



Staff Report of the
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

**WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:
LANDER AVENUE TO VERNALIS
OCTOBER 1995 THROUGH SEPTEMBER 1997
(WATER YEARS 1996 AND 1997)**



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REPORT PREPARED BY:

Jeanne E. Chilcott, Associate Land and Water Use Analyst
Les F. Grober, Associate Engineering Geologist
Jan L. Eppinger, Student Intern
Armando Ramirez, Student Intern

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Table of Contents

	<u>Page</u>
Executive Summary	1
Introduction	5
Study Area	5
Sampling Program.....	8
Sample Collection Methods	8
Grab Samples.....	8
Composite Automated Samples	10
Quality Control and Quality Assurance	10
Standard.....	10
Special Studies	10
Field vs. Laboratory Preservation.....	11
Rainfall and Discharge Patterns.....	11
Results	13
Electrical Conductivity, Boron and Selenium.....	13
Water Year 1996.....	13
Water Year 1997.....	17
Daily Composite Samples	18
Other Elements of Concern	18
Discussion	18
Comparison Between Water Years 1996 and 1997.....	18
Comparison to Applicable Water Quality Objectives.....	23
Annual Loading of Salt, Boron and Selenium	30
References	39

Appendices

Appendix A. Grab Sample Water Quality Data: Water Year 1996	41
Appendix B. Grab Sample Water Quality Data: Water Year 1997	51
Appendix C. Automated Daily Composite Water Quality Data.....	61
Appendix D. 4-Day Running Average Selenium Concentrations in the San Joaquin River at Crows Landing	71

List of Tables

	<u>Page</u>
1. Tributaries and Drains to the Lower San Joaquin River between Monitoring Stations from the Lander Avenue Bridge to Vernalis.....	7
2. Summary of Monitoring Locations and Constituents Analyzed in the Lower San Joaquin River: Water Years 1996 and 1997.....	9
3. Quality Assurance Tolerance Guidelines.....	11
4. Study: Lab vs Field Preservation Paired Sampling at San Luis Drain.....	12
5. Study: Lab vs Field Preservation Paired Sampling at San Joaquin River, Crows Landing.....	12
6. Annual Minimum, Median and Maximum Electrical Conductivity, Boron and Selenium at Monitoring Sites on the Lower San Joaquin River: Water Years: 86-95, 96 and 97.....	16
7. Summary of Copper, Chromium, Lead, Nickel, Zinc, and Molybdenum Results at Selected Sites in the Lower San Joaquin River: Water Years 1996 and 1997.....	21
8. Boron, Selenium, and Molybdenum Water Quality Objectives for the Lower San Joaquin River.....	25
9. Summary of Selenium Water Quality Objectives and Compliance Time Schedule.....	26
10. Monthly Mean Boron Concentrations and Water Quality Objective (WQO) Exceedances in the San Joaquin River: Water Years 1996 and 1997.....	28
11. Monthly Mean Selenium Concentrations and Water Quality Objective (WQO) Exceedances in the San Joaquin River: Water Years 1996 and 1997.....	28
12. Monthly and Annual Discharge, Loads of Salt, Boron and Selenium, and Flow Weighted Concentrations for the San Joaquin River at Crows Landing: Water Years 1996 and 1997.....	31
13. Monthly and Annual Discharge, Loads of Salt, Boron and Selenium, and Flow Weighted Concentrations for the San Joaquin River at Vernalis: Water Years 1996 and 1997.....	32

List of Figures

1. Monitoring Locations Along the Lower San Joaquin River.....	6
2. Comparison of Rainfall at and Discharge Flows from Friant Dam into the San Joaquin River: Water Years 1996 and 1997.....	14
3. Flows in the San Joaquin River at Lander Avenue, Patterson and Vernalis: Water Years 1996 and 1997.....	15
4. Comparison of Boron and Selenium Concentraions from Weekly Grabs vs. Autosampler Collections in the San Joaquin River at Crows Landing: Water Years 1996 and 1997.....	19
5. Daily Composite Electrical Conductivity vs Discharge in the San Joaquin River at Crows Landing: Water Years 1996 and 1997.....	20
6. Comparison of Electrical Conductivity, Boron and Selenium Concentrations in the San Joaquin River at Fremont Ford: Water Years 1996 and 1997.....	22
7. Comparison of Weekly Measurements of Electrical Conductivity, Boron and Selenium Concentrations in the San Joaquin River at Hills Ferry, Crows Landing and Vernalis: Water Years 1996 and 1997.....	24
8. 4-day Running Average Selenium Concentrations in the San Joaquin River at Crows Landing Compared to the 5 µg/L Water Quality Objective: Water Years 1996 and 1997.....	29
9. Monthly Salt Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997.....	34
10. Monthly Boron Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997.....	35
11. Monthly Selenium Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997.....	36

List of Figures continued:

	<u>Page</u>
12. Annual Discharge from the Drainage Problem Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997.....	37
13. Annual Salt Load from the Drainage Problem Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997.....	37
14. Annual Boron Load from the Drainage Problem Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997.....	38
15. Annual Selenium Load from the Drainage Problem Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997.....	38

EXECUTIVE SUMMARY

Since May 1985, the Central Valley Regional Water Quality Control Board has conducted a water quality monitoring program on the lower San Joaquin River to evaluate the effects of subsurface agricultural drainage inflows. The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue near Stevinson to Airport Way near Vernalis. Five major tributaries flow into the river within this study area: Salt Slough, Mud Slough (north), and the Merced, Tuolumne, and Stanislaus Rivers. Salt Slough and Mud Slough (north) drain the Grassland Watershed of western Merced County and are the major source of agricultural subsurface drainage water discharges to the river system. The Merced, Tuolumne, and Stanislaus Rivers are east side streams which drain the Sierra Nevada and provide high quality dilution flows.

During the period covered by this report, 1 October 1995 through 30 September 1997 (Water Years 1996 and 1997¹), a major change occurred in management of agricultural drainage water in the Grassland Watershed: the advent of the Grassland Bypass Project. The project began operation on 23 September 1996 and consolidated subsurface agricultural drainage, which historically flowed through wetland habitat, into a single channel, allowing the drainage to bypass approximately 90 miles of wetland water supply channels and Salt Slough. The drainage was redirected into the final nine miles of Mud Slough (north) and eventually into the San Joaquin River. Data presented in this report represents water quality at selected sites along the river one year prior to and one year after the advent of the Bypass project.

During both Water Years 1996 and 1997, water quality information was collected at eight sites along the river, representing both background water quality and influences of major inflows. The primary constituents evaluated included electrical conductivity, boron and selenium, with more limited analyses of molybdenum, copper, chromium, lead, nickel, zinc, chloride and sulfate. Grab samples were collected on a weekly, monthly or quarterly schedule depending on the location and automated, composite samples were collected at Crows Landing to provide information on fluctuating concentrations and to provide a more complete data set for calculation of salt, boron, and selenium loads.

The San Joaquin River Index is used to classify water year type in the river basin based on total runoff (SWRCB, 1997). Both Water Years 1996 and 1997 were classified as wet water years with high flows occurring during February and March of 1996 and during early January, 1997. Flooded conditions along the river during these time periods resulted in limited water quality data at a number of sites, with levee breaks leading to unrecorded discharges in the river at Patterson and Vernalis.

During Water Year 1996, constituent concentrations followed trends observed during the previous years of study. The highest concentrations occurred downstream of discharges from the Grassland Watershed, while the lowest concentrations were recorded at the background (Lander Avenue) site and downstream of the eastside tributary dilution flows, at Vernalis. Concentrations tended to peak during the pre-irrigation and irrigation seasons (March and April and June through August, respectively).

Between Water Years 1996 and 1997, little difference in water quality concentrations or seasonal trends is apparent at the majority of river stations monitored. The one exception is the San Joaquin River at Fremont Ford. Between Water Years 1996 and 1997, concentrations of electrical conductivity, boron and selenium all decreased at the Fremont Ford site. The decrease can be attributed to the operation of the Grassland Bypass Project that resulted in the diversion of subsurface agricultural drainage out of Salt Slough and into Mud Slough (north). Salt Slough discharges into the San Joaquin River upstream of the Fremont Ford site and Mud Slough (north) discharges into the San Joaquin River downstream of the Fremont Ford site. Further reductions in constituent concentrations did not occur until inflows from major eastside tributaries (Merced, Tuolumne and Stanislaus Rivers) provided dilution water.

In October 1988, the Regional Board adopted water quality objectives for boron, molybdenum and selenium for the lower San Joaquin River between Sack Dam and Vernalis. Two sets of objectives were developed. One set of objectives was established for the river reach with minimal freshwater flow (between Sack Dam and the mouth of the Merced River) and the second set was for the reach of river with

¹ A Water Year covers the time period from 1 October through 30 September of the following year.

highly managed freshwater flows (from the mouth of the Merced River to Vernalis). The boron objective is also based on season, with more stringent objectives applying during the irrigation season (March 15 through September 15) when downstream crops would be susceptible to boron toxicity from irrigation water. In May 1996, the Regional Board adopted revised selenium water quality objectives for the lower San Joaquin River along with a compliance time schedule. The selenium compliance time schedule does not require full compliance with the selenium objective until 1 October 2005 to 1 October 2010, depending on which reach of the river is being evaluated and the classification of the water year.

During both water years, the applicable monthly mean boron objective (0.8 mg/L) was exceeded at the Crows Landing and Patterson sites, primarily between June and August. Review of daily composited data indicates an expanded time period of exceedance, from April through August, during Water Year 1997. The objectives were not exceeded downstream of the Patterson site (downstream of additional eastside tributary inflows from the Tuolumne and Stanislaus Rivers).

During Water Year 1996, monthly mean selenium concentrations exceeded the applicable selenium water quality objectives from April through July at the Fremont Ford site (concentrations greater than 10 µg/L) and during June and July at the downstream Hills Ferry, Crows Landing and Patterson sites (greater than 10 µg/L at Hills Ferry and 5 µg/L downstream). The selenium objectives changed to a 5 µg/L 4-day average subject to a compliance time schedule, at all sites along the river in Water Year 1997. Using the final objective, exceedances increased at the Hills Ferry site, with elevated concentrations from March through August. Downstream of the Merced River inflow, the objective was exceeded in April and June at both the Crows Landing and Patterson locations. An improvement was seen at the Fremont Ford site, with no exceedances during Water Year 1997. The improvement is likely due to management changes as part of the Grassland Bypass Project.

The molybdenum water quality objectives were met at all sites monitored. The highest molybdenum concentration detected in the San Joaquin River during the study period, was 12 µg/L at the Hills Ferry site on 19 June 1997. The reported maximum concentration does not exceed any of the adopted continuous or maximum molybdenum water quality objectives.

Salt, boron, and selenium loads for the San Joaquin River at Crows Landing and near Vernalis were estimated based upon the flow weighted monthly average of the available water quality data. For Water Year 1997, monthly discharge and load estimates are approximate during the flood events of January and February due to numerous levee breaks allowing much of the discharge in the river to occur outside of the channel. When flood flows occur outside of the channel, discharge can be far greater than is estimated using existing stage discharge relationships.

Annual discharge at Crows Landing increased from 1.4 million acre-feet in 1996 to 4.2 million acre-feet in 1997, while at Vernalis, discharge increased from 1.0 million acre-feet to 6.8 million acre-feet during the same time period. The annual salt and boron loads showed similar increases. Salt loads increased from 800,000 tons to just under one millions tons at Crows Landing, and from 1.2 million to 1.4 million tons at Vernalis. The annual boron load at Crows Landing increased from 1.8 million pounds in 1996 to 2.1 million pounds in 1997, with a corresponding increase from 2.2 to 2.6 million pounds at Vernalis.

In contrast, selenium loads dropped between 1996 and 1997. The annual selenium load at Crows Landing decreased from 10,700 pounds in 1996 to just under 8,700 pounds in 1997 and from 11,400 to 11,200 pounds at Vernalis. Higher salt and boron loads in 1997 were likely attributable to significantly higher rainfall, river flows, and leaching of naturally occurring salts that are widespread through the basin. Lower selenium loads in 1997 are at least in part due to additional controls of subsurface agricultural drainage from the Drainage Project Area within the Grassland Watershed, particularly during low flow months.

The pattern of monthly loading of all constituents is similar for both water years, with the highest loads occurring between January and April. A marked increase in loads is evident during the flood events in January and February 1997. Flood flows and limited data availability during the 1997 flood makes flow and load estimates suspect.

When compared to annual records since Water Year 1986, loads during wet Water Years 1996 and 1997 were similar to loads for wet water year 1986 but lower than loads during wet Water Year 1995, even though annual discharge for Water Year 1997 is the highest on record. Water Year 1995 followed several years of dry and critically dry years. High loads of all constituents in 1995 likely resulted from the leaching of salts that had accumulated in the basin during previous years. Generally lower loads of all constituents in 1996 and 1997 was likely due to lower residual salt loads from the Grassland Watershed following a series of wet years and ongoing drainage management activities in the Drainage Project Area.

Water quality monitoring along the lower San Joaquin River will continue to allow evaluation of management practices on instream water quality and on constituent loads. A companion report, *Agricultural Drainage Contribution to Water Quality in the Grassland Watershed of Western Merced County, California: October 1995 - September 1997, Water Years 1996 and 1997* (Chilcott et al., 1998), discusses the water quality evaluated in the Grassland Watershed during the same time period as this report.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985 to evaluate the effects of subsurface agricultural drainage inflows. Water quality samples have been collected at eight monitoring sites along a 60-mile section of the River, extending from near Stevinson in Merced County to Airport Way near Vernalis in San Joaquin County, since the beginning of the program. This monitoring program has provided an on-going database for selected inorganic constituents found in San Joaquin River water. The database is used to assess the immediate effects of agricultural drainage water on the quality of the San Joaquin River, as well as the long-term effects of regional agricultural drainage reduction programs on overall river water quality.

This report contains laboratory results and a summary of water quality analyses for constituents measured as part of the program during Water Years 1996 and 1997 (October 1995 through September 1997). These two years represent conditions one year prior to and one year after a major change in the agricultural drainage water management in the Grassland Watershed: the advent of the Grassland Bypass Project. The Grassland Bypass began operation on 23 September 1996. The project consolidated subsurface agricultural drainage, which historically flowed through ditches and canals within Grassland Water District leading to both Salt Slough and Mud Slough (north) and ultimately into the San Joaquin River, into a single channel which discharges into Mud Slough (north). The primary goal of the project is to remove subsurface agricultural discharges from wetland water supply canals and Salt Slough. This report presents the data collected during both years, and compares salinity (measured as electrical conductivity), boron and selenium water quality at selected sites on the San Joaquin River, upstream and downstream of the Mud Slough (north) inflow, with respect to hydrology, change in water management, and applicable water quality objectives.

Water quality data collected during the previous years of study can be found in both a summary report presenting salinity, boron, and selenium information from May 1985 through September 1996 (Steensen *et al.*, 1998) and in a series of annual reports presenting all water quality information collected (James, *et al.*, 1988; Westcot, *et al.*, 1989a, 1990, 1991, and 1992, Karkoski and Tucker, 1993; Chilcott, *et al.*, 1995; and Steensen *et al.*, 1996). This monitoring program was designed to complement monitoring programs conducted by other state, federal, and local agencies.

STUDY AREA

The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue (Highway 165) near Stevinson to Airport Way near Vernalis. Monitoring sites are located near seven of the eight river overcrossings on this section of the River (Figure 1).

Five major tributaries flow into the San Joaquin River within this study area: Salt Slough, Mud Slough (north), and the Merced, Tuolumne, and Stanislaus Rivers. Salt Slough and Mud Slough (north) drain the Grassland Watershed of western Merced County and discharge to the San Joaquin River in the southern portion of the study area (Figure 1). These two sloughs are the major source of agricultural subsurface drainage water discharges to the San Joaquin River and carry a varying mixture of surface and subsurface agricultural drainage, operational spillage from irrigation canals, and seasonal drainage from duck ponds flooded each winter for waterfowl habitat. The Merced, Tuolumne, and Stanislaus Rivers are east side streams which drain the Sierra Nevada. All three streams receive some agricultural return flows in their lower reaches upstream of the San Joaquin River; however, overall water quality remains relatively high.

In addition to the five major tributaries, there are also a number of smaller tributaries, as well as surface and subsurface agricultural drains, that discharge to the San Joaquin River within the study area. All significant inflows and their locations, including the monitoring sites, are referenced by river mile and listed in Table 1. A full description of the inflow points that occur in this 60-mile section of the river is in James, *et al.* (1989).

Figure 1. Monitoring Locations Along the Lower San Joaquin River.

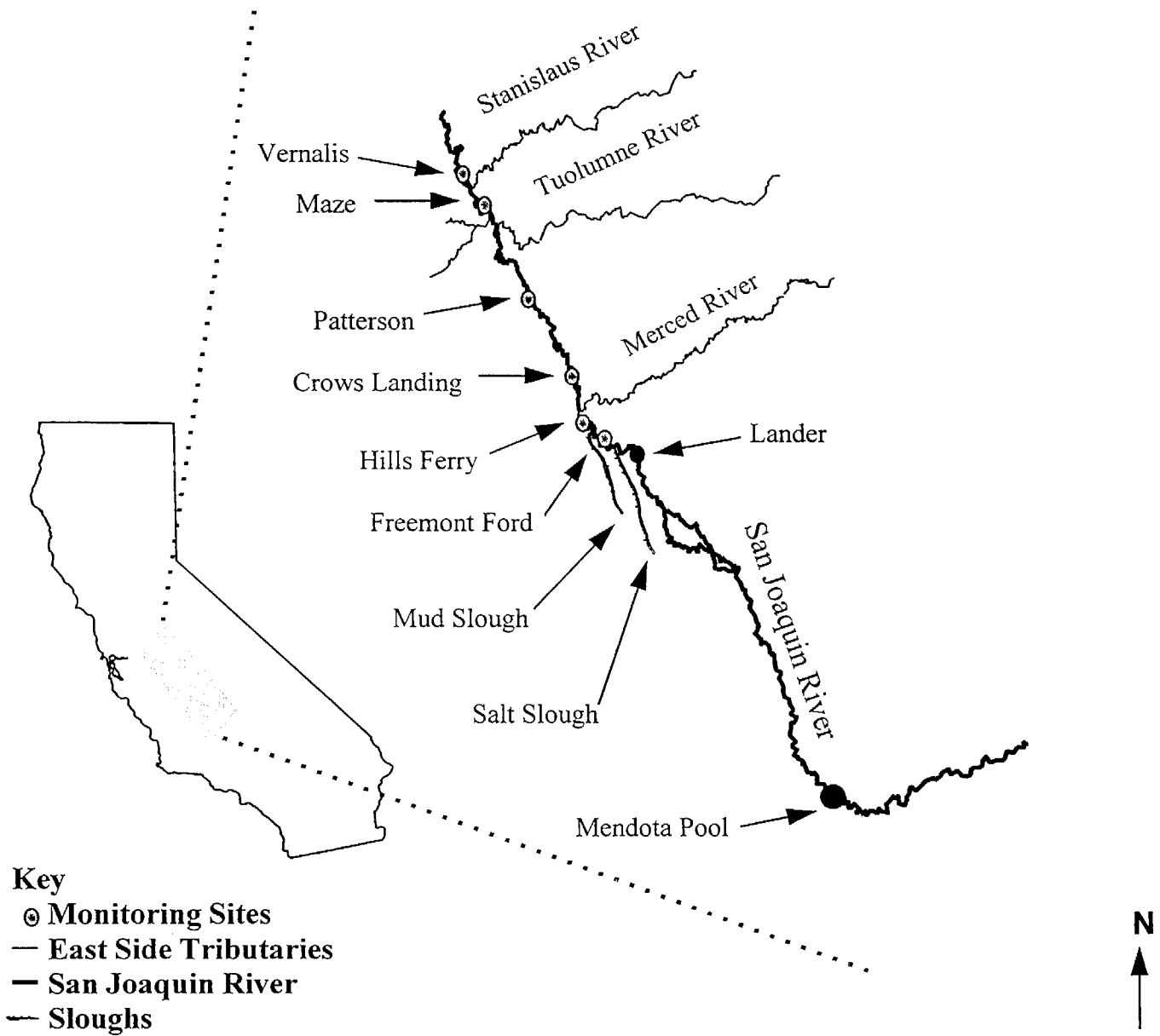


Table 1. Tributaries and Drains to the San Joaquin River Between Monitoring Stations from the Lander Avenue Bridge to Vernalis (James et al., 1989)

River Mile	Description	Water Make-up	Sampling Period of Record
132.9	Lander Avenue (Site A)	R	85-97
129.7	Salt Slough	T,S	85-97
125.1	Freemont Ford (Site B)	R	85-97
121.2	Mud Slough	T,S	85-97
119.6	Newman Wasteway	O,S	
119.5	Newman Drainage District Collector Line A	T	
119.1	Hills Ferry Road Drain	S	
118.8	Hills Ferry Road (Site C)	R	85-97
118.2	Merced River	N	
117.5	Newman Drainage District Lateral Line 1	T	
117.2	Azevedo Road Drain	S	
113.4	Frietas Road Drain and South of Frietas Road Drain	S	
112	Turlock Irrigation District Lateral 6	S,O	
109	Orestimba Creek	N,S	94
107.2	Crows Landing Road (Site D)	R	85-97
105	Spanish Grant, Marshall Road, Moran Road Drain	S,T	
103.5	Turlock Irrigation District Lateral 5	S	
100	Ramona Lake Main Drain	S,T	
98.6	Patterson Water District Main Drain	S,T	
98.4	Patterson: Las Palmas Launching Facility (Site E)	R	85-97
97.6	Olive Avenue Drain	S	
97.3	Lemon Avenue Drain	S	
97	Eucalyptus Avenue Drain	S	
95.2	Turlock Irrigation District Lateral 3	S	
92.9	Del Puerto Creek	N,S	
91.4	Houk Ranch Drain	S,T	
90.3	Turlock Irrigation Lateral 4	S	
89.1	Grayson Road (Site F)*	R	85-92
87	Old San Joaquin River Channel	S	
83.7	Tuolumne River	N	
81.1	Merced Irrigation District Lateral 4	S	
79.9	Hospital/Ingram Creeks	S,T	
78.9	Center Road Drain	S	
77.6	Blewett Drain	S,T	
77.4	Blewett Drain	S	
77.3	Maze Boulevard (Site G)	R	85-97
74.9	Stanislaus River	N	
73.6	Vernalis (Airport Way) (Site H)	R	85-97

LEGEND

- R San Joaquin River Water
- S Surface Agriculture Drain
- T Subsurface Agriculture Drain
- N Natural Stream
- O Operation Spillage

* Deleted from monitoring program after WY93

Prior to October 1996, subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tail water) from the Grassland Watershed was discharged to the San Joaquin River through Salt Slough and/or Mud Slough (north). These two sloughs are tributary to the San Joaquin River and serve as the primary drainage outlets for the Grassland Watershed with Salt Slough carrying the bulk of subsurface agricultural drainage since Water Year 1989 (Steensen, et al., 1998).

After October 1996, all subsurface agricultural drainage from a 97,000 acre area within the Grassland Watershed known as the Drainage Project Area (DPA), was rerouted into the Grassland Bypass which discharges into the final 28 miles of the San Luis Drain. The consolidated subsurface drainage is then released into the final nine miles of Mud Slough (north) for eventual discharge into the San Joaquin River. Consolidating the subsurface drainage removes the primary source of selenium in approximately 90 miles of canals within the Grassland Watershed which can supply water for wetland habitat, and also removes this drainage from Salt Slough. Reducing selenium in these water bodies is a primary goal of the project, since elevated concentrations of selenium have been documented to be hazardous to waterfowl (Skorupa, 1998). Subsurface drainage from areas outside of the 97,000 acre area served by the Grassland Bypass Project, continues to flow to Salt Slough and Mud Slough (north).

SAMPLING PROGRAM

The Regional Board monitoring program for the San Joaquin River began in May of 1985 and continued through Water Year 1997 (WY 97). Grab samples were collected at seven of the eight original sites during WYs 96 and 97. The eighth site, the San Joaquin River at Grayson Road, was deleted from the program after December 1992. Water temperature, pH, electrical conductivity (EC), and sample time were recorded in the field at each site. Laboratory analyses for total recoverable selenium, boron, and EC were performed on all samples weekly, except at the San Joaquin River at Lander Avenue site where samples were analyzed for selenium and boron monthly in WY 96 and quarterly in WY 97. In WY 96, samples from all sites were analyzed for chloride, sulfate and hardness on a monthly basis. Samples from selected sites were analyzed for total recoverable molybdenum, copper, chromium, lead, nickel and zinc either monthly or quarterly in WY96. Samples from the Hills Ferry Road site were also analyzed quarterly for selected dissolved trace elements. Analyses were decreased in WY 97 due to monetary constraints. During WY97, the program focused analyses on electrical conductivity, boron and selenium.

A continuous automated sampler was employed at the Crows Landing site during both water years. The autosampler collected daily composite samples near mid-channel for electrical conductivity, boron and selenium analyses. Location of the autosampler on a floating dock made access difficult to impossible during some flood events, resulting in some gaps in sample collection.

A summary of the sites and frequency of constituent monitoring is listed in Table 2.

SAMPLE COLLECTION METHODS

Two distinct types of water samples were collected for this program: grab samples and composite automated samples. Field measurements for water temperature, electrical conductivity (EC), and pH were conducted at all sites. Follow up EC measurements were made on all samples at the Regional Board office laboratory within 24 hours of sample collection by Regional Board staff. The types of samples, methods for collection and quality control and assurance are discussed below.

Grab Samples

During both water years 1996 and 1997, grab samples were collected on either a weekly, monthly or quarterly basis depending on site and the constituent to be analyzed (Table 2). Analyses for EC, total boron, and total selenium were conducted on all samples. Selected sites were also monitored for molybdenum, copper, chromium, nickel, lead, and zinc on a monthly or quarterly basis.

**Table 2. Monitoring Sites, Sampling Frequencies, and Parameters Measured in the San Joaquin River:
Water Years 1996 and 1997.**

Site ID	Site Description	Constituents								Dissolved TE's	Auto- Samplers
		Temp	pH	EC	Se	Mo	TE's	B	Part Min		
Water Year 1996											
	San Joaquin River at:										
MER522	Lander Avenue	W	W	W	M	Q	Q	M	M		
MER538	Fremont Ford	W	W	W	W			W	M		
STC512	Hills Ferry	W	W	W	W	Q	M	W	M	Q	
STC504	Crows Landing	W	W	W	W	Q	M	W	M	Q	a
STC507	Patterson	W	W	W	W			W	M		
STC510	Maze	W	W	W	W			W	M		
SJC501	Vernalis	W	W	W	W	Q	Q	W	M		
Water Year 1997											
	San Joaquin River at:										
MER522	Lander Avenue	W	W	W	Q	Q		Q	Q		
MER538	Fremont Ford	W	W	W	W			W			
STC512	Hills Ferry	W	W	W	W	M		W			
STC504	Crows Landing	W	W	W	W	M		W	Q		a
STC507	Patterson	W	W	W	W			W			
STC510	Maze	W	W	W	W			W			
SJC501	Vernalis	W	W	W	W	M		W			

W = weekly

M = monthly

Q = quarterly (October, January, April, and July)

a = daily composite sample for Se and B

TE's: Trace Elements (Chromium, copper, lead, nickel, zinc)

Part Min: B, Cl, SO4, and Hardness

TSS: total suspended solids

Temp: temperature

EC: electrical conductivity

Se: selenium

Mo: molybdenum

Grab samples were collected in polyethylene bottles, usually within six feet of the bank. All sample bottles were rinsed with deionized water before use. All bottles were also rinsed three times with the water to be sampled prior to sample collection. All samples were kept on ice after collection and until processing. Selenium, boron, and trace element samples were preserved by lowering the pH to less than 2 within 24 hours of collection, using reagent grade nitric acid. Mineral samples were kept on ice until submittal to the laboratory for analysis. Additional quality assurance and control procedures are discussed in a later section.

Composite Automated Samples

In addition to grab samples, daily composite sampling was conducted on the San Joaquin River at Crows Landing through the use of an automated Sigma sampling device. Each daily composite is made up of two 250 ml collections pulled at 12 hour intervals for a total sample volume of 500 ml. During both water years, the autosampler was serviced every two weeks. All samples were analyzed for EC, boron and selenium. Quality control and assurance methods for the autosamplers are discussed below.

QUALITY CONTROL AND QUALITY ASSURANCE

Standard

Potential contamination from the reagent grade nitric acid used to control pH was evaluated by submitting a deionized water matrix preserved with the normal amount of acid used (1 ml of acid for each 500 ml of sample), to the analyzing laboratories at monthly intervals to be analyzed for the trace elements of concern. All reported recoveries for these acid check samples were below the analytical detection limit.

Field and handling contamination was evaluated by submitting a travel blank on a monthly basis. The travel blank consisted of a sample of deionized water which was collected at the Regional Board laboratory, traveled through the sampling run, and was then processed with the sample set. All results for travel blanks fell below the analytical detection limits for the elements of concern.

Additional quality control and quality assurance was conducted using blind split and spiked samples. Blind split samples were collected at a ten percent frequency for each sampling event by collecting the sample in a container double the normal sample volume and splitting that sample into two equal amounts for submittal to the analyzing laboratory. On a monthly basis, half of the blind split samples were spiked with known concentrations of constituents to be analyzed. Comparing the spiked splits to the background splits provided information on analytical accuracy. Comparing data from nonspiked splits provided information on analytical precision.

To evaluate the potential for contamination and evapo-concentration in samples collected using autosampler, a series of special checks were developed. First, whenever the sampler was serviced, a deionized blank sample, without a cap, was left in the collection base to be collected on the next servicing and analyzed for potential contamination. Second, during each servicing, two "grab" samples were collected through the autosampler mechanism, one was left in the sampler to be collected at the next servicing and the other was processed for immediate analyses. Final results of the two grabs were evaluated to determine concentration or dilution potentials.

Only data from sample sets whose blind QA/QC met specifications outlined in Table 3 have been included in this report.

Special Studies

With the advent of the Grassland Bypass Project, a number of State and Federal agencies (US Bureau of Reclamation, US Geological Survey, US Fish and Wildlife Service, and California Department of Fish and Game) became involved in monitoring potential environmental impacts from the Grassland Bypass Project. The Data Collection and Reporting Team (DCRT) was formed and chaired by the US Bureau of Reclamation to coordinate activities. This committee intends to utilize information presented by the

TABLE 3. Quality Assurance Tolerance Guidelines

Constituent	Recovery Range at Low Levels ($\mu\text{g/L}$)*	Acceptable Blind Duplicate Spike Recovery Range
Copper	1-20 +/- 5	> 20 70-130%
Chromium	1-20 +/- 5	> 20 70-130%
Lead	5-25 +/- 8	> 25 60-140%
Molybdenum	1-10 \pm 2	>10 80-115%
Nickel	5-25 +/- 6	>25 65-135%
Selenium	0.4-10 \pm 0.8	>10 90-110%
Zinc	1-20 +/- 6	> 20 70-130%
Boron	50	85-115%
Chloride	5000	85-115%

* For certain constituents, recovery is expressed as an absolute value rather than a percentage at low levels. For example, if the result of copper analysis for a particular sample is 10 $\mu\text{g/L}$, a duplicate analysis must fall between 5 $\mu\text{g/L}$ and 15 $\mu\text{g/L}$. If the sample is greater than 20 $\mu\text{g/L}$, recovery is expressed as a percent and must be between 70 and 130%. If a recovery range is not shown at low levels, the detection limit is given.

Regional Board to evaluate water quality impacts from the project and raised a concern on the potential differences which may apply to sampling conducted on the lower San Joaquin River if samples are preserved with nitric acid in the laboratory 24 hours after sampling, rather than in the field immediately upon collection. A limited study of potential differences was conducted during WY 97 and is discussed below.

Field vs Laboratory Preservation

Samples collected for selenium analyses require preservation with acid to a pH of less than 2. The Regional Board staff generally acidify samples in the laboratory within 12 hours of sample collection and not more than 24 hours after collection. Field acidification of samples, immediately after sample collection, is not routinely conducted by Regional Board staff due to safety concerns.

A special study was conducted to assess the impacts on sample integrity from delaying sample preservation. Two paired samplings were conducted in which samples were collected and immediately split into two containers by incremental pouring of small volumes and agitating between pourings. One of the splits was immediately acidified in the field and the other was acidified at a later time as per standard sample handling protocol. A set of samples were collected along the San Luis Drain (Table 4) to represent a high selenium environment. Another set of samples were collected at the San Joaquin River at Crows Landing (Table 5) to represent a relatively low selenium environment.

Statistical analysis of the differences of the paired data was conducted. A test for normality according to the method of Shapiro and Wik (W test) (Gilber, 1987) demonstrated that the data were not normally distributed. Thus, a non-parametric technique, the sign test (Helseland Hirsch, 1997) was used to test the null hypothesis that the probability of $x > y$ is equal to 0.5, where x and y are paired results. The analyses failed to reject the null hypothesis at α equal to 0.01. The conclusion is that there is no difference in selenium concentrations between field and laboratory-preserved samples.

RAINFALL AND DISCHARGE PATTERNS

The San Joaquin River Index, as described in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB, 1995) is used to classify the water year type in the river basin based on runoff. The 60-20-20 Index includes one "wet" classification, two "normal" classifications (above and below normal), and two "dry" classifications (dry and critical), for a total of five water year types. Water years 1996 and 1997 were both classified as "wet" based on runoff exceeding 3.8 million acre feet.

**Table 4. Study: Lab vs Field Preservation
Paired Sampling at San Luis Drain**

Miles below Check 19	Selenium (ug/L)		
	Preserved in Lab	Preserved in Field	Diff.
0.50	62.9	63.0	0.1
1.00	69.1	69.4	0.3
1.65	63.6	62.7	-0.9
3.33	62.5	61.7	-0.8
5.63	63.6	64.3	0.7
7.00	61.1	60.2	-0.9
9.50	54.1	54.2	0.1
10.96	65.1	65.2	0.1
14.16	55.4	55.1	-0.3
14.70	55.2	55.4	0.2
15.20	55.0	55.5	0.5
15.90	57.6	57.2	-0.4
18.00	53.1	52.8	-0.3
19.77	64.5	67.4	2.9
22.47	116	108	-8.0
22.62	112	112	0.0
24.44	91.7	82	-9.7
27.07	83.5	82.2	-1.3
Mean:			-1.0
Standard deviation:			3.0

**Table 5. Study: Lab vs Field Preservation
Paired Sampling at San Joaquin River, Crows Landing**

Feet from East Bank	Time Collected	Selenium (ug/L)		
		Preserved in Lab	Preserved in Field	Diff.
east bank	930	2.41	2.40	-0.01
10	1110	2.48	2.42	-0.06
20	1120	2.42	2.44	0.02
30	1126	2.51	2.62	0.11
40	1131	2.53	2.66	0.13
50	1135	2.58	2.60	0.02
60	1141	2.58	2.61	0.03
70	1146	2.58	2.54	-0.04
80	1151	2.64	2.62	-0.02
90	1157	2.67	2.63	-0.04
100	1201	2.64	2.56	-0.08
110	1207	2.48	2.58	0.10
west pier	1246	2.66	2.63	-0.03
center pier	1247	2.63	2.58	-0.05
east pier	1248	2.58	2.64	0.06
Sigma*	1305	2.65	2.62	-0.03
west bank	1415	2.60	2.86	0.26
Mean:			0.0	
Standard deviation:			0.1	

* = composite sampler

Friant Dam essentially serves as the headwaters of the lower San Joaquin River. A comparison of rainfall at and discharge from Friant Dam into the San Joaquin River for WYs 96 and 97 is depicted in Figure 2. During both water years, early rainfall events had little if any effect on the releases from Friant Dam, indicating the highly managed nature of the San Joaquin River hydrology. The majority of water from Friant Dam is diverted into the Friant Kern Canal for use in agricultural irrigation outside of the San Joaquin River Basin. The only releases which do reach the San Joaquin River are during flood events and high flows from winter snow melt. During WY 96, these releases occurred between the end of February and beginning of June, while during WY 97, the releases were primarily limited to January and February. The majority of freshwater flows to the lower San Joaquin River are from three major eastside tributaries, the Merced, Tuolumne and Stanislaus Rivers. Remaining inflow is from agricultural return flows and seasonal westside creeks draining the coastal range.

Flows at San Joaquin River at Lander Avenue, Patterson, and Vernalis, a series of sites moving downstream to the Sacramento-San Joaquin Delta, have been depicted in Figure 3. During water year 1996, high flows occurred in February and March. During water year 1997, flows peaked in early January due to unusually high rainfall in the basin. Flood conditions along the river during these time periods resulted in limited water quality data at a number of sites. Many levees were broken, leading to unrecorded discharge in the river at Patterson and Vernalis

RESULTS

Water quality analytical results for minerals and trace elements, as well as EC, pH, and temperature at time of sampling, are listed by site in Appendices A and B. Appendix A includes sites sampled in Water Year 1996 (WY 96) and Appendix B contains data for the sites sampled during Water Year 1997 (WY 97). All information collected using automated Sigma samplers is presented in Appendix C. The number of sampling events and the ranges, mean and median concentrations for each measured constituent at each site are shown in these appendices. The results have been grouped into two sections for discussion. The first section covers electrical conductivity, boron and selenium, while the second section reviews results for other constituents of concern.

Electrical Conductivity, Boron and Selenium

The electrical conductivity, boron and selenium results have been grouped by water year (1996 and 1997) and are presented by site in the order of the site's location on the San Joaquin River, from upstream to the most downstream site. The first site, the San Joaquin River at Lander Avenue, is the furthest upstream and considered the background site for this program. The subsequent sites discussed progress downstream from the Lander Avenue site. Table 6 summarizes annual minimum, median and maximum EC, boron and selenium concentrations in the river during WYs 96 and 97 and compares those values to the average range in concentration during the previous ten water years of record. The previous ten years of record contained seven critically dry years and three wet years as determined using the San Joaquin River Index (SWRCB, 1995). Since both WYs 96 and 97 were classified as wet water years, the previous data record's summary information, although presented in full, has also been separated into critically dry years and wet years. Results from the autosampler which collected composite samples from the Crows Landing site have also been presented.

Water Year 1996

As documented during the previous years of the monitoring program, water quality at the Lander Avenue site continues to show the lowest boron and selenium concentrations (Table 6). Maximum EC, boron and selenium remained below 1050 $\mu\text{mhos/cm}$, 0.16 mg/L and 0.4 $\mu\text{g/L}$, respectively, during WY 96. This site serves as the background site for the monitoring program on the lower San Joaquin River, as it is located upstream of major agricultural and fresh water inflows. River water at the Lander Avenue site is primarily comprised of seasonal flows from Friant dam, limited irrigation supply and tailwater, and ground water accretions.

Figure 2. Comparison of Rainfall and Discharge Flows From Friant Dam Into the San Joaquin River: Water Years 1996 and 1997.

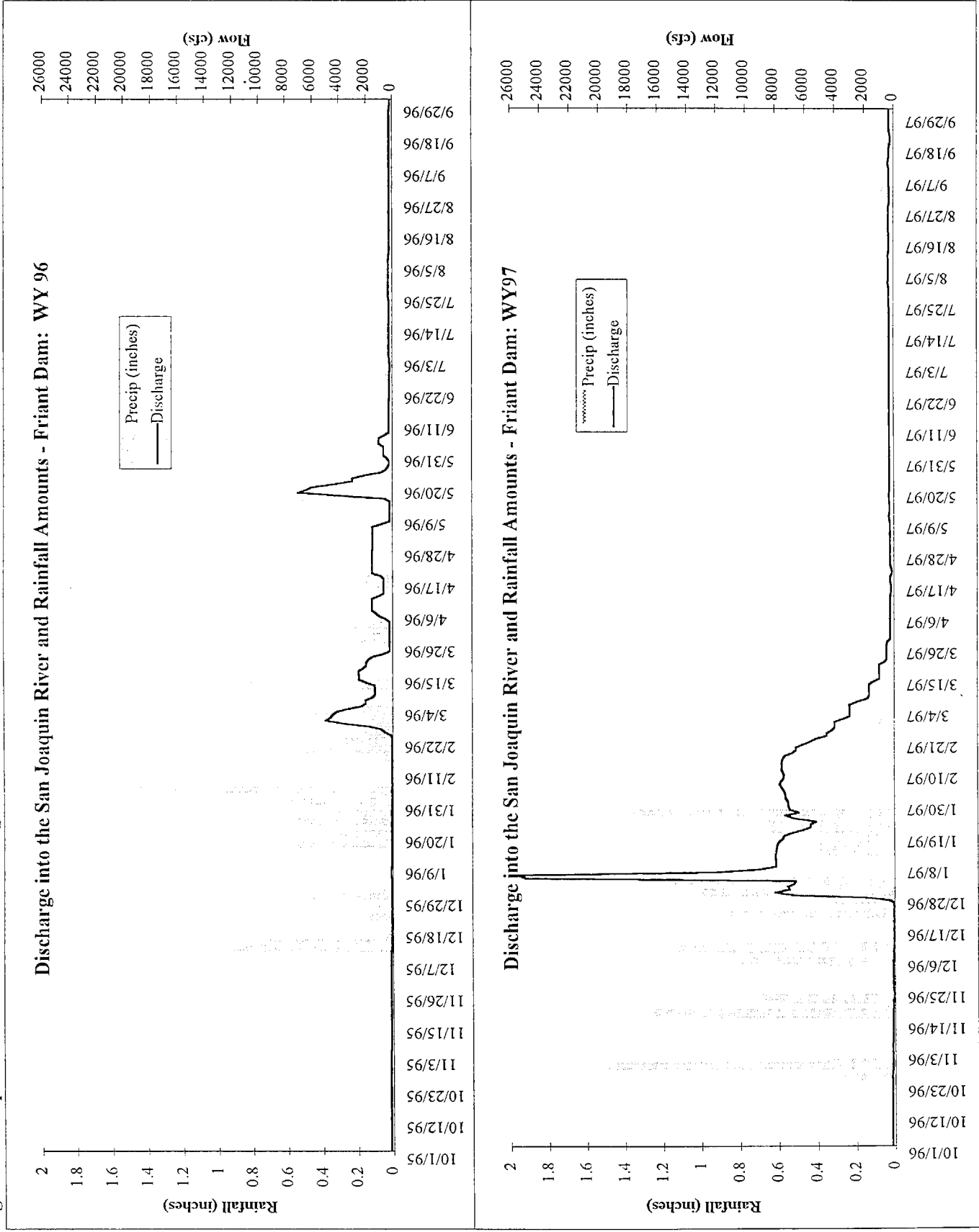


Figure 3. Flows in the San Joaquin River at Lander Avenue, Patterson and Vernalis: Water Years 1996 and 1997.

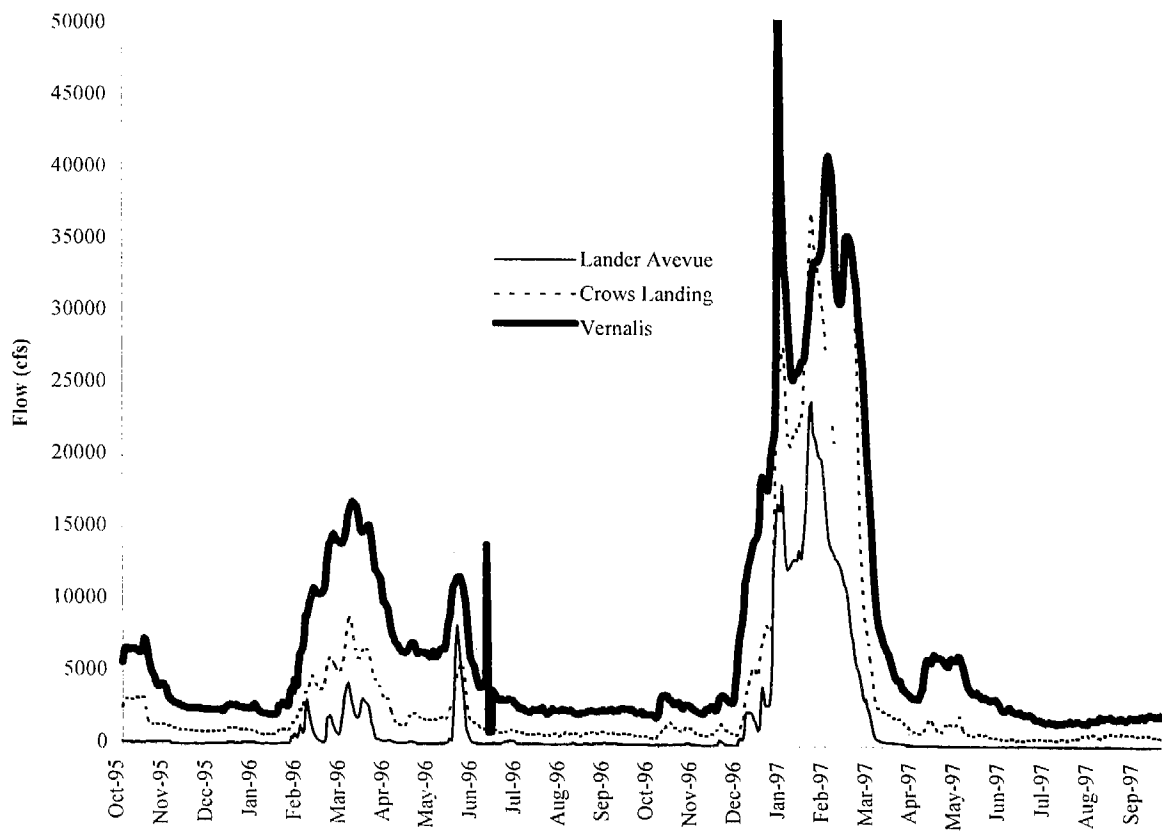


Table 6. Annual Minimum, Median and Maximum Electrical Conductivity, Boron, and Selenium at Monitoring Sites on the Lower San Joaquin River: Water Years 86-95, 96 and 97.

Site	Count	EC (umhos/cm)			Boron (mg/L)			Selenium (ug/L)		
		Min	Median	Max	Min	Median	Max	Min	Median	Max
SJR at Lander Avenue										
WYs 86-95	394	46	1430	4060	<0.01	0.31	1.1	<0.4	0.5	5.0
WYs 86-95 (critical) ¹	304	100	1730	3990	0.03	0.36	0.98	0.4	0.5	1.8
WYs 86-95 (wet) ²	84	46	1060	4060	0.01	0.30	1.1	<0.4	0.5	5.0
WY 96	11	73	371	1050	0.05	0.06	0.13	<0.4	<0.4	0.5
WY 97	6	88	784	1600	<0.05	<0.05	0.16	<0.4	<0.4	<0.4
SJR at Fremont Ford										
WYs 86-95	432	64	2130	4290	0.03	1.8	4.9	<0.4	11.0	35.0
WYs 86-95 (critical)	313	600	2300	4290	0.28	1.9	4.9	0.8	13.2	35.2
WYs 86-95 (wet)	113	64	1660	4050	0.03	1.3	3.5	<0.4	8.0	29.0
WY 96	47	420	1470	2560	0.20	1.3	2.2	0.7	9.0	21.7
WY 97	47	85	1190	2110	0.08	0.54	0.96	<0.4	0.8	1.8
SJR at Hills Ferry Road										
WYs 86-95	428	258	2220	4360	0.17	1.7	5.0	0.6	9.1	28.0
WYs 86-95 (critical)	308	750	2350	4360	0.34	1.9	5.0	1.0	10.9	28.4
WYs 86-95 (wet)	114	258	1740	3650	0.17	1.3	3.0	1.0	7.0	23.0
WY 96	50	406	1490	2510	0.09	1.3	2.0	0.6	7.2	14.0
WY 97	46	76	1680	2700	0.05	1.3	2.5	<0.4	5.8	18.0
SJR at Crows Landing										
WYs 86-95	438	143	1450	2490	0.05	1.0	2.1	<0.4	5.0	17.0
WYs 86-95 (critical)	315	209	1570	2490	0.11	1.1	2.1	0.5	6.2	17.0
WYs 86-95 (wet)	117	143	918	2060	0.05	0.61	2.1	<0.4	3.0	12.0
WY 96	50	135	863	1520	<0.05	0.60	1.3	<0.4	3.3	8.3
WY 97	48	128	989	1460	0.06	0.66	1.2	<0.4	2.7	8.2
SJR at Las Palmas Launch (Patterson)										
WYs 86-95	310	146	1400	2450	0.08	0.83	3.0	<0.4	3.8	14.0
WYs 86-95 (critical)	191	249	1530	2460	0.11	0.98	3.0	0.5	4.9	14.0
WYs 86-95 (wet)	113	146	959	2120	0.08	0.60	1.8	<0.4	3.0	11.0
WY 96	49	170	958	1570	0.06	0.58	1.1	<0.4	3.4	6.9
WY 97	47	218	981	1510	0.11	0.62	1.0	0.5	2.6	7.0
SJR at Maze Blvd.										
WYs 86-95	349	125	1110	1750	0.03	0.58	1.3	<0.4	2.5	9.8
WYs 86-95 (critical)	234	211	1190	1750	0.08	0.68	1.3	0.4	3.3	9.8
WYs 86-95 (wet)	109	125	703	1620	0.03	0.39	0.92	<0.4	2.0	5.0
WY 96	40	146	689	1860	0.06	0.36	0.70	<0.4	1.7	4.2
WY 97	47	172	702	1110	0.09	0.37	0.68	<0.4	1.5	4.7
SJR at Vernalis (Airport Way)										
WYs 86-95	433	123	870	1680	0.01	0.45	1.2	<0.4	2.1	17.0
WYs 86-95 (critical)	313	217	931	1680	0.02	0.51	1.2	0.4	2.5	9.6
WYs 86-95 (wet)	113	123	604	1420	0.01	0.33	0.83	<0.4	2.0	17.0
WY 96	49	134	564	972	0.05	0.29	0.50	<0.4	1.4	2.6
WY 97	45	156	563	816	0.07	0.26	0.43	<0.4	1.1	2.9
Autosampler Data										
SJR at Crows Landing										
WY 96	323	134	897	1640	<0.05	0.60	1.5	0.5	3.4	9.2
WY 97	327	121	979	1740	0.05	0.68	1.6	<0.4	2.9	10.0

Count = the minimum number of analyses out of the three constituents

Water year type is based on the San Joaquin 60-20-20 River Index as follows:

¹Critical Water Year: Runoff < 2.1 million ac-ft (WYs 87-92 and 94)

²Wet Water Year: Runoff > 3.81 million ac-ft (WYs 86, 95, 96, and 97)

The next downstream site sampled on the San Joaquin River is at Fremont Ford, downstream of the confluence with Salt Slough. During WY 96, Salt Slough carried a combination of agricultural surface and subsurface drainage, storm runoff from surrounding lands and the city of Los Banos, and seasonal releases from duck clubs. Constituents of concern at the Fremont Ford site were elevated over the concentrations reported upstream at Lander Avenue. Median EC, boron and selenium values were reported at 1470 $\mu\text{mhos/cm}$, 1.3 mg/L and 9.0 $\mu\text{g/L}$, respectively, while maximum concentrations reached 2560 $\mu\text{mhos/cm}$, 2.2 mg/L, and 21.7 $\mu\text{g/L}$.

The next downstream sampling site on the San Joaquin River is near Hills Ferry Road, just downstream of the confluence of Mud Slough (north) but upstream of the Merced River inflow. Mud Slough (north), as with Salt Slough, carried a combination of agricultural return flows, storm water, and wetland releases, during WY 96. Drainage flows can readily be switched between the two sloughs through a series of diversion structures so that either slough is able to carry runoff from the other's watershed. During WY 96, Salt Slough carried the majority of subsurface agricultural drainage out of the Grassland Watershed. EC concentrations in the river near Hills Ferry, reached 2510 $\mu\text{mhos/cm}$ with a median of 1490 $\mu\text{mhos/cm}$. Median concentrations for boron and selenium were 1.3 mg/L and 7.2 $\mu\text{g/L}$, respectively. These concentrations are similar to those measured at the Fremont Ford site during WY 96.

Downstream of the Merced River inflow, constituent concentrations in the San Joaquin River rapidly decreased. During WY 96, maximum EC, boron and selenium concentrations at Crows Landing (the first site downstream of the Merced River inflow) were 1640 $\mu\text{mhos/cm}$, 1.5 mg/L and 9.2 $\mu\text{g/L}$, respectively, while median values were recorded at 897 $\mu\text{mhos/cm}$, 0.6 mg/L and 3.4 $\mu\text{g/L}$, respectively. At the final downstream sampling location, the San Joaquin River at Vernalis (downstream of the Tuolumne and Stanislaus River inflows), maximum EC, boron and selenium concentrations dropped to 972 $\mu\text{mhos/cm}$, 0.5 mg/L and 2.6 $\mu\text{g/L}$, respectively. Median concentrations of the same constituents were 564 $\mu\text{mhos/cm}$, 0.29 mg/L and 1.4 $\mu\text{g/L}$, respectively.

Water Year 1997

During WY 97, the background site on the San Joaquin River at Lander Avenue was sampled monthly for EC and quarterly for boron and selenium. The decrease in sampling frequency over WY 96, reflected the consistently low constituent concentrations apparent at this site since the program began in 1985. Ranges in concentrations are comparable to previous water years, with median EC, boron and selenium values at 784 $\mu\text{mhos/cm}$, <0.05 mg/L, and <0.4 $\mu\text{g/L}$, respectively.

Constituent concentrations at the Fremont Ford site reflect operation of the Grassland Bypass Project which resulted in the diversion of subsurface agricultural drainage water out of Salt Slough and into Mud Slough (north), in WY 97. Salt Slough discharges into the San Joaquin River upstream of the Fremont Ford site and Mud Slough (north) discharges into the San Joaquin River downstream of the Fremont Ford site. Between WYs 96 and 97, concentrations of all constituents of concern decreased at the Fremont Ford site. Median EC, boron, and selenium concentrations dropped from 1470 $\mu\text{mhos/cm}$, 1.3 mg/L, and 9.0 $\mu\text{g/L}$, respectively, during WY 96, to 1190 $\mu\text{mhos/cm}$, 0.54 mg/L, and 0.8 $\mu\text{g/L}$, respectively, during WY 97.

The San Joaquin River at Hills Ferry Road receives inflow from Mud Slough (north) and Salt Slough. EC concentrations at the Hills Ferry site ranged from 76 $\mu\text{mhos/cm}$ (following the flood events of January, 1997) to 2700 $\mu\text{mhos/cm}$ with a median of 1680 $\mu\text{mhos/cm}$. Median concentrations for boron and selenium at the Hills Ferry Road site were the highest of all the sites sampled in WY 97 at 1.3 mg/L and 5.8 $\mu\text{g/L}$, respectively. Maximum boron and selenium concentrations reached 2.5 mg/L and 18.0 $\mu\text{g/L}$, respectively.

Freshwater inflow from the Merced River, diluted constituent concentrations in the San Joaquin River at the downstream Crows Landing sampling location. Grab samples for EC, boron and selenium recorded maximum concentrations of 1460 $\mu\text{mhos/cm}$, 1.2 mg/L, and 8.2 $\mu\text{g/L}$, respectively, and median values at 989 $\mu\text{mhos/cm}$, 0.66 mg/L, and 2.7 $\mu\text{g/L}$, respectively.

Concentrations continued to decrease downstream in the San Joaquin River with the inflow from two additional east side tributaries: the Tuolumne and Stanislaus Rivers. Salt, boron and selenium concentrations are very low in these tributaries and improve the water quality in the San Joaquin River accordingly. The Las Palmas site near Patterson, is just upstream of these tributary inflows and concentrations at this site corresponded to those measured at the Crows Landing Bridge site. Monitoring sites downstream of the Las Palmas site showed decreasing constituent concentrations. At the farthest downstream sampling location, the San Joaquin River at Vernalis, ECs ranged from 156 to 816 $\mu\text{mhos/cm}$, while median boron and selenium concentrations were 0.26 mg/L and 1.1 $\mu\text{g/L}$, respectively.

Daily Composite Samples

During both WYs 96 and 97, daily composite water samples for EC, boron and selenium were collected from the San Joaquin River at the Crows Landing site using automated Sigma samplers. Some data gaps occurred within the sample set due to high flood waters stranding the sampler mid-river on a floating dock. These data gaps occur as follows:

23 February 1996 to 18 March 1996;
18 January 1997 to 8 February 1997; and
8 March 1997 to 14 March 1997.

All available data has been presented in Appendix C. Figure 4 presents a comparison of boron and selenium water quality information from the composite samples with grab samples collected during the same time period. Figure 5 compares the daily composite EC values with the daily discharge at the site.

Values recorded in the San Joaquin River at Crows Landing demonstrate the tremendous influence of dilution flows on the water quality at that site. During the storm season and high runoff events, concentrations remain low, with selenium concentrations below 0.5 $\mu\text{g/L}$ during much of the flooding which occurred between mid-December 1996 and March 1997. Concentrations of all constituents increased in April (normally a period of agricultural pre-irrigation). Although some of the EC and boron and the majority of the selenium increase can be attributed to increased subsurface agricultural drainage flows from the Grassland Watershed, other pre-irrigation drainage and wetland releases also contribute salt and boron. The highest concentrations of EC, boron and selenium were observed during the period of April through July, followed by a trend of diminishing concentrations through September.

Other Elements of Concern

During WY96, limited additional water quality analyses were conducted quarterly for copper, chromium, lead, nickel and zinc, and monthly for molybdenum at four sites along the San Joaquin River: Lander Avenue, Hills Ferry, Crows Landing, and Vernalis. Many of these additional analyses were discontinued during WY 97 due to monetary constraints. Apparent laboratory contamination also invalidated many of the copper and zinc results, during WY 96. Results which satisfied the quality control criteria listed in Table 3, have been summarized in Table 7. None of the concentrations noted reach or exceed existing water quality objectives.

DISCUSSION

Comparison Between Water Year 1996 and Water Year 1997

Between WYs 96 and 97, little difference in water quality concentrations or seasonal trends is apparent at the majority of San Joaquin River stations monitored. The one exception is the San Joaquin River at Fremont Ford. During WY 97, all constituents measured at this site (electrical conductivity, boron and selenium), showed a marked reduction in concentration when compared to WY 96 (Figure 6). The decrease can be attributed to rerouting of agricultural drainage in the upstream Grassland Watershed as part of the Grassland Bypass Project.

Figure 4. Comparison of Boron and Selenium Concentrations from Weekly Grabs vs. Autosampler Collections in the San Joaquin River at Crows Landing: Water Years 1996 and 1997.

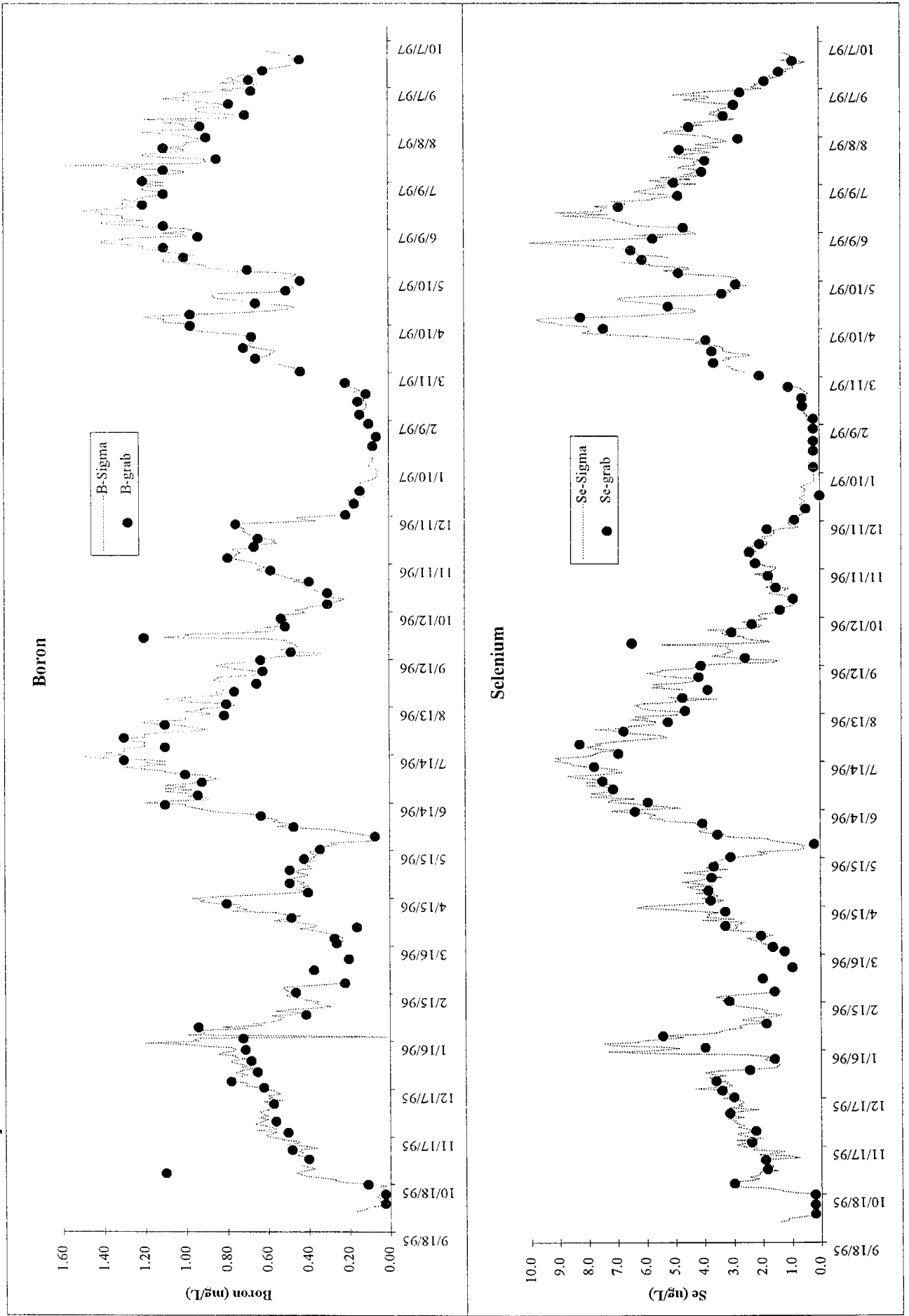


Figure 5. Daily Composite Electrical Conductivity vs. Discharge in the San Joaquin River at Crows Landing: Water Years 1996 and 1997.

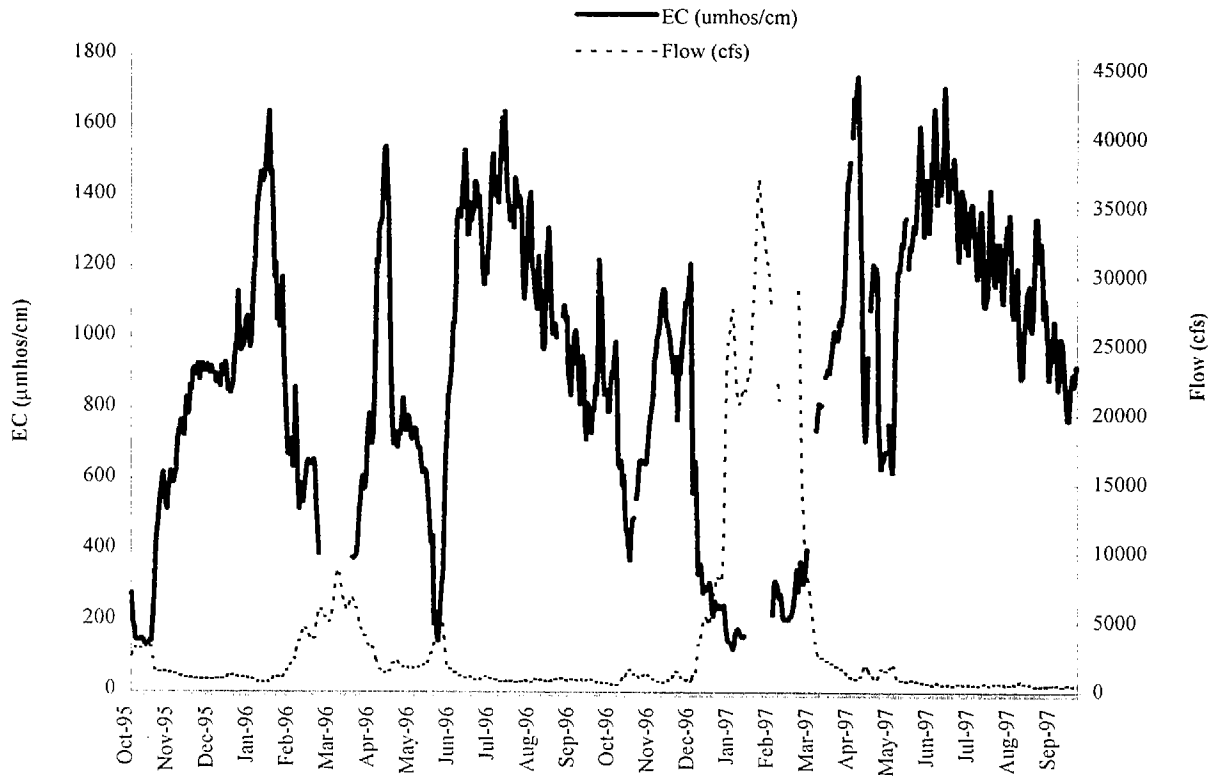


Table 7. Summary of Copper, Chromium, Lead, Nickel, Zinc and Molybdenum Results at Selected Sites in the Lower San Joaquin River: Water Years 1996 and 1997.

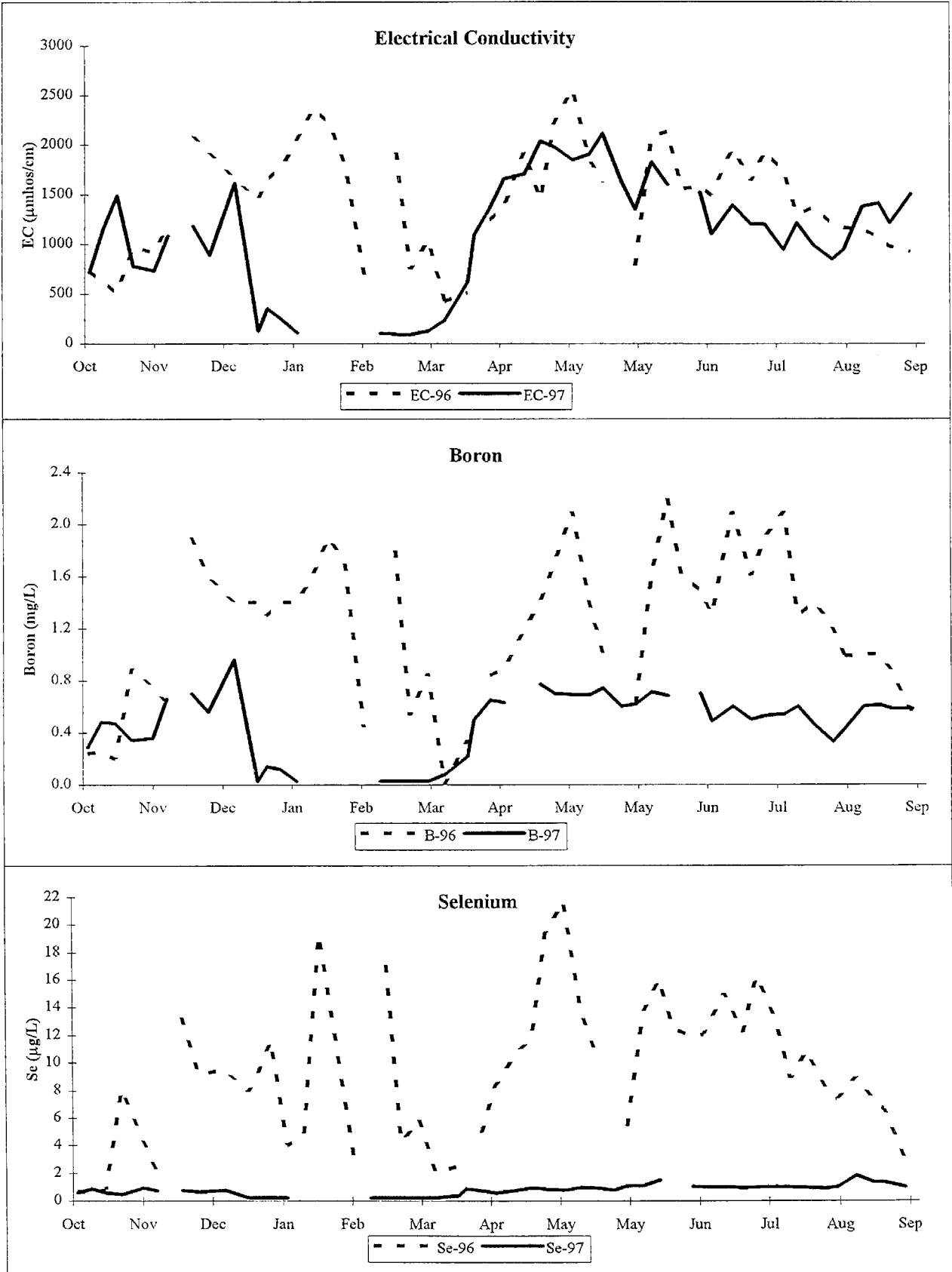
WY / Constituent	Concentrations (ug/L)											
	Lander Avenue*			Hills Ferry†			Crows Landing†			Vernalis*		
	min	mean	max	min	mean	max	min	mean	max	min	mean	max
Water Year 1996 total:												
Cu	4	5	6	3	6	8	2	5	8	3	5	8
Cr	2	4	6	5	8	12	2	7	10	3	6	10
Pb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ni	<5	<5	5	6	8	11	<1	6	11	<5	6	11
Zn	4	7	12	7	12	21	<1	10	20	2	9	16
Mo	1	3	6	5	7	8	2	4	5	1	2	3
dissolved:												
Cu				3	6	9	4	6	9			
Cr				<1	3	7	<1	2	5			
Pb				<5	<5	<5	<5	<5	<5			
Ni				<5	6	7	<5	<5	<5			
Zn				[7]	[12]	[17]	[8]	[9]	[9]			
Water Year 1997 Total Mo	1	3	6	1	7	12	<1	4	6	<1	2	4

* = sampled quarterly

[] = only 2 samples analyzed

† = sampled monthly

Figure 6. Comparison of Electrical Conductivity, Boron, and Selenium Concentrations in the San Joaquin River at Fremont Ford: Water Years 1996 and 1997.



During WY 96, the majority of subsurface agricultural drainage discharge from the watershed was routed to Salt Slough which enters the San Joaquin River upstream of the Fremont Ford site. Beginning 26 September 1996, the bulk of this drainage was rerouted to the lower reach of Mud Slough (north) and entered the river downstream of the Fremont Ford site. Redirection of this drainage clearly reduced electrical conductivity, boron and especially selenium concentrations in the river at Fremont Ford. Redirection of the drainage did not appreciably impact water quality in the river downstream of Fremont Ford. Electrical conductivity, boron and selenium concentrations are comparable for both water year 1996 and 1997 at the next downstream site (Hills Ferry) which has historically received the commingled discharge from Salt Slough and Mud Slough (north).

Further reduction in river electrical conductivity, boron and selenium concentrations does not occur until inflows from major eastside tributaries (Merced, Tuolumne and Stanislaus Rivers) provide dilution water (Figure 7). Figure 7 depicts the constituent concentrations at three locations in the San Joaquin River, both upstream (Hills Ferry) and downstream (Crows Landing and Vernalis) of the Merced River inflow, during WYs 96 and 97. As shown in Figure 7, concentrations were the highest upstream of the Merced River at the Hills Ferry site, although all sites follow similar trends. Concentrations appear to peak at the Hills Ferry site during the irrigation season (April through August), with a sharp increase occurring during March 1997, a period of very dry weather and little upstream dilution flow. Concentrations decrease downstream of the Merced River inflow, at the Crows Landing site. More significant reductions in concentrations occur downstream of inflows from the Tuolumne and Stanislaus Rivers, as shown at the Vernalis site.

Comparison to Applicable Water Quality Objectives

In October 1988, the Regional Board adopted water quality objectives for boron, molybdenum and selenium for the lower San Joaquin River between Sack Dam and Vernalis. Two sets of objectives were developed. One set of objectives was established for the river reach with minimal freshwater flow, between Sack Dam and the inflow from the Merced River. The second set is for the reach of river from the inflow of the Merced River to Vernalis, which has highly managed freshwater inflows. The objectives were also based on water year type, as classified by the San Joaquin River Index (SWRCB, 1987 and SWRCB, 1995), and season. Slightly relaxed objectives were implemented during critical water years reflecting the lack of good quality dilution flows from tailwater and/or flows from the eastside tributaries. In addition, more stringent boron objectives were adopted during the irrigation season, 15 March through 15 September, when downstream crops would be susceptible to boron toxicity from irrigation water. As specified in the amendment, compliance monitoring for selenium and boron water quality objectives is conducted on the San Joaquin River at the Crows Landing Road Bridge site. The Crows Landing Road Bridge site is downstream of the Merced River inflow and also receives water from agricultural return flows and groundwater seepage.

On 22 December 1992, the US Environmental Protection Agency (EPA) finalized promulgation of water quality standards for all states which they felt had not satisfied section 303(c)(2)(b) of the Clean Water Act. Section 303(c)(2)(b) required the setting of enforceable numeric water quality criteria on all surface water of the Nation. California was included in the promulgation for a limited number of criteria and specifically included for a maximum criteria of 20 µg/L selenium in the San Joaquin River from Sack Dam to the mouth of the Merced River and a continuous (four-day average) criteria of 5 µg/L for selenium in the river from Sack Dam to Vernalis. Although the promulgation applied directly to permitted point source discharges, some uncertainty remained on the application of the criteria to nonpoint source discharges such as agricultural drainage.

In May 1996, the Regional Board adopted revised selenium water quality objectives for the lower San Joaquin River and also a compliance time schedule which includes performance goals. These objectives are consistent with the US EPA promulgation.

Water quality objectives for boron, selenium and molybdenum, which applied to the two segments of the lower San Joaquin River during WYs 96 and 97 (both wet water years), have been listed in Table 8. The compliance time schedule and performance goals which apply to the selenium objective, are listed in Table 9.

Figure 7. Comparison of Weekly Measurements of Electrical Conductivity, Boron and Selenium Concentrations in the San Joaquin River at Hills Ferry, Crows Landing and Vernalis: Water Years 1996 and 1977

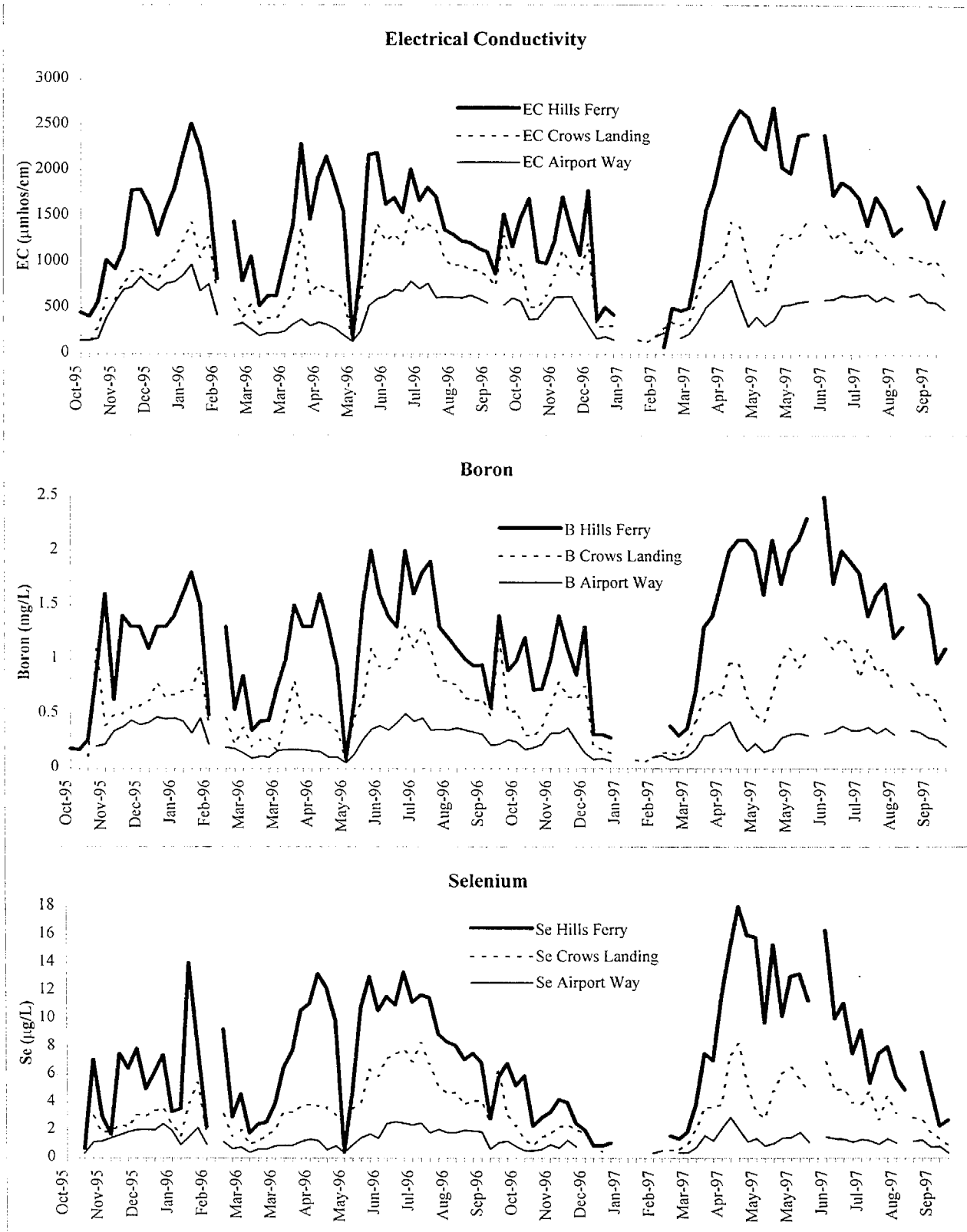


Table 8. Boron, Selenium and Molybdenum Water Quality Objectives for the Lower San Joaquin River.

Water Body	Boron (mg/L)		Selenium ($\mu\text{g/L}$)		Molybdenum ($\mu\text{g/L}$)	
	Continuous	Maximum	Continuous	Maximum	Continuous	Maximum
San Joaquin River between Sack Dam and the Merced River Inflow						
WY 1996	2.0 (monthly mean) [†]	5.8	10 (monthly mean)	26	19 (monthly mean)	50
WY 1997	2.0 (monthly mean) [†]	5.8	5 (4-day average) [*]	20	19 (monthly mean)	50
San Joaquin River from the Merced River Inflow to Vernalis						
WY 1996	0.8 (monthly mean) [†]	2.0 [†]	5 (monthly mean)	12	10 (monthly mean)	15
WY 1997	1.0 (monthly mean) ^{††}	2.6 ^{††}	5 (4-day average) ^{**}	12	same	same

[†] = The water quality objective only applies from 15 March through 15 September

^{††} = The water quality objective only applies from 16 September through 14 March

^{*} = Compliance time schedule adopted and in effect until October 2010

^{**} = Compliance time schedule adopted and in effect until October 2005

Table 9. Summary of Selenium Water Quality Objectives and Compliance Time Schedule
[Selenium Water Quality Objectives (in bold) and Performance Goals (in italics)]

Water Body/ Water Year Type ¹	1 October 1996	1 October 2002	1 October 2005	1 October 2010
San Joaquin River below the Merced River; Above Normal and Wet Water Year types		<i>5 µg/L monthly mean</i>	5 µg/L 4-day average	
San Joaquin River below the Merced River; Critical, Dry, and Below Normal Water Year types		<i>8 µg/L monthly mean</i>	<i>5 µg/L monthly mean</i>	5 µg/L 4-day average
San Joaquin River from Sack Dam to the Merced River.				5 µg/L 4-day average

¹ The water year classification will be established using the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification (as defined in Footnote 17 for Table 3 in the State Water Resources Control Board *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*, May 1995) at the 75th exceedance level using data from the Department of Water Resources Bulletin 120 series. The previous water year's classification will apply until an estimate is made of the current water year.

Boron

Separate boron water quality objectives apply to the lower San Joaquin River upstream and downstream of the Merced River inflow. Downstream of the Merced River, the objectives are further divided seasonally: 0.8 mg/L during the irrigation season (15 March through 15 September) and 1.0 mg/L for the remainder of the year. Table 10 lists the mean monthly boron concentrations at all sites monitored in the San Joaquin River for both water years and indicates whether the applicable monthly mean water quality objective was exceeded.

During both water years, the applicable monthly mean boron objectives were exceeded at the Crows Landing and Patterson sites, primarily between June and August. Review of the daily composited data from the Crows Landing site indicates an expanded time period of exceedance, from April through August, during WY 97. The objectives were not exceeded downstream of the Patterson site (downstream of additional eastside tributary inflows from the Tuolumne and Stanislaus Rivers).

The instantaneous maximum boron water quality objectives (ranging from 2.0 mg/L to 5.8 mg/L, depending on location on the river and season) were not exceeded during either WY 96 or WY 97. The highest boron concentration recorded was 2.2 mg/L at Fremont Ford in June 1996 (WY 96) and 2.5 mg/L at Hills Ferry in June 1997 (WY 97).

Selenium

The selenium water quality objective was revised between WY 96 and WY 97. Prior to WY 97, the selenium objective varied based on location, upstream or downstream of the Merced River inflow. After 10 January 1997, the continuous selenium objective became 5 µg/L based on a 4-day average, and is subject to a compliance time schedule (Table 9). The maximum objective still varies according to location (Table 8).

Table 11 presents the monthly mean selenium concentrations at selected locations in the San Joaquin River and indicates whether the water quality objectives would have been exceeded had they not been subject to a compliance time schedule. During WY 96, elevated monthly mean selenium concentrations exceeded water quality objectives from April through July at the Fremont Ford site and during June and July at the downstream Hills Ferry, Crows Landing and Patterson sites.

Just prior to WY 97, the Grassland Bypass Project went into operation and diverted subsurface agricultural drainage from Salt Slough, which discharges into the San Joaquin River upstream of the Fremont Ford site, to Mud Slough (north), which discharges downstream of Fremont Ford. During WY 97, no selenium water quality objective exceedances were recorded in the river at the Fremont Ford site, even though the objective was lowered from 10 µg/L to 5 µg/L. With the lower selenium objective, potential exceedances increased at the Hills Ferry site, with monthly mean concentrations above 5 µg/L from March through August. Downstream of the Merced River inflow, the 5 µg/L selenium objective was exceeded in April and June at both the Crows Landing and Patterson locations. Further downstream, the objective was met during all months at the Maze Blvd. and Vernalis sites, based on monthly averages.

The maximum selenium water quality objectives which applied, 12 µg/L to 26 µg/L, depending on location and water year (Table 8), were not exceeded at any time during either water year. The highest selenium concentrations recorded in the river were 21.7 µg/L at Fremont Ford in May 1996 (WY 96) and 18.0 µg/L at Hills Ferry in April 1997 (WY 97).

The concentrations listed in Table 11 are monthly mean concentrations for comparison; however, the selenium water quality objective is a 4-day average. Daily composite samples were analyzed for selenium at the Crows Landing site. Figure 8 compares the 4-day running average selenium concentration at Crows Landing against the 5 µg/L water quality objective for both WY 96 and WY 97. Water quality objective exceedances are grouped within the months of April through August in WY 96, and April and June in WY 97, as was recorded using the monthly mean concentrations.

Table 10. Monthly Mean Boron Concentrations and Water Quality Objective (WQO) Exceedances in the San Joaquin River: Water Years 1996 and 1997.

Water Year/Site	WQO mg/L	Monthly Mean Concentration (mg/L)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Water Year 1996													
Lander Avenue	2†	<0.05	0.11	0.07	0.05	<0.05	0.06	0.09	<0.05	0.06	0.13	0.06	<0.05
Freemont Ford	2†	0.40	1.2	1.4	1.7	0.92	0.68	1.3	1.3	1.7	1.7	1.4	0.85
Hills Ferry	2†	0.38	1.2	1.3	1.6	0.78	0.56	1.28	0.91	1.6	1.7	1.3	0.96
Crows Landing	0.8/1.0††	0.32	0.49	0.66	0.76	0.36	0.25	0.54	0.36	<i>0.90</i>	<i>1.2</i>	<i>0.82</i>	0.73
Las Palmas	0.8/1.0††	0.16	0.48	0.64	0.81	0.31	0.29	0.56	0.39	<i>0.92</i>	<i>0.97</i>	<i>0.85</i>	0.69
Maze Blvd.	0.8/1.0††	0.13	0.35	0.50	0.50	0.19	0.16	0.24	0.17	0.5	0.66	0.49	0.35
Vernalis	0.8/1.0††	0.20	0.35	0.44	0.42	0.20	0.12	0.17	0.11	0.34	0.45	0.36	0.27
Crows Ldg Sigma	0.8/1.0††	0.19	0.51	0.63	0.77	0.44	0.33	0.59	0.33	<i>0.89</i>	<i>1.2</i>	<i>0.93</i>	0.64
Water Year 1997													
Lander Avenue*	2†	<0.05	<0.05	<0.05	<0.05	NA	NA	0.11	NA	NA	0.16	NA	NA
Freemont Ford	2†	0.69	0.71	0.31	<0.05	<0.05	0.36	0.70	0.67	0.70	0.53	0.46	0.59
Hills Ferry	2†	0.91	1.1	0.55	0.37	0.19	0.95	2.0	1.9	<i>2.3</i>	1.8	1.5	1.3
Crows Landing	0.8/1.0††	0.41	0.67	0.32	0.07	0.13	0.50	<i>0.82</i>	0.74	<i>1.1</i>	<i>1.1</i>	<i>0.82</i>	0.60
Las Palmas	0.8/1.0††	0.45	0.58	0.32	0.11	0.14	0.48	0.77	0.69	<i>0.99</i>	<i>0.84</i>	0.73	0.58
Maze Blvd.	0.8/1.0††	0.27	0.45	0.12	0.13	0.12	0.30	0.40	0.40	0.60	0.49	0.42	0.37
Vernalis	0.8/1.0††	0.22	0.32	0.09	0.1	0.10	0.23	0.31	0.23	0.31	0.36	0.34	0.27
Crows Ldg Sigma	0.8/1.0††	0.42	0.64	0.32	0.08	0.13	0.47	<i>0.82</i>	<i>0.81</i>	<i>1.2</i>	<i>1.1</i>	<i>0.95</i>	0.66

† = water quality objective only applies 15 March through 15 September

†† = 0.8 mg/L objective applies 15 March through 15 September; 1.0 mg/L objective applies 16 September through 14 March

* = only analyzed quarterly

Bold Italic = water quality objective exceedance

Table 11. Monthly Mean Selenium Concentrations and Water Quality Objective (WQO) Exceedances in the San Joaquin River: Water Years 1996 and 1997.

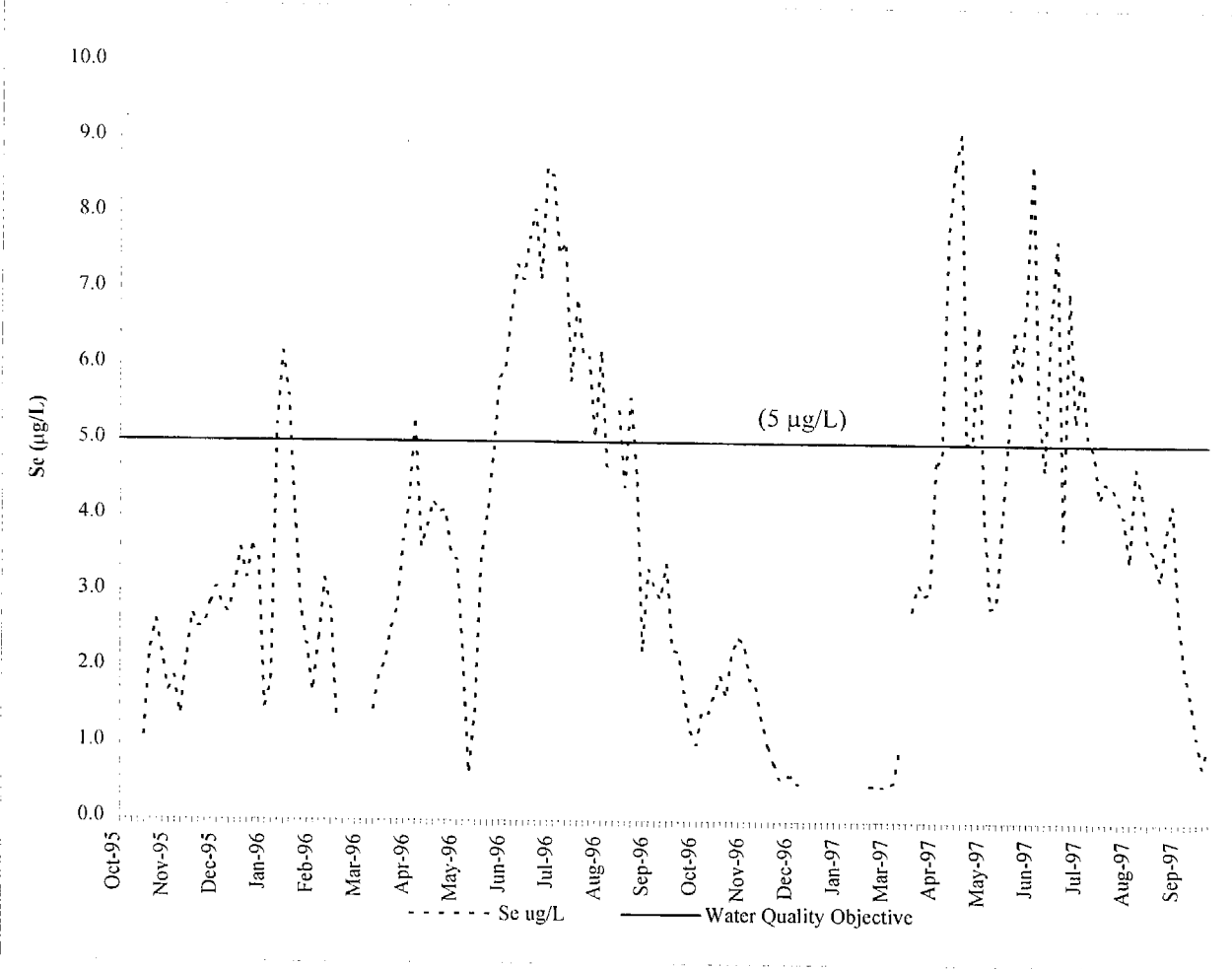
Water Year/Site	WQO* µg/L	Monthly Mean Concentration (µg/L)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Water Year 1996													
Lander Avenue	10	0.2	0.3	0.2	0.5	0.2	NA	0.3	0.3	0.2	0.3	0.2	0.1
Freemont Ford	10	2.6	7.2	9.5	9.9	8.0	4.5	<i>12.6</i>	<i>12.9</i>	<i>13.5</i>	<i>13.8</i>	9.6	6.4
Hills Ferry	10	2.1	4.7	6.6	7.2	4.8	3.1	9.0	8.1	<i>11.5</i>	<i>11.8</i>	8.8	5.7
Crows Landing	5	0.9	2.1	3.3	3.4	2.2	1.6	3.6	2.8	<i>5.9</i>	<i>7.7</i>	5.0	4.4
Las Palmas	5	0.9	2.0	3.4	3.5	2.2	1.6	3.4	3.0	<i>5.5</i>	<i>6.4</i>	4.8	3.4
Maze Blvd.	5	0.7	1.4	2.5	2.0	1.0	0.9	1.5	0.9	2.7	3.9	2.7	1.8
Vernalis	5	0.5	1.6	2.1	1.7	0.9	0.7	1.1	0.8	1.8	2.5	1.9	1.4
Crows Ldg Sigma	5	1.1	2.2	3.1	3.9	2.4	2.0	4.0	2.8	<i>6.1</i>	<i>7.6</i>	<i>5.8</i>	3.7
Water Year 1997													
Lander Avenue**	5	<0.4	<0.4	<0.4	<0.4	NA	NA	<0.4	NA	NA	<0.4	NA	NA
Freemont Ford	5	0.7	0.7	<0.4	<0.4	<0.4	0.5	0.8	0.9	1.2	1.0	1.0	1.4
Hills Ferry	5	4.6	3.5	1.2	1.1	0.9	<i>5.1</i>	<i>15.1</i>	<i>12.8</i>	<i>13.6</i>	<i>8.6</i>	<i>6.6</i>	4.4
Crows Landing	5	1.8	2.1	0.9	<0.4	0.4	2.6	<i>6.2</i>	4.7	<i>5.8</i>	4.5	3.4	1.7
Las Palmas	5	1.8	1.8	0.8	0.5	0.5	2.5	<i>5.6</i>	4.3	<i>5.8</i>	3.5	2.9	1.8
Maze Blvd.	5	1.0	1.3	0.3	0.6	0.4	1.4	2.9	2.1	3.2	1.9	1.5	1.1
Vernalis	5	0.8	1.0	<0.4	0.4	0.4	1.0	2.1	1.3	1.5	1.3	1.2	0.8
Crows Ldg Sigma	5	1.9	2.0	0.9	<0.4	0.4	2.4	<i>6.6</i>	4.7	<i>6.8</i>	4.8	3.9	1.9

* = Water quality objective applied as a monthly mean in WY96 and a 4-day average subject to a compliance time schedule in WY97

** = only monitored quarterly

Bold Italic = water quality objective exceedance

Figure 8. 4-Day Running Average Selenium Concentrations in the San Joaquin River at Crows Landing Compared to the 5 µg/L Water Quality Objective: Water Years 1996 and 1997.



Molybdenum

The molybdenum water quality objectives adopted for the lower San Joaquin River primarily reflect concern over the potential accumulation in livestock forage if the water is used for irrigation. Upstream of the Merced River, the monthly mean molybdenum objective is 19 µg/L with an instantaneous maximum of 50 µg/L. Downstream of the Merced River, the monthly mean molybdenum objective drops to 12 µg/L with an instantaneous maximum of 15 µg/L. The highest molybdenum concentration detected in the San Joaquin River during the study period, was 12 µg/L at the Hills Ferry site on 19 June 1997. The reported maximum concentration does not exceed any of the adopted continuous or maximum molybdenum water quality objectives listed in Table 8.

ANNUAL LOADING OF SALT, BORON AND SELENIUM

Salt, boron, and selenium loads for the San Joaquin River at Crows Landing and near Vernalis were estimated based upon the flow weighted monthly average of the available water quality data. Preliminary daily discharge data and daily electrical conductivity for the two sites was obtained from the USGS (Pat Shiffer, personal communication). Salt loads are based upon daily electrical conductivity measurements at the two sites. Boron and selenium loads are based upon Regional Board water quality data. Sigmatm automatic sample data for the Crows Landing site was supplemented with grab samples for periods during which no automatic samples were collected due to flooding. Only grab samples were collected and used for the Vernalis site. The methodology used to present loads can be found Grober et al., 1998. Raw data used to present loads have been tabulated and are available at the Regional Board's Sacramento Office. This information can also be found at the Regional Board web site. Follow the links to view or download files from:

<http://www.swrcb.ca.gov/~rwqcb5/home.html>

Tabulated flow and water quality data used to compute loads for water years 1986 through 1997 are presented chronologically. Each year of data is comprised of four data tables; the first table contains mean daily flow data; the second, third and fourth contain electrical conductivity (EC), boron and selenium data, respectively. Additionally, EC, boron, and selenium data are presented for five SigmaTM automatic sampler sites for water years 1995, 1996 and 1997. Matrices are sparsely filled for some water quality data.

For Water Year 1997, monthly discharge and load estimates are approximate for Crows Landing and Vernalis during the flood events of January and February because of estimated peak discharges and limited water quality data availability. Much of the discharge in the San Joaquin River near Vernalis occurred outside of the channel due to numerous levee breaks during these flood events. When this occurs, discharge can be far greater than is estimated using existing stage discharge relationships. Model estimated discharges for the San Joaquin River near Vernalis (SJRMP, 1997) suggest that the actual daily discharge during the January-February floods was up to fifty percent higher than the preliminary discharge estimated by the USGS. Flood flows also restricted access to sites limiting the number of samples collected. Boron and selenium loads for the San Joaquin River near Vernalis in January were based on only a single grab sample rather than the usual four monthly samples. Additionally, grab samples collected during flood flows may not be representative of the mean water quality at a site because of the large volume of overland flow that occurs during these events. Pumping of water from flooded fields just upstream of the Crows Landing site on the right (east) bank during February, for example, likely skewed the water quality at the Regional Board sampling location so that it was not necessarily representative of the mean discharge. Similarly, overland flow on the left (west) bank of the San Joaquin River, just upstream of the Vernalis sampling location, likely skewed the water quality at this site such that it was not representative of the mean.

Monthly discharge, monthly flow weighted average concentrations and loads for water years 1996 and 1997 are presented for the San Joaquin River at Crows Landing (Table 12) and near Vernalis (Table 13). Annual discharge at Crows Landing increased from 1.4 million acre-feet in 1996 to 4.2 million acre-feet in 1997. Annual discharge near Vernalis increased from 4.0 million acre-feet in 1996 to 6.8 million acre-

Table 12. Monthly and Annual Discharge, Loads of Salt, Boron and Selenium, and Flow Weighted Concentrations for the San Joaquin River at Crows Landing: Water Years 1996 and 1997.

Water Year 1996 Month	Flow (af)	Loads			Flow Weighted Conc.		
		Se (lbs)	B (1000 lbs)	TDS (tons)	Se (ppb)	B (ppm)	TDS (ppm)
Oct-95	143,748	334	53	31,001	0.9	0.14	159
Nov-95	59,236	338	83	40,112	2.1	0.52	498
Dec-95	61,176	517	108	48,318	3.1	0.65	581
Jan-96	59,022	628	118	55,579	3.9	0.74	692
Feb-96	247,201	1,554	269	117,474	2.3	0.40	349
Mar-96	370,920	1,712	303	146,389	1.7	0.30	290
Apr-96	118,445	1,200	181	92,958	3.7	0.56	577
May-96	172,124	1,070	130	64,336	2.3	0.28	275
Jun-96	67,345	1,051	156	69,413	5.7	0.85	758
Jul-96	49,180	1,014	157	57,062	7.6	1.17	853
Aug-96	49,932	775	124	47,291	5.7	0.91	696
Sep-96	47,402	493	82	35,667	3.8	0.64	553
WY 96 Total	1,445,730	10,686	1,765	805,600	2.7	0.45	410

Water Year 1997 Month	Flow (af)	Loads			Flow Weighted Conc.		
		Se (lbs)	B (1000 lbs)	TDS (tons)	Se (ppb)	B (ppm)	TDS (ppm)
Oct-96	59,165	260	61	31,448	1.6	0.38	391
Nov-96	58,025	314	99	42,450	2.0	0.63	538
Dec-96	267,166	454	139	72,904	0.6	0.19	201
Jan-97 *	1,570,139	1,290	322	217,686	0.3	0.08	102
Feb-97 *	1,599,174	1,416	566	286,266	0.3	0.13	132
Mar-97	351,943	1,270	285	150,392	1.3	0.30	314
Apr-97	76,153	1,283	161	69,033	6.2	0.78	667
May-97	72,875	831	140	56,154	4.2	0.70	567
Jun-97	33,554	620	113	38,655	6.8	1.24	847
Jul-97	33,421	436	101	31,194	4.8	1.12	686
Aug-97	33,935	354	88	18,523	3.8	0.95	401
Sep-97	27,308	140	49	22,523	1.9	0.66	607
WY 97 Total	4,182,858	8,667	2,124	1,037,228	0.8	0.19	182

*flood flows and overland flows; water quality samples may have been skewed
water quality concentration and load data are approximate

Table 13. Monthly and Annual Discharge, Loads of Salt, Boron and Selenium, and Flow Weighted Concentrations for the San Joaquin River at Vernalis: Water Years 1996 and 1997.

Month	Flow (af)	Loads			Flow Weighted Conc.		
		Se (lbs)	B (1000 lbs)	TDS (tons)	Se (ppb)	B (ppm)	TDS (ppm)
Oct-95	351,608	435	53	74,553	0.5	0.06	156
Nov-95	158,354	595	145	83,120	1.4	0.34	386
Dec-95	155,033	897	184	94,797	2.1	0.44	450
Jan-96	165,085	752	179	101,869	1.7	0.40	454
Feb-96	616,320	1,516	322	139,094	0.9	0.19	166
Mar-96	889,332	1,593	284	164,837	0.7	0.12	136
Apr-96	429,270	1,249	196	121,751	1.1	0.17	209
May-96	512,661	957	139	89,727	0.7	0.10	129
Jun-96	236,197	1,110	221	103,333	1.7	0.34	322
Jul-96	152,134	1,037	186	83,450	2.5	0.45	403
Aug-96	143,371	746	139	71,984	1.9	0.36	369
Sep-96	143,756	543	104	64,308	1.4	0.27	329
WY 96 Total	3,953,120	11,431	2,151	1,192,823	1.1	0.20	222

Month	Flow (af)	Loads			Flow Weighted Conc.		
		Se (lbs)	B (1000 lbs)	TDS (tons)	Se (ppb)	B (ppm)	TDS (ppm)
Oct-96	165,402	324	95	59,859	0.7	0.21	266
Nov-96	161,515	417	136	74,113	0.9	0.31	337
Dec-96	749,455	557	173	122,971	0.3	0.08	121
Jan-97 *	2,740,109	1,981	493	230,430	0.4	0.10	91
Feb-97 *	2,185,068	2,127	512	255,465	0.4	0.10	97
Mar-97	801,271	1,639	378	192,052	0.8	0.17	176
Apr-97	281,289	1,470	215	116,068	1.9	0.28	303
May-97	294,138	988	175	97,534	1.2	0.22	244
Jun-97	157,470	662	134	77,246	1.5	0.31	361
Jul-97	107,935	384	106	57,836	1.3	0.36	394
Aug-97	115,232	370	106	57,365	1.2	0.34	366
Sep-97	123,105	271	89	60,644	0.8	0.26	362
WY 97 Total	6,770,716	11,190	2,611	1,401,584	0.6	0.14	152

*flood flows, levee breaks and overland flows; discharge estimated using SJRIO water quality model
water quality samples may have been skewed; concentration and load data are approximate

feet in 1997. The annual salt load at Crows Landing increased from 800,000 tons in 1996 to just under 1 million tons in 1997, whereas salt load increased from 1.2 to 1.4 million tons at Vernalis. The annual boron load at Crows Landing increased from 1.8 million pounds in 1996 to 2.1 million pounds in 1997 whereas boron load increased from 2.2 to 2.6 million pounds at Vernalis. The increase in salt load from Water Year 1996 to Water Year 1997 is likely attributable to the significantly higher discharge in Water Year 1997. All of the additional load at both Crows Landing and Vernalis can be accounted for in the extremely high flow months of January and February 1997.

Although, discharge, salt and boron loads increased at both river sites from 1996 to 1997, selenium loads dropped. The annual selenium load at Crows Landing decreased from 10,700 pounds in 1996 to just under 8,700 pounds in 1997 and from 11,400 to 11,200 pounds at Vernalis. Higher salt and boron loads in 1997 were likely attributable to significantly higher rainfall, river flows, and leaching of naturally occurring salts that are widespread throughout the basin. Lower selenium loads in 1997 are at least in part due to additional controls of subsurface agricultural drainage from the Drainage Project Area within the Grassland Watershed (tributary to the San Joaquin River), particularly during low flow months.

Monthly loads of salt for Crows Landing and Vernalis are presented graphically in Figure 9. Figures 10 and 11 show the monthly loads of boron and selenium, respectively. Monthly salt loads in water year 1997 were generally the same or slightly lower than water year 1996 loads at both sites except during the flood months of January and February. Salt loads in January and February, 1997 appear to have been much higher than the previous year, but flood flows and limited data availability during the 1997 flood makes flow and load estimates suspect. The March 1997 salt loads are somewhat higher than the March, 1996 loads at Vernalis.

Boron loading at the two sites has a similar pattern to salt loading but the pattern of selenium loading is somewhat different. Selenium loads at both sites were 40 to 70 percent lower during the June to September period of water year 1997 than the same months in water year 1996. Loads were slightly lower at Crows Landing and up to 30 percent lower at Vernalis during the October through December period of water year 1997 as compared to water year 1996. Although flood flows and limited data availability during the 1997 flood makes selenium load estimates for January and February suspect, the limited data suggests that selenium loads during January, 1997 at Crows Landing and Vernalis were more than double the prior year's load. Selenium loads were also higher in February, 1997 than in February, 1996 at the Vernalis site.

Figures 12 through 15 show the annual discharge, TDS load, boron load, and selenium load for the two San Joaquin River sites, Crows Landing and Vernalis, and two additional Grassland Watershed sites, one summarizing loads from the Drainage Project Area and the other depicting loads from the entire watershed. Water Years 1996 and 1997 were wet years with similar discharge and loading to water years 1995 and 1986. Although annual discharge at Crows Landing and Vernalis were higher in 1997 than during all other years, including 1995, loads of salt, boron, and selenium were higher at both sites in water year 1995. Loads of selenium at both river sites were lower in 1997 than in 1995 and 1996 even though discharge was much higher than in 1996. Water year 1995 was the first wet year following several dry and critically dry years. High loads of all constituents in 1995 may have resulted from the leaching of salts that had accumulated in the basin during previous years or from an expansion of the total irrigated area. Generally lower loads of all constituents in 1996 and 1997 may be due to lower residual salt loads in the basin. Markedly lower selenium loads from the Drainage Project Area are also attributable to district recycling and other water conservation and drainage reduction methods that were initiated in 1997 to reduce selenium loads as part of the Grassland Bypass Project.

Figure 9. Monthly Salt Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997

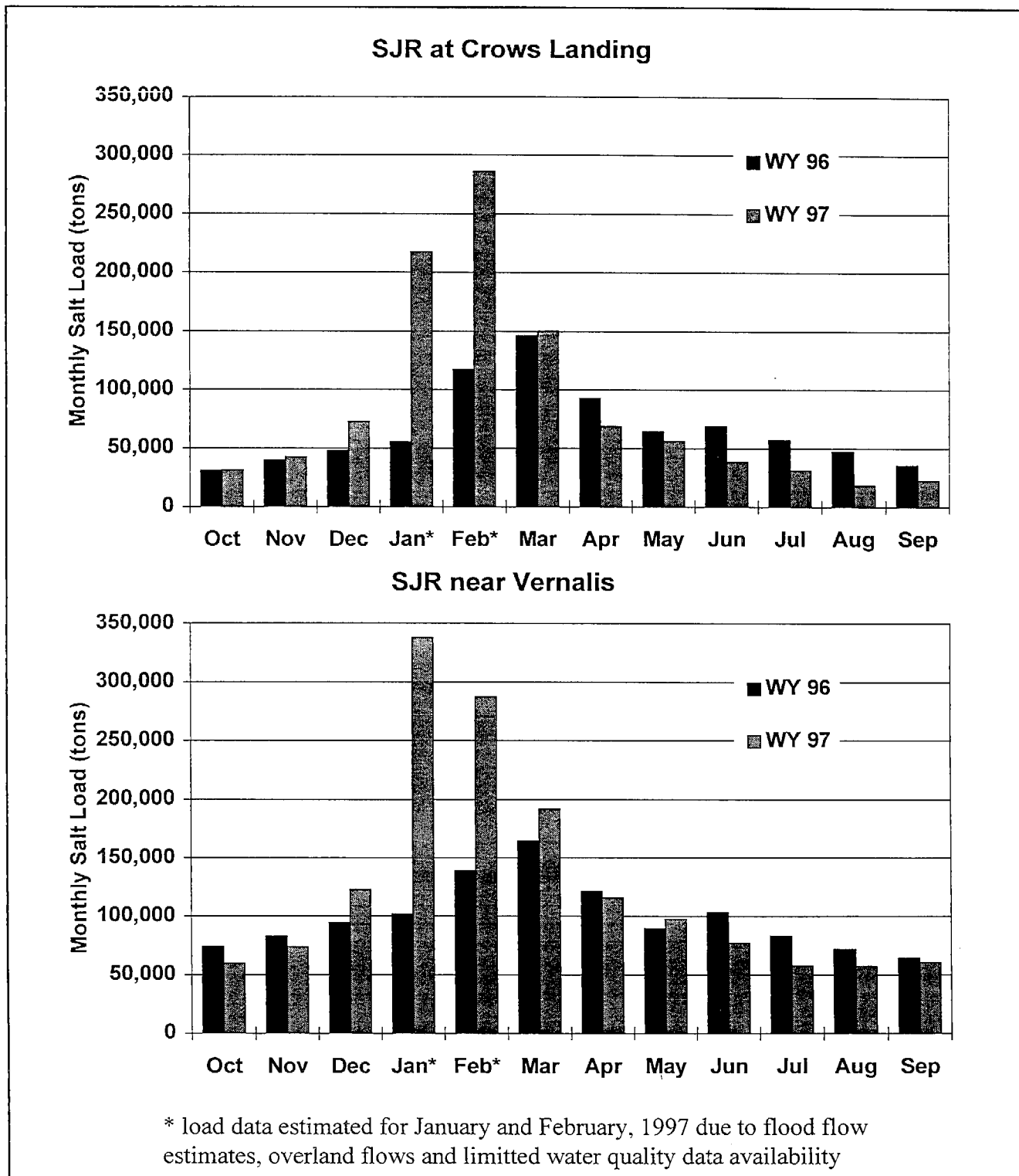


Figure 10. Monthly Boron Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997

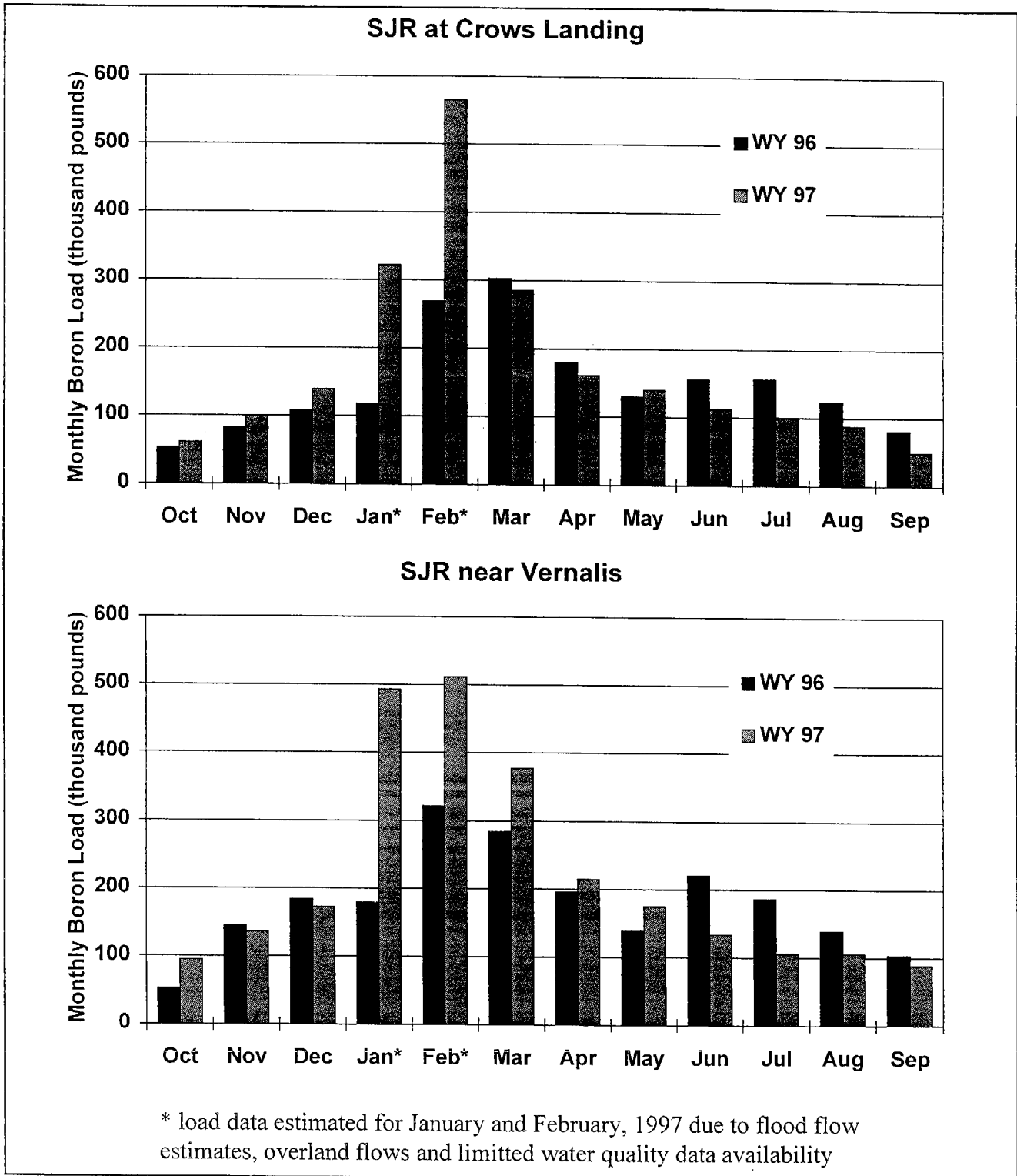


Figure 11. Monthly Selenium Loads Measured in the San Joaquin River at Crows Landing and Vernalis, Water Years 1996 and 1997

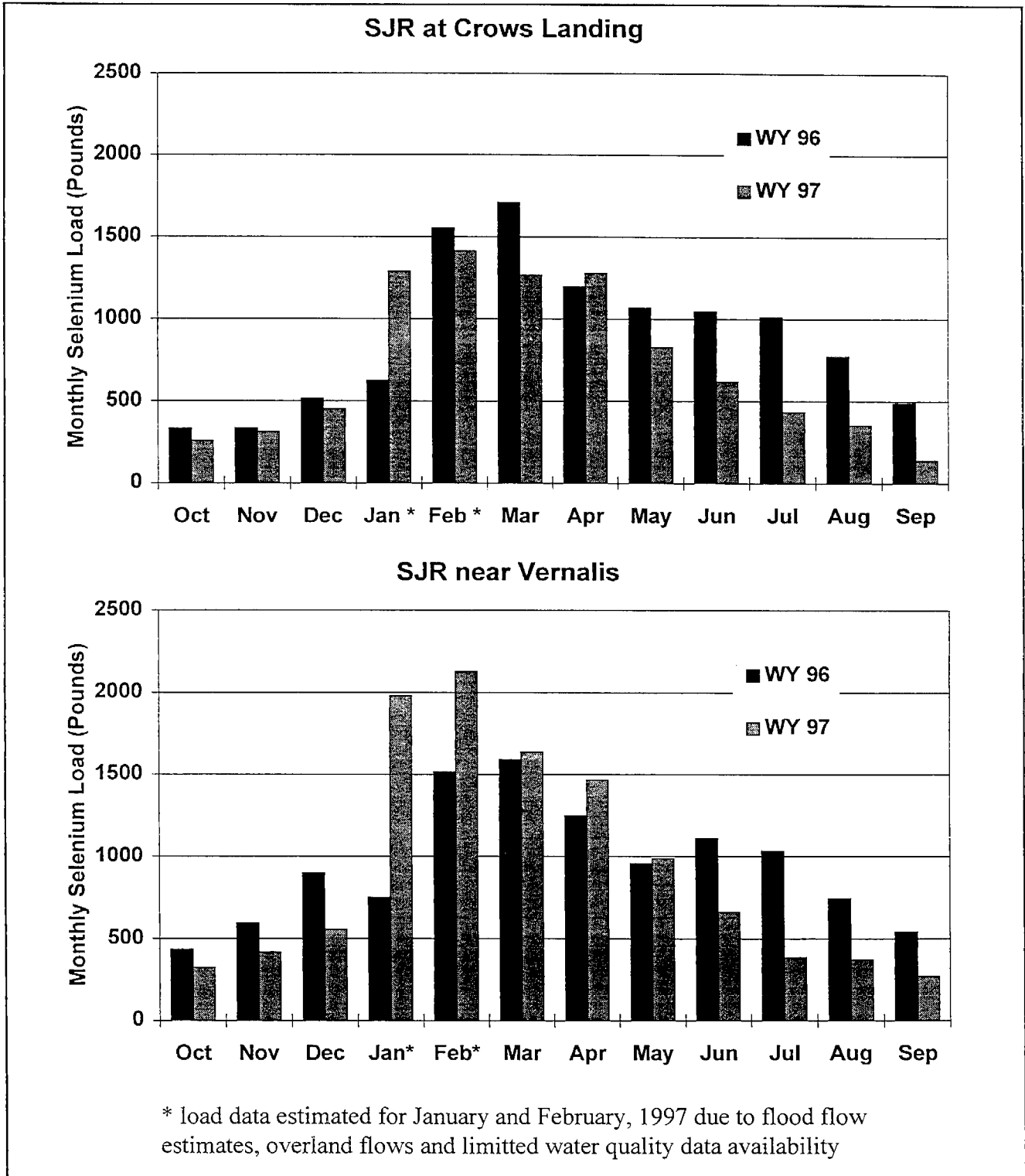


Figure 12. Annual Discharge from the Drainage Project Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997

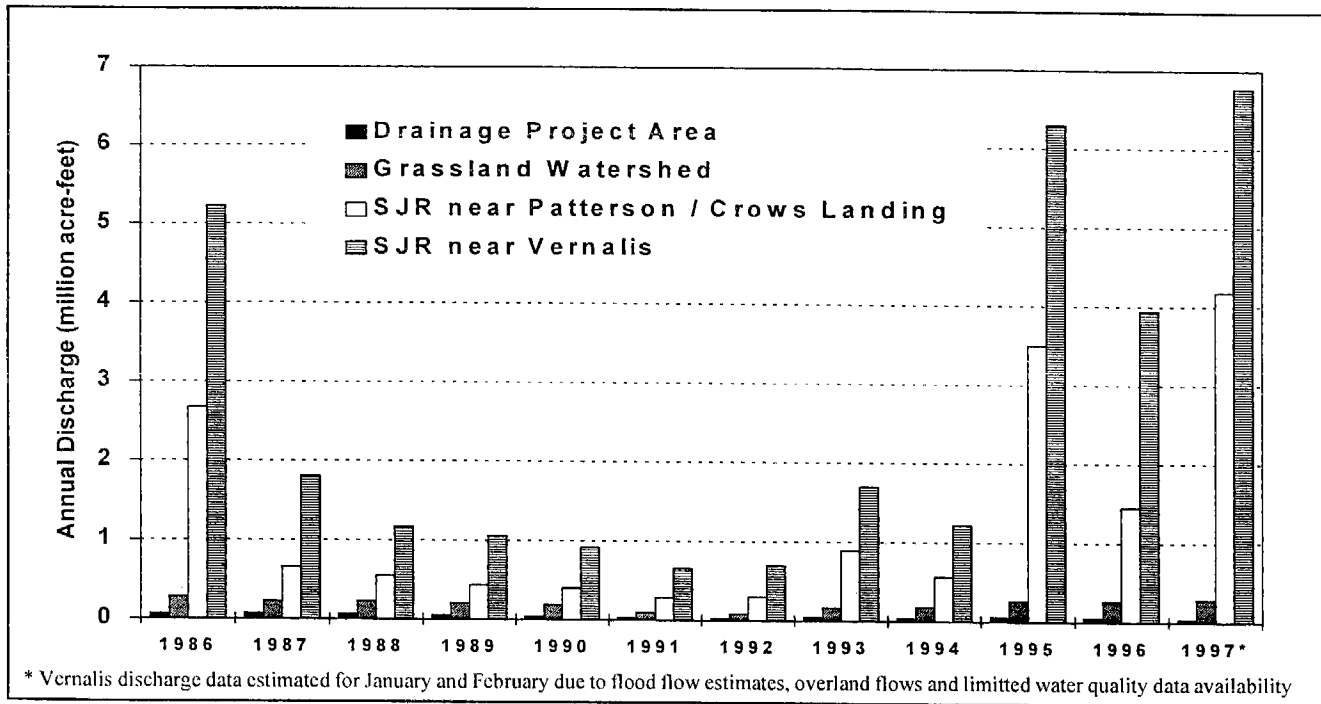


Figure 13. Annual Salt Load from the Drainage Project Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997

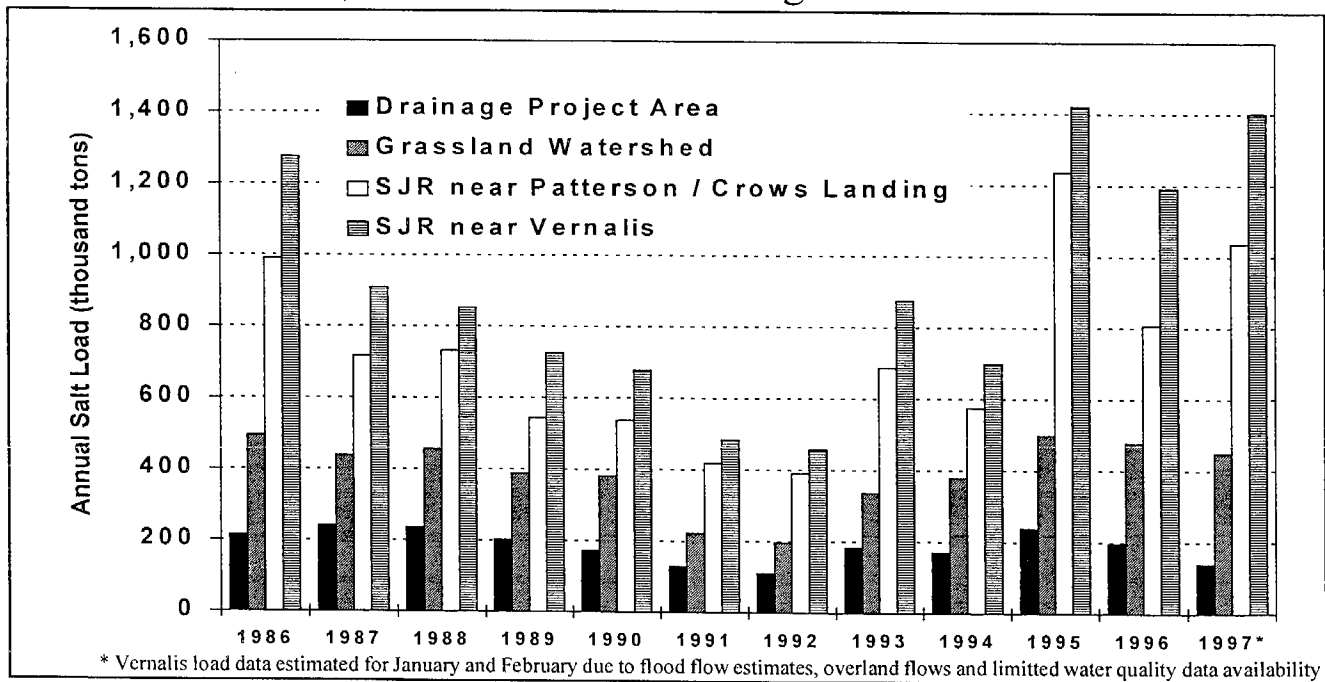


Figure 14. Annual Boron Load from the Drainage Project Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997

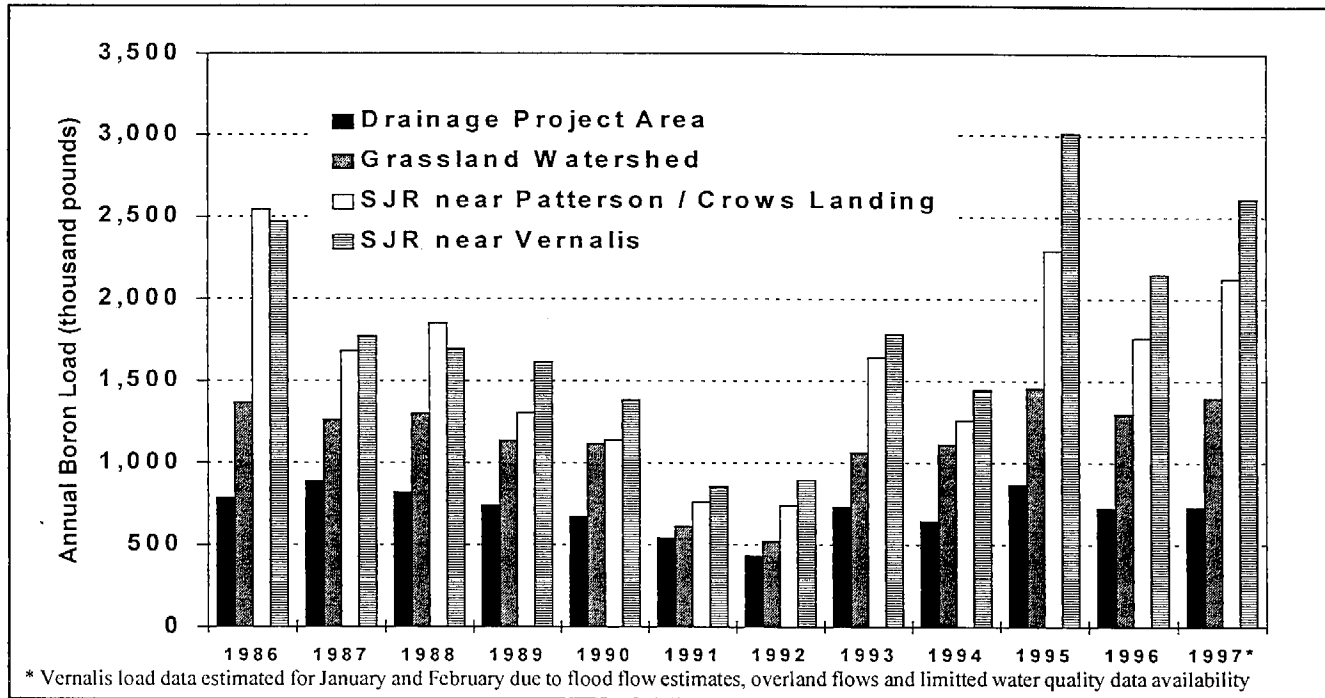
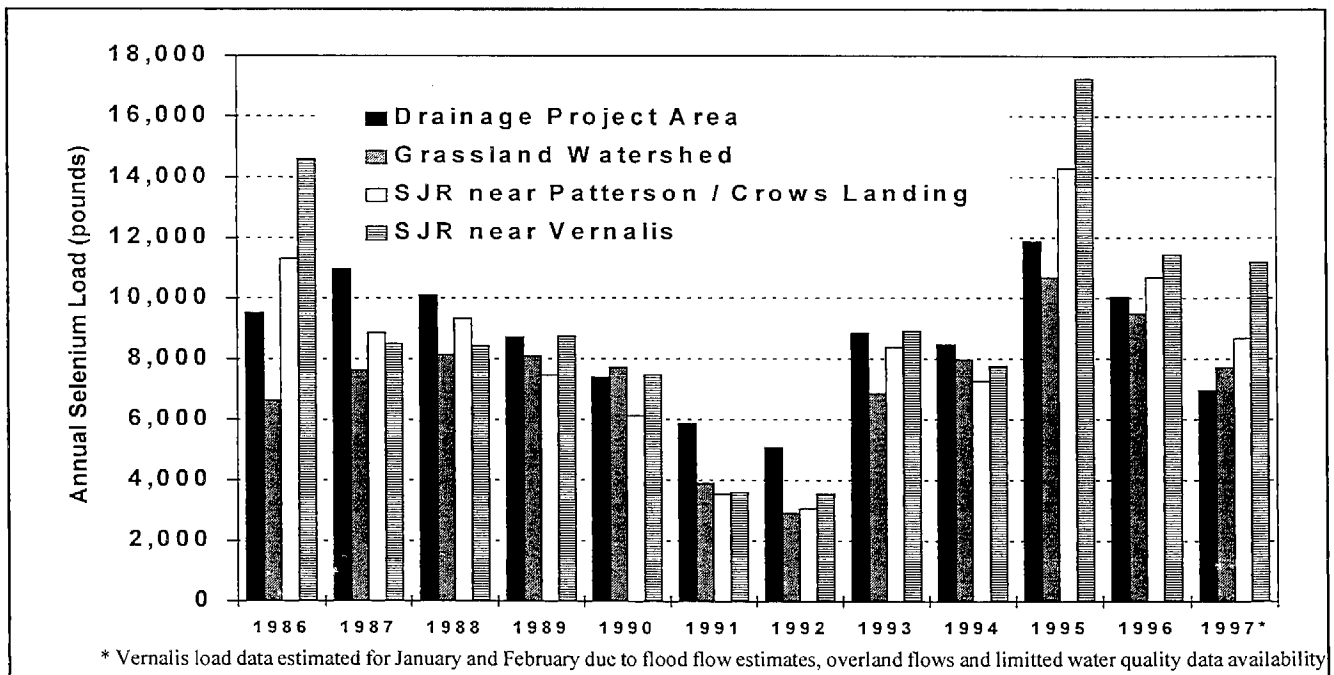


Figure 15. Annual Selenium Load from the Drainage Project Area, Grassland Watershed, and the San Joaquin River at Crows Landing and Vernalis, Water Years 1986 through 1997



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APPENDIX A
Grab Sample Water Quality Data
Water Year 1996

RWQCB Site I.D.	Site Name	Page
	San Joaquin River at:	
MER522	Lander Avenue	43
MER538	Fremont Ford	44
STC512	Hills Ferry Road	45
STC504	Crows Landing	46
STC507	Patterson (Las Palmas)	47
STC510	Maze Blvd.	48
SJC501	Vernalis (Airport Way)	49

Legend of Abbreviations

EC = Electrical Conductivity
 Se = Selenium
 Mo = Molybdenum
 Cr = Chromium
 Cu = Copper
 Ni = Nickel
 Pb = Lead
 Zn = Zinc
 B = Boron
 Cl = Chloride
 SO4 = Sulfate
 HDNS = Hardness

San Joaquin River at Lander Avenue (State Highway 165) (MER522)

Location: Latitude 37°17'43", Longitude 120°51'01". In NE 1/4, NE 1/4, Sec. 27, T.7S., R.10E. East Bank, 50 ft West of Lander Avenue (Highway 165), 2.3 mi. south of Stevinson. River Mile 132.9

Date	Time	Temp		EC umhos/cm	Se	Mo	Cr	Cu	Ni	Pb	Zn	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
		F	pH														
10/6/95	1250	72	8.4	210	NA							NA					
10/12/95	1050	66	8.1	146	NA							NA					
10/18/95	1155	70	7.7	136	NA							NA					
10/25/95	950	62	8.1	140	<0.4	1	6	4	5	<5	5	<0.05	12	6.6	40	8.6	4.3
11/3/95	1316	64	8.7	126	NA							NA					
11/9/95	1005	64	8.3	401	NA							NA					
11/20/95	1109	64	8.4	863	NA							NA					
11/27/95	840	55	8.2	874	<0.4							0.11	130	51	140	36	12
12/8/95	1208	58	8.2	326	NA							NA					
12/18/95	1226	NA	8.4	337	NA							NA					
12/22/95	1130	50	8.1	394	NA							NA					
12/28/95	1015	49	8.2	367	<0.4							0.07	43	25	84	21	7.6
1/4/96	1320	56	8.0	438	NA							NA					
1/11/96	1027	52	7.9	604	NA							NA					
1/18/96	1400	52	8.1	955	NA							NA					
1/25/96	858	46	7.8	380	0.5	1	3	6	<5	<5	4	0.05	38	27	97	23	9.7
2/2/96	1330	57	8.0	183	NA							NA					
2/9/96	NA	NA	NA	NA	NA							NA					
2/16/96	1040	64	7.7	495	NA							NA					
2/22/96	845	47	7.3	246	<0.4							<0.05	15	12	74	17	7.8
3/1/96	1515	54	8.1	235	NA							NA					
3/8/96	1055	60	8.1	141	NA							NA					
3/18/96	1305	66	6.7	145	NA							NA					
3/21/96	1135	66	NA	138	NA							NA					
3/28/96	1005	61	8.0	298	NA							0.06	36	27	100	25	99
4/3/96	1600	68	7.8	478	NA							NA					
4/12/96	1258	62	7.7	824	NA							NA					
4/19/96	1205	64	8.1	523	NA							NA					
4/25/96	1045	66	8.2	621	<0.4	3	4	6	<5	<5	12	0.09	85	43	130	31	12
5/3/96	1050	74	8.2	914	NA							NA					
5/10/96	1125	67	8.1	1040	NA							NA					
5/16/96	1400	72	8.0	533	NA							NA					
5/24/96	1230	64	8.0	73	<0.4							NA					
5/30/96	1140	71	7.7	134	NA							<0.05	9.2	7.1	41	11	3.3
6/6/96	1315	86	8.0	669	NA							NA					
6/13/96	1123	79	8.5	910	NA							NA					
6/19/96	1100	78	8.2	320	NA							NA					
6/27/96	1200	71	8.1	374	<0.4							0.06	44	29	80	19	8
7/2/96	1037	82	8.1	282	NA							NA					
7/11/96	1120	84	8.5	946	NA							NA					
7/19/96	1050	78	8.1	545	NA							NA					
7/25/96	1240	86	8.8	781	<0.4	6	2	4	<5	<5	6	0.13	110	55	140	35	14
8/2/96	1300	86	8.3	648	NA							NA					
8/8/96	1325	82	8.1	695	NA							NA					
8/15/96	1150	86	8.1	457	NA							NA					
8/23/96	1305	80	8.2	320	NA							NA					
8/28/96	1230	78	8.5	331	<0.4							0.06	34	23	68	15	7.5
9/5/96	1132	72	8.6	367	NA							NA					
9/12/96	743	68	7.9	227	NA							NA					
9/17/96	1440	72	8.5	216	NA							NA					
9/26/96	955	70	7.4	228	<0.4							<0.05	22	10	40	9.1	4.1
Count		49	49	50	11	4	4	4	4	4	4	12	12	12	12	12	12
Min		46	7	73	<0.4	1	2	4	<5	<5	4	<0.05	9.2	6.6	40	8.6	3.3
Max		86	8.8	1040	0.5	6	6	6	5	<5	12	0.13	130	55	140	36	99
Mean		67	8.1	441	0.2	3	4	5	3	2.5	6.75	0.06	48	26	86	21	16
Geo Mean		66	8.1	361	0.2	2	3	5	3	2.5	6.16	0.05	35	21	79	19	9.3
Median		66	8.1	371	0.2	2	3.5	5	2.5	2.5	5.5	0.06	37	26	82	20	7.9

San Joaquin River at Fremont Ford (MER538)

Location: Latitude 37°18'34", Longitude 120°55'45". In NW 1/4, NW 1/4, Sec. 24, T.7S., R.9E. West Bank at Fremont Ford State Recreation Area, 50ft. south of Highway 140. 5.4 mi NE of Gustine. River Mi 125.2

Date	Time	Temp F	pH	EC umhos/cm	Se ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
10/6/95	1305	68	7.9	725	0.7	0.24					
10/12/95	1102	69	7.7	624	0.7	0.26					
10/18/95	1205	71	7.4	508	0.8	0.20					
10/25/95	1010	62	7.7	971	8.1	0.90	130	210	200	46	20
11/3/95	1331	63	8.0	912	4.4	0.75					
11/9/95	1018	61	7.9	1190	2.0	0.63					
11/20/95	1121	62	7.7	2090	13.3	1.9					
11/27/95	850	54	8.0	1920	9.1	1.6	280	380	380	89	39
12/8/95	1219	58	7.7	1660	9.5	1.4					
12/18/95	1110	NA	8.2	1440	7.9	1.4					
12/22/95	1144	49	7.7	1650	9.0	1.3					
12/28/95	1035	49	7.8	1760	11.6	1.4	270	350	360	83	36
1/4/96	1330	54	7.6	2050	4.0	1.4					
1/11/96	1043	52	7.8	2370	4.7	1.6					
1/18/96	1411	52	7.9	2220	19.3	1.9					
1/25/96	811	45	7.3	1780	11.7	1.7	240	380	360	86	36
2/2/96	1340	56	7.4	675	2.6	0.44					
2/9/96	NA	NA	NA	NA	NA	NA					
2/16/96	1100	64	7.6	1920	17.1	1.8					
2/22/96	904	47	7.5	739	4.2	0.53	76	120	150	37	15
3/1/96	1525	54	7.8	1040	5.9	0.86					
3/8/96	1120	59	7.6	420	2.0	NA					
3/18/96	1256	68	8.7	510	2.5	0.35					
3/21/96	1200	NA	NA	NA	NA	NA					
3/28/96	935	61	7.1	1240	4.9	0.84	160	200	370	64	27
4/3/96	1610	67	7.7	1360	8.3	0.89					
4/12/96	1311	64	7.6	1940	10.6	1.2					
4/19/96	1230	63	7.9	1430	11.9	1.4					
4/25/96	950	66	7.7	2220	19.4	1.7	300	450	460	110	45
5/3/96	1102	72	8.0	2560	21.7	2.1					
5/10/96	1140	62	8.0	1840	13.8	1.4					
5/16/96	1410	70	7.8	1610	10.8	1.0					
5/24/96	NA	NA	NA	NA	NA	NA					
5/30/96	1118	72	7.8	777	5.4	0.62	95	150	160	41	14
6/6/96	1325	88	7.7	2080	13.6	1.6					
6/13/96	1136	78	7.9	2130	16.0	2.2					
6/19/96	1115	76	7.9	1550	12.4	1.6					
6/27/96	1150	71	8.0	1580	11.9	1.5	200	330	525	90	73
7/2/96	1050	84	7.8	1490	12.0	1.3					
7/11/96	1135	82	8.1	1960	15.0	2.1					
7/19/96	1100	76	7.8	1630	12.1	1.6					
7/25/96	1215	83	8.1	1930	16.2	1.9	210	420	390	98	35
8/2/96	1315	84	8.0	1740	13.0	2.1					
8/8/96	1335	78	8.1	1300	8.8	1.3					
8/15/96	1210	83	7.9	1372	10.8	1.4					
8/23/96	1320	78	7.9	1210	8.0	1.2					
8/28/96	1213	74	8.6	1170	7.3	0.99	140	230	240	54	25
9/5/96	1145	70	8.2	1150	8.9	1.0					
9/12/96	1233	73	8.1	1070	7.3	1.0					
9/17/96	1455	69	7.8	977	6.6	0.87					
9/26/96	1010	68	7.2	927	2.9	0.54	120	140	170	36	19

Count	47	48	48	48	47	12	12	12	12	12
Min	45	7.1	420	0.7	0.20	76	120	150	36	14
Max	88	8.7	2560	21.7	2.2	300	450	525	110	73
Mean	67	7.8	1450	9.2	1.2	185	280	314	70	32
Geo Mean	66	7.8	1330	7.2	1.1	170	255	289	65	29
Median	68	7.8	1470	9.0	1.3	180	280	360	74	31

San Joaquin River at Crows Landing Road (STC504)
 Location: Latitude 37°25'55", Longitude 121°00'42", In Section 8 T.6S., R.8E., West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

Date	Time	Temp F	pH	EC umbrosom							Zn	Dissolved ug/L																
				Se	Mo	Cr	Cu	Ni	Pb	B		Cl	SO4	HDNS	TDS	CO3	HCO3	Talk	Ca	Mg	Na	K	Cr	Cu	Ni	Pb	Zn	
10/6/95	1354	64	8.3	<0.4																								
10/12/95	1205	64	7.8	145																								
10/18/95	1345	72	7.4	135	<0.4																							
10/25/95	1130	63	7.9	280	<0.4																							
11/3/95	1431	62	8.1	603	3.0	3	5	4	5	<5	4																	
11/9/95	1156	62	8.1	599	1.9																							
11/20/95	1333	62	7.6	770	1.9																							
11/27/95	1040	56	7.9	893	2.4																							
12/8/95	1530	58	7.9	922	2.2	2	2	2	<1	<5	5																	
12/18/95	1330	NA	7.9	877	3.1																							
12/22/95	1413	49	7.9	824	3.0																							
12/28/95	1235	51	8.1	958	3.4	3	2	2	<5	<5	<1																	
1/4/96	1445	55	7.8	1030	3.6	3	2	2	<5	<5	<1																	
1/11/96	1214	54	7.8	1230	2.4																							
1/18/96	1515	52	8.0	1430	1.6																							
1/25/96	1120	46	7.7	1050	4.0	4	6	4	7	<5	11																	
2/2/96	1450	56	7.8	1270	5.4																							
2/9/96	NA	NA	NA	687	1.9																							
2/16/96	1143	62	7.8	NA	NA																							
2/22/96	1415	47	7.5	603	3.1	10	7	11	<5	<5	10																	
3/1/96	1610	54	8.0	398	1.6																							
3/8/96	1205	59	7.7	538	2.0																							
3/18/96	1000	62	8.1	324	1.0																							
3/21/96	1310	64	7.4	388	1.2																							
3/28/96	1150	59	8.3	389	1.6																							
4/3/96	1615	64	8.2	516	2.0	4	6	<5	<5	<5	NA																	
4/12/96	1526	66	8.0	692	3.3																							
4/19/96	1320	62	8.1	1370	3.3																							
4/25/96	1235	65	8.3	NA	NA	2	8	5	<5	<5	10																	
5/3/96	1424	72	8.4	757	3.8																							
5/10/96	1220	68	8.0	699	3.7																							
5/16/96	1515	67	7.8	377	3.7																							
5/24/96	1335	64	7.4	594	3.1																							
5/30/96	908	68	7.4	377	<0.4																							
6/6/96	1410	80	7.7	144	4.0																							
6/13/96	1342	79	7.9	1020	4.0																							
6/19/96	1210	78	8.0	677	6.4																							
6/27/96	920	69	7.9	1410	5.9																							
7/2/96	1250	84	7.9	594	7.1																							
7/11/96	1400	82	8.0	1300	7.5																							
7/19/96	1408	77	8.1	1190	7.8																							
7/25/96	935	79	7.9	1320	6.9																							
8/2/96	1405	82	7.9	1420	8.3																							
8/8/96	1505	79	8.0	1350	6.8																							
8/15/96	1325	82	7.9	1030	5.2																							
8/23/96	1445	NA	8.0	955	4.6																							
8/28/96	934	70	7.8	881	4.7																							
9/5/96	1445	72	8.0	981	3.9																							
9/12/96	1320	72	8.2	912	4.2																							
9/17/96	1530	70	8.2	910	4.1																							
9/26/96	1203	70	8.2	848	4.1																							
				742	2.6																							
				1280	6.5	6	4	4	6	<5	10																	
Count		48	50	50	50	4	12	12	12	12	10	50	13	13	13	1	1	1	1	1	1	1	13	13	13	13	2	
Min		46	7	135	<0.4	2	2	<1	<5	<1	<10	<0.05	37	58	58	360	360	360	360	360	360	37	58	58	58	3	3	
Max		84	8.4	1520	8.3	5	10	8	11	<5	20	1.3	320	430	320	360	<1	<1	<1	<1	<1	98	80	80	80	<5	<5	
Mean		66	7.9	850	3.5	4	7	5	6	3	10	0.61	121	176	195	360	<1	<1	<1	<1	98	80	80	80	<5	<5		
Geo Mean		65	7.9	745	2.7	3	6	5	5	3	7	0.48	106	155	178	360	<1	<1	<1	<1	98	80	80	80	<5	<5		
Median		64	7.9	863	3.3	4	6	6	6	6	10	0.60	110	150	190	360	<1	<1	<1	<1	98	80	80	80	<5	<5		

San Joaquin River at Las Palmas Launching Facility (Patterson) (STC507)

Location: Latitude 37°29'52", Longitude 121°04'54". In SW 1/4, NW 1/4, SW 1/4, Sec. 15, T.5S., R.8E. West Bank, 0.3 mi.

N of Patterson Bridge at NE corner of Las Palmas Launching Facility parking lot, 3.2 mi. NE of Patterson. River Mile 98.6.

Date	Time	Temp		EC umhos/cm	Sc ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
		F	pH								
10/6/95	1444	64	8.2	178	<0.4	0.06					
10/12/95	1230	63	7.6	200	<0.4	0.06					
10/18/95	1440	70	7.2	307	<0.4	0.11					
10/25/95	1205	64	7.7	702	2.8	0.40	88	120	150	33	17
11/3/95	1515	64	7.9	667	1.7	0.39					
11/9/95	1213	66	7.8	889	1.8	0.48					
11/20/95	1441	66	7.7	873	2.1	0.49					
11/27/95	1055	56	7.9	956	2.3	0.55	130	150	194	43	21
12/8/95	1612	60	7.9	932	3.1	0.59					
12/18/95	1345	NA	7.9	864	3.1	0.59					
12/22/95	1452	49	7.8	1020	3.9	0.73					
12/28/95	850	51	7.8	1050	3.4	0.65	150	170	200	45	21
1/4/96	1500	56	7.6	1260	2.5	0.67					
1/11/96	1231	54	7.8	1440	1.8	0.71					
1/18/96	1533	52	7.9	1360	4.8	0.92					
1/25/96	1200	46	7.7	1240	4.8	0.94	160	220	250	57	27
2/2/96	1510	56	7.8	768	2.1	0.20					
2/9/96	NA	NA	NA	NA	NA	NA					
2/16/96	1210	62	7.6	633	3.5	0.48					
2/22/96	1138	48	7.7	405	1.1	0.24	35	54	100	22	11
3/1/96	1620	54	7.8	548	2.1	0.38					
3/8/96	1215	60	7.6	322	1.0	0.17					
3/18/96	826	61	7.6	390	1.4	0.22					
3/21/96	1330	64	NA	391	1.3	0.24					
3/28/96	1220	60	8.1	540	2.2	0.43	74	100	140	32	15
4/3/96	1634	62	8.0	704	2.9	0.45					
4/12/96	1549	68	7.7	1310	3.6	0.79					
4/19/96	1400	63	7.8	730	3.4	0.54					
4/25/96	1300	65	8.1	861	4.0	0.46	100	150	170	38	18
5/3/96	1514	72	7.9	992	3.7	0.53					
5/10/96	1240	72	7.8	1140	4.2	0.56					
5/16/96	1530	68	7.7	675	3.0	0.32					
5/24/96	1350	64	7.5	170	0.5	0.07					
5/30/96	835	71	7.3	684	3.5	0.46	77	120	150	37	14
6/6/96	1430	82	7.9	1420	4.7	0.79					
6/13/96	1426	81	8.0	1490	5.5	1.0					
6/19/96	1235	78	7.9	1390	NA	1.0					
6/27/96	900	70	7.8	1440	6.4	0.87	170	270	290	67	29
7/2/96	1350	85	7.7	1410	6.9	0.95					
7/11/96	1450	85	7.9	1340	6.2	1.1					
7/19/96	1430	78	8.1	1190	6.4	0.82					
7/25/96	908	80	7.6	1350	6.3	1.0	160	230	300	71	30
8/2/96	1425	84	7.9	1280	5.5	0.96					
8/8/96	1530	81	7.9	1570	5.3	0.86					
8/15/96	1345	84	7.7	1510	4.8	0.89					
8/23/96	1508	80	8.0	1350	4.3	0.83					
8/28/96	903	70	7.5	1110	4.1	0.72	120	200	240	50	27
9/5/96	1502	74	8.0	1410	4.3	0.87					
9/12/96	1426	74	8.1	939	3.9	0.60					
9/17/96	1550	72	8.0	959	2.2	0.54					
9/26/96	1245	72	8.0	1330	3.1	0.74	150	220	250	51	29
Count		49	49	50	46	50	12	12	12	12	12
Min		46	7.2	170	<0.4	0.06	35	54	100	22	11
Max		85	8.2	1570	6.9	1.1	170	270	300	71	30
Mean		67	7.8	954	3.5	0.59	118	167	203	46	22
Geo Mean		66	7.8	838	3.1	0.49	109	154	193	43	21
Median		66	7.8	958	3.4	0.58	125	160	197	44	21

San Joaquin River at Maze Blvd. (State Highway 132) (STC510)

Location: Latitude 37°38'31", Longitude 121°13'40". In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E.

West Bank, 400 ft S of Maze Blvd Bridge upstream of Blewett Drain, River Mile 77.2

Date	Time	Temp F	pH	EC umhos/cm	Sc ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
10/6/95	1530	66	8.1	164	<0.4	<0.05					
10/12/95	1300	66	7.6	146	<0.4	<0.05					
10/18/95	1556	68	7.4	193	0.6	0.06					
10/25/95	1245	66	7.6	427	1.7	0.20	52	58	52	21	11
11/3/95	1548	62	7.9	606	0.6	0.25					
11/9/95	1250	66	8.2	762	1.2	0.34					
11/20/95	1514	64	7.6	820	1.9	0.43					
11/27/95	1145	56	7.8	742	1.7	0.38	99	99	160	36	18
12/8/95	1642	58	7.9	827	2.4	0.44					
12/18/95	1450	NA	7.8	866	2.6	0.48					
12/22/95	1523	52	7.8	855	2.3	0.53					
12/28/95	820	51	7.6	879	3.0	0.54	120	140	180	39	19
1/4/96	1530	55	7.7	980	2.2	0.49					
1/11/96	1300	53	7.8	1140	1.2	0.48					
1/18/96	NA	NA	NA	NA	NA	NA					
1/25/96	1230	46	7.8	835	2.6	0.52	100	130	170	37	18
2/2/96	NA	NA	NA	NA	NA	NA					
2/9/96	NA	NA	NA	NA	NA	NA					
2/16/96	1255	60	7.5	320	1.4	0.21					
2/22/96	1523	48	7.6	288	0.6	0.16	23	36	79	17	9
3/1/96	1635	54	7.9	311	1.1	0.19					
3/8/96	1230	57	8.0	229	0.7	0.11					
3/18/96	757	58	7.7	258	0.8	0.13					
3/21/96	1400	61	NA	260	0.8	0.14					
3/28/96	1315	59	8.3	290	1.1	0.21	34	47	88	22	8.1
4/3/96	1701	60	8.0	375	1.2	0.21					
4/12/96	1620	62	7.3	497	1.3	0.24					
4/19/96	1430	62	7.9	372	1.6	0.26					
4/25/96	1415	65	8.1	445	1.9	0.23	51	66	96	22	10
5/3/96	1544	68	8.2	423	1.7	0.22					
5/10/96	1310	66	7.9	316	0.6	0.12					
5/16/96	NA	NA	NA	NA	NA	NA					
5/24/96	1410	62	7.5		<0.4	<0.05					
5/30/96	757	64	7.1	278	1.2	0.16	25	40	62	15	6
6/6/96	1535	78	7.6	656	1.8	0.33					
6/13/96	1455	77	8.0	880	2.7	0.54					
6/19/96	1315	76	8.0	850	2.3	0.56					
6/27/96	830	70	7.9	1010	4.0	0.55	130	160	200	46	21
7/2/96	1420	84	7.9	939	4.2	0.63					
7/11/96	1530	84	7.9	1050	3.6	0.70					
7/19/96	1700	77	8.1	1040	4.1	0.65					
7/25/96	830	78	7.3	1020	3.6	0.65	120	150	240	54	26
8/2/96	1450	84	7.9	906	2.9	0.57					
8/8/96	NA	NA	NA	NA	NA	NA					
8/15/96	1405	83	8.2	772	2.5	0.46					
8/23/96	NA	NA	NA	NA	NA	NA					
8/28/96	823	72	6.0	747	2.6	0.44	88	100	160	33	19
9/5/96	NA	NA	NA	NA	NA	NA					
9/12/96	1447	72	8.3	689	2.3	0.42					
9/17/96	NA	NA	NA	NA	NA	NA					
9/26/96	1345	70	8.3	623	1.4	0.27	77	75	120	25	14

Count	42	42	42	43	43	43	12	12	12	12	12
Min	46	6	146	<0.4	<0.05	<0.05	23	36	52	15	6
Max	84	8.3	1140	4.2	0.7	0.7	130	160	240	54	26
Mean	65	7.8	621	1.8	0.34	0.34	77	92	134	31	15
Geo Mean	64	7.8	538	1.4	0.26	0.26	66	81	121	28	14
Median	65	7.9	673	1.7	0.33	0.33	83	87	140	29	16

San Joaquin River at Airport Way (SJC501)

Location: Latitude 37°40'32", Longitude 121°15'51". In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E.

West Bank, south of Airport Way Bridge, 3.2 miles NE of Vernalis River Mile 72.3.

Date	Time	Temp	pH	EC umhos/cm	Se	Mo	Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	Ca	Mg
		F										mg/L					
10/6/95	1545	67	8.0	147	<0.4							<0.05					
10/12/95	1315	66	7.5	144	<0.4							<0.05					
10/18/95	1615	66	NA	167	0.4							<0.05					
10/25/95	1300	64	7.1	392	1.2	2	3	3	<5	<5	2	0.20	51	50	91	20	10
11/3/95	1604	62	7.9	564	1.2							0.22					
11/9/95	1305	64	7.9	700	1.5							0.34					
11/20/95	1532	62	7.6	730	1.7							0.38					
11/27/95	1155	58	7.9	839	1.9							0.44	110	110	180	38	20
12/8/95	1654	58	7.8	747	2.0							0.40					
12/18/95	1500	NA	7.8	688	2.0							0.42					
12/22/95	1538	52	7.8	767	2.0							0.47					
12/28/95	805	51	7.5	786	2.5							0.45	110	120	160	35	17
1/4/96	1543	58	7.6	858	2.0							0.46					
1/11/96	1311	53	7.8	972	1.0							0.43					
1/18/96	1604	51	7.8	687	1.6							0.32					
1/25/96	1250	46	7.7	759	2.2	3	4	4	6	<5	3	0.46	93	110	160	35	17
2/2/96	1545	55	7.8	426	1.0							0.22					
2/9/96	NA	NA	NA	NA	NA							NA					
2/16/96	1315	60	7.5	311	1.2							0.19					
2/22/96	1500	47	7.6	336	0.7							0.18	31	44	83	19	8.7
3/1/96	1645	56	7.8	264	0.8							0.14					
3/8/96	1305	59	7.2	196	0.4							0.09					
3/18/96	741	57	7.8	227	0.7							0.11					
3/21/96	1415	62	7.2	222	0.6							0.10					
3/28/96	1350	58	8.0	246	0.9							0.16	29	40	76	18	7.5
4/3/96	1720	59	8.0	322	0.9							0.17					
4/12/96	1642	60	7.9	373	0.9							0.17					
4/19/96	1500	61	7.8	303	1.2							0.17					
4/25/96	1400	64	8.3	341	1.4	1	5	5	5	<5	13	0.16	36	48	78	18	8
5/3/96	1557	68	8.1	319	1.2							0.15					
5/10/96	1330	68	7.7	269	0.6							0.10					
5/16/96	1600	62	7.7	200	0.9							0.10					
5/24/96	1421	64	7.9	134	0.4							0.05					
5/30/96	740	64	6.8	248	1.0							0.13	23	35	60	14	6
6/6/96	1520	76	7.6	529	1.5							0.26					
6/13/96	1508	76	7.9	600	1.7							0.36					
6/19/96	1330	74	8.0	630	1.4							0.39					
6/27/96	810	67	8.4	697	2.5							0.35	87	95	140	33	15
7/2/96	1430	82	7.8	683	2.6							0.42					
7/11/96	1545	83	7.8	791	2.5							0.50					
7/19/96	1515	76	8.2	707	2.4							0.43					
7/25/96	815	75	7.2	769	2.5	2	10	8	11	<5	16	0.46	92	110	186	42	20
8/2/96	1510	80	7.8	613	1.8							0.35					
8/8/96	1700	78	8.3	623	2.1							0.36					
8/15/96	1430	82	8.1	616	1.8							0.35					
8/23/96	1610	78	8.1	612	1.8							0.37					
8/28/96	800	70	5.8	642	2.0							0.35	77	86	140	30	16
9/5/96	1538	74	8.1	603	1.9							0.33					
9/12/96	1510	72	8.2	557	1.9							0.31					
9/17/96	1620	70	8.3	NA	0.7							0.21					
9/26/96	1355	70	7.0	537	1.1							0.22	64	62	110	23	12
Count		49	49	49	50	4	4	4	4	4	4	50	12	12	12	12	12
Min		46	5.8	134	<0.4	1	3	3	<5	<5	2	<0.05	23	35	60	14	6
Max		83	8.4	972	2.6	3	10	8	11	<5	16	0.50	110	120	186	42	20
Mean		65	7.7	508	1.4	2	5.5	5.0	6.1	2.5	8.5	0.27	67	76	122	27	13
Geo Mean		64	7.7	446	1.2	2	4.9	4.7	5.4	2.5	5.9	0.22	59	69	114	26	12
Median		64	7.8	564	1.4	2	4.5	4.5	5.5	2.5	8.0	0.29	71	74	125	27	14

APPENDIX B
Grab Sample Water Quality Data
Water Year 1997

RWQCB Site I.D.	Site Name	Page
	San Joaquin River at:	
MER522	Lander Avenue	53
MER538	Fremont Ford	54
STC512	Hills Ferry Road	55
STC504	Crows Landing	56
STC507	Patterson (Las Palmas)	57
STC510	Maze Blvd.	58
SJC501	Vernalis (Airport Way)	59

Legend of Abbreviations

EC = Electrical Conductivity
 Se = Selenium
 Mo = Molybdenum
 Cr = Chromium
 Cu = Copper
 Ni = Nickel
 Pb = Lead
 Zn = Zinc
 B = Boron
 Cl = Chloride
 SO4 = Sulfate
 HDNS = Hardness

San Joaquin River at Lander Avenue (State Highway 165) (MER522)

Location: Latitude 37°17'43", Longitude 120°51'01". In NE 1/4, NE 1/4, Sec. 27, T.7S., R.10E. East Bank, 50 ft West of Lander Avenue (Highway 165), 2.3 mi. south of Stevinson. River Mile 132.9

Date	Time	Temp		EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
		F	pH														
10/3/96	0755	68	6.9	189	NA							NA					
10/8/96	1040	74	8.0	530	NA							NA					
10/17/96	1010	66	6.6	302	NA							NA					
10/24/96	0935	57	7.3	175	NA							NA					
10/31/96	1015	58	6.7	184	<0.4	1						<0.05					
11/7/96	0725	56	5.2	436	NA							NA					
11/15/96	1018	59	7.8	964	NA							NA					
11/22/96	1100	63	7.8	479	NA							NA					
11/27/96	1100	58	7.5	254	<0.4	1						<0.05	19	14	78	18	8
12/6/96	1115	52	7.5	731	NA							NA					
12/12/96	1120	59	7.0	106	NA							NA					
12/19/96	1215	51	7.1	168	NA							NA					
12/26/96	1314	47	7.7	145	<0.4	1						<0.05					
1/9/97	1245	54	NA	106	NA							NA					
1/24/97	1245	52	7.0	NA	<0.4	1						<0.05	3.9	5.1	41	3.8	10
2/7/97	1430	56	7.9	102	NA							NA					
2/13/97	1249	52	7.8	91	NA							NA					
2/21/97	1030	54	7.9	88	NA							NA					
2/26/97	1240	53	7.8	107	NA							NA					
3/5/97	1625	56	7.8	135	NA							NA					
3/12/97	1810	60	7.6	342	NA							NA					
3/20/97	1045	66	8.0	594	NA							NA					
3/27/97	1255	71	6.8	585	NA							NA					
4/3/97	1007	57	7.6	680	NA							NA					
4/10/97	0830	60	8.1	802	NA							NA					
4/17/97	1010	70	8.2	1270	NA							NA					
4/24/97	0952	65	7.0	766	<0.4	6						0.11	100	59	160	37	15
5/2/97	0745	64	8.4	1250	NA							NA					
5/8/97	0836	70	7.9	1390	NA							NA					
5/15/97	0850	76	8.6	1480	NA							NA					
5/23/97	1150	74	8.2	1420	NA							NA					
5/29/97	1040	78	8.7	1420	NA							NA					
6/5/97	NA	NA	NA	NA	NA							NA					
6/12/97	1230	82	8.9	1510	NA							NA					
6/19/97	NA	NA	NA	NA	NA							NA					
6/25/97	1000	76	8.7	980	NA							NA					
7/2/97	1145	76	8.6	1120	NA							NA					
7/10/97	0917	78	8.9	966	NA							NA					
7/17/97	1050	80	8.6	1170	NA							NA					
7/24/97	0931	81	8.1	1220	NA							NA					
7/31/97	1025	80	8.1	926	<0.4	6						0.16	120	64	170		
8/7/97	0823	82	6.7	973	NA							NA					
8/14/97	1122	84	6.9	1050	NA							NA					
8/21/97	1200	82	6.7	1200	NA							NA					
8/27/97	1442	84	7.2	1300	NA							NA					
9/5/97	1100	82	8.3	1290	NA							NA					
9/12/97	0755	74	6.3	1440	NA							NA					
9/18/97	1027	76	6.6	1600	NA							NA					
9/25/97	1610	82	8.5	1250	NA							NA					

Count	47	46	46	6	6	0	0	0	0	0	0	6	4	4	4	3	3
Min	47	5.2	88	<0.4	1							<0.05	3.9	5.1	41	3.8	8
Max	84	8.9	1600	<0.4	6							0.16	120	64	170	37	15
Mean	67	7.6	767	0.2	2.7							0.06	60.7	35.5	112	19.6	11
Geo Mean	66	7.6	540	0.2	1.8							0.04	30.7	22.8	97	13.6	10.6
Median	66	7.8	784	0.2	1.0							0.03	59.5	36.5	119	18	10

San Joaquin River at Fremont Ford (MER538)

Location: Latitude 37°18'34", Longitude 120°55'45". In NW 1/4, NW 1/4, Sec. 24, T.7S., R.9E. West Bank at Fremont Ford State Recreation Area, 50ft. south of Highway 140. 5.4 mi NE of Gustine. River Mi 125.2

Date	Time	Temp		EC	Sc	B	Cl	SO4	HDNS	Ca	Mg
		F	pH	umhos/cm	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10/3/96	0810	68	6.7	714	0.6	0.29					
10/8/96	1010	71	8.0	1150	0.9	0.48					
10/17/96	0957	63	5.6	1490	0.6	0.47					
10/24/96	0955	58	7.1	777	0.5	0.34					
10/31/96	1035	57	6.8	728	0.9	0.36					
11/7/96	0840	55	6.0	1080	0.7	0.66					
11/15/96	1035	59	7.7	1590	0.8	0.91					
11/22/96	1120	64	7.6	1180	0.8	0.70					
11/27/96	1115	58	7.2	889	0.6	0.56	110	120	190	45	20
12/6/96	1130	52	7.5	1610	0.8	0.96					
12/12/96	1050	59	6.9	125	<0.4	<0.05					
12/19/96	1205	52	7.4	347	<0.4	0.14					
12/26/96	1300	48	7.9	243	<0.4	0.12					
1/9/97	1305	54	7.8	106	<0.4	<0.05					
1/24/97	1225	51	7.1	102	<0.4	<0.05					
2/7/97	1227	54	7.2	100	<0.4	<0.05					
2/13/97	1233	52	7.7	92	<0.4	<0.05					
2/21/97	0855	54	7.4	85	<0.4	<0.05					
2/26/97	1220	54	7.9	128	<0.4	<0.05					
3/5/97	1755	54	8.7	234	<0.4	0.08					
3/12/97	1800	61	7.7	617	0.4	0.22					
3/20/97	1055	66	8.0	1090	0.9	0.50					
3/27/97	1240	68	7.7	1360	0.7	0.65					
4/3/97	0940	59	8.1	1650	0.6	0.63					
4/10/97	0845	58	7.9	1700	0.8	2.0**					
4/17/97	0950	69	7.1	2030	0.9	0.77					
4/24/97	0922	64	7.9	1970	0.8	0.70					
5/2/97	1040	64	8.1	1840	0.8	0.69					
5/8/97	0851	67	8.0	1900	1.0	0.69					
5/15/97	0830	74	7.8	2110	0.9	0.74					
5/23/97	1135	70	6.8	1630	0.8	0.60					
5/29/97	1020	76	8.2	1350	1.1	0.62					
6/5/97	0924	70	8.2	1820	1.1	0.71					
6/12/97	1215	80	8.4	1590	1.5	0.68					
6/19/97	NA	NA	NA	NA	NA	NA					
6/25/97	0950	75	8.2	1520	1.0	0.70					
7/2/97	1115	72	7.9	1100	1.0	0.49					
7/10/97	0858	76	8.0	1390	1.0	0.60					
7/17/97	1035	78	8.0	1200	0.9	0.50					
7/24/97	0907	78	7.9	1200	1.0	0.53					
7/31/97	1005	78	7.5	944	1.0	0.54					
8/7/97	0806	80	8.1	1210	1.0	0.60					
8/14/97	1105	79	7.9	990	0.9	0.46					
8/21/97	1142	81	7.8	849	0.9	0.33					
8/27/97	1455	80	8.2	952	1.0	0.43					
9/5/97	1110	81	8.4	1380	1.8	0.60					
9/12/97	0850	74	7.2	1420	1.4	0.61					
9/18/97	1001	72	7.9	1220	1.3	0.58					
9/25/97	1630	83	8.4	1510	1.0	0.58					

Count	48	48	48	48	47	1	1	1	1	1
Min	48	5.6	85	<0.4	0.08	110	120	190	45	20
Max	83	8.7	2110	1.8	0.96	110	120	190	45	20
Mean	66	7.6	1090	0.8	0.47	110	120	190	45	20
Geo Mean	65	7.6	804	0.6	0.32	110	120	190	45	20
Median	66.5	7.8	1190	0.8	0.54	110	120	190	45	20

San Joaquin River at Hills Ferry Road (STC512)

Location: Latitude 37°20'33", Longitude 120°58'38". In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E. West Bank, 0.9 mi. SE of Hills Ferry Road at an abandoned tallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River Mile 118.1

Date	Time	Temp F	pH	Se umhos/cm		mg/L																	
				EC	Se	Mo	Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	T.Alk	Ca	Mg	Na	K
10/3/96	0840	67	6.8	1170	6.8	0.90																	
10/8/96	0940	73	7.7	1480	5.2	0.99																	
10/17/96	1110	67	7.5	1690	5.9	1.2																	
10/24/96	1030	59	7.5	1010	2.3	0.72																	
10/31/96	1310	59	7.9	989	2.9	0.73	3																
11/7/96	0909	58	6.2	1230	3.3	1.0																	
11/15/96	1110	60	7.8	1710	4.2	1.4																	
11/22/96	1150	66	7.7	1360	4.0	1.1																	
11/27/96	1330	60	7.5	1080	2.5	0.86	5																
12/6/96	1200	52	7.5	1780	2.0	1.3																	
12/12/96	1010	58	7.4	370	0.9	0.31																	
12/19/96	1130	52	7.2	510	0.9	0.31																	
12/26/96	1212	48	7.0	431	1.1	0.28	1																
1/9/97	NA	NA	NA	NA	NA	NA																	
1/24/97	1150	52	7.6	548	1.1	0.37	1																
2/7/97					<0.4	<0.05																	
2/13/97	1136	56	8.2	76	<0.4	<0.05																	
2/21/97	1105	58	7.6	506	1.6	0.39																	
2/26/97	1155	54	7.7	473	1.4	0.30																	
3/5/97	1815	54	8.0	507	1.9	0.37																	
3/12/97	1735	61	7.3	968	3.9	0.71																	
3/20/97	1145	67	7.9	1570	7.5	1.3																	
3/27/97	1210	70	7.3	1830	7.0	1.4	8																
4/3/97	0850	57	7.9	2270	11.4	1.7																	
4/10/97	0930	58	7.8	2500	15.0	2.0																	
4/17/97	0920	69	7.6	2670	18.0	2.1																	
4/24/97	0902	62	7.6	2590	16.0	2.1	11																
5/2/97	1105	66	8.2	2340	15.8	2.0																	
5/8/97	0931	69	6.5	2240	9.7	1.6																	
5/15/97	1535	81	8.2	2700	15.3	2.1																	
5/23/97	0930	70	7.6	2040	10.2	1.7																	
5/29/97	1130	80	8.1	1980	13.0	2.0	9																
6/5/97	0906	69	8.1	2390	13.2	2.1																	
6/12/97	0925	76	8.3	2410	11.3	2.3																	
6/19/97	NA	NA	NA	NA	NA	NA																	
6/25/97	0905	74	8.3	2400	16.3	2.5	12																
7/2/97	1100	73	8.1	1740	10.0	1.7																	
7/10/97	0830	76	8.2	1880	11.1	2.0																	
7/17/97	1000	78	7.7	1820	7.5	1.9																	
7/24/97	0847	77	7.8	1710	9.2	1.8																	
7/31/97	0920	74	6.6	1410	5.4	1.4	6																
8/7/97	0748	79	7.9	1720	7.5	1.6																	
8/14/97	1040	78	7.5	1580	8.0	1.7																	
8/21/97	1119	79	7.6	1300	5.8	1.2																	
8/27/97	1520	82	8.0	1380	4.9	1.3	7																
9/5/97	1135	82	8.2	1840	7.6	1.6																	
9/12/97	1100	79	8.1	1700	4.9	1.5																	
9/18/97	0942	72	7.7	1380	2.3	0.97																	
9/25/97	1650	86	8.4	1680	2.7	1.1	10																
Count		46	46	46	47	10	0	0	0	0	0	47	2	1	1	1	2	2	1	1	1	1	1
Min		48	6.2	76	<0.4	1					<0.05	130	150	220	610	1	150	120	50	23	120	5.3	
Max		86	8.4	2700	18.0	12					2.5	140	160	230	610	<1	150	120	51	26	120	5.3	
Mean		67	7.7	1540	6.8	7					1.3	135	155	225	610	<1	150	120	50.5	24.5	120	5.3	
Geo Mean		67	7.7	1300	4.5	5					0.97	135	155	225	610	<1	150	120	50.498	24.5	120	5.3	
Median		68	7.7	1680	5.8	8					1.3	135	155	225	610	<1	150	120	50.5	24.5	120	5.3	

San Joaquin River at Crows Landing Road (STCS04)
Location: Latitude 37°25'55", Longitude 121°00'42". In Section 8 T.6S., R.8E. West Bank, 100 yards south
of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

Date	Time	Temp F	pH	EC µmhos/cm	Se	Mo	Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	T.Aik	CA	Mg	Na	K
10/31/96	0900	68	7.0	846	3.0							0.51											
10/8/96	0915	71	7.8	967	2.3							0.53											
10/17/96	1150	64	8.0	524	1.4							0.30											
10/24/96	1050	58	7.8	503	0.9							0.30											
10/31/96	1340	59	7.9	638	1.5	2						0.39	78	87	140	420	<1	110	93	33	15	70	4
11/7/96	0930	58	6.4	857	1.8							0.58											
11/15/96	1130	60	7.9	1130	2.2							0.79											
11/22/96	1215	65	7.9	945	2.4							0.66											
11/27/96	1400	59	7.5	857	2.1	5						0.64	100	120	200				44	21			
12/6/96	1220	52	7.8	1210	1.8							0.75											
12/12/96	0955	56	7.4	305	0.9							0.21											
12/19/96	1115	53	7.0	299	0.5							0.17											
12/26/96	0923	48	7.5	315	<0.4	2						0.14											
1/9/97	NA	NA	NA	NA	NA							NA											
1/14/97																							
1/24/97	1055	51	7.6	154	<0.4	<1						0.08	11	15	45				11	4			
1/30/97												0.06											
2/7/97	0927	53	7.1	190	<0.4							0.10											
2/13/97	1000	53	7.6	279	<0.4							0.14											
2/21/97	1135	55	7.9	351	0.6							0.15											
2/26/97	1100	54	7.3	312	0.6	2						0.11											
3/5/97	1835	52	8.0	358	1.1							0.21											
3/12/97	1715	60	7.4	670	2.1							0.43											
3/20/97	1205	64	7.9	882	3.6							0.65											
3/27/97	1030	70	7.4	994	3.7	4						0.71											
4/3/97	0815	54	7.9	1040	3.9							0.67											
4/10/97	0950	58	7.9	1440	7.4							0.97											
4/17/97	0855	68	7.5	1390	8.2							0.97											
4/24/97	0822	63	7.4	990	5.2	6						0.65	130	160	210				48	22			
5/2/97	1137	62	8.1	695	3.3							0.50											
5/8/97	0951	66	7.8	691	2.9							0.43											
5/15/97	1600	77	7.9	1090	4.8							0.69											
5/23/97	0850	70	7.7	1310	6.1							1.0											
5/29/97	1155	78	8.2	1270	6.5	6						1.1											
6/5/97	0750	68	8.0	1300	5.7							0.93											
6/12/97	0900	76	8.1	1460	4.7							1.1											
6/19/97	NA	NA	NA	NA	NA							NA											
6/25/97	0840	74	8.1	1410	6.9	6						1.2											
7/2/97	0950	70	7.9	1250	4.8							1.1											
7/10/97	0802	75	8.1	1350	5.0							1.2											
7/17/97	0915	76	7.6	1230	4.0							1.1											
7/24/97	0817	75	7.7	1080	3.9							0.84											
7/31/97	0815	74	6.9	1280	4.8	6						1.1	150	220	290								
8/7/97	0723	79	7.9	1160	2.8							0.89											
8/14/97	1005	78	7.3	1080	4.5							0.92											
8/21/97	1058	79	7.4	990	3.3							0.70											
8/28/97	0750	74	7.2	1070	2.9	6						0.78											
9/5/97	1155	80	8.2	1040	2.7							0.67											
9/12/97	1130	76	8.4	987	1.9							0.68											
9/18/97	0905	72	7.5	1020	1.4							0.61											
9/25/97	1715	80	8.4	863	0.9	4						0.43											
Count		47	47	48	49	12	0	0	0	0	0	48	5	5	5	1	1	1	1	4	4	1	1
Min		48	6.4	128	<0.4	<1						0.06	11	15	45	420	<1	110	93	11	4	4	4
Max		80	8.4	1460	8.2	6						1.2	150	220	290	420	<1	110	93	48	22	70	4
Mean		66	7.7	880	2.9	4						0.62	94	120	177	420	<1	110	93	34	16	70	4
Geo Mean		65	7.7	756	1.9	3						0.49	70	89	150	420	<1	110	93	30	13	70	4
Median		66	7.8	989	2.7	5						0.66	100	120	200	420	<1	110	93	39	18	70	4

San Joaquin River at Las Palmas Launching Facility (Patterson) (STC507)

Location: Latitude 37°29'52", Longitude 121°04'54". In SW 1/4, NW 1/4, SW 1/4, Sec. 15, T.5S., R.8E. West Bank, 0.3 mi. N of Patterson Bridge at NE corner of Las Palmas Launching Facility parking lot, 3.2 mi. NE of Patterson. River Mile 98.6.

Date	Time	Temp F	pH	EC umhos/cm	Se ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
10/3/96	0920	68	7.1	1100	2.9	0.61					
10/8/96	0850	70	7.4	1340	2.7	0.66					
10/17/96	1213	67	7.8	560	1.2	0.29					
10/24/96	1150	59	7.6	541	1.0	0.30					
10/31/96	1400	61	7.7	677	1.1	0.37	77	85	160	37	16
11/7/96	1025	58	6.5	921	1.7	0.56					
11/15/96	1210	61	8.1	960	1.4	0.55					
11/22/96	1310	65	7.9	981	2.3	0.66					
11/27/96	1505	60	7.1	845	1.6	0.55	99	110	190	44	20
12/6/96	1300	53	7.7	1230	1.4	0.70					
12/12/96	0925	56	7.1	388	0.8	0.26					
12/19/96	1040	53	6.7	312	0.5	0.17					
12/26/96	0855	48	7.4	259	0.7	0.14					
1/9/97	NA	NA	NA	NA	NA	NA					
1/24/97	0930	52	NA	221	0.5	0.11					
2/7/97	0907	53	7.2	254	0.5	0.15					
2/13/97	0923	51	7.6	242	0.6	0.15					
2/21/97	1245	56	8.2	218	0.5	0.12					
2/26/97	0910	52	7.4	234	0.6	0.12					
3/5/97	1855	54	7.8	328	1.1	0.20					
3/12/97	1700	59	6.5	624	2.0	0.40					
3/20/97	1615	63	7.6	906	3.3	0.62					
3/27/97	0935	66	7.6	1040	3.4	0.68					
4/3/97	0734	54	7.8	1030	3.7	0.63					
4/10/97	1055	58	7.5	1070	6.8	0.93					
4/17/97	0835	68	7.2	1410	7.0	0.88					
4/24/97	0730	61	7.1	969	4.9	0.64					
5/2/97	1205	64	8.0	694	3.1	0.45					
5/8/97	1113	70	7.9	698	2.5	0.40					
5/15/97	1620	77	7.9	1110	4.7	0.68					
5/23/97	0830	72	7.5	1300	5.8	0.98					
5/29/97	1215	78	8.2	1210	5.3	0.93					
6/5/97	0725	67	7.9	1350	6.6	0.97					
6/12/97	0840	76	8.1	1510	4.0	1.0					
6/19/97	NA	NA	NA	NA	NA	NA					
6/25/97	0820	74	8.0	1390	6.8	1.0					
7/2/97	0920	68	7.9	1200	4.1	0.92					
7/10/97	0727	74	7.9	1170	3.1	0.88					
7/17/97	0855	78	7.2	1100	3.2	0.78					
7/24/97	0736	76	7.4	1060	3.5	0.74					
7/31/97	0745	76	6.2	1170	3.6	0.89					
8/7/97	0654	79	7.6	1210	3.0	0.89					
8/14/97	0945	78	6.5	1060	3.6	0.80					
8/21/97	1031	77	7.2	895	2.6	0.56					
8/28/97	0935	74	7.7	1070	2.6	0.68					
9/5/97	1215	81	8.3	1230	3.6	0.78					
9/12/97	1210	76	8.9	995	1.5	0.60					
9/18/97	0831	72	7.2	979	1.4	0.51					
9/25/97	1800	80	8.1	926	0.8	0.42					

Count	47	46	47	47	47	2	2	2	2	2
Min	48	6.2	218	0.5	0.11	77	85	160	37	16
Max	81	8.9	1510	7.0	1.0	99	110	190	44	20
Mean	66	7.5	893	2.8	0.58	88	98	175	41	18
Geo Mean	65	7.5	784	2.1	0.49	87	97	174	40	18
Median	67	7.6	981	2.6	0.62	88	98	175	41	18

San Joaquin River at Maze Blvd. (State Highway 132) (STC510)

Location: Latitude 37°38'31", Longitude 121°13'40". In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E.

West Bank, 400 ft S of Maze Blvd Bridge upstream of Blewett Drain, River Mile 77.2

Date	Time	Temp		EC umhos/cm	Sc ug/L	B mg/L	Cl mg/L	SO4 mg/L	IDNS mg/L	Ca mg/L	Mg mg/L
		F	pH								
10/3/96	0955	69	7.2	673	1.5	0.33					
10/8/96	0820	69	6.9	717	1.1	0.31					
10/17/96	1315	66	7.8	458	0.8	0.22					
10/24/96	1230	59	7.9	450	0.7	0.24					
10/31/96	1445	60	7.7	562	0.8	0.26					
11/7/96	1055	59	6.6	730	1.2	0.39					
11/15/96	1315	60	7.6	899	1.1	0.50					
11/22/96	1405	64	7.7	788	1.5	0.49					
11/27/96	1545	59	7.3	690	1.3	0.40	83	81	150	35	16
12/6/96	1400	53	8.0	418	0.6	0.20					
12/12/96	0855	56	7.1	227	<0.4	0.12					
12/19/96	1015	53	5.8	186	<0.4	0.09					
12/26/96	0825	48	7.4	172	0.4	0.09					
1/9/97	NA	NA	NA	NA	NA	NA					
1/24/97	0845	NA	NA	231	0.6	0.13					
2/7/97	0832	52	7.1	219	0.5	0.13					
2/13/97	0837	49	7.5	240	0.6	0.14					
2/21/97	1440	56	7.7	194	<0.4	0.10					
2/26/97	0825	50	7.2	193	0.4	0.10					
3/5/97	1945	54	7.9	214	0.5	0.12					
3/12/97	1630	59	5.6	376	1.0	0.21					
3/20/97	1650	63	7.9	694	2.3	0.44					
3/27/97	0900	65	7.5	757	1.8	0.42					
4/3/97	0700	53	7.7	829	2.8	0.47					
4/10/97	1145	60	7.5	1020	3.8	0.55					
4/17/97	0805	66	6.7	702	3.0	0.37					
4/24/97	0651	58	6.6	393	1.7	0.22					
5/2/97	1315	64	8.2	518	1.8	0.29					
5/8/97	1149	66	8.0	411	1.3	0.21					
5/15/97	1705	72	7.9	473	1.5	0.25					
5/23/97	0740	70	6.7	999	3.1	0.64					
5/29/97	1250	78	8.2	956	2.9	0.60					
6/5/97	0647	66	7.6	1110	4.7	0.68					
6/12/97	0805	72	8.0	993	2.2	0.54					
6/19/97	NA	NA	NA	NA	NA	NA					
6/25/97	0745	74	8.0	950	2.8	0.57					
7/2/97	0840	67	7.8	806	2.1	0.50					
7/10/97	0648	73	7.8	861	2.1	0.54					
7/17/97	0823	78	6.4	829	2.0	0.49					
7/24/97	0605	75	7.2	795	1.8	0.45					
7/31/97	0715	74	6.0	792	1.7	0.47					
8/7/97	0617	77	7.3	747	1.3	0.43					
8/14/97	0920	76	6.4	737	1.6	0.44					
8/21/97	0959	76	6.9	708	1.5	0.40					
8/28/97	1000	76	8.0	770	1.5	0.42					
9/5/97	1310	81	8.9	842	1.8	0.48					
9/12/97	1300	78	8.5	713	1.1	0.36					
9/18/97	0803	72	6.9	693	1.1	0.36					
9/25/97	0905	77	7.0	623	0.5	0.26					
Count		46	46	47	47	47	1	1	1	1	1
Min		48	5.6	172	<0.4	0.09	83	81	150	35	16
Max		81	8.9	1110	4.7	0.68	83	81	150	35	16
Mean		65	7.4	625	1.5	0.35	83	81	150	35	16
Geo Mean		65	7.3	552	1.2	0.30	83	81	150	35	16
Median		66	7.5	702	1.5	0.37	83	81	150	35	16

San Joaquin River at Airport Way (SJC501)

Location: Latitude 37°40'32", Longitude 121°15'51". In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E.

West Bank, south of Airport Way Bridge, 3.2 miles NE of Vernalis River Mile 72.3.

Date	Time	Temp	pH	EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	Ca mg/L	Mg mg/L
		F															
10/3/96	1010	68	7.3	611	1.2							0.26					
10/8/96	0800	68	6.7	574	0.9							0.24					
10/17/96	1335	70	7.8	375	0.5							0.17					
10/24/96	1250	58	7.6	385	0.5							0.19					
10/31/96	1510	NA	7.7	500	0.6	1						0.22					
11/7/96	1130	60	6.8	619	1.0							0.32					
11/15/96	1345	60	7.9	625	0.7							0.32					
11/22/96	1420	64	8.0	631	1.3							0.37					
11/27/96	1600	59	7.4	465	0.8	2						0.25	50	52	110	25	11
12/6/96	1415	53	7.8	310	<0.4							0.14					
12/12/96	0835	55	6.9	168	<0.4							0.08					
12/19/96	1000	53	5.4	190	<0.4							0.09					
12/26/96	0815	48	6.8	156	<0.4	<1						0.07					
1/9/97	NA	NA	NA	NA	NA							NA					
1/24/97	0805	NA	7.6	NA	0.4	<1						0.10	16	20	57	13	5.9
2/7/97	0818	52	7.1	193	0.4							0.10					
2/13/97	0805	49	7.5	236	0.6							0.12					
2/21/97	1500	NA	7.7	NA	<0.4							0.08					
2/26/97	0810	50	6.7	180	0.4	1						0.09					
3/5/97	2015	52	7.8	222	0.4							0.11					
3/12/97	1615	60	5.7	348	0.8							0.18					
3/20/97	1703	NA	7.4	512	1.6							0.30					
3/27/97	0840	64	7.0	604	1.3	2						0.31					
4/3/97	0630	53	7.3	691	2.1							0.38					
4/10/97	1205	60	6.6	816	2.9							0.43					
4/17/97	0750	64	6.5	539	2.0							0.26					
4/24/97	0634	58	6.6	302	1.2	1						0.16					
5/2/97	1345	64	8.2	412	1.4							0.23					
5/8/97	1209	67	8.0	309	0.9							0.15					
5/15/97	1730	NA	7.8	374	1.1							0.18					
5/23/97	0720	66	6.2	533	1.5							0.28					
5/29/97	1310	72	8.3	545	1.5	2						0.31					
6/5/97	0622	61	6.8	571	1.9							0.32					
6/12/97	0750	70	7.8	582	1.2							0.30					
6/19/97	NA	NA	NA	NA	NA							NA					
6/25/97	0725	70	8.2	595	1.5	2						0.32					
7/2/97	0820	66	7.9	605	1.4							0.34					
7/10/97	0619	70	7.6	647	1.4							0.39					
7/17/97	0800	76	6.0	629	1.2							0.35					
7/24/97	0545	73	6.5	643	1.3							0.35					
7/31/97	0655	74	5.7	656	1.3	2						0.38					
8/7/97	0600	76	6.8	583	1.0							0.32					
8/14/97	0859	76	5.8	632	1.4							0.37					
8/21/97	0942	76	6.6	587	1.1							0.31					
8/28/97	NA	76	8.1	640	1.2	4						0.35					
9/5/97	1320	81	8.3	668	1.3							0.33					
9/12/97	1320	78	NA	576	0.8							0.28					
9/18/97	0745	72	6.6	563	0.8							0.26					
9/25/97	0845	75	7.4	489	0.4	2						0.20					
Count		42	46	45	47	12	0	0	0	0	0	47	2	2	2	2	2
Min		48	5.4	156	<0.4	<1						0.07	16	20	57	13	6
Max		81	8.3	816	2.9	4						0.43	50	52	110	25	11
Mean		65	7.2	491	1.0	1.7						0.25	33	36	84	19	8.5
Geo Mean		64	7.1	453	0.8	1.4						0.22	28	32	79	18	8.1
Median		65	7.3	563	1.1	2.0						0.26	33	36	84	19	8.5

APPENDIX C
Automated Daily Composite Water Quality Data

RWQCB Site I.D.	Site Name	Period of Record
MER504S	San Joaquin River at Crows Landing	10/95-9/97

Legend of Abbreviations

EC Electrical Conductivity
Se Selenium
B Boron

San Joaquin River at Crows Landing Road: Turlock Sportsman Club (STC504S)

Location: Latitude 37°25'55", Longitude 121°00'42". In Section 8 T.6S., R.8E. West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

AUTOSAMPLER DATA : 12 hour daily composite samples - WY 96

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
10/1/95	277	1.4	0.17	11/24/95	926	2.8	0.61
10/2/95	195	1.1	0.12	11/25/95	922	2.9	0.66
10/3/95	186	1.1	0.12	11/26/95	905	2.4	0.64
10/4/95	148	0.7	0.08	11/27/95	917	2.4	0.62
10/5/95	146	<0.4	<0.05	11/28/95	922	2.6	0.6
10/6/95	145	<0.4	0.05	11/29/95	916	2.8	0.65
10/7/95	146	<0.4	0.05	11/30/95	899	2.7	0.60
10/8/95	150	<0.4	0.06	12/1/95	917	2.8	0.62
10/9/95	149	<0.4	0.05	12/2/95	903	3.0	0.63
10/10/95	146	<0.4	0.07	12/3/95	897	2.9	0.64
10/11/95	135	<0.4	0.06	12/4/95	898	3.2	0.60
10/12/95	135	<0.4	0.05	12/5/95	872	2.7	0.57
10/13/95	134	<0.4	<0.05	12/6/95	894	3.0	0.58
10/14/95	136	<0.4	<0.05	12/7/95	887	3.3	0.58
10/15/95	146	<0.4	<0.05	12/8/95	862	3.2	0.57
10/16/95	143	<0.4	0.05	12/9/95	918	2.7	0.62
10/17/95	201	<0.4	<0.05	12/10/95	892	2.1	0.53
10/18/95	268	<0.4	0.10	12/11/95	903	3.2	0.60
10/19/95	383	0.9	0.22	12/12/95	928	2.7	0.58
10/20/95	450	1.3	0.27	12/13/95	902	2.8	0.60
10/21/95	481	1.5	0.27	12/14/95	851	2.7	0.54
10/22/95	525	1.8	0.34	12/15/95	856	2.7	0.56
10/23/95	558	2.9	0.41	12/16/95	843	3.1	0.57
10/24/95	590	2.8	0.44	12/17/95	859	3.4	0.63
10/25/95	618	3.1	0.46	12/18/95	873	3.0	0.64
10/26/95	574	2.9	0.44	12/19/95	932	2.9	0.71
10/27/95	534	2.3	0.39	12/20/95	975	3.2	0.70
10/28/95	515	2.1	0.37	12/21/95	989	3.4	0.71
10/29/95	571	2.5	0.41	12/22/95	1130	3.4	0.78
10/30/95	587	2.1	0.44	12/23/95	1020	4.3	0.78
10/31/95	623	2.1	NA	12/24/95	963	3.3	NA
11/1/95	615	2.1	0.44	12/25/95	972	3.1	0.73
11/2/95	591	1.5	NA	12/26/95	977	3.2	0.70
11/3/95	612	2.0	0.41	12/27/95	1020	3.2	0.76
11/4/95	627	1.7	0.40	12/28/95	1050	3.7	0.74
11/5/95	701	1.7	0.45	12/29/95	1060	3.6	0.72
11/6/95	726	1.8	0.46	12/30/95	1030	3.8	0.66
11/7/95	750	1.8	0.43	12/31/95	972	3.3	0.73
11/8/95	766	2.0	0.45	1/1/96	990	3.7	0.70
11/9/95	745	1.9	0.44	1/2/96	1080	4.0	0.75
11/10/95	722	0.7	0.36	1/3/96	1180	3.5	0.78
11/11/95	795	1.1	0.41	1/4/96	1210	2.6	0.78
11/12/95	831	2.1	0.51	1/5/96	1330	1.5	0.70
11/13/95	782	1.5	0.45	1/6/96	1390	1.5	0.76
11/14/95	794	1.3	0.45	1/7/96	1410	1.4	0.76
11/15/95	865	2.3	0.52	1/8/96	1450	1.5	0.84
11/16/95	853	2.2	0.54	1/9/96	1470	1.6	0.82
11/17/95	902	2.7	0.59	1/10/96	1440	1.9	0.77
11/18/95	913	2.9	0.61	1/11/96	1450	1.9	0.76
11/19/95	909	2.7	0.58	1/12/96	1480	1.7	0.78
11/20/95	894	2.4	0.56	1/13/96	1540	2.5	0.91
11/21/95	926	2.9	0.66	1/14/96	1590	5.4	1.0
11/22/95	880	2.0	0.56	1/15/96	1640	7.3	1.2
11/23/95	905	2.4	0.58	1/16/96	1460	5.6	0.94

WY 96 Crows Landing Sigma Autosampler Data (cont)

Date	EC μmhos/cm	Se μg/L	B mg/L	Date	EC μmhos/cm	Se μg/L	B mg/L
1/17/96	1470	4.9	0.96	3/16/96	NA	NA	NA
1/18/96	1350	5.2	0.93	3/17/96	NA	NA	NA
1/19/96	1170	7.2	0.02	3/18/96	NA	NA	NA
1/20/96	1210	7.5	0.99	3/19/96	379	1.5	0.23
1/21/96	1050	6.3	0.91	3/20/96	376	1.4	0.24
1/22/96	1120	6.1	0.93	3/21/96	382	1.7	0.23
1/23/96	1030	5.3	0.91	3/22/96	388	1.8	0.25
1/24/96	1090	4.7	0.70	3/23/96	422	2.0	0.25
1/25/96	1170	5.4	0.82	3/24/96	505	2.0	0.31
1/26/96	956	4.0	0.62	3/25/96	536	2.4	0.34
1/27/96	850	3.5	0.67	3/26/96	582	2.5	0.38
1/28/96	772	3.4	0.60	3/27/96	610	1.9	0.44
1/29/96	671	3.1	0.55	3/28/96	572	1.6	0.37
1/30/96	674	2.7	0.53	3/29/96	577	1.9	0.36
1/31/96	667	2.8	0.52	3/30/96	625	2.2	0.40
2/1/96	714	2.6	0.58	3/31/96	727	3.2	0.49
2/2/96	635	2.1	0.47	4/1/96	786	2.9	0.57
2/3/96	696	2.0	0.44	4/2/96	753	2.9	0.50
2/4/96	858	2.7	0.56	4/3/96	701	2.9	0.46
2/5/96	733	2.4	0.49	4/4/96	731	2.7	0.44
2/6/96	571	1.5	0.36	4/5/96	845	2.6	0.52
2/7/96	516	1.4	0.29	4/6/96	1010	4.1	0.56
2/8/96	588	1.9	0.35	4/7/96	1220	3.0	0.77
2/9/96	581	2.0	0.37	4/8/96	1210	3.9	0.70
2/10/96	535	1.8	0.35	4/9/96	1320	3.8	0.75
2/11/96	574	2.1	0.42	4/10/96	1320	3.8	0.73
2/12/96	616	2.6	0.43	4/11/96	1340	3.5	0.74
2/13/96	648	3.0	0.49	4/12/96	1460	4.4	0.86
2/14/96	654	3.0	0.51	4/13/96	1530	5.2	0.93
2/15/96	644	3.2	0.48	4/14/96	1540	6.4	0.91
2/16/96	643	3.4	0.49	4/15/96	1470	6.0	0.97
2/17/96	641	3.1	0.51	4/16/96	1360	4.9	0.87
2/18/96	656	3.6	0.52	4/17/96	1140	4.0	0.70
2/19/96	635	3.3	0.52	4/18/96	882	3.4	0.53
2/20/96	529	2.4	0.41	4/19/96	754	3.3	0.43
2/21/96	477	1.8	0.29	4/20/96	699	4.1	0.43
2/22/96	389	1.4	0.23	4/21/96	734	3.6	0.46
2/23/96	NA	NA	NA	4/22/96	700	3.5	0.42
2/24/96	NA	NA	NA	4/23/96	690	4.3	0.40
2/25/96	NA	NA	NA	4/24/96	736	3.7	0.44
2/26/96	NA	NA	NA	4/25/96	726	4.1	0.42
2/27/96	NA	NA	NA	4/26/96	775	4.4	0.45
2/28/96	NA	NA	NA	4/27/96	829	4.6	0.50
2/29/96	NA	NA	NA	4/28/96	779	3.7	0.47
3/1/96	NA	NA	NA	4/29/96	737	4.2	0.42
3/2/96	NA	NA	NA	4/30/96	765	4.7	0.40
3/3/96	NA	NA	NA	5/1/96	779	4.3	0.45
3/4/96	NA	NA	NA	5/2/96	765	3.9	0.46
3/5/96	NA	NA	NA	5/3/96	726	3.4	0.44
3/6/96	NA	NA	NA	5/4/96	713	3.7	0.38
3/7/96	NA	NA	NA	5/5/96	731	4.1	0.39
3/8/96	NA	NA	NA	5/6/96	745	4.7	0.41
3/9/96	NA	NA	NA	5/7/96	739	3.9	0.43
3/10/96	NA	NA	NA	5/8/96	701	3.2	0.39
3/11/96	NA	NA	NA	5/9/96	686	3.9	0.36
3/12/96	NA	NA	NA	5/10/96	688	3.6	0.40
3/13/96	NA	NA	NA	5/11/96	647	3.5	0.37
3/14/96	NA	NA	NA	5/12/96	619	3.5	0.36
3/15/96	NA	NA	NA	5/13/96	619	3.6	0.38

WY 96 Crows Landing Sigma Autosampler Data (cont)

Date	EC μmhos/cm	Se μg/L	B mg/L	Date	EC μmhos/cm	Se μg/L	B mg/L
5/14/96	628	3.4	0.39	7/12/96	1530	8.6	1.4
5/15/96	622	3.3	0.36	7/13/96	1620	8.6	1.5
5/16/96	580	2.7	0.33	7/14/96	1540	9.2	1.3
5/17/96	530	2.0	0.34	7/15/96	1640	8.9	1.4
5/18/96	453	1.8	0.30	7/16/96	1480	9.1	1.3
5/19/96	417	2.2	0.26	7/17/96	1400	8.2	1.3
5/20/96	441	0.8	0.29	7/18/96	1380	7.8	1.3
5/21/96	191	0.6	0.09	7/19/96	1330	7.7	1.2
5/22/96	225	0.6	0.10	7/20/96	1360	7.6	1.2
5/23/96	165	0.5	0.09	7/21/96	1340	6.9	1.2
5/24/96	144	0.9	0.08	7/22/96	1310	7.7	1.2
5/25/96	197	1.3	0.13	7/23/96	1450	8.0	1.3
5/26/96	261	1.7	0.19	7/24/96	1420	7.6	1.3
5/27/96	302	1.8	0.23	7/25/96	1370	7.7	1.2
5/28/96	343	3.0	0.27	7/26/96	1400	7.2	1.2
5/29/96	517	3.5	0.41	7/27/96	1390	6.7	1.2
5/30/96	660	3.3	0.55	7/28/96	1340	5.8	1.1
5/31/96	723	4.1	0.51	7/29/96	1180	5.3	0.97
6/1/96	829	4.2	0.49	7/30/96	1110	5.4	0.89
6/2/96	854	3.9	0.57	7/31/96	1150	6.2	0.94
6/3/96	884	3.9	0.55	8/1/96	1240	6.7	1.0
6/4/96	934	4.1	0.58	8/2/96	1360	6.9	1.1
6/5/96	1040	4.3	0.64	8/3/96	1390	7.7	1.2
6/6/96	1040	4.2	0.64	8/4/96	1410	6.7	1.2
6/7/96	1120	5.4	0.68	8/5/96	1200	6.5	1.0
6/8/96	1330	5.4	0.84	8/6/96	1180	5.7	1.0
6/9/96	1360	5.9	0.88	8/7/96	1130	5.7	0.95
6/10/96	1340	5.8	0.92	8/8/96	1110	5.7	0.92
6/11/96	1340	5.7	0.97	8/9/96	1080	6.5	0.87
6/12/96	1400	6.0	1.0	8/10/96	1230	5.9	1.0
6/13/96	1460	7.2	1.0	8/11/96	1140	6.4	0.92
6/14/96	1530	6.7	1.2	8/12/96	1130	4.9	0.93
6/15/96	1470	4.8	1.1	8/13/96	974	4.7	0.79
6/16/96	1290	5.3	0.89	8/14/96	967	4.9	0.76
6/17/96	1290	6.1	0.90	8/15/96	990	5.7	0.78
6/18/96	1380	6.4	0.99	8/16/96	1220	6.2	0.97
6/19/96	1330	7.3	0.95	8/17/96	1250	6.2	1.0
6/20/96	1350	7.2	1.0	8/18/96	1310	6.4	1.1
6/21/96	1360	6.4	1.1	8/19/96	1230	6.0	1.0
6/22/96	1440	7.9	0.97	8/20/96	1080	4.9	0.87
6/23/96	1430	7.1	1.1	8/21/96	1010	5.0	0.82
6/24/96	1370	7.9	1.0	8/22/96	1030	3.5	0.85
6/25/96	1400	7.4	1.1	8/23/96	1040	5.3	0.84
6/26/96	1340	7.1	0.98	8/24/96	1000	NA	0.81
6/27/96	1270	7.0	0.92	8/25/96	NA	NA	NA
6/28/96	1180	7.2	0.89	8/26/96	NA	NA	NA
6/29/96	1150	8.0	0.84	8/27/96	NA	NA	NA
6/30/96	1220	7.1	0.88	8/28/96	NA	4.7	NA
7/1/96	1180	8.0	0.89	8/29/96	1060	5.8	0.83
7/2/96	1240	7.5	1.0	8/30/96	1090	5.4	0.86
7/3/96	1290	7.7	1.1	8/31/96	1050	5.7	0.84
7/4/96	1380	8.4	1.1	9/1/96	1060	4.8	0.84
7/5/96	1470	8.7	1.2	9/2/96	904	4.4	0.67
7/6/96	1520	7.5	1.3	9/3/96	879	4.2	0.64
7/7/96	1410	6.8	1.2	9/4/96	838	4.3	0.63
7/8/96	1400	7.3	1.1	9/5/96	914	5.3	0.67
7/9/96	1420	7.0	1.2	9/6/96	987	5.6	0.76
7/10/96	1380	7.5	1.1	9/7/96	1010	6.0	0.79
7/11/96	1470	8.1	1.2	9/8/96	1020	5.5	0.85

WY 96 Crows Landing Sigma Autosampler Data (cont)

Date	EC µmhos/cm	Se µg/L	B mg/L
9/9/96	973	5.4	0.82
9/10/96	889	4.4	0.73
9/11/96	813	4.3	0.64
9/12/96	822	4.1	0.64
9/13/96	949	3.4	0.58
9/14/96	914	1.6	0.54
9/15/96	762	1.4	0.35
9/16/96	712	2.5	0.33
9/17/96	817	3.2	0.50
9/18/96	806	3.7	0.53
9/19/96	757	3.3	0.51
9/20/96	731	3.2	0.45
9/21/96	790	3.0	0.46
9/22/96	799	3.1	0.46
9/23/96	865	3.2	0.51
9/24/96	840	3.1	0.50
9/25/96	937	5.4	0.61
9/26/96	1220	2.3	1.1
9/27/96	1120	1.7	0.98
9/28/96	1110	2.3	1.0
9/29/96	892	2.6	0.67
9/30/96	840	2.6	0.57
Count	337	337	334
Min	134	0.5	0.02
Max	1640	9.2	1.5
Mean	907	3.8	0.64
Geo Mean	807	3.1	0.53
Median	897	3.3	0.60

San Joaquin River at Crows Landing Road: Turlock Sportsman Club (STC504S)

Location: Latitude 37°25'55", Longitude 121°00'42". In Section 8 T.6S., R.8E. West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

AUTOSAMPLER DATA : 12 hour daily composite samples - WY 97

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
10/1/96	845	3.2	0.56	11/24/96	947	2.4	0.55
10/2/96	853	3.4	0.61	11/25/96	942	2.5	0.57
10/3/96	792	3.1	0.54	11/26/96	768	1.9	0.56
10/4/96	794	3.8	0.55	11/27/96	948	1.8	0.62
10/5/96	868	2.7	0.53	11/28/96	899	1.8	0.65
10/6/96	902	2.1	0.52	11/29/96	952	2.0	0.68
10/7/96	908	2.0	0.50	11/30/96	998	1.9	0.69
10/8/96	943	2.2	0.55	12/1/96	1040	2.0	0.71
10/9/96	989	2.7		12/2/96	1100	1.7	0.72
10/10/96	866	2.5	0.52	12/3/96	1100	1.6	0.71
10/11/96	647	1.8	0.41	12/4/96	1120	1.6	0.73
10/12/96	634	2.0	0.42	12/5/96	1170	1.6	0.76
10/13/96	653	2.1	0.46	12/6/96	1210	1.4	0.77
10/14/96	585	2.0	0.40	12/7/96	853	0.8	0.58
10/15/96	612	1.4	0.40	12/8/96	561	1.0	0.36
10/16/96	500	1.3	0.32	12/9/96	599	1.1	0.42
10/17/96	460	1.5	0.29	12/10/96	652	1.1	0.45
10/18/96	439	1.3	0.28	12/11/96	509	0.9	0.33
10/19/96	399	1.0	0.24	12/12/96	333	0.7	0.21
10/20/96	371	0.9	0.22	12/13/96	347	0.9	0.22
10/21/96	454	1.0	0.28	12/14/96	361	0.8	0.23
10/22/96	486	1.0	0.31	12/15/96	325	0.6	0.19
10/23/96	492	1.0	0.31	12/16/96	281	0.6	0.17
10/24/96	NA	NA	NA	12/17/96	293	0.6	0.16
10/25/96	545	1.1	0.35	12/18/96	288	0.5	0.16
10/26/96	569	1.4	0.37	12/19/96	300	0.6	0.16
10/27/96	630	1.8	0.40	12/20/96	289	0.6	0.17
10/28/96	654	1.6	0.42	12/21/96	310	0.7	0.20
10/29/96	655	1.2	0.41	12/22/96	293	0.6	0.17
10/30/96	648	1.1	0.40	12/23/96	222	0.5	0.12
10/31/96	652	1.8	0.47	12/24/96	215	0.6	0.12
11/1/96	643	1.6	0.44	12/25/96	256	0.7	0.14
11/2/96	649	1.7	0.48	12/27/96	245	0.5	0.15
11/3/96	695	1.7	0.51	12/28/96	246	0.5	0.15
11/4/96	744	1.6	0.54	12/29/96	238	0.5	0.14
11/5/96	773	1.7	0.56	12/30/96	235	0.5	0.14
11/6/96	807	1.8	0.61	12/31/96	239	0.5	0.14
11/7/96	843	1.9	0.65	1/1/97	246	0.6	0.14
11/8/96	936	2.2	0.63	1/2/97	203	0.5	0.10
11/9/96	953	1.8	0.61	1/3/97	167	0.4	0.08
11/10/96	1000	1.7	0.64	1/4/97	147	<0.4	0.06
11/11/96	1010	1.5	0.65	1/5/97	141	<0.4	0.06
11/12/96	1040	1.5	0.66	1/6/97	139	<0.4	0.06
11/13/96	1090	1.9	0.71	1/7/97	136	<0.4	0.06
11/14/96	1120	2.0	0.75	1/8/97	121	<0.4	0.05
11/15/96	1140	2.2	0.77	1/9/97	136	<0.4	0.06
11/16/96	1130	2.4	0.75	1/10/97	164	<0.4	0.08
11/17/96	1050	2.3	0.75	1/11/97	174	<0.4	0.10
11/18/96	1040	2.2	0.73	1/12/97	178	<0.4	0.10
11/19/96	1020	2.6	0.74	1/13/97	172	<0.4	0.09
11/20/96	1000	2.5	0.78	1/14/97	162	<0.4	0.08
11/21/96	962	2.4	0.68	1/15/97	156	<0.4	0.08
11/22/96	939	2.2	0.65	1/16/97	155	0.4	0.08
11/23/96	902	2.4	0.65				

WY 97 Crows Landing Sigma Autosampler Data continued:

Date	EC μmhos/cm	Se μg/L	B mg/L	Date	EC μmhos/cm	Se μg/L	B mg/L
1/17/97	159	0.4	0.08	3/16/97	817	3.0	0.53
1/18/97	NA	NA	NA	3/17/97	807	3.1	0.54
1/19/97	NA	NA	NA	3/18/97	812	3.2	NA
1/20/97	NA	NA	NA	3/19/97	NA	NA	NA
1/21/97	NA	NA	NA	3/20/97	NA	NA	NA
1/22/97	NA	NA	NA	3/21/97	891	3.3	0.62
1/23/97	NA	NA	NA	3/22/97	899	3.1	0.58
1/24/97	NA	NA	NA	3/23/97	912	3.2	0.58
1/25/97	NA	NA	NA	3/24/97	901	2.4	0.55
1/26/97	NA	NA	NA	3/25/97	928	2.4	0.56
1/27/97	NA	NA	NA	3/26/97	956	3.1	0.62
1/28/97	NA	NA	NA	3/27/97	993	3.3	0.66
1/29/97	NA	NA	NA	3/28/97	1020	3.3	0.68
1/30/97	NA	NA	NA	3/29/97	1000	3.3	0.68
1/31/97	NA	NA	NA	3/30/97	993	3.4	0.66
2/1/97	NA	NA	NA	3/31/97	1000	3.9	0.66
2/2/97	NA	NA	NA	4/1/97	1050	4.2	0.68
2/3/97	NA	NA	NA	4/2/97	1040	4.0	0.65
2/4/97	NA	NA	NA	4/3/97	1070	4.4	0.68
2/5/97	NA	NA	NA	4/4/97	1100	5.1	0.73
2/6/97	NA	NA	NA	4/5/97	1180	6.0	0.81
2/7/97	NA	NA	NA	4/6/97	1320	7.2	0.91
2/8/97	218	<0.4	0.11	4/7/97	1440	8.1	0.99
2/9/97	292	<0.4	0.14	4/8/97	1450	7.9	0.96
2/10/97	314	<0.4	0.15	4/9/97	1500	7.9	0.97
2/11/97	306	<0.4	0.15	4/10/97	NA	NA	NA
2/12/97	290	0.4	0.14	4/11/97	1570	8.0	1.0
2/13/97	264	<0.4	0.14	4/12/97	1680	8.9	1.1
2/14/97	277	0.4	0.14	4/13/97	1670	9.1	1.1
2/15/97	250	0.4	0.13	4/14/97	1700	9.6	1.1
2/16/97	211	0.5	0.12	4/15/97	1740	9.7	1.2
2/17/97	204	0.5	0.11	4/16/97	1560	9.6	1.1
2/18/97	206	0.5	0.11	4/17/97	1320	7.5	0.9
2/19/97	206	0.5	0.11	4/18/97	1210	6.2	0.68
2/20/97	204	0.5	0.11	4/19/97	919	5.4	0.58
2/21/97	213	0.4	0.12	4/20/97	781	4.3	0.49
2/22/97	213	0.4	0.12	4/21/97	711	4.2	0.46
2/23/97	224	0.5	0.12	4/22/97	746	4.4	0.48
2/24/97	238	0.5	0.12	4/23/97	948	5.2	0.57
2/25/97	269	0.5	0.13	4/24/97	NA	NA	NA
2/26/97	306	0.5	NA	4/25/97	1080	5.5	0.70
2/27/97	346	0.5	0.17	4/26/97	1160	6.0	0.76
2/28/97	285	0.4	0.14	4/27/97	1210	6.7	0.85
3/1/97	332	0.4	0.16	4/28/97	1170	6.9	0.86
3/2/97	369	0.5	0.19	4/29/97	1200	6.8	0.86
3/3/97	323	0.6	0.19	4/30/97	1170	6.0	0.83
3/4/97	307	0.6	0.19	5/1/97	764	3.6	0.51
3/5/97	321	0.9	0.20	5/2/97	690	3.4	0.51
3/6/97	359	0.9	0.22	5/3/97	631	3.0	0.46
3/7/97	402	1.1	0.24	5/4/97	658	3.1	0.47
3/8/97	NA	NA	NA	5/5/97	657	2.7	0.44
3/9/97	NA	NA	NA	5/6/97	679	3.1	0.45
3/10/97	NA	NA	NA	5/7/97	681	2.4	0.45
3/11/97	NA	NA	NA	5/8/97	NA	NA	NA
3/12/97	NA	NA	NA	5/9/97	757	3.0	0.52
3/13/97	NA	NA	NA	5/10/97	679	2.8	0.48
3/14/97	739	2.6	0.46	5/11/97	641	2.8	0.46
3/15/97	779	2.9	0.50	5/12/97	620	2.8	0.45
				5/13/97	732	3.3	0.55

WY 97 Crows Landing Sigma Autosampler Data continued:

	EC	Se	B		EC	Se	B
Date	µmhos/cm	µg/L	mg/L	Date	µmhos/cm	µg/L	mg/L
5/14/97	975	5.0	0.78	7/12/97	1380	4.4	1.2
5/15/97	1100	4.9	0.81	7/13/97	1340	5.4	1.2
5/16/97	1190	5.3	0.88	7/14/97	1280	4.1	1.1
5/17/97	1190	4.5	0.89	7/15/97	1230	4.6	1.0
5/18/97	1220	4.5	0.91	7/16/97	1170	4.3	1.0
5/19/97	1270	5.8	1.0	7/17/97	1210	4.0	1.1
5/20/97	1260	5.8	1.1	7/18/97	1320	4.3	1.3
5/21/97	1330	6.7	1.1	7/19/97	1360	4.8	1.2
5/22/97	1340	6.9	1.1	7/20/97	1300	4.7	1.6
5/23/97	NA	NA	NA	7/21/97	1110	4.2	0.93
5/24/97	1200	5.2	0.95	7/22/97	1090	4.3	0.89
5/25/97	1260	5.4	1.0	7/23/97	1110	4.3	0.90
5/26/97	1250	6.5	1.1	7/24/97	1120	4.0	0.90
5/27/97	1280	6.3	1.1	7/25/97	1290	4.5	1.1
5/28/97	1320	6.5	1.2	7/26/97	1420	5.1	1.2
5/29/97	1300	6.5	1.2	7/27/97	1340	4.8	1.2
5/30/97	1340	7.0	1.2	7/28/97	1240	4.4	1.1
5/31/97	1430	7.6	1.3	7/29/97	1160	3.7	1.0
6/1/97	1510	8.3	1.4	7/30/97	1150	4.1	1.0
6/2/97	1600	10.0	1.4	7/31/97	1270	4.8	1.1
6/3/97	1500	8.9	1.3	8/1/97	1170	3.5	1.0
6/4/97	1440	7.7	1.3	8/2/97	1270	3.7	0.99
6/5/97	1290	5.9	0.99	8/3/97	1250	4.2	1.0
6/6/97	1350	5.4	1.0	8/4/97	1120	3.6	0.93
6/7/97	1450	6.3	1.1	8/5/97	1100	3.2	0.87
6/8/97	1320	4.2	1.0	8/6/97	1200	3.4	0.94
6/9/97	1300	4.3	0.96	8/7/97	1270	3.7	0.96
6/10/97	1390	4.7	1.0	8/8/97	1320	3.8	1.0
6/11/97	1500	4.7	1.2	8/9/97	1290	4.5	1.1
6/12/97	1490	4.9	1.2	8/10/97	1350	5.3	1.2
6/13/97	1650	6.2	1.4	8/11/97	1230	5.2	1.1
6/14/97	1580	6.5	1.4	8/12/97	1080	4.3	0.92
6/15/97	1380	6.6	1.2	8/13/97	1060	4.4	0.92
6/16/97	1460	7.0	1.3	8/14/97	1130	4.7	1.0
6/17/97	1440	7.1	1.3	8/15/97	1160	4.0	1.0
6/18/97	1410	7.6	1.3	8/16/97	1200	4.6	1.1
6/19/97	1490	8.9	1.4	8/17/97	1050	4.1	0.93
6/20/97	1530	7.3	1.4	8/18/97	941	3.2	1.2
6/21/97	1710	9.1	1.5	8/19/97	887	2.9	0.74
6/22/97	1580	7.5	1.4	8/20/97	895	3.3	0.72
6/23/97	1440	7.5	1.3	8/21/97	1000	3.5	0.76
6/24/97	1390	7.3	1.2	8/22/97	1040	3.7	0.86
6/25/97	1460	7.7	1.3	8/23/97	1110	3.7	0.93
6/26/97	1480	6.7	1.3	8/24/97	1130	3.4	0.94
6/27/97	1430	6.7	1.2	8/25/97	1150	3.5	0.94
6/28/97	1510	7.1	1.3	8/26/97	1030	3.1	0.79
6/29/97	1430	5.7	1.2	8/27/97	1020	2.8	0.81
6/30/97	1400	5.7	1.2	8/28/97	1070	2.8	0.83
7/1/97	1260	5.0	1.1	8/29/97	1190	3.7	0.91
7/2/97	1220	4.7	1.1	8/30/97	1340	4.2	1.0
7/3/97	1310	6.0	1.1	8/31/97	1340	4.6	1.1
7/4/97	1420	6.4	1.2	9/1/97	1260	3.8	1.0
7/5/97	1400	6.0	1.2	9/2/97	1220	3.8	0.96
7/6/97	1390	5.7	1.2	9/3/97	1270	5.0	1.0
7/7/97	1260	5.3	1.1	9/4/97	1190	4.3	0.98
7/8/97	1300	5.6	1.2	9/5/97	1060	3.9	0.76
7/9/97	1240	4.2	1.1	9/6/97	1110	2.9	0.82
7/10/97	1360	5.3	1.2	9/7/97	1050	2.0	0.68
7/11/97	1360	5.8	1.2	9/8/97	996	2.3	0.68

WY 97 Crows Landing Sigma Autosampler Data continued:

Date	EC μmhos/cm	Se μg/L	B mg/L
9/9/97	884	2.1	0.64
9/10/97	931	2.2	0.82
9/11/97	942	1.9	0.72
9/12/97	983	1.9	0.76
9/13/97	1050	2.0	0.79
9/14/97	995	1.4	0.73
9/15/97	936	1.7	0.72
9/16/97	856	1.6	0.62
9/17/97	896	1.3	0.62
9/18/97	1000	1.1	0.64
9/19/97	985	1.3	0.59
9/20/97	925	0.9	0.53
9/21/97	867	0.9	0.48
9/22/97	812	1.0	0.45
9/23/97	769	0.6	0.42
9/24/97	769	0.5	0.42
9/25/97	855	1.3	0.47
9/26/97	870	1.0	0.46
9/27/97	899	1.0	0.48
9/28/97	866	1.0	0.48
9/29/97	897	1.1	0.53
9/30/97	922	1.3	0.60

Date	EC μmhos/cm	Se μg/L	B mg/L
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Count	330	330	327
Min	121	<0.4	0.05
Max	1740	10.0	1.6
Mean	909	3.2	0.68
Geo Mean	771	2.2	0.53
Median	979	2.9	0.68

APPENDIX D

4-Day Running Average Selenium Concentrations in the San Joaquin River at Crows Landing

RWQCB Site I.D.	Site Name	Period of Record
MER504S	San Joaquin River at Crows Landing	10/95-9/97

Legend of Abbreviations

EC	Electrical Conductivity
Sc	Selenium
B	Boron

San Joaquin River at Crows Landing Road: Turlock Sportsman Club (STC504S)

Location: Latitude 37°25'55", Longitude 121°00'42". In Section 8 T.6S., R.8E. West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

AUTOSAMPLER DATA : 4 day average based on daily composite samples - WY 96

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
10/1/95				11/24/95	909	2.5	0.60
10/2/95				11/25/95	908	2.5	0.60
10/3/95				11/26/95	915	2.6	0.62
10/4/95	202	1.1	0.12	11/27/95	918	2.6	0.63
10/5/95	169	0.8	0.09	11/28/95	917	2.6	0.63
10/6/95	156	0.6	0.07	11/29/95	915	2.6	0.63
10/7/95	146	0.3	0.05	11/30/95	914	2.6	0.62
10/8/95	147	0.2	0.05	12/1/95	914	2.7	0.62
10/9/95	148	0.2	0.05	12/2/95	909	2.8	0.63
10/10/95	148	0.2	0.06	12/3/95	904	2.9	0.62
10/11/95	145	0.2	0.06	12/4/95	904	3.0	0.62
10/12/95	141	0.2	0.06	12/5/95	893	3.0	0.61
10/13/95	138	0.2	0.05	12/6/95	890	3.0	0.60
10/14/95	135	0.2	0.04	12/7/95	888	3.1	0.58
10/15/95	138	0.2	0.03	12/8/95	879	3.1	0.58
10/16/95	140	0.2	0.03	12/9/95	890	3.1	0.59
10/17/95	157	0.2	0.03	12/10/95	890	2.8	0.58
10/18/95	190	0.2	0.05	12/11/95	894	2.8	0.58
10/19/95	249	0.4	0.10	12/12/95	910	2.7	0.58
10/20/95	326	0.7	0.15	12/13/95	906	2.7	0.58
10/21/95	396	1.0	0.22	12/14/95	896	2.9	0.58
10/22/95	460	1.4	0.28	12/15/95	884	2.7	0.57
10/23/95	504	1.9	0.32	12/16/95	863	2.8	0.57
10/24/95	539	2.3	0.37	12/17/95	852	3.0	0.58
10/25/95	573	2.7	0.41	12/18/95	858	3.0	0.60
10/26/95	585	2.9	0.44	12/19/95	877	3.1	0.64
10/27/95	579	2.8	0.43	12/20/95	910	3.1	0.67
10/28/95	560	2.6	0.42	12/21/95	942	3.1	0.69
10/29/95	549	2.5	0.40	12/22/95	1007	3.2	0.73
10/30/95	552	2.3	0.40	12/23/95	1028	3.6	0.74
10/31/95	574	2.2	0.41	12/24/95	1025	3.6	0.76
11/1/95	599	2.2	0.43	12/25/95	1021	3.5	0.76
11/2/95	604	2.0	0.44	12/26/95	982	3.5	0.74
11/3/95	610	1.9	0.43	12/27/95	984	3.2	0.73
11/4/95	611	1.8	0.42	12/28/95	1006	3.3	0.73
11/5/95	633	1.7	0.42	12/29/95	1029	3.4	0.73
11/6/95	667	1.8	0.43	12/30/95	1042	3.6	0.72
11/7/95	701	1.7	0.44	12/31/95	1030	3.6	0.71
11/8/95	736	1.8	0.45	1/1/96	1014	3.6	0.70
11/9/95	747	1.9	0.45	1/2/96	1019	3.7	0.71
11/10/95	746	1.6	0.42	1/3/96	1057	3.6	0.74
11/11/95	757	1.4	0.42	1/4/96	1117	3.4	0.75
11/12/95	773	1.5	0.43	1/5/96	1202	2.9	0.75
11/13/95	783	1.4	0.43	1/6/96	1280	2.3	0.76
11/14/95	801	1.5	0.46	1/7/96	1337	1.8	0.75
11/15/95	818	1.8	0.48	1/8/96	1397	1.5	0.77
11/16/95	824	1.8	0.49	1/9/96	1432	1.5	0.80
11/17/95	854	2.1	0.53	1/10/96	1445	1.6	0.80
11/18/95	883	2.5	0.57	1/11/96	1454	1.7	0.80
11/19/95	894	2.6	0.58	1/12/96	1462	1.8	0.78
11/20/95	905	2.7	0.59	1/13/96	1479	2.0	0.81
11/21/95	911	2.7	0.60	1/14/96	1515	2.9	0.86
11/22/95	902	2.5	0.59	1/15/96	1564	4.2	0.97
11/23/95	901	2.4	0.59	1/16/96	1558	5.2	1.01

WY 96 Crows Landing 4-day running average continued:

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
1/17/96	1540	5.8	1.03	3/16/96	NA	NA	NA
1/18/96	1481	5.7	1.01	3/17/96	NA	NA	NA
1/19/96	1363	5.7	0.71	3/18/96	NA	NA	NA
1/20/96	1301	6.2	0.72	3/19/96			
1/21/96	1196	6.5	0.71	3/20/96			
1/22/96	1138	6.7	0.71	3/21/96			
1/23/96	1103	6.3	0.94	3/22/96	381	1.6	0.24
1/24/96	1073	5.6	0.86	3/23/96	392	1.7	0.24
1/25/96	1103	5.4	0.84	3/24/96	424	1.9	0.26
1/26/96	1062	4.9	0.76	3/25/96	463	2.1	0.29
1/27/96	1017	4.4	0.70	3/26/96	511	2.2	0.32
1/28/96	937	4.1	0.68	3/27/96	558	2.2	0.37
1/29/96	812	3.5	0.61	3/28/96	575	2.1	0.38
1/30/96	742	3.2	0.59	3/29/96	585	2.0	0.39
1/31/96	696	3.0	0.55	3/30/96	596	1.9	0.39
2/1/96	682	2.8	0.55	3/31/96	625	2.2	0.41
2/2/96	673	2.5	0.53	4/1/96	679	2.5	0.46
2/3/96	678	2.4	0.50	4/2/96	723	2.8	0.49
2/4/96	726	2.3	0.51	4/3/96	742	3.0	0.51
2/5/96	731	2.3	0.49	4/4/96	743	2.9	0.49
2/6/96	715	2.2	0.46	4/5/96	758	2.8	0.48
2/7/96	670	2.0	0.43	4/6/96	822	3.1	0.50
2/8/96	602	1.8	0.37	4/7/96	952	3.1	0.57
2/9/96	564	1.7	0.34	4/8/96	1073	3.4	0.64
2/10/96	555	1.8	0.34	4/9/96	1192	3.7	0.70
2/11/96	570	2.0	0.37	4/10/96	1270	3.6	0.74
2/12/96	577	2.1	0.39	4/11/96	1300	3.8	0.73
2/13/96	593	2.4	0.42	4/12/96	1361	3.9	0.77
2/14/96	623	2.7	0.46	4/13/96	1413	4.2	0.82
2/15/96	641	3.0	0.48	4/14/96	1469	4.9	0.86
2/16/96	647	3.1	0.49	4/15/96	1501	5.5	0.92
2/17/96	646	3.2	0.50	4/16/96	1477	5.6	0.92
2/18/96	646	3.3	0.50	4/17/96	1378	5.3	0.86
2/19/96	644	3.4	0.51	4/18/96	1213	4.6	0.77
2/20/96	615	3.1	0.49	4/19/96	1034	3.9	0.63
2/21/96	574	2.8	0.44	4/20/96	868	3.7	0.52
2/22/96	508	2.2	0.36	4/21/96	767	3.6	0.46
2/23/96	NA	NA	NA	4/22/96	722	3.6	0.44
2/24/96	NA	NA	NA	4/23/96	706	3.9	0.43
2/25/96	NA	NA	NA	4/24/96	715	3.8	0.43
2/26/96	NA	NA	NA	4/25/96	713	3.9	0.42
2/27/96	NA	NA	NA	4/26/96	732	4.1	0.43
2/28/96	NA	NA	NA	4/27/96	767	4.2	0.45
2/29/96	NA	NA	NA	4/28/96	777	4.2	0.46
3/1/96	NA	NA	NA	4/29/96	780	4.2	0.46
3/2/96	NA	NA	NA	4/30/96	778	4.3	0.45
3/3/96	NA	NA	NA	5/1/96	765	4.2	0.44
3/4/96	NA	NA	NA	5/2/96	762	4.3	0.43
3/5/96	NA	NA	NA	5/3/96	759	4.1	0.44
3/6/96	NA	NA	NA	5/4/96	746	3.8	0.43
3/7/96	NA	NA	NA	5/5/96	734	3.8	0.42
3/8/96	NA	NA	NA	5/6/96	729	4.0	0.41
3/9/96	NA	NA	NA	5/7/96	732	4.1	0.40
3/10/96	NA	NA	NA	5/8/96	729	4.0	0.41
3/11/96	NA	NA	NA	5/9/96	718	3.9	0.40
3/12/96	NA	NA	NA	5/10/96	704	3.6	0.40
3/13/96	NA	NA	NA	5/11/96	681	3.5	0.38
3/14/96	NA	NA	NA	5/12/96	660	3.6	0.37
3/15/96	NA	NA	NA	5/13/96	643	3.5	0.38

WY 96 Crows Landing 4-day running average continued:

EC Se B				EC Se B			
Date	µmhos/cm	µg/L	mg/L	Date	µmhos/cm	µg/L	mg/L
5/14/96	628	3.5	0.38	7/12/96	1450	7.8	1.23
5/15/96	622	3.4	0.37	7/13/96	1499	8.2	1.30
5/16/96	612	3.2	0.37	7/14/96	1540	8.6	1.35
5/17/96	590	2.8	0.36	7/15/96	1582	8.8	1.40
5/18/96	546	2.5	0.33	7/16/96	1570	9.0	1.38
5/19/96	495	2.2	0.31	7/17/96	1517	8.8	1.33
5/20/96	460	1.7	0.30	7/18/96	1478	8.5	1.33
5/21/96	376	1.3	0.24	7/19/96	1402	8.2	1.28
5/22/96	319	1.0	0.19	7/20/96	1371	7.8	1.25
5/23/96	256	0.6	0.14	7/21/96	1356	7.5	1.23
5/24/96	181	0.7	0.09	7/22/96	1337	7.5	1.20
5/25/96	183	0.8	0.10	7/23/96	1366	7.6	1.23
5/26/96	192	1.1	0.12	7/24/96	1381	7.6	1.25
5/27/96	226	1.4	0.16	7/25/96	1388	7.8	1.25
5/28/96	276	1.9	0.21	7/26/96	1410	7.6	1.25
5/29/96	356	2.5	0.28	7/27/96	1396	7.3	1.23
5/30/96	456	2.9	0.37	7/28/96	1375	6.9	1.18
5/31/96	561	3.5	0.44	7/29/96	1328	6.3	1.12
6/1/96	682	3.8	0.49	7/30/96	1255	5.8	1.04
6/2/96	767	3.9	0.53	7/31/96	1195	5.7	0.98
6/3/96	823	4.0	0.53	8/1/96	1170	5.9	0.95
6/4/96	875	4.0	0.55	8/2/96	1215	6.3	0.98
6/5/96	928	4.0	0.59	8/3/96	1285	6.9	1.06
6/6/96	975	4.1	0.60	8/4/96	1350	7.0	1.13
6/7/96	1033	4.5	0.64	8/5/96	1340	7.0	1.13
6/8/96	1131	4.8	0.70	8/6/96	1295	6.7	1.10
6/9/96	1211	5.2	0.76	8/7/96	1230	6.1	1.04
6/10/96	1287	5.6	0.83	8/8/96	1155	5.9	0.97
6/11/96	1343	5.7	0.90	8/9/96	1125	5.9	0.94
6/12/96	1360	5.8	0.94	8/10/96	1138	5.9	0.94
6/13/96	1387	6.2	0.97	8/11/96	1140	6.1	0.93
6/14/96	1434	6.4	1.04	8/12/96	1145	5.9	0.93
6/15/96	1466	6.2	1.08	8/13/96	1119	5.5	0.91
6/16/96	1439	6.0	1.05	8/14/96	1053	5.2	0.85
6/17/96	1394	5.7	1.02	8/15/96	1015	5.1	0.82
6/18/96	1356	5.7	0.97	8/16/96	1037	5.4	0.83
6/19/96	1321	6.3	0.93	8/17/96	1105	5.8	0.88
6/20/96	1337	6.7	0.96	8/18/96	1190	6.1	0.96
6/21/96	1356	6.8	1.01	8/19/96	1251	6.2	1.02
6/22/96	1372	7.2	1.01	8/20/96	1218	5.9	0.99
6/23/96	1397	7.1	1.04	8/21/96	1158	5.6	0.95
6/24/96	1400	7.3	1.04	8/22/96	1090	4.9	0.89
6/25/96	1410	7.6	1.04	8/23/96	1041	4.7	0.85
6/26/96	1385	7.4	1.05	8/24/96	1022	4.6	0.83
6/27/96	1345	7.3	1.00	8/25/96	NA	NA	NA
6/28/96	1299	7.1	0.97	8/26/96	NA	NA	NA
6/29/96	1238	7.3	0.91	8/27/96	NA	NA	NA
6/30/96	1208	7.3	0.88	8/28/96	NA	NA	NA
7/1/96	1187	7.6	0.88	8/29/96			
7/2/96	1201	7.7	0.90	8/30/96			
7/3/96	1235	7.6	0.97	8/31/96		5.4	
7/4/96	1274	7.9	1.02	9/1/96	1063	5.4	0.84
7/5/96	1347	8.1	1.10	9/2/96	1025	5.1	0.80
7/6/96	1417	8.1	1.18	9/3/96	973	4.8	0.75
7/7/96	1447	7.8	1.20	9/4/96	921	4.4	0.70
7/8/96	1451	7.6	1.20	9/5/96	884	4.5	0.65
7/9/96	1437	7.1	1.20	9/6/96	905	4.8	0.68
7/10/96	1401	7.1	1.15	9/7/96	938	5.3	0.71
7/11/96	1415	7.5	1.15	9/8/96	983	5.6	0.77

WY 96 Crows Landing 4-day running average continued:

Date	EC μmhos/cm	Se μg/L	B mg/L
9/9/96	997	5.6	0.81
9/10/96	973	5.3	0.80
9/11/96	923	4.9	0.76
9/12/96	874	4.5	0.71
9/13/96	868	4.0	0.65
9/14/96	875	3.4	0.60
9/15/96	862	2.6	0.53
9/16/96	834	2.2	0.45
9/17/96	801	2.2	0.43
9/18/96	774	2.7	0.43
9/19/96	773	3.2	0.47
9/20/96	778	3.3	0.50
9/21/96	771	3.3	0.49
9/22/96	769	3.1	0.47
9/23/96	796	3.1	0.47
9/24/96	824	3.1	0.48
9/25/96	860	3.7	0.52
9/26/96	966	3.5	0.68
9/27/96	1030	3.1	0.80
9/28/96	1098	2.9	0.92
9/29/96	1086	2.2	0.94
9/30/96	991	2.3	0.81

San Joaquin River at Crows Landing Road: Turlock Sportsman Club (STC504S)

Location: Latitude 37°25'55", Longitude 121°00'42". In Section 8 T.6S., R.8E. West Bank, 100 yards s
of Crows Landing Road Bridge, 4.2 miles northeast of Crows Landing. River Mile 107.1

AUTOSAMPLER DATA : 4 DAY RUNNING AVERAGE BASED ON DAILY COMPOSITE SAMPLES -

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
10/1/96				11/24/96	938	2.3	0.63
10/2/96				11/25/96	933	2.4	0.61
10/3/96				11/26/96	890	2.3	0.58
10/4/96	821	3.4	0.57	11/27/96	901	2.1	0.58
10/5/96	827	3.3	0.56	11/28/96	889	2.0	0.60
10/6/96	839	3.0	0.54	11/29/96	892	1.9	0.63
10/7/96	868	2.7	0.53	11/30/96	949	1.9	0.66
10/8/96	905	2.3	0.53	12/1/96	973	1.9	0.68
10/9/96	936	2.2	0.52	12/2/96	1022	1.9	0.70
10/10/96	927	2.3	0.52	12/3/96	1058	1.8	0.71
10/11/96	861	2.3	0.49	12/4/96	1088	1.7	0.72
10/12/96	784	2.2	0.45	12/5/96	1120	1.6	0.73
10/13/96	700	2.1	0.45	12/6/96	1147	1.5	0.74
10/14/96	630	2.0	0.42	12/7/96	1087	1.3	0.71
10/15/96	621	1.9	0.42	12/8/96	948	1.2	0.62
10/16/96	588	1.7	0.40	12/9/96	805	1.0	0.53
10/17/96	539	1.5	0.35	12/10/96	666	1.0	0.45
10/18/96	503	1.4	0.32	12/11/96	580	1.0	0.39
10/19/96	450	1.3	0.28	12/12/96	523	0.9	0.35
10/20/96	417	1.2	0.26	12/13/96	460	0.9	0.30
10/21/96	416	1.1	0.26	12/14/96	388	0.8	0.25
10/22/96	428	1.0	0.26	12/15/96	342	0.8	0.21
10/23/96	451	1.0	0.28	12/16/96	329	0.7	0.20
10/24/96	477	1.0	0.30	12/17/96	315	0.6	0.19
10/25/96	508	1.1	0.32	12/18/96	297	0.6	0.17
10/26/96	535	1.2	0.34	12/19/96	291	0.6	0.16
10/27/96	581	1.4	0.37	12/20/96	293	0.6	0.16
10/28/96	600	1.5	0.39	12/21/96	297	0.6	0.17
10/29/96	627	1.5	0.40	12/22/96	298	0.6	0.18
10/30/96	647	1.4	0.41	12/23/96	279	0.6	0.17
10/31/96	652	1.4	0.43	12/24/96	260	0.6	0.15
11/1/96	650	1.4	0.43	12/25/96	247	0.6	0.14
11/2/96	648	1.5	0.45	12/27/96	239	0.6	0.14
11/3/96	660	1.7	0.48	12/28/96	249	0.6	0.15
11/4/96	683	1.6	0.49	12/29/96	243	0.5	0.15
11/5/96	715	1.7	0.52	12/30/96	241	0.5	0.15
11/6/96	755	1.7	0.56	12/31/96	240	0.5	0.14
11/7/96	792	1.7	0.59	1/1/97	240	0.5	0.14
11/8/96	840	1.9	0.61	1/2/97	231	0.5	0.13
11/9/96	885	1.9	0.63	1/3/97	214	0.5	0.11
11/10/96	934	1.9	0.63	1/4/97	191	0.5	0.10
11/11/96	977	1.8	0.63	1/5/97	165	0.4	0.08
11/12/96	1003	1.6	0.64	1/6/97	149	0.3	0.07
11/13/96	1037	1.6	0.67	1/7/97	141	0.3	0.06
11/14/96	1066	1.7	0.69	1/8/97	134	0.3	0.06
11/15/96	1097	1.9	0.72	1/9/97	133	0.3	0.06
11/16/96	1119	2.1	0.75	1/10/97	139	0.3	0.06
11/17/96	1110	2.2	0.76	1/11/97	149	0.2	0.07
11/18/96	1089	2.3	0.75	1/12/97	163	0.2	0.08
11/19/96	1059	2.4	0.74	1/13/97	172	0.2	0.09
11/20/96	1027	2.4	0.75	1/14/97	172	0.2	0.09
11/21/96	1005	2.4	0.73	1/15/97	167	0.3	0.09
11/22/96	980	2.4	0.71	1/16/97	161	0.3	0.08
11/23/96	951	2.4	0.69				

WY 97 Crows Landing 4-day running average continued:

Date	EC µmhos/cm	Se µg/L	B mg/L	Date	EC µmhos/cm	Se µg/L	B mg/L
1/17/97	158	0.3	0.08	3/16/97			
1/18/97	157	0.4	0.08	3/17/97	786	2.9	0.51
1/19/97	157	0.4	0.08	3/18/97	804	3.0	0.52
1/20/97	159	0.4	0.08	3/19/97	NA	NA	NA
1/21/97	NA	NA	NA	3/20/97	NA	NA	NA
1/22/97	NA	NA	NA	3/21/97			
1/23/97	NA	NA	NA	3/22/97			
1/24/97	NA	NA	NA	3/23/97			
1/25/97	NA	NA	NA	3/24/97	901	3.0	0.58
1/26/97	NA	NA	NA	3/25/97	910	2.8	0.57
1/27/97	NA	NA	NA	3/26/97	924	2.8	0.58
1/28/97	NA	NA	NA	3/27/97	945	2.8	0.60
1/29/97	NA	NA	NA	3/28/97	973	3.0	0.63
1/30/97	NA	NA	NA	3/29/97	992	3.2	0.66
1/31/97	NA	NA	NA	3/30/97	1001	3.3	0.67
2/1/97	NA	NA	NA	3/31/97	1003	3.5	0.67
2/2/97	NA	NA	NA	4/1/97	1013	3.7	0.67
2/3/97	NA	NA	NA	4/2/97	1021	3.9	0.66
2/4/97	NA	NA	NA	4/3/97	1042	4.1	0.67
2/5/97	NA	NA	NA	4/4/97	1066	4.4	0.69
2/6/97	NA	NA	NA	4/5/97	1097	4.8	0.72
2/7/97	NA	NA	NA	4/6/97	1168	5.6	0.78
2/8/97				4/7/97	1260	6.6	0.86
2/9/97				4/8/97	1347	7.3	0.92
2/10/97				4/9/97	1428	7.8	0.96
2/11/97	283	0.2	0.14	4/10/97	1463	8.0	0.97
2/12/97	301	0.3	0.15	4/11/97	1506	7.9	0.98
2/13/97	294	0.3	0.15	4/12/97	1585	8.3	1.02
2/14/97	284	0.3	0.14	4/13/97	1643	8.7	1.07
2/15/97	270	0.4	0.14	4/14/97	1657	8.9	1.08
2/16/97	251	0.4	0.13	4/15/97	1700	9.3	1.13
2/17/97	236	0.5	0.13	4/16/97	1669	9.5	1.13
2/18/97	218	0.5	0.12	4/17/97	1580	9.1	1.08
2/19/97	207	0.5	0.11	4/18/97	1457	8.3	0.97
2/20/97	205	0.5	0.11	4/19/97	1252	7.2	0.82
2/21/97	207	0.5	0.11	4/20/97	1057	5.8	0.66
2/22/97	209	0.5	0.12	4/21/97	906	5.0	0.55
2/23/97	214	0.5	0.12	4/22/97	789	4.6	0.50
2/24/97	222	0.5	0.12	4/23/97	797	4.5	0.50
2/25/97	236	0.5	0.12	4/24/97	802	4.6	0.50
2/26/97	259	0.5	0.12	4/25/97	924	5.0	0.58
2/27/97	290	0.5	0.14	4/26/97	1061	5.5	0.68
2/28/97	302	0.5	0.15	4/27/97	1148	6.0	0.77
3/1/97	312	0.5	0.16	4/28/97	1154	6.3	0.79
3/2/97	321	0.4	0.16	4/29/97	1183	6.6	0.83
3/3/97	329	0.4	0.16	4/30/97	1186	6.6	0.85
3/4/97	341	0.5	0.18	5/1/97	1075	5.8	0.77
3/5/97	333	0.5	0.18	5/2/97	955	5.0	0.68
3/6/97	330	0.7	0.19	5/3/97	813	4.0	0.58
3/7/97	328	0.8	0.20	5/4/97	686	3.3	0.49
3/8/97	347	0.9	0.21	5/5/97	659	3.1	0.47
3/9/97	NA	NA	NA	5/6/97	656	3.0	0.46
3/10/97	NA	NA	NA	5/7/97	669	2.8	0.45
3/11/97	NA	NA	NA	5/8/97	672	2.7	0.45
3/12/97	NA	NA	NA	5/9/97	706	2.8	0.47
3/13/97	NA	NA	NA	5/10/97	706	2.7	0.48
3/14/97				5/11/97	692	2.9	0.49
3/15/97				5/12/97	674	2.9	0.48
				5/13/97	668	3.0	0.49

WY 97 Crows Landing 4-day running average continued:

Date	EC μmhos/cm	Se μg/L	B mg/L	Date	EC μmhos/cm	Se μg/L	B mg/L
5/14/97	742	3.5	0.56	7/12/97	1337	4.9	1.18
5/15/97	858	4.0	0.65	7/13/97	1360	5.2	1.20
5/16/97	999	4.6	0.76	7/14/97	1342	4.9	1.18
5/17/97	1114	4.9	0.84	7/15/97	1308	4.6	1.13
5/18/97	1176	4.8	0.87	7/16/97	1253	4.6	1.08
5/19/97	1217	5.0	0.92	7/17/97	1221	4.2	1.05
5/20/97	1234	5.2	0.98	7/18/97	1230	4.3	1.10
5/21/97	1270	5.7	1.03	7/19/97	1263	4.3	1.15
5/22/97	1300	6.3	1.08	7/20/97	1296	4.4	1.30
5/23/97	1311	6.5	1.10	7/21/97	1272	4.5	1.26
5/24/97	1292	6.3	1.05	7/22/97	1214	4.5	1.16
5/25/97	1266	5.9	1.02	7/23/97	1151	4.4	1.08
5/26/97	1235	5.7	1.02	7/24/97	1107	4.2	0.91
5/27/97	1248	5.8	1.04	7/25/97	1152	4.3	0.95
5/28/97	1277	6.2	1.10	7/26/97	1234	4.5	1.03
5/29/97	1287	6.4	1.15	7/27/97	1292	4.6	1.10
5/30/97	1310	6.6	1.18	7/28/97	1322	4.7	1.15
5/31/97	1347	6.9	1.23	7/29/97	1289	4.5	1.13
6/1/97	1396	7.4	1.28	7/30/97	1223	4.3	1.08
6/2/97	1471	8.2	1.33	7/31/97	1206	4.3	1.05
6/3/97	1512	8.7	1.35	8/1/97	1188	4.0	1.03
6/4/97	1513	8.7	1.35	8/2/97	1216	4.0	1.02
6/5/97	1459	8.1	1.25	8/3/97	1241	4.1	1.02
6/6/97	1396	7.0	1.15	8/4/97	1204	3.7	0.98
6/7/97	1382	6.3	1.10	8/5/97	1186	3.7	0.95
6/8/97	1352	5.5	1.02	8/6/97	1167	3.6	0.94
6/9/97	1355	5.1	1.02	8/7/97	1174	3.4	0.93
6/10/97	1367	4.9	1.02	8/8/97	1222	3.5	0.94
6/11/97	1381	4.5	1.04	8/9/97	1269	3.8	1.00
6/12/97	1423	4.7	1.09	8/10/97	1306	4.3	1.07
6/13/97	1509	5.1	1.20	8/11/97	1296	4.7	1.10
6/14/97	1555	5.6	1.30	8/12/97	1237	4.8	1.08
6/15/97	1526	6.1	1.30	8/13/97	1180	4.8	1.04
6/16/97	1518	6.6	1.33	8/14/97	1125	4.7	0.99
6/17/97	1467	6.8	1.30	8/15/97	1106	4.4	0.96
6/18/97	1424	7.1	1.28	8/16/97	1136	4.4	1.01
6/19/97	1452	7.6	1.33	8/17/97	1134	4.4	1.01
6/20/97	1469	7.7	1.35	8/18/97	1087	4.0	1.06
6/21/97	1535	8.2	1.40	8/19/97	1020	3.7	0.99
6/22/97	1579	8.2	1.43	8/20/97	943	3.4	0.90
6/23/97	1565	7.8	1.40	8/21/97	931	3.2	0.86
6/24/97	1530	7.8	1.35	8/22/97	956	3.4	0.77
6/25/97	1467	7.5	1.30	8/23/97	1013	3.6	0.82
6/26/97	1441	7.3	1.28	8/24/97	1071	3.6	0.87
6/27/97	1439	7.1	1.25	8/25/97	1109	3.6	0.92
6/28/97	1470	7.0	1.28	8/26/97	1105	3.4	0.90
6/29/97	1463	6.5	1.25	8/27/97	1083	3.2	0.87
6/30/97	1442	6.3	1.23	8/28/97	1069	3.1	0.84
7/1/97	1401	5.9	1.20	8/29/97	1078	3.1	0.84
7/2/97	1329	5.3	1.15	8/30/97	1154	3.4	0.89
7/3/97	1298	5.4	1.13	8/31/97	1234	3.8	0.96
7/4/97	1303	5.5	1.13	9/1/97	1282	4.1	1.00
7/5/97	1338	5.8	1.15	9/2/97	1290	4.1	1.02
7/6/97	1379	6.0	1.18	9/3/97	1274	4.3	1.02
7/7/97	1368	5.8	1.18	9/4/97	1236	4.2	0.99
7/8/97	1338	5.6	1.18	9/5/97	1184	4.2	0.93
7/9/97	1298	5.2	1.15	9/6/97	1157	4.0	0.89
7/10/97	1291	5.1	1.15	9/7/97	1103	3.3	0.81
7/11/97	1316	5.2	1.18	9/8/97	1054	2.8	0.74

WY 97 Crows Landing 4-day running average continued:

Date	EC μmhos/cm	Se μg/L	B mg/L
9/9/97	1011	2.3	0.71
9/10/97	966	2.2	0.71
9/11/97	938	2.1	0.72
9/12/97	935	2.0	0.74
9/13/97	978	2.0	0.77
9/14/97	994	1.8	0.75
9/15/97	992	1.8	0.75
9/16/97	960	1.7	0.72
9/17/97	921	1.5	0.67
9/18/97	923	1.4	0.65
9/19/97	935	1.3	0.62
9/20/97	953	1.1	0.60
9/21/97	945	1.0	0.56
9/22/97	897	1.0	0.51
9/23/97	843	0.9	0.47
9/24/97	804	0.8	0.44
9/25/97	801	0.9	0.44
9/26/97	816	0.9	0.44
9/27/97	848	0.9	0.46
9/28/97	873	1.1	0.47
9/29/97	883	1.0	0.49
9/30/97	896	1.1	0.52

Date	EC μmhos/cm	Se μg/L	B mg/L
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