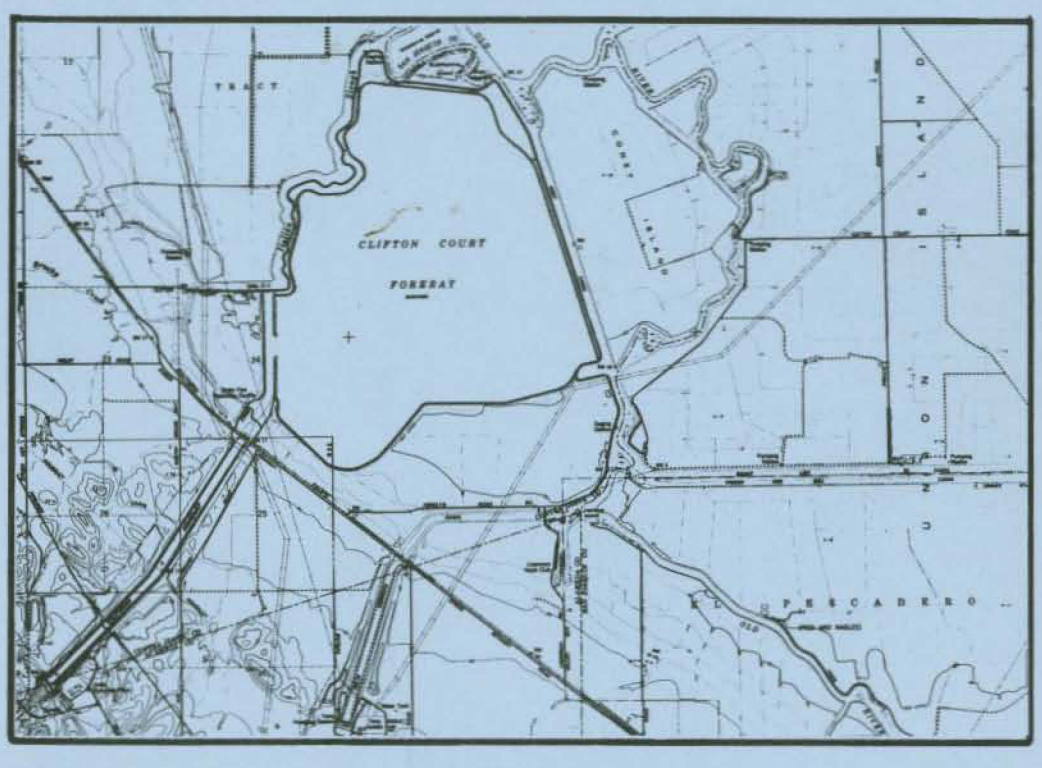
State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Central District

INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM

PROJECT REPORT



December 1986

Gordon K. Van Vleck
Secretary for Resources
THE RESOURCES AGENCY

George Deukmejian
Governor
STATE OF CALIFORNIA

David N. Kennedy
Director
DEPARTMENT OF WATER RESOURCES

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INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM

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December 1986

Portions of this report were prepared with the assistance of

Marvin Jung and Associates

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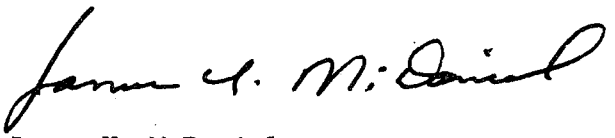
FOREWORD

In 1982, the Department of Water Resources appointed a panel of scientists to evaluate the human health aspects of using Delta water supplies. The panel concluded that there was insufficient data on many important factors and contaminant sources that could affect water quality. Some of these factors include tidal action and riverflows, agricultural drainages, pesticide use, waste water discharges, and water movement within the Delta. The panel recommended a program to develop a comprehensive analytical model that would incorporate and analyze these factors.

In April 1983, the Interagency Delta Health Aspects Monitoring Program was initiated in response to the panel's recommendation. The program is now in its fourth year of monitoring and examining the effects of natural and man-related events on the quality of Delta water supplies.

The 1986 Project Report describes program activities and presents findings for data collected between January 1985 and June 1986. Study results indicate that Delta water supplies are generally of acceptable quality with respect to the levels of chemical contaminants and minerals that may affect human health.

The program should continue to provide needed information on sources of degradation of Delta water supplies. The program's combined activities of monitoring and investigating water quality changes are invaluable to water resource planning and protection.



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CONTENTS

Tables

Figures

State of California
GEORGE DEUKMEJIAN, GOVERNOR
The Resources Agency
GORDON K. VAN VLECK, Secretary for Resources

Department of Water Resources
DAVID N. KENNEDY, Director

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SUMMARY

In 1982 the Department of Water Resources appointed a scientific advisory panel to examine human health aspects related to the use of water supplies from the Sacramento-San Joaquin Delta. The panel submitted a report with several long-term recommendations for monitoring and studying the water quality of the Delta. The panel had specific concerns about the effects from waste discharges, riverflow conditions, pesticides, ocean water intrusion, agricultural drainage, and water project operations. The Interagency Delta Health Aspects Monitoring Program was initiated in July 1983 in response to the panel report.

Several tasks were undertaken to meet specific concerns of the 1982 scientific advisory panel. Separate tasks were developed to:

° Monitor pesticide contaminants in water,

° Study effects of tides and riverflow on export water quality,

° Characterize and track water sources and movement,

° Identify and study agricultural drainages,

° Examine contributing sources of total trihalomethane formation potential,

° Examine waste discharges, and

° Test computer models that might help predict impacts from both point (e.g. sewage outfalls) and non-point (e.g. land runoff) sources of pollutants.

This project report of the monitoring program describes activities from January 1985 through June 1986 and presents current findings.

Monitoring data showed selenium, pesticides, and sodium levels in Delta water supplies are below drinking water standards or Department of Health Services action levels.

By examining the electrical conductivity and chloride to sodium ion ratios, water sources were identified. The data showed that the interaction of tidal excursions and Sacramento River flow during the summer had a significant effect on the quality of water exported by the Delta-Mendota Canal and Banks Pumping Plant facilities. During the last half of 1985, export water was predominantly a mixture of Sacramento River water blended with San Francisco Bay tide water. The effect of San Joaquin River water on export water quality was not apparent.

Agricultural drain water and irrigation return water could be significant sources of trihalomethane precursor material to Delta waters. They may also affect mineral content of receiving waters by increasing the concentration of salts. Efforts are in progress to quantify these loads to the Delta.

Discharge of treated effluent from the Sacramento Regional Wastewater Treatment Plant did not significantly affect the quality of water downstream at Hood and Greene's Landing. This may be attributed to the high level of treatment and dilution at the discharge site at Freeport.

A pesticide monitoring selection scheme was developed to target monitoring efforts. The scheme eliminated the approach of conducting expensive and numerous laboratory tests for chemicals with a low probability of detection in water. Emphasis was placed on site- and time-specific monitoring for chemicals in high use or with a relatively high potential of being carried by water.

Computer models developed by the U. S. Environmental Protection Agency are being tested for predicting the effects of pollutants on Delta water quality. The models could improve monitoring efforts and identify additional types of measurements or studies needed to help predict the effects of natural and man-induced events on water quality in the Delta.

The Department will continue the program to meet the long-term objectives of the scientific advisory panel and the needs of its Technical Advisory Group.

Chapter 1. INTRODUCTION

This is the second project report of the Interagency Delta Health Aspects Monitoring Program. Five semiannual progress reports and a project report were published earlier.

The program began in July 1983; initial focus was on monitoring raw water supplies in the Delta for contaminants that could affect human health. The scope of work has expanded to collection of data on specific factors that can affect the water quality and quantity of exported water supplies. These factors include riverflows, agricultural related practices, and tidal movements.

These new activities were initiated to meet the recommended long-term objectives of a scientific advisory panel that investigated human health aspects of Sacramento-San Joaquin Delta water supplies. This panel was appointed by the Department of Water Resources because of concerns about the quality of raw water supplies diverted from the Delta for domestic use. Findings of the panel were submitted to the Department on December 31, 1982, in a report titled, Public Health Aspects of Sacramento-San Joaquin Delta Water Supplies /1/.

The panel had recommended the following long-term objectives to the Department:

1. Establish a monitoring program that identifies sources of contaminants to the Delta, how contaminants from each source are transported through the system, and how they affect concentration at points of withdrawal.

2. Obtain information on factors that affect the movement and fate of contaminants in the Delta.

3. With such information, develop a comprehensive analytical model to incorporate and analyze the following elements:

- Location and magnitude of sodium, asbestos, and organic material, including inflows to the Delta, agricultural drainage, waste water discharges, and ocean water intrusion.
- Factors affecting contributions from each important source such as riverflow, season, level of waste water treatment, and reservoir release patterns.
- Variability of constituent concentrations at critical points of the Delta as affected by sources and flow patterns.
- Effects of Delta water quality, storage, transport, blending, and treatment on the quality of treated drinking water.

4. This model would provide information for making decisions on how to manage the water resources of the State.

Separate tasks are being performed to address some of the concerns expressed in the long-term objectives. These tasks are described in subsequent sections of the report and are summarized in Table 1.

Table 1

PROGRAM TASKS TO ADDRESS SPECIFIC CONCERNS

Effects from Tidal Excursions and Riverflows

Task WQ1, Health Aspects Water Quality Monitoring. Sampling is conducted monthly at key Delta locations for sodium, trihalomethane formation potential, minerals, and other parameters to determine if raw water supplies can be treated to meet drinking water standards and to identify potential treatment and human health problems.

Task WQ2, Characterization of Water Sources. Water sources are being characterized by comparing constituents at key Delta stations. The data will be used to help track general water movement and water quality trends in the Delta.

Task WQ3, Tidal Effects Study on Exported Water Quality. During different summer tidal stages, the direction and mixing of water along Old and Middle rivers and other channels are being studied. The data will be used to help quantify the effects on water quality from different sources of water to the Clifton Court Forebay and Delta-Mendota Canal intakes during low Delta outflow and various tidal conditions.

Effects from Agriculture Related Activities

Task AG1, Drainage Water Quality Monitoring. Irrigation return flows from drainages at Empire Tract, Grand Island, and Tyler Island are being monitored for salts, pesticides, trihalomethane (THM) formation potential, and other constituents. The data will be used to assess the loading effects of drainage on receiving water quality during the year.

Task AG2, Locating Irrigation Return Water Discharges. Discharge points of irrigation return water on leveed Delta islands are being identified and mapped. This information will be used to identify sources of contaminants and plan upcoming work to assess the impact of agricultural drainages on Delta water quality.

Task AG3, San Joaquin River Monitoring. Comprehensive water quality monitoring near Vernalis for total and dissolved trace inorganics, pesticides, and other constituents has been initiated to study the effects of San Joaquin River water quality on exported water. There is concern about selenium and other trace elements that are discharged into the San Joaquin River from agricultural drainage.

Task AG4, Selected Pesticide Monitoring. Through a selection protocol based on pesticide usage patterns and environmental behavior, water samples are collected for specific pesticide analyses. The data are used to identify potential contamination problems for raw water supplies and treatment plants. Sampling is conducted more frequently during chemical application periods.

Task AG5, Modeling Pesticide Fate and Transport. Existing computer models developed by the U.S. Environmental Protection Agency (EPA) to predict the fate and movement of organic pesticides in an aquatic system are being tested to help assess the threat of contamination to drinking water supplies. The models are used to evaluate the pesticide monitoring selection protocol for

Task AG4 and to study the effects of riverflow and other environmental conditions on the distribution of pesticide contaminants.

Task AG6, Health Effects Database on Selected Chemicals. Drinking water standards now exist for only a few pesticides. A computer literature search for human health effects data is underway for chemicals appearing on the selected pesticide monitoring task (AG4) for which there are no drinking water standards. The data will be used to assess the degree of risk to users of Delta water supplies found with traces of these contaminants.

Effects from Waste Water Discharges

Task WD1, Survey Major Waste Water Dischargers. The Central Valley Regional Water Quality Control Board provided effluent monitoring data on major municipal and industrial waste dischargers within the program study area. The data will be examined to estimate total waste loads and to determine if special studies on receiving water impacts are needed.

Effects of Raw Water Quality and Treatment

Task TR1, Assess THM (Trihalomethane) Formation Potential. As part of the monthly water quality monitoring activities (Task WQ1), parameters such as total organic carbon and color are measured. In addition, water samples are chlorinated and analyzed for total THM formation potential and THM species to identify potential THM treatment problems. Water quality parameters related to the extent of THM formation during disinfection are also being studied.

Modeling Water Quality in the Delta

Task MOD1, Use Existing Water Quality Models. Computer models developed by EPA to study the distribution, fate, and transport of waste waters and spilled materials are being tested for use in studying Delta water quality as affected by waste water discharges and pesticide usage. EPA recently made several models available for personal computer use. Models under study include EXAMS (exposure analysis modeling system), QUAL2E (a stream quality routing model), and WASP3P (a chemical transport and fate model).

Chapter 2. FINDINGS

Results of the Interagency Delta Health Aspects Monitoring Program for 1985 through June 1986 showed:

1. Selenium concentrations in the Delta are meeting the (10 ug/L) drinking water standard. The highest concentrations have been observed in the lower San Joaquin River in Mud and Salt sloughs. Subsequent dilution and natural removal processes result in concentrations of 2 ug/L or less at the San Joaquin River near Vernalis. The data indicate that selenium does not constitute a health threat to consumers of Delta water supplies.

2. Pesticides concentrations have been far below Department of Health Services action levels or drinking water criteria. When found, the levels were barely above the analytical limit of detection (generally 1 ug/L or less). The data indicate a wide margin of safety in the drinking water quality with respect to harmful pesticide concentrations.

3. Irrigation return flow drainage can have major effects on water quality. Preliminary data indicate that drainage from Delta islands is a major contributing source of trihalomethane precursor materials and may have the most significant effect on the total trihalomethane formation potential of Delta water supplies exported by the State and Federal water projects.

4. Asbestos analyses of surface waters need to be improved to obtain reproducible results. Until the methodology is refined, asbestos data cannot be interpreted.

5. Sodium levels in Delta channels met the National Academy of Sciences recommended limit of 270 mg/L for persons on moderately restricted sodium diets. However, the levels exceeded the 20 mg/L limit for persons on severely restricted sodium diets. Persons on severely restricted sodium diets generally drink sodium-free water.

6. The quality of export water was significantly affected by Sacramento River flows and tidal influences during the last half of 1985. Comparisons of chloride and sodium ratios showed the direction and predominant source of water to the export pump intakes. Electrical conductivity measurements alone were insufficient "tracers" of water movement.

7. The quality of export water was reflective of Sacramento River water mixed with saline bay water. The effects of San Joaquin River quality and flows on export water were not detectable.

8. The drinking water quality of the Sacramento River downstream of the Sacramento Regional Wastewater Treatment Plant outfall does not appear to be greatly affected by the waste discharge.

9. The use of water quality models to study the fate and transport of constituents in surface waters and discharges may help predict water quality changes and improve monitoring effectiveness.

Chapter 3. RECOMMENDATIONS

The following recommendations are offered as a result of monitoring to date.

1. Efforts should be continued to meet the long-term objectives of a 1982 Department appointed scientific advisory panel that examined human health factors of Delta water supplies.

2. Monitoring possible effects of San Joaquin River flows and quality on export waters should continue in view of public concern over selenium, pesticides, and agricultural drainage constituents.

3. The potential effect of Delta island irrigation return waters on Delta water quality should be examined, as preliminary data suggest these drainages are major sources of trihalomethane precursors and may have the most important effect on the total trihalomethane formation potential of Delta water exported by the State and Federal water projects.

4. The monitoring program and special tasks should be performed to meet the information requirements of computer water quality models developed to predict the effects on water quality from spills, waste discharges, project operations, and riverflow.

5. Standard mineral analyses should be included in the monitoring program to improve the characterization of water sources. Ionic ratios proved to be more useful than electrical conductivity measurements alone.

6. Asbestos monitoring should be discontinued until the analytical method for quantifying asbestos can provide confidence in the interpretation of results.

Chapter 4. PROGRAM TASKS AND RESULTS

Department of Water Resources staff has been responsible for conducting the Interagency Delta Health Aspects Monitoring Program. Program activities are developed to meet the recommendations of a Technical Advisory Group and the long-term objectives recommended by the 1982 Department appointed scientific advisory panel.

Laboratory support is provided by the Department's Bryte Laboratory and through contractual agreement with McKesson Environmental Services in Pleasanton. The Bryte Lab conducted standard water quality measurements (e.g. conductance, mineral content), trihalomethane testing, and on occasion, pesticide analyses. The McKesson laboratory primarily performed pesticide and priority pollutant analyses. Bromide and dissolved copper testing were also performed on request. Bromide and copper analyses were later stopped because detection limits were above sample concentrations. Performance of both laboratories was evaluated by duplicate sample splitting, internal quality control measurements, and spiked samples. Details are discussed in Appendix D, Laboratory Performance 1985-86.

This second project report presents findings and progress of various tasks associated with the program from January 1985 through June 1986. Activities prior to 1985 were reported in an earlier project report /2/.

Water Quality and Tidal Effects Studies

Three tasks are underway to study the effects of tidal excursions and riverflows on Delta water quality.

Health Aspects Water Quality Monitoring (Task WQ1)

Monthly sampling is conducted at key Delta locations for sodium, trihalomethane formation potential, minerals, and other parameters. The data are used to determine if raw water supplies are meeting drinking water standards and to identify potential treatment and human health problems. The study area and locations of key monitoring stations are shown in Figure 1.

Field measurements of conductivity, pH, dissolved oxygen, and temperature are made on site. Water samples are collected with a stainless steel Kemmerer-type sampler. Samples are appropriately treated and stored in clean containers provided by the laboratories for the type of analyses to be conducted. Glass bottles and vials are used for water samples undergoing pesticide, trihalomethane, and priority pollutant analyses. Plastic containers are used for standard mineral analyses. Samples undergoing pesticide analysis are delivered to the laboratories on the day of collection.

Results of the field and laboratory measurements are presented in Appendix A, Monitoring Program Data. Field sampling methodology is described in Appendix B, Field Sampling Procedures.

The National Academy of Sciences (NAS) has recommended a 270 mg/L limit in drinking water for persons on moderately restricted sodium diets and a 20 mg/L limit for those on severely restricted sodium diets. Sodium levels in all water samples were below the 270 mg/L limit except for agricultural

drain water samples taken from Empire Tract. Since agricultural drainage is not used as a drinking water supply, the NAS limit would not apply. Sodium levels were occasionally above the 20 mg/L limit at some stations; however, most persons on a severely restricted sodium diet use sodium-free bottled water.

The current drinking water standard for selenium is 10 ug/L. EPA is currently proposing a 45 ug/L drinking water criterion. Water samples collected from all stations had selenium concentrations at or below 2 ug/L. Most results were below the analytical detection limit of 1 ug/L.

Starting in 1985, measurement of water samples for asbestos was reduced to a sampling frequency of twice a year because the interpretative value is in question due to high variability in the data. Asbestos analyses done in triplicate on the same water samples differed significantly. Until improvements are made in the determination of asbestos in water, high confidence in asbestos data cannot be obtained.

Pesticide monitoring for a select group of chemicals meeting specific behavioral characteristics was also conducted. A complete description of the pesticide monitoring task is presented later in this report. In general, most pesticides monitored were below the analytical limit of detection (1 ug/L or less). Of those chemicals detected, trace amounts were found near the limit of detection.

Tests for trihalomethane formation potential and trihalomethane species that are formed when raw water samples are chlorinated were also conducted. These tests do not reflect the actual trihalomethane concentrations in finished (treated) drinking water available to the public. The tests were conducted to identify when and where modified water treatment operations may be necessary when water is withdrawn from a specific area in the Delta.

Complete descriptions of the pesticide monitoring results and the trihalomethane studies are presented separately in this report.

Characterization of Water Sources (Task WQ2)

Constituents are being compared to characterize water sources and mixing at key stations. Comparisons of electrical conductivity, major ion concentrations, and specific ion ratios by molarity and weight are some of the methods being used to follow general water movement and water quality trends in the Delta.

The quality of water exported by the Delta-Mendota Canal and the State Water Project is affected by a complex variety of sources and conditions. Primary water sources include fresh water of the Sacramento and San Joaquin rivers. These waters, in turn, are affected by agricultural drainage, sea water intrusion, waste discharges, and land runoff. The proportion of Sacramento and San Joaquin river waters entering the State and Federal water projects has been estimated by salinity measurements (electrical conductivity or total dissolved solids). However, salinity measurements may not accurately reflect water movement and mixing, as waters of similar salinity may differ significantly in ionic composition.

As a first step in studying water movement and quality changes in the Delta that affect the State and Federal water projects, the characteristics of water at the intakes and major channels leading to the intakes were examined. For January 1985 through June 1986, the data showed:

1. Exported waters, measured at the Banks Pumping Plant headworks and

Station Location Number	Station Name Station Number
1	American River at Water Treatment Plant A0714010
2	Sacramento River at Greene's Landing B9D82071327
3	Cache Slough at Vallejo Pumping Plant B9D81781448
4	Lindsey Slough at Hastings Cut B9D81581462
5	Agricultural Drain on Grand Island B9V81171369
6	Agricultural Drain on Tyler Island B9V80801348
7	Little Connection Slough at Empire Tract (end of 8-Mile Road) B9D80361299
8	Agricultural Drain on Empire Tract (west end of 8-Mile Road) B9V80361274
9	Rock Slough at Old River B9D75841348
10	Clifton Court Intake KA000000
11	Delta-Mendota Intake at Lindeman Road B9C74901336
12	H. O. Banks Delta Pumping Plant at Headworks KA000331
13	Middle River at Borden Highway (Middle River at Highway 4 Bridge) B9D75351293
14	San Joaquin River near Vernalis B0702000
15	Lake Del Valle Stream Release DV004000
16	Mallard Slough at CCWDPP B8X80221556
17	Sacramento River at Mallard Island E0B80261551
18	North Bay Interim Pumping Plant Intake KE000000

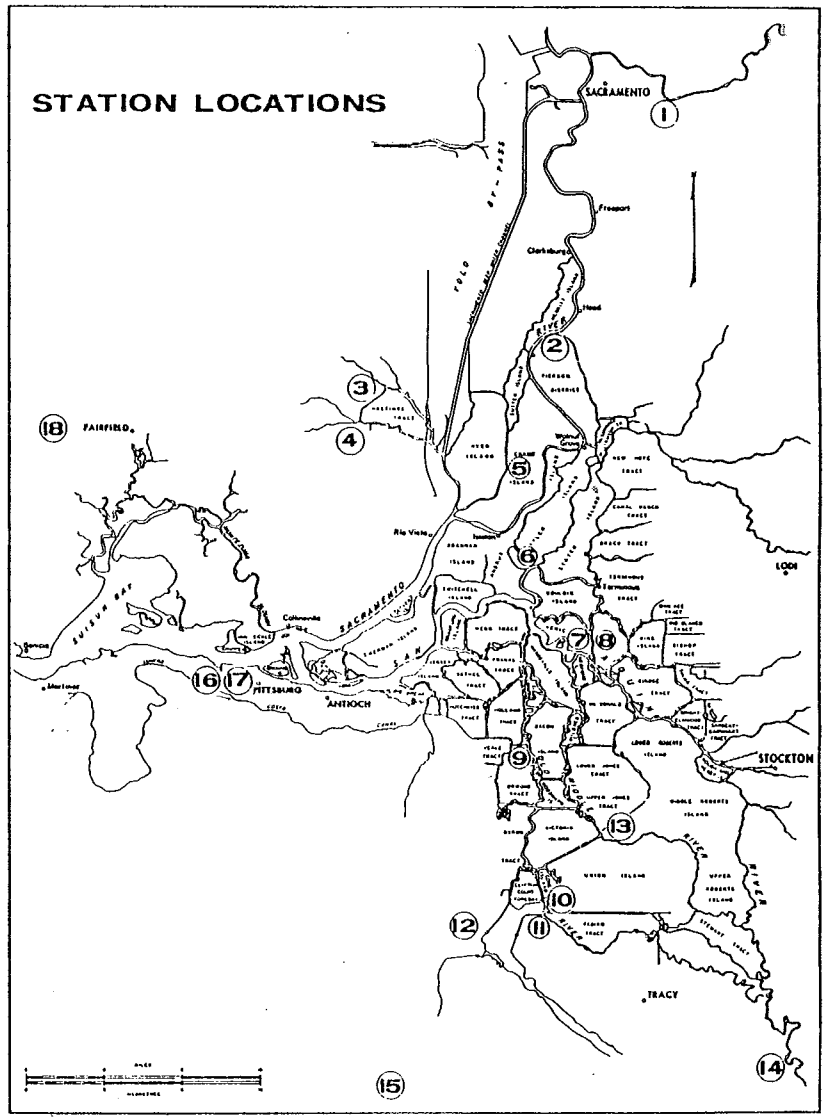


Figure 1

Delta-Mendota Canal intake, were higher in EC and chloride to sodium (Cl:Na) molar ratios during the last half of 1985 than in 1984 (Figure 2).

2. The rise and fall of EC and Cl:Na molar ratios at the Banks headworks and Delta-Mendota Canal intake corresponded with similar observations at the Rock Slough at Old River station and Middle River station (Figure 3).

3. The rise and fall of EC and Cl:Na molar ratios at the Rock Slough and Middle River stations corresponded to that of the Sacramento River at Mallard Island station, which is subject to tidal excursion and bay salinity intrusion during low riverflows. Rock Slough station water was more affected by the Mallard Island water quality than was Middle River (Figure 4).

4. Observed water quality at the aforementioned stations corresponded to reduced Sacramento River flows, which were lower than flows during the same period in 1984. San Joaquin River flows were essentially unchanged from the previous year. (Figure 5). Molar chloride to sodium ratios indicated fairly constant composition of river water quality at Greene's Landing and Vernalis (Figure 5).

5. San Joaquin River EC measured near Vernalis resembled export water conductivity, but falsely suggested that the waters were similar in composition. The molar Cl:Na ratios differentiated between the water types during July 1985 through January 1986 (Figure 6). Quality of exported water was more similar to water flowing into the southern Delta through Old and Middle rivers. The value of using ionic ratios over salinity values was demonstrated in this study of water movement and characterization.

Standard mineral analyses have been added to the list of laboratory determinations to be performed on water samples. Ionic ratios will also be analyzed to improve the ability to track water sources and changes with time. Results of recent mineral analyses are shown in Table 2.

Study of Tidal Effects on Export Water Quality (Task WQ3)

The direction and mixing of water along Old and Middle rivers and other channels will be studied during different tidal stages. The data will be used to help quantify water quality effects of different sources of water to the Clifton Court and Delta-Mendota Canal intakes.

Three sampling runs were conducted during high slack tide (Figure 7). On August 7, Old River was sampled; on August 21, both Old River and Middle River were sampled; and on August 22, the east and west ends of Potato Slough were sampled. Water samples were collected at the 6-foot depth for standard mineral analyses. Results of laboratory analyses are not yet available, but depth profiles of field conductivity and temperature measurements are presented in Appendix E, Tidal Effects Study Field Measurements. Sampling during other hydrologic conditions and at other reaches is being planned. The studies will provide information on the proportion of Sacramento and San Joaquin river waters and bay water diverted to the Federal and State water project intakes.

Figure 2

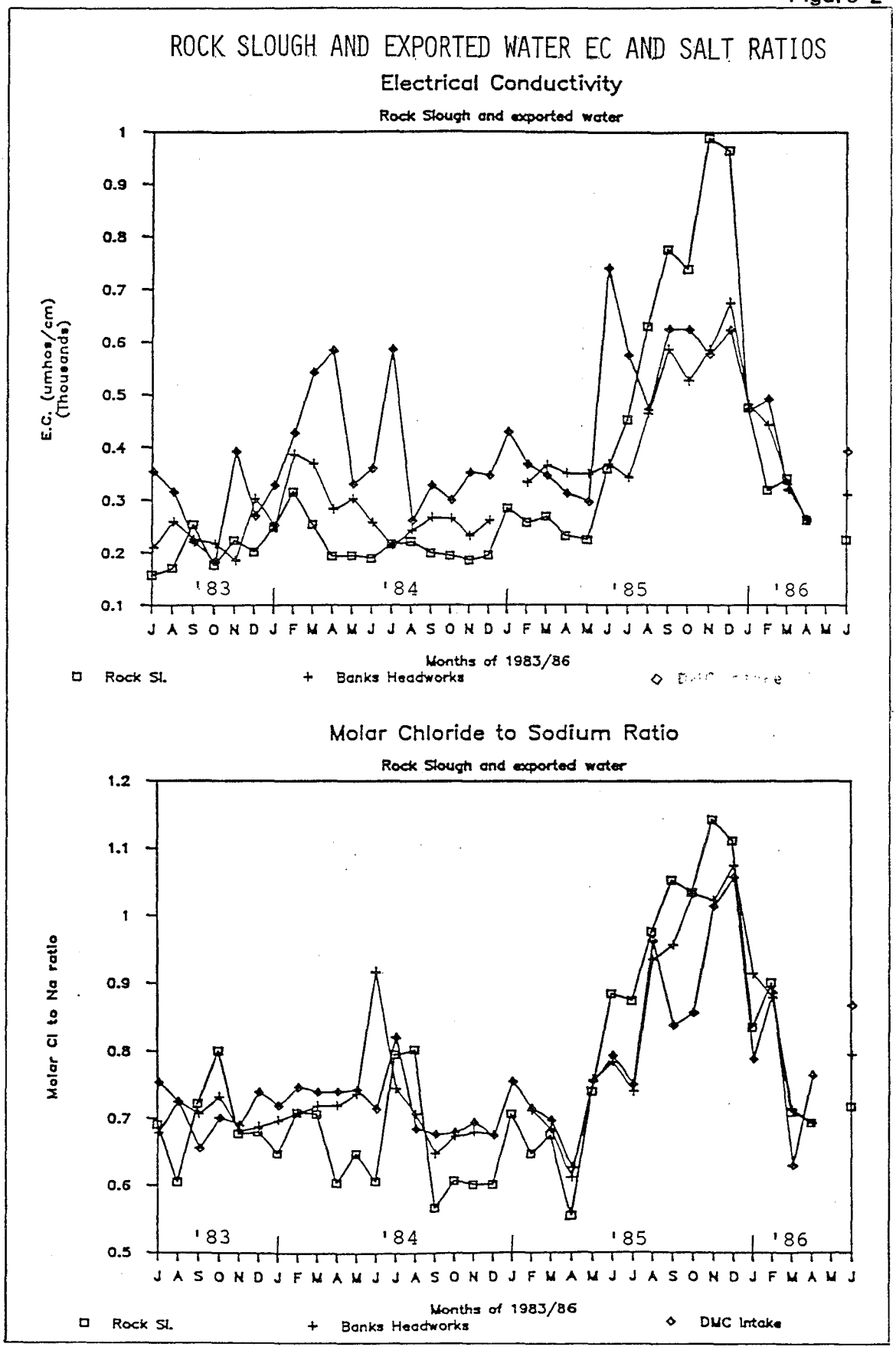

ROCK SLOUGH AND EXPORTED WATER EC AND SALT RATIOS
Electrical Conductivity
Rock Slough and exported water
E.C. (umhos/cm) (Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Rock Sl.
Banks Headworks
Molar Chloride to Sodium Ratio
Rock Slough and exported water
Molar Cl to Na ratio
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Rock Sl.
Banks Headworks
DMC Intake

Figure 3

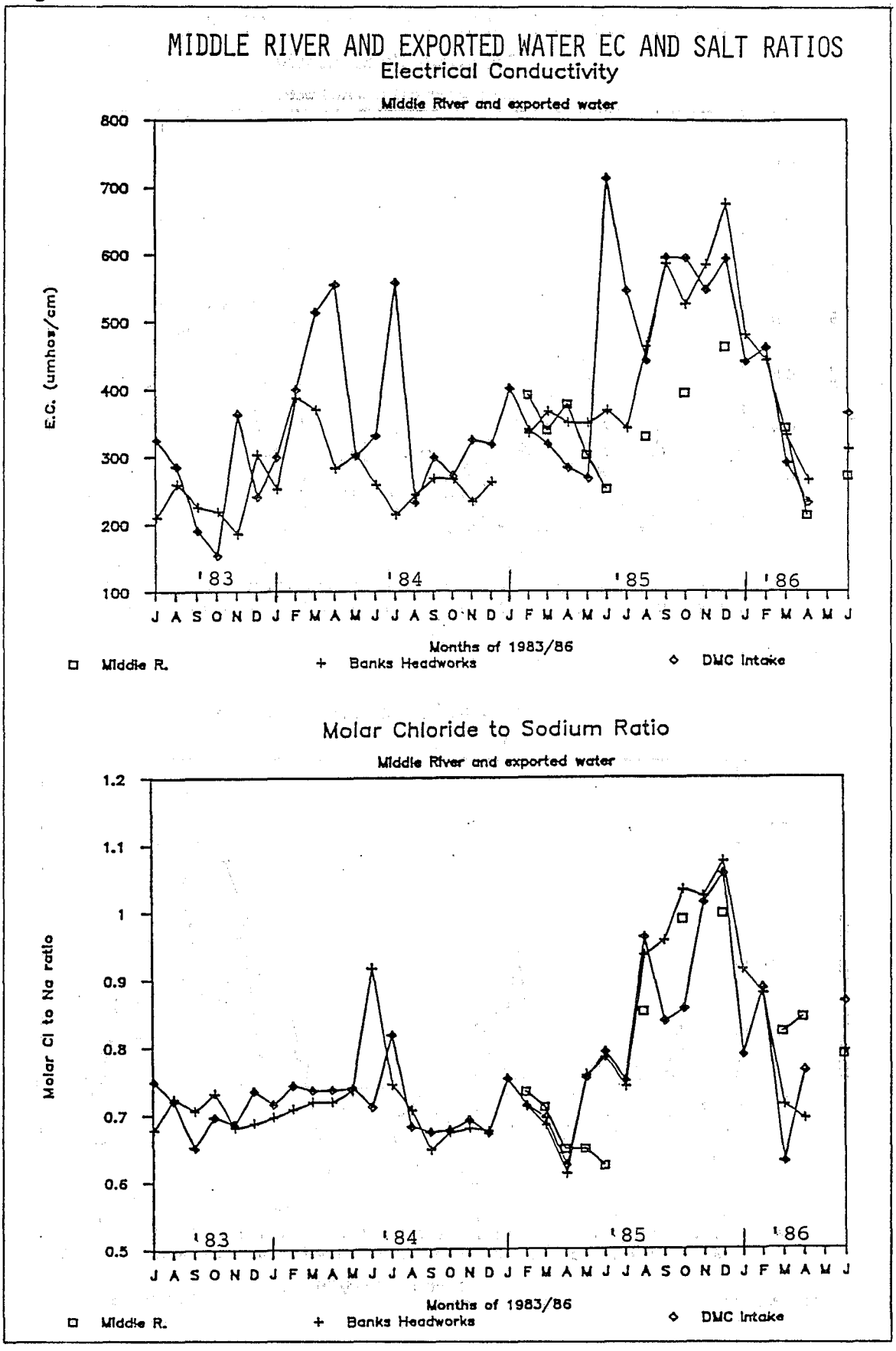

MIDDLE RIVER AND EXPORTED WATER EC AND SALT RATIOS
Electrical Conductivity
Middle River and exported water
E.C. (umhos/cm)
800
700
600
500
400
300
200
100
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Middle R.
Banks Headworks
DMC Intake
Molar Chloride to Sodium Ratio
Middle River and exported water
Molar Cl to Na ratio
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Middle R.
Banks Headworks
DMC Intake

Figure 4

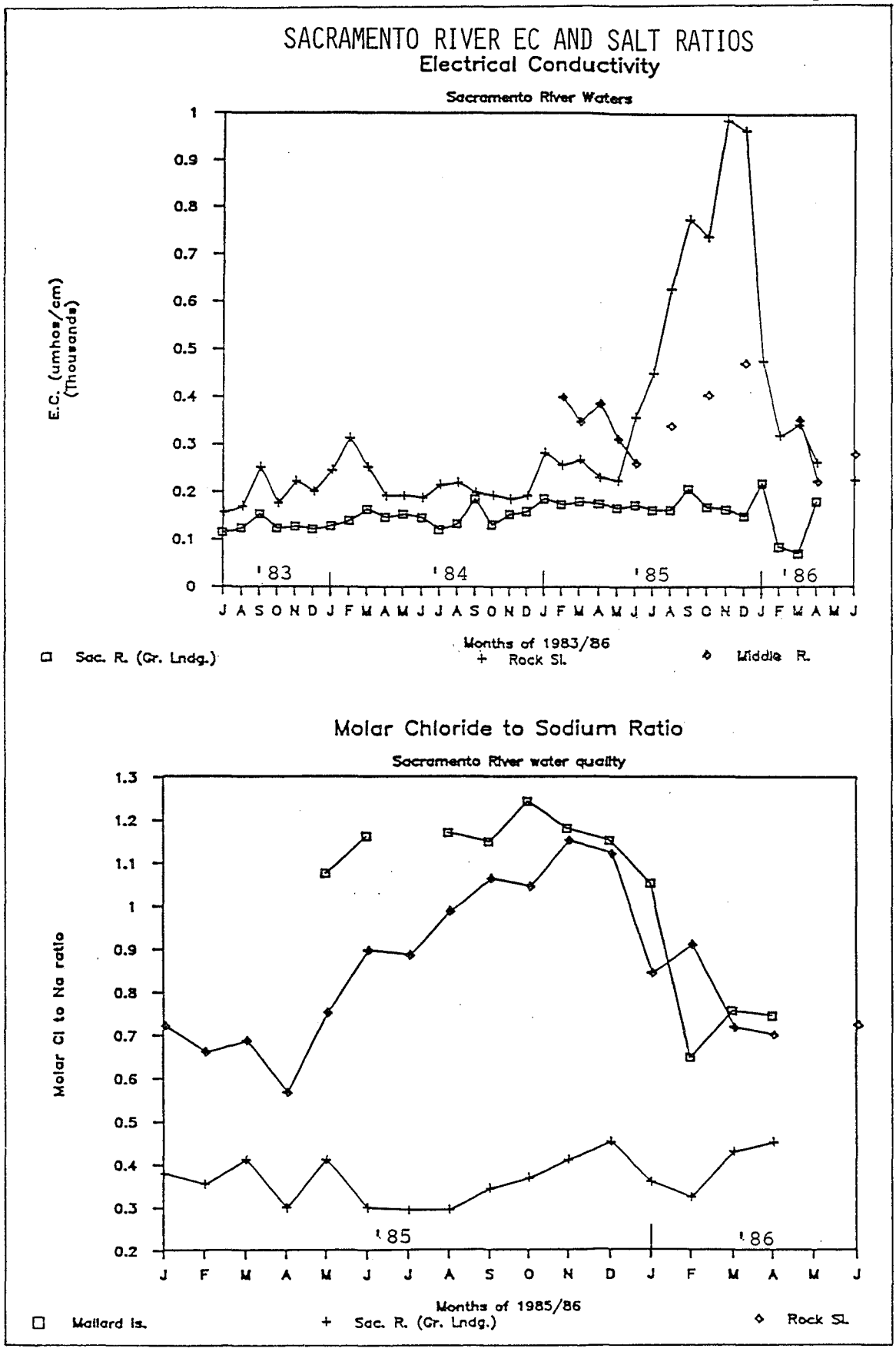

SACRAMENTO RIVER EC AND SALT RATIOS
Electrical Conductivity
Sacramento River Waters
E.C. (umhos/cm)
(Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Sac. R. (Gr. Lndg.)
Rock Sl.
Middle R.
Molar Chloride to Sodium Ratio
Sacramento River water quality
Molar Cl to Na ratio
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
'85
'86
J F M A M J J A S O N D J F M A M J
Months of 1985/86
Mallard Is.
Sac. R. (Gr. Lndg.)
Rock SL

Figure 5

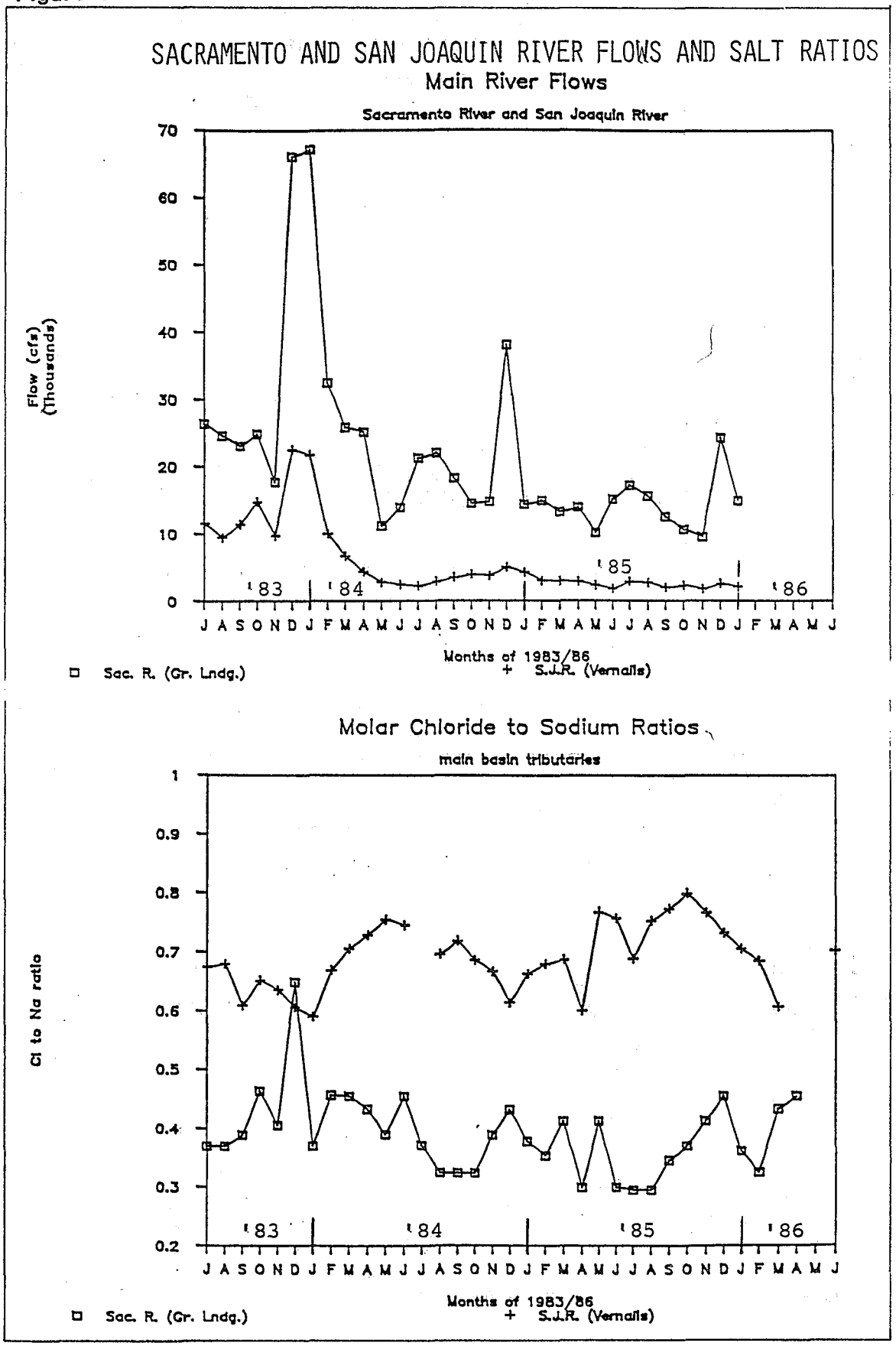

SACRAMENTO AND SAN JOAQUIN RIVER FLOWS AND SALT RATIOS
Main River Flows
Sacramento River and San Joaquin River
Flow (cfs) (Thousands)
70
60
50
40
30
20
10
0
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Sac. R. (Gr. Lndg.)
S.J.R. (Vernalis)
Molar Chloride to Sodium Ratios
main basin tributaries
Cl to Na ratio
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
Sac. R. (Gr. Lndg.)
S.J.R. (Vernalis)

Figure 6

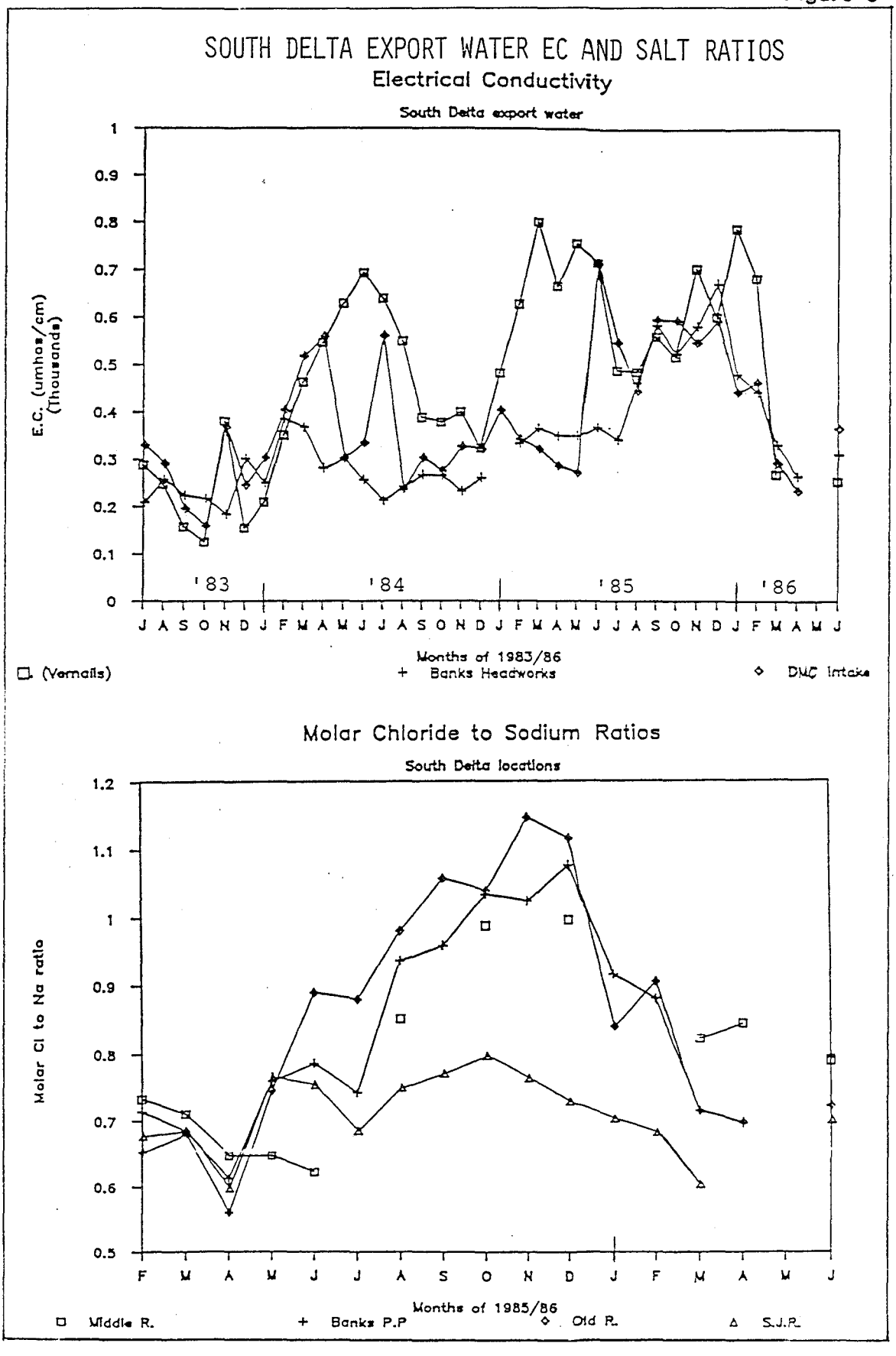
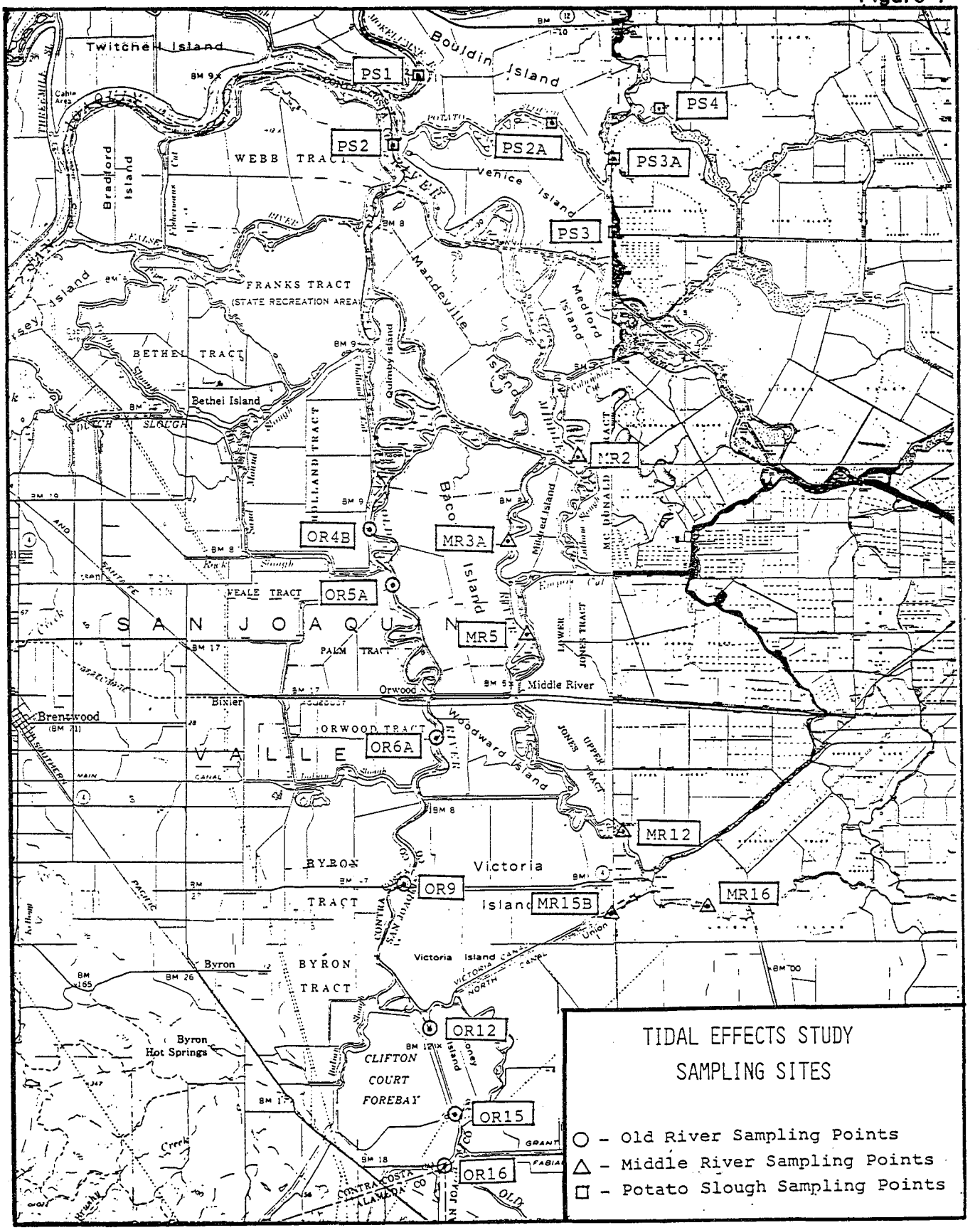

SOUTH DELTA EXPORT WATER EC AND SALT RATIOS
Electrical Conductivity
South Delta export water
E.C. (umhos/cm)
(Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
'83
'84
'85
'86
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
Months of 1983/86
(Vernalis)
Banks Headworks
DMC Intake
Molar Chloride to Sodium Ratios
South Delta locations
Molar Cl to Na ratio
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
F M A M J J A S O N D J F M A M J
Months of 1985/86
Middle R.
Banks P.P
Old R.
S.J.R.

Table 2

MINERAL DATA

STATION NAME	DATE	TEMP (C)	pH FIELD	EC (uS)	DO	CA	MG	NA	K	Alk*	SO4	Cl	NO3	B	TDS	TH**	TURB (FTU)
					<---------- Milligrams per Liter ----------												
AGDEMPIRE	03/04/86	19.5	7.3	2840	8.0	205	100	233	2.7	127	345	595	138.0	0.4	1860	924	7
AGDEMPIRE	04/17/86	15.0	7.4	1610	8.8	90	47	148	3.3	202	62	357	5.3	0.3	996	418	10
AGDEMPIRE	05/13/86	21.5	7.5	2000	6.6	108	56	204	2.7	217	50	506	0.8	0.3	1190	500	15
AGDEMPIRE	06/11/86	22.0	8.1	2760	5.7	150	84	296	2.5	215	18	830	0.0	0.4	1630	720	14
AGDGRAND	02/27/86	17.5	7.0	602	4.4	46	29	35	4.0	118	132	27	27.0	0.4	419	235	24
CLIFTON	03/04/86	16.5	7.3	306	7.8	15	7	29	2.1	50	41	29	3.1	0.2	177	66	21
CLIFTON	04/09/86	16.5	7.2	197	8.8	11	5	20	1.5	39	24	20	1.2	0.2	121	48	14
CLIFTON	05/07/86	15.5	7.3	280	8.8	16	7	27	1.8	55	36	28	3.2	0.2	171	69	13
CLIFTON	06/04/86	20.5	7.3	303	8.2	16	8	29	1.7	52	39	33	3.8	0.2	177	73	26
DMC	07/02/86	24.5	7.3	530	7.0	28	14	54	2.6	78	65	62	5.2	0.3	338	128	13
BANKS	07/02/86	24.0	7.3	305	6.4	16	9	31	2.3	59	34	33	1.6	0.2	231	77	25
ROCKSL	07/02/86	25.5	7.3	225	6.3	13	8	19	1.9	56	21	19	1.0	0.1	144	66	15
GREENES	03/13/86	11.5	7.3	70	11.0	6	3	3	0.8	30	4	2	0.9	0.0	49	28	58
GREENES	04/23/86	18.5	7.3	179	8.5	13	8	10	1.2	64	12	7	3.1	0.0	114	66	14
GREENES	05/28/86	23.5	7.3	188	7.5	13	8	12	1.4	65	14	9	2.1	0.0	109	66	14
GREENES	06/25/86	24.5	7.3	161	7.8	11	7	11	1.2	52	11	8	1.5	0.1	106	56	13
MALLARDIS	02/27/86	14.5	7.0	169	8.8	12	6	12	2.0	43	18	12	5.8	0.1	102	54	58
MALLARDIS	03/13/86	13.0	7.3	161	9.4	10	6	12	1.8	42	18	14	2.6	0.1	108	50	51
MALLARDIS	04/23/86	16.5	7.3	226	8.9	12	7	20	1.6	48	22	23	2.6	0.1	136	59	22
MALLARDIS	05/28/86	17.0	7.6	4160	8.6	41	90	680	29.0	65	193	1240	1.4	0.4	2340	473	26
MALLARDIS	06/25/86	21.0	7.7	4250	8.1	40	94	689	28.0	65	197	1280	0.9	0.4	2430	487	36
VERNALIS	03/04/86	15.0	7.3	268	8.3	14	6	28	1.9	50	38	26	2.6	0.2	166	60	26
VERNALIS	04/09/86	15.0	7.3	169	9.2	10	5	18	1.5	39	24	18	1.5	0.1	114	45	20
VERNALIS	05/07/86	14.5	7.3	257	8.8	15	7	27	1.8	54	37	27	4.9	0.2	168	66	17
VERNALIS	06/04/86	20.5	7.3	254	8.0	15	7	26	1.6	49	37	28	3.3	0.2	160	66	22
VERNALIS	07/02/86	23.0	7.5	595	7.9	31	16	65	3.0	90	82	75	5.6	0.3	390	144	9

Figure 7


Twitchell Island
Bouldin Island
PS1
PS2
PS2A
PS3
PS3A
PS4
WEBB TRACT
Bradford Island
Venice Island
FRANKS TRACT
(STATE RECREATION AREA)
Mandeville Island
Medford Island
BETHEL TRACT
Bethel Island
Quimby Island
MR2
OR4B
MR3A
OR5A
MR5
SAN JOAQUIN
VALLE
Middle River
Orwood
Brentwood
ORWOOD TRACT
OR6A
Woodward Island
MR12
BYRON TRACT
Victoria Island
OR9
MR15B
MR16
Byron
Byron Hot Springs
OR12
CLIFTON COURT FOREBAY
OR15
OR16
CONTRA COSTA CO
ALAMEDA CO
TIDAL EFFECTS STUDY
SAMPLING SITES
○ - Old River Sampling Points
△ - Middle River Sampling Points
□ - Potato Slough Sampling Points

Effects of Agriculture on Water Quality Studies

There are six program tasks to study effects of agriculture and related activities on Delta water quality.

Drainage Water Quality Monitoring (Task AG1)

Irrigation return flows from drainages at Empire Tract, Grand Island, and Tyler Island are being monitored for salts, pesticides, THM formation potential, and other constituents. The data will be used to assess the loading effects of drainage on receiving water quality during the year.

The sampling locations and estimated size of each island are shown in Figures 8 and 9. Data to compute monthly loadings of drainage constituents have been requested from the island managers. Monthly loadings will be estimated by multiplying constituent concentrations by pumping rates. Electrical energy usage and data on pump efficiencies will be used to estimate pumping rates.

Monthly conductivity and molar chloride to sodium ratios are shown in Figure 10. During the historic flood of February 1986, the levee at Tyler Island failed, resulting in the inundation of the island. No samples were collected from Tyler Island until after the levee was repaired and water was pumped back into the channels. Sampling resumed in June 1986, but the data may not reflect typical drainage. Debris and many dead fish were observed in the drain, attributed to the receding water and to clean-up operations on the island. The drainage was highly turbid, deeply colored, and odorous (hydrogen sulfide gas).

Monthly sampling at drainages on Empire Tract and Grand Island was not interrupted.

Drainage quality at Empire Tract is distinctly different than drainage from Tyler and Grand islands. Empire Tract drainage exhibits chloride to sodium ratios similar to sea water. The electrical conductivity value of the drainage is about 1,000 uS/cm higher than that of the other two islands. Also, the laboratory analyses show a greater fraction of brominated trihalomethanes in Empire Tract drainage compared to the other islands. These differences may be due to a connate water source.

At all three drainages, similar patterns in conductivity were observed. Peak levels generally occurred in October through March, followed by progressively decreasing values in April and May, with annual lows in June through August. The shifts in the values result from application of river water during the irrigation months and leaching of soils during winter.

Pesticide concentrations were below detection or in trace amounts when detected at these drains. Sodium levels and conductance would exceed health standards if used for domestic purposes. Trihalomethane formation potentials were exceptionally high and indicate a significant contribution of THM precursor material to Delta waters (Table 3).

Locating Irrigation Return Water Discharges (Task AG2)

Discharge points of irrigation return water are being identified and mapped. This information will be used to identify sources of contaminants and to plan upcoming work to assess their impact on water quality.

Figure 11 is a map showing drainage discharge points near the Clifton Court and Delta-Mendota Canal intakes. A request for data to estimate loadings

Figure 8

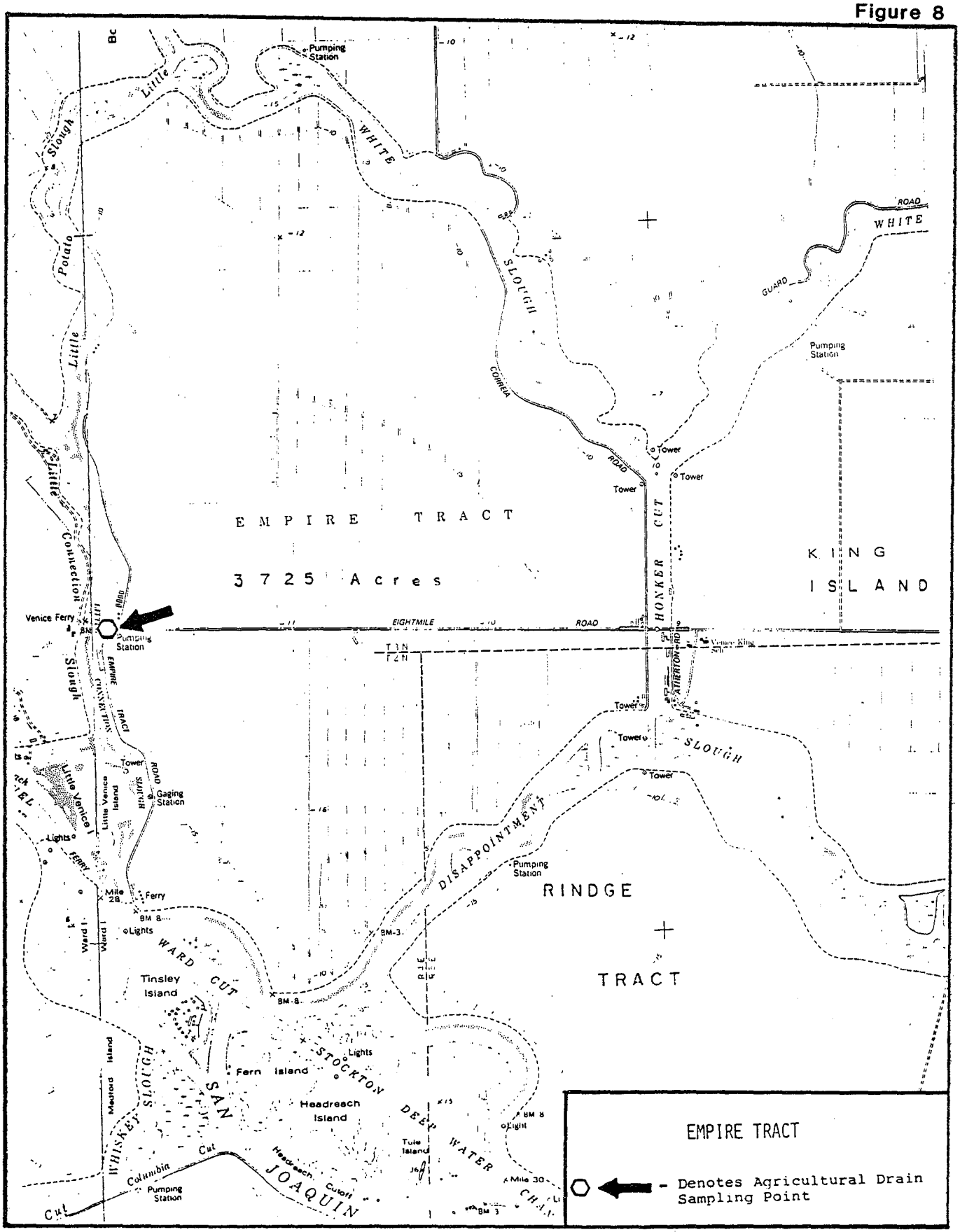

Pumping Station
Little Potato Slough
WHITE SLOUGH
ROAD
WHITE
GUARD
CORNELL
ROAD
Tower
Tower
Tower
Pumping Station
EMPIRE TRACT
3725 Acres
HONKER CUT
KING ISLAND
Little Connection Slough
Venice Ferry
Pumping Station
EIGHTMILE ROAD
T 3 N
T 2 N
ATHERTON RD
Venice King Sch
EMPIRE TRACT
Tower
Tower
Tower
SLOUGH
Tower
ROAD
Little Venice Island
Gaging Station
Lights
FERRY
Mile 28
Ferry
BM 8
Lights
Ward I
Ward I
WARD CUT
Tinsley Island
BM-3
BM-8
DISAPPOINTMENT
Pumping Station
RINDGE
TRACT
R 3 E
Medford Island
HOLLAND
Fern Island
Lights
STOCKTON
Headreach Island
SAN JOAQUIN
DEEP WATER
WHISKEY
Columbia Cut
Pumping Station
Headreach Cutoff
Tule Island
Light
BM 8
Mile 30
BM 3
CHAN.
EMPIRE TRACT
- Denotes Agricultural Drain Sampling Point

Figure 9

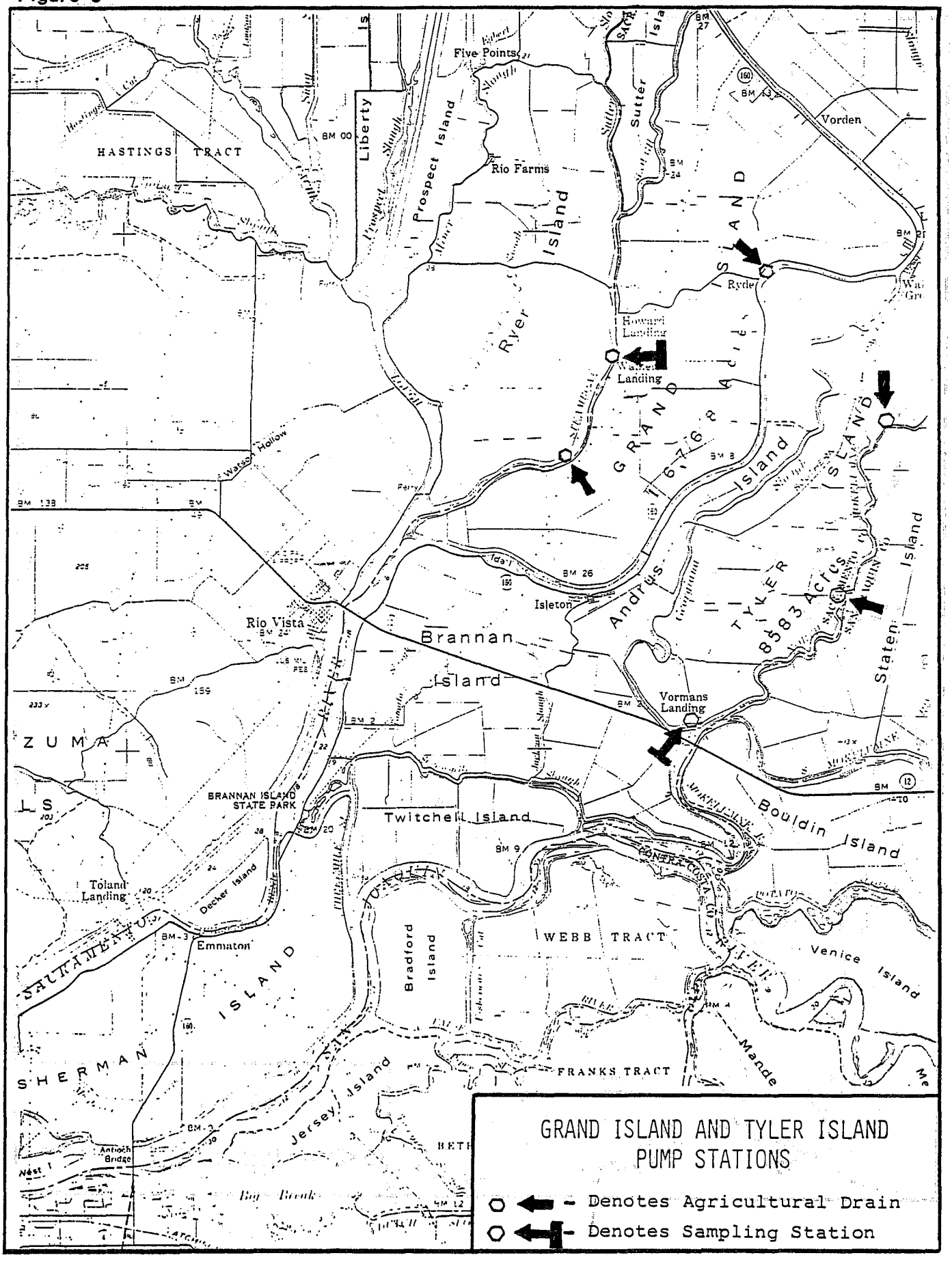

HASTINGS TRACT
Liberty Island
Prospect Island
Five Points
Rio Farms
Ryer Island
Sutter Island
Vorden
Ryde
Howard Landing
Walker Landing
GRAND ISLAND
6767 Acres
TYLER ISLAND
8583 Acres
Watson Hollow
Andrus Island
Isleton
Rio Vista
Brannan Island
Vormans Landing
Staten Island
ZUMA
BRANNAN ISLAND STATE PARK
Twitchell Island
Bouldin Island
Toland Landing
Decker Island
Emmaton
SACRAMENTO
SHERMAN ISLAND
Bradford Island
WEBB TRACT
Venice Island
Mandeville
FRANKS TRACT
Jersey Island
Antioch Bridge
Big Break
GRAND ISLAND AND TYLER ISLAND
PUMP STATIONS
- Denotes Agricultural Drain
- Denotes Sampling Station

Figure 10

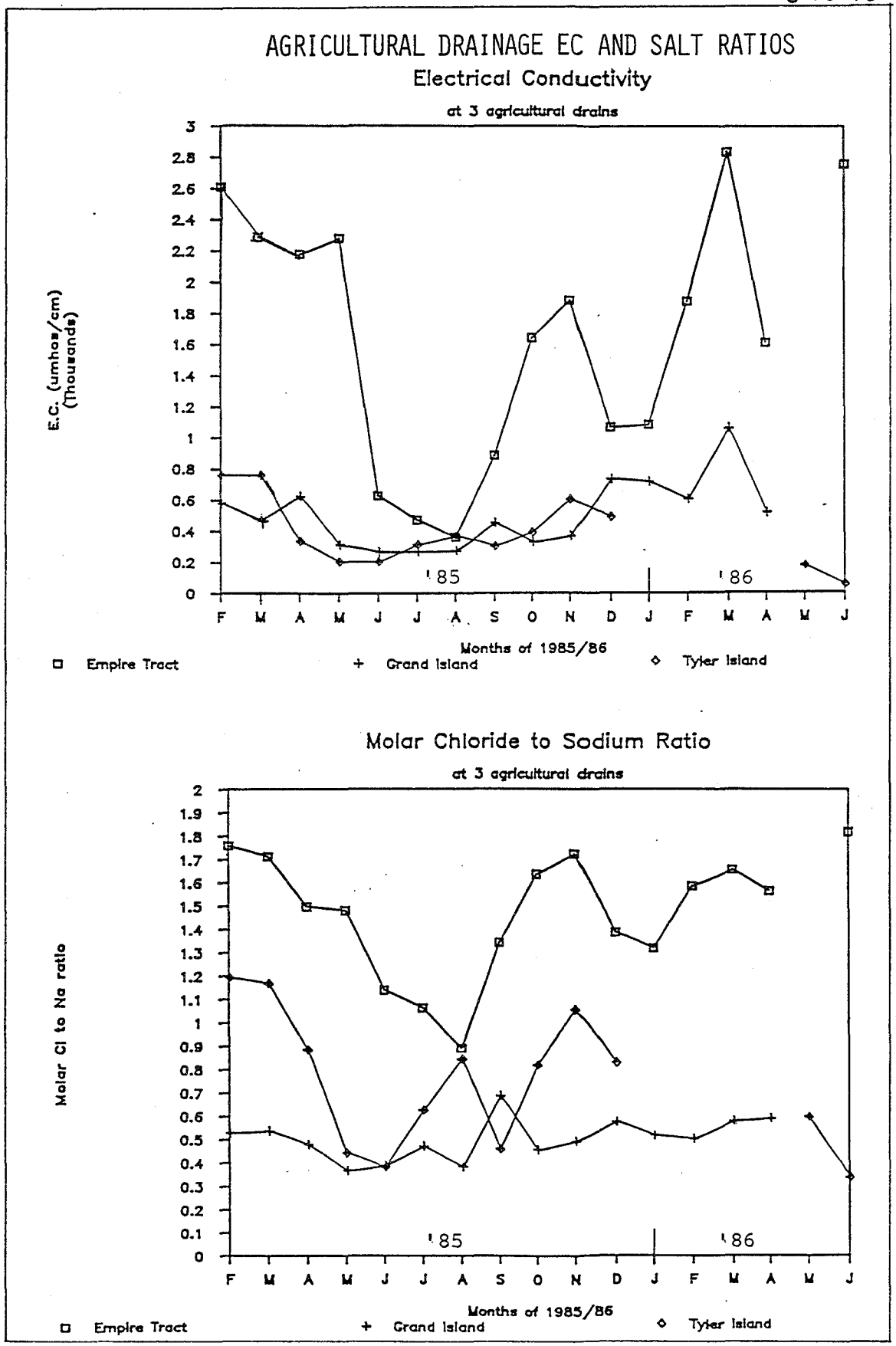
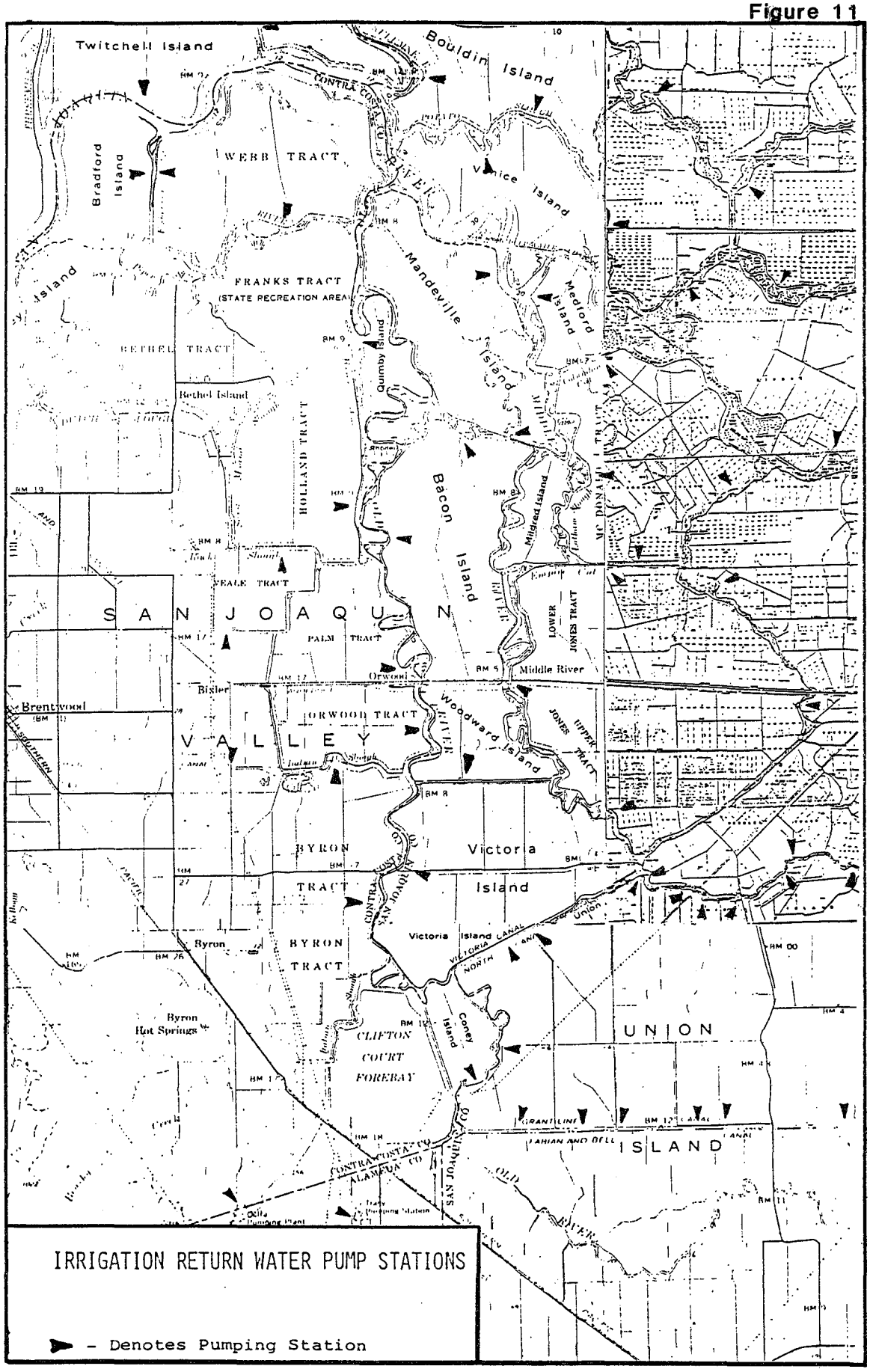

AGRICULTURAL DRAINAGE EC AND SALT RATIOS
Electrical Conductivity
at 3 agricultural drains
E.C. (umhos/cm)
(Thousands)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
'85
'86
F M A M J J A S O N D J F M A M J
Months of 1985/86
Empire Tract
Grand Island
Tyler Island
Molar Chloride to Sodium Ratio
at 3 agricultural drains
Molar Cl to Na ratio
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
'85
'86
F M A M J J A S O N D J F M A M J
Months of 1985/86
Empire Tract
Grand Island
Tyler Island

Table 3

AGRICULTURAL DRAINAGE QUALITY

STATION	DATE	Na	Cl	Se	EC	Turb	Color	Asbest	CH Cl3	CH Cl2Br	CH ClBr2	CH Br3	TTHMFP
		(-----mg/L-------)			(uS)	(FTU)		(MF/L)	(----------ug/L----------)				
AGDEMPIRE	02/06/85	252	684	0.000	2610	26	25		1500	920	930	81	3400
AGDEMPIRE	03/06/85	226	597	0.000	2330	14		92					
AGDEMPIRE	04/05/85	224	517		2180	10	75		1800	920	370	31	3100
AGDEMPIRE	05/01/85	248	566	0.000	2280	14	160		1800	900	440	29	3200
AGDEMPIRE	06/05/85	54	95		629	15	75		1800	280	25	0	2100
AGDEMPIRE	07/24/85	42	69		472	10	40		2100	140	19	0	2300
AGDEMPIRE	08/01/85	32	44	0.000	360	8	100		2100	150	10	0	2300
AGDEMPIRE	09/11/85	83	172		886	4	150		3000	460	48	2	3500
AGDEMPIRE	10/02/85	149	376	0.000	1640	10	50		2200	790	330	26	3300
AGDEMPIRE	11/13/85	170	452	0.000	1880	4	80		2100	920	390	40	3400
AGDEMPIRE	12/03/85	87	186		1070	8	200	76	2900	360	44	1	3300
AGDEMPIRE	01/16/86	112	228		1087	3	160		6900	490	67	1	7500
AGDEMPIRE	02/13/86	162	396		1880	11	150		2600	650	170	8	3400
AGDEMPIRE	03/04/86	233	595		2840	7	200		1500	660	210	14	2400
AGDEMPIRE	04/17/86	148	357	0.000	1610	10	160		1900	830	320	13	3100
AGDEMPIRE	05/13/86			0.001			150		570	330	160	15	1100
AGDEMPIRE	06/11/86	296	830	0.000	2760	14	80						
AGDGRAND	02/06/85	43	35	0.000	576	34	25		2100	32	4	0	2100
AGDGRAND	03/06/85	35	29	0.000	468	21		630					
AGDGRAND	04/05/85	53	39		625	30	80		2000	100	4	0	2100
AGDGRAND	05/01/85	23	13	0.000	310	26	50		1000	41	0	0	1000
AGDGRAND	06/05/85	20	12		265	22	35		840	37	0	0	880
AGDGRAND	07/24/85	22	16		267	70	80		1800	60	2	0	1900
AGDGRAND	08/01/85	22	13	0.000	273	30	50		1300	49	1	0	1400
AGDGRAND	09/11/85	31	33		451	28	30		1100	94	8	0	1200
AGDGRAND	10/02/85	27	19	0.000	327	25	30		820	56	3	0	880
AGDGRAND	11/13/85	29	22	0.000	368	16	35		890	69	3	0	960
AGDGRAND	12/03/85	55	49	0.000	735	31	100	2100	2800	160	5	0	3000
AGDGRAND	01/16/86	64	51		716	26	80		3500	130	6	0	3600
AGDGRAND	02/27/86	35	27		602	24	100		1700	83	2	0	1800
AGDGRAND	03/13/86	64	57	0.001	1060	22	160		3200	180	5	0	3400
AGDGRAND	04/23/86	32	29	0.000	513	54	50		1700	82	2	0	1800
AGDGRAND	05/28/86	21	16		323	36	50		640	29	3	1	670
AGDGRAND	06/25/86	20	15		290	35	40						
AGDTYLER	03/27/85	46	84	0.000	743	29		530					
AGDTYLER	04/24/85	56	100		743	28	100		2100	260	27	0	2400
AGDTYLER	05/22/85	23	31	0.000	320	17	70		1800	91	4	0	1900
AGDTYLER	06/26/85	15	10		188	18	50		1400	45	3	0	1400
AGDTYLER	07/10/85	14	8		189	17	100		1600	51	1	0	1600
AGDTYLER	08/28/85	21	20	0.000	299	9	100		2100	78	3	0	2200
AGDTYLER	09/11/85	24	31		354	10	50		2200		6	0	
AGDTYLER	10/02/85	26	18	0.000	289	14	100		1200	70	2	0	1300
AGDTYLER	11/13/85	28	35	0.000	376	11	160		2000	120	2	0	2100
AGDTYLER	12/03/85	36	58	0.000	587	12	100	190	2100	85	2	0	2200
AGDTYLER	01/16/86	38	48		476	9	120		3500	83	8	0	3600
AGTYLER	06/11/86	10	9	0.000	158	768							

Figure 11


Twitchell Island
Bouldin Island
WEBB TRACT
Bradford Island
Venice Island
FRANKS TRACT
(STATE RECREATION AREA)
Mandeville Island
Medford Island
BETHEL TRACT
Bethel Island
Quimby Island
HOLLAND TRACT
Bacon Island
Mildred Island
McDONALD TRACT
SAN JOAQUIN
VALLEY
PEALE TRACT
PALM TRACT
ORWOOD TRACT
Orwood
Bixler
Brentwood
Middle River
LOWER JONES TRACT
UPPER JONES TRACT
Woodward Island
BYRON TRACT
Victoria Island
Victoria Island CANAL
Byron
Byron Hot Springs
CLIFTON COURT FOREBAY
Corey Island
UNION ISLAND
Old River
CONTRA COSTA CO.
ALAMEDA CO.
SAN JOAQUIN CO.
IRRIGATION RETURN WATER PUMP STATIONS
- Denotes Pumping Station

discharged into the rivers has also been made. Monthly loadings will be estimated by multiplying constituent concentrations by pumping rates, which will be estimated using information on electrical energy usage and pump efficiencies.

Actual pumping efficiencies may be lower than estimated, as the program's field crew found one return flow drain (east side of Orwood Tract) to be poorly maintained (e.g. intense algal mats and hyacinth growth at the pump station). This particular drain appeared to be discharging mostly air, rather than drainage, into Old River because of suction problems at the pump station inlet. Other drains are probably in a similar state.

San Joaquin River Monitoring (Task AG3)

Comprehensive water quality monitoring near Vernalis has been initiated to study the effects of San Joaquin River on exported water quality. There are concerns about pesticides, selenium, and other trace elements that are being discharged from agricultural drainage into the San Joaquin River.

The drinking water standard for selenium is 10 ug/L. Maximum selenium concentrations so far have been 2 ug/L or less at the Vernalis station. Concentrations at some sites in the San Joaquin River upstream of Vernalis have been higher than 2 ug/L. Substantial amounts of farm drainage are discharged into the lower reach of the river. The highest selenium concentrations are in Salt and Mud sloughs, where selenium-laden agricultural drainage enters from the Grasslands area (Figure 12 and Table 4).

In February 1985, an experiment was conducted to reduce selenium concentrations in the South Grasslands area. Participants included the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, Department of Fish and Game, Central Valley Regional Water Quality Control Board, and Department of Water Resources. The study consisted of two steps: (1) rerouting subsurface drainage flows around the Southern Grasslands into Mud Slough, a tributary of the San Joaquin River, and (2) diverting Delta-Mendota Canal water into the South Grasslands area for dilution and flushing.

Department of Water Resources staff participated in monitoring selenium levels in the San Joaquin River during the experiment. The short-term experiment showed a reduction in selenium concentrations in surface waters with distance from the discharge point (Table 5 and Figure 12). Overall, data indicate the selenium drinking water standard is being met at Vernalis.

Pesticide levels have generally been below laboratory detection limits, except for methyl parathion (2.5 ug/L). Overall, none of the monitored pesticides is affecting drinking water quality of the San Joaquin River near Vernalis (Table 6).

Figure 12

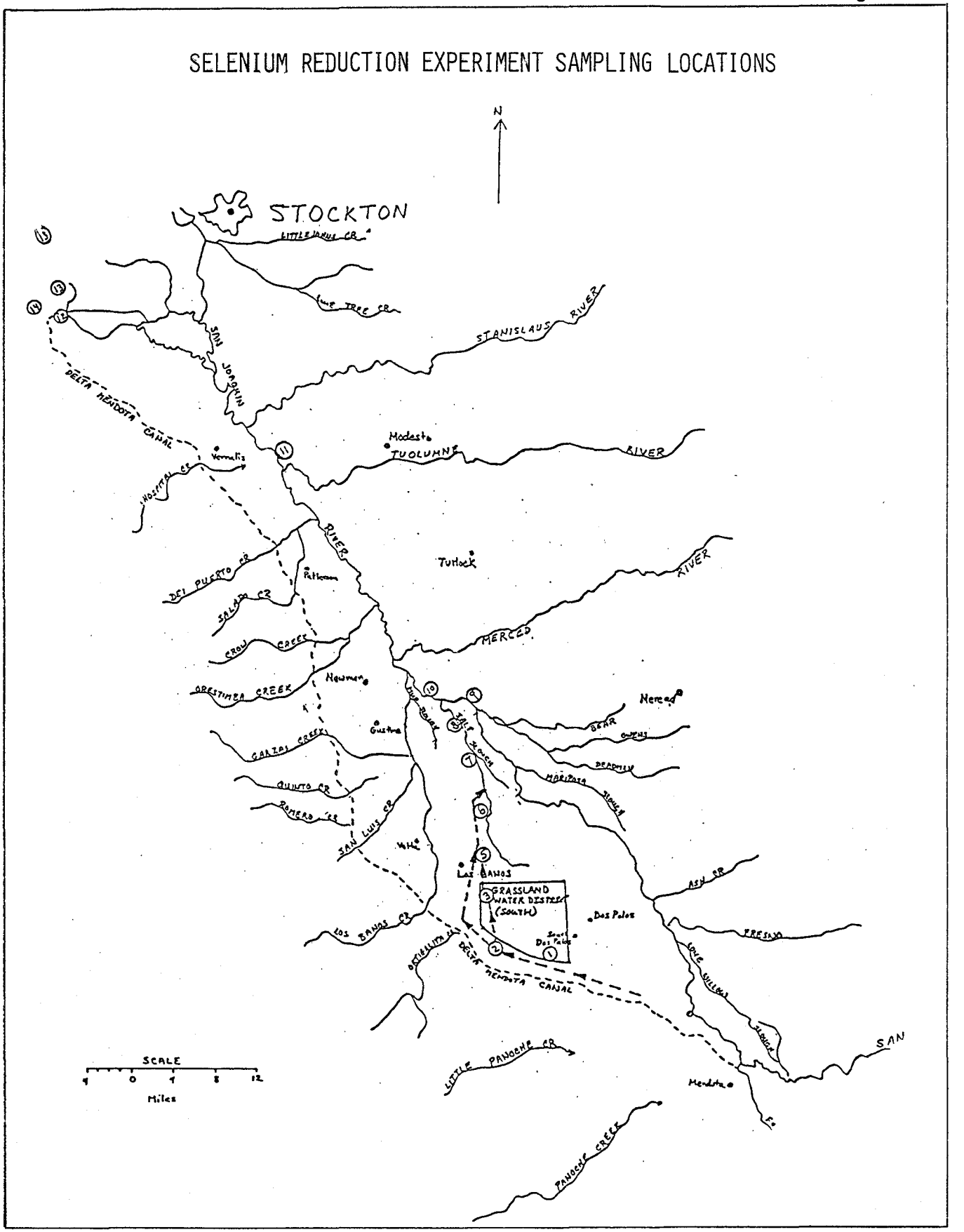

SELENIUM REDUCTION EXPERIMENT SAMPLING LOCATIONS
N
STOCKTON
LITTLE JOHN CR
LIME TREE CR
STANISLAUS RIVER
SAN JOAQUIN
DELTA MENDOTA CANAL
Modesto
TUOLUMNE
RIVER
HOSPITAL CR
Vernalis
Turlock
DEL PUERTO CR
Patterson
SALADO CR
CROW CREEK
MERCED
RIVER
Newman
ORESTIMBA CREEK
Gustine
Merced
CAMPBELL CREEK
QUINTO CR
ROMERO CR
SAN LUIS CR
MUD SLOUGH
LAS BANOS
GRASSLAND WATER DISTRICT (SOUTH)
Dos Palos
Dos Palos
LOS BANOS CR
OCHELLATA
DELTA MENDOTA CANAL
ASH CR
FRESNO
LITTLE PANOCHE CR
Mendota
PANOCHE CREEK
SCALE
0
4
8
12
Miles

Table 4

MINOR ELEMENTS IN LOWER SAN JOAQUIN RIVER AND TRIBUTARIES

STANAME	DATE	TIME (PST	TEMP (oC)	pH	DO (mg/L)	FLOW (cfs)	EC (uS)	B	TDS	Ba	Cd	Cr	Cu	Mn	Hg	Se	Zn	Mo	Ni
								<----------				Milligrams per Liter							---------->
MERCED	03/11/86	1215	17.0	7.0	10.8	3400	69	0.0	56	0	0.00	0.00	0.00	0.02	0.000	0.000	0.01	0.00	0.00
MERCED	04/21/86	1200	16.0	8.4	9.8	1000	53	0.0	45	0	0.00	0.01	0.00	0.03	0.000	0.000	0.01	0.00	0.00
MERCED	05/06/86	925	13.0	7.1	9.5	1000	52	0.0	42	0	0.00	0.00	0.01	0.03	0.000	0.000	0.01	0.00	0.00
MUDSL	03/12/86	1230	16.0	7.7	8.5	1600	736	0.7	447	0	0.00	0.00	0.00	0.04	0.000	0.002	0.01	0.00	0.00
MUDSL	04/21/86	1310	24.0	7.8	8.4	200	1030	1.1	656	0	0.00	0.00	0.00	0.12	0.000	0.006	0.00	0.01	0.00
MUDSL	05/06/86	1030	17.0	7.8	7.0	50	2150	1.9	1420	0	0.00	0.00	0.01	0.50	0.000	0.006	0.01	0.01	0.00
ORESTIMBA	03/12/86	1140	14.0	8.0	10.0	509	445	0.2	283	0	0.00	0.00	0.00	0.02	0.000	0.001	0.00	0.00	0.00
ORESTIMBA	04/21/86	1345	24.0	7.6	8.1	60.9	337	0.2	213	0	0.00	0.01	0.00	0.04	0.000	0.000	0.01	0.00	0.00
ORESTIMBA	05/06/86	1100	15.0	8.3	9.8	13	615	0.2	401	0	0.00	0.00	0.00	0.00	0.000	0.001	0.00	0.00	0.00
SALTSL	03/11/86	1030	13.5	7.3	8.7	889	1770	2.2	1160	0	0.00	0.00	0.01	0.17	0.000	0.010	0.01	0.01	0.01
SALTSL	04/21/86	1105	23.0	7.5	5.7	740	1380	1.4	898	0	0.00	0.02	0.00	0.22	0.000	0.008	0.01	0.01	0.01
SALTSL	05/06/86	830	15.0	7.4	7.7	525	1230	1.3	809	0	0.00	0.00	0.01	0.18	0.000	0.010	0.01	0.01	0.00
FREMONTFD	03/12/86	1300	16.0	7.1	9.5	5000	89	0.0	68	0	0.00	0.00	0.00	0.02	0.000	0.000	0.00	0.00	0.00
FREMONTFD	04/21/86	1245	22.0	7.4	8.8	3772	128	0.1	87	0	0.00	0.00	0.00	0.05	0.000	0.000	0.01	0.00	0.01
FREMONTFD	05/06/86	1015	16.0	7.4	7.9	1900	538	0.4	316	0	0.00	0.00	0.00	0.12	0.000	0.003	0.00	0.00	0.00
GRAYSON	03/12/86	1030	14.0	7.1	8.2	22000	294	0.2	182	0	0.00	0.00	0.00	0.05	0.000	0.001	0.00	0.00	0.00
GRAYSON	04/21/86	1515	21.0	7.4	8.7	11000	249	0.2	154	0	0.00	0.00	0.00	0.06	0.000	0.001	0.02	0.01	0.00
GRAYSON	05/06/86	1245	15.0	7.3	8.5	10000	403	0.3	244	0	0.00	0.00	0.00	0.08	0.000	0.002	0.00	0.00	0.00
MAZE	03/12/86	930	12.0	7.1	8.5	17830	234	0.2	145	0	0.00	0.00	0.01	0.07	0.000	0.001	0.02	0.00	0.00
MAZE	04/22/86	845	16.0	7.2	8.4	10790	213	0.1	134	0	0.00	0.01	0.00	0.04	0.000	0.000	0.01	0.01	0.00
MAZE	05/06/86	1400	15.0	7.3	8.5	8600	317	0.2	190	0	0.00	0.00	0.00	0.03	0.000	0.001	0.01	0.00	0.00
PATTERSON	03/11/86	1330	14.5	7.3	8.8	9090	290	0.2	179	0	0.00	0.00	0.00	0.04	0.000	0.001	0.01	0.00	0.00
PATTERSON	04/21/86	1430	22.0	7.4	8.5	8775	249	0.2	155	0	0.00	0.01	0.00	0.05	0.000	0.001	0.01	0.00	0.00
PATTERSON	05/06/86	1200	15.0	7.4	8.2	6300	392	0.3	244	0	0.00	0.00	0.01	0.05	0.000	0.002	0.01	0.00	0.00
STEVINSON	03/11/86	1130	14.0	7.3	9.1	12010	91	0.0	69	0	0.00	0.00	0.00	0.03	0.000	0.000	0.01	0.00	0.00
STEVINSON	04/21/86	1130	22.0	7.3	8.9	6431	69	0.0	56	0	0.00	0.00	0.00	0.03	0.000	0.000	0.00	0.00	0.00
STEVINSON	05/06/86	945	16.0	7.5	8.8	1600	170	0.0	110	0	0.00	0.00	0.01	0.04	0.000	0.000	0.00	0.00	0.00
STANISLAUS	03/12/86	840	11.0	7.1	10.5	4849	80	0.0	58	0	0.00	0.00	0.00	0.02	0.000	0.000	0.00	0.00	0.00
STANISLAUS	04/22/86	750	16.0	7.4	9.4	1670	89	0.0	65	0	0.00	0.01	0.00	0.03	0.000	0.000	0.01	0.00	0.00
STANISLAUS	05/06/86	1545	13.0	7.1	11.2	1560	-0-	-0-	-0-	0	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00
TUOLUMNE	03/11/86	1445	13.5	7.1	9.5	6100	68	0.0	53	0	0.00	0.00	0.00	0.03	0.000	0.000	0.01	0.00	0.00
TUOLUMNE	04/21/86	1540	17.0	7.4	11.0	4550	54	0.0	44	0	0.00	0.01	0.00	0.03	0.000	0.000	0.01	0.00	0.00
TUOLUMNE	05/06/86	1315	13.0	7.3	9.9	2900	68	0.0	48	0	0.00	0.00	0.00	0.00	0.000	0.000	0.01	0.00	0.00

Sampling Stations

Station Name	Location	Station Number
MERCED	Merced River at Milliken Bridge	B0513100
MUDSL	Mud Slough near Stevinson	B0040000
ORESTIMBA	Orestimba Creek below Highway 33	B0873500
SALTSL	Salt Slough near Stevinson	B0047000
FREMONTFD	San Joaquin River at Fremont Ford Bridge	B0737500
GRAYSON	San Joaquin River near Grayson	B0708000
MAZE	San Joaquin River at Maze Road Bridge	B0704000
PATTERSON	San Joaquin River at Patterson Bridge	B0720000
STEVINSON	San Joaquin River near Stevinson	B0740000
STANISLAUS	Stanislaus River at Koetitz Ranch	B0311500
TUOLUMNE	Tuolumne River at Tuolumne City	B0410500

Table 5

SELENIUM REDUCTION EXPERIMENT
(February 27, 1986)

	Station Number and Description	Selenium (ug/L) Board	DWR
1	Agatha Canal @ Helm Canal (No Drainwater)	<5	
2	Camp 13 Ditch @ CCID Main Canal (Blended Drainwater)	42	
3	Camp 13 Ditch (Mud Slough 100 feet North of Mallard Road)	21	
4	Mud Slough @ Santa Fe Grade	18	
5	Santa Fe Canal @ Highway 152	18	
6	Santa Fe Canal Discharge to Mud Slough (100 feet West of Mud Slough)	29	31
7	Salt Slough (South Boundary of San Luis Island NWR)	12	
8	Salt Slough @ Lander Ave	10	
9	San Joaquin River @ Lander Ave	<5	
10	San Joaquin River @ Highway 140	8	
11	San Joaquin River Vernalis station		2
12	Delta-Mendota Canal Intake (Lindeman Road)		<1
13	Clifton Court Intake		<1
14	Harvey O. Banks Delta Pumping Plant		<1
15	Rock Slough @ Old River		<1

Board = Central Valley Regional Water Quality Control Board
DWR = Department of Water Resources Bryte Laboratory

TABLE 6

VERNALIS STATION PESTICIDE MONITORING DATA

Chemical	7/16 1985	8/20 1985	12/4 1985	5/21 1985
2,4-D salt	ND	ND	--	ND
bentazon	ND	ND	--	ND
carbofuran	ND	ND	--	ND
chloropicrin	ND	ND	--	ND
copper	--	--	8	--
dacthal	ND	ND	--	ND
D-D mixture	ND	ND	ND	ND
MCPA	ND	ND	--	ND
metalaxyl	ND	ND	--	ND
methamidophos	ND	ND	--	ND
methyl bromide	ND	ND	ND	ND
methyl parathion	2.5	ND	--	ND
molinate	ND	ND	--	ND
paraquat dichloride	ND	ND	--	ND
thiobencarb	ND	ND	--	ND
xylene	ND	ND	ND	ND

ND = Not detected above analytical detection limit of 1 ug/L or less, or not reported when less than twice the background quality control blanks.

Analyses performed by McKesson Environmental Services.

Selected Pesticide Monitoring (Task AG4)

Through a selection protocol based on pesticide usage patterns and environmental behavior, water samples are collected for specific pesticide analyses. The data are used to identify potential contamination to raw water supplies and at treatment plants. Attention is focused on chemicals that might present treatment difficulties, such as the highly water soluble compounds. Less soluble compounds tend to be removed more readily by flocculation, settling, and filtration processes because they are generally associated with suspended particulate matter such as silt and clays.

The selection protocol produces a site- and time-specific target list of pesticides for monitoring to improve chances of detecting any chemicals in the water and to eliminate the need for broad scans for hundreds of chemicals. Instead, the target list includes

specifically named chemicals and those detectable under the same analytical method. The target lists are developed from the California Department of Food and Agriculture annual pesticide use database, which was sorted by counties and chemicals. Chemicals that are water soluble or in high use are identified for each watershed where sampling stations are located. The period of application or use of each chemical is also included in the database. Identified chemicals then appear on the monthly target lists for each sampling station. A more complete description of the pesticide monitoring selection scheme is provided in Appendix F, Pesticide Monitoring Selection Scheme.

Results of the pesticide monitoring are shown in Table 7. Sampling primarily focused on the application period (summer), with a sampling run in winter (runoff months) and a run in early spring (pre-emergent herbicide applications). Most of the targeted chemicals were below the analytical limit of detection. Reported chemicals were generally below State Action Levels for drinking water or were near the low level detection limits of the laboratories. These results indicate Delta water supplies are acceptable for domestic uses.

Modeling Pesticide Fate and Transport (Task AG5)

Computer models developed by EPA to predict the fate and movement of organic pesticides in an aquatic system are being tested to help assess the potential of contamination to drinking water supplies. The models are used to test the pesticide monitoring selection protocol for Task AG4 and to study the effects of changing riverflow and other environmental conditions on the distribution of pesticide contaminants.

One model under review is EXAMS (Exposure Analysis Modeling System). EXAMS is a steady state and dynamic model designed for rapid evaluation of the behavior of synthetic organic chemicals in aquatic ecosystems. The program computes:

- Exposure (the ultimate expected environmental concentrations resulting from a long-term steady pattern of pollutant loadings),
- Fate (the distribution of the chemical in the environment and the fraction of the loadings consumed by each transport and transformation process), and
- Persistence (the time required for effective purification of the system once the loadings cease).

A model such as EXAMS could be used to assess the likelihood of contamination to water supplies in a given reach in the Delta. Other possibilities are to help target monitoring to those environmental compartments (sediment, water, biota) where the chemicals will most likely be distributed and, thereby, allow more effective monitoring of their presence.

Brief descriptions of the EPA computer models are presented in Appendix G.

Health Effects Database on Selected Chemicals (Task AG6)

Drinking water standards currently exist for only a few pesticides. A computer literature search for human health effects data is underway for those chemicals appearing on the selected pesticide monitoring target lists that do not have drinking water standards. The data will be used to help assess the degree of risk presented to Delta water supplies found with traces of these contaminants.

A summary of current information on the toxicity of some of these chemicals appears in Table 8.

Table 7

PESTICIDE MONITORING DATA, 1985 AND 1986
(All Units in ug/L)

Target pesticide	Sampling date	Detection limits	Cache Slough	Lindsey Slough	Sac.R.@ Grn's Ldg	Empire ag.dr.	Grand ag.	Is.S.J.R. dr.nr. Vern.	Banks P.P.	DMC intake	Middle River	Mallard Isl.	Natomas main dr.	Clifton Ct. intake	Action Level
2,4-D salt	07/16/85	0.1			ND	ND	ND	ND	0.1	ND	ND	ND			----
	08/20/85	0.01			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	0.01				ND						ND	ND		----
	05/21/86	0.5				1		ND						ND	----
bentazon	07/16/85	0.1			1.6	ND	ND	ND	0.3	ND	ND	ND			----
	08/20/85	0.2			ND	ND	ND	ND	0.5	ND	ND	ND			----
	12/04/85	0.5				ND						ND	ND		----
	05/21/86	1				ND		ND						ND	----
carbofuran	07/16/85	0.5			ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	0.5			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	0.1				ND						ND	ND		----
	05/21/86	0.2				ND		ND						ND	----
chloropicrin	07/16/85	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			*50
	08/20/85	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			*50
	12/04/85	0.1			ND	ND		ND	ND			ND	ND		*50
	05/21/86	0.1				ND		ND						ND	*50
copper dacthal	12/04/85	5			5	13		8	ND			8	10		----
	07/16/85	0.01			ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	0.05			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	0.3				ND						ND	ND		----
	05/21/86	0.01				ND		ND						ND	----
D-D mixture	07/16/85	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	0.5			ND	ND		ND	ND			ND	ND		----
	05/21/86	0.2				ND		ND						ND	----
MCPA	07/16/85	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	2				ND						ND	ND		----
	05/21/86	20				ND		ND						ND	----
metalaxyl	07/16/85	1			ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	10			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/86	0.1				ND						ND	ND		----
	05/21/86	0.05				ND		ND						ND	----
methamidophos	07/16/85	2			ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	0.5			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	5				ND						ND	ND		----
	05/21/86	5				ND		ND						ND	----
methyl bromide	07/16/85	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	0.7			ND	ND		ND	ND			ND	ND		----
	05/21/86	0.5				ND		ND						ND	----
methyl parathion	07/16/85	2.5			ND	ND	ND	2.5	ND	ND	ND	ND			30
	08/20/85	1			ND	ND	ND	ND	ND	ND	ND	ND			30
	12/04/85	0.01				ND						ND	ND		30
	05/21/86	0.005				ND		ND						0.03	30
molinate	07/16/85	1	ND	1	ND	ND	ND	ND	ND	ND	ND	ND			20
	08/20/85	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			20
	12/04/85	0.05				ND						ND	ND		20
	05/21/86	0.05				ND		ND						ND	20
paraquat dichloride	07/16/85	10			ND	ND	ND	ND	ND	ND	ND	ND			----
	08/20/85	10			ND	ND	ND	ND	ND	ND	ND	ND			----
	12/04/85	20				ND						ND	ND		----
	05/21/86	10				ND		ND						ND	----
thiobencarb	07/16/85	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			*10
	08/20/85	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			*10
	12/04/85	0.05				ND						ND	ND		*10
	05/21/86	0.05				ND		ND						ND	*10
xylene	07/16/85	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			620
	08/20/85	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			620
	12/04/85	0.4			ND	ND		ND	ND			ND	ND		620
	05/21/86	0.2				ND		ND						ND	620

* Tentative recommended action level. The recommended action level for taste and odor threshold is 1.0 ug/L for thiobencarb and 37 ug/L for chloropicrin.

Note: Blanks indicate no analysis performed for that chemical.
ND = Not detected when less than twice the blank value.

Analyses performed by McKesson Environmental Services.

Table 8
PESTICIDE TOXICITY INFORMATION

Chemical	Characteristics	Symptoms of Poisoning	Acute Toxicity (LD50)*	Subacute Toxicity: Animal Tested	Subacute Toxicity: Dose (ppm)	Subacute Toxicity: Length of Test	Subacute Toxicity: Results	Chronic Toxicity: Animal Tested	Chronic Toxicity: Dose (ppm)	Chronic Toxicity: Length of Test	Chronic Toxicity: Results
2,4-D Salt	White crystals	No characteristic symptoms for humans	375					Rat Dog	1250 500 (Higher levels not tested)	2 yrs 2 yrs	No effect No effect
Bentazon	White crystalline solid	Apathy, ataxia, prostration, tremors, anorexia, vomiting	1100	Rat Dog	1600 3000	90 days 90 days	Minimum effect level	Rat	350	2 yrs	Minimum effect level
Carbofuran	White crystalline solid**		8								
Chloro-picrin	Slightly oily liquid** Reduced amenities, Faint odor-0.0073mg/L***		250								
Dacthal	White crystalline solid		3000	Adult mallard	5000	100 days	No effect	Rat Dog	10000 10000	2 yrs 2 yrs	No effect No effect
D-D Mixture			140								
Methyl bromide	Colorless liquid or gas*** Threshold limit 20 ppm Cumulative poison*		1mg/L								
Paraquat dichloride	White crystalline solid; faint ammoniacal odor	Vomiting, diarrhea, general malaise	150					Rat Dog	170 85, 170	2 yrs 27 mos	No significant abnormalities Effects apparent
Thio-bencarb	Light yellow or brownish yellow liquid		920	Rat Dog	660 660	90 days 90 days	Minimum effect level	Rat Dog	30 30	2 yrs 2 yrs	Minimum effect level

Unless otherwise noted, information is from "Herbicide Handbook of the Weed Science Society of America" (4th Edition), 1979.
* W. T. Thomas, "Agricultural Chemicals"; LD50 values resulted from tests performed on white rats, in milligrams per kilogram of body weight.
** "The Merck Index" (9th Edition)
***Karel Verschueren, "Handbook of Environmental Data on Organic Chemicals" (2nd Edition)

Waste Waters, THMs, and Modeling Studies

Three tasks are underway to examine waste water discharges, trihalomethane formation potential, and water quality modeling.

Survey Major Waste Water Dischargers (Task WD1)

The Central Valley Regional Water Quality Control Board provided effluent monitoring data on major municipal and industrial waste dischargers within the program study area. The data will be examined to estimate total waste loads and to determine if special studies on receiving water impacts are needed.

Data on the Sacramento Regional Wastewater Treatment Plant are shown in Table 9 for some months of 1985 and 1986. This is the largest publicly owned waste water treatment facility in the Delta. The effluent outflow is significantly small in comparison to the Sacramento River outflow. This suggests that there is sufficient mixing and dilution of this highly treated effluent. For comparison, water quality downstream in the Sacramento River at Hood and Greene's Landing appears to be well within drinking water standards (Table 10). Effluent data for other waste dischargers are also being tabulated for review.

Table 9

SACRAMENTO REGIONAL WASTE WATER TREATMENT PLANT
MONTHLY AVERAGE EFFLUENT DATA

Date	Effluent Discharge (MGD)	Suspended Matter (mg/L)	Suspended Matter (lbs/day)	TDS (ppm)	EC (uS/cm)	River Flow (MGD)
1/85	120	9	9,007	330	590	17,100
2/85	123	38	38,981	370	650	18,700
3/85	124	20	25,837	339	597	14,500
4/85	109	9	8,182	364	620	12,600
9/85	124	10	10,342		640	12,500
10/85	127	13	13,769		600	9,900
11/85	143	38	45,320		610	10,900
12/85	143	17	20,275		600	16,600
1/86	143	15	17,889		590	19,300
2/86	198	8	14,356		570	67,250
3/86	175	8	11,676		610	74,403
4/86	142	8	9,474		630	26,100

1 million gallons per day (MGD) equals 1.55 cubic foot per second (cfs).

SOURCE: Central Valley Regional Water Quality Control Board

Table 10

SACRAMENTO RIVER WATER QUALITY AT GREENE'S LANDING AND AT HOOD

STATION NAME	DATE	TEMP (C)	pH	DO (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS)	Turb (FTU)	Color	Asbest (MF/L)	CH Cl3 (ug/L)	CH Cl2Br (ug/L)	CH ClBr2 (ug/L)	CH Br3 (ug/L)	TTHMFP (ug/L)	TOC (mg/L)	FLOW (CFS)
GREENES	07/21/83	19.5	7.3	8.7	7	4		115	9	2		190	8	1	0	200	1.6	26400
GREENES	08/18/83	21.0	7.5	8.2	7	4		124	8	8		200	14	1	0	220	1.6	24600
GREENES	09/13/83	20.5	7.3	8.3	10	6		154	12	8		600	18	2	0	620	1.8	23100
GREENES	10/04/83	18.0	7.3	9.0	7	5		124	10	5	380	200	9	0	0	210	1.6	24800
GREENES	11/01/83	17.0	7.3	9.1	8	5		128	6	5	340	210	8	0	0	220	1.7	17700
GREENES	12/06/83	10.5	7.4	10.6	4	4		122	30	30	2200	300	9	0	0	310	4.1	66100
GREENES	01/10/84	9.0	7.3	10.7	7	4		129	19	20	3200	220	10	1	0	230	1.7	67200
GREENES	02/01/84	10.0	7.1	10.8	7	5		140	14	12	740	190	11	1	0	200	1.5	32400
GREENES	03/07/84	12.0	7.5	10.8	10	7		164	8	8	540	230	28	1	0	260	1.6	25800
GREENES	04/04/84	13.5	7.5	10.4	9	6		148	8	5	680	250	14	1	0	260	1.6	25100
GREENES	05/02/84	16.0	7.3	9.4	10	6		154	8	8	110	180	13	1	0	190	2.0	11200
GREENES	06/06/84	18.0	7.5	8.7	10	7		146	9	8	200	250	15	1	0	270	2.0	13900
GREENES	07/10/84	22.5	7.4	8.2	7	4		121	11	5	150	260	10	0	0	270	1.6	21200
GREENES	08/01/84	21.5	7.4	7.9	8	4		133	11	5		300	10	1	0	310	1.6	22000
GREENES	09/05/84	22.0	7.4	7.7	12	6	0.000	185	11	8		390	20	1	0	410	2.4	18240
GREENES	10/04/84	17.5	7.4	9.0	8	4	0.000	132	7	5		170	13	1	0	180	1.6	14500
GREENES	11/08/84	14.0	7.3	9.7	10	6	0.000	154	11	8		210	11	0	0	220	2.1	14800
GREENES	12/05/84	10.5	7.4	10.9	9	6	0.000	160	24	15	1100	240	14	1	0	260	2.6	38100
GREENES	01/30/85	9.0	7.4	11.9	12	7	0.000	186	3									14300
GREENES	02/06/85	8.0	7.5	12.1	11	6	0.000	174	8	10		360	14	1	0	380		14900
GREENES	03/06/85	11.0	7.4	10.5	11	7	0.000	180	5		180							13200
GREENES	04/05/85	19.0	7.4	9.3	13	6	0.000	176	7	2		160	13	0	0	170		13900
GREENES	05/01/85	19.0	7.3	8.8	11	7	0.001	167	11	10		210	12	1	0	220		10200
GREENES	06/05/85	21.0	7.4	8.5	13	6	0.000	173	9	10		290	19	1	0	310		15100
GREENES	07/24/85	22.5	7.3	8.0	11	5	0.000	163	8									17200
GREENES	08/01/85	22.5	7.5	7.9	11	5	0.000	163	10	10		480	14	2	0	500	3.9	15600
GREENES	09/04/85	22.0	7.3	7.8	15	8	0.001	207	8	5		220	22	2	0	240	3.5	12500
GREENES	10/02/85	21.5	7.5	8.2	14	8	0.000	168	7	5		200	14	1	0	220	1.6	10600
GREENES	11/13/85	12.0	7.3	9.7	11	7	0.000	163	6	5		290	20	1	0	310	2.8	9500
GREENES	12/03/85	11.5	7.3	9.3	10	7	0.000	149	28	35	380	690	21	1	0	710	16	24200
GREENES	01/16/86	10.0	7.3	10.6	18	10	0.000	218	9	15		660	22	1	0	680	2.3	14900
GREENES	02/27/86	12.5	7.1	10.5	4	2	0.000	84	64	20		340	7	0	0	350	4.2	
GREENES	03/13/86	11.5	7.3	11.0	3	2	0.000	70	58	10		430	8	0	0	440	2.4	
GREENES	04/23/86	18.5	7.3	8.5	10	7	0.000	179	14	10		310	22	1	0	330	1.9	
GREENES	05/28/86	23.5	7.3	7.5			0.000			10		170	12	2	1	180	2.9	
GREENES	06/25/86	24.5	7.3	7.8			0.000											
HOOD	03/30/82	11.0	7.3	10.7		4		131	20	5		310	9	0	0	320		40000
HOOD	06/29/82	20.0	7.9	8.5		5		128	6			230	12	0	0	240		20000
HOOD	08/26/82	22.0	7.5	8.1		5		149	10			280	13	0	0	290		23200
HOOD	10/21/82	18.0	7.5	8.7		4		122	4			260	10	0	0	270		16300
HOOD	12/29/82	9.5	7.2	10.9		4		130	33			480	16	1	0	500		71700
HOOD	02/24/83	12.0	7.5	10.6		2		113	30			120	4	0	0	120		74000
HOOD	04/27/83		7.3	10.0		3		112	26			166	6	4	4	180		54600
HOOD	06/22/83	19.5	7.3	9.1		3		101	17			200	8	0	0	210		43540

Assess THM (Trihalomethane) Formation Potential (Task TR1)

Trihalomethanes (THMs) are a group of compounds that can be formed in drinking water during the disinfection process of chlorination. Organic substances such as fulvic and humic acids occurring naturally in the water react with chlorine to form THMs. There are four species of THMs normally found in drinking water: chloroform ($CHCl_3$), bromodichloromethane ($CHCl_2Br$), dibromochloromethane ($CHBr_2Cl$), and bromoform ($CHBr_3$).

As part of the monthly water quality monitoring (Task WQ1), parameters such as total organic carbon, bromide, and color are measured. In addition, water samples are chlorinated and analyzed for THM species and total THM formation potential to determine if THM control might be a problem.

Total trihalomethane formation potential (TTHMFP) measurements are summarized in Table 11. The TTHMFP test is designed to estimate the maximum levels of THMs that could be produced from a water supply and, accordingly, does not predict actual concentrations of THMs in finished drinking water. Many factors, including temperature, pH, and chlorine contact time and dosage, affect actual THM formation in water treatment facilities. Treated drinking water contains lower THM concentrations than the maximum potential estimated by this assay procedure. There are also methods such as ammonia addition after chlorination to reduce THM levels in finished drinking water supplies. The

Table 11
TRIHALOMETHANE FORMATION POTENTIALS

Station (Raw Water Supply)	Number Samples	Maximum	Average	Std. Dev.	Minimum	Maximum Bromoform
Ag Drain at Empire Tract	15	7500	3160	1332	1100	81
Ag Drain at Grand Island	15	3600	1779	904	670	1
Ag Drain at Tyler Island	9	3600	2078	648	1300	0
American River at WTP	28	380	238	57	150	0
Banks Pumping Plant	41	1900	550	267	220	13
Cache Slough	15	920	707	171	380	2
Clifton Court Intake	29	710	467	120	170	13
Cosumnes River	18	840	252	153	140	0
Delta-Mendota Canal Intake	29	860	465	138	230	10
Sacramento River at Greene's Landing	32	710	309	140	170	1
Honker Cut	12	570	402	104	250	5
Sacramento River at Hood	8	500	266	107	120	4
Little Connection Slough	11	710	404	165	170	0
Lindsey Slough	19	2300	1049	408	420	2
Mallard Slough	7	810	446	182	210	280
Sacramento River at Mallard Island	11	1400	904	255	510	990
Middle River	10	880	603	138	390	5
Mokelumne River	18	420	250	66	120	0
North Bay Interim Pumping Plant	27	780	370	100	280	0
Rock Slough at Old River	29	770	460	132	220	36
San Joaquin River at Vernalis	42	1500	519	237	220	12
OVERALL	425	7500	645	712	120	990

test is used to compare the relative level of THM forming materials in raw water supplies. The EPA Maximum Contaminant Level for total THM is 100 ug/L in finished drinking water supplies. There is no standard for TTHMFP in raw waters.

The diverse sources of natural organic matter include biological productivity in the water column and watershed, waste discharges, and farm drainage. Total organic carbon (TOC) analyses were performed to measure the potential amount of available organic matter for THM formation. However, due to laboratory quality control problems with TOC analyses, data analysis to correlate TOC measurements with TTHMFP values are temporarily suspended. Laboratory staff are examining lab workbooks and correcting erroneously computed results (see Appendix D).

TTHMFP results from the three agricultural drains indicate that Delta soils may be a major source of organic trihalomethane precursors. Bromoform, a THM that is more difficult to treat, appeared at some stations. Bromide, a common sea water constituent, combines with trihalomethane precursors during chlorination to form brominated THM species such as bromoform, dichlorobromomethane, and dibromochloromethane. Brominated THMs were highest in Mallard Slough and in the Sacramento River near Mallard Island. Water quality here is significantly controlled by riverflow and tidal influences, as seen by conductance, sodium, chloride, and brominated THM data. The trace amounts of bromoform at the Banks Pumping Plant headworks, Clifton Court intake, Delta-Mendota Canal intake, Rock Slough at Old River, and Middle River reflect diluted tidal waters that are exported by pumping operations at the State and Federal facilities. Bromoforms at Vernalis and other areas probably reflect the application of Project waters diverted from the Delta that contained bromides or leaching of bromide deposits in soils from ancient marine deposits.

Total THM formation potential was greater in the southern Delta than in the Sacramento River at Greene's Landing and at the American River Water Treatment Plant stations. The potential is most likely higher because of lower channel flows, agricultural drainages, and higher biological productivity within the southern region as compared to stations on the Sacramento and American rivers.

The TTHMFP at Lindsey Slough was also high and may be attributed to local agricultural drainage and extensive riparian vegetation at the sampling station and a long water retention time that might increase the concentration of precursors in the water from decaying matter.

Use of Existing Water Quality Models (Task MOD1)

Computer models developed by the Environmental Protection Agency to study the distribution, fate, and transport of waste waters and spilled materials are being tested for use in studying Delta water quality as affected by waste water discharges and pesticide usage. EPA recently made several models available for use on microcomputers.

One model under study is QUAL2E (Enhanced Stream Water Quality Model), a stream quality routing model. QUAL2E is a steady state model for conventional pollutants in branching streams and well mixed lakes. It includes conservative substances, temperature, coliform bacteria, biochemical oxygen demand, dissolved oxygen, nitrogen, phosphorus, and algae. The model is widely used for waste load allocation and permitting in the United States and other countries.

Another model is WASP (Water Quality Analysis Program). WASP is a generalized modeling framework for contaminant fate and transport in surface waters. Based on a flexible compartment modeling approach, WASP can be applied in one, two, or three dimensions if desired. Problems studied using WASP include biochemical oxygen demand-dissolved oxygen dynamics, nutrients and eutrophication, bacterial contamination, and toxic chemical movement.

These EPA models are described in Appendix G.

REFERENCES

1 Public Health Aspects of Sacramento-San Joaquin Delta Water Supplies -- A Panel Report for the California Department of Water Resources. California Department of Water Resources. December 31, 1982. 59 pp.

2 Interagency Delta Health Aspects Monitoring Program, Project Report. California Department of Water Resources, Central District. May 1985.

Appendix A

MONITORING PROGRAM DATA

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CHCl3 (ug/L)	CHBrCl2 (ug/L)	CHBr2Cl (ug/L)	CHBr3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
AGDEMPIRE	02/06/85	905	6.0	7.3	9.8	252	685	0.000	2610	26	25	--	--	1500	920	930	81	3400	--
AGDEMPIRE	03/06/85	945	10.5	7.3	7.6	226	597	0.000	2330	14	--	--	92	--	--	--	--	--	--
AGDEMPIRE	04/05/85	850	21.5	7.3	3.9	224	517	--	2180	10	75	--	--	1800	920	370	31	3100	--
AGDEMPIRE	05/01/85	830	20.0	7.6	6.5	248	566	0.000	2280	14	160	--	--	1800	900	440	29	3200	--
AGDEMPIRE	06/05/85	807	20.0	7.3	4.0	54	95	--	629	15	75	--	--	1800	280	25	0	2100	--
AGDEMPIRE	07/24/85	907	23.0	6.8	4.1	42	69	--	472	10	40	--	--	2100	140	19	0	2300	--
AGDEMPIRE	08/01/85	825	22.0	6.8	5.5	32	44	0.000	360	8	100	22.0	--	2100	150	10	0	2300	--
AGDEMPIRE	09/11/85	1020	19.5	6.9	4.5	83	172	--	886	4	150	19.0	--	3000	460	48	2	3500	--
AGDEMPIRE	10/02/85	700	18.0	7.6	7.6	149	376	0.000	1640	10	50	18.0	--	2200	790	330	26	3300	--
AGDEMPIRE	11/13/85	800	7.0	7.3	9.0	170	452	0.000	1880	4	80	34.0	--	2100	920	390	40	3400	--
AGDEMPIRE	12/03/85	1710	14.0	7.0	5.4	87	186	--	1070	8	200	44.0	76	2900	360	44	1	3300	--
AGDEMPIRE	01/16/86	1145	12.0	6.8	5.8	112	228	--	1087	3	160	31.0	--	6900	490	67	1	7500	--
AGDEMPIRE	02/13/86	1200	14.0	6.8	6.7	162	396	--	1880	11	150	40.0	--	2600	650	170	8	3400	--
AGDEMPIRE	03/04/86	1330	19.5	7.3	8.0	233	595	--	2840	7	200	65.0	--	1500	660	210	14	2400	--
AGDEMPIRE	04/17/86	915	15.0	7.4	8.8	148	357	0.000	1610	10	160	47.0	--	1900	830	320	13	3100	--
AGDEMPIRE	05/13/86	1000	21.5	7.5	6.6	204	506	0.001	2000	15	150	61.0	--	570	330	160	15	1100	--
AGDEMPIRE	06/11/86	800	22.0	8.1	5.7	296	830	0.000	2760	14	80	65.0	--	--	--	--	--	--	--
AGDGRAND	02/06/85	1030	11.5	7.1	7.5	43	35	0.000	576	34	25	--	--	2100	32	4	0	2100	--
AGDGRAND	03/06/85	1100	12.5	6.9	5.3	35	29	0.000	468	21	--	--	630	--	--	--	--	--	--
AGDGRAND	04/05/85	1000	18.5	7.3	5.0	53	39	--	625	30	80	--	--	2000	100	4	0	2100	--
AGDGRAND	05/01/85	945	18.5	6.9	5.7	23	13	0.000	310	26	50	--	--	1000	41	0	0	1000	--
AGDGRAND	06/05/85	915	21.0	7.3	6.6	20	12	--	265	22	35	--	--	840	37	0	0	880	--
AGDGRAND	07/24/85	715	22.5	7.2	5.5	22	16	--	267	70	80	--	--	1800	60	2	0	1900	--
AGDGRAND	08/01/85	945	21.5	7.1	6.5	22	13	0.000	273	30	50	17.0	--	1300	49	1	0	1400	--
AGDGRAND	09/11/85	1150	19.5	7.2	6.1	31	33	--	451	28	30	14.0	--	1100	94	8	0	1200	--
AGDGRAND	10/02/85	900	19.0	7.2	6.0	27	19	0.000	327	25	30	4.5	--	820	56	3	0	880	--
AGDGRAND	11/13/85	945	12.5	7.3	4.5	29	22	0.000	368	16	35	9.0	--	890	69	3	0	960	--
AGDGRAND	12/03/85	1845	13.0	7.0	3.8	55	49	0.000	735	31	100	39.0	2100	2800	160	5	0	3000	--
AGDGRAND	01/16/86	1315	13.5	7.3	7.3	64	51	--	716	26	80	20.0	--	3500	130	6	0	3600	--
AGDGRAND	02/27/86	1130	17.5	7.0	4.4	35	27	--	602	24	100	28.0	--	1700	83	2	0	1800	--
AGDGRAND	03/13/86	1300	14.5	6.6	5.8	64	57	0.001	1060	22	160	56.0	--	3200	180	5	0	3400	--
AGDGRAND	04/23/86	1200	18.5	7.3	7.6	32	29	0.000	513	54	50	23.0	--	1700	82	2	0	1800	--
AGDGRAND	05/28/86	1115	22.5	7.3	7.4	21	16	--	323	36	50	38.0	--	640	29	3	1	670	--
AGDGRAND	06/25/86	1200	24.5	7.2	6.8	20	15	--	290	35	40	43.0	--	--	--	--	--	--	--
AGDTYLER	03/27/85	1245	11.5	6.8	7.8	46	84	0.000	743	29	--	--	530	--	--	--	--	--	--
AGDTYLER	04/24/85	1230	19.5	7.3	5.8	56	100	--	743	28	100	--	--	2100	260	27	0	2400	--
AGDTYLER	05/22/85	1130	21.5	7.2	4.7	23	31	0.000	320	17	70	--	--	1800	91	4	0	1900	--
AGDTYLER	06/26/85	1115	24.0	6.8	5.5	15	10	--	188	18	50	--	--	1400	45	3	0	1400	--
AGDTYLER	07/10/85	1200	25.5	7.0	4.5	14	8	--	189	17	100	--	--	1600	51	1	0	1600	--
AGDTYLER	08/28/85	1200	23.5	7.3	6.7	21	20	0.000	299	9	100	38.0	--	2100	78	3	0	2200	--
AGDTYLER	09/11/85	1115	19.5	7.2	6.1	24	31	--	354	10	50	27.0	--	2200	--	6	0	--	--
AGDTYLER	10/02/85	800	17.5	6.9	3.2	26	18	0.000	289	14	100	15.0	--	1200	70	2	0	1300	--
AGDTYLER	11/13/85	900	6.0	6.8	8.1	28	35	0.000	376	11	160	19.0	--	2000	120	2	0	2100	--
AGDTYLER	12/03/85	1800	12.5	7.0	3.7	36	58	0.000	587	12	100	64.0	190	2100	85	2	0	2200	--
AGDTYLER	01/16/86	1245	11.0	6.9	4.6	38	48	--	476	9	120	35.0	--	3500	83	8	0	3600	--
AGDTYLER	06/11/86	915	19.5	7.3	7.9	10	9	0.000	158	768	--	--	--	--	--	--	--	--	--
AMERICAN	07/21/83	945	17.0	7.3	10.0	2	1	--	35	1	2	1.2	--	230	3	0	0	230	5000.0
AMERICAN	08/18/83	1400	19.0	7.3	10.1	2	1	--	36	1	2	1.2	--	210	16	2	0	230	4500.0
AMERICAN	09/13/83	1000	19.5	7.2	9.2	2	1	--	39	2	0	1.0	--	220	4	0	0	220	4000.0
AMERICAN	10/04/83	1215	20.0	7.1	9.1	2	1	--	42	1	5	1.8	110	160	11	0	0	170	3500.0
AMERICAN	11/01/83	1205	17.0	7.1	9.0	2	1	--	40	2	5	1.2	110	150	4	0	0	150	2500.0
AMERICAN	12/06/83	1025	11.0	7.2	11.8	2	1	--	46	9	12	2.3	1100	270	4	0	0	270	8570.0

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CHCl3 (ug/L)	CHBrCl2 (ug/L)	CHBr2Cl (ug/L)	CHBr3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
AMERICAN	01/10/84	1130	9.0	7.0	11.9	2	1	--	50	10	10	1.1	2200	200	4	0	0	200	8380.0
AMERICAN	02/01/84	1220	9.5	7.1	11.9	2	2	--	53	4	5	1.0	490	200	4	0	0	200	3080.0
AMERICAN	03/07/84	1030	9.5	7.3	11.6	2	1	--	57	3	2	1.3	260	260	17	0	0	280	3980.0
AMERICAN	04/04/84	1035	11.0	7.1	11.4	2	1	--	55	2	2	1.2	190	200	5	0	0	200	4370.0
AMERICAN	05/02/84	810	12.5	7.1	11.7	2	1	--	54	1	2	1.3	18	160	4	0	0	160	2440.0
AMERICAN	06/06/84	1045	15.0	7.3	10.3	2	2	--	52	3	2	1.0	12	270	10	1	0	280	4070.0
AMERICAN	07/10/84	950	18.0	7.3	9.4	2	1	--	48	1	0	1.2	18	290	4	0	0	290	4920.0
AMERICAN	08/01/84	1050	19.5	7.2	9.1	2	1	--	46	1	2	1.2	--	310	4	0	0	310	4890.0
AMERICAN	09/05/84	915	22.0	7.2	8.6	2	1	--	51	1	2	1.3	--	320	5	0	0	320	1470.0
AMERICAN	10/04/84	1130	19.5	7.1	9.1	2	1	--	42	2	2	1.2	--	160	5	0	0	160	2220.0
AMERICAN	11/08/84	1120	16.0	7.0	9.3	2	2	--	51	11	15	3.2	--	280	5	0	0	280	1730.0
AMERICAN	12/05/84	1120	11.0	7.3	11.2	2	2	--	59	6	5	1.5	110	180	4	0	0	180	5020.0
AMERICAN	02/13/85	1320	10.0	7.3	11.9	2	2	--	63	2	15	--	--	230	6	0	0	240	1740.0
AMERICAN	03/13/85	1215	12.0	7.3	11.2	2	2	--	63	5	--	--	82	--	--	--	--	--	1280.0
AMERICAN	04/10/85	1130	14.5	7.3	10.5	3	2	--	67	2	0	--	--	180	6	0	0	190	1270.0
AMERICAN	05/08/85	1120	14.0	7.3	10.7	3	2	0.000	62	1	5	--	--	240	3	0	0	240	3730.0
AMERICAN	06/12/85	1200	18.5	7.3	9.9	2	2	--	60	2	0	--	--	290	5	1	0	300	2800.0
AMERICAN	08/14/85	1115	20.0	7.2	9.1	2	2	--	56	1	2	1.5	--	210	8	0	0	220	3350.0
AMERICAN	10/09/85	1130	16.5	7.2	9.2	2	2	0.000	52	1	0	1.4	--	180	5	0	0	180	1460.0
AMERICAN	12/03/85	2030	12.5	7.2	10.5	3	2	--	64	6	5	2.0	70	260	6	0	0	270	1440.0
AMERICAN	03/11/86	1315	12.0	7.1	12.0	2	1	--	56	76	25	3.3	--	370	5	0	0	380	--
AMERICAN	04/17/86	1130	14.5	7.3	11.2	2	1	0.000	55	6	15	1.4	--	300	5	0	0	300	--
AMERICAN	05/13/86	1145	16.5	7.3	10.0	2	2	0.000	53	3	25	1.4	--	190	6	1	0	200	--
AMERICAN	06/11/86	1130	16.5	7.3	10.0	2	2	0.000	46	3	15	2.7	--	--	--	--	--	--	--
CACHE	01/31/84	1045	11.5	8.3	12.4	85	88	--	976	13	8	5.5	980	300	85	31	2	420	--
CACHE	02/22/84	1055	12.5	8.1	10.4	82	82	--	896	76	15	6.4	2500	360	87	26	1	470	--
CACHE	03/14/84	1030	16.5	8.1	8.4	79	80	--	897	14	15	7.6	650	270	82	27	0	380	--
CACHE	04/11/84	1005	15.5	8.6	10.1	59	57	--	720	20	10	8.0	1700	500	81	18	0	600	--
CACHE	05/23/84	1045	21.0	8.3	9.0	36	34	--	488	34	30	6.7	1100	570	63	8	0	640	--
CACHE	06/13/84	815	19.0	8.2	8.5	42	42	--	595	52	30	7.0	4000	760	83	8	0	850	--
CACHE	07/11/84	900	24.5	8.3	8.5	36	34	--	541	46	25	8.4	1400	800	64	4	0	870	--
CACHE	08/22/84	1040	21.5	8.1	7.5	32	29	--	495	90	50	7.1	--	600	51	4	0	660	--
CACHE	09/12/84	1100	23.0	8.1	8.9	39	38	0.001	577	20	30	8.4	--	630	64	5	0	700	--
CACHE	10/11/84	930	19.5	8.2	7.8	44	42	--	594	29	25	6.0	--	850	69	6	0	920	--
CACHE	11/15/84	1000	12.5	7.4	7.7	38	38	0.000	460	95	30	9.0	--	730	47	4	0	780	--
CACHE	12/06/84	950	10.5	7.9	8.8	64	64	0.001	744	50	50	8.5	3200	720	87	10	0	820	--
CACHE	04/10/85	935	16.0	8.3	9.5	63	62	0.001	713	24	10	--	--	640	88	16	0	740	--
CACHE	05/08/85	935	16.5	8.4	9.4	44	38	0.001	560	28	25	--	--	760	77	6	0	840	--
CACHE	05/29/85	1015	17.5	8.4	9.5	36	33	--	512	22	--	--	--	--	--	--	--	--	--
CACHE	06/12/85	1000	24.0	8.1	7.1	35	33	0.001	499	50	20	--	--	870	43	5	0	920	--
CLIFTON	07/26/83	1135	21.0	7.3	7.9	20	22	--	208	22	8	3.2	--	310	42	7	0	360	1481.0
CLIFTON	08/23/83	1000	21.5	7.3	7.7	27	31	--	283	20	8	3.1	--	360	72	12	0	440	2242.0
CLIFTON	09/14/83	1035	22.5	7.3	7.8	17	17	--	180	11	10	3.3	--	330	23	4	0	360	0.0
CLIFTON	10/12/83	910	20.0	7.1	8.3	12	13	--	137	12	12	2.8	530	310	27	2	0	340	0.0
CLIFTON	11/08/83	945	16.0	7.3	8.5	33	36	--	324	10	20	3.3	910	270	63	17	0	350	652.0
CLIFTON	12/13/83	1110	12.0	7.1	9.6	16	16	--	171	13	25	2.9	510	380	30	3	0	410	0.0
CLIFTON	01/24/84	940	10.0	7.3	10.8	22	22	--	226	12	25	3.1	510	300	39	6	0	340	0.0
CLIFTON	02/28/84	1105	13.0	7.5	10.2	39	42	--	389	7	18	3.1	410	280	67	18	0	360	2367.0
CLIFTON	03/27/84	945	16.5	7.4	9.4	35	40	--	362	10	25	3.8	480	380	79	17	0	480	2452.7
CLIFTON	04/25/84	1040	16.5	7.3	9.3	27	30	--	288	12	15	3.8	890	320	56	13	0	390	4199.1
CLIFTON	05/30/84	820	24.0	7.1	7.4	29	33	--	307	19	20	4.9	650	420	67	15	0	500	2779.4
CLIFTON	06/27/84	945	25.5	7.2	6.3	50	56	--	472	28	30	5.4	500	350	110	31	1	490	2994.7

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CHCl3 (ug/L)	CHBrCl2 (ug/L)	CHBr2Cl (ug/L)	CHBr3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
CLIFTON	07/25/84	940	24.0	7.5	8.6	18	21	0.000	212	18	25	4.4	960	420	52	8	0	480	4753.7
CLIFTON	08/29/84	815	24.5	7.3	7.6	20	23	--	222	11	15	3.2	--	390	54	10	0	450	3827.1
CLIFTON	09/27/84	1040	22.0	7.5	8.3	24	24	0.000	261	6	15	3.2	--	390	49	12	0	450	1704.6
CLIFTON	10/25/84	1045	17.0	7.5	10.0	27	29	--	284	7	18	3.4	--	300	54	14	0	370	0.0
CLIFTON	11/29/84	1245	12.0	7.3	10.2	20	21	--	233	11	30	3.7	--	460	48	6	0	510	2400.0
CLIFTON	12/12/84	1055	11.5	7.3	10.0	21	22	0.000	252	16	35	4.7	420	390	52	5	0	450	5150.0
CLIFTON	01/30/85	925	7.0	7.1	10.5	32	37	0.000	348	8	--	--	--	--	--	--	--	--	2500.0
CLIFTON	02/27/85	1100	13.0	7.3	9.8	26	28	0.000	303	14	40	--	--	410	64	8	0	480	4200.0
CLIFTON	03/27/85	1030	12.5	7.4	9.6	33	34	0.000	334	8	--	--	670	--	--	--	--	--	3620.0
CLIFTON	04/24/85	1030	18.0	7.6	9.6	24	24	0.000	277	8	8	--	--	470	56	7	0	530	4200.0
CLIFTON	05/22/85	930	21.5	8.1	9.2	25	29	0.000	264	21	15	--	--	610	65	11	0	690	2490.0
CLIFTON	06/26/85	915	24.5	7.5	7.7	37	40	0.000	314	17	15	--	--	550	88	24	1	660	5290.0
CLIFTON	07/10/85	900	25.5	7.5	6.5	43	50	0.001	386	15	--	--	--	--	--	--	--	--	4500.0
CLIFTON	08/28/85	1000	23.5	7.4	7.7	51	69	0.000	458	10	10	4.0	--	460	110	47	3	620	5770.0
CLIFTON	09/25/85	940	22.5	7.4	6.6	64	80	0.000	602	12	--	--	--	--	--	--	--	--	3000.0
CLIFTON	10/23/85	915	17.5	7.5	8.9	52	77	0.000	484	9	10	2.3	--	330	130	59	4	520	3490.0
CLIFTON	11/15/85	1045	12.0	7.4	10.2	92	143	0.000	679	12	--	--	--	--	--	--	--	--	1800.0
CLIFTON	12/03/85	1305	12.0	7.4	10.1	98	162	0.000	744	10	8	3.7	230	310	220	170	13	710	5960.0
CLIFTON	01/23/86	1045	11.5	7.3	9.0	48	60	0.000	410	8	--	--	--	--	--	--	--	--	5510.0
CLIFTON	02/13/86	950	11.5	7.3	10.4	41	55	0.000	423	17	--	--	--	--	--	--	--	--	--
CLIFTON	03/04/86	1045	16.5	7.3	7.8	29	29	0.001	306	21	20	8.0	--	520	64	7	0	590	--
CLIFTON	04/09/86	1100	16.5	7.2	8.8	20	20	0.000	197	14	20	3.9	--	570	62	5	0	640	--
CLIFTON	05/07/86	850	15.5	7.3	8.8	27	28	0.001	280	13	20	6.3	--	350	51	7	0	410	--
CLIFTON	06/04/86	945	20.5	7.3	8.2	29	33	0.001	303	26	--	10.0	--	140	28	6	0	170	--
CLIFTON	07/02/86	920	24.5	7.3	6.5	55	66	--	534	11	--	--	--	--	--	--	--	--	--
COSUMNES	07/21/83	830	22.5	7.3	8.5	3	2	--	67	1	2	1.0	--	200	6	0	0	210	257.0
COSUMNES	08/18/83	1255	28.0	7.7	8.3	4	2	--	85	1	5	1.2	--	190	9	0	0	200	102.0
COSUMNES	09/13/83	900	25.0	7.3	7.8	4	2	--	90	1	2	1.2	--	210	8	0	0	220	76.0
COSUMNES	10/04/83	1105	21.5	7.3	8.9	4	2	--	80	2	5	1.2	140	150	6	0	0	160	102.0
COSUMNES	11/01/83	1110	18.0	7.3	9.3	4	2	--	82	9	8	1.6	180	170	5	0	0	180	378.0
COSUMNES	12/06/83	935	8.5	7.2	12.0	7	2	--	81	7	18	2.4	230	830	7	0	0	840	1420.0
COSUMNES	01/10/84	1030	8.0	7.2	11.8	3	2	--	78	4	8	1.0	300	160	4	0	0	160	1230.0
COSUMNES	02/01/84	1115	9.5	7.0	11.5	4	2	--	93	2	5	0.9	18	140	5	0	0	140	561.0
COSUMNES	03/07/84	935	11.5	7.3	11.4	4	2	--	86	1	5	1.3	91	190	11	0	0	200	766.0
COSUMNES	04/04/84	940	14.0	7.1	10.7	3	2	--	80	1	5	1.6	95	200	9	0	0	210	794.0
COSUMNES	05/02/84	720	14.0	7.3	10.6	4	1	--	76	1	2	1.0	25	130	5	0	0	140	597.0
COSUMNES	06/06/84	950	19.0	7.3	9.1	3	2	--	74	2	5	1.2	33	230	11	1	0	240	294.0
COSUMNES	07/10/84	900	27.5	7.7	7.6	4	2	--	86	2	2	1.6	10	240	9	0	0	250	74.0
COSUMNES	08/01/84	1003	27.0	7.6	8.1	4	2	--	93	1	10	2.1	--	320	9	0	0	330	48.0
COSUMNES	09/05/84	820	25.5	7.3	7.1	4	2	--	96	1	5	2.0	--	300	11	0	0	310	--
COSUMNES	10/04/84	1025	21.0	7.4	9.0	4	2	--	90	2	2	1.5	--	160	7	0	0	170	--
COSUMNES	11/08/84	1015	13.5	7.2	10.2	4	2	--	82	12	25	2.5	--	280	6	0	0	290	--
COSUMNES	12/05/84	1040	10.5	7.3	11.3	5	4	--	129	2	8	2.2	9	280	9	0	0	290	--
DMC	07/26/83	1045	23.0	7.3	7.5	33	38	--	322	31	5	3.6	--	290	54	10	0	350	4723.0
DMC	08/23/83	905	21.5	7.3	7.7	28	31	--	283	22	5	3.2	--	400	59	9	0	470	3573.0
DMC	09/14/83	940	21.0	7.3	7.8	18	18	--	188	19	12	2.4	--	310	26	4	0	340	3245.0
DMC	10/12/83	835	18.5	7.3	8.5	14	15	--	151	18	12	3.2	760	200	26	2	0	230	2439.0
DMC	11/08/83	915	16.5	7.2	8.2	37	39	--	361	11	20	3.4	1100	270	48	14	0	330	153.0
DMC	12/13/83	1035	12.0	7.2	9.5	23	26	--	238	18	35	3.5	570	320	37	6	0	360	3725.0
DMC	01/24/84	915	10.5	7.3	10.7	30	33	--	297	16	35	3.2	1600	340	52	11	0	400	1198.0
DMC	02/28/84	1025	12.5	7.5	10.0	42	48	--	397	11	18	3.1	370	280	76	25	1	380	4309.0
DMC	03/27/84	915	16.0	7.3	9.5	53	60	--	511	24	15	3.8	700	270	90	35	2	400	4402.0

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CHCl3 (ug/L)	CHBrCl2 (ug/L)	CHBr2Cl (ug/L)	CHBr3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
DMC	04/25/84	955	15.5	7.5	9.3	60	68	--	552	18	10	4.7	1800	300	120	45	2	470	4071.0
DMC	05/30/84	750	23.5	7.4	7.6	29	33	--	298	24	20	4.7	380	380	66	14	0	460	2390.0
DMC	06/27/84	905	25.5	7.3	6.0	32	35	--	328	30	35	5.0	730	380	70	15	0	460	3313.0
DMC	07/25/84	910	24.0	7.7	7.4	58	73	--	554	28	15	4.4	1100	450	150	57	4	660	4688.0
DMC	08/29/84	740	24.5	7.3	7.3	21	22	--	229	16	18	3.7	--	330	48	9	0	390	3027.0
DMC	09/27/84	1005	22.0	7.4	8.2	28	29	0.000	296	13	15	3.8	--	330	55	12	0	400	3150.0
DMC	10/25/84	1000	16.0	7.8	9.8	25	26	0.000	268	8	20	3.3	--	360	66	12	0	440	3959.0
DMC	11/29/84	1215	11.0	7.4	10.2	32	34	0.000	321	9	25	4.1	--	400	64	12	0	480	3901.0
DMC	12/12/84	1015	11.5	7.2	9.3	31	32	0.000	315	18	25	4.9	590	370	60	8	0	440	4004.0
DMC	01/30/85	850	7.5	7.3	10.6	38	44	0.001	398	7	--	--	--	--	--	--	--	--	4003.0
DMC	02/27/85	1015	13.0	7.5	9.9	31	34	0.000	336	11	35	--	--	410	75	12	0	500	4221.0
DMC	03/27/85	945	12.0	7.4	9.8	29	31	0.000	315	8	--	--	980	--	--	--	--	--	3144.0
DMC	04/24/85	1000	17.5	7.5	9.5	25	24	0.000	280	9	5	--	--	340	57	5	0	400	3997.0
DMC	05/22/85	900	20.5	8.3	9.1	25	29	0.000	265	22	20	--	--	550	71	10	0	630	3136.0
DMC	06/26/85	830	24.5	7.6	7.1	78	95	0.001	710	23	10	--	--	580	180	9	10	860	2877.0
DMC	07/10/85	830	24.5	7.4	6.7	59	68	0.001	544	24	--	--	--	--	--	--	--	--	4578.0
DMC	08/28/85	920	23.0	7.4	7.7	50	74	0.000	441	17	20	9.7	--	410	120	70	3	600	4160.0
DMC	09/25/85	915	22.5	7.5	6.8	66	85	0.001	593	15	--	--	--	--	--	--	--	--	3980.0
DMC	10/23/85	840	16.5	7.4	7.2	60	79	0.000	592	13	5	3.6	--	270	110	58	5	440	3890.0
DMC	11/15/85	1015	12.0	7.4	10.5	68	106	0.000	545	11	--	--	--	--	--	--	--	--	4040.0
DMC	12/03/85	1305	12.0	7.4	10.1	72	117	0.000	591	10	15	6.3	370	360	190	120	6	680	3940.0
DMC	01/23/86	1000	11.5	7.3	8.8	52	63	0.000	439	8	--	--	--	--	--	--	--	--	3310.0
DMC	02/13/86	915	11.5	7.5	10.2	44	60	0.000	460	16	--	--	--	--	--	--	--	--	--
DMC	03/04/86	1015	16.5	7.3	7.9	29	28	0.001	288	25	25	7.8	--	580	61	6	0	650	--
DMC	04/09/86	945	16.0	7.3	9.0	23	27	0.000	229	22	25	4.2	--	600	58	7	0	660	--
DMC	05/07/86	815	16.0	7.2	8.3	27	28	--	278	15	10	6.2	--	260	40	5	0	300	--
DMC	06/04/86	900	21.5	7.3	7.7	36	48	0.000	362	31	--	9.5	--	250	54	8	0	310	--
DMC	07/02/86	845	24.5	7.3	7.0	54	62	0.001	530	13	--	--	--	--	--	--	--	--	--
BANKS	03/30/82	900	12.5	7.3	9.7	38	35	--	315	9	--	--	--	930	66	7	0	1000	6300.0
BANKS	06/29/82	720	20.0	8.0	8.3	--	41	--	322	11	--	--	--	490	83	14	0	590	240.0
BANKS	08/26/82	905	21.0	7.9	8.3	--	19	--	213	19	--	--	--	430	34	4	0	470	4240.0
BANKS	10/21/82	845	18.5	7.2	8.0	--	23	--	212	6	--	--	--	370	45	7	0	420	2779.0
BANKS	12/29/82	1200	10.0	7.1	9.7	--	23	--	225	9	--	--	--	630	49	4	0	680	645.0
BANKS	02/24/83	1210	14.0	7.4	9.3	--	30	--	288	10	--	--	--	190	26	4	0	220	6119.0
BANKS	04/27/83	910	--	7.3	8.4	--	42	--	367	6	--	--	--	360	69	10	6	440	125.0
BANKS	06/22/83	830	20.5	7.2	8.4	--	14	--	143	11	--	--	--	350	28	4	0	380	2262.0
BANKS	07/26/83	1000	23.0	7.3	8.3	21	22	--	211	17	8	2.8	--	300	38	6	0	340	1306.0
BANKS	08/23/83	830	22.5	7.3	8.0	25	28	--	261	17	8	3.5	--	420	58	9	0	490	2179.0
BANKS	09/14/83	850	22.0	7.3	7.0	22	24	--	226	8	20	2.9	--	330	38	8	0	380	61.0
BANKS	10/12/83	755	20.5	7.3	7.6	23	26	--	219	6	20	3.1	860	260	47	8	4	320	306.0
BANKS	11/08/83	850	16.5	7.2	8.6	19	20	--	186	7	25	2.8	--	310	40	7	0	360	1154.0
BANKS	12/13/83	940	12.0	7.3	10.2	32	34	--	305	13	40	3.3	820	360	42	7	0	410	326.0
BANKS	01/24/84	850	9.5	7.3	11.2	26	28	--	252	5	20	2.9	490	320	44	8	0	370	267.0
BANKS	02/28/84	940	12.0	7.5	10.0	42	46	--	388	5	20	3.2	--	310	75	20	0	400	2563.0
BANKS	03/27/84	840	16.5	7.3	9.8	36	40	--	370	20	30	4.2	--	460	80	16	0	560	104.0
BANKS	04/25/84	915	15.0	7.3	9.3	27	30	--	283	37	25	3.9	--	570	62	12	0	640	3925.0
BANKS	05/30/84	725	23.0	7.5	7.1	29	33	--	304	16	12	4.7	--	400	72	18	0	490	1865.0
BANKS	06/27/84	820	24.5	7.3	6.6	24	34	--	258	29	40	4.9	--	410	59	8	0	480	2884.0
BANKS	07/25/84	830	23.0	7.4	8.1	20	23	--	214	16	20	4.7	--	420	57	9	0	490	4359.0
BANKS	08/29/84	715	23.0	7.3	7.4	22	24	--	244	7	18	3.1	--	360	55	10	0	420	3438.0
BANKS	09/27/84	925	22.5	7.3	8.6	25	25	0.000	268	7	15	3.3	--	370	55	10	0	440	1723.0
BANKS	10/25/84	920	16.5	7.7	9.3	25	26	0.000	266	8	20	2.9	--	300	59	9	0	370	903.0

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O.	Na	Cl	Se	EC	Turb.	Color	TOC	Asbest.	THM FORMATION POTENTIAL CH Cl3	CH BrCl2	CH Br2Cl	CH Br3	TTHMFP	FLOW
					(------	mg/L	------)		(uS/cm)	(TU)	(CU)	(mg/L)	(mF/L)	(---------	ug/L	--------)			(cfs)
BANKS	11/29/84	1130	11.5	7.5	10.5	20	21	0.000	233	11	30	3.3	--	430	44	6	0	480	2797.0
BANKS	12/12/84	945	11.5	7.3	10.0	23	24	--	263	10	25	4.3	--	380	50	6	0	440	4258.0
BANKS	02/27/85	945	13.5	7.5	9.5	30	33	0.000	335	8	35	--	--	310	71	10	0	390	4151.0
BANKS	03/27/85	900	12.5	7.4	10.1	36	38	0.000	367	11	--	--	520	--	--	--	--	--	3486.0
BANKS	04/24/85	915	17.5	7.6	8.7	36	34	--	351	11	5	--	--	410	81	17	0	510	4520.0
BANKS	05/22/85	815	19.5	8.1	8.6	35	41	0.000	351	26	5	--	--	580	90	17	0	690	1917.0
BANKS	06/07/85	850	23.5	7.5	7.4	32	37	--	322	30	--	--	--	--	--	--	--	--	2619.0
BANKS	06/26/85	800	23.5	7.7	7.5	38	46	--	370	32	20	--	--	550	110	24	1	680	5222.0
BANKS	07/10/85	800	24.5	7.5	7.5	42	48	0.000	343	16	15	--	--	590	160	35	2	790	4572.0
BANKS	08/28/85	830	22.5	7.4	7.8	54	78	0.000	466	10	10	6.4	--	390	140	69	5	600	5260.0
BANKS	09/25/85	820	22.5	7.5	7.9	69	102	0.000	588	6	10	2.7	--	340	89	40	10	480	3020.0
BANKS	10/23/85	800	17.0	7.6	8.9	59	94	0.000	527	7	5	4.0	--	290	150	90	13	540	3200.0
BANKS	11/15/85	930	12.0	7.4	9.5	71	112	0.000	586	6	10	2.9	--	260	160	100	--	--	2150.0
BANKS	12/03/85	1415	11.5	7.4	10.1	85	141	0.000	676	10	10	3.6	230	240	210	150	10	610	6320.0
BANKS	01/23/86	920	12.0	7.3	9.2	56	79	0.000	482	12	25	7.2	--	1700	170	47	2	1900	5170.0
BANKS	02/13/86	845	11.5	7.7	10.5	45	61	0.000	444	17	25	8.6	--	780	140	28	1	950	--
BANKS	03/04/86	930	16.5	7.3	8.2	30	33	0.000	332	14	30	5.8	--	600	70	6	0	680	--
BANKS	04/09/86	915	17.5	7.5	9.4	29	31	0.000	265	13	20	5.0	--	630	76	10	0	720	--
BANKS	05/07/86	745	15.5	7.3	8.9	28	31	--	284	11	15	5.0	--	460	74	10	0	540	--
BANKS	06/04/86	815	19.5	7.5	8.6	31	38	0.001	312	32	--	--	--	340	45	9	0	390	--
BANKS	07/02/86	805	24.0	7.3	6.4	31	33	0.000	305	25	--	--	--	--	--	--	--	--	--
HONKER	02/23/83	1045	13.0	7.3	8.9	--	27	--	233	13	--	--	--	210	33	6	0	250	--
HONKER	04/27/83	1030	--	7.3	8.8	--	33	--	303	9	--	--	--	300	72	10	5	390	--
HONKER	06/22/83	1000	23.5	7.3	7.6	--	20	--	184	11	--	--	--	370	43	7	0	420	--
HONKER	08/17/83	1000	24.5	7.3	7.1	8	8	--	126	6	8	2.5	--	310	25	5	0	340	--
HONKER	10/04/83	700	20.5	7.3	8.0	7	7	--	114	6	12	2.1	190	290	14	1	0	300	--
HONKER	12/06/83	820	10.0	7.2	10.0	17	26	--	232	18	60	6.4	620	520	47	7	0	570	--
HONKER	02/01/84	755	10.0	7.1	9.7	27	32	--	302	11	25	5.8	380	450	68	10	0	530	--
HONKER	04/04/84	815	15.0	7.3	9.6	12	14	--	171	9	12	3.0	500	310	32	4	0	350	--
HONKER	06/06/84	740	19.0	7.5	7.6	13	12	--	178	10	10	3.8	260	340	40	7	0	390	--
HONKER	08/01/84	702	23.0	7.3	7.2	11	12	--	166	8	15	2.8	--	460	34	4	0	500	--
HONKER	10/04/84	750	18.5	7.3	8.8	7	5	--	120	5	5	1.8	--	240	14	1	0	260	--
HONKER	12/05/84	850	10.5	7.2	9.8	12	15	--	184	13	35	5.0	770	480	37	4	0	520	--
DVGH	08/10/83	1200	23.5	8.5	8.4	19	16	--	466	1	5	3.2	--	310	32	4	0	350	--
DVGH	08/10/83	1145	12.5	7.8	3.9	14	11	--	395	3	2	2.9	--	360	26	2	0	390	--
DVSR	09/20/83	720	14.5	7.3	5.3	15	12	--	414	2	8	2.9	--	450	16	2	0	470	--
DVSR	10/18/83	1150	18.0	8.0	7.0	17	13	--	430	1	8	2.9	54	--	--	--	--	--	--
DVSR	11/21/83	1150	15.5	7.9	8.4	18	15	--	469	4	15	3.6	310	230	29	4	0	260	--
DVSR	03/11/86	845	13.0	8.1	11.3	14	12	0.000	322	90	30	6.6	--	660	33	1	0	690	--
DVSR	05/13/86	700	16.0	8.2	6.4	15	11	0.000	356	4	20	4.8	--	510	24	2	0	540	--
LINDSEY	07/11/84	940	24.5	8.4	6.7	37	29	--	426	36	35	6.3	2700	770	57	6	0	830	--
LINDSEY	08/22/84	1105	21.5	8.0	7.6	35	26	--	411	65	50	7.1	--	950	65	4	0	1020	--
LINDSEY	09/12/84	1155	22.5	7.6	7.0	34	25	0.000	424	27	50	7.5	--	930	59	3	0	990	--
LINDSEY	10/11/84	950	19.5	7.8	8.0	32	21	--	383	28	50	5.6	--	840	59	4	0	900	--
LINDSEY	11/15/84	1045	12.5	7.5	8.6	31	23	0.000	353	28	25	4.7	--	570	45	2	0	620	--
LINDSEY	12/06/84	1050	11.0	7.3	8.3	44	34	0.000	441	37	50	9.7	3500	1000	59	2	0	1100	--
LINDSEY	01/25/85	1045	6.0	7.4	9.2	56	46	0.000	558	12	--	--	--	--	--	--	--	--	--
LINDSEY	02/13/85	1150	10.5	7.3	6.7	43	35	0.000	381	110	50	--	--	1200	65	3	0	1300	--
LINDSEY	02/22/85	1030	11.0	7.4	8.6	57	39	0.000	445	65	--	--	--	--	--	--	--	--	--
LINDSEY	03/13/85	1145	12.5	7.6	9.1	51	41	0.000	482	60	--	--	7500	--	--	--	--	--	--
LINDSEY	04/10/85	1015	18.0	7.7	8.6	61	44	0.000	531	20	15	--	--	580	86	9	0	680	--
LINDSEY	05/08/85	1000	17.0	8.1	8.8	60	47	0.000	574	18	20	--	--	660	88	4	0	750	--

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O.	Na	Cl	Se	EC	Turb.	Color	TOC	Asbest.	THM FORMATION POTENTIAL CH Cl3	CH BrCl2	CH Br2Cl	CH Br3	TTHMFP	FLOW
					(------	mg/L	------)		(uS/cm)	(TU)	(CU)	(mg/L)	(mF/L)	(---------	ug/L	--------)			(cfs)
LINDSEY	05/29/85	1030	20.0	7.9	8.6	55	47	--	571	27	--	--	--	--	--	--	--	--	--
LINDSEY	06/12/85	1045	25.0	7.9	7.1	51	45	0.000	541	28	30	--	--	900	97	6	0	1000	--
LINDSEY	07/24/85	610	22.0	7.6	7.0	40	33	0.000	421	36	--	--	--	--	--	--	--	--	--
LINDSEY	08/14/85	955	21.0	7.8	8.6	38	32	0.000	405	48	30	8.2	--	750	69	5	0	820	--
LINDSEY	09/11/85	900	19.5	7.7	7.5	40	37	0.000	443	30	25	9.8	--	820	54	4	0	880	--
LINDSEY	10/09/85	1005	16.5	7.6	8.1	42	41	0.000	496	31	38	17.0	--	1500	66	3	0	1600	--
LINDSEY	11/19/85	820	8.5	7.5	10.0	40	37	0.000	442	18	15	7.7	--	--	--	--	--	--	--
LINDSEY	12/03/85	720	11.5	7.4	8.7	56	63	0.000	569	25	60	15.0	1160	1300	70	2	0	1400	--
LINDSEY	01/16/86	745	10.5	7.3	6.7	65	58	0.000	458	38	80	15.0	--	2200	56	2	0	2300	--
LINDSEY	02/27/86	750	16.5	6.8	3.0	21	16	0.000	208	46	60	10.0	--	790	26	0	0	820	--
LINDSEY	03/13/86	730	13.5	7.1	6.2	23	20	0.000	221	68	100	15.0	--	1300	47	1	0	1300	--
LINDSEY	04/23/86	730	18.5	7.6	5.3	44	39	0.000	387	48	70	12.0	--	1100	84	6	0	1200	--
LINDSEY	05/28/86	600	20.0	8.0	6.0	52	47	0.000	528	26	25	8.0	--	380	38	5	2	420	--
LINDSEY	06/25/86	635	21.5	8.0	7.2	43	37	0.000	461	38	20	22.0	--	--	--	--	--	--	--
LCONNECTSL	02/06/85	845	7.0	7.4	11.2	20	22	--	252	5	15	--	--	660	46	6	0	710	--
LCONNECTSL	03/06/85	915	11.0	7.4	10.0	14	18	--	218	7	--	--	140	--	--	--	--	--	--
LCONNECTSL	04/05/85	815	17.5	7.3	9.5	13	11	--	188	6	5	--	--	230	26	2	0	260	--
LCONNECTSL	05/01/85	800	19.0	7.4	9.1	13	11	0.000	175	5	5	--	--	280	27	2	0	310	--
LCONNECTSL	06/05/85	745	20.5	7.5	8.7	13	10	--	180	7	5	--	--	300	26	2	0	330	--
LCONNECTSL	06/07/85	700	23.0	7.7	8.7	13	9	--	178	7	--	--	--	--	--	--	--	--	--
LCONNECTSL	08/01/85	800	22.5	7.4	8.0	13	10	--	186	5	10	3.8	--	360	32	2	0	390	--
LCONNECTSL	10/02/85	640	20.0	7.5	7.8	18	11	--	209	4	5	3.1	--	240	26	3	0	270	--
LCONNECTSL	11/13/85	730	11.5	7.3	9.0	12	11	--	183	3	25	3.4	--	340	34	2	0	380	--
LCONNECTSL	12/03/85	1645	11.5	7.3	10.2	15	15	--	204	5	15	6.8	68	380	36	3	0	420	--
LCONNECTSL	03/11/86	1145	14.5	7.3	9.0	12	19	--	192	22	25	17.0	--	650	51	3	0	700	--
LCONNECTSL	04/17/86	945	15.5	7.2	8.5	17	20	0.001	195	11	20	4.2	--	440	51	7	0	500	--
LCONNECTSL	05/13/86	945	19.5	7.3	8.4	12	15	--	162	14	25	4.2	--	150	16	2	0	170	--
LCONNECTSL	06/11/86	745	21.5	7.3	7.9	9	8	--	136	12	25	5.8	--	--	--	--	--	--	--
MALLARD	07/28/83	1045	24.2	7.3	8.6	11	11	--	137	18	5	3.3	--	260	26	2	0	290	--
MALLARD	08/25/83	950	21.0	7.6	8.0	21	27	--	216	19	15	3.4	--	300	65	13	0	380	--
MALLARD	09/20/83	900	21.0	7.3	7.7	15	16	--	181	13	15	3.4	--	410	21	3	0	430	--
MALLARD	10/18/83	910	17.5	7.3	8.5	13	13	--	152	9	30	3.2	690	--	--	--	--	--	--
MALLARD	11/21/83	1005	12.5	7.2	9.5	15	16	--	180	16	40	4.5	1400	170	36	4	0	210	--
MALLARD	12/28/83	930	10.0	7.3	10.3	13	13	--	168	38	30	3.7	26000	390	30	5	0	430	--
MALLARD	02/13/85	750	11.5	7.7	11.9	96	155	0.000	749	12	25	--	--	220	190	130	28	570	--
MALLARD	03/13/85	815	14.0	8.4	13.5	320	558	0.000	2160	10	--	--	1300	--	--	--	--	--	--
MALLARD	04/10/85	730	16.0	7.5	8.0	348	569	--	2210	25	5	--	--	90	180	260	280	810	--
MIDDLER	02/06/85	830	6.5	7.3	11.2	38	43	0.000	391	13	25	--	--	780	84	20	0	880	--
MIDDLER	03/06/85	900	10.0	7.4	10.0	31	34	0.000	339	12	--	--	210	--	--	--	--	--	--
MIDDLER	04/05/85	730	17.0	7.5	8.9	40	40	--	378	6	5	--	--	300	76	16	0	390	--
MIDDLER	05/01/85	650	19.0	7.6	9.3	29	29	0.001	303	9	10	--	--	410	68	10	0	490	--
MIDDLER	06/05/85	640	20.0	7.8	9.0	26	25	--	252	17	5	--	--	550	67	8	0	620	--
MIDDLER	06/07/85	805	23.5	7.7	8.9	23	25	--	256	16	--	--	--	--	--	--	--	--	--
MIDDLER	08/01/85	700	22.0	7.4	7.8	35	46	0.000	331	12	20	3.9	--	660	110	26	1	800	--
MIDDLER	10/23/85	1115	18.0	7.5	9.4	40	61	0.000	396	7	10	2.2	--	380	120	45	2	550	--
MIDDLER	12/03/85	1215	11.5	7.4	10.3	54	83	0.000	464	8	12	4.6	100	340	160	68	5	570	--
MIDDLER	03/11/86	1030	14.5	7.3	8.2	30	38	0.001	343	24	25	6.2	--	530	110	12	0	650	--
MIDDLER	04/17/86	730	14.0	7.3	8.8	20	26	0.001	213	12	25	3.5	--	440	60	9	0	510	--
MIDDLER	05/13/86	830	19.5	7.3	8.1	26	30	0.000	270	13	30	4.0	--	480	76	11	0	570	--
MIDDLER	06/11/86	615	22.5	7.3	7.8	28	34	0.000	272	14	20	7.5	--	--	--	--	--	--	--
MOKELUMNE	07/21/83	715	18.0	7.2	9.6	2	1	--	34	3	2	1.4	--	230	3	0	0	230	1550.0
MOKELUMNE	08/18/83	800	19.0	6.6	9.2	2	1	--	34	2	5	1.2	--	240	8	0	0	250	928.0

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CHCl3 (ug/L)	CHBrCl2 (ug/L)	CHBr2Cl (ug/L)	CHBr3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
MOKELUMNE	09/13/83	750	19.0	7.1	8.8	2	1	--	33	2	2	1.3	--	250	6	2	0	260	1040.0
MOKELUMNE	10/04/83	815	17.5	6.8	9.5	2	1	--	32	2	5	1.4	17	240	4	0	0	240	1210.0
MOKELUMNE	11/01/83	750	16.5	6.6	8.3	1	1	--	31	6	8	1.6	31	190	3	0	0	190	1420.0
MOKELUMNE	12/06/83	740	12.0	6.8	10.4	2	1	--	38	6	8	4.6	200	190	3	0	0	190	2990.0
MOKELUMNE	01/10/84	925	10.5	6.9	11.0	2	1	--	42	9	12	1.8	170	220	3	0	0	220	3790.0
MOKELUMNE	02/01/84	850	9.5	6.7	11.2	2	1	--	44	6	10	1.4	32	110	5	0	0	120	1210.0
MOKELUMNE	03/07/84	830	11.0	7.2	11.5	2	1	--	45	3	8	1.5	26	260	5	0	0	260	907.0
MOKELUMNE	04/04/84	735	13.0	7.3	10.9	2	1	--	47	2	2	1.5	44	230	5	0	0	240	439.0
MOKELUMNE	05/02/84	625	14.0	7.2	10.7	2	1	--	46	2	5	1.7	10	200	4	0	0	200	270.0
MOKELUMNE	06/06/84	825	15.5	7.3	10.2	2	1	--	47	2	2	1.5	53	230	7	0	0	240	265.0
MOKELUMNE	07/10/84	755	17.5	7.3	9.5	2	1	--	48	1	2	1.6	12	360	5	0	0	360	333.0
MOKELUMNE	08/01/84	820	23.5	7.2	9.5	2	1	--	47	1	0	1.7	--	310	5	0	0	320	303.0
MOKELUMNE	09/05/84	720	18.5	7.3	9.3	2	1	--	48	1	5	1.5	--	420	5	0	0	420	--
MOKELUMNE	10/04/84	915	17.5	7.2	9.4	2	1	--	44	2	2	1.6	--	290	5	0	0	300	--
MOKELUMNE	11/08/84	920	16.0	7.0	9.6	2	1	--	45	7	8	2.3	--	260	4	0	0	260	--
MOKELUMNE	12/05/84	945	12.0	7.2	10.9	2	2	--	46	4	5	1.8	19	200	4	0	0	200	--
NOBAY	07/28/83	830	21.0	7.9	9.0	10	5	--	301	4	5	2.7	--	290	15	1	0	310	5.0
NOBAY	08/25/83	725	19.0	8.5	8.9	10	5	--	301	4	5	2.7	--	340	26	2	0	370	5.0
NOBAY	09/20/83	1120	20.0	7.6	9.7	9	5	--	301	2	5	3.1	--	350	9	0	0	360	5.0
NOBAY	10/18/83	720	17.0	8.9	9.5	10	5	--	298	2	12	3.2	200	--	--	--	--	--	11.1
NOBAY	11/21/83	845	11.0	7.8	10.4	11	7	--	312	11	25	3.0	1600	280	18	1	0	300	1.0
NOBAY	12/28/83	815	11.5	7.6	10.2	11	6	--	279	22	20	2.6	6000	270	17	5	0	290	1.0
NOBAY	01/31/84	850	11.5	8.2	11.3	12	7	--	322	4	8	2.6	2600	300	18	1	0	320	1.0
NOBAY	02/22/84	925	12.0	8.2	10.7	12	6	--	314	6	8	3.1	2900	290	18	1	0	310	0.5
NOBAY	03/14/84	850	16.0	8.3	8.2	13	6	--	333	4	5	3.0	1500	340	21	1	0	360	0.0
NOBAY	04/11/84	840	15.0	8.4	10.4	10	6	--	310	4	2	2.8	2000	290	18	1	0	310	1.0
NOBAY	05/23/84	925	20.0	8.4	9.3	10	5	--	312	4	5	3.2	370	400	18	1	0	420	1.5
NOBAY	06/13/84	640	17.5	8.5	9.5	9	5	--	306	1	5	2.8	1100	400	18	1	0	420	4.0
NOBAY	07/11/84	735	19.5	7.5	9.1	9	5	--	308	4	5	2.9	1200	340	17	1	0	360	4.5
NOBAY	08/22/84	917	19.0	8.4	9.2	10	5	--	314	8	8	2.8	--	340	17	1	0	360	5.0
NOBAY	09/12/84	930	19.5	8.4	9.0	9	5	--	321	2	2	3.0	--	380	20	1	0	400	4.5
NOBAY	10/11/84	815	18.0	8.2	9.1	9	5	--	312	3	5	2.5	--	470	20	1	0	490	7.0
NOBAY	11/15/84	845	13.0	8.0	9.4	10	6	--	296	4	10	2.6	--	310	15	1	0	330	11.0
NOBAY	12/06/84	825	10.5	8.1	10.1	15	10	--	339	12	18	3.6	1600	400	23	1	0	420	11.0
NOBAY	02/13/85	920	10.5	8.0	8.7	18	10	0.000	321	60	50	--	--	750	31	1	0	780	13.0
NOBAY	03/13/85	930	13.0	8.3	10.0	13	8	0.000	350	4	--	--	1100	--	--	--	--	--	1.0
NOBAY	04/10/85	830	17.5	8.4	9.5	14	8	--	371	3	0	--	--	260	22	2	0	280	4.5
NOBAY	05/08/85	830	16.0	8.1	9.8	11	5	0.000	334	4	10	--	--	300	22	1	0	320	4.5
NOBAY	06/12/85	845	20.0	8.2	9.2	10	5	--	325	4	10	--	--	320	26	1	0	350	6.5
NOBAY	08/14/85	900	18.0	8.3	10.1	10	5	--	336	2	5	3.4	--	250	27	1	0	280	5.5
NOBAY	10/09/85	900	16.0	8.3	9.7	9	5	0.001	330	1	5	3.2	--	310	20	2	0	330	6.0
NOBAY	12/03/85	840	11.5	8.0	10.3	10	6	0.000	320	7	5	3.9	430	300	24	1	0	320	13.0
NOBAY	03/13/86	915	14.0	8.0	9.5	11	6	0.000	278	30	20	3.7	--	520	22	1	0	540	--
NOBAY	04/23/86	1045	18.0	8.2	9.1	13	7	0.000	336	7	10	2.7	--	320	24	2	0	350	--
NOBAY	05/28/86	945	19.5	8.3	9.6	10	5	0.000	306	7	5	3.1	--	300	15	1	0	320	--
NOBAY	06/25/86	845	19.0	8.3	9.2	9	5	0.000	293	5	10	7.2	--	--	--	--	--	--	--
ROCKSL	07/26/83	1240	23.0	7.0	7.0	15	16	--	158	16	8	3.4	--	310	34	5	0	350	--
ROCKSL	08/23/83	1100	24.5	7.2	6.9	15	14	--	171	17	8	2.6	--	440	35	4	0	480	--
ROCKSL	09/14/83	1145	25.0	7.1	6.1	26	29	--	254	15	35	4.6	--	440	43	9	0	490	--
ROCKSL	10/12/83	1005	21.0	7.1	7.7	17	21	--	177	11	20	2.8	950	270	39	6	6	320	--
ROCKSL	11/08/83	1030	17.0	7.2	8.4	22	23	--	224	10	25	3.5	570	260	37	7	0	300	--
ROCKSL	12/13/83	1220	12.0	6.9	9.8	20	21	--	202	11	30	3.0	560	270	36	4	0	310	--

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O.	Na	Cl	Se	EC	Turb.	Color	TOC	Asbest.	THM FORMATION POTENTIAL CH Cl3	CH BrCl2	CH Br2Cl	CH Br3	TTHMFP	FLOW
					(mg/L)				(uS/cm)	(TU)	(CU)	(mg/L)	(mF/L)	(ug/L)					(cfs)
ROCKSL	01/24/84	1025	10.0	7.3	10.8	25	25	--	248	16	35	3.3	500	320	42	8	0	370	--
ROCKSL	02/28/84	1205	13.5	7.5	10.0	32	35	--	316	11	30	3.6	500	340	65	12	0	420	--
ROCKSL	03/27/84	1030	16.5	7.5	9.8	22	24	--	254	17	30	3.2	480	370	54	8	0	430	--
ROCKSL	04/25/84	1135	16.5	7.3	9.6	15	14	--	193	14	15	3.4	1100	310	31	4	0	340	--
ROCKSL	05/30/84	905	24.0	7.5	8.1	15	15	--	194	16	12	3.8	140	360	39	5	0	400	--
ROCKSL	06/27/84	1050	26.0	7.2	6.8	16	15	--	189	12	30	3.5	430	380	39	4	0	420	--
ROCKSL	07/25/84	1045	24.0	7.7	8.1	22	27	--	217	10	15	2.5	600	320	63	17	0	400	--
ROCKSL	08/29/84	900	24.0	7.4	8.2	21	26	--	221	5	12	2.6	--	310	60	16	0	390	--
ROCKSL	09/27/84	1130	23.0	7.8	8.3	16	14	--	199	9	10	2.8	--	310	31	3	0	340	--
ROCKSL	10/25/84	1130	17.0	8.0	10.9	16	15	--	194	8	12	3.2	--	330	32	4	0	370	--
ROCKSL	11/29/84	1330	12.0	7.4	10.5	14	13	--	186	10	30	3.7	--	580	32	2	0	610	--
ROCKSL	12/12/84	1145	11.0	7.3	9.7	14	13	--	195	11	30	4.4	540	410	31	2	0	440	--
ROCKSL	01/30/85	1015	8.0	7.2	10.8	22	24	0.001	284	3	--	--	--	--	--	--	--	--	--
ROCKSL	02/27/85	1145	14.0	7.5	10.3	21	21	0.000	258	6	25	--	--	350	45	5	0	400	--
ROCKSL	03/27/85	1115	12.0	7.4	10.1	24	25	0.000	269	6	--	--	590	--	--	--	--	--	--
ROCKSL	04/24/85	1123	18.0	7.8	10.1	21	18	0.000	232	7	2	--	--	430	42	5	0	480	--
ROCKSL	05/22/85	1020	21.5	8.2	9.2	21	24	0.000	225	17	15	--	--	520	56	11	0	590	--
ROCKSL	06/07/85	930	23.0	7.9	9.1	25	30	--	252	16	--	--	--	--	--	--	--	--	--
ROCKSL	06/26/85	1000	23.0	7.6	8.0	41	56	0.000	360	19	10	--	--	600	110	60	3	770	--
ROCKSL	07/10/85	955	25.0	7.3	7.6	60	81	0.000	453	8	--	--	--	--	--	--	--	--	--
ROCKSL	08/28/85	1045	23.5	7.6	8.1	81	122	0.000	630	8	10	2.8	--	340	160	100	19	620	--
ROCKSL	09/25/85	1032	22.5	7.6	8.1	101	164	0.000	776	8	--	--	--	--	--	--	--	--	--
ROCKSL	10/23/85	1015	17.5	7.8	10.0	99	158	0.000	738	7	5	2.1	--	210	210	140	36	600	--
ROCKSL	11/15/85	1140	12.5	7.5	10.4	135	238	0.000	988	4	--	--	--	--	--	--	--	--	--
ROCKSL	12/03/85	1125	11.5	7.4	10.5	133	228	0.000	965	6	10	3.1	260	140	200	210	24	570	--
ROCKSL	01/23/86	1145	11.0	7.3	9.6	66	85	0.000	476	6	--	--	--	--	--	--	--	--	--
ROCKSL	02/13/86	1045	11.5	7.4	10.2	36	50	0.000	319	13	--	--	--	--	--	--	--	--	--
ROCKSL	03/04/86	1140	17.5	7.3	6.2	32	35	0.000	342	16	35	8.4	--	670	67	6	0	740	--
ROCKSL	04/09/86	1215	17.0	7.3	8.5	29	31	0.000	262	11	20	3.5	--	520	81	11	0	610	--
ROCKSL	05/07/86	945	17.0	7.2	7.4	21	23	--	227	13	20	7.8	--	510	48	5	0	560	--
ROCKSL	06/04/86	1040	22.5	7.3	7.6	19	21	0.000	225	21	--	12.0	--	200	23	2	0	220	--
ROCKSL	07/02/86	1000	25.5	7.3	6.3	19	19	--	225	15	--	--	--	--	--	--	--	--	--
GREENES	07/21/83	600	19.5	7.3	8.7	7	4	--	115	9	2	1.6	--	190	8	1	0	200	26400.
GREENES	08/18/83	645	21.0	7.5	8.2	7	4	--	124	8	8	1.6	--	200	14	1	0	220	24600.
GREENES	09/13/83	640	20.5	7.3	8.3	10	6	--	154	12	8	1.8	--	600	18	2	0	620	23100.
GREENES	10/04/83	925	18.0	7.3	9.0	7	5	--	124	10	5	1.6	380	200	9	0	0	210	24800.
GREENES	11/01/83	650	17.0	7.3	9.1	8	5	--	128	6	5	1.7	340	210	8	0	0	220	17700.
GREENES	12/06/83	635	10.5	7.4	10.6	4	4	--	122	30	30	4.1	2200	300	9	0	0	310	66100.
GREENES	01/10/84	815	9.0	7.3	10.7	7	4	--	129	19	20	1.7	3200	220	10	1	0	230	67200.
GREENES	02/01/84	950	10.0	7.1	10.8	7	5	--	140	14	12	1.5	740	190	11	1	0	200	32400.
GREENES	03/07/84	735	12.0	7.5	10.8	10	7	--	164	8	8	1.6	540	230	28	1	0	260	25800.
GREENES	04/04/84	635	13.5	7.5	10.4	9	6	--	148	8	5	1.6	680	250	14	1	0	260	25100.
GREENES	05/02/84	530	16.0	7.3	9.4	10	6	--	154	8	8	2.0	110	180	13	1	0	190	11200.
GREENES	06/06/84	625	18.0	7.5	8.7	10	7	--	146	9	8	2.0	200	250	15	1	0	270	13900.
GREENES	07/10/84	650	22.5	7.4	8.2	7	4	--	121	11	5	1.6	150	260	10	0	0	270	21200.
GREENES	08/01/84	600	21.5	7.4	7.9	8	4	--	133	11	5	1.6	--	300	10	1	0	310	22000.
GREENES	08/21/84	1040	23.0	7.3	8.2	11	6	--	164	12	10	1.8	--	250	16	1	0	270	17800.
GREENES	09/05/84	605	22.0	7.4	7.7	12	6	0.000	185	11	8	2.4	--	390	20	1	0	410	18240.
GREENES	10/04/84	620	17.5	7.4	9.0	8	4	0.000	132	7	5	1.6	--	170	13	1	0	180	14500.
GREENES	11/08/84	820	14.0	7.3	9.7	10	6	0.000	154	11	8	2.1	--	210	11	0	0	220	14800.
GREENES	12/05/84	745	10.5	7.4	10.9	9	6	0.000	160	24	15	2.6	1100	240	14	1	0	260	38100.
GREENES	01/30/85	1145	9.0	7.4	11.9	12	7	0.000	186	3	--	--	--	--	--	--	--	--	14300.

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O.	Na	Cl	Se	EC	Turb.	Color	TOC	Asbest.	THM FORMATION POTENTIAL CH Cl3	CH BrCl2	CH Br2Cl	CH Br3	TTHMFP	FLOW
					(------	mg/L	------)		(uS/cm)	(TU)	(CU)	(mg/L)	(mF/L)	(----------	ug/L	---------)			(cfs)
GREENES	02/06/85	1130	8.0	7.5	12.1	11	6	0.000	174	8	10	--	--	360	14	1	0	380	14900.
GREENES	03/06/85	1200	11.0	7.4	10.5	11	7	0.000	180	5	--	--	180	--	--	--	--	--	13200.
GREENES	04/05/85	1035	19.0	7.4	9.3	13	6	0.000	176	7	2	--	--	160	13	0	0	170	13900.
GREENES	05/01/85	1030	19.0	7.3	8.8	11	7	0.001	167	11	10	--	--	210	12	1	0	220	10200.
GREENES	05/29/85	510	18.0	7.4	9.5	13	7	--	178	10	--	--	--	--	--	--	--	--	15200.
GREENES	06/05/85	955	21.0	7.4	8.5	13	6	0.000	173	9	10	--	--	290	19	1	0	310	15100.
GREENES	07/24/85	800	22.5	7.3	8.0	11	5	0.000	163	8	--	--	--	--	--	--	--	--	17200.
GREENES	08/01/85	1035	22.5	7.5	7.9	11	5	0.000	163	10	10	3.9	--	480	14	2	0	500	15600.
GREENES	09/04/85	930	22.0	7.3	7.8	15	8	0.001	207	8	5	3.5	--	220	22	2	0	240	12500.
GREENES	10/02/85	1015	21.5	7.5	8.2	14	8	0.000	168	7	5	1.6	--	200	14	1	0	220	10600.
GREENES	11/13/85	1040	12.0	7.3	9.7	11	7	0.000	163	6	5	2.8	--	290	20	1	0	310	9500.0
GREENES	12/03/85	1930	11.5	7.3	9.3	10	7	0.000	149	28	35	16.0	380	690	21	1	0	710	24200.
GREENES	01/16/86	1400	10.0	7.3	10.6	18	10	0.000	218	9	15	2.3	--	660	22	1	0	680	14900.
GREENES	02/27/86	1240	12.5	7.1	10.5	4	2	0.000	84	64	20	4.2	--	340	7	0	0	350	7600
GREENES	03/13/86	1345	11.5	7.3	11.0	3	2	0.000	70	58	10	2.4	--	430	8	0	0	440	9900
GREENES	04/23/86	1245	18.5	7.3	8.5	10	7	0.000	179	14	10	1.9	--	310	22	1	0	330	17500
GREENES	05/28/86	1200	23.5	7.3	7.5	12	9	0.000	188	14	10	2.9	--	170	12	2	1	180	14000
GREENES	06/25/86	1250	24.5	7.3	7.8	11	8	0.000	161	13	--	--	--	--	--	--	--	--	11200
HOOD	03/30/82	1050	11.0	7.3	10.7	--	4	--	131	20	5	--	--	310	9	0	0	320	40000.
HOOD	06/29/82	905	20.0	7.9	8.5	--	5	--	128	6	--	--	--	230	12	0	0	240	20000.
HOOD	08/26/82	1100	22.0	7.5	8.1	--	5	--	149	10	--	--	--	280	13	0	0	290	23200.
HOOD	10/21/82	1150	18.0	7.5	8.7	--	4	--	122	4	--	--	--	260	10	0	0	270	16300.
HOOD	12/29/82	1400	9.5	7.2	10.9	--	4	--	130	33	--	--	--	480	16	1	0	500	71700.
HOOD	02/24/83	1410	12.0	7.5	10.6	--	2	--	113	30	--	--	--	120	4	0	0	120	74000.
HOOD	04/27/83	540	--	7.3	10.0	--	3	--	112	26	--	--	--	166	6	4	4	180	54600.
HOOD	06/22/83	1100	19.5	7.3	9.1	--	3	--	101	17	--	--	--	200	8	0	0	210	43540.
MALLARDIS	05/08/85	700	16.0	7.8	8.7	1740	2890	0.000	9290	14	10	--	--	12	84	330	650	1100	7170.0
MALLARDIS	05/29/85	835	17.0	7.7	8.7	454	736	--	2720	26	--	--	--	--	--	--	--	--	8520.0
MALLARDIS	06/12/85	700	21.5	7.8	8.0	469	840	--	2980	19	5	--	--	65	170	340	300	880	4480.0
MALLARDIS	08/14/85	730	19.0	8.0	8.5	1390	2510	0.000	8480	19	5	3.7	--	61	54	250	680	1000	1910.0
MALLARDIS	09/11/85	735	18.5	7.9	8.2	1230	2180	0.000	7320	12	5	3.0	--	21	94	370	500	980	3580.0
MALLARDIS	10/09/85	735	17.0	8.0	8.4	980	1880	0.000	6330	10	5	4.5	--	21	140	340	520	1000	1860.0
MALLARDIS	11/19/85	1015	11.5	8.1	9.6	2340	4260	0.000	13100	9	5	3.1	--	--	--	--	--	--	4610.0
MALLARDIS	12/03/85	1010	12.0	7.5	9.9	1760	3130	0.000	9970	8	8	3.4	240	11	72	340	640	1100	17200.
MALLARDIS	01/16/86	940	10.0	7.7	10.2	2180	3540	0.000	10700	16	20	4.6	--	5	44	320	990	1400	8270.0
MALLARDIS	02/27/86	955	14.5	7.0	8.8	12	12	0.000	169	58	25	5.3	--	490	29	1	0	520	--
MALLARDIS	03/13/86	1130	13.0	7.3	9.4	12	14	0.000	161	51	30	5.4	--	670	38	2	0	710	--
MALLARDIS	04/23/86	915	16.5	7.3	8.9	20	23	0.000	226	22	20	3.5	--	440	64	8	0	510	--
MALLARDIS	05/28/86	815	17.0	7.6	8.6	680	1240	0.000	4160	26	15	7.1	--	39	88	260	350	740	--
MALLARDIS	06/25/86	1035	21.0	7.7	8.1	689	1280	0.000	4250	36	10	10.0	--	--	--	--	--	--	--
VERNALIS	03/30/82	715	10.5	7.3	9.9	--	36	--	341	14	13	--	--	1400	67	9	0	1500	9720.0
VERNALIS	06/29/82	530	18.0	7.7	8.4	--	30	--	267	15	--	--	--	470	93	12	0	580	7400.0
VERNALIS	08/26/82	710	21.0	7.7	7.3	--	50	--	392	22	--	--	--	390	71	19	0	480	3750.0
VERNALIS	10/21/82	715	16.0	7.3	9.0	--	17	--	166	8	--	--	--	330	37	0	0	370	7420.0
VERNALIS	12/29/82	800	9.0	7.0	9.3	--	12	--	152	28	--	--	--	770	37	0	0	810	21500.
VERNALIS	02/24/83	1040	13.0	7.5	9.6	--	26	--	264	18	--	--	--	190	24	4	0	220	29100.
VERNALIS	04/27/83	740	--	7.1	9.7	--	11	--	150	12	--	--	--	310	20	6	5	340	36600.
VERNALIS	06/22/83	630	21.0	7.0	8.5	--	10	--	117	23	--	--	--	380	23	2	0	400	24100.
VERNALIS	07/26/83	815	20.0	7.3	7.7	29	30	--	288	29	5	3.5	--	290	54	12	0	360	11300.
VERNALIS	08/23/83	700	20.0	7.2	8.0	23	24	--	247	19	5	3.0	--	420	39	7	0	470	9170.0
VERNALIS	09/14/83	715	20.0	7.4	8.2	15	14	--	158	16	10	2.8	--	350	21	3	0	370	11200.
VERNALIS	10/12/83	625	17.5	7.1	8.5	11	11	--	126	12	10	2.8	780	270	24	3	0	300	14500.

Note: -- = no data

At Freeport

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CH Cl3 (ug/L)	CH BrCl2 (ug/L)	CH Br2Cl (ug/L)	CH Br3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
VERNALIS	11/08/83	730	15.0	7.3	8.2	39	38	--	381	18	25	4.2	1300	300	62	12	0	370	9370.0
VERNALIS	12/13/83	825	11.0	7.1	10.0	14	13	--	155	14	30	3.2	740	330	22	2	0	350	22200.
VERNALIS	01/24/84	735	10.0	7.0	10.0	21	19	--	210	14	25	3.1	870	340	32	4	0	380	21400.
VERNALIS	02/28/84	815	12.0	7.5	9.7	38	39	--	352	10	15	3.2	270	250	60	15	0	320	9640.0
VERNALIS	03/27/84	720	14.5	7.3	9.4	48	52	--	464	34	15	3.9	1800	280	86	23	2	390	6300.0
VERNALIS	04/25/84	755	14.0	7.3	8.8	59	66	--	547	24	8	4.8	1700	290	110	42	2	440	3980.0
VERNALIS	05/30/84	620	24.5	7.9	7.3	69	80	--	629	75	10	6.1	1300	380	120	56	3	560	2440.0
VERNALIS	06/27/84	650	25.5	7.3	6.3	77	88	--	694	50	25	5.8	1300	360	130	58	3	550	2050.0
VERNALIS	07/25/84	705	23.0	7.5	6.5	--	92	0.001	640	-	15	5.4	3300	450	150	72	7	680	1840.0
VERNALIS	08/29/84	620	24.0	7.6	7.1	58	62	--	549	24	20	4.8	--	350	110	48	2	510	2520.0
VERNALIS	09/27/84	725	20.0	7.4	8.3	39	43	0.000	388	17	10	4.2	--	280	79	21	0	380	3140.0
VERNALIS	10/25/84	810	15.5	7.4	7.9	39	41	0.000	378	15	12	3.9	--	260	64	23	1	350	3580.0
VERNALIS	11/29/84	940	11.5	7.1	9.2	43	44	0.000	400	10	25	4.4	--	380	68	15	0	460	3440.0
VERNALIS	12/12/84	830	11.0	7.3	9.2	34	32	0.000	324	6	12	3.6	510	240	50	12	0	300	4700.0
VERNALIS	01/30/85	750	8.0	7.4	10.5	54	55	0.001	483	3	--	--	--	--	--	--	--	--	3850.0
VERNALIS	02/22/85	1310	12.0	7.4	6.4	75	69	0.001	598	10	20	--	--	--	--	--	--	--	3170.0
VERNALIS	02/27/85	815	12.5	7.4	9.6	70	73	0.002	629	8	25	--	--	220	97	48	6	370	2640.0
VERNALIS	03/27/85	845	12.0	7.4	9.0	92	97	0.002	801	17	--	--	810	--	--	--	--	--	2580.0
VERNALIS	04/24/85	745	17.0	7.4	7.9	87	80	0.002	667	19	5	--	--	360	140	61	3	560	2520.0
VERNALIS	05/22/85	700	20.5	7.4	7.2	84	99	0.002	756	31	10	--	--	400	160	68	12	640	1920.0
VERNALIS	05/29/85	645	18.0	7.7	7.9	89	98	--	774	28	--	--	--	--	--	--	--	--	1900.0
VERNALIS	06/26/85	645	23.0	7.5	7.3	81	94	0.001	717	52	10	--	--	540	160	66	7	770	1420.0
VERNALIS	07/10/85	645	22.5	7.4	7.1	55	58	0.001	490	28	5	--	--	520	130	41	3	690	2500.0
VERNALIS	08/28/85	715	19.5	7.7	7.4	52	60	0.001	487	18	5	3.9	--	410	100	34	2	550	2400.0
VERNALIS	09/25/85	707	21.5	7.4	6.8	59	70	0.000	563	21	5	3.1	--	380	98	30	4	510	1600.0
VERNALIS	10/23/85	700	15.5	7.4	7.4	53	65	0.000	519	12	5	2.4	--	320	110	29	2	460	1950.0
VERNALIS	11/15/85	820	8.5	7.5	9.7	80	94	0.001	706	7	15	2.9	--	220	130	71	7	430	1400.0
VERNALIS	12/03/85	1530	13.5	7.4	8.9	66	74	0.001	604	18	18	6.5	560	590	140	32	0	760	2250.0
VERNALIS	01/23/86	745	12.0	7.5	8.8	99	107	0.000	790	18	15	3.2	--	930	160	76	7	1200	1750.0
VERNALIS	02/13/86	730	11.5	7.3	9.0	82	86	0.002	686	15	5	4.3	--	450	140	56	3	650	--
VERNALIS	03/04/86	800	15.0	7.3	8.3	28	26	0.001	268	26	35	7.8	--	540	56	6	0	600	--
VERNALIS	04/09/86	800	15.0	7.3	9.2	18	18	0.000	169	20	25	5.3	--	650	47	4	0	700	--
VERNALIS	05/07/86	630	14.5	7.3	8.8	27	27	0.001	257	17	15	6.0	--	330	51	6	0	390	--
VERNALIS	06/04/86	745	20.5	7.3	8.0	26	28	0.001	254	22	--	--	--	220	41	6	0	270	--
VERNALIS	07/02/86	650	23.0	7.5	7.9	65	75	--	595	9	--	--	--	--	--	--	--	--	--
SLDCK2	07/20/83	1125	25.0	8.6	9.0	2420	1760	--	12600	1	5	9.2	--	19	140	500	550	1200	11.6
SLDCK2	08/17/83	650	28.0	7.9	8.0	2120	1640	--	11600	1	8	9.3	--	26	110	420	280	840	9.6
SLDCK2	09/06/83	915	26.5	7.8	8.0	2220	1660	--	11900	1	10	9.5	--	67	340	720	380	1500	8.8
SLDCK2	10/06/83	815	21.5	8.4	8.3	2200	1610	--	11900	2	25	28.0	--	36	260	710	630	1600	7.4
SLDCK2	11/15/83	1425	15.5	8.8	13.0	2140	1470	--	11300	6	45	30.0	--	39	280	710	680	1700	8.5
SLDCK2	12/20/83	1110	13.5	8.2	10.3	2120	1380	--	10500	1	18	7.5	--	42	190	410	330	970	15.5
SLDCK17	07/20/83	915	23.5	8.5	9.0	2130	1590	--	11500	1	5	9.5	--	34	160	520	610	1300	11.6
SLDCK17	08/16/83	1240	30.5	7.9	9.4	2120	1580	--	11500	2	8	10.0	--	30	140	750	340	1300	10.3
SLDCK17	09/06/83	800	25.5	7.9	8.0	2180	1560	--	11700	5	12	18.0	--	70	310	600	470	1400	9.5
SLDCK17	10/05/83	1340	23.0	8.6	12.5	2160	1600	--	11800	2	30	29.0	--	31	210	750	680	1700	--
SLDCK17	11/15/83	1330	16.5	8.6	11.5	2300	1440	--	11700	3	25	19.0	--	35	230	580	710	1600	6.9
SLDCK41	07/20/83	805	21.5	8.3	9.5	1970	1500	--	11000	1	5	7.3	--	37	150	480	540	1200	11.6
SLDCK41	08/16/83	1130	25.0	7.6	7.5	2020	1540	--	11100	4	8	10.0	--	18	130	420	250	820	9.5
SLDCK41	09/06/83	700	23.5	7.9	11.6	2070	1560	--	11400	3	15	11.0	--	100	330	350	180	960	9.1
SLDCK41	10/05/83	1245	22.0	8.3	7.7	2040	1600	--	11400	1	15	13.0	--	30	160	370	280	840	7.5
SLDCK41	11/15/83	1240	16.5	8.6	15.5	2700	1580	--	13400	4	25	21.0	--	25	200	480	230	930	6.9
SLDCK41	12/20/83	955	15.0	8.1	10.8	1760	1340	--	9320	2	8	9.8	--	32	140	310	230	710	13.6

Note: -- = no data

DELTA HEALTH ASPECTS PROGRAM MONITORING DATA

Station Name	Date	Time (PST)	Temp. (oC)	pH	D.O. (mg/L)	Na (mg/L)	Cl (mg/L)	Se (mg/L)	EC (uS/cm)	Turb. (TU)	Color (CU)	TOC (mg/L)	Asbest. (mF/L)	THM FORMATION POTENTIAL CH Cl3 (ug/L)	CH BrCl2 (ug/L)	CH Br2Cl (ug/L)	CH Br3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)
SLDPD5	07/20/83	1210	22.0	8.6	4.0	2940	2160	--	14700	0	12	11.0	--	21	180	780	950	1900	--
SLDPD5	08/17/83	715	25.0	7.5	1.4	2980	2250	--	15200	1	12	11.0	--	20	190	720	520	1400	--
SLDPD5	09/06/83	950	24.0	7.5	1.5	2540	1960	--	13600	0	8	8.7	--	76	340	750	490	1700	--
SLDPD5	10/06/83	855	20.0	7.7	3.3	2300	1780	--	12500	0	25	11.0	--	58	270	660	1300	2300	--
SLDPD5	11/15/83	1455	13.0	8.6	10.8	2120	1520	--	11200	2	35	26.0	--	59	320	750	960	2100	--
SLDPD5	12/20/83	1135	13.0	8.0	8.7	2020	1390	--	10200	1	20	11.0	--	63	220	470	380	1100	--
SLDPC	07/28/83	945	23.0	7.5	8.4	944	865	--	5890	3	2	4.2	--	36	120	190	140	490	--
SLDPC	08/25/83	845	20.0	8.1	8.8	940	860	--	5900	3	5	4.0	--	42	170	260	140	610	--
SLDPC	09/20/83	1000	22.5	7.6	8.5	1120	1010	--	6910	96	5	4.3	--	38	110	290	160	600	--

Note: -- = no data

Appendix B

FIELD SAMPLING PROCEDURES

APPENDIX B

APPARATUS AND METHODS EMPLOYED

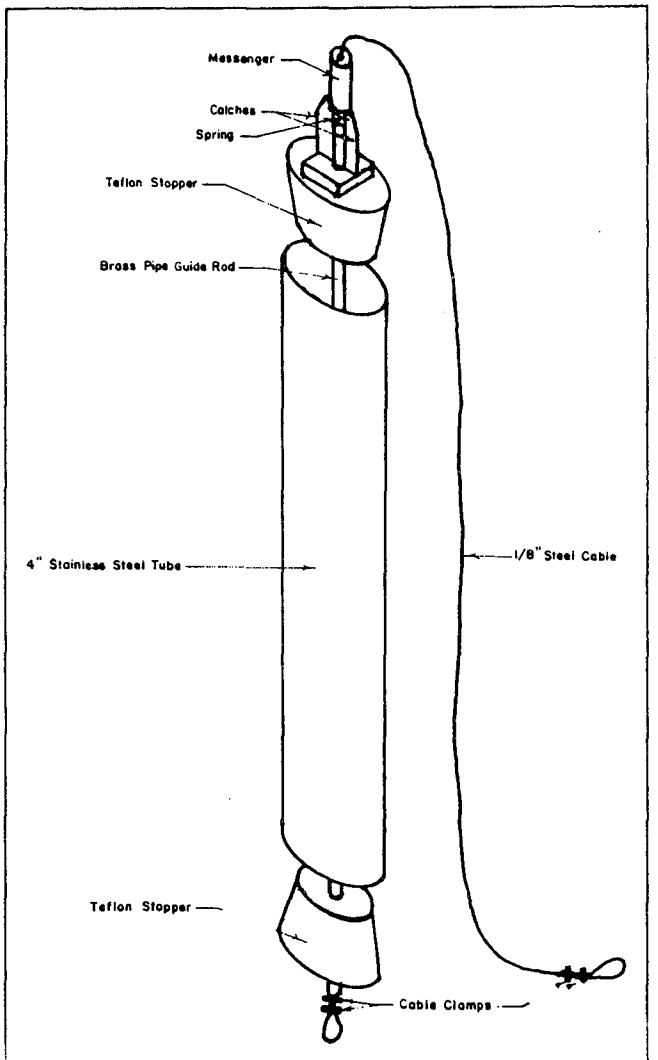
This appendix describes sampling apparatus, sampling methods, and analytical methods employed in the Interagency Delta Health Aspects Monitoring Program.

Sampling Apparatus

Prior to January 1984, samples were collected in a 1.5-liter steel bucket with a 1-meter chain attached; the bucket and chain were prepared for sampling by detergent washing and drying. The equipment was transported in detergent-washed aluminum foil. Sampling involved attaching a small diameter nylon rope to the end of the chain and dipping the bucket into the water to collect the sample. To avoid contamination, the rope was not allowed to enter the water.

Beginning in January 1984, and continuing since then, samples have been collected using a specially constructed device developed by the Department of Water Resources (see Figure 1). A stainless steel tube with Teflon closures and a triggering mechanism are the main components of the device, which was produced using parts from old Kemmerer samplers. The important feastures of the device are: (1) it enables subsurface sampling, and (2) the water being sampled is not in contact with potentially contaminating materials.

Before being used for the first time, the device was soaked for about a week in water containing detergent. This procedure was intended to cleanse the equipment of any surface contaminants that may have been present.



ORGANIC POLLUTANTS SAMPLER

Prior to sampling, the device was washed in detergent, rinsed, dried, and wrapped in detergent-washed foil. A nylon rope attached to a short length of steel cable was used to suspend and operate the sampler. As was the case with the sampling bucket, the rope was not allowed to contact the water.

Sampling Methods

Samples for Total Trihalomethane Formation Potential analyses were filtered through 0.45uM Millipore membranes, using a stainless steel filtration apparatus that was washed in detergent, rinsed, dried, and wrapped in detergent-washed foil prior to sampling. The purpose of the filtration was to simulate the clarification and filtration processes employed in water treatment.

Filtration apparently has only a minor effect on trihalomethane formation potential of most fresh water samples. Twenty-five fresh water samples were analyzed in duplicate, one sample being filtered and the other unfiltered. The average difference between the filtered and unfiltered samples was 14 percent; this difference is in the order of magnitude of the analytical variation of the test method. Filtered water was poured into 40 mL screw-top vials with Teflon septa, leaving no airspace, as specified by the U. S. Environmental Protection Agency /1/.

Water samples for total organic carbon analyses were poured into acid-fixed 30 mL glass bottles with tapered glass stoppers, then sealed with washed foil.

Samples for the above analyses were transported iced to the DWR Bryte Laboratory within 24 hours of sampling.

Field analyses were performed at the time of sampling. Temperatures were taken by means of a radial thermometer graduated in intervals of 0.5 degrees Celsius. Measurements of pH were performed by use of a Hellige colorimetric pH comparator. Dissolved oxygen concentrations were determined in the field by the modified Winkler titration method, and electrical conductivity was determined by use of a Beckman SoluBridge for conductivities less than 8,000 umhos/cm and a Beckman Model RC-19 electrical conductivity bridge for higher conductivities.

Asbestos samples were collected in pint-sized polyethylene bottles and shipped on the day of collection via express mail to the EMS Laboratory in Hawthorne, California. Priority pollutant samples were collected in gallon containers, three per sample (for extractables). Also, 40 mL samples were collected in glass containers (five per sample) for volatile organic analyses. The sample containers were completely filled, eliminating headspace. Volatilization losses during filling were minimized by tilting sample vials and allowing the sample to run down the inside of the vial without causing turbulence. The caps of the sample containers were Teflon-lined. These samples were delivered to McKesson Environmental Services laboratory in Dublin, California, within 24 hours of collection.

Analytical Methods

Upon delivery to the DWR Bryte Laboratory, raw water samples for trihalomethane formation potential analyses were chlorinated at about 50 milligrams per liter (mg/L) chlorine dosage. This high dosage was used to assure a chlorine residual after the 7-day incubation period at 25 degrees Celsius. This procedure should be acceptable, as studies have determined that ultimate trihalomethane formation is independent of dosage, where the dosage exceeds the chlorine demand of the sample /2/. At the end of seven days, samples were dechlorinated using sodium thiosulfate and analyzed by the purge and trap method of gas chromatographic analysis established by EPA /1,3/. Asbestos samples and priority pollutant samples were likewise analyzed by methodology established by EPa /4,5/. Selenium was analyzed by a method developed by the U S. Geological Survey for its low detection level work /6/. All other analyses were performed according to Standard Methods /7/.

APPENDIX B REFERENCES

1 Federal Register. 44:231 (November 29, 1979) Appendix C, Part III, 68690-68691.

2 R. A. Minear and C. M. Morrow. Raw Water Bromide Levels and Relationship to Distribution of Trihalomethanes in Finished Drinking Water. Tennessee Water Resources Research Center, Knoxville. Prepared for Office of Water Research and Technology, Washington, D.C. Contract DI-14-34-001-1145. PB83-256735. March 1983. 271 pp.

3 Federal Register. 44:231 (November 29, 1979) Appendix C, Part I, 68672-68682.

4 Interim Method for Determining Asbestos in Water. EPA-600/4-80-005. January 1980.

5 J. E. Longbottom and J. J. Lichtenberg. Test Methods -- Methods for Organic Analysis of Municipal and Industrial Wastewater. EPA-600/4-82-057. July 1982.

6 J. G. Crock and F. E. Lichte. An Improved Method for the Determination of Trace Levels of Arsenic and Antimony in Geological Materials by Automated Hydride Generation - Atomic Absorption Spectroscopy. Analytica Chimica Acta. 144:223-233. 1982.

Appendix C

LABORATORY QUALITY CONTROL PROCEDURES

McKesson Environmental Services
6363 Clark Avenue, P.O. Box 2277, Dublin CA 94568 Tel 415 828 1446
Outside California 800 227 1316

McKesson

LIMITS OF DETECTION

Pollution of Delta waters by industrial or agricultural chemicals can occur from both point sources and non-point sources. In either case, the high degree of dilution afforded by the high volume of run-off water entering the Delta is expected to result in very low concentrations of synthetic organic chemicals in Delta waters. These expected low concentrations challenge the analytical methodologies available for the detection and measurement of compounds of interest.

For the present program, primary emphasis has been placed on analysis for the EPA "Priority Pollutants." For this purpose we have used the following EPA Test Methods:

Method 624 - Purgeables
Method 601 - Purgeable Halocarbons
Method 625 - Base/Neutrals and Acids
Method 608 - Organochlorine Pesticides and PCBs.

When certain non-priority pollutant compounds have been determined, other EPA methods were employed; for example, Method 614 - Organophosphorous Pesticides.

Each of the EPA methods includes values for method detection limits for many of the compounds covered by the specific method. The GC/MS methods (624 and 625) are the methods of choice for an initial survey, since the mass spectrometer is a universal detector which also provides positive identification of the analyte. However, the sensitivity of this detector is such that the method detection limit is generally higher than the expected level of those organic pollutants in Delta waters. Consequently, some procedural modifications have been used and some additional analyses using more sensitive detectors have been completed.

For purgeable priority pollutants, the initial analysis was by Method 624, for which method detection limits of 1 - 10 µg/L are reported. This was supplemented by use of Method 601, for which detection limits of 0.1 - 1 µg/L can be achieved. This latter method uses a halogen specific detector of high sensitivity.

For extractable organics, Method 625 offers detection limits in the range of 2 to 20 µg/L. In order to improve on this, the procedure has been modified slightly to increase the concentration factor by x10 and consequently to lower the detection limit by a factor of 10. This was achieved by increasing the sample volume to 2 liters (from 1 liter) and concentrating the extract to 0.2 ml (instead of 1 ml).

A similar treatment of sample extraction has been used with Method 608 and Method 614. These methods employ highly sensitive detectors, with very low reported method detection limits (0.002 µg/L for dieldrin and 0.012 µg/L for diazinon, for example).

The method detection limits (MDL) as quoted above may be considerably lower than the actual limit of detection (LOD) for any real sample since the MDL is determined without consideration of matrix interferences, sample blanks, etc. For the present project, matrix interferences are the limiting factor, restricting the amount by which the LOD can be lowered by increasing the concentration factor. Values quoted for LOD in this report (for non-GC/MS methods) are analysts' estimates of analyte concentrations needed for determination of that analyte above the matrix interference level.

QUALITY CONTROL / QUALITY ASSURANCE

McKesson Environmental Services laboratories operate under a thorough program of quality assurance/ quality control.

Sample Receipt, Handling, Storage and Control

When a sample arives from the field, the sample custodian performs the following functions:

- Receipt of sample is recorded.
- Package is inspected and any damage recorded.
- Package contents are verified.
- Chain-of-Custody document is completed and discrepancies reported.
- Sample is logged in, number assigned and sample tagged.
- Laboratory sample sheet is initiated.
- Sample is assigned to storage.

Security, Chain-of-Custody and Document Control

In order to maintain a clear record for sample traceability and document accountability, the following procedures are enforced:

- Environmental Services laboratories and sample storage areas are maintained as secure facilities at all times.
- Chain-of-Custody procedures are rigorously followed.
- A document control officer is appointed.
- Documents are numbered and a document inventory maintained to include log books, sample sheets, and quality assurance documents.

Laboratory Operations

The laboratory performs adequate quality control on samples to assure the precision and accurancy of the data. The following are the minimum quality control requirements:

- One sample analyzed in duplicate for every ten samples or batch of samples.
- One spiked sample for every ten samples or batch of samples. Spikes shall be made at two to three times the detection limit, or at the analyte level.
- Surrogate compounds for volatile organic, base/neutral, and acid extractables.
- Method and field blanks, as apropriate, especially for aqueous samples.

For the present program, Methods 601, 624 and 625 employ surrogate spike compounds with the analysis of each sample. An internal standard is used with each sample for Method 608 and individual compound recoveries have been determined for typical compounds covered by other methods used.

QUALITY CONTROL PROCEDURES
DEPARTMENT OF WATER RESOURCES
BRYTE LABORATORY

1. Laboratory blanks are run on each analytical day.

2. Travel blanks are run along with each group of samples.

3. Standards are run at the beginning and end of each group of analyses.

4. Sample aliquot volumes are adjusted so standards bracket concentration of analyte, or are within 10 percent of sample peak height for each compound being analyzed.

5. Duplicate spiked samples are analyzed for precision and accuracy determinations on approximately 10 percent of samples.

LIMITS OF DETECTION
DEPARTMENT OF WATER RESOURCES BRYTE LABORATORY

Compound	Detection Limit (ug/L)
chloroform	0.1
bromodichloromethane	0.1
dibromochloromethane	0.2
bromoform	0.5
Alachlor	0.01
Atrazine	0.01
Azinphosmethyl (Guthion)	0.01
Bentazon	-.-
Chlorothalonil	0.01
2,4-D, Alkanolamine Salts	0.01
D-D Mixture	0.1
DEF	0.01
Diazinon	0.01
2,6-Dichloro-4-Nitroaniline	0.01
Dicofol	0.01
Dimethoate	0.01
Dimethyl Tetrachloroterephthalate (Dacthal)	0.01
DNBP (Dinoseb)	0.01
Disulfoton	0.01
Diuron	0.01
Ethylene Dibromide	0.2
Malathion	0.01
Methyl Bromide	0.1
Methyl Parathion	0.01
Parathion	0.01
Simazine	0.01
Toxaphene	0.5
Trifluralin	-.-
Xylene	4

GAS CHROMATOGRAPHIC CONDITIONS EMPLOYED FOR VOLATILE HALOCARBON ANALYSES

Gas Chromatograph: Tracor 565

Detectors:
Hall 700A Electrolytic Conductivity Detector
Tracor 703 Photoionization Detector

Column: 6-foot glass tube, 2 mm I.D.

Column Packing:
1% SP-1000 on Carbopack B 60/80 mesh (Supelco, Inc.)
Confirmation: n-octane on Porisil-C 100/200 mesh (Supelco, Inc.)

Temperatures:
Injector: 200°C

Column:
1% SP-1000; 100°C - 4 min.; 8°C/min to 200°C; hold 8 min.

n-octane; 60°C - 4 min; 6°C/min to 170°C; hold 4 min.

Detector Base: 250°C

Reactor: 825°C

Carrier Gas: He; Flow 30 mL/min

Reaction Gas: H2; Flow 50 mL/min

Recorder Chart Speed: 0.5 inch/min

Sampler: 5mL - Tekmar Liquid Sample Concentrator, Model LSC-2.
Purge 11 min; Desorb 4 min; Bake 10 min.

Trap: As specified in EPA Method 601 /1/

Approximate Retention Time (min) /2/:

	n-octane	SP-1000
Chloroform	7.0	7.4
Bromodichloromethane	9.8	10.4
Dibromochloromethane	12.4	13.6
Bromoform	15.0	16.6

/1/ Reference: Federal Register. 44:233 - Purgeable Halocarbons Method 601

/2/ Standards: Trihalomethane Mixture 4-8746. Supelco, Inc., Bellefonte, PA 16823

ANALYSIS OF TRIHALOMETHANE REFERENCE SAMPLE, MARCH 1982

Organization	Trihalomethane Concentration (ug/L) CHC13	CHBrC12	CHBr2C1	CHBr3	Total
DWR Bryte Laboratory	3.1	3.3	8.6	36	51
DOHS Sanitation and Radiation Laboratory	2.8	2.8	6.4	31.7	43.7

Appendix D

LABORATORY PERFORMANCE 1985-86

Appendix D

LABORATORY PERFORMANCE 1985-86

The performance of the Department's Bryte Laboratory and of McKesson Environmental Services was measured by the analytical results of internal quality control and inter-laboratory quality assurance samples. Several methods were used for appraisal; they included the analysis of spiked samples, field replicates, and laboratory replicates.

Bryte Laboratory

Measurements of standard water quality parameters and volatile organic trihalomethane compounds were performed by the Department's Bryte Laboratory.

Results of duplicate sample analyses are shown in Table 1. The laboratory experienced repeated difficulties in controlling the quality of TOC (total organic carbon) analyses. There were unacceptable differences in the results of duplicate samples.

Bryte Laboratory staff identified one cause for the TOC discrepancies. Two analysts had used incorrect multiplication factors to report values based on the sample aliquot sizes they had used. Four different volumes (1, 2, 3, or 5 mL) were used in the TOC analyses. Laboratory worksheets are being examined and checked for computation errors.

Table 1

ANALYSIS OF SPLIT SAMPLES BY DWR BRYTE LABORATORY

Station	Date	Time PST	Temp °C	pH	EC uS	DO	Na	Cl	Se	TOC	Turb	Color	C13	C12Br	ClBr2	Br3	TTHMFP
						<---mg/L--->							<---ug/L--->				
Clifton	04/09/86	1100	16.5	7.2	197	8.8	20	20	0.000	3.9	14	20	570	62	5	0	640
		1115	16.5	7.2	195	8.8	20	20	0.001	3.9	14	30	610	53	5	0	670
Banks	09/25/85	0820	22.5	7.5	588	7.9	69	102	0.000	2.7	6	10	340	89	40	10	400
		0820	22.5	7.5	584	7.9	70	102	0.000	6.5	6	5	290	170	63	13	540
Lindsey	06/25/86	0635	21.5	8.0	461	7.2	43	37	0.000	4.4	38	20	350	36	4	1	390
		0600	20.0	7.9	480	7.0	44	38	0.000	8.4	38	10	270	34	8	3	320
No.Bay	05/28/86	0945	19.5	8.3	306	9.6	10	5	0.000	3.1	7	5	300	15	1	0	320
		1045	19.5	8.3	300	9.5	9	5	0.000	2.8	6	10	120	8	3	2	130
Mallard Island	12/03/85	1010	12.0	7.5	9970	9.9	1760	3130	0.000	3.4	8	8	11	72	340	640	1100
		1010	12.0	7.5	9950	9.9	1760	3130	0.000	7.1	8	5	9	78	280	540	910
Greene's	02/27/86	1240	12.5	7.1	84	10.5	4	2	0.000	4.2	64	20	340	7	0	0	350
		1240	12.5	7.1	84	10.5	4	2	0.000	2.9	63	10	320	8	0	0	330
Vernalis	11/15/85	0820	8.5	7.5	706	9.7	80	94	0.001	2.9	7	15	220	130	71	7	430
		0820	8.5	7.5	709	9.7	80	94	0.001	4.1	7	5	240	130	71	8	450

The cause for disparities in TOC results for duplicate samples when aliquot volumes were the same was traced to instrumentation problems. A new TOC analyzer will be purchased. Until the accuracy of the TOC data can be established, program staff will not interpret or correlate TOC data with other parameters.

The differences in chloroform values between duplicate samples were considered small and acceptable to the monitoring program. However, duplicate sample analyses for TTHMFP and some THM species had significant discrepancies. Color measurements were also rarely repeatable in the laboratory, for no known reason. The results of duplicate samples for other water quality parameters were found to be acceptable.

The installation of several new analytical instruments has disrupted work at the Bryte Laboratory, and a large backlog of samples has built up. As a result of the backlog and because of the problems with TOC analyses, the TTHMFP and TOC samples will be analyzed by the McKesson Environmental Services laboratory starting in November 1986.

McKesson Environmental Services

McKesson Environmental Services (MES) is a commercial laboratory facility located in Pleasanton, California. MES is under contract to the Department to provide pesticide and priority pollutant analyses of water for the Health Aspects Monitoring Program. On occasion, MES conducted bromide and dissolved copper analyses when requested. However, these two analyses were discontinued because sample concentrations were often much lower than the MES laboratory detection limits. Quality control procedures are presented in Appendix C.

MES conducted spike recovery tests on each chemical requested for analysis by the Department. Table 2 shows the results of these tests for field samples collected in June through August 1985, December 1985, and May 1986. Both distilled water and field samples were spiked to conduct these recovery measurements.

In general, method spike recoveries varied between sampling runs and among analytes, but overall recoveries were better than 70 percent. Exceptions were analyses for methamidophos (24%, 46%, and 60% at 40 ug/L); 2,4-D salt (50% at 20 ug/L); MCPA (52% at 60 ug/L); and methyl parathion (42% at 1 ug/L). The method spikes represent the achievable recovery and variation with the analytical method used by the laboratory. Extraction methods to improve the recovery of methamidophos were initiated by MES as a result of the consistently low recoveries.

Spiked samples prepared by the Department's Bryte Laboratory were also submitted with each batch of field samples. These spiked samples were coded and "blind" to MES. The samples consisted of tap water spiked with pesticides. Results are presented in Table 3. The results pinpointed some errors in identifying compounds and reporting laboratory results. Upon notification, MES conducted an investigation to correct the problems. The problems and corrective actions were /1/:

1. MES reported no detection of 2,4-D in the August 20 and 21, 1985 QA spike. Upon re-examination of the data, MES discovered an incorrect transcription of results from laboratory worksheets to the final report form. The chemical 2,4-D was actually found and confirmed on a second gas chromatography (GC) column.

2. MES reported 1.7 ug/L of metalaxyl in a reference spike that was not spiked with metalaxyl. MES re-examined the chromatogram and noted that the retention time for metalaxyl was outside the retention time range set

Table 2

McKESSON ENVIRONMENTAL SERVICES RECOVERIES OF SPIKED SAMPLES FOR IN-HOUSE QUALITY CONTROL MEASUREMENTS

Lab Method	Chemical	June 1985 analyses Spiked Amount	June 1985 analyses Percent Recovery	July 1985 analyses Spiked Amount	July 1985 analyses Percent Recovery	August 1985 analyses Spiked Amount	August 1985 analyses Percent Recovery	Dec. 1985 analyses Spiked Amount	Dec. 1985 analyses Percent Recovery	May 1986 analyses Spiked Amount	May 1986 analyses Percent Recovery
622	2,4-D salt	10	71	10	50	10.4	72	20	32	20	50 *
HPLC	Bentazon	20	107 *	20	93 *	30	38	30	75	30	140 *
614	Carbofuran	10	110	10	97	5	58	5.3	107 *	---	---
GC-ECD	Chloropicrin	11	100	11	27	1.14	62	1.1	73	1.0	120 *
608	Dacthal	10	137	10	140	1	100	1	110 *	1.5	150 *
601/602	D-D mixture	12	97 *	8	101 *	20	95	20	88	20	76
622	MCPA	30	74	30	60	31	80	60	42	60	52 *
614	Metalaxyl	30	81 *	30	81 *	5	80	5	54	---	---
614	Methamidophos	315	10	315	10	40	46 *	40	60 *	40	26 *
614	Methyl bromide	12	98 *	8	105 *	20	145	20	93	20	119
614	Methyl parathion	1	42 *	10	40	5	100 *	5	120 *	---	---
614	Molinate	10	119	10	140	5	74 *	5.1	82 *	---	---
wet chem	Paraquat dichloride	200	85 *	20	77	20	98	20	99	20	75 *
614	Thiobencarb	10	110	10	98	5	44	5	94 *	---	---
601/602	Xylene	12	98 *	8	114 *	60	127	40	93	20	74
AAS	Copper	50	106 *	50	96	15	111	10	107	---	---
	Bromide	8	91	8	88	0.8	81	---	---	---	---

The "*" designates these were recoveries of spikes in distilled water samples.
Values without "*" in percent recovery column were recoveries of spikes to actual field samples.
All units in ug/L except for bromide which is in mg/L.

Table 3

ANALYSIS OF SPLIT SAMPLES BY McKESSON ENVIRONMENTAL SERVICES LABORATORY

Sample Number	Date Sampled	Date Reported	Spike Compound	Spike Concentration ug/L	Recovered* Concentration ug/L	Percent Recovery
RP52	6/17/85	8/20/85	2,4-D Salt	5.0	2.7	54
			Dacthal	4.9	(6.0)	122
			Molinate	5.4	5.9	109
RP67	7/16/85	9/29/85	2,4-D Salt	4.9	1.0	20
			Dacthal	4.7	(4.2)	85
			Molinate	5.3	3.6	68
RP71	8/20/85	9/20/85	2,4-D Salt	5.0	(1.6)	32
			Dacthal	4.9	(1.7)	35
			Molinate	5.4	3.7	69
RP86	9/4/85	10/2/85	2,4-D Salt	5.0	2.7	54
			Dacthal	4.9	4.2	86
			Methyl Parathion	5.1	3.2	63

All spike samples were prepared by Department of Water Resources Bryte Laboratory.

* Where numbers are in parentheses, the spike was not detected.
Numbers are revised values after discovering the cause of the errors.

for its identification. The chromatogram also contained numerous large peaks, making interpretation difficult, and probably resulted from dirty glassware.

3. MES did not detect Dacthal in three reference spikes that contained about 5 ug/L Dacthal. It was later determined that MES had been led to an incorrect identification of the retention time for Dacthal peaks on the gas chromatograms because of a contaminated reference standard used by MES for internal spikes. The contaminated Dacthal standard produced two peaks, one for Dacthal and the other for the contaminant chlorobenzene. When further analyses were performed with a new, pure Dacthal standard, the misidentifications were corrected and the chromatograms showed the correct retention time for Dacthal. All chromatograms of DWR samples were then re-examined and corrected with the proper Dacthal results.

The Department of Health Services (DOHS) was particularly concerned about future misidentifications and failure of reporting unidentified peaks. DOHS offered the following suggestions /2/:

> "1. For each analysis requested by DWR from its support laboratories, information pertaining to all unidentified peaks should be reported. When such peaks occur, retention times may offer qualitative information; quantitative data is accessible by one or both of the following two formats:
>
> (i) Using the retention time of the standard chemical compound nearest the unknown as a reference, calculate, and report the unknown chemical's concentration on the basis of relative peak heights between standard and unknown. Reagent- and method blanks should be used and compared as well.
>
> (ii) Using the lowest relative response for any standard of known concentration analyzed by the method in question, calculate the maximum concentration for any unknown peak observed. Make proper accounting for blank contributions and report this also."

MES agreed to follow the DOHS recommendations on tabulating retention time and peak area data for the Department, but cautioned against attempts to quantify the data from reported unidentified peak areas. MES experience had led to the observation that /3/:

> Electron capture of flame photometric detectors common to pesticide analysis have sensitivities which may vary by several orders of magnitude from one compound to another. Without some knowledge of the compound producing the peak, no quantitative information can be inferred."

DWR requested MES to follow the DOHS recommendations on a trial basis thereafter.

Field duplicates were also submitted to MES. These are samples taken from the same location and time and split into more than one sample set for analysis. When field duplicates were not obtained, field replicates were taken. Replicate samples are those taken from the same location within a short time period, with each replicate stored in its own sample container. When large volumes of water are needed for analysis, field replicates are more convenient to obtain than proportioning water samples among several containers. There was good agreement in the results (Table 4).

Field duplicate samples were also split between MES and the DWR Bryte Lab for comparison. The results are shown in Table 4.

Table 4

McKESSON ENVIRONMENTAL SERVICES LABORATORY ANALYSES OF DUPLICATE SAMPLES

Chemical	6-17-85 San Joaquin River near Vernalis RP 56	RP 57	l.o.d.	7-16-85 San Joaquin River near Vernalis RP 66	RP 68	l.o.d.	8-20-85 San Joaquin River near Vernalis RP 75	RP 76	l.o.d.	9-4-85 Colusa Basin Drain RP 82	RP 85	l.o.d.
2,4-D salt	ND	ND	.1	ND	ND	.1	ND	ND	.01	ND	ND	.5
Bentazon	ND	ND	.2	ND	ND	.1	ND	ND	.2	0.9	0.8	.2
Carbofuran	ND	ND	.5	ND	ND	.5	ND	ND	.5	ND	0.08	.02
Chloropicrin	ND	ND	.1	ND	ND	.1	ND	ND	.1	ND	ND	.1
Dacthal	ND	ND	.01	ND	ND	.01	ND	ND	.05	ND	ND	.01
D-D mixture	ND	ND	.1	ND	ND	.1	ND	ND	.1	ND	ND	.2
MCPA	ND	ND	1.0	ND	ND	1.0	ND	ND	10	ND	ND	20
Metalaxyl	ND	ND	1.0	ND	ND	1.0	ND	ND	10	ND	ND	.05
Methamidophos	ND	ND	2.0	ND	ND	2.0	ND	ND	.5	ND	ND	13
Methyl bromide	ND	ND	.5	ND	ND	.5	ND	ND	.5	ND	ND	.5
Methyl parathion	ND	ND	2.5	2.5	ND	2.5	ND	ND	1	ND	ND	.01
Molinate	ND	ND	1.0	ND	ND	1.0	ND	ND	.5	0.09	0.08	.01
Paraquat dichloride	ND	ND	20.0	ND	ND	20.0	ND	ND	10	ND	ND	10
Thiobencarb	ND	ND	8.0	ND	ND	8.0	ND	ND	1	0.08	0.07	.01
Xylene	ND	ND	1.0	ND	ND	.2	ND	ND	.5	ND	ND	.2
Copper	ND	ND	5.0	6.0	16	5.0	5	ND	5			
Bromide	ND	ND	0.6	2.6	ND	0.6	ND	ND	.1			
Chloride	87	85	.2	64	64	.1	130	120	.02			

l.o.d. = limit of detection ND = not detected
All units in ug/L except for bromide and chloride values which are in mg/L.
RP numbers (e.g. RP 56) are sample identification codes.

Department of Health Services Evaluation

In May 1986, the Department of Health Services was asked to evaluate the performance of pesticide analyses by McKesson Environmental Services and the DWR Bryte Laboratory. River water was collected from the Sacramento River at Greene's Landing and spiked with a variety of pesticides. The staff of the DOHS Sanitation and Radiation Laboratory in Berkeley performed the spiking. The amounts and materials placed into the water samples were unknown to the DWR staff and to the laboratories. Duplicate sets of the spiked samples were delivered to MES and the Bryte Lab by the monitoring program staff. The Bryte Lab does not routinely perform pesticide analyses for the Health Aspects Monitoring Program because of limited capabilities. However, samples were sent to Bryte to assess its current limitations and assist the laboratory in upgrading its capabilities.

Duplicate samples from three Delta locations were also submitted to each laboratory. These samples were not spiked.

Both laboratories were requested to analyze for specific compounds and report unidentified peaks in the chromatograms.

The reports of MES and the Bryte Lab were submitted to DOHS for review. The initial cursory review suggested major reporting discrepancies in the analysis for some compounds in the spiked reference samples and raised many points that needed clarification (Attachment 1) /4, 5/.

A meeting among DOHS, DWR, and MES representatives was held on October 3, 1986 to discuss and clarify the results. The meeting revealed a misunderstanding between MES and DWR on the reporting requirements that were expected and MES' reporting policy on trace contaminants and limits of detection by the laboratory. The full text of these discussions is presented in Attachment 2 /6/.

In summary, the qualitative assessment of the QA study indicated MES is capable of detecting the compounds spiked in the samples. Compounds spiked by DOHS but not reported by MES resulted when analyses or the appropriate analytical methodology were not requested by DWR.

Another QA study will be conducted with the inclusion of the laboratories of The Metropolitan Water District of Southern California and East Bay Municipal Utility District.

The QA program has been effective in identifying laboratory problems and miscommunication between the Monitoring Program staff and the laboratories. In all cases, investigations have been fruitful and corrective actions have been taken. The limited QA activities thus far clearly demonstrate the importance of continuing QA as an integral part of the program.

APPENDIX D REFERENCES

1 Michael Larson and Dr. Warren Steele, McKesson Environmental Services. Letter to Richard Woodard, Department of Water Resources. October 9, 1985.

2 Dr. Michael Volz, Department of Health Services. Memorandum to B. J. Archer, Department of Water Resources. March 27, 1986.

3 Dr. Warren Steel, McKesson Environmental Services. Letter to B. J. Archer, Department of Water Resources. April 28, 1986.

4 Dr. Michael Volz, Department of Health Services. Memorandum to B. J. Archer, Department of Water Resources. September 15, 1986.

5 Dr. Ben Tamplin and Dr. Michael Volz, Department of Health Services. Memorandum to B. J. Archer, Department of Water Resources. October 1, 1986.

6 Dr. Michael Volz, Department of Health Services. Memorandum to B. J. Archer, Department of Water Resources. October 8, 1986.

Attachment 1

State of California — Department of Health Services

Memorandum

To : Mr. B. J. Archer, Chief
Water Quality and Reuse Section, Central District
Department of Water Resources (DWR)

Via: B. R. Tamplin, Ph.D., Chief
Sanitation and Radiation Laboratory

From : Michael G. Volz, Ph.D.
Environmental Biochemist
Quality Assurance Officer
Sanitation and Radiation Laboratory

Date : September 15, 1986

Subject: QA Evaluation of SRL Spike Sample Study with MES and DWR/Bryte

Attached find a qualitative summary of analytical results (Table 1) and pertinent information (Table 2) generated by the Sanitation and Radiation Laboratory of the Department of Health Services (SRL), McKesson Environmental Services (MES), and DWR's Bryte Laboratory (DWR/Bryte) in support of the recent QA activity involving spikes of selected organic chemicals by SRL into river water supplied by DWR.

SRL attempted to meet as many as possible of DWR's requests for spiked samples pertaining to specific analytical groups in this study. However, as indicated in Table 2, we were limited by the breadth of our supply of stock reference samples and chronic problems with instrumentation requisite to substantiate spiked sample composition. Despite these inhibitions, the precision over 4 replications of the combined spiking and analytical protocols for many analytes was exceptionally good (Table 2). This suggests that each laboratory received representative spikes.

After an examination of the results, SRL recommends the following:

(1) MES and DWR/Bryte should reevaluate their analytical data in support of the QA activity taking into account the information presented in Tables 1 and 2.

   (a) Some spiked compounds originally not reported actually may have been seen on chromatograms but were not correctly identified.

   (b) Other compounds not spiked into river water by SRL but reported by one or both of the other laboratories may simply be misidentifications in conjunction with (a) above or, in the case of analytes associated with those analyses not performed by SRL, may be reflective of actual contamination of the river water.

(2) MES and DWR/Bryte should clarify their reporting procedure for laboratory data. We do not know if some spiked compounds were not reported simply because method and/or matrix "blank" concentrations were accounted for internally prior to the data reporting phase. We also do not know if Limits of Detection were nominal such as the MDLs in the EPA 600 series or whether the reported Limits of Detection were actually attained by the laboratories.

(3) MES and DWR/Bryte should consider the impact(s) of knowing what chemicals specifically mentioned by DWR as requiring quantitation in this activity or as part of DWR's regular IDHAMP monitoring program may have influenced data interpretation following generic laboratory methodology. For example, if it was assumed for one or more reasons that certain substances were expected to be present, was it the convention to assume that the peaks found were "close" enough to warrant a "positive" finding in the absence of more substantive confirmatory information?

(4) MES and DWR/Bryte should address how previous information and chromatographic characteristics in their respective data bases characterizing river water quality may have influenced qualitative interpretations of the data generated in this study.

(5) Quantitative assessments regarding relative laboratory performance on specific analytical methodologies should be addressed in future communications.

Please contact us should you need further assistance at 8-571-2201 or (415) 540-2201.

cc: G. W. Fuhs, Dr. sci. nat., DL/DHS
✓M. Jung, DWR
R. Woodard, DWR
A. del Rosario, SRL/DHS
S. Khalifa, Ph.D., SRL/DHS

Table 1
Qualitative Summary

Analytical Method Chemical Compound	(µg/L) Spiked** by SRL	Presence Reported*		
		SRL	MES	DWR/Bryte
EPA 601/602	(0.5-3)			
Methylene chloride	(+)	+		
1,1-Dichloroethylene	(+)	+		
1,1-Dichloroethane	(+)	+	+	
Chloroform	(+)	+	+	+
Carbon Tetrachloride	(+)	+	+	+
1,2-Dichloropropane	(+)	+	+	
Trichloroethylene	(+)	+	+	+
1,1,2-Trichloroethane	(+)	+		
Dibromochloromethane	(+)	+	+	
Tetrachloroethylene	(+)	+	+	+
Chlorobenzene	(+)	+	+	+
2-Chloroethyl vinyl ether	(+)#			
trans-1,2-Dichloroethylene	(+)	+	+	+
1,2-Dichloroethane	(+)	+	+	
1,1,1-Trichloroethane	(+)	+	+	+
Bromodichloromethane	(+)	+		+
trans-1,3-Dichloropropene	(+)	+		
cis-1,3-Dichloropropene	(+)	+		
Benzene	(+)	(N/A)	+	
Bromoform	(+)	+	+	
1,1,2,2-Tetrachloroethane	(+)	+		
Toluene	(+)	(N/A)	+	
Ethylbenzene	(+)	(N/A)	+	
Dichlorobenzene	(-)	(N/A)		+
EPA 608	(0.2-6)			
Dacthal	(+)	+	+	+
Heptachlor	(+)	+		
Heptachlor Epoxide	(+)	+		
Lindane	(+)	+		
DDE	(+)	+		
Endrin	(+)	+		+
DDD	(+)	+		+
DDT	(+)	+		
Methoxychlor	(+)	+		

Analytical Method Chemical Compound	(ug/L) Spiked** by SRL	Presence Reported* SRL	 MES	 DWR/Bryte
EPA 614	(0.6-0.9)			
Diazinon	(+)	+	+	+
Methyl Parathion	(+)	+	+	
Ethyl Parathion	(+)	+	+	
Molinate	(-)		+	
Carbofuran	(-)		+	
Malathion	(-)		+	+
EPA 622	(12-18)			
2,4-D	(+)	+	+	+
EPA 632-HPLC	(5-8)			
Carbaryl	(+)	(N/A)		
Methomyl	(+)	(N/A)		
GC-ECD	(N.S.)			
Chloropicrin	(-)	(N/A)		
Wet Chemistry	(N.S.)			
Paraquat	(-)	(N/A)		
Others	(N.S.)			
Atrazine/Simazine	(-)	(N/A)		+
EDB	(-)	(N/A)	+	+

* - (+) denotes presence of chemical compound was reported; no entry denotes presence of chemical compound was not reported; data is from Summary Tables in memo of 8/14/86 from B. J. Archer (DWR) to Dr. B. R. Tamplin (SRL/DHS).

** - (+) denotes chemical compound spiked into river water;
(-) denotes chemical compound was not spiked into river water.

(N/A) - Chemical compound was not analyzed for. See Table 2 for additional information.

- Manufacturer cannot guarantee stability of this compound in standard mixture.

N.S. - Not spiked by SRL.

Table 2

SRL Analytical Support Information[a]

Analytical Method	Limits of Detection	Comment(s)
EPA 601	0.5 µg/L (Nominal)*	See *
EPA 602	(N/A)-0.5 µg/L (Nominal)*	Spiked with Benzene, Toluene, Ethylbenzene. See **
EPA 608	0.01-0.20 µg/L	Method Spike Recoveries: 80 - 90 %: Range in precision for each analyte over all analytes: 1.3 - 11.1 %
EPA 614	0.02 - 0.05 µg/L	Method Spike Recoveries: Range in precision for each analyte over all analytes: 1.3 - 3.2 %
EPA 622	0.08 µg/L (2,4-D)#	Method Spike Recovery: 81% precision: ± 9.9%
EPA 632-HPLC	N/A	Spiked with Carbaryl and Methomyl. See **.
GC-ECD	N/A	Did not spike with Chloropicrin.
Wet Chemistry	N/A	Did not spike with Paraquat.

[a] - Analytical results derived from mean of 4 separate analyses (4 spiked bottles of river water.

* - For purposes of reporting as per AB 1803 policy; for EPA 601 instrumental limits of detection (areal integration) range: 0.003 - 0.19 µg/L.

** - Instrument non-operational.

N/A - Analysis not performed by SRL/DHS.

- Analytical method (SRL/DHS) was from Application Scientist Vol. 1 (J. T. Baker) as per S. Khalifa, Ph.D.

Memorandum

To : Mr. B.J. Archer, Chief
Water Quality and Reuse Section
Central District
Dept. of Water Resources (DWR)
P.O. Box 160088
3251 "S" St.
Sacramento, CA 95816

Date : October 8, 1986

Subject: QA Evaluation of MES' Performance on Spiked River Water Samples

Via : B.R. Tamplin, Ph.D., Chief BRT
Sanitation and Radiation Lab

From: M.G. Volz, Ph.D. MGV
Environmental Biochemist
Sanitation and Radiation Lab

On October 3, 1986, in Pleasanton, CA, Rick Woodard and Marvin Jung of your staff and I met with Dr. Warren Steele of DWR's contract laboratory, McKesson Environmental Services (MES). The purpose of the meeting was to discuss results of the recent Quality Assurance (QA) Study designed to evaluate the analytical proficiency of MES when DWR provided them with river water samples which had been previously spiked with selected organic compounds by the Sanitation and Radiation Laboratory (SRL) of the Department of Health Services (DHS). See attached memo of M. Volz to B. Archer, 9/15/86, for details.

Our discussion has revealed that, rather than analytical methodologies being highly suspect as might be concluded from a superficial evaluation of the attached results, the following statements better describe the data.

1. Some compounds like methylene chloride (a widely used organic solvent in extraction protocols) were not reported because of inherent contamination problems with both samples and blanks that are typical of commercial laboratory operations.

2. Certain compounds co-elute with others on chromatograms, e.g., several of the EPA m601 analytes, thus preventing definitive compound identification and subsequent reporting.

3. Many analytes in the EPA m608 scan were apparently detected on chromatograms by MES staff but were not reported except as "unidentified peaks" pursuant to prior agreement with DWR.

4. Additional compounds reported by MES in the EPA m614 methodology may be reflective of the actual presence of these pesticides in unspiked

river water. A similar argument could be made for Atrazine, Simazine, and EDB.

5. A compound like Bentazon (specifically requested as an analyte by DWR) would not have been seen using EPA m632. Hence, MES utilized an alternate procedure. However, the SRL spikes of Carbaryl and Methomyl then were not quantifiable by MES and not reported.

As a result of the above, SRL/DHS recommends the following:

A. Each chemical which was spiked into river water by SRL but was not reported by MES should be evaluated as an individual analyte and be commented upon by MES to DWR.

B. Similarly each chemical reported by MES but not spiked by SRL should be addressed as in (A). Those instances where the actual presence of compounds in unspiked river water may have been expected to occur should be differentiated from those where suspected or confirmed compound misidentification and reporting has taken place. In the future, unspiked river water also should be provided to participating laboratories to help resolve this issue.

C. Careful evaluation of what truly was expected of MES by DWR and DHS with respect to each and every analyte and/or analytical method under consideration should be made. There appeared to be several instances of miscommunication in the QA Study. Resolution of these discrepancies is essential for future program-and cost effective QA activities in support of the IDHAMP.

D. The performance of DWR's Bryte laboratory also should be carefully evaluated using criteria (A)-(C) above. Proficient laboratory support from this source is essential for the IDHAMP.

E. Quantitative assessment of the present QA Study should be made only after the qualitative aspects described above have been resolved. Perhaps any quantitative assessment should be held in abeyance until EBMUD and MWD have entered future QA evaluations. They both indicated such an interest in our September 26, 1986 meeting.

For further information please contact this office at 8-571-2201 or (415) 540-2201.

cc: G.W. Fuhs, Dr. sci. nat.
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Appendix E

TIDAL EFFECTS STUDY FIELD MEASUREMENTS

OLD RIVER TIDE CYCLE STATIONS

Program Station Number	DWR Station Number	Station Name
OR 4b	B9D75891348	Old River North of Rock Slough
OR 5a	B9D75821343	Old River opposite Rancho del Rio
OR 6a	B9D75571335	Old River South of Orwood
OR 9	B9D75351342	Old River near Byron (Highway 4)
OR 12	B9D75111331	West Canal at Old River
OR 15	B9D74971332	West Canal at Clifton Court Forebay Intake
OR 16	B9D74901334	Delta-Mendota Canal near Intake from Old River

MIDDLE RIVER TIDE CYCLE STATIONS

Program Station Number	DWR Station Number	Station Name
MR 2	B9D80011306	Middle River at Latham Slough
MR 3a	B9D75881321	Middle River North of Empire Cut
MR 5	B9D75741317	Middle River at Bacon Island Bridge
MR 12	B9D75431293	Middle River North of Highway 4 Bridge
MR 15b	B9D75311300	Victoria Canal near Middle River
MR 16	B9D75311282	Middle River West of Tracy Blvd.

POTATO SLOUGH TIDE CYCLE STATIONS

Program Station Number	DWR Station Number	Station Name
PS 1	B9D80611333	Mokelumne River near Mouth
PS 2	B9D80501344	San Joaquin River at Mouth of Potato Slough
PS 2a	B9D80531311	Potato Slough near Little Potato Slough
PS 3	B9D80371300	Little Connection Slough at Venice Ferry
PS 3a	B9D80481300	Little Potato Slough near Potato Slough
PS 4	B9D80561291	White Slough near Little Potato Slough

FIELD MEASUREMENTS DURING HIGH SLACK TIDE
Old River Sampling Run -- August 7, 1986

Station I.D.	Time PST	Depth ft.	Temp. F.	E.C. uS/cm	Bottom depth (ft.)	Comments
OR-4B	0708	1	72	220	27	midchannel
		3	72	220		
		6	72	225		
		9	72	235		
	0705	12	71	240		
		15	71	240		
		18	71	245		
	0702	24	71	245		
OR-4B	0716	3	72	230	21.5	dragged anchor
		6		230		to south
		9		235		
		12		235		slack water
	0719	15		240		ended 0820
OR-5A	0741	1		235	15	slack water
		3		230		ended 0840
		6		230		
		9		230		
	0744	12		230		
OR-6A	0800	3		230	17	slack water
		6		230		ended 0910
	0810	12		230		
OR-9	0819	3		230	24	sampled at
		6		225		center support
		9		225		of Highway 4
		12		225		bridge on
		15	74	225		southside
OR-12	0841	3	74	240	32	negative flow
		6		245		observed
		9		245		W. Canal site
		18		245		
	0845	24	74.5	250		
OR-15	0905	3	75	240	19	Clifton Ct.
		9		240		gates all open
		18	75	240		
OR-16C	0927	3	75	245	8	DMC intake
		6		245		
OR-16S	0938	3	75	240	24	Old River
		9		240		side
		15		240		strong current
		21		240		sampled depths
						are less than
						noted

FIELD MEASUREMENTS DURING HIGH SLACK TIDE
Old River Sampling Run -- August 21, 1986

Station I.D.	Time PST	Depth ft.	Temp. F.	E.C. uS/cm	Bottom depth (ft.)	Comments
OR-4B	0720	3	70	260	35	
		6		260		
		9		265		
		12		265		
		15		265		
	0726	18		265		
OR-4B	0810	3		245	35	At slack
		6		250		
		9		260		
		12		265		
		15		265		
		18		265		
		21		270		
		24	70	270		
OR-5A	0819	3	70	260	19	
		6		260		
		9		260		
		12		260		
		15		260		
	0821	18	71	260		
OR-6A	0836	3	71	260	21	
		6		260		
		9		260		
		12		260		
		15		260		
	0840	18		260		
OR-9	0853	3	72	265	20	
		6		265		
		9		265		
		12		265		
		15		265		
	0856	18		265		
OR-12	0917	3	72	280	28	strong current sampled depths less than noted
		6		280		
		9		280		
		12		280		
	0920	15		280		
OR-15	0925	3	72	285	20	Clifton Ct. gates closed
		6		285		
		9		280		
		12		280		
		15		280		
OR-16S	0935	3	72	290	14	Old River side of DMC intake
		6		290		
		9		290		
		12		290		
	0937	15		290		
OR-16C	0943	3	72	300	17	Canal side of DMC intake
		6		300		
		9		300		
	0946	12		300		

FIELD MEASUREMENTS DURING HIGH SLACK TIDE
Middle River Sampling Run -- August 21, 1986

Station I.D.	Time PST	Depth ft.	Temp. F.	E.C. uS/cm	Bottom depth (ft.)	Comments
MR-1	0730	1		174		
	0734	6		171		
		9		171		
		12		170		
	0735	15		170		
		18		169		
		21		169		
		24		168		
		27		168		
		30		168		
MR-3A	0747	1		182		
		6		180		
		9		180		
		12		180		
		15		179		
		18		178		
		21		179		
		24		178		
		27		178		
MR-5	0802	1		258		
		6		259		
		9		260		
		12		260		
		15		261		
		18		260		
		21		260		
		24		260		
		27		260		
		30		260		
MR-12	0842	1		237		
		6		237		
		9		236		
		12		235		
		15		244		
MR-15B	0907	1		251		
		6		246		
		9		246		
		12		246		
MR-16	0933	1		247		
		6		249		

FIELD MEASUREMENTS DURING HIGH SLACK TIDE
Potato Slough Sampling Run -- August 22, 1986

Station I.D.	Time PDT	Depth ft.	Temp. F.	E.C. uS/cm	Bottom depth (ft.)	Comments
PS-1	0800	3	70	200		
		6		200		
		9		200		
		12		200		
		15		200		
		18		200		
	0802	21		200		
PS-2	0821	3	68	210		Windy and chopp
		6		210		
		9		210		Sampled depths
		12		210		less than noted
	0822	21		210		
PS-2A	0843	3	70	180		
		6		178		
		9		178		
		12		178		
	0844	15		178		
PS-3	0857	3	72	175		South of
		6		175		ag drain
		9		175		discharge
		12		175		on Empire Tr.
	0859	18		180		
PS-3A	0908	3	70	180		
		6		180		
		9		183		
		12		185		
		15		185		
	0910	18		185		
PS-4	0919	3	71	195		
		6		195		
		9		195		
		12		195		
	0920	15		195		

Appendix F

PESTICIDE MONITORING SELECTION SCHEME

PESTICIDE MONITORING SELECTION SCHEME

As part of the Interagency Delta Health Aspects Monitoring Program, surface waters were monitored for agricultural chemicals that might be difficult to control using conventional water treatment practices. In general, such chemicals are water soluble and have a low affinity for adsorption onto particulate matter. Consequently, flocculation, settling, and filtration processes are ineffective in removing these dissolved substances. On the other hand, chemicals with sparingly low water solubilities tend to be readily attracted to solid media and can be controlled in a typical treatment facility.

Selection of chemicals and timing for monitoring at a site can be difficult. Broad scans for hundreds of chemicals are expensive (thousands of dollars per sample) and do not produce significantly more information than does taking a sensible and rational approach. The continued practice of limiting analyses to traditionally monitored chemicals such as banned chlorinated pesticides may even be less productive in assessing current water quality conditions.

The Department chose to develop and use a selection scheme based on a combination of quantitative information (e.g. reported chemical usage patterns and properties) and judgmental assessments (e.g. major activities upstream of a sampling site). A database of the quantitative information was compiled for the selection process.

The objective of the scheme was to develop a list of those chemicals with the highest probability of posing treatment difficulties to public water supplies in the Delta. Chemicals on this list would be monitored.

The selection scheme produced site- and time-specific target lists of chemicals for monitoring. The scheme and database can also be used in other types of monitoring programs (e.g. ground water, biological contamination surveys) by using different selection criteria values (e.g. ranges of water solubilities and partition coefficients). Target lists could be developed for different environmental compartments (e.g. sediment, water, biota).

Method

Pesticide and crop pattern data of the State Department of Food and Agriculture were compiled to determine the amount and period of usage. Data were obtained for 1983, the most recent database containing a full year of record at the time of the compilation. Data for pesticide usage were ranked for each county and then combined for watersheds of interest

to this program (those encompassing our sampling sites). The chemicals were then ranked by usage for each watershed.

Information was compiled for each chemical on water solubility, log P (octanol/water partition coefficients), log Koc (soil activity coefficients), estimated half-life in water, period of use by month, type of use, and whether it was on the AB-1803 list. (The AB-1803 list is the California Assembly Bill 1803 list of chemicals that must be monitored in ground water by the Department of Health Services).

The octanol/water partition coefficient is defined as the ratio of a chemical's concentration in the octanol phase to that in the aqueous phase of a two-phase octanol/water system. The ratios are often reported in logarithmic units (log P). Values of P are meaningful since they represent the tendency of a chemical to partition itself between an organic phase (e.g. soil, fish) and an aqueous phase. Chemicals with low P values are relatively hydrophilic (i.e. water soluble) and have small soil/sediment absorption coefficients, and small bioconcentration factors for aquatic life. Chemicals with high P values (e.g. log P greater than 4) are very hydrophobic. The P values can be measured in the laboratory or estimated from water solubility relationships, knowledge of chemical structure, and other solvent/water partition coefficients.

The soil adsorption coefficient, Koc, is the ratio of the amount of chemical adsorbed per unit weight of organic carbon (oc) in the soil or sediment to that amount in solution at equilibrium. Logarithmic values, log Koc, are reported because of the high range of values. The degree of adsorption affects the chemical's mobility, volatilization, photolysis, hydrolysis, and biodegradation. Koc can be measured in the laboratory and estimated from empirical relationships with other chemical properties (e.g. solubility, log P).

Information on the chemical properties was compiled from numerous recent publications /1-11/ and the ISHOW (Information System for Hazardous Organics in the Water Environment) computer database of EPA. When conflicting values were found, the lower values were entered into the database. An excellent discussion of the degree of error associated with measurements of chemical properties is presented in Lyman et al /12/.

The chemicals were grouped by selected ranges of reported or calculated water solubilities and specified ranges of partition coefficients as measured by their affinities for water or organic-laden soil (e.g. by log P and log Koc values). Eight groups were created from the following criteria:

Group	Water Solubility	log P and log Koc
1	> 999 mg/L	equal to or <2
2	> 999 mg/L	>2 but < or equal to 3
3	100-999 mg/L	equal to or <2
4	100-999 mg/L	>2 but < or equal to 3
5	10-99 mg/L	equal to or <2
6	10-99 mg/L	>2 but < or equal to 3
7	< 10 mg/L	equal to or <2
8	< 10 mg/L	>2 but < or equal to 3

A ninth group that would comprise those chemicals of log P or Koc values above 3 was not pertinent because it represented the very hydrophobic chemicals generally controllable in a modern water treatment plant.

Chemicals that had certain water solubilities and both log P and log Koc values were sorted and placed into the appropriate groups. However, those chemicals missing solubility data, log P, or Koc data were read as zero values by the computer software program, Lotus Symphony.

The groups represented those chemicals more likely to be dissolved in water (Groups 1 and 2) and those more likely to be in suspended material and organic particles in the water column (increasingly hydrophobic in order of group number).

The selection process for developing a list of candidate chemicals to be monitored consisted of inclusion of the most water soluble chemicals (Group 1 and 2 chemicals) and those with moderate water solubilities and partition coefficients (Groups 3 and 4). Additional pesticides, regardless of solubilities and partition coefficients, were added to the list when applied amounts were significant (among the top in ranked usage for the watershed) and the application method might lead to water contamination. For example, rice herbicides were added to the list because of the large quantities used and because they are applied to rice ponds just a few days before pond water and surface agricultural drainage are discharged into nearby rivers. To eliminate selection bias, each chemical was given a unique code for identification during the sorting and selection of pesticides for inclusion in the candidate lists. This step was taken to avoid inclusion of chemicals that technically might not meet the selection criteria but that were popular or traditional chemicals in other monitoring studies.

A final target list of chemicals to be monitored at specific sampling stations was developed after site location data on riverflow direction and upstream pesticide use and cropping pattern data were considered. This step reduced the list to those chemicals with the higher probability of contaminating waters upstream of the sites. For example, pesticide use data for the watershed where the American River water treatment plant is located represented use data for Sacramento, El Dorado, and Placer counties. The rice chemicals molinate and thiobencarb ranked high in use and were on the list of candidate

chemicals for monitoring. However, rice fields are not located upstream of this site and therefore these two chemicals were not on the final target list of chemicals to be monitored at the American River water treatment plant site.

Site- and time-specific target lists were developed, since information on the months of application (based on cropping patterns) were included in the database. The monthly target lists provided information on which water soluble chemicals would more likely be detected in water (dissolved phase) at the Delta sampling stations.

Conclusion

The database will be revised as new information on pesticide use, application, and physical-chemical properties is received. The success in developing target lists depends on the reliability and accuracy of such data. The resulting tabulations and information can also be used to predict which chemicals would be found in different compartments of an aquatic system (e.g. sediment, water, biota).

The described protocol illustrates the need to combine numerical selection criteria (e.g. usage, solubilities, and partition values) and non-numerical information (e.g. station location and upstream activities) to improve the possibility of detecting chemicals in the aquatic system.

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Appendix G

U. S. ENVIRONMENTAL PROTECTION AGENCY

WATER QUALITY MODELS

APPENDIX G

U. S. ENVIRONMENTAL PROTECTION AGENCY WATER QUALITY MODELS

Selected water quality models are now available through the Center for Water Quality Modeling for the personal computer. These models were taken from mainframe or minicomputer systems and are designed for the DOS environment on the IBM PC XT/AT family of microcomputers and compatible systems. The models are EXAMS, QUAL2E, WASP3, DYNHYD3, PRZM, and MINTEQ.

EXAMS

The Exposure Analysis Modeling System is a steady state and dynamic model designed for rapid evaluation of the behavior of synthetic organic chemicals in aquatic ecosystems. EXAMS computes exposure (the ultimate expected environmental concentrations resulting from a long-term steady state pattern of pollutant loadings), fate (the distribution of the chemical in the environment and the fraction of the loadings consumed by each transport and transformation process), and persistence (the time required for effective purification of the system once the loadings cease). EXAMS is an interactive program and allows the user to specify and store the properties of chemicals and ecosystems, modify the characteristics of either via simple English-like commands, and conduct rapid, efficient evaluations of probable fate of chemicals.

QUAL2E

The Enhanced Stream Water Quality Model QUAL2E is a steady state model for conventional pollutants in branching streams and well mixed lakes. It includes conservative substances, temperature, coliform bacteria, biochemical oxygen demand, dissolved oxygen, nitrogen, phosphorus and algae. QUAL2E is widely used for waste load allocation and permitting in the United States and other countries.

WASP3

The Water Quality Analysis Simulation Program is a generalized modeling framework for contaminant fate and transport in surface waters. Based on the flexible compartment modeling approach, WASP can be applied in one, two, or three dimensions. Problems that have been studied using WASP include biochemical oxygen demand-dissolved oxygen dynamics, nutrients and eutrophication, bacterial contamination, and toxic chemical movement.

A variety of water quality problems can be addressed with the selection of appropriate kinetic subroutines that may be either selected from a library or written by the user. Toxics WASP (TOXIWASP) combines a kinetic structure adapted from EXAMS with the WASP transport structure and simple sediment balance algorithms to predict dissolved and sorbed chemical concentrations in the bed and overlying waters. Eutrophication WASP (EUTROWASP) combines a kinetic structure adapted from the Potomac Eutrophication Model with the WASP transport structure. EUTROWASP predicts dissolved oxygen, carbonaceous biochemical oxygen demand, phytoplankton, carbon, and chlorophyll a, ammonia, nitrate, organic nitrogen, and ortho-phosphate in the bed and overlying waters.

DYNHYD3

DYNHYD3 is a simple 2 dimensional hydrodynamic model capable of handling variable tidal cycles, wind, and unsteady inflows. DYNHYD3 was updated from the Potomac Dynamic Estuary Model (DEM). This model has the ability to produce an output file that can be linked with WASP3 to supply the flows and volumes to the water quality model.

PRZM

The Pesticide Root Zone Model simulates the vertical movement of pesticides in unsaturated soil, within and below the plant root zone, and extending to the water table using generally available input data that are reasonable in spatial and temporal requirements. The model consists of hydrology and chemical transport components that simulate runoff, erosion, plant uptake, leaching, decay, foliar wash off, and volatilization (implicity) of a pesticide. Predictions can be made daily, monthly or annually.

MINTEQ

MINTEQ is a geochemical model that is capable of calculating equilibrium aqueous speciation, adsorption, gas phase partitioning, solid phase saturation states, and precipitation-dissolution of 11 metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc). MINTEQ can solve a broad range of chemical equilibrium problems for surface and ground waters. MINTEQ contains an extensive thermodynamic data set and contains 6 different algorithms for calculating adsorption.

SWMM and DYNTOX

Two other water quality models are under development for the PC environment. The projected release date for the distribution of these models was July 1, 1986. A brief description of each model is given below.

The Storm Water Management Model (SWMM) is a comprehensive model for simulation of urban runoff quantity and quality. All aspects of the urban hydrologic and quality cycles are simulated including surface runoff, transport through the drainage network, and storage and treatment (including cost). A choice of techniques is available for simulation in a sewer system, a kinematic wave procedure for most problem assessments, and a full equation routing method of surcharged systems. SWMM can be used for both single event and continuous simulation. It has been used in a planning context as well as for detailed design studies. SWMM also has a long history of use in the United States and Canada for urban drainage design.

DYNTOX is a waste load allocation procedure based upon dilution of whole effluent toxicity using a probabilistic modeling technique. It is a simple, interactive program using ANNIE as the user interface. DYNTOX can perform three types of simulations -- Continuous, Monte Carlo and Log Normal -- that, based on probabilities, can aid in deriving a waste load allocation limit.

Reference: U. S. Environmental Protection Agency. 1986. "Research and Development NEWSLETTER -- Water Quality Exposure and Risk Modeling". U. S. Environmental Protection Agency. EPA/600/M-86/018. July 1986.

CONVERSION FACTORS

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimetres (mm)	inches (in)	0.03937	25.4
	centimetres (cm) for snow depth	inches (in)	0.3937	2.54
	metres (m)	feet (ft)	3.2808	0.3048
	kilometres (km)	miles (mi)	0.62139	1.6093
Area	square millimetres (mm^2)	square inches (in^2)	0.00155	645.16
	square metres (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometres (km^2)	square miles (mi^2)	0.3861	2.590
Volume	litres (L)	gallons (gal)	0.26417	3.7854
	megalitres	million gallons (10^6 gal)	0.26417	3.7854
	cubic metres (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic metres (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekametres (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic metres per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	litres per minute (L/min)	gallons per minute (gal/min)	0.26417	3.7854
	litres per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megalitres per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekametres per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lb)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb)	1.1023	0.90718
Velocity	metres per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.33456	2.989
Specific Capacity	litres per minute per metre drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per litre (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimetre (uS/cm)	micromhos per centimetre	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8 × °C)+32	(°F−32)/1.8