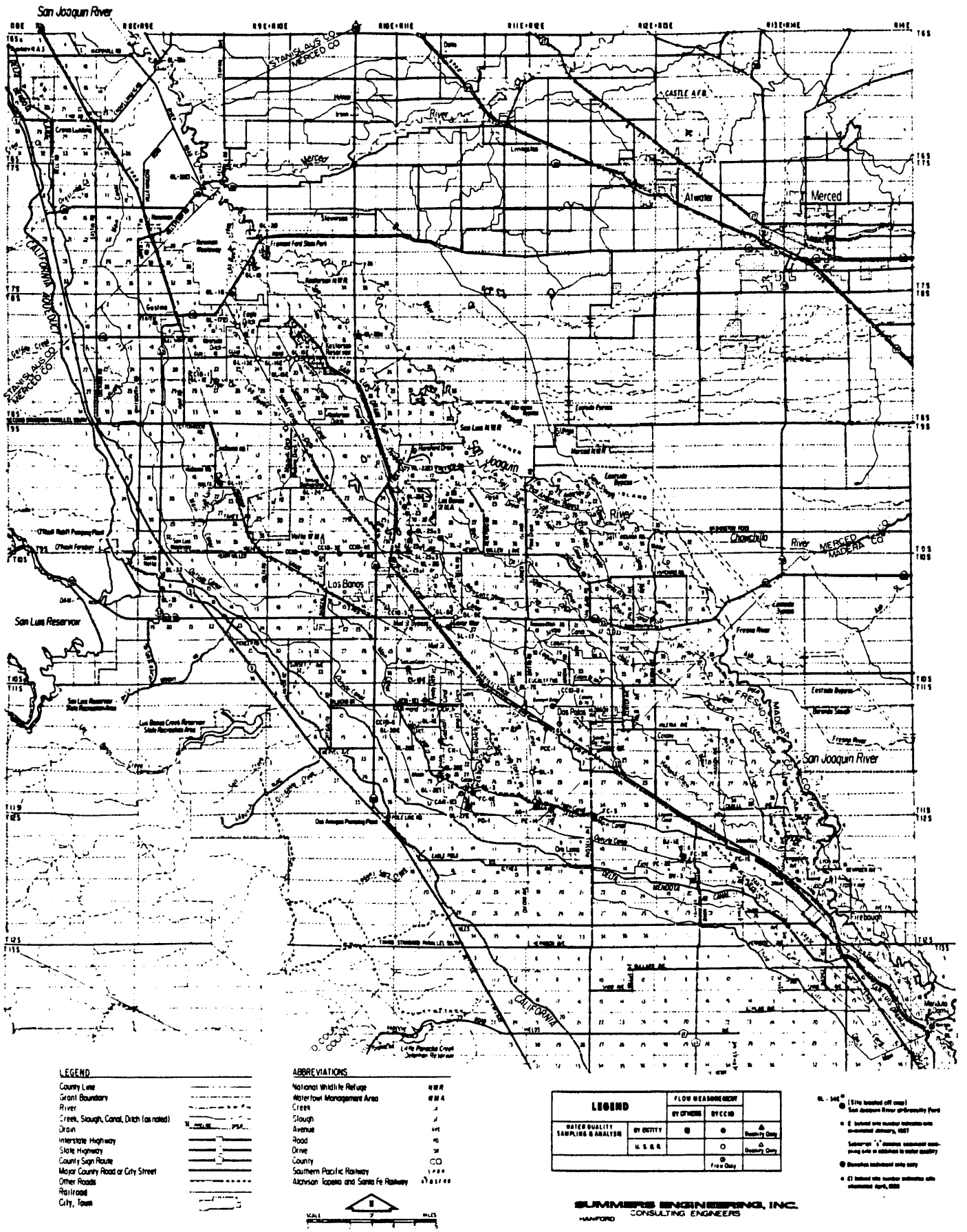


Figure G- 1. Monitoring stations within the Grassland area (Summers, 1991).

Table G -1 Detailed description of monitoring sites within the Grassland area

SURFACE WATER MONITORING v.8

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
	Routine Grassland monitoring sites as listed in SWRCB (1991)																	
1	Broadview Drain	GWD	BV-3	C			M	M	M								TREND OPER	May 84 -
2	Main Drain (Firebaugh) Russell Blvd.	CRWQCB GWD	MER556 FC-5 * 18 *	C	M	M	M M	M M	M M							DPFU PT2D	TREND OPER	Mar 87 -
3	CCID Main Canal Russell Avenue	CRWCB	MER510 * 18a *		M	M	M	M	M							DPFU PT2D	TREND	
4	Panoche Drain at O'Banion Agatha Canal	CRWQCB GWD	MER501 PE-14 * 19 *	C	M	M	M C	M M	M M							DPFU PT2D	TREND	July 84 -
5	Agatha Canal inlet drain	CRWQCB GWD	MER552 AG1 * 19a *		M	M	M M	M M	M M							DPFU PT2D	TREND	
6	Agatha Canal at location of Main Canal	CRWQCB	MER506 GL-4E * 20 *		M	M	M	M	M							DPFU PT2D	TREND	Nov 85 -
7	Agatha Canal 1.5 miles north of main Canal	GWD	GL-5	M			M	M	M								TREND	Nov 85 -
8	Colony Branch #2 at Swift Road	GWD	GL-6	M			M	Q									TREND	Nov 85 -
9	Colony Branch # 3 at weir , west of Swift Road	GWD	CCID-8	M			Q	A									TREND	Nov 85 -
10	Rice Drain at Grassland boundary	CRWQCB GWD	MER509 PCC-1 * 21 *		M	M	M M	M Q	M M							DFPU PT2D	TREND OPER	Apr 85 -
11	Pacheco Outlet on Hamburg Drain between Main and Outside Canals	CRWQCB GWD	MER504 PO-1 * 22 *	M	M	M	M M	M M	M M							DFPU PT2D	TREND OPER	May 84 -

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
12	Camp 13 Canal north of main Canal	CRWQCB GWD USBR	MER505 GL-3 DSAGWD01 *23*	 M	M	M	M M	M M	M M							DFPU PT2D	TREND OPER	Nov 85 -
13	Charleston Drain at location of Main Canal	CRWQCB	MER502 GL-2 *24*		M	M	M	M	M							DFPU PT2D	TREND	Nov 85 -
14	Charleston Drain at location of Gadwall Canal	GWD	CH-1	M			M	M	M								TREND OPER	Dec 84 -
15	Almond Drive Drain at location of Main Canal	CRWQCB GWD	MER555 CCID-6 *25*	 M	M	M	M M	M M	M M							DFPU PT2D	TREND OPER	 Nov 84 -
16	Mueller Weir	GWD	SL-17				M	Q	M								HIST	Jun 85 -
17	San Luis Canal at location of Highway 152	CRWQCB GWD USBR	MER527 CCID-5 DSAGWD08 *25a*	 M	M	M	M M	M M	M M							DFPU PT2D	HIST OPER	Nov 85 -
18	San Luis Canal below San Luis/Santa Fe split (San Luis spillway)	GWD USBR	GL-24 SFC101	M													HIST	Nov 85 -
19	Santa Fe Canal at Mud Slough diversion point at Henry Miller Road	GWD	GL-25	MO													OPER	Oct 85 -
20	Boundary Drain at Fish and game pumping station	CRWQCB	MER521 SL-2 *25c*		M	M	M	M	M							DFPU PT2D	OPER	Jan 85 -
21	Salt Slough in the low water channel	GWD	SL-1				M M	M M	M M								TREND	Jan 85 -
22	Salt Slough at location of Hereford Road	CRWQCB	MER528 *26*		M	M	M	M	M							DFPU PT2D	COMP TREND	

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
23	San Luis Creek at location of Ingomar Grade	GWD	GL-11	M			M	Q									TREND	Nov 85 -
24	Garzas Creek at Verdi (Worthy) weir	GWD	CCID-1 GL-12	M			M	Q	M								HIST	Nov 85 -
25	City Drain at location of Mud Slough	GWD	GL-23 *27 / 25b*	M												DPFU PT2D	HIST	Jan 85 -
26	California Aqueduct at Check 13 (near Hwy 207)	GWD	GL-31	M			Q	Q	Q								TREND OPER	Dec 85 -
27	Delta Mendota Canal at Check 13 (near Hwy 207)	GWD	GL-32	M			Q	Q	Q								TREND OPER	Dec 85 -
28	Mendota Pool at location of Mowbray Bridge	GWD	GL-33	M			M	M	M								TREND OPER	Dec 85 -

Monitoring of the San Joaquin River and its tributaries in the vicinity of Grasslands

29	San Joaquin River at Lander Avenue	CRWQCB USGS DWR	MER522 260815 B07400 *1*	 C	W C	W	W C C	W M	W TA							UOD DPFU PT2D	TREND OPER	
30	Salt Slough at Lander Avenue	CRWQCB USGS GWD DWR	MER531 261100 GL-22/22a B00470 *2*	 C C	W	W	W C M	W M	W M							DPFU PT2D	COMP OPER	
31	San Joaquin River at Fremont Ford	CRWQCB GWD DWR USBR	MER558 GL20 B07375 SJR140 *3*		W	W	W M C	W M M	W M A2							UOD DPFU PT2D	TREND OPER	Sep 85 -
32	Mud Slough at the San Luis Drain, near Gustine	CRWQCB USGS	MER542 262900 *4*	 C	W C	W	W C	W	W							UOD DPFU PT2D	COMP OPER	

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
33	Los Banos Creek at location of Highway 140	CRWQCB GWD	MER554 GL-18 *5*	 M	M	M	M M	M Q	M M							DPFU PT2D	HIST	Nov 85 -
34	Mud Slough at location of Highway 140 downstream of San Luis Drain	GWD	GL-19 *4a*				M	M	M							UOD DPFU PT2D	COMP OPER	Oct 85 -
35	Mud Slough at Newman Gun Club	CRWQCB	MER552 *6*		W	W	W	W	W							UOD DPFU PT2D	TREND	
36	San Joaquin River upstream of the Merced River	CRWQCB	STC512 GL-21 *7*		W	W	W	W	W							UOD DPFU PT2D	TREND OPER	Oct 85 -
37	Merced River near Stevinson	USGS	272500 *8*	C	C		C									DPFU PT2D	TREND OPER	
38	San Joaquin River near Newman	USGS DWR	274000 B07300 *9*	C												UOD DPFU PT2D	TREND COMP OPER	
39	San Joaquin River near Crows Landing	GWD CRWQCB	GL-21a STC504 *10*		 W	 W	M W	M W	M W							DPFU PT2D	TREND MULTI	
40	San Joaquin River at Patterson	CRWQCB DWR USGS	STC507 B07200 274570 *11*	 C	W	W	W	W M	W A2							DPFU	TREND	
41	San Joaquin River at Grayson	CRWQCB DWR	STC511 *12*		W	W	W	W M	W A2							DPFU	TREND	
42	Tuolomne River at Modesto	USGS DWR	290000 B04120 *13*	C C	C C		C C									DPFU PT2D	TREND OPER	
43	Tuolomne River at Tuolomne City	DWR	B04105 *14*				C									DPFU PT2D	TREND	

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
44	San Joaquin River at Maze	CRWQCB DWR	STC510 B07040 * 15 *	 C	W	W	W C	W M	W A2							DPFU PT2D	TREND OPER	
45	Stansilaus River at Ripon	USGS	303000 * 16a *	C	C		C									DPFU	TREND	
46	Stanislaus River at Koetitz Ranch	DWR	B03115 * 16 *	C			C										TREND	
47	San Joaquin River at Vernalis	CRWQCB USGS DWR	SLC501 303500 B07020 * 17 *	 C C	W C C	W	W C C	W	W							DPFU PT2D	TREND COMP OPER	

Additional Grasslands sites monitored by Grasslands Water District prior to 1987

E - designation indicates site eliminated in GWD monitoring program in January 1987

E1 - designation indicates site eliminated in GWD monitoring program in April 1989

1	Firebaugh Drain near Santa-Fe Grade	GWD	FC-1E														HIST	Nov 84 - Apr-89
2	Firebaugh Drain West of Crooked Drain	GWD	FC-2E														HIST	Nov 84 - Apr-89
3	Firebaugh Drain West of Crooked Drain	GWD	FC-3E														HIST	Oct 85 - Apr-89
4	Main Drain at Camp 13 south side of Main Canal	GWD	FC-4E															
5	Firebaugh Drain at Desjardins	GWD	DJ-1E														HIST	Oct 85 - Apr-89
6	Agatha Canal at Britto Road, north of Santa Fe Grade	GWD USBR	GL-7E DASGWD12														HIST	Nov 85 -

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
7	CCID Main Canal diversion at Ascot Ditch	GWD	GL-29E														TREND	Nov 85 - Dec-87
8	CCID Main Canal diversion at Silva Ditch	GWD	GL-30E														HIST	Nov 85 - Dec-97
9	Gadwall Ditch at Almond Drive Ditch	GWD USBR	GL-1E DSAGWD05														HIST	Jan 85 -
10	Jensen and Brandi Drain at Almond Drive Ditch	GWD	JEN-1E1														HIST	Nov 85 -
11	Cotton Drain at Terceira Road	GWD	GL-10E														HIST	Nov 85 - Jun-87
12	Santa Fe Canal at Highway 152	GWD USBR	GL-8E DASGWD09														HIST	Nov 85 -
13	Mud Slough (south) at Highway 152	GWD USBR	GL-9E MSL152														TREND	Nov 85 -
14	Santa Fe Canal - Mud Slough Diversion at Henry Miller Road Bypass 21 + 30	GWD	GL25s1														HIST	Sep 85 -
15	Santa Fe Canal - Mud Slough Diversion at Henry Miller Road Bypass 61 + 05	GWD	GL-25s3														HIST	Sep 85 -
16	Santa Fe Canal - Mud Slough Diversion at Henry Miller Road Bypass 122 + 00	GWD	GL-25s4														HIST	Sep 86 -
17	Santa Fe Canal - Mud Slough Diversion at Henry Miller Road Bypass 140 + 00	GWD	GL-25s5														HIST	Sep 85 -

SURFACE WATER MONITORING v.8

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
18	Mexican Drain at Henry Miller Avenue	CCID	CCID-4E														HIST	Nov 85 - Feb-87
19	Johnson Field Drain at Henry Miller Road	CCID	CCID-3E														HIST	Nov 85 - Feb-87
20	Los Banos Creek at Henry Miller Road	CCID	CCID-2E1														HIST	Nov 85 - Oct-88
21	Mud Slough (south) downstream of City Drain	GWD	GL-26E														TREND	Sep 85 - Feb-87
22	Westside Ditch at Santa Fe Grade 0.5 miles south of Lone Tree	GWD USBR	GL-17E1 WSDSFG														HIST	Nov 85 -
23	Eagle Ditch at Gun Club Road	GWD USBR	GL-13E EDGCR														HIST	Nov 85 -
24	Santa Fe Canal at Gun Club Road	GWD USBR	GL-14E SFOGCR														TREND	Jan 85 -
25	Mud Slough at Gun Club Road upstream from the Fremont Canal	GWD USBR	GL-15E MSLCGR														TREND	Nov 85 -
26	Fremont Canal at Gun Club Road north side of road	GWD USBR	GL-16E FRECA2														HIST	Nov 85 -
27	Salt Slough at Wolfsen Road 1.0 mile east of Highway 165	GWD	GL-22E1				M	M	M							DPFU	HIST	Oct 85 -
28	Hillside Ferry Road at the San Joaquin River	GWD	GL-21E1													DPFU	HIST	Oct 85 -

Monitoring sites sampled by LBL in the vicinity of Kesterson Reservoir

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			
1	Fremont Canal between pond 6 and Gun Club Road	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Apr 88 -
2	Mud Slough 0.9 miles north of Gun Club Road west of pond # 10	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Apr 88-
3	Kesterson Reservoir ephemeral pools east border of pond # 6	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Mar-87
4	Kesterson Reservoir ephemeral pools west border of pond # 10	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Mar-87
5	Kesterson Reservoir ephemeral pools north - east corner of pond # 3	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Mar-87
6	Kesterson Reservoir ephemeral pools south - west corner of pond # 3	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Dec-88
7	Kesterson Reservoir ephemeral pools north central edge of pond # 4	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Dec-88
8	Kesterson Reservoir ephemeral pools pond # 5 across from site at pond # 4	LBL		NF		NF	NF	NF	NF							PT2D	TREND	Dec-88
9																		Dec-88

SURFACE WATER MONITORING v.8

	LOCATION	AGENCY (CURRENT)	STATION ID	PHYSICAL DATA				CHEMICAL		BIO - RESOURCE DATA						MONITORING PLANS	USE OF DATA (PURPOSE)	LENGTH OF RECORD
				Flow	Temp	pH	EC	Se	B	eggs	birds	fish	invert	plants	other			

5 - map ID from SWRCB map

KEY CRWQCB - California Regional Water Quality Control Board
GWD - Grasslands Water District (Summers Engineering)
DWR - Department of Water Resources
USGS - US Geological Survey
USBR - US Bureau of Reclamation

KEY C - continuous : TC - telemetered continuous
W - weekly (april - sept) : WW - weekly (all year)
M - monthly (april-sept) : MM - monthly (all year)
MO - monthly during operation : Q - quarterly
A - annual monitoring (irrigation season)
A2 - twice annually
NF - no fixed schedule for collection

MONITORING PLANS KEY

KEY UOD - sites included in plan for use of San Luis Drain (USBR) - (Delamore, 1992)
DPFU - sites suggested in monitoring plan for the SJVDP (follow-up) - (Alemi, 1992)
PT2D - possible sites to be included in USBR interactive database using ARC-INFO and PT2

USE OF MONITORING DATA - KEY

COMP	compliance with SWRCB, CRWQCB or USBR water quality objectives or criteria
TREND	trend analysis - comparison with background levels at a later date by one or more agencies (including the USGS NAWQA Program)
OPER	data that could be processed for setting or adjusting water (or drainage) district operations
HIST	data collected under contract by one or more agencies, not currently included for trend comparisons or compliance analysis.
MULTI	data that may be combined with flow or quality data from other sites to improve assessment of constituent loads
E	sites eliminated January 1987
E1	sites eliminated April 1989