Chapter 4. Water Quality

FOCUS OF THE REVISED DRAFT EIR/EIS ANALYSIS

Issues Raised in Water Right Hearing Testimony and Comments on the 1995 Draft EIR/EIS

As described in the 1995 DEIR/EIS, the Delta Wetlands Project could affect water quality in Delta waters during project diversion and discharge operations. Project effects on salinity and DOC concentrations in Delta channels and exports are a major concern for other Delta water users, especially providers of municipal drinking water. Project effects on other water quality variables (e.g., temperature, suspended sediments, dissolved oxygen, and chlorophyll) were also described qualitatively in the 1995 DEIR/EIS. Project effects on temperature and dissolved oxygen were addressed during the ESA consultation process, and no new information on other variables, such as suspended sediment and chlorophyll, has been presented in testimony or comment letters. Therefore, this REIR/EIS analysis focuses on project effects on DOC and salinity.

The Delta Wetlands Project could affect water quality in the following ways:

- Diverting water onto the project islands would reduce Delta outflows. As a result, brackish water from Suisun Bay would intrude into the central Delta and salinity in Delta channels and exports would increase.

- While water is stored on the reservoir islands, salinity and DOC concentrations would increase because of evaporative losses, and DOC concentrations would increase as a result of peat-soil leaching and algal growth. Therefore, discharges from the Delta Wetlands Project islands would contribute to increased concentrations of salinity and DOC in Delta channel receiving waters and in exports.

- Increases in DOC and salinity could indirectly cause increases in THMs and other disinfection byproducts (DBPs) in treated drinking-water supplies that are diverted or exported from the Delta.

For more information on Delta water quality issues, refer to Chapter 3C of the 1995 DEIR/EIS.

Although commenters on the 1995 DEIR/EIS and parties to the water right hearing generally agreed on the processes through which the Delta Wetlands Project could affect water quality, the methods and assumptions used to determine the magnitude of those impacts were debated at length. The magnitude of the effect of project operations on other water users' water quality depends on several factors:

- quality of water when it is diverted onto the project islands;
- length of time that water is held on the islands;
- rate of peat-soil leaching and other DOC-loading mechanisms;
- quality of receiving waters at the time of project discharges; and
- amount of Delta Wetlands water exported (the portion of total exports), which is determined by the rate of release from the reservoir islands.

The following components of the Delta Wetlands impact analysis for water quality were the focus of many comments:

- the concentrations of constituents in Delta inflow and Delta agricultural drainage, and resulting baseline water quality;
- DOC loading rates from peat-soil leaching, plant material growth and degradation, and interceptor well pumping activities under project operations;
- the question of whether ceasing agricultural activities on the Delta Wetlands Project islands can be considered to benefit water quality and to what degree it may offset the effects of project diversions and discharges; and
- methods of determining how much DBP would form as a result of export salinity (bromide [Br^-]) and DOC concentration.

Several commenters suggested that the lead agencies could obtain a more accurate estimate of the potential range of project effects by using new data on Delta DOC loading and ambient salinity developed through DWR programs. Commenters also suggested that revised methods of predicting the relationship between DOC and salinity levels and the formation of THMs and other DBPs at municipal water treatment plants would yield a better estimate of project effects.

This chapter updates the assessment of Delta Wetlands Project effects on water quality presented in Chapter 3C and Appendices C1 through C5 of the 1995 DEIR/EIS. New information has been reviewed and the previous analysis has been revised as appropriate.

Summary of Issues Addressed in This Chapter

The analysis presented in this chapter addresses the following questions, which represent the concerns expressed by stakeholders at the SWRCB water right hearing on the Delta Wetlands Project and in comments on the 1995 DEIR/EIS:

- What will be the DOC loading on the reservoir islands from short-term and long-term peat-soil leaching, plant material growth and decay, and interceptor well water returns?
- What impact will DOC from reservoir island water have on in-Delta water quality and senior water right holders?
- What impact will Delta Wetlands Project operations have on salinity in the Delta and at diversion points for senior water right holders?
- What impact would the Delta Wetlands Project's incremental change of DOC and salinity (Br^-) have on the formation of DBPs, including THMs and bromate, at municipal treatment plants receiving Delta water?

The analysis addresses these questions by providing new estimates of monthly Delta export water quality using a revised version of the DeltaSOS model. As described in Chapter 3, "Water Supply and Operations", this version incorporates new baseline DWRSIM model input, revised Delta standards and AFRP program measures, and Delta Wetlands Project operating rules. It augments the previously presented information with the most recent DWR data on Delta water quality constituents, and with updated information on the assumed relationship between constituents in raw water and municipal water treatment plant operations.

Definition of Terms

The following are definitions of key terms as they are used in this chapter:

- *Central Delta Water:* Used in the DeltaSOQ model to represent the source of export water from the central Delta, which includes a mixture of water from the Sacramento, Mokelumne, and Cosumnes Rivers; seawater intrusion from the western Delta; and some portion of the San Joaquin River that does not flow directly to the export locations.
- *Delta Drainage Water Quality Model (DeltaDWQ):* A model developed for the 1995 DEIR/EIS analysis to estimate how much the Delta Wetlands islands contribute to EC, DOC, Cl^-, and Br^- levels at Delta channel locations and in Delta diversions and exports under no-project conditions and under project operations.

- *Delta Exports:* The water pumped from the Delta to south-of-Delta users by DWR at Banks Pumping Plant and by Reclamation at the CVP Tracy Pumping Plant, and the amount diverted by CCWD at its Rock Slough and Old River intakes.

- *Delta Standards, Operations, and Quality Model (DeltaSOQ):* A modified version of the DeltaSOS model that incorporates equations that predict the water quality of agricultural drainage and Delta Wetlands reservoir island storage. This model also incorporates equations that predict the effects of agricultural drainage and Delta Wetlands discharges on EC levels and DOC concentrations in Delta channels and exports.

- *Electrical Conductivity (EC):* A general measure of dissolved minerals (i.e., salinity); the most commonly measured variable in Delta waters.

- *Leaching:* The removal of soluble substances from soil by percolating water.

- *Simulated Disinfection System (SDS):* A method of determining THM formation potential. This laboratory analytical method was developed to simulate municipal water treatment facilities' actual disinfection process (and THM concentrations) more closely than other methods; it uses a much lower chlorine (Cl_2) dose and much less contact time.

- *Trihalomethane (THM):* A class of carcinogenic substances, including chloroform ($CHCl_3$) and bromoform ($CHBr_3$), formed from chlorination of drinking-water supplies.

- *Trihalomethane Formation Potential (THMFP):* The potential for creation of THMs during chlorination or other oxidation treatment processes used for disinfection of municipal water supplies; an index of the maximum possible THM concentrations that could be produced by maximum chlorination of Delta water.

- *Ultraviolet Absorbance (UVA):* A physical measurement used in the study of humic acids and THM precursors, often found to be linearly related to DOC concentration. UVA may provide a measure of the humic and fulvic acid portion of total DOC in a water sample; this portion of total DOC is thought to be the precursor for THM.

- *Water Treatment Plant (WTP) Model:* A U.S. Environmental Protection Agency (EPA) model used for the 1995 DEIR/EIS to estimate THM concentrations at a typical water treatment plant that may use Delta exports containing water released from the Delta Wetlands Project islands. The model consists of a series of subroutines that simulate removal of organic THM precursor compounds and formation of THM. A more detailed description of the operation of the WTP model is provided in Appendix C5 of the 1995 DEIR/EIS. The model predicts total THM concentration, then estimates the relative concentrations of each of the four types of THM molecules by using separate regression equations for each type of THM molecule.

Organization of This Chapter

The remainder of this chapter presents information supporting the updated evaluation of water quality effects of Delta Wetlands Project operations in sections that can be divided into two themes. The first half describes new and updated information that has been considered in the analysis of project impacts, and is organized into the following major sections:

- "Overview of Sources of New and Updated Information": Provides an overview of the following four sections.

- "Updated Measurements of Inflow, Export, and Agricultural Drainage Water Quality": Presents Delta water quality data recently collected by the DWR MWQI program and other programs.

- "California Department of Water Resources Special Multipurpose Applied Research Technology Station Studies": Describes DWR's recent peat-soil flooding experiments.

- "Reported Estimates of Dissolved Organic Carbon Loading": Summarizes available estimates of DOC loading under existing and with-project conditions.

- "Changes in Disinfection Byproduct Rules": Discusses changes in rules for TOC removal and THM concentrations for water treatment.

The contents of these sections are described more fully under "Overview of Sources of New and Updated Information".

The second half of this chapter presents the impact analysis for the Delta Wetlands Project and is organized as follows:

- "Impact Assessment Methodology": Describes the methods used to assess project impacts and explains how the new and updated information has been incorporated into the modeling used to determine those impacts. Includes discussions of the updated methods for estimating project effects on DOC and salinity levels and for predicting the formation of THMs and bromate at water treatment plants. These methods are described more fully in Appendix G, "Water Quality Assessment Methods".

- "Criteria for Determining Impact Significance":

  - describes the impact significance thresholds used in the 1995 DEIR/EIS analysis,

  - summarizes comments on these criteria,

- discusses the relationship between the significance thresholds and mitigation triggers of water right terms and conditions, and
- presents the criteria used in this REIR/EIS.

■ "Environmental Consequences":

- presents the results of simulations of Delta water quality conditions for the No-Project Alternative and of effects of the proposed project on Delta salinity, export DOC levels, and THMs produced at water treatment plants,
- compares the impacts of the 1995 DEIR/EIS project alternatives on water quality to those identified for the proposed project using the new information and updated methods presented in this analysis,
- describes options for applying the recommended mitigation and discusses how mitigation measures may be refined in water right permit terms and conditions,
- describes cumulative impacts of the proposed project, and
- discusses the implications of the changes in water quality information and assessment methods with regard to Alternatives 1 and 3 in the section "Impact Evaluation of Project Alternatives from the 1995 Draft EIR/EIS".

OVERVIEW OF SOURCES OF NEW AND UPDATED INFORMATION

A great amount of water quality data is collected in the Delta each year. Data are collected by the Municipal Water Quality Investigations (MWQI) program of the DWR Division of Planning and Local Assistance, the Interagency Ecological Program (IEP), and the U.S. Geological Survey (USGS) Water Resources Division.

DWR's MWQI program has collected data on numerous water quality variables in Delta inflows and exports. The MWQI data include measurements of EC, DOC, THMFP, and related variables; therefore, they are the most relevant source of baseline Delta water quality information for this assessment. Appendices C1 and C2 of the 1995 DEIR/EIS presented MWQI monitoring data collected through water year 1991. This REIR/EIS includes the most recent MWQI data through water year 1998.

The MWQI program has also collected data on Delta agricultural drainage water quality, including measurements from drainage pumps on the four Delta Wetlands Project islands. Delta agricultural drainage data from 1986-1991 were included in Appendix C4 of the 1995 DEIR/EIS; this REIR/EIS includes the MWQI data on agricultural drainage through 1998 (California Department of Water Resources 1999a). However, most of the drainage sampling was discontinued in 1994, so only limited information from drainage sampling is available to augment the information presented in the 1995 DEIR/EIS. The MWQI data are used to estimate the contributions of water quality constituents of concern from Delta sources under no-project conditions and under project operations.

Also evaluated for this assessment of Delta Wetlands Project effects are data from DWR's Special Multipurpose Applied Research Technology Station (SMARTS), which conducts peat-soil flooding experiments at the DWR Bryte facility in West Sacramento (California Department of Water Resources 1999b), and data from flooded-island studies conducted jointly by DWR and the USGS on Twitchell Island. In addition, this chapter summarizes information on potential DOC loading received from water right hearing participants. This information has been used to refine the assumptions used in the 1995 DEIR/EIS regarding the potential loading of DOC from the Delta Wetlands islands under no-project conditions and under project operations.

Since publication of the 1995 DEIR/EIS, standards for total organic carbon (TOC) removal before treatment have been adopted under the Safe Drinking Water Act, and EPA has revised its standard for THM concentrations in drinking water. These newly adopted standards and potential future standards are also described below.

This chapter and the accompanying appendix (Appendix G) describe methods for calculating Delta Wetlands Project contributions to salinity, DOC concentrations, and THMFP in water that could be exported from the Delta and subsequently treated for municipal use. Revised equations used to predict formation of THMs and bromate at treatment plants have been reviewed and incorporated, as appropriate, into the REIR/EIS analysis.

The following sections present the results of this review of new and updated information:

- "Updated Measurements of Inflow, Export, and Agricultural Drainage Water Quality" presents data collected since 1995 on existing inflow, export, and agricultural drainage water quality. These data, reported by the DWR MWQI program and other programs, are used to update assumptions of existing water quality conditions in the Delta for impact analysis.

- "California Department of Water Resources Special Multipurpose Applied Research Technology Station Studies" describes the methods and results from these peat-soil flooding experiments and discusses the applicability of these results to the Delta Wetlands Project.

- "Reported Estimates of Dissolved Organic Carbon Loading" summarizes information from the 1995 DEIR/EIS, estimates from recent in-field and experimental data, and evidence presented at the Delta Wetlands water right hearing and in comments on the 1995 DEIR/EIS regarding DOC loading under existing and with-project conditions.

- "Changes in Disinfection Byproduct Rules" discusses new, revised, and proposed rules for TOC removal and THM concentrations for water treatment.

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This information is used to estimate existing Delta conditions (e.g., inflow and export water quality, agricultural drainage operations and water quality) and to provide input toward an estimate of DOC loading under existing (i.e., agricultural) and project conditions. The "Impact Assessment Methodology" section that follows describes how this information is incorporated into the quantitative modeling used to determine impacts of the Delta Wetlands Project.

UPDATED MEASUREMENTS OF INFLOW, EXPORT, AND AGRICULTURAL DRAINAGE WATER QUALITY

Measured data on the quality of water in Sacramento and San Joaquin River inflows, at Delta export locations, and in agricultural drainage in the Delta are presented below. Data on Delta inflow and export EC, Cl^-, Br^-, DOC, and THMFP are taken from the DWR MWQI data collection program. Agricultural drainage data from the MWQI program on the Delta Wetlands islands and from USGS, DWR, and California Urban Water Agencies (CUWA) investigations on Twitchell Island are summarized below; Appendix G includes more detailed information about agricultural drainage from the Delta Wetlands islands.

Measurements of Delta Water Quality Variables in Delta Inflows and Exports

Data on Delta inflow and export water quality constituents, as reported by the DWR MWQI program, are used to describe existing inflow and export water quality conditions and to determine how the concentrations of constituents change as water flows through the Delta. The difference between concentrations of a selected water quality constituent, such as DOC, in Delta inflows and concentrations in exports is used to estimate the net contribution from Delta sources, including agricultural drains. For a discussion of the way that these contributions are estimated for the impact assessment and used in the quantitative modeling, see "Delta Source Contributions of Salinity and Dissolved Organic Carbon" in Appendix G.

This section describes MWQI program measurements of EC values and the concentrations of several constituents in Sacramento and San Joaquin River inflows and at Delta export locations collected during the most recent 15-year period, 1984-1998 (California Department of Water Resources 1999a). The 1995 DEIR/EIS analysis used data from the 10-year period of 1982-1991 (see Appendix C1, "Analysis of Delta Inflow and Export Water Quality Data", in the 1995 DEIR/EIS). The 15-year period used in this REIR/EIS reflects several significant hydrological events. The 1988-1993 water years were a significant period of drought. In addition, flooding events and wet-year-type conditions experienced in 1995, 1997, and 1998 provide recent data that broaden the span of much of the range of potential hydrological conditions (except those of extreme drought, such as the 1976-1977 period). Sacramento River inflows are generally the largest source of Delta water and have lower concentrations of DOC and related constituents than other sources; therefore, the Sacramento River concentrations are used as the baseline for determining Delta source contributions.

The DWR MWQI data collection program has changed each year. Sampling from the Sacramento River and Delta export locations began in 1983. Several assay techniques for THMFP measurement have been used since 1992; major revisions were made in 1994 and 1996. Results from the differing assay methods are not directly comparable. DOC measurements began in 1987, and Br^- and UVA measurements began in 1990. The use of UVA data is explained below.

The number of samples collected at each station each year has also changed. At the SWP Banks Pumping Plant, for example, five samples were collected in water year 1982; nine samples were collected in water year 1983; and 11 or 12 (monthly) samples were collected in water years 1984 through 1989. During water years 1990 through 1994, sampling was generally conducted on a weekly or biweekly schedule. Intensive sampling began in May 1995 and continued through August 1996, averaging 11 samples per month. Recent sampling has returned to a monthly schedule. Intensive sampling was also conducted in the Sacramento River at Greene's Landing from February 1993 through water year 1995. During this period, samples were often collected daily for several consecutive months. Samples from the San Joaquin River at Vernalis, from the Old River near the Rock Slough intake for CCWD's diversion, and at the CVP Tracy Pumping Plant for the DMC have generally been collected on a regular monthly schedule.

A standardized data set of monthly values for the entire 1984-1998 period was created using the first grab sample collected in each calendar month and eliminating any additional samples collected that month. Samples were often, but not always, collected on about the same day at each of the sampling stations. The mean values of the monthly samples did not differ by more than 10% from those of the entire data set. This is the same method used for the data from the 1982-1991 period in the 1995 DEIR/EIS analysis, as summarized in Table C1-1 of Appendix C1 of the 1995 DEIR/EIS.

The MWQI program did not collect data on all these variables for all years of the 1984-1998 period. However, the graphs show all available data plotted against the 1984-1998 time period to provide for easy comparison of water quality conditions for each year. The following sections describe the data for EC, Cl^-, Br^-, DOC, and THMFP.

Delta Electrical Conductivity Values

EC is a general measure of dissolved minerals (i.e., salinity) and is the most commonly measured variable in Delta waters. High levels of dissolved minerals can limit beneficial uses of Delta water for agricultural, municipal, and industrial water supplies. Changes in EC values can be used to interpret the movement of water and the mixing of salt in the Delta (see 1995 DEIR/EIS Appendix B2, "Salt Transport Modeling Methods and Results").

Figure 4-1 and Table 4-1 show 1984-1998 EC measurements for the DWR MWQI samples from Sacramento and San Joaquin River inflows and from the following three export locations:

- the SWP Banks Pumping Plant,
- the CVP Tracy Pumping Plant, and
- Rock Slough for CCWD's pumping plant.

The data show ranges of EC values at these monitoring locations that are consistent with those presented in the 1995 DEIR/EIS for 1982-1991.

The EC values for the Sacramento River are generally in the range of 100 to 200 microsiemens per centimeter (μS/cm), although measurements during the 1986, 1995, and 1997 high-flow periods were less than 100 μS/cm, and 5% of the values exceeded 200 μS/cm. Sacramento River EC measurements, shown in Figure 4-2, generally decrease with higher flows, exhibiting a typical flow-dilution relationship.

The EC values for the San Joaquin River are usually much higher than Sacramento River EC values, fluctuating between 150 and 1,300 μS/cm. Figure 4-3 indicates that San Joaquin River EC measurements also generally decrease with higher flows, exhibiting a flow-dilution relationship.

Several San Joaquin River EC values observed during the winters of 1988-1993 exceeded 1,000 μS/cm and are as much as 500 μS/cm higher than the EC values estimated with the flow-dilution equation. These elevated EC values suggest that an additional load of salt drainage may have been released into the San Joaquin River during these drought years. Values in the recent postdrought years 1995-1998 indicate a lower trend of San Joaquin salt content similar to the pre-drought period. Measurements, when available, are superior to flow-regression estimates of inflow water quality; flow regressions must be used for planning and assessment studies.

Observed EC values at the three export locations have fluctuated between about 200 and 1,000 μS/cm. During months when low EC values were measured, corresponding to periods of high Delta outflow, the export locations each had similar EC values. During months when high EC values were measured, EC values at Rock Slough (CCWD) were generally the highest because effects of salinity intrusion are usually strongest there. Local agricultural drainage may also have different effects at each export location.

The DWR MWQI EC data presented here and in the 1995 DEIR/EIS clearly indicate that EC (representing dissolved salts) usually increases between Sacramento River inflow and the export locations. The net source of elevated EC may differ for each month and each export location, however. San Joaquin River inflows, seawater intrusion, agricultural drainage, and municipal discharges (e.g., from Stockton) may each contribute to elevated EC measurements.

Delta Chloride Data

Cl^- concentration is important in evaluating the quality of the domestic water supply and is a major parameter for judging Delta water quality. The ratio of Cl^- to EC (using units of mg/l for Cl^- and μS/cm for EC) can be used to distinguish between sources of water from different inflows (e.g., Sacramento River, San Joaquin River, and seawater) sampled at different Delta locations. Delta Wetlands Project operations would influence the relative contributions of water from different Delta inflow sources; therefore, they would affect concentrations of minerals (including Cl^-) in the Delta. (See 1995 DEIR/EIS Appendices B2 and C1 for more information.)

For example, seawater has a Cl^- concentration of 19,000 mg/l and an EC value of approximately 55,000 μS/cm, for a Cl^-:EC ratio of about 0.35 (CRC 1989). As described below, Sacramento River water, with a Cl^- concentration of approximately 6 mg/l and an EC value of 150 μS/cm, has a Cl^-:EC value of about 0.04. Therefore, a mixture of 1% seawater and 99% Sacramento River water would have a Cl^- concentration of 196 mg/l and an EC concentration of 699 μS/cm, resulting in a Cl^-:EC ratio of 0.28. A Cl^-:EC ratio of more than 0.20 indicates that seawater intrusion is a dominant source of salinity in the Delta.

Figure 4-4 and Table 4-1 show DWR MWQI data on Cl^- concentrations for water years 1984 through 1998 for the two Delta inflow and three Delta export locations. Cl^- concentration patterns are similar but not identical to the EC patterns because each major water source has a different Cl^-:EC ratio value. Figure 4-5 shows the Cl^-:EC ratios for each of the monthly DWR MWQI samples. These two figures will be described together. The patterns among the different monitoring locations seen in the updated (1984-1998) data are essentially identical to those described in the 1995 DEIR/EIS for 1982-1991.

Sacramento River Cl^- concentrations were less than 10 mg/l in 94% of the monthly measurements (Figure 4-4), and the Cl^-:EC value (mg/l:μS/cm) in this inflow averaged 0.04 (Figure 4-5). Some of the scatter in the Sacramento Cl^-:EC values was caused by low Cl^- concentrations.

San Joaquin River Cl^- concentrations fluctuated between 7 and 183 mg/l (Figure 4-4), and Cl^-:EC ratio values increased from 0.055 at low EC values to 0.16 at high EC values (Figure 4-5). The variability in the Cl^-:EC values of this inflow may be explained by the fact that the inflow represents a mixture of water from the San Joaquin River, Stanislaus River, and especially during wet periods, other tributaries. Nevertheless, the Cl^-:EC value of 0.055 to 0.16, averaging 0.12, for the San Joaquin River inflow is distinct from the lower Cl^-:EC value of about 0.04 for the Sacramento River.

There are only three basic sources of Delta salinity: seawater, San Joaquin River water, and Sacramento River water. The proportion of water from each of these sources in exports can be estimated by evaluating the Cl^-:EC ratio together with the Cl^- concentrations and EC values.

Measurements of Cl^- concentrations from the export locations fluctuated between 11 and 303 mg/l (Figure 4-4). The Cl^- concentrations in CCWD diversions from Rock Slough were the highest, indicating a stronger influence from seawater intrusion or local agricultural drainage at this location.

Cl^-:EC values for the export locations were greater than 0.16 (the maximum San Joaquin River ratio) during periods with the highest Cl^- concentrations (Figure 4-5). These high Cl^-:EC values suggest that seawater intrusion is the dominant source of Cl^- during these periods. CCWD water diverted at Rock Slough usually has a higher Cl^-:EC value than water exported from the other export locations, suggesting a higher seawater contribution at this location.

Delta Bromide Data

Similar to Cl^- concentration, Br^- concentration is important in evaluating domestic water supply quality and influences the potential formation of DBPs, including THM and bromate. Br^- is more difficult to measure than Cl^-, so measurements of Cl^- are often used to calculate Br^- concentrations based on observed ratios of Br^- to Cl^-.

Figure 4-6 shows DWR MWQI Br^-:Cl^- values, based on Br^- measurements that began in January 1990. The Br^-:Cl^- value for concentrations measured from San Joaquin River samples (mostly in the range of 0.0025 to 0.0035) is similar to the Br^-:Cl^- value for seawater (0.0035). Br^-:Cl^- values for Sacramento River inflow were scattered (mostly 0.001 to 0.006) because of low concentrations of Cl^- and Br^-, but they were generally lower than those of seawater or San Joaquin River water. These DWR MWQI data suggest that Br^- concentrations may be adequately estimated from Cl^- measurements. Based on the limited data available during the preparation of the 1995 DEIR/EIS, a single value of 0.0035 was assumed for all source waters for impact assessment purposes. The recent postdrought data (1993-1998) more clearly show an average Br^-:Cl^- ratio that is approximately 0.0030 for San Joaquin River water and 0.0020 for Sacramento River water. Therefore, these revised Br^-:Cl^- ratios are used in this REIR/EIS analysis.

Delta Dissolved Organic Carbon Data

Figure 4-7 shows DWR MWQI measurements of DOC at Delta inflow and export locations since collection began in 1987. DOC is considered to be the major organic precursor of DBPs, including THMs. DOC is therefore one of the most important water quality variables for assessment of potential formation of DBPs in treated drinking water from the Delta.

DOC concentrations in Sacramento River samples are generally the lowest measured in the Delta, with average measured values of 2.3 mg/l (Figure 4-7 and Table 4-1). American River samples have even lower DOC concentrations (California Department of Water Resources 1989a). Sacramento River DOC concentrations sometimes exceed 3 mg/l, with 21 of the 124 measured DOC values above 3 mg/l and two above 5 mg/l. Daily measurements taken periodically between 1993 and 1995 have confirmed that Sacramento River DOC concentrations can be elevated above 2 mg/l when sources of DOC material appear in surface runoff, with 430 of 694 measurements at or above 2 mg/l (California Department of Water Resources 1999a).

DOC concentrations in the San Joaquin River were higher and more variable than Sacramento River DOC concentrations. The average measured DOC value was 3.7 mg/l (Table 4-1); 98 of the 118 measured DOC values (83%) were between 2.5 mg/l and 6 mg/l and four exceeded 8 mg/l during major storm events. The San Joaquin River must therefore be considered a major source of DOC relative to the Sacramento River, which has comparatively low DOC concentrations.

DOC concentrations at the export locations averaged 3.7 mg/l, with 85% of the measured values in the range of 2.5 to 6 mg/l. The DWR MWQI data clearly show that Delta sources or San Joaquin River inflow contribute DOC. The relative influences of the various possible sources cannot be easily identified from these data alone. The patterns seen in the more recent (1992-1998) data shown in Figure 4-7 and Table 4-1 are similar to the 1987-1991 data described in the 1995 DEIR/EIS; however, the newer data also show that DOC concentrations measured in some wet months are considerably higher than the average concentration of DOC.

Figure 4-8 compares DWR MWQI measurements of DOC and Cl^- to EC values for the Sacramento and San Joaquin Rivers for 1984-1998. DOC concentrations in Sacramento and San Joaquin River samples do not demonstrate a clear relationship to concentrations of either EC or Cl^-. Therefore, it is not possible to estimate DOC concentrations in the river inflows as a function of either flow or salinity. Consequently, frequent measurements are the only accurate method for establishing the river-inflow DOC concentrations.

Delta Trihalomethane Precursor Data

To provide a comparative measure of THM precursors in Delta water, the DWR MWQI program has developed assays for determining THMFP, an index of the maximum possible THM concentrations that could be produced by maximum chlorination of Delta water. Starting in 1984, the assay was performed by spiking a water sample with an initial 120-mg/l concentration of Cl_2, holding the sample for 7 days (168 hours) at 25°C, then measuring the THM species with standard EPA procedures (gas chromatograph purge and trap, EPA method 502.2).

In 1994, the original method was discontinued and a buffered variation was implemented in which the pH of the sample was adjusted to a constant value of about 8.2. In 1996, two new methods were implemented, one of them a reactivity method in which the sample is spiked with a Cl_2 dose of 4.5 times the DOC concentration and held for 7 days. However, both the buffered and reactivity methods have been discontinued.

The SDS method is currently used for the MWQI program. This method was developed to simulate the actual disinfection process (and THM concentrations) of municipal water treatment facilities more closely than other methods; it uses a much lower Cl_2 dose and much less contact time. Because the SDS method results in substantially lower values for THMFP and very few SDS data are available, only data generated from the original, buffered, or reactivity methods were plotted for the analysis of data trends presented below.

The four types of THM molecules are chloroform ($CHCl_3$), dichlorobromomethane ($CHCl_2Br$), dibromochloromethane ($CHClBr_2$), and bromoform ($CHBr_3$). The carbon-fraction concentrations of the four types of THM molecules are added together to calculate the carbon equivalent of the total THM concentration, called the C-THM concentration. The DWR MWQI program uses the term "total formation potential carbon" (TFPC) for the same variable.

Dividing the C-THM concentration by the initial DOC concentration in a water sample provides a direct estimate of the fraction of the initial DOC concentration that was converted to THM molecules during the THMFP assay. The ratio of C-THM to DOC is called the "THM yield" and is generally in the range of 0.005 to 0.02 for the high chlorination dose used in the THMFP assay.

Delta C-THM Data. Figure 4-9 and Table 4-1 show the C-THM concentrations measured by the DWR MWQI for 1984-1998. The results indicate conditions similar to those analyzed in the 1995 DEIR/EIS for 1982-1991.

The Sacramento River concentrations of C-THM averaged 28 μg/l, with 25% of the measured concentrations greater than 30 μg/l. Most (90%) export concentrations of C-THM were between about 30 and 90 μg/l, and were generally higher than Sacramento River concentrations. San Joaquin River C-THM concentrations averaged 47 μg/l, exceeding Sacramento River concentrations but remaining almost the same as export concentrations (Table 4-1). Because the C-THM concentrations for Sacramento River inflow fluctuated, and because the San Joaquin River C-THM concentrations were similar to those measured at the export locations, it is difficult to directly estimate the monthly contributions of C-THM from Delta sources.

Figure 4-10 shows the data for ratios of C-THM to DOC for the two inflow and three export locations for 1984-1998. With allowances made for a certain amount of scatter in both measurements, these ratios for THM yield from DOC range from 0.005 to 0.02, indicating that approximately 0.5% to 2% of DOC became THM molecules during the THMFP assay in most samples. The THM yield has less scatter in the results from 1994-1998; this change may be related to the introduction of the new measurement methods described above, which served to better standardize pH and Cl_2 dose in the samples. This yield relationship shown in Figure 4-10 suggests that DOC measurements can be used to estimate the C-THM concentration in a THMFP assay. This relatively constant C-THM:DOC value might be used to condition Delta Wetlands operations; therefore, frequent DOC measurements may be used to monitor project effects on THM concentration and minimize the need for using the comparatively expensive and time-consuming THMFP assay procedure. This procedure for estimating THMFP is described in Appendix C-3 of the 1995 DEIR/EIS and is illustrated in Figure 4-11.

Delta Ultraviolet Absorbance Data. UVA (254-nanometer [nm] wavelength) was added to the DWR MWQI program as a measurement variable in 1990. UVA is measured with a spectrophotometer and reported in units of 1/cm. UVA may provide a measure of the humic and fulvic acid portion of total DOC in a water sample; this portion of total DOC is thought to be the precursor for THM. The ratio of UVA to DOC may increase with a higher proportion of humic substances. A greater yield of THM molecules may also be expected from samples with higher UVA:DOC values because the humic substances are thought to be the most active THM-precursor component of DOC.

Figure 4-12 and Table 4-1 show data from 1990-1998 and indicate that most Delta inflow and export samples have UVA (1/cm):DOC (mg/l) ratios of between 0.02 and 0.04, with an average slightly above 0.03. The Sacramento and San Joaquin River UVA:DOC values tend to be slightly lower than the UVA:DOC values for the export locations (Table 4-1). The MWQI program calls this ratio the specific UVA (i.e., SUVA). The patterns shown in Figure 4-12 are the same as those indicated in the 1995 DEIR/EIS.

Data on Delta Agricultural Drainage Salinity and Dissolved Organic Carbon

The purpose of the agricultural drainage data analysis is to estimate annual loading of DOC and salinity from existing agricultural operations. Agricultural drainage discharges containing natural decomposition products of peat soil and crop residues are considered dominant sources of DOC in Delta waters. Also, because the objectives specified in the 1995 WQCP substantially protect Delta water supplies from salinity intrusion effects during periods of reduced Delta outflow, agricultural drainage is the major remaining source of concern with regard to elevated salinity in Delta waters. This section of the REIR/EIS updates information about measurements of water quality constituents in agricultural drainage presented in Appendix C2, "Analysis of Delta Agricultural Drainage Water Quality Data", of the 1995 DEIR/EIS.

There are two general ways to estimate the observed DOC loads (expressed as grams per square meter [g/m^2]) from the agricultural islands in the Delta:

- Multiply the annual drainage volume (expressed as water depth in meters [m]) by the average DOC concentration (mg/l) of the drainage water to estimate the DOC load.

- Multiply the DOC increase observed between the Sacramento and San Joaquin River inflows and the export locations by the export flow to estimate the increased mass of DOC. This increased mass (g) of DOC is then divided by the area of the Delta agricultural islands to estimate the average load of DOC (g/m^2).

Both methods have been used to evaluate the DOC load from Delta agricultural islands under existing conditions. The following section summarizes the results of these analyses; Appendix G, "Water Quality Assessment Methods", presents detailed information on agricultural drainage water quality for Bacon Island, Webb Tract, Bouldin Island, Holland Tract, and Twitchell Island.

The 1995 DEIR/EIS presented water quality data collected at a large number of Delta island agricultural drainage pumping stations from 1986 through 1991 to determine annual drainage volumes and DOC concentrations. DWR stopped monitoring drainage water quality at the majority of Delta island drainage pumping locations in July 1994. The data used in this REIR/EIS were updated to include the more recent measurements. The following analysis presents agricultural drainage water quality data collected from the Delta Wetlands Project island locations from 1986 through 1994, with the exception of Bacon Island, where sampling was continued through August 1999, and Twitchell Island (not a project island), the location of several DWR and USGS studies that began in 1994.

Agricultural Drainage Volumes

The 1995 DEIR/EIS presented a detailed analysis of drainage volume calculations for Delta islands based on available data collected by DWR in 1954-1955. Because DWR stopped monitoring drainage water quality at the majority of Delta island drainage pumping locations in July 1994, no comprehensive drainage volume measurements have been collected since preparation of the 1995 DEIR/EIS that would substantially change the results of the analysis.

A study by USGS (U.S. Geological Survey 1997) determined that measuring electrical power usage from Delta pumps might be a reliable method of determining drainage volumes if more calibration of drainage pumps (volume per kilowatt-hour [kwh]) and regular monthly power usage records were available. However, no Delta-wide estimates of drainage flow were attempted. This method was used to estimate the drainage from Twitchell Island for calendar year 1995; the results were determined to be very close to (within 10% of) the flow measured using flow meters in the two Twitchell Island drainage pumps.

Dissolved Organic Carbon and Salt Budgets for Delta Islands

Results presented in the 1995 DEIR/EIS showed that 1986-1991 MWQI measurements of drainage EC from many of the Delta island agricultural drains show a strong seasonal pattern, with the highest EC values in drainage water during winter. EC values generally ranged from low values characteristic of Delta channel water (137 to 568 μS/cm) to much higher values (1,280 to 2,870 μS/cm). This range in drainage EC values is expected because of the variation in Delta precipitation and irrigation, leaching, and drainage practices. Higher EC values indicate that the salt has become concentrated in the agricultural soils through ET. Cl^- concentrations in agricultural drainage samples follow the seasonal EC patterns. DOC concentrations in these samples have a similar seasonal pattern; however, the variation in DOC concentrations is greater because the agricultural soils can be a source of DOC, and because evaporation of soil water during the growing season can increase DOC concentrations.

Agricultural drainage from Delta islands will have a Cl^-:EC ratio that reflects that of the original applied water because Cl^- and the dissolved solids that contribute most of the EC in water are conservative in water and not removed by biological or other physical and chemical processes. The concentrations of dissolved substances in drainage will vary because of dilution by rainwater or increases from evaporation losses.

Table 4-2 summarizes the average DWR MWQI drainage data available for the Delta Wetlands islands and Twitchell Island. A detailed description of these results for each island is provided in Appendix G.

CALIFORNIA DEPARTMENT OF WATER RESOURCES SPECIAL MULTIPURPOSE APPLIED RESEARCH TECHNOLOGY STATION STUDIES

SMARTS is a new test facility located in West Sacramento that began operating in 1998 and is managed under DWR's MWQI program. The facility consists of a series of large tanks specifically designed for conducting a variety of water quality studies under controlled static or continuous water-flow conditions. The first studies at SMARTS were designed to measure DOC loads from peat soils. Two reports from SMARTS studies have been prepared (California Department of Water Resources 1999b, 1999c) and are referred to below as SMARTS 1 and SMARTS 2. For the purpose of this analysis of Delta Wetlands Project effects on water quality, results of the SMARTS studies were evaluated for information on potential DOC loading rates from peat soils and are summarized below. The following summary and interpretation of the SMARTS reports were reviewed by MWQI's consultant Marvin Jung, who confirmed that the loading calculations described below are appropriate (Jung pers. comm.).

Summary of Methods

The SMARTS experiments measured DOC loading from peat soils by partially filling tanks with peat soil taken from Twitchell Island and measuring changes in EC and DOC concentrations in the peat-soil pore water and surface water. EC values were used to track evaporation and salt loading from the peat soil; DOC concentrations were measured to track DOC loading from the peat soil.

The SMARTS 1 report presents results of a 12-week experiment and SMARTS 2, results of a 27-week experiment. The SMARTS facility tanks have a diameter of 5 feet, with a surface area (for peat-water interface) of 1.8 square meters (m^2). The control tank (tank 9) was filled with 11 feet of water (volume of 1,616 gallons) with no peat soil. The following conditions varied for the eight experimental tanks:

- water flow,
- depth of peat soil,
- depth of water, and
- initial peat-soil composition.

These conditions are described below.

Water-Flow Conditions

The experiment used two water-flow conditions: "static" and "flushing". Four of the tanks (1, 3, 5, and 7) held static water depths above the peat soil. The static tanks were refilled as needed to compensate for evaporation losses, so the water level was held constant. However, the term "static" does not mean that there was no movement of water in the tanks. The surface water in the static tanks was mixed with submersible pumps that circulated about 1,680 gallons per day (gpd) in SMARTS 1; the mixing increased with larger 2,880-gpd pumps in SMARTS 2. Because the water depth was held constant in the static tanks, the load (g/m^2) for a static tank can be estimated as the change in DOC concentration (mg/l [equivalent to g/m^3]) times the depth of water (m).

Other tanks (2, 4, 6, and 8) were flushed repeatedly during the experiment. The total water volume in each tank was replaced weekly as water was added continuously while being removed from the top of the tank. The load of the flushing tanks can be estimated as the weekly flushing depths times the difference between the weekly inflow and outflow concentration. However, the volume of outflow from the tanks and DOC concentrations in the outflow were not directly measured. The pumps were set at the beginning of the experiment to flush a certain volume. Weekly measurements were not conducted to verify the assumed volume of water being pumped from the flushing tanks, and for the SMARTS 1 experiment, it was reported, when the output was checked, that the observed flushing volumes appeared to be as much as 50% more than anticipated. DOC concentration in the tank water was measured weekly; this measurement was assumed to represent the outflow DOC concentration. Because the cumulative depth of water for the flushing tanks was large (either 26 feet [8 meters] or 138 feet [42 meters]), very small changes in the measured tank DOC concentrations result in large changes in the load estimate (where DOC load = flushing depth • outflow concentration). The loading estimates were sensitive to even very low concentrations of DOC. Because the flushing volumes (i.e., depths) and changes in outflow DOC concentration are uncertain for the flushing tanks, DOC load estimates obtained from the flushing tanks are questionable and are not applied to the Delta Wetlands Project. Therefore, the results reported below focus on DOC loading from the static tanks (1, 3, 5, and 7).

Water and Peat Depth

The water and peat depth for the four static tanks varied; the water depth was either 2 feet (0.6 meters) or 7 feet (2.1 meters), and the peat depth was either 1.5 feet or 4 feet.

Initial Peat-Soil Composition

The initial peat-soil composition (e.g., pore-water DOC and EC concentrations, peat-soil density, soil salt content) also varied in each tank and for each experiment. Oxidized peat soils were taken from the top 2 feet of Twitchell Island to use in the experiments. The intent was for each tank to have similar soil characteristics. However, in SMARTS 1, although all the peat soil was mixed together before the tanks were filled, peat-soil pore-water EC measurements in the eight tanks ranged widely (842 to 2,140 μS/cm) at the start of the experiment. In SMARTS 2, two different peat-soil sources were used. Initial peat-soil pore-water EC concentrations had an even greater range, with one peat-soil source resulting in initial pore-water EC concentrations of 578 to 1,232 μS/cm (tanks 5–8) and the other source resulting in initial pore-water EC concentrations of 3,640 to 4,800 μS/cm (tanks 1–4).

Dissolved Organic Carbon and Salinity Measurements

The SMARTS static tank results can be evaluated by considering that two pools of EC or DOC are being measured:

- EC or DOC in the peat-soil pore-water volume, measured by the bottom sampling spigot (0.5 foot from the bottom of the tank), and
- surface-water EC or DOC.

The amount of salt (EC) or DOC observed in the surface water is directly influenced by the concentration in the peat-soil pore water and the exchange rate caused by mixing processes. There may be a gradient of pore-water EC and DOC concentrations as EC and DOC are transferred from the soil into the surface water, but the average pore-water EC and DOC concentrations are assumed to be characterized by the measurements made from the bottom port. The peat-soil pore-water volume was not directly measured in the SMARTS studies but can be approximated from previous peat-soil measurements, which reported 40% to 60% solids (Table C3-8 in Appendix C3 of the 1995 DEIR/EIS). Because the percentage of solids averages 50%, the porosity of peat soil is assumed to be 50%, and the pore-water volume is assumed to be half the peat-soil volume.

Summary of Results

SMARTS 1 Pore-Water EC and DOC Concentrations

Table 4-3 summarizes the results of the SMARTS 1 (12-week) experiment, and Table 4-4 summarizes the results of the SMARTS 2 (27-week) experiment.

The peat-soil pore-water measurements of EC for the SMARTS 1 experiment ranged from 842 to 2,140 μS/cm at the start of the experiment. The range of measurements from the eight tanks indicates that although all the peat soil was mixed together before the tanks were filled, the peat-soil salt content in each tank varied.

The initial peat-soil pore-water DOC concentrations (week 1) for SMARTS 1 ranged from 143 to 226 mg/l (Table 4-3). This range is higher than any soil DOC values measured by the USGS at Twitchell Island (U.S. Geological Survey 1998), which were generally in the range of 40 to 100 mg/l. They are also greater than the DOC in surface saturated soil samples collected from Holland Tract, which were in the range of 25 to 75 mg/l (as shown in Table C3-8 in Appendix C3 of the 1995 DEIR/EIS).

By the fifth week, approximate peat-soil pore-water DOC concentrations had increased to between 271 and 341 mg/l. By week 9, the peat-soil pore-water DOC concentrations were 58 to 386 mg/l, and in the final sampling at week 12, they were 74 to 358 mg/l (Table 4-3). Pore-water DOC did not increase between weeks 9 and 12 in most of the peat-soil pore-water measurements.

Therefore, although the flooded peat-soil DOC concentration is high, these results may indicate that the peat soil does not contain an unlimited supply of DOC, at least in the limited depth samples used in the experiment.

SMARTS 2 Pore-Water EC and DOC Concentrations

The SMARTS 2 peat-soil pore-water EC values on week 1 (January 21, 1999) ranged from 3,640 to 4,800 μS/cm in tanks 1–4 and from 578 to 1,232 μS/cm in tanks 5–8 (Table 4-4). By week 15, the pore-water EC values were 2,383 to 3,280 μS/cm in tanks 1–4 and 455 to 998 μS/cm in tanks 5–8. As described above, these two groups of tanks were filled with different peat-soil sources from different locations on Twitchell Island. The peat soil used to fill tanks 1–4 is extremely high in soil EC (dissolved minerals apparently had not been leached by rainfall or field-flooding operations).

SMARTS 2 DOC concentrations in the peat-soil pore water were very high in tanks 1–4, but were relatively low in tanks 5–8. Again, the soils for these tanks came from different locations on Twitchell Island. The differences illustrate the wide range of peat-soil conditions in the Delta. On January 21 (week 1), the peat-soil pore-water DOC ranged from 82 to 96 mg/l in tanks 1–4 and from 11 to 28 mg/l in tanks 5–8. By April 28 (week 15), the peat-soil pore-water DOC concentration had increased to between 342 and 561 mg/l in tanks 1–4 and between 30 and 84 mg/l in tanks 5–8. On July 21 (week 27), the DOC concentration of peat-soil pore water in tanks 1–4 ranged from 368 to 590 mg/l and from 40 to 100 mg/l in tanks 5–8. The DOC concentrations in the peat-soil pore water increased substantially during the first months but did not continue to increase from week 15 to week 27, even though the temperature was higher. The experimental design called for the same peat-soil content in all eight tanks. However, because the peat-soil composition differed between tanks 1–4 and tanks 5–8, peat-soil composition is another factor to consider in the interpretation of the SMARTS 2 results.

DOC Loading Estimates

The DOC load that was transferred from the peat-soil pore water into the surface water through the various possible exchange processes (including the submersible pumps) can be calculated from the final water DOC concentration and surface water depth in the static tanks. These calculations result in loading estimates of 24 to 32 g/m^2 for the static tanks with 1.5 feet of peat (tanks 1 and 7) and 53 to 54 g/m^2 for the static tanks with 4 feet of peat in SMARTS 1 (tanks 3 and 5) (Table 4-3). The SMARTS 2 experiment resulted in a wide range of load estimates because the tanks' peat-soil pore-water DOC concentrations varied considerably. The SMARTS 2 experiment data for week 27 indicated that the DOC load from the high-DOC static peat tanks (tanks 1 and 3) was 73 to 121 g/m^2, and from the low-DOC static peat tanks (tanks 5 and 7), 23 to 42 g/m^2 (Table 4-4).

Application to the Delta Wetlands Project

The peat-soil DOC loads measured in the SMARTS tanks are higher than the estimates obtained from agricultural drainage samples, and the peat-soil pore-water DOC concentrations were considerably higher than any DOC concentrations that have been measured in Delta peat soils. DOC loads in the static tanks are higher than the DOC load estimates from the Delta agricultural drains, but the peat-soil pore-water DOC concentrations in the SMARTS experiments were probably higher than would be experienced in undisturbed Delta agricultural peat soils that are flooded, based on USGS measurements at Twitchell Island. To determine the applicability of the SMARTS results to the Delta Wetlands Project, the experimental variables (i.e., water-flow condition, depth of peat, depth of water, and initial peat-soil composition) were evaluated for their consistency with proposed Delta Wetlands Project operations.

As discussed above, results from the static tanks were used to determine DOC loading estimates. The submersible pumps may mimic wave-induced mixing that would occur on the Delta Wetlands islands. The observed SMARTS loads were proportional to the depth of the peat soil and the DOC concentration of the peat-soil pore water. Likewise, DOC loading of flooded agricultural peat soils on the Delta Wetlands islands would be proportional to the depth of oxidized peat soil on the islands. Release of DOC is generally much greater for oxidized soil than for anaerobic (reduced) soils. Under existing agricultural practices, depth of oxidized soil on the Delta Wetlands islands has been assumed to be 2 feet based on DWR's Delta depletion analysis. Therefore, it is unlikely that Delta soils will have 4 feet of recently oxidized (aerobic) peat. The tanks with a 1.5-foot peat layer are perhaps the most realistic representation of Delta agricultural peat soils; however, loading estimates from both the 1.5-foot and 4-foot peat-soil depths were considered.

Peat soil composition on Delta islands is variable. However, the initial peat-soil pore-water EC and DOC concentrations reported for tanks 1–4 in the SMARTS 2 report exceed measured results from most other Delta soils. Initial pore-water EC values in tanks 1–4 were 3,640 to 4,800 μS/cm and pore-water DOC reached 374 to 590 mg/l by week 27. In comparison, samples of soil water (i.e., pore water extracted from soil samples) collected at the soil surface and at a depth of 2 feet from the demonstration wetland site on Holland Tract in 1992 yielded EC values between 612 and 1,990 μS/cm and DOC concentrations between 24 and 71 mg/l with an average of 55 mg/l (n=9). Soil-water samples collected from an agricultural field on Holland Tract in 1992 included measured EC values between 455 and 11,500 μS/cm and DOC concentrations between 41 and 240 mg/l with an average of 141 mg/l (n=9) (see Tables C3-8 and C3-9 in Appendix C3 of the 1995 DEIR/EIS). The SMARTS 2 pore-water DOC measurements are considerably higher than those of the surface or 2-foot-deep peat samples collected on Holland Tract.

The SMARTS 1 surface-water load estimates for static tanks with 1.5 feet of peat soil (tanks 1 and 7) were 24 to 32 g/m^2, and for static tanks with 4 feet of peat soil (tanks 3 and 5) were 53 to 54 g/m^2. For the SMARTS 2 tanks filled with peat soil that produced pore-water DOC concentrations of 40 to 100 mg/l (tanks 5–8), the DOC load estimates were 23 to 42 g/m^2 for static tanks with 1.5 and 4.0 feet of peat, respectively. These values suggest that submerged peat soil with a previous history of agricultural use may produce a DOC load of 2 to 5 times the measured agricultural drainage DOC loads (of about 12 g/m^2).

CCWD sent a letter to the SWRCB (Shum pers. comm.) suggesting that the 12-week load estimates from the SMARTS 1 experiment should be multiplied by 52/12 to estimate the annual loads. However, it seems clear from the measurements that the DOC concentrations in the water and in the peat-soil pore-water samples were approaching loading limits after week 9 (SMARTS 1); it would not be reasonable to expect 4 times these observed 12-week loads to originate from the peat soil during a year of submergence. The SMARTS 2 experiments confirm that the peat-soil pore-water DOC and the surface-water DOC concentrations do not continue to increase during longer submergence as rapidly as during the initial 3 months of submergence. The SMARTS 2 results indicate that surface-water DOC did continue to increase for the life of the experiment (27 weeks) in the static tanks, but average weekly peat-soil pore-water DOC concentrations increased at a slower rate after week 11 in all static tanks.

In conclusion, loading estimates from static tanks were considered in the context of estimates from other studies and expert testimony (described in the next section) to develop assumptions about Delta Wetlands reservoir islands under initial-fill operations. The loading observed in the SMARTS experiments may correspond to the first year of flooding of agricultural soils, but it is unlikely that the high initial level of peat-soil pore-water DOC would be produced in subsequent years from moist peat soils (U.S. Geological Survey 1998). The SMARTS experiments have not tested the DOC load from a second year of peat-soil submergence. It is likely that the DOC loads in subsequent years will be less than those measured for the first year of peat-soil submergence.

It should be noted that the SMARTS experiments do not represent the proposed conditions on the Delta Wetlands islands, and the experimental design and sampling methods may not be applicable to in-situ conditions. However, the SMARTS experiments provide the best source of experimental or laboratory data on DOC release from peat soils.

See "Impact Assessment Methodology" below and Appendix G for more information about how results of the SMARTS studies were used in the impact analysis.

REPORTED ESTIMATES OF DISSOLVED ORGANIC CARBON LOADING

DOC loading is a function of many variables, including peat-soil depth, pore-water concentration, pore-water and water column mixing, and plant material growth and degradation. Agricultural production, wetland habitat, and flooded island conditions may result in different DOC loadings. For example, DOC loading from plant material growth and decay (including algal blooms) is expected to be greater under agricultural production or wetland habitat conditions than under flooded reservoir conditions.

During the Delta Wetlands Project water right hearing and in comments on the 1995 DEIR/EIS, the estimates of DOC loading on the Delta Wetlands islands under agricultural, reservoir, and wetland habitat conditions were debated at length. The lead agencies have received a wide range of estimates of potential DOC loading rates. Table 4-5 summarizes the loading estimates for agricultural drainage, seasonal wetland, and flooded island conditions that were presented in the 1995 DEIR/EIS, obtained from the Twitchell Island and SMARTS experiments, and presented at the

SWRCB water right hearing for Delta Wetlands by expert witnesses. For purposes of comparison, these estimates are presented in similar units; all estimates have been reported as grams of DOC per square meter per year ($g/m^2/yr$). Units of $g/m^2/yr$ can be converted to pounds per acre per year (lbs/ac/yr) by multiplying the value by 8.9. For example, 10 $g/m^2/yr$ is equivalent to 89 lbs/ac/yr.

Source loading estimates represent attempts to characterize DOC loading from individual DOC loading components, such as vegetation residue, primary production, and peat soil, or from all components and factors expressed as a total DOC load. Some estimates are based on actual field data collection and experiments; others are based only on general theory calculations (e.g., organic carbon production and hydrodynamics). Some of the DOC load estimates vary considerably; the estimates range over several orders of magnitude from less than 5 to more than 1,800 $g/m^2/yr$.

The following text describes the estimates of DOC loading rates presented in Table 4-5 and summarizes DOC loading estimates and criticisms of the 1995 estimates presented at the water right hearing. Consult the sources listed in the notes for Table 4-5 for more detail about how these estimates were derived. The use of DOC loading estimates for the impact analysis is described under "Impact Assessment Methodology".

Dissolved Organic Carbon Loading in Existing Agricultural Drainage

Estimates of DOC loading from agricultural operations in the Delta provide a baseline DOC loading level for the impact analysis. The 1995 DEIR/EIS used information from DWR MWQI agricultural measurements to establish existing DOC budgets and loading estimates. Those estimates have been updated based on DWR MWQI measurements of DOC concentrations and annual drainage volume (see Appendix G). That fraction of the average DOC concentrations not accounted for in applied-water DOC was multiplied by estimated annual drainage depth to provide a calculated load. A similar method of load calculation was conducted for Twitchell Island records. These estimates are described further in Appendix G.

Assumed agricultural loads from two modeling studies are also included in the list of agricultural drainage estimates. Using the Delta Wetlands island drainage load values as a reasonable range of likely DOC loads, an average of 12 $g/m^2/yr$ was used in the DeltaDWQ model in the 1995 DEIR/EIS. This average value for the project islands was supported further when the model was calibrated to export DOC concentration data; the loading estimate of 12 $g/m^2/yr$ correlated well with DOC concentrations measured at the SWP and CVP pumping plants (see Appendices C2 and C4 of the 1995 DEIR/EIS).

Estimates of drainage flows and drainage DOC concentrations presented in an MWQI report titled "Candidate Delta Regions for Treatment to Reduce Organic Carbon Loads, MWQI-CR #2" (Jung and Tran 1999) were used to calculate the average DOC load for Delta lowlands islands. These estimates were based on DOC concentrations and drainage volumes from DWR Delta lowlands modeling. The calculated load was 8 $g/m^2/yr$.

Dissolved Organic Carbon Loading under Project Conditions

Estimates from the 1995 DEIR/EIS

Several experiments were conducted for the Delta Wetlands Project to assess DOC loading under seasonal wetland and reservoir operations (see Appendix C3 of the 1995 DEIR/EIS). The methods and results of these experiments were challenged at the water right hearing and in comments on the 1995 DEIR/EIS. A brief summary of the experiment results and a discussion of challenges to those results follows.

In the wetland demonstration experiment, a portion of Holland Tract was flooded and a shallow flooded wetland habitat (0.5 meter deep) was created. Water samples were collected for approximately 3 months, and a DOC load was estimated. The wetland demonstration project estimated a total DOC load of 7 to 17 $g/m^2/yr$. In addition, a second experiment was conducted to ascertain the DOC load generated from the decay of wetland plants. Wetland plant decay experiments suggested a load of 5.1 to 7.5 $g/m^2/yr$. Compared to agricultural conditions, wetlands may provide lower DOC loads because the peat soil of wetlands generally will be more moist and less aerobic than that of agricultural soils. However, a seasonal wetland loading of 12 $g/m^2/yr$ was assumed in DeltaDWQ, equivalent to the assumed agricultural drainage load.

Additional experiments were conducted to assess DOC loading under Delta Wetlands Project reservoir operations. At the demonstration wetland on Holland Tract, loading was estimated for an extended period of time when a seasonal wetland was deep-flooded (to approximately 0.8 m) to characterize possible reservoir operations. In this experiment, the overall DOC load was estimated from the combined flooded wetland and water storage periods at the Holland Tract wetland demonstration project. The result was an estimated DOC load of 21 $g/m^2/yr$.

In 1991, as part of DWR's emergency water bank, Tyler Island was flooded for approximately one month. DOC loading was estimated based on collected water samples. The Tyler Island experiment resulted in an estimated total DOC load of 30 to 36 $g/m^2/yr$. Much of the DOC loading was probably the result of the rapid decay of cornfield vegetation residue and oxidized surface peat soil.

Parties to the water right hearing questioned the validity of these experimental results. CUWA, CCWD, and others argued that the Holland Tract flooded wetland experiment was stopped too soon; they said that it was unclear whether the level of DOC had started to level off or not, and that the reported DOC loading was therefore underestimated. Additionally, for all the experiments, CUWA stated that the testing procedure for THMFP was inaccurate in waters containing more than 10 mg/l of DOC and that the laboratory used for water quality testing did not maintain good laboratory practices (Krasner testimony 1997).

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Estimates from the Special Multipurpose Applied Research Technology Station Studies

The SMARTS experiments provided estimates of DOC loading from flooded peat soils obtained from a field on Twitchell Island that had been in agricultural conditions during the previous year. The results of the SMARTS experiments are discussed above in detail; Table 4-5 includes loading results from the static tanks.

Estimates from Water Right Hearing Participants

Table 4-5 summarizes the range of estimated DOC loads provided in testimony. A wide range of DOC estimates was provided; the estimates were based on physical/chemical process theory, including molecular diffusion, advection, and bioturbation (i.e., mixing by benthic organisms). Estimates from Stuart Krasner and Richard Losee for CUWA, K. T. Shum for CCWD, and Michael Kavanaugh for Delta Wetlands are briefly discussed below. Refer to the hearing exhibits for more information on how these values were developed. The estimates of DOC loading provided in testimony are theoretical; no direct in-field or experimental results on DOC loading under project conditions were presented.

Stuart Krasner of CUWA estimated the potential impact of the Delta Wetlands Project on THM formation and water treatment operations using estimated DOC concentrations from the Delta Wetlands reservoirs of 8, 16, and 32 mg/l. Assuming a reservoir depth of 6 meters and an initial applied-water DOC concentration of 3 mg/l, the resulting DOC loading estimates would be 30, 78, and 174 $g/m^2/yr$, respectively (Krasner testimony 1997).

Richard Losee of CUWA provided independent estimates of DOC from primary production (i.e., algae biomass) and from peat soil. Losee identifies the following sources of primary production on the reservoir islands:

- planktonic algae or phytoplankton,
- benthic or attached algae,
- submersed macrophytes,
- floating vegetation,
- emergent macrophytes, and
- terrestrial vegetation.

Based on *Cladophora* production rates in a shallow MWD reservoir reported by Losee and assuming a Delta Wetlands reservoir depth of 6 meters, DOC loading from primary production is calculated as 50 to 1,250 $g/m^2/yr$. Losee also estimated peat soil as a source of DOC by determining the amount of organic carbon that is potentially available from mass estimates of the organic carbon in the sediment pools. This analysis resulted in an estimated DOC concentration of 300 mg/l in water 6 meters deep, which translates into a DOC loading estimate of 1,830 $g/m^2/yr$. Losee's DOC loading estimates were the highest estimates presented at the hearing and more than 10 times greater than measurements from the SMARTS experiments. (Losee testimony 1997.)

K. T. Shum of CCWD and Losee provided an estimate of DOC loading from seepage control pump operations (see Chapter 6). They estimated groundwater DOC concentrations of 20 to 40 mg/l (loading of 9.2 to 18.4 $g/m^2/yr$) based on an assumption that 8,100 af of water would be pumped through the wells on Bacon Island during a 9-month storage period. (Losee and Shum testimony 1997.)

Shum also testified about the magnitude of the flux of TOC from the peat sediments when molecular diffusion is the only transport process present. This estimate is based on an assumed peat-soil pore-water DOC concentration of 70 mg/l from the top 0.3 meter of the soil and a water column DOC concentration of 10 or 40 mg/l. Based on a 5- to 25-fold increase in the DOC diffusion loading rate as a result of various transport mechanisms such as bioturbation, wave pumping, and seepage, the resulting loading values were 16 to 160 $g/m^2/yr$. (Shum testimony 1997.)

Michael Kavanaugh for Delta Wetlands estimated DOC loading on habitat and reservoir islands based on diffusion from sediments, vegetative biomass, and algae production. Results for the reservoir islands were 3.5 to 11.9 $g/m^2/yr$ for Bacon Island and 3.5 to 12.7 $g/m^2/yr$ for Webb Tract; results for the habitat islands were 7.3 to 20.6 $g/m^2/yr$ for Bouldin Island and 3.7 to 10.3 $g/m^2/yr$ for Holland Tract. (Kavanaugh testimony 1997.)

See "Impact Assessment Methodology" below and Appendix G for information about how estimates presented in testimony were considered in the impact analysis.

CHANGES IN DISINFECTION BYPRODUCT RULES

Since release of the 1995 DEIR/EIS, new or revised standards have been adopted or proposed regarding DBPs in treated drinking water. The following sections describe new rules for TOC removal before treatment and revised and proposed THM standards.

Total Organic Carbon Removal Requirements

Since release of the 1995 DEIR/EIS, standards for TOC removal before treatment have been adopted under the Safe Drinking Water Act (SDWA). TOC consists of both DOC and particulate organic carbon (POC). DOC represents more than 90% of the TOC present in Delta waters (California Department of Water Resources 1994). The SDWA rules specify requirements for the removal of TOC. Municipal water treatment plants may remove this substance by enhanced coagulation (e.g., using alum); water systems that obtain their water supplies from surface-water or groundwater sources and use conventional filtration processes may use enhanced softening to remove TOC.

The following table shows the percentage of TOC that must be removed based on the alkalinity and TOC concentrations in source water. Removal of TOC before chlorination will generally reduce the THM concentrations. Because Delta water generally has an alkalinity between

60 and 120 mg/l as calcium carbonate ($CaCO_3$), removal of 25% or 35% of the raw-water TOC will be required. This TOC would be removed before the water is chlorinated to reduce the necessary Cl_2 dose and to reduce the subsequent formation of THMs.

Requirements for Percentage of Total Organic Carbon to be Removed
for Systems Using Conventional Treatment

	Alkalinity (mg/l as $CaCO_3$)		
Source Water TOC (mg/l)	0-60	60-120	>120
2–4	35%	25%	15%
4–8	45%	35%	25%
>8	50%	40%	30%

Revised Trihalomethane Standards

The EPA maximum contaminant level (MCL) for THM concentrations in drinking water has been revised from 100 to 80 μg/l since release of the 1995 DEIR/EIS. Because THM concentrations vary seasonally, the THM standard is applied to a moving annual average based on quarterly or monthly samples at the treatment plants. Many water treatment plants have responded to the regulatory change by using enhanced coagulation with Cl_2 as the primary disinfectant or by changing treatment technology (e.g., ozone [O_3]).

EPA has also proposed future ("Stage 2") THM rules. The proposed rule, which is expected to go into effect in 2002, would lower the MCL for THMs to 40 μg/l. To respond to this regulatory change, treatment plants will likely need to install treatment systems using O_3, granular activated carbon (GAC), and/or membranes. These changes will increase water treatment costs.

IMPACT ASSESSMENT METHODOLOGY

This section provides an overview of the assessment methods used to evaluate water quality impacts of the proposed Delta Wetlands Project and explains how the new or updated information described above has been incorporated into the assumptions and methods used. The section focuses on the quantitative models used to estimate Delta drainage and export water quality (i.e., DOC and salinity) and DBP concentrations (i.e., THMs and bromate) at the treatment plants under baseline and with-project conditions. Additional information about these methods can also be found in Appendix G of this REIR/EIS and Chapter 3C and Appendix C4 of the 1995 DEIR/EIS.

Modeling Delta Wetlands Project Effects on Salinity and Dissolved Organic Carbon

Water quality at Delta export locations is a function of the quality of water coming into the Delta, the ways in which that quality may change as a result of in-Delta activities, the volume of Delta inflows and exports, and the proportion of the export water coming from each source. Export water is a mixture of water from the central Delta, San Joaquin River water, and Delta agricultural drainage. Under Delta Wetlands Project operations, Delta Wetlands discharges would be another source of export water and would therefore affect Delta export water quality. Quantitative modeling is used to estimate the contribution of the Delta Wetlands islands to levels of water quality constituents at Delta channel locations and in Delta diversions and exports.

Modeling Used for the 1995 Draft EIR/EIS Impact Assessment

Before the 1995 DEIR/EIS was prepared, no model existed for estimating the relationship between the water budget for Delta agricultural islands (diversions, ET, and drainage) and the salinity (EC) and DOC concentration patterns in agricultural drainage. The Delta drainage water quality model DeltaDWQ was developed to estimate the contribution of the Delta Wetlands islands to levels of EC, DOC, Cl^-, and Br^- at Delta channel locations and in Delta diversions and exports under no-project conditions and under project operations. DeltaDWQ combined all of the following:

- DeltaSOS simulations of monthly channel flows;
- DeltaSOS estimates of monthly diversion, storage, and discharge volumes for the Delta Wetlands Project islands; and
- simulations of water quality constituent concentrations in monthly agricultural drainage flows and Delta Wetlands Project discharges.

DeltaDWQ simulated Delta agricultural drainage water quality by simultaneously accounting for water, salt, and DOC budgets. Refer to Appendix C4 in the 1995 DEIR/EIS for a detailed description of the DeltaDWQ model.

Modeling Used for This Revised Draft EIR/EIS Impact Assessment

For this REIR/EIS, the DeltaSOS model was modified to incorporate the equations for predicting the water quality of agricultural drainage and Delta Wetlands reservoir island storage. The revised model also incorporated equations that would predict the effects of agricultural drainage and Delta Wetlands discharges on constituent concentrations in Delta channels and exports. Simplified water budget and DOC and salt loading functions were included in the model. This modification of DeltaSOS with water quality calculations is called the DeltaSOQ model. Use of the DeltaSOQ model eliminates the need for a separate DeltaDWQ model. This section provides a summary of the assessment method; Appendix G describes the method in detail by:

- describing the methods included in DeltaSOQ for estimating Delta source contributions of DOC and salt concentrations,

- explaining the assumptions and methods used for calculating DOC loading from agricultural drainage and Delta Wetlands discharges, and

- demonstrating the calibration of the model using historical water quality measurements of Delta inflows and exports.

Estimating Changes in Salinity. The salinity (EC and Cl^-) of water from the central Delta, the San Joaquin River, agricultural drainage, and the Delta Wetlands Project islands and the proportions in which water from these sources is present in the exports determine export salinity. The volume of Delta flows and exports and salinity intrusion from Suisun Bay are used in calculations of Delta salinity. Methods used to simulate project effects on salinity in this REIR/EIS are similar to the methods described in the 1995 DEIR/EIS, but the equations have been updated to reflect updated salinity measurements from MWQI and other sources. Appendix G provides more detail on the equations used to calculate salinity in DeltaSOQ.

Estimating Changes in Dissolved Organic Carbon. Project effects on DOC concentrations in Delta exports are a function of the following:

- the DOC concentrations in water diverted onto the Delta Wetlands islands;

- evaporative losses;

- DOC loading from peat soils and plant growth;

- residence time (i.e., the length of time water is stored on the islands before being discharged);

- DOC concentrations in Delta receiving waters at the time of Delta Wetlands discharges; and

- the relative amount of Delta Wetlands water in exports.

The methods used to estimate DOC under existing conditions (i.e., DOC in Delta inflows and Delta agricultural drainage) are based on DOC measurements and mass balance estimates, similar to the methods used for salinity (see Appendix G). Although Delta Wetlands would cease farming operations on the islands under project conditions, the contribution of Delta Wetlands islands to agricultural drainage DOC (estimated as 1 g/m^2/month or 12 g/m^2/yr, as shown in Appendix C4 of the 1995 DEIR/EIS) is simulated as a constant under no-project and with-project conditions in response to comments on the 1995 DEIR/EIS. To determine project effects on DOC concentrations in the exports, the model includes an estimate of DOC loading under project operations in addition to the no-project estimate, as described below.

An additional load of DOC could result from inundation of the peat soils during reservoir operations under the proposed project. Reservoir operations might cause more DOC to be mixed from the pore water into the water column than when the peat soils are drained under agricultural practices. Measured data on DOC loading under flooded peat-soil conditions similar to conditions proposed by Delta Wetlands are not available; therefore, an estimated range of possible DOC loading from reservoir operations is based on experimental results.

For purposes of impact analysis, a range of potential DOC loads on the reservoir islands was assumed. In the long term, repeated filling and emptying of the Delta Wetlands reservoir islands might leach out most of the soluble organic material, and DOC loading from peat soils might decline over time. However, the first fillings of the islands would likely result in high DOC loading. The analysis presents three simulations of potential project effects on DOC in Delta exports: an assumption for long-term DOC loading (1 g/m^2/month of storage), an assumption for initial-filling DOC loading (4 g/m^2/month of storage), and an assumption for high initial-filling DOC loading (9 g/m^2/month of storage). The initial-fill assumptions include potential DOC loads from interceptor well operations. The loading estimates are summarized in Table 4-6 and are discussed in more detail in Appendix G.

Modeling Delta Wetlands Project Effects on Disinfection Byproducts

The potential effects of Delta Wetlands Project operations on treated-drinking-water DBPs (i.e., THM and bromate) are evaluated as an additional level of water quality impact assessment. DBP concentrations are determined by the raw water quality parameters (DOC and Br^-) as well as the treatment process parameters (chlorination dose, pH, temperature); therefore, only representative estimates of the incremental effects of increased DOC and Br^- concentrations on these DBP concentrations can be calculated. The latest Malcolm Pirnie equation for use in predicting THM concentrations and the Ozekin predictive equation for bromate formation in treating drinking water were evaluated for use in the impact analysis. The review of these assessment methods and the equations used in the DeltaSOQ model are described in Appendix G. Potential effects of Delta Wetlands Project operations on THM concentrations are calculated in the model; the effects on bromate concentration are not calculated because no reliable relationship between bromate and DOC or Br^- could be identified.

CRITERIA FOR DETERMINING IMPACT SIGNIFICANCE

The State CEQA Guidelines encourage each public agency to develop and publish thresholds of significance. The SWRCB has not published specific significance criteria for projects affecting Delta water quality; however, the SWRCB and EPA have established regulatory objectives and numerical standards, such as those contained in the 1995 WQCP, to protect beneficial uses of Delta waters. The criteria used to determine the significance of effects of Delta Wetlands Project operations on water quality have been set to conform with these existing objectives and standards. For Delta water quality variables for which no regulatory objectives or numerical standards have been set, the selected significance threshold is a percentage change from existing measured values that encompasses natural variability in water quality constituents.

Since release of the 1995 DEIR/EIS, numerical requirements for TOC removal before water treatment have been established under the Safe Drinking Water Act, and EPA has revised its standard for THM concentrations in drinking water. Also, during the Delta Wetlands water right hearing, some protestants raised concerns about the adequacy of the 1995 DEIR/EIS significance criteria in protecting Delta water quality. As discussed below, these factors were considered when significance criteria were established for this REIR/EIS impact analysis for water quality.

Significance Criteria Used in the 1995 Draft EIR/EIS

For the 1995 DEIR/EIS analysis, it was assumed that there are benefits to maintaining water quality better than that specified by the numerical water quality criteria. Therefore, significance thresholds for variables with numerical water quality criteria were established at 90% of the specified water quality standards. If simulated project operations caused the value for a water quality variable to exceed 90% of the numerical standard for that variable, the effect was considered in the 1995 DEIR/EIS to be a significant water quality impact. Maximum significance criteria were not set for constituents that do not have numerical regulatory standards.

A second significance criterion was based on the assumption that some changes may be substantial compared with the natural variability of the water quality variable under no-project conditions and could be considered significant impacts. Natural variability caused by tidal flows, river inflows, agricultural drainage, and biological processes in the Delta channels is sometimes quite large relative to the numerical standards or mean values of water quality variables. Natural variability was assumed to be 10% of the specified numerical limit for variables with numerical limits or 10% of the mean value for variables without numerical limits. Measurement errors and modeling uncertainties were likewise assumed to be about 10% of the measured or modeled values. Therefore, simulated changes that were less than 10% of either the numerical limit or the measured or simulated mean value of the variable were not considered to be changes. In other words, these changes are not greater than natural variability and model uncertainty. Based on professional experience, the second (i.e., incremental) significance criterion adds 10%, adding up to 20% of the numerical limits for water quality variables with numerical limits or 20% of the mean value for variables without numerical limits.

Comments on Significance Criteria

Several parties to the water right hearing and commenters on the 1995 DEIR/EIS have questioned the adequacy of the significance thresholds used in the impact analysis for water quality, arguing that these thresholds would not ensure the protection of all beneficial uses, most notably municipal water uses. The challenges are based on the concern that natural variability differs among water quality constituents and that any change for some constituents may unacceptably degrade resources that are already impaired. In addition, some parties have argued that economic effects on treatment plant operators (increases in treatment costs) that could result from project-related increases in salinity and DOC concentrations should be considered significant impacts.

The determination of impact significance and proposed mitigation described in the 1995 DEIR/EIS and in this REIR/EIS are intended to ensure that the project complies with CEQA and NEPA requirements. A lead agency is directed by CEQA to assess the significant environmental effects of a proposed project and has discretion regarding the most appropriate methodology for determining the significance of effects. The lead agency may adopt thresholds of significance for general use developed through a public review process, or may use other methods for determining impact significance for each particular project, based on substantial evidence. In addition, the State CEQA Guidelines state that a change in the environment is not significant if it complies with a "standard". A standard is defined as, among other things, a quantitative requirement adopted by a public agency through a public review process. (State CEQA Guidelines Sections 15126, 15064.7, and 15064.) NEPA requires that an EIS disclose the direct, indirect, and cumulative effects of the proposed action but does not require significance determinations for individual project effects (40 CFR 1502.16). Also, the State CEQA Guidelines state that economic changes resulting from a project "shall not be treated as significant effects on the environment"; similarly, NEPA requires discussion of economic effects to the extent that they are interrelated with environmental impacts (State CEQA Guidelines Section 15064; 40 CFR 1508.14). Therefore, economic effects will be considered by the SWRCB and USACE in their project approval processes, but no significance thresholds are required for such effects.

Normally, significance thresholds are based on established regulatory standards. The 1995 WQCP established numerical objectives for some of the Delta water quality variables assessed in this analysis (i.e., Cl^-, EC). In this EIR/EIS, significance thresholds for these variables are set to be more stringent than the adopted standards based on the following assumptions:

- It would be beneficial to maintain water quality that is better than that specified by the water quality objectives.
- Measurement errors and modeling uncertainties account for 10% of measured or modeled values.

The significance thresholds of a change of 20% of the numerical limit and a change to a value that is more than 90% of the allowed limit for these variables therefore exceed the expectations of CEQA and NEPA.

Established standards do not exist for project effects on DOC concentrations in Delta waters. In the absence of recognized standards, this analysis proposes 20% of average measured DOC values as the significance threshold for the assessment of project effects. This criterion was selected to detect changes that exceed the range of natural variability and that can therefore be attributed to project operations. It would be unreasonable to establish a significance threshold that does not allow for project effects that are within the natural variability of the constituents in question because project effects would be impossible to differentiate from no-project conditions.

In addition, EPA has set numerical limits for THM levels at municipal water treatment plants. Although the Delta Wetlands Project would not directly produce THMs, project contributions to DOC and Br^- concentrations in Delta waters could affect the subsequent formation of THMs at treatment plants. Therefore, the 20% and 90% significance thresholds described above have also been applied to the THM limits, with potential THM increases calculated based on estimated increases in DOC concentrations under unmitigated project operations. The potential effects of DOC loading under project operations are thus covered under two significance determinations, one for increases in DOC concentrations and one for estimated effects on treatment plant production of THMs.

The impact assessment for Delta Wetlands Project effects on water quality is performed using the available monthly average measurements and simulations of monthly average Delta conditions and project operations. Use of monthly data allows for a preliminary estimate of the number of months in which unmitigated project operations could substantially affect water quality; it also provides the basis for a comparison of relative effects of the project alternatives, consistent with CEQA and NEPA requirements. However, Delta Wetlands would be required to adjust actual operations daily in response to daily monitoring of actual Delta conditions and the quality of water stored on the Delta Wetlands islands. The significance criteria and estimates of the potential for project operations to cause exceedances of specified parameters presented in this impact assessment are used to develop mitigation measures under CEQA and NEPA on a monthly time step (see "Recommended Mitigation and Application to Delta Wetlands Project Operations" below). However, significance criteria for CEQA/NEPA analysis may differ from the requirements in water right terms and conditions that may be used to trigger changes in project operations.

During the water right decision process, the SWRCB will consider project effects on present and anticipated beneficial uses of Delta water. For example, some beneficial uses are more sensitive to changes in specific water quality variables than to changes in other variables; in these cases, the lead agencies may apply a mitigation trigger other than 90% of a specified limit or 20% change. In other words, the SWRCB may apply different performance standards for triggering mitigation, based on substantial evidence, in the terms and conditions of the water right permits. Possible mitigation approaches and the relationship between CEQA/NEPA mitigation measures and the terms and conditions of water right permits are discussed in "Recommended Mitigation and Application to Delta Wetlands Project Operations" below.

Summary of Significance Criteria Used in This Revised Draft EIR/EIS Analysis

The significance criteria used in this analysis are identical to those used in the 1995 DEIR/EIS except that the THM criterion has been updated in response to changes in the federal Disinfection Byproducts Rule. The selected water quality impact assessment variables and the significance criteria used in this REIR/EIS for each variable are summarized in Table 4-7.

The EPA standard for THM concentrations in drinking water has been revised from 100 to 80 μg/l since preparation of the 1995 DEIR/EIS. For the REIR/EIS analysis, the significance criterion was lowered to exceedance of 72 μg/l (90% of 80 μg/l) or changes greater than 16 μg/l

(20% of 80 μg/l) to reflect the new THM standard. Because the THM standard is based on an annual running average of THM measurements, the significance criterion may be applied more appropriately to the annual average THM values. However, the monthly criterion has been used for both the 1995 DEIR/EIS and REIR/EIS analyses to provide a more conservative approach to THM impact analysis.

Changes in export DOC concentrations caused by Delta Wetlands Project operations could affect TOC removal requirements at treatment plants (see "Changes in Disinfection Byproduct Rules" above). An increase in export DOC might cause the TOC removal requirement to change from 25% to 35%. Although the project-related changes in export DOC are within existing variations in DOC, the Delta Wetlands Project could affect the frequency with which treatment plants would need to meet higher TOC removal requirements and, as a result, could affect the cost of treatment operations. As discussed above, changes in treatment costs are not considered an environmental impact (State CEQA Guidelines Section 15064[e]). No new significance criteria are needed for this water quality variable.

ENVIRONMENTAL CONSEQUENCES

Water quality impacts of Delta Wetlands Project operations were assessed by comparing conditions under simulated project operations with conditions under the simulated No-Project Alternative. The simulated No-Project Alternative represents Delta water quality conditions that are likely to exist in the absence of Delta Wetlands Project operations (i.e., continued and intensified farming operations on the four Delta Wetlands Project islands), with a repeat of the historical hydrologic conditions, but with existing facilities, water demands, and Delta standards. See Chapter 3 for a description of the DeltaSOS modeling assumptions.

The 25-year period of 1967-1991 was used in the 1995 DEIR/EIS assessment of water quality effects for several reasons:

- The range of hydrologic conditions during this period is similar to that of the full 73-year period of the hydrologic record (1922-1994) (see Appendix A1 of the 1995 DEIR/EIS).
- Most reservoirs and diversion facilities were operational during this 25-year period.
- Historical EC and water quality data are available for this period.

The full 1922-1994 period is used in this REIR/EIS assessment. The results from the most recent 23-year period of the hydrologic record (1972-1994) are shown graphically to illustrate the model calculations and results.

As described in the 1995 DEIR/EIS, four locations in the Delta (Chipps Island, Emmaton, Jersey Point, and Delta exports) were selected for assessment of impacts related to Delta salinity conditions. A representative Delta export location was used because the impact assessment methods cannot distinguish reliably between water quality conditions at the major export or diversion locations (CVP exports at Tracy, SWP exports at Banks, and CCWD diversions at Rock Slough or Old River intakes).

Impacts related to DOC and THM concentrations were assessed for Delta exports only. Export DOC concentrations were evaluated with the DeltaSOQ model for a range of estimates of DOC loading from the Delta Wetlands reservoir islands. THM concentrations in treated drinking water were evaluated using the revised THM equation (Appendix G).

Simulated Delta Water Quality for the No-Project Alternative

As noted above, the No-Project Alternative is simulated to represent likely Delta conditions that would result from a repeat of the historical hydrologic sequence, but with existing water project facilities (reservoirs, diversions, and canals) and current levels of demand for upstream diversions and Delta exports. Delta conditions under the No-Project Alternative are assumed to be controlled by objectives of the 1995 WQCP and other applicable water rights, agreements, and requirements. The results of simulations of the No-Project Alternative are compared with historical data to confirm the reliability of the DeltaSOQ model in predicting general trends. Water quality conditions were simulated for 1922 through 1994 (73 years) based on the results of baseline water supply and operations modeling (i.e., DWRSIM results; see Chapter 3, "Water Supply and Operations"). Results for the entire 73-year study period are presented in tables, and a series of figures compares simulation results and available historical data for 1972 to 1994.

Because of the differences in facilities, levels of demand, and regulatory requirements between the No-Project Alternative and historical conditions, however, the No-Project Alternative simulation results should not be expected to correspond in all details to historical Delta operations and should not be confused with actual Delta operating conditions for the years compared. Once the reliability of DeltaSOQ in predicting trends is established, the simulated No-Project Alternative serves as the baseline condition with which simulated Delta Wetlands Project operations are compared for impact assessment purposes, as described below.

Simulated Electrical Conductivity at Delta Channel Locations and Chloride in Delta Exports

As reported in the 1995 DEIR/EIS, the simulated maximum EC values at all four Delta locations and the export Cl^- concentrations were generally lower than measured historical values because Delta outflow, as simulated by DeltaSOS, satisfies the 1995 WQCP objectives and therefore is generally higher than historical flows.

Figure 4-13 shows simulated patterns of EC at Chipps Island for 1972-1994 for the No-Project Alternative. Table 4-8 lists the simulated no-project EC values at Chipps Island for the entire 1922-1994 study period. During periods of high Delta inflow, salts at Chipps Island are flushed and salinity becomes similar to river-inflow EC (assumed to be 150 μS/cm). During periods of low Delta inflow, outflow is often controlled by required minimum outflow objectives or salinity standards. The maximum monthly EC value for Chipps Island was 12,355 μS/cm for the simulated No-Project Alternative.

Figure 4-14 shows simulated patterns of EC at Emmaton for 1972-1994 for the No-Project Alternative. Table 4-9 lists the simulated no-project EC values at Emmaton for the entire 1922-1994 study period. The simulated maximum EC value for Emmaton for the No-Project Alternative was 3,115 μS/cm.

Figure 4-15 shows simulated patterns of EC at Jersey Point for 1972-1994 for the No-Project Alternative outflows. Table 4-10 lists the simulated no-project EC values at Jersey Point for the entire 1922-1994 study period. The simulated maximum EC value for the No-Project Alternative at Jersey Point was 2,522 μS/cm.

Seawater intrusion effects are much less pronounced in central Delta exports than at Jersey Point; Sacramento River diversions through the DCC and Georgiana and Threemile Sloughs into the central Delta mix with tidal flows from the lower San Joaquin River to produce relatively freshwater conditions in Delta exports. In addition to seawater intrusion episodes, other fluctuations in simulated EC and Cl^- concentrations in Delta exports are caused by variations in San Joaquin River inflow and agricultural drainage effects. These effects are included in the DeltaSOQ estimates of Delta export EC and Cl^- concentrations.

Figures 4-16 and 4-17 show the simulated patterns of EC and Cl^- concentration, respectively, in Delta exports for 1972-1994 for the No-Project Alternative. Simulated monthly EC values reach a maximum of about 1,000 μS/cm during low-outflow periods when seawater intrusion is greatest. Maximum simulated monthly Cl^- concentrations are about 230 mg/l, which is less than the maximum allowable (i.e., WQCP objective) concentration of 250 mg/l. Table 4-11 lists the simulated export EC values for the No-Project Alternative for the entire 1922-1994 study period and the flow-weighted average export EC values for each water year. Table 4-12 lists the simulated export Cl^- concentrations for the No-Project Alternative for the entire study period. The flow-weighted average export Cl^- concentrations range from 38 to 171 mg/l, with an overall average export Cl^- concentration of 87 mg/l.

Simulated Dissolved Organic Carbon in Delta Exports

Figure 4-18 shows simulated monthly values of DOC concentrations in Delta exports for 1972-1994 for the No-Project Alternative. Historical DOC data from the export locations was available only after 1986; however, the graph shows the data plotted against the 1972-1994 time period to provide for easy comparison with Cl^- data in Figures 4-13 through 4-17. Table 4-13 lists the simulated export DOC concentrations for the No-Project Alternative for the entire 1922-1994 study period. The simulated monthly values ranged from 2.4 to 11.4 mg/l but were generally between about 3 and 6 mg/l, with occasional DOC concentrations of greater than 10 mg/l that correspond to periods when Delta agricultural drainage returns are highest (i.e., December–March) (see Table G-2 in Appendix G) account for a high portion of the exported water. The simulated

DOC concentrations were highest in the winter months (January–March) because of rainfall, drainage, and leaching of salt from the agricultural islands. The simulated flow-weighted average export DOC concentrations for the No-Project Alternative ranged from 3.2 to 6.2 mg/l, with an average export DOC concentration of 4.3 mg/l.

Estimated Trihalomethane Concentrations for a Typical Treatment Plant

Figure 4-19 shows the estimated THM concentrations in chlorinated drinking water from Delta exports for the No-Project Alternative for 1972-1994. Table 4-14 lists the simulated THM concentrations for the No-Project Alternative for the entire 1922-1994 study period. The concentrations were estimated using the revised THM equation described in Appendix G. The monthly values ranged from 32 to 171 μg/l, but were generally between about 30 and 80 μg/l, with occasional THM concentrations of greater than 100 μg/l that corresponded to high DOC or Cl^- concentrations at the export locations. Because the THM drinking-water MCL standard (80 μg/l) is based on an annual moving average, the flow-weighted annual average THM concentrations may be more relevant for regulatory compliance purposes than the monthly concentrations. The average flow-weighted THM concentration for the No-Project Alternative was 55.7 μg/l.

Impacts of the Proposed Project

The proposed project represents Delta Wetlands Project operations with two reservoir islands (Bacon Island and Webb Tract) and two habitat islands (Bouldin Island and most of Holland Tract). As described in Chapter 3, the proposed project in this REIR/EIS analysis is represented by Alternative 2 of the 1995 DEIR/EIS with the revisions described in Chapter 2 of this REIR/EIS. The most consequential of these changes is the addition of the FOC terms. Under the proposed project, discharges from the Delta Wetlands Project islands would be exported in any month when combined CVP and SWP delivery deficits exist, there is unused pumping capacity within the permitted pumping rate at the SWP and CVP pumps, and the FOC and other operating rules are met.

Significant water quality impacts of Delta Wetlands Project operations may occur during months for which Delta Wetlands diversions or discharges are simulated. Project diversions could occur during months with relatively high Delta outflows, when EC values in the Delta are low. Most diversions would occur from November through February, the only months with simulated diversions of more than 500 cfs. Most project discharges would occur from June through August.

Operational Scenarios and Maximum Water Quality Effects

Chapter 3 presents DeltaSOS simulation results for the proposed project under two operational scenarios for discharge to export. To establish the maximum potential effects from Delta Wetlands Project operations, all project discharges are assumed to reach the exports under both scenarios. In one scenario, project discharges are assumed to be exported if pumping capacity exists within the permitted pumping limits at the SWP and CVP pumping plants and if the FOC terms and other operating rules are met. In the other scenario, project discharges for export are subject to these same limits and are limited to periods when there are simulated south-of-Delta delivery deficits.

The salinity impacts of the proposed project are expected to be substantially less than shown in the 1995 DEIR/EIS because of the restrictions on project diversions incorporated into the project description for this REIR/EIS (see Chapter 3). Because of evaporation, the Delta Wetlands discharge salinity would be only slightly higher with the delivery-deficit restriction than it would be without such a restriction.

DOC loading from the reservoir islands is anticipated to increase with the period of storage; as a result, the proposed project operations defined by the second scenario (with discharges limited by south-of-Delta delivery deficits) represent the worst-case DOC loading. The simulations of project operations show that Delta Wetlands discharges under the second scenario are sometimes delayed by a few months compared with discharges under the first scenario; additionally, carryover storage on the reservoir islands is more likely under the delivery-deficit restriction (see Tables 3-15 and 3-18). Therefore, the DOC loading and Delta Wetlands discharge DOC concentrations are highest under the simulated conditions of the second scenario. For this reason, the second scenario has been used in the REIR/EIS DeltaSOQ simulations.

Table 4-24 compares the impact conclusions of the 1995 DEIR/EIS and this REIR/EIS and summarizes recommended mitigation measures.

Delta Salinity Impacts (Electrical Conductivity, Chloride)

Water quality impacts of salinity increases were assessed for four selected locations in the Delta: Chipps Island, Emmaton, Jersey Point, and Delta exports. To simulate maximum project effects, it is assumed in DeltaSOQ that all Delta Wetlands discharges go to the export facilities. Therefore, when Delta Wetlands is discharging for exports, Delta outflow would not change, so Delta Wetlands discharges would not affect EC values at Chipps Island, Emmaton, or Jersey Point. Delta Wetlands discharges would change the export EC and Cl^- concentration if the Delta Wetlands discharge salinity were different from the central Delta salinity.

Delta Wetlands diversions are allowable only when Delta outflow is relatively large, so the simulated effects of the diversions are generally small at any of the Delta locations. The diversions may reduce the export fractions from the San Joaquin River or from agricultural drainage, causing a slight change in export salinity. Depending on the magnitude of Delta flows and exports and the timing of Delta Wetlands discharges, the EC values and Cl^- concentrations of these discharges may be less than or greater than export salinity. DWRSIM results used in the DeltaSOS simulations include required Delta outflows that are designed to satisfy applicable 1995 WQCP objectives for EC at all Delta locations. Therefore, simulated Delta Wetlands diversions are not allowed to prevent the Delta salinity objectives from being met.

The applicable 1995 WQCP EC objective changes with month, water-year type, or runoff conditions, or with the applicable minimum required outflow. Significance criteria may therefore differ for each month at each Delta location. Once the monthly effective EC objective is determined, the significance criteria are established as 90% and 20% of the maximum EC limit under the applicable conditions. For example, the applicable estuarine salinity (X2) objective for Chipps Island for February to June of some years requires an effective outflow of 11,400 cfs and is equivalent to an EC value of about 2,600 μS/cm. However, for some months with lower runoff, the X2 objective is at Collinsville (requiring an effective outflow of 7,100 cfs), and the Chipps Island EC value would be approximately 5,000 μS/cm. During most other months, the required Delta outflow is between 3,000 and 4,500 cfs, corresponding to EC values of between 10,000 and 14,000 μS/cm.

Chipps Island. Table 4-15 compares the monthly changes in simulated EC values for the proposed project at Chipps Island with the EC values for the No-Project Alternative. In the table, positive values represent increases in EC and negative values represent decreases in EC under the proposed project when compared to the simulated No-Project Alternative.

The project effects on Chipps Island EC shown in Table 4-15 are less than those reported in the 1995 DEIR/EIS because the FOC terms now limit Delta Wetlands Project operations. The average changes in EC at Chipps Island in months with major Delta Wetlands diversions (December through February) are relatively small percentages (0.8 to 2.8%) of the No-Project Alternative values (shown in Table 4-8). The largest simulated project increase in EC at Chipps Island during February through June, when the significance criterion would be 520 μS/cm, is 140 μS/cm. Therefore, as a result of incorporating the FOC terms into proposed project operations, none of the simulated changes in EC at Chipps Island exceed the significance criterion. This impact is considered less than significant. Although no mitigation is required, the lead agencies likely will require that Delta Wetlands monitor salinity effects of the project to demonstrate compliance with the FOC terms and Delta salinity standards.

Emmaton. Table 4-16 compares the monthly changes in simulated EC values for the proposed project at Emmaton with the EC values for the No-Project Alternative. EC objectives for Emmaton, applicable from April to August, range from 450 to 2,780 μS/cm, depending on water-year type. It is unlikely that Delta Wetlands would divert during these months, except to compensate for evaporative losses (if permitted to do so). The changes in Emmaton EC values under simulated project operations are less than those predicted in the 1995 DEIR/EIS because the FOC terms now limit Delta Wetlands diversions. As shown in the table, the largest simulated project increases in EC at Emmaton occur in August 1974 and August 1975 (120 and 103 μS/cm, respectively). These are wet years and the applicable EC standard during these years is a 14-day moving average of 450 μS/cm, with an associated 20% change significance criterion of 90 μS/cm. Therefore, monthly simulated project operations indicate that the significance criterion would be exceeded in these two months. As reported in the 1995 DEIR/EIS, this impact is considered significant and mitigation is recommended (see Table 4-24).

Jersey Point. Table 4-17 compares the monthly changes in simulated EC values for the proposed project at Jersey Point with the EC values for the No-Project Alternative. EC objectives for Jersey Point, applicable from April to August, range from 450 to 2,200 μS/cm, depending on water-year type. The results for Jersey Point are less than those predicted in the 1995 DEIR/EIS because the FOC terms limit Delta Wetlands diversions in these months. As shown in the table, the largest simulated project increases in EC at Jersey Point occur in August 1974 and August 1975

(96 and 82 μS/cm, respectively). These are wet years and the applicable EC standard is a 14-day moving average of 450 μS/cm, with an associated 20% change significance criterion of 90 μS/cm. Therefore, monthly simulated project operations indicate that the significance criterion would be exceeded in one month. As reported in the 1995 DEIR/EIS, this impact is considered significant and mitigation is recommended (see Table 4-24).

Delta Exports. Table 4-18 compares the monthly changes in simulated export EC values for the proposed project with the export EC values for the No-Project Alternative. The results reflect changes caused by both diversion and discharge operations of Delta Wetlands. The applicable EC standard is 1,000 μS/cm and the 20% change criterion is 200 μS/cm. None of the simulated monthly EC changes was greater than the criterion, so these impacts on export EC values are considered less than significant, and no mitigation is recommended. Changes in export EC values are less than those presented in the 1995 DEIR/EIS because the FOC terms limit Delta Wetlands diversions and simulated delivery deficits limit Delta Wetlands discharges.

Commenters on the 1995 DEIR/EIS raised the concern that salinity in water diverted onto the reservoir islands might be very high because Delta Wetlands would divert water during an initial winter stormflow, which may be higher in salinity because of the proportion of agricultural drainage in Delta channels at that time. However, as described in Chapter 3 (see "Restrictions for Fish Protection" in the section "Revisions to DeltaSOS"), for monthly modeling purposes, diversions are restricted until the previous month's Cl^- concentration is less than 150 mg/l. Although this restriction on diversions is not specified in the FOC, it is used in DeltaSOQ to approximate the daily restrictions on project operations that would be applied in response to daily changes in Delta water quality that cannot be directly modeled in the monthly model. The FOC restriction against diverting until the X2 location has been downstream of Chipps Island for 1 or 10 days will generally result in Cl^- concentration decreasing to less than the concentration of 150 mg/l simulated in DeltaSOQ.

Table 4-19 compares the monthly changes in simulated export Cl^- concentrations for the proposed project with the Cl^- concentrations for the No-Project Alternative. The simulated export Br^- changes would be directly proportional to the export Cl^- changes. The maximum simulated increase in Cl^- is 24 mg/l, which is equivalent to less than 0.1 mg/l of Br^-. The applicable Cl^- objective for all Delta exports is 250 mg/l, with some periods of 150 mg/l required for CCWD diversions (depending on water-year type). The impacts on export Cl^- concentrations shown in Table 4-19 are less than those presented in the 1995 DEIR/EIS because the FOC terms limit Delta Wetlands diversions and the assumed delivery deficits limit Delta Wetlands discharges. DeltaSOQ also limits diversions until the central-Delta Cl^- concentration is reduced to less than 150 mg/l. This lowers the Delta Wetlands discharge Cl^- concentrations compared with those in the 1995 DEIR/EIS simulations.

As a result of incorporating the FOC terms into proposed project operations, none of the simulated changes in export Cl^- concentrations exceed the 20% change criterion (Table 4-19). Therefore, this impact is considered less than significant and no mitigation is recommended.

Export Concentrations of Dissolved Organic Carbon

An additional load of DOC could result from inundation of the peat soils during reservoir operations under the proposed project. In the long term, repeated filling and emptying of the Delta Wetlands reservoir islands might leach out most of the soluble organic material, and DOC loading from peat soils should therefore decline over time. At least the first few fillings, however, might result in high DOC loading. Therefore, the tables and discussion presented below show export DOC concentrations under three assumptions for DOC loading to stored water: an assumed initial-filling DOC loading of 4 g/m^2/month of storage, an assumed high DOC loading of 9 g/m^2/month of storage, and an assumed long-term DOC loading of 1 g/m^2/month of storage. Total Delta agricultural drainage DOC contributions (12 g/m^2/year) are assumed to remain the same under no-project and proposed project conditions, resulting in an additional 1 g/m^2/month of DOC loading on the project islands.

The simulated effects of proposed project operations on export DOC concentrations during months with Delta Wetlands discharges for export depend on the difference between the estimated DOC concentration in the discharges under project conditions and the export DOC simulated for the No-Project Alternative. The selected significance criterion for a change in export DOC concentration is 0.8 mg/l, which is 20% of the mean measured export DOC concentration (4 mg/l).

Export Concentrations of Dissolved Organic Carbon under Long-Term Reservoir Operations. Figure 4-20 shows the simulated export DOC concentrations and the simulated Delta Wetlands reservoir storage DOC concentrations for 1972-1994 using the long-term reservoir island loading assumption of 1 g/m^2 per month during periods of flooding. Periods when Delta Wetlands DOC concentration is shown as 0 mg/l are those periods when the reservoirs are empty. The DOC concentration in stored water increases during the storage period as follows:

$$\frac{\text{Monthly DOC loading rate } (g/m^2)}{\text{Storage depth } (m)} =$$

$$\text{Monthly increase in storage DOC concentration } (g/m^3, \text{or } mg/l)$$

For a given loading rate, as depth of stored water increases, the DOC will be diluted more and DOC concentration will be reduced. Concentration will be higher with less water depth for the same loading rate. Under the assumed long-term loading rate of 1 g/m^2/month, when the reservoir is full (i.e., storage depth is 6 meters), the Delta Wetlands DOC concentration increases during the storage period by 0.167 mg/l per month (1 $g/m^2 \div 6$ m). This corresponds to an increase of approximately 2.0 mg/l per year.

For example, as shown in Table 3-14, the simulated Delta Wetlands reservoir filled in November 1974 and remained full until March of water-year 1976. The initial Delta Wetlands DOC concentration was assumed to equal the export DOC concentration of 3 mg/l. With an increase of 2 mg/l per year, the DOC concentration increased to about 5 mg/l in water-year 1974, and further increased to about 7 mg/l in 1975 (Figure 4-20). About half of the Delta Wetlands storage water was discharged in March 1976. With the average depth of Delta Wetlands storage reduced, the subsequent increase in Delta Wetlands DOC concentration was more rapid until June 1976, when all but 3 TAF of Delta Wetlands storage water was discharged, with a DOC concentration of 10 mg/l. The very high Delta Wetlands DOC concentration of 20 mg/l shown in July 1976 corresponds to the very small remaining volume, which was discharged in July. A similar rapid increase in Delta Wetlands DOC concentration was simulated in 1987, when a Delta Wetlands storage volume of 40 TAF was simulated. Periods with the greatest effect on export DOC resulting from Delta Wetlands discharges can be identified by comparing the simulated export DOC for the long-term loading and for the no-project conditions (Figures 4-20 and 4-18). Because Delta Wetlands discharges are a small proportion of total exports, Delta Wetlands discharges with high DOC concentrations do not result in dramatic changes in export DOC concentrations, as illustrated in the figure.

Table 4-20 compares the resulting monthly changes in simulated export DOC concentrations for the proposed project with DOC concentrations for the No-Project Alternative. The simulation results indicate that the proposed project would increase average export DOC concentrations during months when Delta Wetlands discharges occur. Simulated export DOC concentrations decreased slightly during months with Delta Wetlands diversions because the diversions reduced the fraction of agricultural drainage and San Joaquin River inflow in exports. The DeltaSOQ model assumes that the Delta Wetlands habitat islands, and the reservoir islands during periods of no storage, would contribute the same DOC load as agricultural drainage. As shown in the table, some of the simulated monthly changes (20 out of 876) were greater than or equal to 0.8 mg/l. This occurred in 15 of the 73 simulated water-years. These results are higher than those predicted in the 1995 DEIR/EIS, which showed a change greater than 0.8 mg/l in one of 300 months. Therefore, project effects on export DOC are considered significant and mitigation is recommended (see Table 4-24).

Export Concentrations of Dissolved Organic Carbon under Initial-Filling Operations. To simulate DOC loading under initial-filling operations, an assumed DOC load of 4 g/m^2/month during storage periods was simulated. Figure 4-21 shows the simulated DOC concentrations in the Delta Wetlands storage water and exports using the initial-fill DOC-loading assumption. Table 4-21 compares the monthly changes in simulated export DOC concentrations for the proposed project under the initial-filling DOC-loading assumption with the simulated DOC concentrations under the No-Project Alternative. As shown in the table, increases in export DOC concentrations greater than or equal to 0.8 mg/l were simulated in at least one month of approximately half (37) of the years. As described above under the long-term load assumption, project impacts on export DOC are considered significant and mitigation is recommended (see Table 4-24).

Export Concentrations of Dissolved Organic Carbon under High Initial-Filling Operations. Figure 4-22 shows the simulated DOC concentrations in Delta Wetlands storage water and exports using the high initial-filling DOC loading assumption of 9 g/m^2/month during the flooded period. Table 4-22 compares the resulting monthly changes in simulated export DOC concentrations for the proposed project with DOC concentrations for the No-Project Alternative. As shown in the table, simulated monthly changes were greater than or equal to 0.8 mg/l in 41 of the simulated water-years when discharges from the project are simulated (48 of the 73 simulated water-years). The following section describes how the recommended mitigation (Table 4-24) would affect Delta Wetlands operations.

Example of Discharge of Delta Wetlands Storage Water with High Dissolved Organic Carbon Concentrations under Mitigation Recommended in the 1995 Draft EIR/EIS. As described in the 1995 DEIR/EIS, the recommended mitigation for high DOC concentrations in water stored on the Delta Wetlands islands is to restrict Delta Wetlands discharges to prevent DOC increases of more than 0.8 mg/l in Delta exports on a monthly basis. High DOC concentrations in Delta Wetlands storage water are anticipated particularly during the first several fill operations. Changes in export DOC under the assumed initial-fill or high initial-fill DOC load rates are shown in Tables 4-21 and 4-22. Implementation of the recommended mitigation measure would affect Delta Wetlands' ability to export water.

An example of how Delta Wetlands discharges would be restricted to prevent significant increases in DOC at the export pumps is presented here. Channel DOC concentration is assumed to be 4 mg/l. The highest observed DOC load from the SMARTS 2 experiment (121 g/m^2 from tank 3) is used in this example to represent worst-case DOC loading in the first year of Delta Wetlands storage operation. With DOC loading at a given rate (g/m^2) during the first year of storage, the DOC concentration (g/m^3, or mg/l) depends on the depth of water (m) in which the DOC is diluted. If the depth of stored water were 20 feet (6 meters), the DOC concentration of the stored water would increase by the end of the first year of storage by 20 mg/l (121 $g/m^2 \div 6$ meters = 20 g/m^3). If the depth of water were only 10 feet (3 meters), representing a half-filled reservoir island, the DOC concentration of the stored water would increase by the end of the first year of storage by 40 mg/l (121 $g/m^2 \div 3$ meters = 40 g/m^3). The worst-case DOC concentrations for Delta Wetlands storage water, therefore, would be 24 to 44 mg/l.

A mass balance equation for export DOC is used to determine the applicable Delta Wetlands discharge rate when the DOC concentration in stored water is high. The allowable increment of export DOC concentration will be specified by the SWRCB as one of the terms and conditions of the water right permits. Consistent with the 1995 DEIR/EIS mitigation measure, the significance threshold of 0.8 mg/l of DOC is used in this example as the allowable increment. A relatively low export flow of 5,000 cfs is assumed for this example, to limit the Delta Wetlands discharge during dry summer conditions. The following mass balance for export DOC would apply to the discharge of DOC from the Delta Wetlands islands:

$$\text{Delta Wetlands DOC (mg/l)} \bullet \text{Delta Wetlands discharge (cfs)} + \text{Export DOC (mg/l)} \bullet \text{Export flow (cfs)} = \text{(Export DOC + Allowed DOC increment [mg/l])} \bullet \text{(Delta Wetlands discharge + Export flow)}$$

The DOC mass balance equation can be rearranged to solve for the allowable Delta Wetlands discharge:

$$\text{Delta Wetlands discharge} = \frac{\text{DOC increment} \bullet \text{Export}}{\text{(Delta Wetlands DOC} - \text{DOC increment)}}$$

For an export DOC of 4 mg/l, with an assumed Delta Wetlands DOC of 24 mg/l and an allowable DOC increment of 0.8 mg/l, the Delta Wetlands discharge would be limited to 208 cfs. This would require 240 days (8 months) to empty one Delta Wetlands reservoir island (100 TAF). If both Delta Wetlands reservoir islands were filled, more than a year (16 months) would be required to discharge the Delta Wetlands storage (200 TAF). DOC concentrations may continue to increase during the discharge period. Assuming Delta Wetlands DOC concentrations were 44 mg/l with exports at 5,000 cfs, a Delta Wetlands discharge of only 104 cfs would be allowed.

The Delta Wetlands discharge rate could be twice as high as the rates reported above if the export pumping were increased to 10,000 cfs, and more Delta Wetlands discharge could occur during high-flow periods when the entire Delta Wetlands discharge would not be transported to the exports (i.e., Webb discharge during periods of high QWEST and Delta outflow). In comparison to the worst-case assumptions presented above, a Delta Wetlands discharge of 2,000 cfs would be allowed when the export pumping was 10,000 cfs and the Delta Wetlands DOC concentration was no greater than 5 mg/l more than the export DOC. If the SWRCB adopts a more stringent allowable DOC increment (i.e., less than 0.8 mg/l), the Delta Wetlands discharge rate would be lower. In conclusion, Delta Wetlands discharges could be limited substantially if initial storage of Delta Wetlands water results in DOC concentrations in the stored water corresponding to the high initial-fill loading illustrated above.

Trihalomethane Concentrations in Treated Drinking Water

Table 4-23 compares the monthly changes in simulated treated-drinking-water THM concentrations for the proposed project with THM concentrations for the No-Project Alternative. The DeltaSOQ calculations of THM for typical treatment conditions indicated that the monthly increases in THM concentrations under the proposed project were almost always less than the criterion of 16 μg/l. As shown in Table 4-23, the 20% change threshold would be exceeded in 6 out of 876 months. This is considered a significant impact, as in the 1995 DEIR/EIS. The mitigation measure has been revised to reflect the new standards for THM (see Table 4-24).

If the THM MCL is reduced to 40 μg/l as proposed by EPA, water treatment plant operations will need to be modified to provide acceptable THM concentrations for the range of DOC and Br^- that is observed in Delta diversions and exports, even without Delta Wetlands Project operations (see "Changes in Disinfection Byproduct Rules" above). Because the linear relationship between treated THM concentrations and Delta DOC and Br^- concentrations under improved treatment conditions will likely remain similar to the relationship under existing treatment conditions (i.e., a 10% increase in DOC or Br^- will increase THM concentration by 10%), the mitigation measures adopted to limit project-related increases in DOC or Br^- are still appropriate methods for controlling changes in THM concentrations as a result of project operations. If new THM regulations take effect, the allowable project-related increase in DOC at the exports could be reduced and the mitigation requirement for Delta Wetlands operations could be changed if needed.

The effect of project-related changes in THM concentrations at the treatment plant is primarily an economic one. The project-related changes in export DOC are within existing seasonal variations in DOC, so operators would have to be prepared to treat those levels under existing or future standards. However, the Delta Wetlands Project could affect the frequency with which higher DOC levels reach the treatment plants, as well as the time (i.e., season) that these DOC levels reach the plants; as a result, the project could affect the cost of treatment operations. Although CEQA and NEPA do not require a significance determination of the economic impacts on treatment plant operators, the lead agencies acknowledge this potential effect of the project. Incremental increases in the cost of water treatment with the proposed project will be considered by the SWRCB and USACE in their project approval processes.

Because of substantial monthly variations in THM concentrations, the current EPA monitoring requirements allow averaging of monthly or quarterly THM samples. The THM MCL is an annual moving average of 80 μg/l. Because Delta Wetlands Project discharges would occur for a limited period each year, the possible effects on annual average THM concentrations would be less than the increases in these concentrations attributable to increased DOC or Br^- concentrations during the discharge period. The flow-weighted annual increase in THM concentrations might be a closer approximation of the actual regulatory requirements (Table 4-23). As described below, mitigation requirements could consider both a maximum monthly and an annual average acceptable change in DOC or expected THM concentrations.

Recommended Mitigation and Application to Delta Wetlands Project Operations

CEQA requires that, for each significant impact identified, an EIR discuss feasible measures to avoid or substantially reduce the project's significant environmental effect; mitigation measures are not required for effects that are not found to be significant (State CEQA Guidelines Section 15126.4[a]). NEPA, on the other hand, does not require federal agencies preparing an EIS to avoid or mitigate impacts even if mitigation is feasible (*Robertson v. Methow Valley Citizens Council* (1989) 490 U.S. 332). In practice, however, most individual federal agency regulations require that adverse effects of a project on protected resources be mitigated.

In the 1995 DEIR/EIS, proposed mitigation measures to offset significant impacts on water quality were based on limiting Delta Wetlands Project operations (i.e., diversions and discharges) so that the levels of water quality variables would remain below the 90% and 20% significance thresholds. This basic mitigation requirement remains the recommended method to prevent significant water quality impacts of Delta Wetlands Project operations. As explained in the description of the 1995 DEIR/EIS mitigation measures, Delta Wetlands Project operations would be regulated based on information from real-time monitoring of actual daily Delta flows, Delta Wetlands Project operating capacities, CVP and SWP operations, Delta water quality, quality of water stored on the Delta Wetlands Project islands, and fisheries. The effects of Delta Wetlands Project operations on Delta flows, water quality, and fish entrainment patterns would be reported in monthly operating reports.

The lead agencies will adopt final mitigation requirements that would be used to trigger adjustments to Delta Wetlands' operations in response to project monitoring. Those mitigation requirements may differ from the significance criteria proposed above to meet CEQA/NEPA requirements (see discussion under "Comments on Significance Criteria" above). The adopted mitigation requirements will specify monitoring and averaging periods for determining Delta Wetlands Project effects; therefore, they may differ from the mitigation requirements that are based on the monthly simulations used in the 1995 DEIR/EIS and this REIR/EIS, which provide a reasonable analysis of the potential for significant project impacts. The lead agencies could specify annual averages, daily maximums, or monthly averages as mitigation triggers, with different criteria used for different variables. The application of different averaging periods for water quality variables is consistent with other water quality standards (e.g., objectives in the WQCP and EPA standards for quality of drinking water). For example, EPA's THM standard is applied to a moving annual average based on quarterly or monthly sampling at treatment plants (see "Changes in Disinfection Byproduct Rules" above). The lead agencies will make a final determination of the mitigation requirements to be applied to the Delta Wetlands Project in the terms and conditions of the water right permits and in the mitigation and monitoring plan they adopt.

The effects of Delta Wetlands diversions on salinity and X2 location could be easily determined with daily calculations and comparison with daily measurements at the established Delta monitoring locations (i.e., Chipps, Collinsville, Emmaton, Jersey Point, and export and diversion locations).

The effects of anticipated Delta Wetlands discharges on salinity and DOC concentrations at the Delta export and diversion locations would be estimated from measurements of Delta Wetlands storage water quality and the measured water quality at the export and diversion locations. The allowable Delta Wetlands discharge flow could then be calculated; the flow would be restricted to preclude Delta Wetlands discharge from causing salinity and DOC concentrations to exceed the allowable increases established by the SWRCB in water right terms and conditions. For example, if the monthly maximum increase in DOC concentration were established as 0.8 mg/l (corresponding to 20% of the average export DOC value, which was used as the significance criterion) and if the measured Delta Wetlands DOC concentration were 8 mg/l, then the Delta Wetlands Project discharge would be limited to 10% of the export pumping (including Delta Wetlands discharge). Such suggested permit conditions would be used to prevent Delta Wetlands Project operations from exceeding acceptable increases in DOC or Cl^- concentrations based on the averaging period (e.g., monthly, annual) adopted by the lead agencies for each variable.

For salinity increases, the 1995 WQCP objectives are generally expressed as monthly average values. The allowable salinity increases from the Delta Wetlands Project could be specified as similar monthly average values, which might be different in each month at each location. An annual limit on the salinity increase resulting from Delta Wetlands discharges might also be specified. Some method for tracking salinity credits from Delta Wetlands operations (i.e., credits for Delta Wetlands discharge salinity being lower than export salinity) might also be allowed.

For DOC, there is no applicable adopted standard, but setting a moving annual average for DOC increases similar to that used for the EPA THM standards may be an appropriate condition for the Delta Wetlands Project. Alternately, the lead agencies could specify a set of monthly and/or annual acceptable increases similar to those described above for salinity.

Potential effects on water treatment costs for downstream water users caused by Delta Wetlands operations are an economic issue outside the scope of this environmental analysis. However, the SWRCB may choose to establish a monitoring and compensation plan for these potential effects in the water right terms and conditions. A procedure for establishing Delta Wetlands' contribution to increased water treatment costs (e.g., for TOC removal) would need to be determined and agreed to by Delta Wetlands and the water treatment operators.

The lead agencies would incorporate into the water right permit terms and conditions and the project mitigation monitoring plan selected mitigation triggers for each water quality variable of concern. These triggers would consist of the suggested significance thresholds (or other adopted criteria) combined with averaging periods deemed most appropriate for each respective water quality variable. In this way, the lead agencies could adopt mitigation measures other than those recommended in this REIR/EIS and could address potential effects on beneficial uses and economic considerations that are beyond the scope of this REIR/EIS.

Cumulative Impacts

Cumulative water supply effects were evaluated using DeltaSOS simulations of the Delta Wetlands Project, as described above, but under the assumption that SWP pumping is permitted at full capacity of Banks Pumping Plant. This scenario represents reasonably foreseeable future Delta conditions and regulatory standards (refer to Chapter 3).

As described in Chapter 3, the proposed project would be operated in fewer years under cumulative conditions than under existing conditions because of limited availability of water for Delta Wetlands diversions. However, because of greater assumed export pumping capacity at Banks Pumping Plant, simulated Delta Wetlands export volumes under cumulative conditions were greater in several of the years than under existing conditions. The average annual simulated Delta Wetlands diversion under cumulative future conditions was 169 TAF/yr, with discharges for export of 147 TAF/yr. These simulated operations are not limited by south-of-Delta delivery deficits and represent the greatest possible DOC-loading impacts at export and diversion locations. Because DOC loads are proportional to the period of storage, loads under cumulative conditions could be somewhat less than for the proposed project, even if simulated exports are slightly higher.

Changes in water quality conditions (levels of EC, Cl^-, DOC, and THM) between the cumulative future no-project conditions and the cumulative with-project conditions would be similar to the changes simulated between no-project and proposed project conditions described above. Results of the revised analyses indicate that Delta Wetlands discharges to export under the proposed project would be less than previously reported for the 1995 DEIR/EIS (refer to Chapter 3). Consequently, impacts on most water quality constituents would be reduced. Similarly, water quality impacts under cumulative conditions would be less than those presented in the 1995 DEIR/EIS analysis for cumulative conditions. However, there remains the likelihood that project operations under future cumulative conditions could exceed applicable significance criteria and would therefore require mitigation.

As described in the 1995 DEIR/EIS, cumulative impacts of the project on water quality concentrations are considered significant and mitigation measures are recommended (see Table 4-24).

Impact Evaluation of Project Alternatives from the 1995 Draft EIR/EIS

As described in Chapter 2, project operations under Alternative 1 in the 1995 DEIR/EIS were assumed to be the same as project operations under Alternative 2, except that discharges to export were assumed to be more restricted (i.e., by strict interpretation of the E/I ratio, the maximum allowed exports as a percentage of inflow). As shown in the 1995 DEIR/EIS analysis and described in Chapter 3 of this REIR/EIS, operations under Alternative 1 provide fewer opportunities for Delta Wetlands discharges to export than Alternative 2 operations. Changes in simulated Alternative 1 project operations between the 1995 DEIR/EIS analysis and this REIR/EIS analysis are similar in magnitude and direction to the changes described above for the proposed project (i.e., Alternative 2). Therefore, Delta Wetlands discharges to exports under Alternative 1 would be less than previously reported in the 1995 DEIR/EIS. The resulting impacts of Alternative 1 on salinity, DOC levels, and potential formation of THMs are less than those estimated for Alternative 1 in the 1995 DEIR/EIS, but remain significant.

Alternative 3, the four-reservoir-island alternative, has not changed since the 1995 DEIR/EIS was published. The FOC and biological opinion terms were developed for the two-reservoir-island operations represented by Alternative 2 in the 1995 DEIR/EIS and are not applicable to a four-reservoir-island alternative. New simulations of Alternative 3, which are based on the Delta water budget developed from DWRSIM study 771 and include AFRP actions, result in minor changes in project diversion, storage, and discharge operations. There are no changes to the conclusions of the environmental impact analysis presented in the 1995 DEIR/EIS for Alternative 3.

Table 4-1. Summary of Average DWR MWQI Data on Water Quality at Delta Channel and Export Locations

Drainage Location	Samples (#)		EC (µS/cm)	Cl^- (mg/l)	DOC (mg/l)	Cl^-:EC Ratio	Br^-:Cl^- Ratio	C-THM (µg/l)	C-THM:DOC Ratio	UVA:DOC Ratio
Sacramento River - Greene's Landing	164	AVG	159	6.8	2.3	0.041	0.0032	28	0.0116	0.0275
		MIN	70	1.0	1.3	0.009	0.0010	7	0.0039	0.0070
		MAX	253	19.0	5.5	0.080	0.0267	122	0.0358	0.0538
San Joaquin River - Vernalis	162	AVG	647	86.0	3.7	0.124	0.0030	47	0.0125	0.0277
		MIN	117	7.0	1.4	0.055	0.0002	21	0.0051	0.0160
		MAX	1320	183.0	11.4	0.161	0.0056	160	0.0226	0.0394
SWP Banks Pumping Plant	172	AVG	439	69.8	3.8	0.143	0.0031	52	0.0134	0.0333
		MIN	143	14.0	1.6	0.083	0.0021	12	0.0043	0.0277
		MAX	877	185.0	10.5	0.225	0.0041	204	0.0272	0.0474
CVP Tracy Pumping Plant	172	AVG	485	71.2	3.8	0.138	0.0030	50	0.0135	0.0317
		MIN	151	12.0	1.9	0.077	0.0021	19	0.0057	0.0200
		MAX	1150	181.0	11.0	0.217	0.0052	154	0.0251	0.0463
CCWD Rock Slough	175	AVG	514	93.7	3.6	0.154	0.0030	51	0.0145	0.0326
		MIN	146	9.0	1.1	0.056	0.0019	24	0.0070	0.0242
		MAX	1250	303.0	9.1	0.254	0.0044	735	0.1008	0.0426

Sources: 1995 DEIR/EIS and California Department of Water Resources 1999a.

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Table 4-2. Summary of Average DWR MWQI Data on Water Quality of Delta Island Drainage

Drainage Location	Sampling Dates	Grab Samples (#)		EC (µS/cm)	Cl^- (mg/l)	Br^- (mg/l)	Cl^-:EC Ratio	Br^-:Cl^- Ratio
Bacon Island	JAN '90 - AUG '99	111	AVG	589	102	0.24	0.17	0.0029
			MIN	200	18	0.05	0.04	0.0005
			MAX	1280	211	0.70	0.42	0.0045
Bouldin Island	MAR '87 - JUL '94	121	AVG	426	32	0.19	0.07	0.0061
			MIN	137	8	0.02	0.04	0.0025
			MAX	1300	94	0.56	0.13	0.0150
Holland Tract	JAN '90 - JUL '94	87	AVG	1177	211	0.65	0.18	0.0032
			MIN	559	64	0.18	0.11	0.0020
			MAX	2870	542	1.18	0.22	0.0052
Webb Tract	JAN '90 - APR '93	33	AVG	1143	183	0.61	0.16	0.0037
			MIN	568	97	0.41	0.11	0.0017
			MAX	2530	378	0.90	0.23	0.0065
Twitchell Island	JAN '94 - JAN '98	476	AVG	937	174	0.45	0.18	0.0028
			MIN	337	49	0.15	0.14	0.0008
			MAX	1980	328	0.72	0.24	0.0050

Drainage Location	Sampling Dates	Grab Samples (#)		DOC (mg/l)	UVA (1/cm)	C-THM (µg/l)	TTHMFP (µg/l)
Bacon Island	JAN '90 - AUG '99	111	AVG	11.4	0.52	129	1236
			MIN	3.4	0.15	18	178
			MAX	29.5	1.27	333	3080
Bouldin Island	MAR '87 - JUL '94	121	AVG	33.7	1.41	271	2511
			MIN	3.5	0.13	45	415
			MAX	96.0	3.48	691	6350
Holland Tract	JAN '90 - JUL '94	87	AVG	18.2	0.83	207	2044
			MIN	5.8	0.34	77	814
			MAX	37.0	1.55	549	6165
Webb Tract	JAN '90 - APR '93	33	AVG	29.7	1.32	258	2487
			MIN	10.0	0.47	102	1075
			MAX	57.0	2.54	483	4551
Twitchell Island	JAN '94 - JAN '98	476	AVG	20.1	0.93	213	2041
			MIN	1.1	0.13	33	360
			MAX	58.9	2.62	519	4840

Sources: 1995 DEIR/EIS and California Department of Water Resources 1999a.

Table 4-3. Results of SMARTS 1 Flooded Peat Soil DOC and Salt (EC) Load Experiments

TANK	Peat Depth (feet)	Water Depth (feet)	Initial Surface Water DOC (mg/l)	Surface Water DOC (mg/l)												Water Load of DOC (g/m²)
				Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	
1 static	1.5	2.0	1	8	11	15	20	23	25	30	32	35	39	40	40	24
2 flushing	1.5	2.0	1	10	10	11	10	9	8	7	8	7	5	4	4	55
3 static	4.0	2.0	1	23	31	43	59	73	83	99	114	135	108	92	88	53
4 flushing	4.0	2.0	1	18	15	19	18	15	12	14	11	9	8	6	7	92
5 static	4.0	7.0	1	6	8	10	13	16	18	20	19	24	26	27	26	54
6 flushing	1.5	7.0	1	8	5	4	5	4	3	3	3	3	3	2	2	143
7 static	1.5	7.0	1	5	6	7	9	11	11	12	14	15	17	19	16	32
8 flushing	4.0	7.0	1	4	3	2	2	2	2	2	2	2	2	2	2	90
9 control	0.0	11.0	1	2	2	1	2	2	2	2	2	2	2	3	2	4
Water Supply			1					1	1	1	1	1	1	1	1	

TANK	Peat Water DOC (mg/l)											
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
1 static	158				287				58			74
2 flushing	205				301				301			279
3 static	222				273				283			270
4 flushing	145				282				324			301
5 static	143				271							323
6 flushing	226				338				339			341
7 static	155				336				386			341
8 flushing	208				341				374			358

TANK	Peat Depth (feet)	Water Depth (feet)	Initial Surface Water EC (µS/cm)	Surface Water EC (µS/cm)												Water Load of Salt (g/m²)
				Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	
1 static	1.5	2.0	135	148	160	167	178	193	204	216	220	236	245	248	256	49
2 flushing	1.5	2.0	135	153	158	160	159	163	165	173	175	179	174	161	152	96
3 static	4.0	2.0	135	157	190	228	228	267	304	203	383	483	532	340	354	89
4 flushing	4.0	2.0	135	180	188	188	188	193	185	208	187	206	201	167	171	214
5 static	4.0	7.0	135	138	149	160	167	180	185	193	212	218	225	229	226	130
6 flushing	1.5	7.0	135	135	135	156	158	155	150	153	164	159	174	177	148	272
7 static	1.5	7.0	135	136	136	146	147	152	152	157	168	169	174	177	177	60
8 flushing	4.0	7.0	135	142	147	154	156	155	152	154	163	160	172	165	154	294
9 control	0.0	11.0	135	135	137	140	141	145	144	146	150	151	150	154	153	40
Water Supply			135	135	135	135	135	135	135	158	158	150	182	134	145	

TANK	Peat Water EC (µS/cm)											
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
1 static	842				1017				345			395
2 flushing	986				1044				1138			1141
3 static	1480				1094				1181			1226
4 flushing	2060				1434				1388			1446
5 static	1931				2000							1852
6 flushing	1830				1516				1535			1830
7 static	1890				1762				1637			1590
8 flushing	2140				1730				1765			1563

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Table 4-4. Results of SMARTS 2 Flooded Peat Soil DOC and Salt (EC) Load Experiments

TANK	Peat Depth (feet)	Water Depth (feet)	Surface Water DOC (mg/l) Initial	Week 1 Jan 21	Week 3 Feb 3	Week 5 Feb 18	Week 7 Mar 4	Week 9 Mar 17	Week 11 Mar 31	Week 13 Apr 13	Week 15 Apr 28	Week 17 May 12	Week 19 May 26	Week 21 Jun 9	Week 23 Jun 23	Week 25 Jul 7	Week 27 Jul 21	Water Load of DOC (g/m²)
1 static	1.5	2.0	1.3	10.7	16.0	19.7	23.0	28.0	33.4	39.3	51.8	65.2	76.9	88.3	99.6	106.5	121	73
2 flushing	1.5	2.0	1.3	16.8	9.6	4.5	4.6	5.4	5.6	4.2	6.6	12	9.9	7.4	7.3	8.05	5	65
3 static	4.0	2.0	1.3	8.6	10.7	13.4	16.8	27.2	39.4	45.1	66.1	88.7	109.0	134.0	146.0	170.1	200	121
4 flushing	4.0	2.0	1.3	11.3	4.7	3.5	4.2	4.4	4.8	4.6	7.5	13.6	11.1	8.2	8.3	8.28	7	62
5 static	4.0	7.0	1.3	1.9	2.3	2.5	2.9	3.5	4.0	4.3	5.4	6	6.9	7.6	8.9	10.3	12.2	23
6 flushing	1.5	7.0	1.3	1.8	1.4	1.2	1.0	1.0	1.3	1.0	1.2	1.2	1.4	1.3	1.4	1.39	1.4	38
7 static	1.5	7.0	1.3	2.2	4.8	3.6	3.8	5.0	6.3	6.9	10.3	13.0	15.7	17.2	18.6	19.54	20.8	42
8 flushing	4.0	7.0	1.3	2.8	1.8	1.4	1.6	1.4	1.7	1.5	2.8	2.7	3.5	3.2	4.0	3.66	3.3	75
9 control	0.0	11.0	1.3	1.1	1.3	1.3	1.1	1.1	1.1	1.0	1.0	1.2	1.1	1.0	1.2	1.07	1.3	0
Water Supply				1.3	1.1	1.0	0.9	0.8	1.0	0.8	0.8	0.9	0.8	1.0	1.1	1.1	0.9	

TANK	Peat Water DOC (mg/l) Initial	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 17	Week 19	Week 21	Week 23	Week 25	Week 27
1 static		82.1	126		233		441.7		561		600		544		590
2 flushing		96	109		214		295.6		426		429		413		392
3 static		85.5	114		161		229.5		342		381		380		374
4 flushing		94.6	118		170		259.8		416		453		411		368
5 static		14.1	16.7		21.1		28.2		35.1		42.2		45.3		46.8
6 flushing		11.3	16.7		20		26.6		29.7		35.6		36.4		40.1
7 static		27.5	32.4		45.6		47.0		52.8		54.2		55.8		57.8
8 flushing		27.9	33.6		47.1		63.0		83.5		97.4		106.0		99.5

TANK	Peat Depth (feet)	Water Depth (feet)	Surface Water EC (µS/cm) Initial	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 17	Week 19	Week 21	Week 23	Week 25	Week 27	Water Load of Salt (g/m²)
1 static	1.5	2.0	116	312	244	386	411	432	461	465	428	574	632	664	717	780	851	300
2 flushing	1.5	2.0	116	483	276	166	166	167	186	142	145	206	219	211	209	177	162	335
3 static	4.0	2.0	116	248	276	302	348	424	500	410	563	825	1029	1177	1378	1513	1597	605
4 flushing	4.0	2.0	116	621	187	172	175	178	198	149	203	249	251	232	234	195	192	466
5 static	4.0	7.0	116	177	182	186	191	191	199	195	171	222	236	243	253	254	260	206
6 flushing	1.5	7.0	116	170	148	139	142	143	163	127	119	152	179	181	177	139	146	43
7 static	1.5	7.0	116	184	188	191	193	195	204	157	206	222	234	238	246	246	251	193
8 flushing	4.0	7.0	116	194	152	142	145	146	166	161	124	159	187	185	180	144	150	202
9 control	0.0	11.0	116	170	173	172	171	170	129	133	143	175	180	182	185	183	185	155
Water Supply				116	154	141	142	152	170	151	122	147	161	176	165	149	149	

TANK	Peat Water EC (µS/cm) Initial	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 17	Week 19	Week 21	Week 23	Week 25	Week 27
1 static		3640	3960		2730		3770		3159		3310		3260		3260
2 flushing		3740	3680		2430		2110		2383		2620		2530		2320
3 static		4000	4450		3400		3100		3115		3310		3140		3010
4 flushing		4800	4790		3290		3130		3280		3360		3300		2880
5 static		708	797		761		790		550		676		714		663
6 flushing		578	604		619		635		454.8		673		658		675
7 static		936	985		915		924		702		990		1021		1021
8 flushing		1232	1321		1308		1250		998		1265		1291		1249

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Table 4-5. Comparative Estimates of DOC Loading Rates (g/m^2/yr)

Source Estimates	Vegetation Residue	Primary Production	Peat Soil	Total DOC Load	Notes
Existing Agricultural Drainage Conditions					
Bacon Island				9.3	a
Webb Tract				10.4	b
Bouldin Island				22.4	c
Holland Tract				2.5	d
Twitchell Island				10	e
Twitchell Island, flow weighted				19	e
DeltaDWQ Model for Agricultural Conditions (1995 DEIR/EIS)				12	f
MWQI-CR#2				8	g
Seasonal Wetland and Flooded Island Conditions (1995 DEIR/EIS)					
Wetland Demonstration				7-17	h
Vegetation Decay Experiment	5.4-7.5				i
Flooded Wetland Demonstration				21	j
Tyler Island Flooding				30-36	k
DeltaDWQ Model for Seasonal Wetlands				12	l
DeltaDWQ Model for Flooded Islands				14-20	m
SMARTS Experiments—Peat Soil Flooding Conditions					
SMARTS 1—1.5 feet of peat (tanks 1 and 7)				24-32	n
SMARTS 1—4.0 feet of peat (tanks 3 and 5)				53-54	n
SMARTS 1—control (tank 9)		4			o
SMARTS 2—1.5 feet of peat (tanks 1 and 7)				42-73	p
SMARTS 2—4.0 feet of peat (tanks 3 and 5)				23-121	p
Water Right Hearing Testimony on Delta Wetlands Project Conditions					
Stuart Krasner, 8 mg/l DOC discharge				30	q
Stuart Krasner, 16 mg/l DOC discharge				78	q
Stuart Krasner, 32 mg/l DOC discharge				174	q
Richard Losee, algal biomass and peat soil		50-1,250	1,830		r
Richard Losee and K.T. Shum, groundwater seepage control pumping				9.2-18.4	s
K.T. Shum, molecular diffusion			16-160		t
Michael Kavanaugh, reservoir islands				3.5-12.7	u
Michael Kavanaugh, habitat islands				3.7-20.6	u

To obtain lb/acre, multiply g/m^2 value by 8.9.

Table 4-5. Continued

Notes:

a. Calculated based on mean drainage depth of 1.73 m and mean excess DOC concentration of 5.4 mg/l. Source: Appendix G.
b. Calculated based on mean drainage depth of 0.5 m and mean excess DOC concentration of 20.7 mg/l. Source: Appendix G.
c. Calculated based on mean drainage depth of 0.83 m and mean excess DOC concentration of 27.1 mg/l. Source: Appendix G.
d. Calculated based on mean drainage depth of 0.4 m and mean excess DOC concentration of 6.2 mg/l. Source: Appendix G.
e. Calculated based on metered drainage volume from Twitchell Island in 1995 (11,232 af), Twitchell Island acreage of 3,580 acres, and mean DOC drainage concentration of 22.6 mg/l (n=231). Applied water DOC concentration assumed to be 3 mg/l (Sacramento River source). Flow-weighted average estimated from weekly flow-weighted DOC measurements from 1995. Sources: USGS 97-350; DWR's "Estimation of Delta Island Diversion and Return Flows", February 1995; MWQI.
f. DeltaDWQ assumed an agricultural drainage DOC loading for Delta lowlands of 12 g/m^2 per year, or 1 g/m^2 per month for 12 months. Source: 1995 DEIR/EIS, Appendix C4.
g. Loadings calculated from data presented in "Candidate Delta Regions for Treatment to Reduce Organic Carbon Loads, MWQI-CR#2" (Marvin Jung Associates in association with Limit to Infinity Enterprises, January 1999). Calculations based on DOC concentrations and volumes of drainage water presented in MWQI-CR#2 converted to mass loadings per square meter for an assumed 420,000-acre Delta lowland area. Loading factor does not account for initial DOC concentration of applied water.
h. Based on measurements of Holland Tract demonstration wetland. Source: 1995 DEIR/EIS, Appendix C3.
i. Based on bench-scale vegetation decay experiments utilizing Holland Tract demonstration wetland vegetation. Source: 1995 DEIR/EIS, Appendix C3.
j. Source: 1995 DEIR/EIS, Appendix C3.
k. DWR sponsored flooding of Tyler Island for a period of 1 month. Depth of stored water estimated based on acre-feet stored divided by Tyler Island acreage. Estimated depth multiplied by DOC concentration of discharge water provided for estimated DOC loading. Source: 1995 DEIR/EIS, Appendix C3.
l. DeltaDWQ assumed habitat island operation would provide a total of 12 g/m^2 per year of DOC between the months of October and March, or 1 g/m^2 per month for the months of October, February, and March and 3 g/m^2 per month for the months of November through January.
m. DeltaDWQ assumed wetland vegetation decay would provide a maximum of 8 g/m^2 per year of DOC if the islands were dry from May through August, based on wetland vegetation decay experiments. Dry reservoir islands were assumed to provide a total of 12 g/m^2 per year of DOC, or 1 g/m^2 per month for dry-period months. For periods when islands were flooded, DOC loads were assumed to be 0.5 g/m^2 per month for those months with flooded conditions to simulate lower DOC release conditions as suggested in flooded wetland/water storage experiments. Depending on monthly conditions, DeltaDWQ modeled a hydrologic year at a possible maximum load of 20 g/m^2 per year (12 dry months with wetland vegetation decay) or a possible minimum load of 6 g/m^2 per year (year-round wet period with no vegetation decay).
n. Loading estimate calculated from data provided in "A Trial Experiment on Studying Short-Term Water Quality Changes in Flooded Peat Soil Environments" (Marvin Jung Associates in association with MWQI, July 1999). Trial experiment used the top 2 feet of soil scraped from Twitchell Island agricultural fields with large clumps of vegetation and roots removed by hand.
o. Primary production DOC load calculated from data provided in "A Trial Experiment on Studying Short-Term Water Quality Changes in Flooded Peat Soil Environments" (Marvin Jung Associates in association with MWQI, July 1999). Primary production was measured in a control tank containing no peat.
p. Loading estimate calculated from data provided in "First Progress Report on Experiment #2: Seasonal Water Quality Changes in Flooded Peat Soil Environments Due to Peat Soil, Water Depth, and Water Exchange Rate" (Marvin Jung Associates, October 1999). This is the second experiment using the SMARTS test facility, and is to continue for at least one year. Data collected span January 21, 1999, through July 21, 1999.
q. Estimates provided by Stuart Krasner for CUWA. Krasner provides discussion of potential water quality effects based on assumed DOC discharge concentrations of 8 mg/l, 16 mg/l, and 32 mg/l. Source: Krasner testimony 1997, page 28. Loading factor in table was calculated by Jones & Stokes based on assumed reservoir depth of 6 m, minus an initial applied water DOC concentration of 3 mg/l.
r. Estimates provided by Richard Losee for CUWA. Algal biomass loading estimate was based on *Cladophora* production rates in a shallow MWD reservoir. Source: Losee testimony 1997, page 6. Peat soil DOC contributions were estimated based on conversion of peat soil to DOC. Testimony presented assumed DOC concentrations in 6-meter-deep storage reservoir water column of 300 mg/l. Source: Losee testimony 1997, page 11. Loading factor in table calculated by Jones & Stokes based on assumed reservoir depth of 6 m.
s. Estimates calculated based on rebuttal testimony provided by Richard Losee and K. T. Shum. Groundwater seepage loading based on 8,100-af perimeter well pumping estimate for Bacon Island during a period of nine months. Seepage water DOC concentration assumed to be 20-40 mg/l. Source: Losee and Shum testimony 1997, page 3.
t. Estimates calculated based on rebuttal testimony provided by K. T. Shum. Molecular diffusion DOC flux based on an assumed peat-soil pore-water DOC concentration of 70 mg/l (top 0.3 m of peat soil) and water column DOC concentration of 40 mg/l (3.1 g/m^2 per year) and a scenario in which the water column DOC concentration is 10 mg/l (6.2 g/m^2 per year). Loading value was estimated based on a 5- to 25-fold increase in DOC diffusion (misquoted from Kavanaugh testimony – Kavanaugh assumed 10-fold increase resulting in diffusion ranging from 5 to 25 mg/m^2 per day) as a result of external force, including advective currents, bioturbation, etc. Source: Shum testimony 1997, page 3.
u. Estimates based on testimony from Michael Kavanaugh. Source: Kavanaugh testimony 1997, Table V.

Table 4-6. Estimates of Dissolved Organic Carbon Loading Using the DeltaSOQ Impact Analysis

	Assumed DOC Loading		Supporting Information
	(g/m^2/month)	(g/m^2/year)	
Agricultural Operations	1	12	MWQI agricultural drainage data for the Delta Wetlands Islands Twitchell Island drainage data MWQI-CR#2 Delta region organic carbon study
Wetland Habitat Operations	1	12	Holland Tract wetland demonstration Vegetation decay experiment MWQI agricultural drainage data
Long-Term Reservoir Operations	1[a]	12	DeltaDWQ Model—1995 DEIR/EIS Tyler Island flooding Holland Tract flooded wetland demonstration
Initial-Fill Reservoir Operations	4[a]	48	SMARTS 1 static tanks 1, 3, 5, and 7 SMARTS 2 static tanks 5 and 7
High Initial-Fill Reservoir Operations	9[a]	108	SMARTS 2 static tanks 1 and 3

[a] For the impact analysis, the agricultural DOC loading estimate (1 g/m^2/month) is assumed under both no-project and with-project conditions. Therefore, the reservoir operation DOC loading assumptions are added to the agricultural loading (i.e., Total monthly reservoir operations DOC loading = Reservoir operations loading + agricultural operations loading).

Table 4-7. Water Quality Impact Assessment Variables and Significance Criteria

Variable	Significance Threshold	Location of Assessment	Discussion of Criteria and Changes Since the 1995 DEIR/EIS
Electrical conductivity and chloride	a. Increase of 20% of applicable standards or b. 90% of applicable standard	Chipps Island, Emmaton, Jersey Point, and representative export location (CCWD, SWP, and CVP) for EC; representative export location for Cl^-[a]	The 1995 WQCP objectives for EC and Cl^- have not changed since the 1995 DEIR/EIS was published. These objectives only apply in some months and at some locations. Therefore, significance criteria for EC and Cl^- are different for each month at each Delta location. For example, the applicable objectives for Cl^- are either 150 mg/l or 250 mg/l at the export locations. The same criteria used in the 1995 DEIR/EIS are used in the REIR/EIS analysis.
Bromide	Increase of 20% equivalent of Cl^- standards, using the Br^-:Cl^- ratio	Representative export location[a]	There are no numerical standards for Br^-. Because the ratio of Br^- to Cl^- is relatively uniform (0.0035) in the Delta, a change of 0.1 mg/l Br^- (equivalent to about 28 mg/l Cl^- or 20% of the most restrictive Cl^- objective of 150 mg/l) is used as the 20% significance criterion. The same criteria used in the 1995 DEIR/EIS are used in the REIR/EIS analysis.
Dissolved organic carbon	Increase of 0.8 mg/l (or 20% of mean value)	Representative export location[a]	There are no numerical standards for DOC. Increases in export DOC of more than 20% of the mean DOC concentration (5 mg/l), or about 1 mg/l, are considered to be significant water quality impacts. This criterion is the same as that used in the 1995 DEIR/EIS.

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Table 4-7. Continued

Variable	Significance Threshold	Location of Assessment	Discussion of Criteria and Changes Since the 1995 DEIR/EIS
Trihalomethanes	a. Increase of 20% of standard (16 μg/l) or b. 90% of applicable standard (72 μg/l)	Treated water from representative export location[a]	The EPA standard for THM concentrations in drinking water has been revised from 100 μg/l to 80 μg/l since preparation of the 1995 DEIR/EIS. For REIR/EIS analysis, the significance criterion was lowered to exceedances of 72 μg/l (90% of 80 μg/l) or changes greater than 16 μg/l (20% of 80 μg/l) to reflect the new THM standard.

Notes:

[a] As described in the 1995 DEIR/EIS, a representative Delta export location was used for the impact assessment because the impact assessment methods cannot reliably distinguish between water quality conditions of CVP exports at Tracy Pumping Plant, SWP exports at Banks Pumping Plant, and CCWD diversions at Rock Slough or Old River.

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Table 4-8. Simulated No-Project Chipps Island EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	11185	10558	4956	2361	153	161	202	150	175	2507	6878	9988	4131
1923	6886	5489	158	161	235	1459	226	731	2155	4589	7916	10086	3774
1924	10598	10248	10066	8453	3736	2193	5268	5419	5477	8337	10925	12295	8118
1925	9989	11172	9758	8084	150	182	253	767	2155	5794	9049	11279	5908
1926	11236	10585	10240	5175	164	1485	413	1656	5274	7203	9744	11649	6311
1927	11440	2976	4471	257	150	151	150	194	1865	3484	6224	9409	3406
1928	9118	3851	3947	509	231	150	179	673	3474	3990	6706	10070	3833
1929	10590	10244	9227	7617	3150	2098	3903	4702	5880	8528	11025	12351	7810
1930	9840	11093	8656	1509	1157	254	1249	2129	5281	7206	9745	11650	5797
1931	11441	10695	10298	8701	5986	6284	5530	5525	5514	8355	10934	12300	9469
1932	9972	11163	4057	2042	916	1693	1912	2028	2057	5745	9025	11266	4510
1933	11229	10581	10238	7652	5315	4173	2701	4246	5913	8544	11033	12355	8357
1934	9822	11083	10033	5031	1807	1871	2277	5456	5446	8323	10918	12291	7045
1935	10007	11181	11818	380	1534	310	151	177	1607	4353	7803	10630	4448
1936	10885	10399	10144	220	150	167	232	580	2266	4634	7937	10587	4501
1937	10862	10387	10138	6884	151	150	198	413	2049	4545	7895	10677	5551
1938	10910	1917	150	161	150	150	150	150	152	2350	6399	5618	2619
1939	2210	4114	1475	801	722	1409	2164	3623	5268	7200	9742	11648	4259
1940	11440	10695	10297	349	150	150	150	485	2730	3759	6759	10061	3915
1941	10585	10241	152	150	150	150	150	150	459	2864	5468	8338	3370
1942	3867	6203	150	150	150	163	150	152	259	2677	6336	8731	2963
1943	5188	2726	317	150	150	150	160	279	2715	3758	6194	9663	3056
1944	10258	10073	9761	2761	161	257	1529	2774	3047	6222	9259	11390	6123
1945	11297	8817	4910	5808	150	157	571	1003	1997	4523	7884	10672	4977
1946	10685	7582	150	150	228	365	1158	1257	2140	4583	7913	10686	4140
1947	10915	10345	5653	6370	1869	839	1635	3423	5526	7312	9771	11663	6771
1948	11448	10699	10300	7886	3148	1585	245	185	1120	4116	7682	9887	6295
1949	10495	10195	8863	7821	4103	153	1072	1697	2690	6049	9174	11345	6659
1950	11272	10605	10250	2753	176	595	458	1015	2075	4556	7900	9741	5254
1951	10419	152	150	150	150	161	747	683	2993	3844	6735	9394	3035
1952	10232	7437	152	150	150	150	150	150	152	1118	3460	2975	2451
1953	3197	3814	151	150	172	276	562	220	841	3083	6276	7948	2864
1954	6724	4257	5383	245	150	150	151	304	2990	3843	6734	10084	3974
1955	10597	7506	1086	610	1614	2226	2720	2357	3148	6268	9282	11402	5025
1956	11304	10621	150	150	150	151	238	152	594	2952	6305	7692	3263
1957	2376	6340	8160	4358	182	151	384	518	2127	3571	6813	9401	4239
1958	5341	6206	1403	163	150	150	150	150	154	2092	3410	3676	2208
1959	3184	6741	5122	163	150	322	2450	2026	5421	5817	8073	9869	4762
1960	10485	10190	10036	8210	431	752	1649	1814	4990	7080	9675	11612	6900
1961	11420	10202	6142	5134	261	982	2060	2350	5492	7298	9764	11660	6445
1962	11446	10698	7216	6994	150	277	1293	1628	3198	4997	8103	10785	5643
1963	221	3920	736	1500	150	198	150	166	1504	3356	6243	8576	2397
1964	9077	560	4255	416	1377	1791	3469	3337	5282	7206	9738	11645	5083
1965	11438	9506	150	150	157	404	151	246	2461	3675	6197	8855	3640
1966	9969	1646	2003	207	189	241	1583	1830	4862	5611	8119	10793	4135
1967	10972	5161	158	150	150	150	150	150	150	657	3891	3416	2001
1968	2874	6591	2372	174	150	154	938	2114	5492	5843	8068	10766	4298
1969	10958	10099	1310	150	150	150	150	150	158	2230	4973	1783	2903
1970	2723	2379	150	150	150	151	727	1402	4178	4199	6155	9790	3134
1971	10444	1573	150	150	214	150	309	174	1057	3180	6268	6089	2688
1972	7876	8903	2505	2023	642	203	1872	1972	4599	5515	8137	10802	5008
1973	10661	2648	658	150	150	150	312	717	1956	3514	6818	9007	3121
1974	8480	150	150	150	150	150	150	170	837	2466	3971	2961	1914
1975	4036	7050	4701	2043	150	150	177	178	354	2780	4709	4916	2955
1976	1788	5158	5653	4817	1239	1860	3605	4993	5479	8338	10926	12295	5472
1977	9969	11161	11807	10609	3128	5682	5395	5450	5488	8342	10928	12297	9747
1978	9990	11172	10156	150	150	150	150	195	1718	3433	6843	8763	3762
1979	7548	8749	9319	337	150	153	399	1090	1800	4439	7844	10651	4705
1980	10479	8829	2459	150	150	150	269	442	1881	3489	6838	8498	4463
1981	9424	9652	3021	194	194	180	590	1997	5448	7279	9781	11669	5704
1982	11451	167	150	150	150	150	150	150	260	1861	3748	1309	1541
1983	376	152	150	150	150	150	150	150	150	165	810	287	270
1984	251	150	150	150	151	154	495	845	2221	3602	6231	9271	2878
1985	9741	297	763	2969	723	584	1487	1944	5365	7242	9756	11655	4596
1986	11444	10697	5455	1047	150	150	178	415	2067	3552	6224	8316	4203
1987	9530	9705	9791	6288	819	254	1897	3954	5169	7157	9713	11632	6881
1988	11431	10690	6480	479	1689	1850	3987	5064	5511	8353	10934	12300	6298
1989	9972	11163	11808	10104	3785	158	301	1929	5415	7264	9766	10877	7412
1990	11018	10469	10180	4097	2111	3114	2614	4015	5458	8328	10920	12293	7414
1991	9988	11171	11812	10612	3150	218	917	3666	5610	8400	10958	12313	6911
1992	9939	11145	11798	10645	231	740	1927	3955	5535	8365	10940	12303	6055
1993	9973	11164	8668	150	150	154	151	165	323	2750	7000	9691	3615
1994	6665	8340	6189	4665	275	1597	3062	3748	5475	8336	10925	12295	6414
Average	8810	7538	5218	2767	854	769	1162	1646	3043	5055	7853	9629	4460

Table 4-9. Simulated No-Project Emmaton EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	2673	2448	817	343	150	150	150	150	150	364	1293	2250	904
1923	1295	940	150	150	151	233	151	173	315	738	1588	2283	759
1924	2462	2339	2277	1751	568	320	888	923	937	1715	2579	3091	1757
1925	2250	2668	2172	1638	150	150	151	175	315	1013	1939	2708	1333
1926	2692	2457	2337	867	150	236	156	254	889	1383	2167	2845	1385
1927	2767	435	713	152	150	150	150	150	278	522	1121	2056	704
1928	1961	589	608	161	151	150	150	169	520	616	1247	2278	757
1929	2459	2338	1996	1501	464	307	599	762	1034	1774	2615	3113	1676
1930	2199	2639	1814	238	205	151	213	311	891	1384	2167	2845	1264
1931	2767	2496	2356	1828	1061	1136	949	948	946	1720	2582	3093	2127
1932	2244	2665	629	300	185	258	284	298	302	1001	1931	2703	915
1933	2689	2456	2336	1511	899	652	392	667	1042	1779	2618	3115	1825
1934	2193	2636	2265	834	271	279	331	932	930	1711	2576	3090	1513
1935	2256	2672	2909	155	241	153	150	150	249	688	1555	2473	1010
1936	2564	2392	2303	151	150	150	151	164	330	747	1595	2458	1028
1937	2556	2388	2301	1295	150	150	150	156	301	728	1582	2490	1232
1938	2574	285	150	150	150	150	150	150	150	341	1166	970	571
1939	322	640	235	177	172	228	316	547	888	1382	2167	2845	835
1940	2767	2496	2356	154	150	150	150	159	397	572	1261	2275	877
1941	2457	2337	150	150	150	150	150	150	158	418	935	1715	766
1942	592	1115	150	150	150	150	150	150	152	389	1149	1837	603
1943	870	396	153	150	150	150	150	152	394	572	1113	2140	605
1944	2343	2279	2173	401	150	152	241	403	447	1120	2006	2749	1317
1945	2714	1864	807	1016	150	150	164	192	295	724	1579	2488	1025
1946	2493	1490	150	150	151	155	205	214	313	736	1587	2493	899
1947	2575	2373	979	1158	279	180	252	511	948	1414	2176	2851	1436
1948	2770	2498	2357	1579	464	246	151	150	202	641	1519	2215	1349
1949	2425	2321	1879	1560	638	150	198	259	391	1076	1979	2732	1420
1950	2705	2464	2340	400	150	165	158	193	304	731	1584	2166	1127
1951	2399	150	150	150	150	150	174	170	438	588	1255	2051	673
1952	2334	1449	150	150	150	150	150	150	150	201	518	435	538
1953	472	582	150	150	150	152	163	151	180	453	1134	1598	547
1954	1252	669	915	151	150	150	150	153	438	588	1254	2283	770
1955	2462	1469	199	166	250	324	395	342	464	1132	2014	2753	1045
1956	2717	2470	150	150	150	150	151	150	165	432	1141	1523	736
1957	345	1150	1661	690	150	150	155	161	311	537	1276	2053	812
1958	905	1116	228	150	150	150	150	150	150	307	509	557	414
1959	470	1256	855	150	150	153	355	298	924	1019	1635	2209	928
1960	2422	2319	2266	1676	157	174	253	272	825	1349	2144	2831	1523
1961	2760	2323	1100	857	152	190	303	341	940	1409	2174	2849	1383
1962	2769	2497	1387	1325	150	152	217	251	472	827	1644	2528	1206
1963	151	602	173	238	150	150	150	150	238	499	1125	1789	478
1964	1947	163	669	157	225	270	519	496	891	1384	2165	2844	1069
1965	2767	2087	150	150	150	156	150	151	357	556	1114	1876	805
1966	2243	253	295	151	150	151	246	274	797	969	1649	2531	869
1967	2596	863	150	150	150	150	150	150	150	168	597	510	448
1968	419	1216	344	150	150	150	187	309	940	1025	1633	2522	860
1969	2591	2288	219	150	150	150	150	150	150	325	821	269	645
1970	396	345	150	150	150	150	172	228	653	657	1103	2182	609
1971	2408	245	150	150	151	150	153	150	196	469	1132	1086	564
1972	1576	1892	363	298	167	150	279	291	740	946	1654	2535	1007
1973	2484	384	168	150	150	150	153	172	289	527	1277	1925	667
1974	1759	150	150	150	150	150	150	150	180	357	612	433	405
1975	625	1340	762	300	150	150	150	150	154	404	763	809	528
1976	269	863	979	787	212	278	544	826	937	1715	2579	3092	1083
1977	2243	2665	2905	2466	460	986	917	930	939	1717	2580	3092	2243
1978	2250	2669	2308	150	150	150	150	150	261	513	1284	1847	841
1979	1481	1843	2026	154	150	150	156	199	271	706	1567	2481	1004
1980	2420	1868	357	150	150	150	152	158	280	523	1282	1764	936
1981	2060	2136	443	150	150	150	165	294	930	1404	2180	2853	1259
1982	2771	150	150	150	150	150	150	150	152	278	570	219	387
1983	155	150	150	150	150	150	150	150	150	150	178	152	154
1984	151	150	150	150	150	150	160	180	324	543	1123	2010	599
1985	2166	153	175	434	172	164	236	288	911	1394	2171	2847	998
1986	2768	2497	932	195	150	150	150	156	303	534	1121	1708	905
1987	2096	2154	2183	1137	178	151	282	609	865	1370	2157	2839	1478
1988	2764	2495	1187	159	258	277	615	842	945	1720	2582	3093	1368
1989	2244	2665	2905	2289	577	150	153	286	922	1400	2175	2562	1691
1990	2612	2416	2316	637	309	458	379	621	932	1712	2577	3090	1604
1991	2250	2668	2907	2467	464	151	185	555	968	1734	2591	3099	1657
1992	2233	2659	2901	2479	151	173	286	609	951	1724	2584	3095	1416
1993	2245	2665	1818	150	150	150	150	150	153	400	1327	2149	824
1994	1236	1716	1112	754	152	248	449	570	936	1715	2579	3091	1328
Average	1991	1657	1133	592	222	210	248	312	518	909	1629	2225	954

C-062784

Table 4-10. Simulated No-Project Jersey Point EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	2169	1988	684	304	150	150	150	150	150	321	1065	1830	753
1923	1066	782	150	150	151	217	151	168	282	620	1301	1857	637
1924	2000	1902	1851	1430	484	286	740	769	779	1402	2093	2503	1436
1925	1830	2165	1767	1341	150	150	151	170	282	841	1581	2196	1096
1926	2184	1996	1899	723	150	219	155	233	741	1136	1764	2306	1138
1927	2244	378	600	151	150	150	150	150	253	447	927	1675	593
1928	1599	501	516	158	151	150	150	165	446	523	1027	1852	635
1929	1997	1900	1627	1231	401	276	509	639	857	1449	2122	2520	1370
1930	1789	2142	1481	221	194	151	200	279	743	1137	1764	2306	1041
1931	2244	2027	1915	1492	878	939	789	789	787	1406	2096	2505	1731
1932	1825	2162	533	270	178	237	257	269	272	831	1575	2192	762
1933	2181	1995	1899	1239	749	552	344	563	864	1453	2124	2522	1490
1934	1785	2139	1842	697	247	253	295	776	774	1399	2091	2502	1240
1935	1835	2167	2357	154	223	152	150	150	229	581	1274	2008	838
1936	2082	1943	1873	151	150	150	151	161	294	628	1306	1996	853
1937	2075	1940	1871	1066	150	150	150	155	271	613	1296	2022	1015
1938	2089	258	150	150	150	150	150	150	150	303	963	806	486
1939	288	542	218	172	168	213	283	468	740	1136	1763	2306	698
1940	2244	2027	1915	153	150	150	150	158	347	488	1039	1850	731
1941	1996	1900	150	150	150	150	150	150	157	364	778	1402	643
1942	504	922	150	150	150	150	150	150	151	341	950	1500	512
1943	726	347	152	150	150	150	150	152	345	488	920	1742	514
1944	1904	1853	1768	351	150	151	222	353	388	926	1635	2229	1084
1945	2201	1522	676	843	150	150	161	184	266	609	1293	2020	850
1946	2024	1222	150	150	151	154	194	201	280	619	1300	2025	749
1947	2090	1929	813	957	253	174	232	439	789	1161	1771	2310	1179
1948	2246	2028	1916	1293	401	227	151	150	191	543	1246	1802	1109
1949	1970	1887	1533	1278	541	150	188	237	342	891	1613	2216	1166
1950	2194	2001	1902	350	150	162	157	184	274	615	1297	1763	931
1951	1949	150	150	150	150	150	169	166	380	500	1034	1670	568
1952	1897	1189	150	150	150	150	150	150	150	191	444	378	460
1953	408	496	150	150	150	152	160	151	174	392	937	1308	468
1954	1031	565	762	151	150	150	150	152	380	500	1034	1856	646
1955	1999	1205	189	163	230	289	346	304	401	936	1641	2232	866
1956	2203	2006	150	150	150	150	151	150	162	375	943	1248	619
1957	306	950	1359	582	150	150	154	159	279	460	1051	1672	679
1958	754	923	212	150	150	150	150	150	150	275	437	475	361
1959	406	1035	714	150	150	153	314	268	769	845	1338	1797	772
1960	1968	1885	1843	1371	156	169	233	248	690	1109	1745	2295	1249
1961	2238	1889	910	716	151	182	272	303	782	1158	1769	2309	1136
1962	2246	2028	1139	1090	150	152	204	231	408	691	1345	2053	995
1963	151	512	168	220	150	150	150	150	220	429	930	1461	413
1964	1588	160	565	155	210	246	445	427	743	1137	1762	2305	886
1965	2243	1700	150	150	150	155	150	151	315	475	921	1531	674
1966	1824	233	266	150	150	151	227	249	667	805	1349	2055	725
1967	2107	721	150	150	150	150	150	150	150	165	508	438	389
1968	365	1003	305	150	150	150	180	277	782	850	1337	2047	718
1969	2103	1860	205	150	150	150	150	150	150	290	687	245	546
1970	346	306	150	150	150	150	168	212	552	556	912	1776	518
1971	1956	226	150	150	151	150	152	150	187	405	935	899	481
1972	1291	1543	321	268	164	150	253	263	622	787	1353	2058	836
1973	2018	337	165	150	150	150	152	167	262	452	1052	1570	564
1974	1437	150	150	150	150	150	150	150	174	316	520	376	354
1975	530	1102	639	270	150	150	150	150	153	353	641	677	453
1976	245	720	813	659	200	252	465	690	780	1402	2093	2503	896
1977	1825	2162	2354	2003	398	819	764	774	781	1403	2094	2504	1824
1978	1830	2165	1876	150	150	150	150	150	239	440	1057	1508	703
1979	1215	1504	1651	153	150	150	155	189	247	595	1284	2015	833
1980	1966	1525	315	150	150	150	151	156	254	448	1056	1442	779
1981	1678	1739	384	150	150	150	162	266	774	1153	1774	2312	1037
1982	2247	150	150	150	150	150	150	150	151	252	486	205	339
1983	154	150	150	150	150	150	150	150	150	150	172	152	153
1984	151	150	150	150	150	150	158	174	289	464	928	1638	509
1985	1763	152	170	377	168	161	219	260	758	1145	1767	2308	829
1986	2245	2028	775	186	150	150	150	155	273	457	927	1397	754
1987	1707	1753	1776	940	173	151	256	517	722	1126	1755	2301	1212
1988	2241	2026	980	157	236	251	522	703	786	1406	2095	2505	1125
1989	1825	2162	2354	1862	492	150	152	259	768	1150	1770	2079	1382
1990	2120	1963	1883	540	277	396	333	527	776	1400	2092	2502	1313
1991	1830	2165	2355	2004	401	151	178	474	805	1417	2103	2509	1356
1992	1816	2157	2351	2013	151	169	259	517	791	1409	2097	2506	1163
1993	1826	2162	1484	150	150	150	150	150	153	350	1091	1749	689
1994	1019	1403	919	633	152	228	390	486	779	1402	2093	2503	1092
Average	1623	1356	936	503	208	198	228	279	444	757	1333	1810	794

Table 4-11. Simulated No-Project Export EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	759	726	374	274	265	303	367	424	272	302	493	705	426
1923	484	419	287	308	433	334	360	435	307	363	576	722	419
1924	752	751	731	626	395	478	561	588	532	713	920	965	656
1925	786	873	739	693	325	386	382	506	346	483	673	830	586
1926	834	799	761	451	321	346	402	498	445	554	717	885	576
1927	865	326	386	311	302	319	375	435	293	322	477	675	410
1928	608	347	355	288	317	298	341	429	354	346	494	737	407
1929	779	751	672	579	364	443	530	557	499	699	907	958	638
1930	771	862	645	350	395	279	442	508	453	559	720	888	558
1931	869	820	770	689	565	652	575	800	646	775	892	979	766
1932	833	912	467	376	364	540	468	491	413	546	693	842	532
1933	796	819	787	623	515	526	528	585	646	771	895	974	707
1934	805	896	761	471	501	495	448	608	481	752	886	964	657
1935	816	865	914	390	452	327	386	407	311	366	591	776	517
1936	757	777	758	329	324	292	359	427	305	375	590	764	485
1937	766	767	735	535	334	363	395	400	312	397	592	768	535
1938	754	280	284	340	272	239	297	262	295	291	459	421	359
1939	308	354	321	377	360	350	453	493	436	546	711	878	452
1940	853	817	797	372	311	310	356	423	322	326	497	718	461
1941	755	740	308	294	320	356	375	372	284	319	409	587	424
1942	355	457	288	419	395	345	373	401	275	312	460	611	395
1943	407	317	267	361	365	298	397	436	349	349	470	688	393
1944	703	727	702	375	388	332	467	465	337	463	687	838	549
1945	829	640	406	477	322	386	446	470	302	371	596	775	488
1946	729	553	298	306	421	330	436	448	309	372	584	775	458
1947	797	754	445	509	333	318	433	513	466	571	719	879	574
1948	865	808	790	615	534	388	386	426	280	354	560	722	568
1949	774	757	652	609	440	299	451	503	325	453	685	842	572
1950	843	799	777	377	298	315	386	470	299	370	573	710	507
1951	769	274	320	314	314	334	421	415	338	335	489	672	410
1952	733	540	283	287	427	358	364	311	294	266	325	315	371
1953	332	372	406	398	367	326	408	396	251	310	458	567	384
1954	491	359	415	298	302	296	346	422	340	335	491	729	409
1955	771	548	258	305	320	363	494	489	335	478	696	848	483
1956	843	790	341	280	306	354	398	448	283	298	460	549	423
1957	314	476	585	384	335	309	393	461	302	320	498	676	425
1958	418	464	263	300	303	370	321	330	293	263	309	327	330
1959	328	487	418	352	358	363	478	478	446	473	583	725	465
1960	776	761	740	632	301	307	446	480	432	546	711	875	598
1961	865	760	474	471	270	324	436	464	460	565	720	886	566
1962	868	813	541	588	338	289	441	466	339	393	584	790	528
1963	250	346	247	314	275	268	364	387	285	309	455	607	340
1964	641	253	359	280	333	335	488	498	445	550	711	873	481
1965	855	694	289	314	301	308	368	400	328	327	458	635	433
1966	663	295	315	334	376	329	444	439	426	459	586	793	453
1967	808	415	287	294	261	297	333	307	304	285	330	327	344
1968	322	481	356	355	337	306	419	447	449	472	582	795	451
1969	803	739	271	323	241	285	280	256	293	294	386	280	378
1970	321	358	417	305	384	349	408	426	387	367	466	702	411
1971	750	271	273	269	315	282	372	387	256	301	458	452	360
1972	564	641	293	298	291	281	443	447	404	443	588	804	462
1973	784	320	256	269	270	306	363	413	285	314	500	638	387
1974	585	253	265	305	355	345	396	439	262	278	339	305	336
1975	360	511	381	332	360	354	361	387	276	292	374	389	364
1976	295	402	428	403	335	336	498	539	451	628	819	937	487
1977	710	819	886	857	673	719	588	791	591	751	896	998	805
1978	916	944	776	367	313	363	317	357	330	384	500	614	465
1979	523	629	675	330	392	373	388	442	279	376	586	770	485
1980	743	636	301	322	286	323	415	428	337	377	492	596	458
1981	616	699	375	390	352	329	404	463	452	559	714	877	543
1982	848	257	258	316	314	318	253	313	291	279	332	286	331
1983	299	310	292	262	224	214	281	287	225	308	247	316	278
1984	422	331	278	319	383	338	431	463	302	326	470	659	408
1985	695	256	252	325	312	304	442	477	447	556	709	870	466
1986	846	790	433	322	283	258	377	396	342	347	483	589	450
1987	650	700	709	497	345	306	441	520	435	548	710	881	576
1988	865	826	493	319	465	444	529	574	475	649	868	957	593
1989	793	864	912	795	702	295	352	475	476	579	728	824	658
1990	833	810	767	419	430	451	457	571	468	678	875	963	649
1991	809	890	942	946	902	332	428	572	688	788	905	989	706
1992	819	911	962	870	377	351	454	542	503	709	936	984	644
1993	800	894	658	330	278	269	337	396	268	325	498	685	437
1994	476	600	458	396	309	332	482	542	449	623	812	931	538
Average	677	610	498	413	365	347	411	456	373	445	598	728	470

Table 4-12. Simulated No-Project Export Chloride Concentrations (mg/l)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	181	171	66	36	32	38	51	62	32	40	100	163	79
1923	95	77	33	38	62	43	49	63	40	62	121	167	72
1924	171	170	169	134	61	67	92	96	92	143	192	225	137
1925	170	195	167	137	38	49	51	73	46	88	146	197	115
1926	191	179	176	79	38	44	54	72	79	113	169	208	116
1927	203	46	64	35	36	39	52	63	36	48	92	153	69
1928	131	54	56	32	37	35	44	60	53	55	100	168	69
1929	181	175	152	119	53	61	81	87	91	144	198	230	134
1930	167	197	143	43	51	30	61	73	80	114	169	211	110
1931	203	188	181	146	100	112	96	123	107	149	202	232	168
1932	169	199	73	50	49	81	69	72	56	95	147	192	93
1933	175	180	176	124	88	82	77	90	108	151	200	231	145
1934	167	197	176	81	69	69	63	100	86	146	199	229	131
1935	167	201	215	49	62	39	54	58	39	61	121	179	95
1936	171	176	170	38	46	35	49	62	40	64	123	180	91
1937	173	174	169	103	48	54	58	60	40	66	121	180	106
1938	174	34	33	44	41	36	45	39	41	38	91	77	59
1939	41	57	40	49	47	46	66	74	77	111	164	203	80
1940	194	179	171	47	39	42	49	61	45	51	100	165	83
1941	174	172	36	35	47	53	56	56	36	45	76	129	76
1942	55	88	34	63	59	46	53	58	33	43	91	135	66
1943	70	44	29	54	55	45	58	65	49	54	90	157	65
1944	159	167	161	53	50	41	69	68	48	91	150	192	109
1945	189	142	71	88	41	55	66	70	38	63	123	179	91
1946	164	115	35	37	59	41	64	65	40	63	123	180	82
1947	184	175	82	96	43	37	60	77	84	115	168	213	117
1948	204	189	179	129	79	50	51	58	31	57	119	166	114
1949	181	175	146	126	70	34	63	73	44	88	150	199	117
1950	197	184	177	53	33	37	51	66	38	63	123	163	97
1951	177	30	42	42	41	44	61	58	48	53	99	153	70
1952	169	113	31	35	62	54	55	47	39	31	49	45	60
1953	49	58	54	55	50	40	57	54	26	44	90	122	61
1954	99	59	76	33	34	34	44	58	48	53	99	168	71
1955	181	115	27	35	40	49	72	71	48	93	155	202	91
1956	196	184	47	42	43	48	57	67	35	42	91	116	76
1957	42	93	127	63	41	37	54	66	39	49	101	154	75
1958	76	90	29	34	37	55	48	50	39	32	46	50	49
1959	48	97	73	44	47	47	70	69	80	87	127	167	85
1960	178	173	173	133	34	35	62	68	75	110	166	211	125
1961	206	177	92	82	28	38	60	65	83	116	169	211	115
1962	205	188	112	114	43	34	64	67	49	70	128	186	104
1963	25	55	25	39	31	29	50	54	34	46	89	134	51
1964	143	26	59	31	42	43	73	74	79	112	167	212	92
1965	202	159	33	41	38	38	51	56	44	50	89	142	77
1966	146	36	41	42	51	41	64	62	73	84	128	186	81
1967	188	74	32	34	28	37	50	46	44	36	52	49	53
1968	46	96	48	44	42	36	59	64	81	87	127	187	81
1969	189	172	30	46	36	43	42	38	44	39	68	34	66
1970	45	49	57	46	58	48	59	61	62	60	90	160	69
1971	173	31	29	29	37	32	50	52	28	43	90	87	57
1972	121	143	39	37	33	30	62	63	68	81	129	191	87
1973	184	43	26	30	32	41	50	60	35	47	100	144	65
1974	125	26	28	39	48	47	58	65	29	36	54	43	49
1975	57	105	65	43	48	50	50	54	32	40	65	68	57
1976	37	72	80	69	42	43	75	86	82	135	193	228	92
1977	154	185	205	183	100	117	97	119	100	148	201	230	171
1978	152	195	178	46	39	54	48	54	45	57	101	135	84
1979	105	138	151	40	59	54	55	65	33	63	121	181	91
1980	172	142	40	45	43	48	61	64	47	57	101	130	86
1981	133	154	54	50	44	40	56	66	81	113	166	209	106
1982	200	26	26	41	47	48	38	47	38	35	52	35	50
1983	39	41	44	39	34	32	42	43	34	45	26	42	38
1984	63	50	42	48	57	45	63	67	39	50	91	149	69
1985	159	26	26	46	37	36	63	69	80	112	165	210	87
1986	200	184	79	38	42	39	57	59	49	53	92	129	85
1987	144	157	162	94	42	35	62	79	77	111	165	208	118
1988	202	183	98	36	63	60	81	92	85	139	196	226	116
1989	168	201	217	178	106	32	42	66	85	117	170	194	139
1990	198	184	179	67	58	66	65	88	84	141	199	228	134
1991	170	200	216	192	135	38	57	86	112	151	203	232	141
1992	170	196	215	194	46	42	63	83	90	145	200	229	124
1993	165	192	143	42	33	31	44	55	30	45	103	157	77
1994	92	130	90	67	36	42	71	82	81	134	197	227	108
Average	146	128	96	66	50	46	59	67	57	80	127	166	87

Table 4-13. Simulated No-Project Export DOC Concentrations (mg/l)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	2.4	2.5	2.6	3.4	3.6	3.6	3.9	4.1	3.4	3.3	3.2	3.3	3.2
1923	3.5	3.3	4.7	4.9	5.1	5.0	4.0	4.8	3.5	3.1	3.8	3.6	4.0
1924	4.2	4.3	3.8	4.9	5.2	7.8	6.2	6.6	4.8	5.6	6.9	5.4	5.0
1925	5.1	5.6	4.3	7.8	5.7	5.3	4.1	5.1	3.9	4.2	4.3	3.9	5.0
1926	4.6	4.9	4.0	5.2	5.9	5.4	4.4	5.4	4.0	4.0	3.3	4.5	4.6
1927	4.4	3.6	3.6	5.7	4.6	4.2	4.0	4.6	3.5	3.3	3.7	3.6	4.1
1928	3.8	3.5	3.6	5.2	5.4	3.9	4.0	5.0	3.9	3.5	3.5	4.2	4.1
1929	4.2	3.8	3.7	5.3	5.2	7.5	5.9	6.3	4.5	5.4	6.3	4.7	4.8
1930	4.9	5.1	3.7	6.1	7.1	4.5	5.1	5.8	4.3	4.2	3.4	4.4	4.8
1931	4.6	4.7	3.7	6.1	6.9	9.1	6.3	8.0	5.5	6.2	5.4	4.9	5.4
1932	5.8	6.2	6.3	5.7	5.6	6.5	5.0	5.3	4.2	4.9	4.7	4.7	5.6
1933	4.9	5.4	4.8	6.2	6.1	7.5	5.7	6.3	5.5	6.0	5.6	4.8	5.7
1934	5.4	5.9	3.9	5.3	8.7	7.9	5.6	6.8	4.5	6.0	5.6	4.8	5.6
1935	5.6	4.6	4.7	6.9	6.6	5.3	4.4	4.6	3.7	3.3	4.2	4.0	4.8
1936	4.2	4.5	4.5	6.0	4.9	4.0	4.1	4.6	3.4	3.2	4.0	3.5	4.3
1937	4.2	4.2	3.7	5.5	5.2	4.0	4.4	4.0	3.4	3.6	4.1	3.6	4.3
1938	3.7	3.4	3.6	5.6	4.0	4.0	4.0	4.0	3.9	3.2	3.1	3.4	3.8
1939	3.6	3.4	4.3	6.6	5.8	5.9	5.2	5.7	4.1	4.1	3.6	5.0	4.5
1940	5.0	5.6	5.8	6.9	5.0	4.1	3.9	4.5	3.4	3.1	3.4	3.6	4.5
1941	3.9	3.6	4.9	4.8	4.7	4.0	4.0	4.0	3.5	3.5	3.1	3.2	4.0
1942	3.6	3.4	3.5	4.0	4.0	4.5	4.2	4.3	3.6	3.5	3.2	3.4	3.7
1943	3.7	3.7	3.7	4.0	4.0	4.0	4.5	4.0	3.8	3.6	3.6	3.6	3.8
1944	3.8	3.8	3.6	5.7	6.4	5.0	5.1	5.2	3.8	3.4	4.4	4.7	4.4
1945	4.7	3.6	3.7	5.2	4.9	5.3	5.0	4.0	3.6	3.3	4.3	4.1	4.3
1946	4.1	3.7	4.1	4.8	5.8	5.2	5.0	5.2	3.8	3.4	4.0	4.0	4.3
1947	4.3	3.9	3.8	5.2	5.2	5.4	5.4	6.2	4.4	4.4	3.5	3.8	4.4
1948	4.3	4.2	4.7	5.0	8.8	6.3	4.5	4.8	3.8	3.4	3.5	3.8	4.5
1949	3.9	4.0	3.7	5.5	6.1	5.0	5.2	5.7	3.9	3.4	4.3	4.1	4.4
1950	4.4	4.4	4.5	6.0	4.9	5.1	4.5	5.2	3.7	3.3	3.4	3.7	4.4
1951	4.1	3.5	4.4	4.8	4.3	4.4	4.7	4.7	3.7	3.3	3.3	3.5	4.0
1952	3.7	3.5	4.5	4.5	4.5	4.0	4.0	4.0	3.8	3.3	3.3	3.5	3.9
1953	3.7	4.1	5.0	5.2	5.0	5.1	4.6	4.5	3.4	3.5	3.3	3.4	4.1
1954	3.5	3.5	3.6	5.7	4.7	4.6	4.1	5.0	4.1	3.4	3.5	3.9	4.0
1955	3.9	3.6	3.7	6.5	5.3	6.0	5.4	5.6	3.9	3.8	4.4	4.1	4.6
1956	4.6	4.1	5.2	4.0	4.1	4.4	4.3	4.6	3.5	3.1	3.2	3.3	4.0
1957	3.6	3.7	3.5	4.7	5.6	4.6	4.6	5.0	3.8	3.3	3.5	3.6	4.0
1958	3.6	3.6	3.6	6.6	4.6	4.5	4.0	4.0	3.8	3.0	3.1	3.2	3.9
1959	3.6	3.5	3.9	5.7	5.1	5.4	5.2	5.4	4.1	4.2	3.3	3.8	4.2
1960	4.3	4.3	3.7	5.6	5.2	4.9	5.2	5.6	4.1	4.1	3.4	3.8	4.4
1961	4.1	3.7	3.6	6.1	4.4	5.4	5.5	6.0	4.2	4.2	3.4	4.3	4.4
1962	4.3	4.3	3.6	6.1	5.7	4.1	4.7	5.0	3.6	3.2	3.2	3.6	4.2
1963	3.5	3.4	3.5	6.0	4.3	4.4	4.2	4.2	3.4	3.2	3.2	3.4	3.9
1964	3.5	3.5	3.5	5.5	5.7	5.7	5.5	5.7	4.2	4.2	3.3	3.8	4.2
1965	4.2	3.6	4.0	4.5	4.4	4.7	4.2	4.5	3.7	3.3	3.4	3.5	4.0
1966	4.0	3.8	4.1	6.1	5.5	5.3	5.1	5.4	4.2	4.2	3.4	4.0	4.5
1967	4.3	3.6	4.5	5.5	3.7	4.0	4.0	4.0	4.2	3.6	3.1	3.4	4.0
1968	3.6	3.5	4.7	6.6	4.6	4.7	4.9	5.4	4.2	4.2	3.4	4.0	4.3
1969	4.0	3.7	3.7	5.0	4.0	4.0	4.0	4.0	4.0	3.4	3.3	3.4	3.9
1970	3.7	4.5	4.3	4.0	4.0	4.4	4.5	4.7	3.8	3.5	3.5	3.7	4.0
1971	3.8	3.5	4.4	4.7	5.2	4.2	4.3	4.4	3.4	3.2	3.3	3.4	3.9
1972	3.5	3.6	3.6	4.9	5.2	5.1	5.4	5.7	4.2	4.0	3.5	4.0	4.2
1973	3.9	4.5	4.0	5.2	3.7	3.9	4.0	4.5	3.3	3.0	3.4	3.2	3.9
1974	3.5	3.3	3.8	4.3	4.6	4.1	4.4	4.7	3.4	3.2	3.3	3.4	3.7
1975	3.7	3.6	3.6	5.6	5.2	4.7	4.2	4.4	3.7	3.3	3.3	3.4	3.9
1976	3.7	3.5	3.6	4.9	6.0	5.8	5.9	6.4	4.2	4.3	4.2	4.2	4.4
1977	4.5	4.9	5.0	8.1	10.0	11.4	6.6	6.1	5.4	6.1	5.7	5.8	6.2
1978	8.0	7.8	4.2	6.3	4.5	4.9	4.0	4.0	3.8	3.9	3.3	3.4	4.5
1979	3.7	3.7	3.8	6.0	4.5	4.6	4.3	4.8	3.4	3.5	4.1	3.6	4.2
1980	3.7	3.5	3.5	4.9	4.0	4.0	4.5	4.0	3.9	3.8	3.2	3.4	3.8
1981	3.8	4.2	4.5	6.5	5.6	5.1	4.7	5.4	4.2	4.2	3.5	4.2	4.5
1982	4.2	3.6	3.7	5.0	4.5	4.0	4.0	4.0	3.8	3.3	3.2	3.5	3.9
1983	3.8	4.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.3	3.1	3.7	3.9
1984	4.0	4.0	4.0	4.0	4.0	4.5	4.7	5.0	3.6	3.3	3.7	3.5	3.9
1985	3.7	3.9	3.6	5.0	5.6	5.6	5.1	5.6	4.3	4.3	3.4	3.9	4.3
1986	4.2	4.0	3.7	6.1	4.0	4.0	4.0	4.0	4.0	3.5	3.7	3.3	4.1
1987	3.6	3.9	3.7	4.9	5.9	5.1	5.3	6.0	4.0	4.0	3.4	4.4	4.3
1988	4.5	5.3	3.6	6.1	8.2	7.8	6.1	6.5	4.4	4.5	5.5	5.0	5.4
1989	5.2	4.6	4.4	5.6	9.9	4.8	4.8	6.2	4.6	4.5	3.5	4.0	4.8
1990	3.9	4.8	3.8	5.5	7.3	7.0	5.8	6.8	4.5	5.2	5.5	5.0	5.2
1991	5.5	5.7	5.7	10.2	11.3	5.4	5.5	6.9	6.0	6.5	5.9	5.4	6.2
1992	5.5	6.7	6.4	6.5	6.6	5.5	5.3	6.5	4.7	5.4	6.6	5.4	6.0
1993	5.4	6.4	4.2	5.2	4.1	3.5	3.6	4.1	3.3	3.4	3.1	3.3	4.0
1994	3.5	3.6	3.3	4.7	5.7	5.4	5.3	5.8	4.0	4.0	3.3	3.9	4.2
Average	4.2	4.2	4.1	5.5	5.4	5.1	4.7	5.1	4.0	3.9	3.9	3.9	4.3

C-062788

Table 4-14. Estimated No-Project Treated Water THM Concentrations (µg/l)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	39.4	40.3	32.0	38.2	40.0	40.4	45.6	50.0	37.5	37.6	42.7	51.8	40.6
1923	46.4	42.0	52.4	55.3	61.9	57.2	47.2	58.4	40.2	38.3	53.7	56.5	49.5
1924	66.7	68.7	60.0	71.9	63.4	96.5	81.9	88.8	63.9	84.6	114.7	96.0	73.0
1925	80.7	94.4	68.4	114.8	64.2	61.6	48.7	63.9	45.1	55.4	64.3	66.1	69.6
1926	77.4	79.5	64.1	66.5	67.0	62.3	52.4	68.2	51.5	56.0	52.7	78.5	64.2
1927	75.0	42.1	44.5	63.8	52.1	47.7	47.1	55.9	39.1	38.3	49.3	54.7	50.3
1928	55.2	41.6	43.1	57.9	60.7	44.1	46.3	60.6	46.5	41.2	47.6	66.4	50.2
1929	67.8	61.1	56.5	75.2	61.4	91.5	76.0	81.6	59.5	81.1	107.3	84.2	69.8
1930	78.4	85.4	55.5	70.8	83.4	49.5	62.4	72.7	54.9	59.4	54.5	76.3	64.9
1931	77.9	77.8	60.8	92.1	93.9	126.1	84.1	114.6	76.2	94.4	92.5	88.4	84.7
1932	92.3	105.3	78.7	67.3	65.8	83.7	62.6	66.5	50.8	65.0	71.0	78.0	73.5
1933	79.4	87.3	77.4	89.4	80.1	95.9	72.6	82.5	76.3	91.6	95.2	87.2	85.1
1934	85.7	100.4	62.6	68.7	108.2	98.2	68.2	91.5	58.2	90.9	94.9	85.7	80.5
1935	88.8	78.3	81.9	80.6	80.2	60.0	52.6	55.5	42.5	40.6	60.0	65.6	63.9
1936	67.3	71.9	71.9	67.5	57.0	44.8	47.5	55.7	39.0	39.7	57.2	57.5	56.1
1937	67.9	68.3	59.4	75.0	60.5	47.6	52.6	48.4	39.1	44.6	57.8	58.0	58.3
1938	60.2	37.9	39.9	64.3	45.7	45.0	46.2	45.5	44.9	36.7	40.6	42.8	45.6
1939	40.9	41.0	48.8	76.8	67.6	68.0	64.5	71.5	51.9	56.9	56.9	85.7	57.3
1940	83.8	91.1	92.7	80.8	56.9	47.1	45.3	55.0	39.6	36.0	45.9	56.1	57.9
1941	62.0	57.7	54.7	54.1	55.2	47.5	47.9	47.8	39.9	40.0	39.7	47.1	49.7
1942	43.3	44.6	39.4	48.8	48.3	52.7	49.4	52.0	40.2	40.7	42.7	50.3	45.3
1943	46.6	42.2	40.4	47.6	47.7	46.3	54.0	49.2	44.6	42.4	48.0	55.5	46.6
1944	58.8	60.5	56.9	67.5	75.1	57.6	63.6	64.9	44.4	44.6	66.7	78.3	60.2
1945	77.4	54.3	45.7	67.3	56.1	62.9	61.4	49.9	41.1	40.7	61.3	66.1	56.2
1946	64.1	51.2	45.7	53.9	70.1	59.7	61.5	63.7	43.0	41.3	56.8	64.9	54.7
1947	70.8	62.6	48.5	69.9	59.7	60.9	65.5	78.4	56.8	62.2	55.6	66.2	61.6
1948	73.9	69.1	75.7	72.7	112.2	74.4	53.0	57.5	41.9	41.3	50.0	59.5	62.4
1949	63.4	64.5	55.9	79.4	76.2	56.1	63.1	71.6	44.8	44.1	66.0	69.5	61.8
1950	73.9	71.9	72.8	71.4	54.2	57.0	52.8	64.3	42.0	40.7	49.4	57.6	58.0
1951	66.5	38.5	51.0	54.5	49.0	51.2	57.1	56.0	43.5	38.9	44.7	54.0	49.6
1952	59.5	49.2	49.9	50.5	54.6	47.5	47.7	46.5	43.4	36.8	38.6	40.0	46.5
1953	43.0	48.7	59.7	62.5	59.0	58.7	55.8	53.8	37.2	40.4	44.1	49.2	49.1
1954	47.2	42.5	45.0	63.8	52.3	51.3	47.2	60.6	47.6	40.5	46.8	61.7	49.6
1955	63.1	50.9	40.3	72.8	60.5	70.7	67.7	70.2	45.3	50.5	67.4	69.6	59.0
1956	77.2	66.9	60.1	45.9	47.5	51.5	51.6	56.8	39.4	36.0	42.2	47.0	50.0
1957	41.8	48.4	51.0	57.0	64.3	51.5	55.0	62.1	42.7	38.6	47.4	55.9	50.2
1958	45.5	47.0	39.9	73.9	52.0	54.1	46.7	46.9	43.1	33.2	35.6	37.7	45.9
1959	41.7	46.9	48.9	66.1	59.8	62.9	65.1	66.8	52.1	54.3	48.3	60.0	53.5
1960	69.2	69.5	59.0	81.6	58.7	55.5	62.9	69.3	51.9	56.3	53.3	66.6	62.6
1961	70.7	60.5	47.8	78.5	48.5	61.7	66.5	73.4	54.5	59.5	54.0	74.4	61.1
1962	74.3	71.6	50.6	85.8	65.7	45.7	57.8	62.1	42.4	40.3	46.9	60.0	57.4
1963	37.5	40.9	37.9	68.5	47.2	48.8	49.0	49.9	38.3	36.6	42.6	49.3	45.4
1964	52.6	38.1	41.9	60.9	65.4	65.1	69.5	71.9	53.5	58.4	53.1	65.6	55.1
1965	72.3	56.1	44.7	52.0	49.3	53.1	49.1	54.4	43.2	38.5	44.2	52.8	50.2
1966	60.5	42.6	47.2	69.4	65.1	60.8	62.8	65.4	53.0	54.0	49.8	66.5	56.9
1967	70.6	45.8	49.8	62.1	40.8	44.6	47.0	46.4	48.0	41.0	37.2	39.8	47.3
1968	42.3	47.0	54.7	76.4	52.6	53.2	58.5	65.6	53.4	54.9	49.6	65.9	54.2
1969	66.0	59.0	40.4	58.1	45.1	46.0	45.9	45.4	46.1	38.8	40.2	37.8	47.4
1970	42.5	52.7	51.3	46.4	48.1	51.2	54.5	57.5	45.7	42.5	46.4	58.0	49.0
1971	60.9	38.8	48.6	51.2	58.6	46.3	50.7	51.5	37.8	37.2	43.9	44.9	46.6
1972	49.8	54.7	40.6	55.6	58.1	56.7	66.3	70.0	52.0	51.6	50.5	66.1	54.1
1973	64.3	52.0	43.2	57.0	41.4	44.4	47.2	54.1	36.7	35.5	46.5	48.9	47.3
1974	50.4	36.3	41.9	49.1	54.0	47.9	52.9	58.3	37.0	36.1	39.1	39.2	43.7
1975	44.1	49.0	43.7	63.9	60.4	54.6	49.5	52.4	41.1	37.6	41.0	42.6	47.2
1976	41.6	44.2	45.5	60.5	68.7	66.6	74.4	83.5	54.4	63.1	70.6	75.8	58.3
1977	69.8	80.9	85.2	133.5	135.0	160.2	88.5	86.4	72.8	93.1	97.4	105.2	98.1
1978	123.0	131.4	67.6	72.9	51.2	58.7	46.7	47.5	44.3	46.5	45.0	50.0	57.7
1979	50.0	54.1	57.3	68.1	54.6	55.3	51.6	58.7	37.6	42.2	58.3	58.9	54.1
1980	58.7	51.7	40.4	56.6	46.0	46.8	54.7	49.0	45.3	45.8	42.9	49.3	49.2
1981	55.1	64.6	53.4	76.1	64.2	58.4	56.7	67.0	53.5	58.8	55.0	72.4	60.6
1982	70.9	39.7	40.9	57.4	52.7	46.7	45.3	46.6	43.0	36.9	38.1	39.0	46.0
1983	43.2	50.0	46.1	45.5	44.7	44.5	45.9	46.0	44.7	49.4	33.7	42.9	44.5
1984	48.9	46.9	45.8	46.7	48.0	52.3	57.9	61.7	40.6	39.0	48.4	53.3	48.2
1985	57.1	42.2	38.8	58.1	62.8	62.9	62.1	69.4	54.4	60.3	54.2	67.8	55.5
1986	70.9	66.3	47.1	69.4	45.9	45.4	47.9	48.3	47.1	40.9	49.4	47.4	52.6
1987	53.6	60.3	58.1	65.4	67.5	56.9	64.0	76.3	51.4	56.2	53.5	76.8	60.1
1988	77.5	87.6	48.6	68.6	100.5	94.9	78.0	86.7	56.7	67.3	91.9	89.7	74.2
1989	83.3	78.0	78.3	91.6	135.5	53.1	55.1	76.6	59.0	63.3	56.0	68.0	70.0
1990	66.4	78.5	62.0	67.7	87.9	86.3	71.8	88.3	57.6	78.2	93.4	90.3	74.4
1991	87.7	96.6	100.2	171.3	166.9	61.6	65.9	89.8	83.7	98.7	100.7	97.4	93.2
1992	88.5	112.3	111.6	109.3	77.0	62.6	64.4	83.4	61.6	81.7	112.5	97.4	86.9
1993	84.9	107.7	62.9	59.6	45.6	39.0	41.0	48.4	36.8	39.9	41.8	50.9	50.5
1994	46.8	51.8	43.6	57.9	64.3	61.8	66.3	74.8	51.2	59.0	56.4	70.4	56.3
Average	63.8	61.5	54.9	68.6	64.4	60.2	57.5	63.6	48.2	51.2	56.8	63.1	55.7

Table 4-15. Differences in Chipps Island EC between Proposed Project and Simulated No-Project (μS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0	0	18	897	3	-0	-1	-0	1	5	3	-28	75
1923	-2	10	13	0	0	-19	-1	-8	-24	-23	-11	-36	-8
1924	-19	-10	-5	-19	-20	-3	-42	-66	-23	-11	-6	-3	-19
1925	-2	-1	25	11	0	0	-1	-8	-3	-1	-1	-0	2
1926	-0	-0	-0	-13	10	6	-3	-19	-65	-28	-14	-8	-11
1927	-4	6	18	163	0	-0	-0	-1	-24	-8	-4	-31	10
1928	-3	936	285	352	3	-0	-0	-7	-43	-13	-6	-3	125
1929	-2	-1	25	-5	-15	-2	-34	-57	-22	-10	-5	-3	-11
1930	-2	-1	24	883	86	-1	-12	-27	-68	-29	-15	-8	69
1931	-4	-2	-1	-17	-6	-2	-45	-68	-24	-11	-6	-3	-16
1932	-2	-1	16	820	52	12	-16	-26	-5	-3	-1	-1	71
1933	-0	-0	-0	-16	-26	-59	-37	-55	-22	-10	-5	-3	-19
1934	-2	-1	25	-4	-9	-2	-22	-60	-21	-10	-5	-3	-9
1935	-2	-1	-0	-1	-0	-3	-0	-0	-19	-9	-4	-2	-3
1936	-1	-1	-0	-0	0	0	-1	-6	-30	-12	-6	-34	-8
1937	-18	-9	-5	-17	2	0	-1	-4	-2	-1	-0	-0	-5
1938	-0	5	0	0	0	-0	-0	-0	0	3	-3	-23	-2
1939	151	63	24	2	1	-19	-25	-45	-68	-29	-15	-8	3
1940	-4	-2	-1	-1	0	0	-0	-4	-33	-20	-9	-34	-9
1941	-18	-9	0	0	0	-0	-0	-0	6	4	271	101	30
1942	131	66	0	-0	0	-0	-0	-0	6	8	4	-26	16
1943	-0	197	4	-0	0	-0	-0	-2	-34	-11	-4	-32	10
1944	-4	-2	24	-3	20	5	-10	-33	-41	-19	-9	-5	-6
1945	-3	12	22	-5	0	0	-4	-12	-23	-10	-5	-2	-2
1946	11	18	0	0	0	18	-5	-15	-28	-24	-12	-6	-4
1947	-3	13	24	9	-8	-12	-18	-42	-75	-33	1	-19	-14
1948	-11	-6	-3	-18	-4	-23	-1	-1	-14	-19	-9	-34	-12
1949	-18	-9	20	-7	-19	1	-5	-20	-38	-31	-15	-8	-13
1950	-4	-2	-1	-8	16	-1	-4	-12	-29	-22	-16	-38	-10
1951	-19	0	0	0	0	-0	-7	-8	-39	-12	-10	-34	-11
1952	-9	9	5	0	0	-0	-0	-0	0	11	37	42	8
1953	37	19	0	-0	0	-1	-5	-1	-11	-5	-2	-28	0
1954	-1	8	21	155	0	-0	-0	-2	-34	-11	-10	-5	10
1955	-3	12	947	161	44	-20	-30	-32	-47	-22	-11	-6	83
1956	-3	-2	0	0	0	-0	-1	-0	-7	-13	-6	-29	-5
1957	380	193	111	256	3	-0	-3	-5	-28	-20	-9	-34	70
1958	-3	10	1171	4	0	-0	-0	-0	0	21	39	-5	103
1959	84	40	40	0	0	0	-21	-27	-67	-25	-17	-38	-3
1960	-20	-10	-5	-19	-2	-10	-18	-24	-65	-28	-14	-7	-19
1961	-4	12	25	-4	26	-4	-20	-30	-71	-31	2	1	-8
1962	1	0	23	9	0	-1	-12	-21	-45	-17	-8	-6	-6
1963	0	8	603	409	0	-1	-0	-0	-19	-7	-3	-29	80
1964	-3	263	222	5	-4	-1	-30	-43	-73	-32	-16	-29	22
1965	-16	6	0	0	0	-4	-0	-1	-29	-18	-8	-32	-9
1966	-16	1401	728	2	0	-1	-15	-23	-60	-22	-16	-8	164
1967	-4	9	14	0	0	-0	-0	-0	0	6	39	47	9
1968	44	22	36	0	0	-0	-8	-26	-64	-24	-11	-6	-3
1969	-3	13	7	0	0	-0	-0	-0	0	23	53	29	10
1970	39	24	0	0	0	-0	-6	-17	-48	-14	-6	-3	-3
1971	-2	4	0	0	0	0	-2	-0	-13	-15	-11	-28	-6
1972	-2	-1	1764	293	13	-1	-18	-26	-59	-22	-10	-17	160
1973	3	7	519	0	0	-0	-2	-8	-26	-9	-4	-31	37
1974	-3	0	0	-0	0	-0	-0	-0	-10	437	595	165	99
1975	59	39	29	135	0	-0	-0	-0	11	10	464	133	73
1976	70	44	35	-1	16	-22	-39	-62	-81	-38	-20	-11	-9
1977	-6	-3	-2	-1	-0	-0	-43	-67	-23	-11	-6	-3	-14
1978	-2	-1	25	-0	0	0	-0	-1	-22	-8	-4	-30	-3
1979	-2	-1	-1	-1	0	-0	-3	-13	-26	-11	-5	-3	-5
1980	11	19	1898	0	0	-0	-1	-4	-25	-9	-9	-32	154
1981	-4	-2	12	76	1	-0	-5	-24	-68	-30	-15	-8	-6
1982	-4	0	0	0	0	-0	-0	-0	6	22	43	20	7
1983	4	0	0	-0	0	0	-0	-0	0	0	8	2	1
1984	2	0	0	-0	0	-0	-4	-10	-29	-9	-4	-31	-7
1985	-4	0	556	228	102	-1	-14	-25	-68	-30	-15	-22	59
1986	-12	-6	17	640	0	-0	-0	-4	-27	-9	-4	-29	47
1987	-3	-1	-1	-15	140	0	-17	-46	-72	-31	-16	-8	-6
1988	-5	-3	20	374	116	21	-25	-57	-21	-10	-5	-3	34
1989	-2	-1	-0	-18	-5	-0	-2	-22	-52	-22	-11	-37	-14
1990	-20	-11	-5	-12	-11	-43	-33	-51	-19	-9	-5	-3	-19
1991	-1	-1	-0	-0	-0	-1	-9	-41	-16	-8	-4	-2	-7
1992	-1	-1	-0	-0	-1	-10	-21	-47	-18	-9	-4	-2	-10
1993	-1	-1	24	0	0	-0	-0	-0	9	9	5	-27	2
1994	-1	-0	20	-5	14	-12	-31	-48	-77	-36	-19	-10	-17
Minimum	-20	-11	-5	-19	-26	-59	-45	-68	-81	-38	-20	-38	-19
Average	10	46	129	78	7	-3	-10	-19	-30	-6	15	-7	17
Maximum	380	1401	1898	897	140	21	-0	-0	11	437	595	165	164

Note: Difference is Proposed Project minus No-Project.

Table 4-16. Differences in Emmaton EC between Proposed Project and Simulated No-Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0	0	4	140	0	-0	-0	-0	0	1	1	-10	11
1923	-0	2	0	0	0	-2	-0	-0	-3	-5	-3	-12	-2
1924	-7	-3	-2	-6	-4	-0	-10	-15	-5	-3	-2	-1	-5
1925	-1	-0	8	3	0	0	-0	-1	-0	-0	-0	-0	1
1926	-0	-0	-0	-3	0	1	-0	-2	-15	-8	-5	-3	-3
1927	-2	1	4	5	0	-0	-0	-0	-3	-1	-1	-10	-1
1928	-1	191	56	21	0	-0	-0	-0	-8	-2	-2	-1	21
1929	-1	-0	8	-1	-3	-0	-6	-12	-5	-3	-2	-1	-2
1930	-1	-0	8	109	8	-0	-1	-3	-16	-8	-5	-3	7
1931	-2	-1	-0	-5	-2	-1	-11	-16	-6	-3	-2	-1	-4
1932	-1	-0	3	117	4	1	-2	-3	-1	-1	-0	-0	10
1933	-0	-0	-0	-5	-6	-12	-6	-11	-5	-3	-2	-1	-4
1934	-1	-0	9	-1	-1	-0	-3	-14	-5	-3	-2	-1	-2
1935	-1	-0	-0	-0	-0	-0	-0	-0	-2	-2	-1	-1	-1
1936	-0	-0	-0	-0	0	0	-0	-0	-4	-3	-2	-12	-2
1937	-6	-3	-2	-5	0	0	-0	-0	-0	-0	-0	-0	-1
1938	-0	1	0	0	0	0	-0	-0	0	0	-1	-6	-0
1939	21	13	2	0	0	-2	-3	-8	-16	-8	-5	-3	-1
1940	-2	-1	-0	-0	0	0	-0	-0	-5	-4	-2	-12	-2
1941	-6	-3	0	0	0	-0	-0	-0	0	1	65	31	7
1942	25	17	0	-0	0	-0	-0	-0	0	1	1	-8	3
1943	-0	31	0	-0	0	-0	-0	-0	-5	-2	-1	-11	1
1944	-1	-1	8	-1	0	0	-1	-5	-7	-5	-3	-2	-1
1945	-1	4	5	-1	0	0	-0	-1	-3	-2	-1	-1	-0
1946	4	5	0	0	0	1	-0	-1	-4	-5	-3	-2	-1
1947	-1	4	6	2	-1	-1	-2	-7	-18	-9	0	-7	-3
1948	-4	-2	-1	-5	-1	-2	-0	-0	-1	-4	-3	-12	-3
1949	-6	-3	6	-2	-4	0	-0	-2	-6	-8	-5	-3	-3
1950	-2	-1	-0	-1	0	-0	-0	-1	-4	-5	-5	-13	-3
1951	-7	0	0	0	0	-0	-0	-0	-6	-2	-3	-11	-3
1952	-3	3	0	0	0	-0	-0	-0	0	1	7	7	1
1953	6	4	0	0	0	-0	-0	-0	-1	-1	-1	-8	-0
1954	-0	2	5	5	0	-0	-0	-0	-6	-2	-3	-2	-0
1955	-1	3	100	10	5	-3	-5	-4	-8	-6	-3	-2	7
1956	-1	-1	0	0	0	-0	-0	-0	-0	-2	-2	-9	-1
1957	56	50	34	53	0	-0	-0	-0	-4	-4	-2	-11	14
1958	-1	3	146	0	0	0	-0	-0	0	3	7	-1	13
1959	14	11	9	0	0	0	-3	-3	-16	-6	-5	-13	-1
1960	-7	-4	-2	-6	-0	-1	-2	-3	-14	-8	-5	-3	-4
1961	-2	4	6	-1	1	-0	-3	-4	-17	-9	1	0	-2
1962	0	0	6	3	0	-0	-1	-2	-8	-4	-2	-2	-1
1963	0	1	48	46	0	-0	-0	-0	-2	-1	-1	-9	7
1964	-1	16	46	0	-0	-0	-5	-7	-17	-9	-5	-11	0
1965	-6	2	0	0	0	-0	-0	-0	-4	-3	-2	-10	-2
1966	-5	194	101	0	0	-0	-2	-3	-13	-5	-5	-3	22
1967	-2	2	0	0	0	-0	-0	-0	0	0	8	8	1
1968	7	6	5	0	0	-0	-1	-3	-15	-6	-3	-2	-1
1969	-1	4	1	0	0	-0	-0	-0	0	3	12	3	2
1970	6	3	0	0	0	-0	-0	-2	-10	-3	-1	-1	-1
1971	-1	0	0	0	0	0	-0	-0	-1	-3	-3	-7	-1
1972	-1	-0	308	39	1	-0	-2	-3	-12	-5	-3	-6	26
1973	1	1	38	0	0	-0	-0	-0	-3	-2	-1	-10	2
1974	-1	0	0	0	0	0	-0	-0	-1	66	120	27	18
1975	12	11	6	18	0	-0	-0	-0	0	2	103	30	15
1976	8	10	8	-0	1	-3	-7	-14	-19	-12	-7	-4	-3
1977	-2	-1	-1	-0	-0	-0	-10	-16	-6	-3	-2	-1	-4
1978	-1	-0	9	-0	0	0	-0	-0	-2	-1	-1	-9	-1
1979	-1	-0	-0	-0	0	-0	-0	-1	-3	-2	-2	-1	-1
1980	4	6	333	0	0	-0	-0	-0	-3	-2	-2	-10	27
1981	-1	-1	2	1	0	-0	-0	-3	-16	-8	-5	-3	-3
1982	-2	0	0	0	0	-0	0	-0	0	3	8	2	1
1983	0	0	0	0	0	0	-0	-0	0	0	1	0	0
1984	0	0	0	-0	0	-0	-0	-1	-4	-2	-1	-10	-1
1985	-1	0	45	38	7	-0	-1	-3	-16	-8	-5	-8	4
1986	-4	-2	4	62	0	0	-0	-0	-3	-2	-1	-9	4
1987	-1	-0	-0	-4	10	0	-2	-9	-16	-9	-5	-3	-3
1988	-2	-1	5	22	13	3	-5	-13	-5	-3	-2	-1	1
1989	-1	-0	-0	-6	-1	-0	-0	-3	-12	-6	-4	-13	-4
1990	-7	-4	-2	-2	-1	-7	-5	-10	-5	-3	-2	-1	-4
1991	-0	-0	-0	-0	-0	-0	-1	-8	-4	-2	-1	-1	-1
1992	-0	-0	-0	-0	-0	-1	-3	-9	-4	-3	-2	-1	-2
1993	-0	-0	8	0	0	-0	-0	-0	0	1	1	-9	0
1994	-0	-0	5	-1	0	-1	-5	-9	-18	-11	-7	-4	-4
Minimum	-7	-4	-2	-6	-6	-12	-11	-16	-19	-12	-7	-13	-5
Average	1	8	19	9	0	-0	-2	-3	-6	-2	2	-3	2
Maximum	56	194	333	140	13	3	0	-0	0	66	120	31	27

Note: Difference is Proposed Project minus No-Project.

Table 4-17. Differences in Jersey Point EC between Proposed Project and Simulated No-Project (μS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0	0	3	112	0	-0	-0	-0	0	1	1	-8	9
1923	-0	2	0	0	0	-2	-0	-0	-3	-4	-3	-10	-2
1924	-5	-3	-1	-5	-3	-0	-8	-12	-4	-3	-2	-1	-4
1925	-0	-0	7	3	0	0	-0	-0	-0	-0	-0	-0	1
1926	-0	-0	-0	-2	0	0	-0	-2	-12	-6	-4	-2	-2
1927	-1	1	3	4	0	-0	-0	-0	-2	-1	-1	-8	-0
1928	-1	153	45	17	0	-0	-0	-0	-6	-2	-1	-1	17
1929	-0	-0	6	-1	-2	-0	-5	-10	-4	-3	-2	-1	-2
1930	-0	-0	6	87	6	-0	-1	-3	-13	-7	-4	-2	6
1931	-1	-1	-0	-4	-1	-1	-9	-13	-5	-3	-2	-1	-3
1932	-0	-0	2	94	3	1	-2	-3	-1	-0	-0	-0	8
1933	-0	-0	-0	-4	-5	-9	-4	-9	-4	-3	-2	-1	-3
1934	-0	-0	7	-1	-1	-0	-2	-11	-4	-2	-1	-1	-1
1935	-0	-0	-0	-0	-0	-0	-0	-0	-2	-1	-1	-1	-0
1936	-0	-0	-0	-0	0	0	-0	-0	-3	-2	-1	-9	-1
1937	-5	-3	-1	-4	0	0	-0	-0	-0	-0	-0	-0	-1
1938	-0	0	0	0	0	0	-0	-0	0	0	-1	-4	-0
1939	17	10	2	0	0	-1	-3	-7	-12	-7	-4	-2	-1
1940	-1	-1	-0	-0	0	0	-0	-0	-4	-3	-2	-9	-2
1941	-5	-3	0	0	0	-0	-0	-0	0	1	52	25	6
1942	20	13	0	-0	0	-0	-0	-0	0	1	1	-7	2
1943	-0	25	0	-0	0	-0	-0	-0	-4	-2	-1	-8	1
1944	-1	-1	7	-0	0	0	-1	-4	-5	-4	-2	-1	-1
1945	-1	3	4	-1	0	0	-0	-1	-2	-2	-1	-1	-0
1946	3	4	0	0	0	1	-0	-1	-3	-4	-3	-2	-0
1947	-1	4	5	2	-1	-1	-2	-6	-14	-7	0	-6	-2
1948	-3	-2	-1	-4	-0	-2	-0	-0	-1	-3	-2	-9	-2
1949	-5	-3	5	-2	-3	0	-0	-2	-5	-6	-4	-2	-2
1950	-1	-1	-0	-1	0	-0	-0	-1	-3	-4	-4	-10	-2
1951	-5	0	0	0	0	-0	-0	-0	-5	-2	-2	-9	-2
1952	-2	2	0	0	0	-0	-0	-0	0	1	5	6	1
1953	5	3	0	0	0	-0	-0	-0	-1	-1	-0	-7	-0
1954	-0	1	4	4	0	-0	-0	-0	-4	-2	-2	-1	-0
1955	-1	3	80	8	4	-2	-4	-4	-6	-4	-3	-2	6
1956	-1	-0	0	0	0	-0	-0	-0	-0	-2	-1	-7	-1
1957	45	40	27	43	0	-0	-0	-0	-3	-3	-2	-9	11
1958	-1	2	116	0	0	0	-0	-0	0	2	6	-1	10
1959	11	9	7	0	0	0	-2	-3	-13	-5	-4	-10	-1
1960	-6	-3	-1	-5	-0	-1	-2	-2	-11	-6	-4	-2	-4
1961	-1	3	5	-1	1	-0	-2	-3	-13	-7	0	0	-2
1962	0	0	5	2	0	-0	-1	-2	-6	-3	-2	-2	-1
1963	0	1	39	37	0	-0	-0	-0	-2	-1	-1	-7	6
1964	-1	13	36	0	-0	-0	-4	-6	-13	-7	-4	-9	0
1965	-5	2	0	0	0	-0	-0	-0	-3	-3	-2	-8	-2
1966	-4	155	81	0	0	-0	-1	-2	-11	-4	-4	-2	17
1967	-1	2	0	0	0	-0	-0	-0	0	0	6	7	1
1968	6	5	4	0	0	-0	-1	-3	-12	-5	-3	-2	-1
1969	-1	4	1	0	0	-0	-0	-0	0	2	10	3	1
1970	5	3	0	0	0	-0	-0	-1	-8	-2	-1	-1	-1
1971	-0	0	0	0	0	0	-0	-0	-1	-2	-2	-6	-1
1972	-0	-0	247	31	1	-0	-2	-3	-10	-4	-2	-5	21
1973	1	1	31	0	0	-0	-0	-0	-3	-1	-1	-8	2
1974	-1	0	0	0	0	0	-0	-0	-1	53	96	22	14
1975	9	9	5	14	0	-0	-0	-0	0	1	82	24	12
1976	7	8	7	-0	1	-2	-6	-11	-15	-9	-6	-3	-3
1977	-2	-1	-1	-0	-0	-0	-8	-13	-4	-3	-2	-1	-3
1978	-0	-0	7	-0	0	0	-0	-0	-2	-1	-1	-8	-0
1979	-1	-0	-0	-0	0	-0	-0	-1	-2	-2	-1	-1	-1
1980	3	5	266	0	0	-0	-0	-0	-2	-1	-2	-8	22
1981	-1	-1	2	1	0	-0	-0	-2	-13	-7	-4	-2	-2
1982	-1	0	0	0	0	-0	0	-0	0	2	6	2	1
1983	0	0	0	0	0	0	-0	-0	0	0	0	0	0
1984	0	0	0	-0	0	-0	-0	-1	-3	-1	-1	-8	-1
1985	-1	0	36	30	5	-0	-1	-2	-13	-7	-4	-6	3
1986	-4	-2	3	50	0	0	-0	-0	-3	-1	-1	-7	3
1987	-1	-0	-0	-3	8	0	-2	-7	-13	-7	-4	-2	-3
1988	-1	-1	4	17	11	2	-4	-10	-4	-2	-1	-1	1
1989	-0	-0	-0	-5	-1	-0	-0	-2	-10	-5	-3	-11	-3
1990	-6	-3	-2	-2	-1	-6	-4	-8	-4	-2	-1	-1	-3
1991	-0	-0	-0	-0	-0	-0	-1	-6	-3	-2	-1	-1	-1
1992	-0	-0	-0	-0	-0	-0	-2	-7	-3	-2	-1	-1	-2
1993	-0	-0	6	0	0	-0	-0	-0	0	1	1	-7	0
1994	-0	-0	4	-1	0	-1	-4	-7	-14	-9	-5	-3	-3
Minimum	-6	-3	-2	-5	-5	-9	-9	-13	-15	-9	-6	-11	-4
Average	1	6	15	7	0	-0	-1	-3	-5	-2	2	-3	1
Maximum	45	155	266	112	11	2	0	-0	0	53	96	25	22

Note: Difference is Proposed Project minus No-Project.

Table 4-18. Differences in Export EC between Proposed Project and Simulated No-Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	-0	-0	1	18	-18	-0	1	1	-2	15	-7	-10	-1
1923	-0	0	-24	-1	-1	0	0	1	33	-1	-9	-2	-1
1924	-1	-0	-0	-1	-0	-2	-1	-1	-3	-3	-2	-0	-1
1925	-0	-0	1	1	-26	83	1	2	95	2	2	2	8
1926	2	2	1	2	-24	23	1	2	-2	-2	-1	-0	-1
1927	-0	0	1	-36	-4	-1	0	1	22	9	-1	-2	-2
1928	0	36	12	-20	-0	-0	0	1	27	19	0	1	6
1929	1	1	2	1	0	-1	1	0	-2	-2	-1	-0	0
1930	0	0	2	-4	57	2	1	1	10	-2	-1	-0	5
1931	-0	0	0	-1	-0	-3	-2	3	-6	-4	-1	-1	-1
1932	-0	-0	-0	-1	0	-24	0	1	-2	-2	-1	-0	-2
1933	-0	-0	-0	-1	-1	-1	0	0	-5	-4	-2	-1	-1
1934	-0	-0	2	-0	-1	-4	-1	-2	-2	-4	-2	-1	-1
1935	-0	-0	-0	-0	-1	1	0	0	-1	-1	-1	-1	-0
1936	-0	-0	-0	-0	-34	-2	0	1	8	-3	-1	-3	-5
1937	-1	-1	-1	-1	-35	0	0	0	51	32	1	1	1
1938	1	1	-28	1	0	0	0	0	-3	-0	-0	-1	-3
1939	1	3	-1	-0	-1	1	1	0	-16	-15	-2	-1	-2
1940	-1	-1	-1	-1	-28	-2	0	1	13	-1	-10	-3	-4
1941	-1	-1	-1	-24	-1	0	0	0	-1	-1	13	7	-1
1942	3	4	-1	0	0	-1	0	1	-3	-0	0	-2	0
1943	-0	3	-0	0	0	0	1	0	34	25	0	-2	5
1944	0	0	2	1	-58	-3	1	0	12	-6	-17	-1	-5
1945	-1	1	1	-0	-32	-8	0	0	36	5	-6	0	-1
1946	1	1	-28	0	9	-6	1	1	53	-1	8	1	2
1947	1	2	2	2	1	1	1	1	-3	-2	0	-2	0
1948	-1	-0	0	-1	-1	1	1	1	-0	-1	-1	-3	-1
1949	-1	-1	1	-0	-0	-6	0	1	16	-2	-1	-1	0
1950	-0	-0	-0	-0	-19	9	0	1	-1	-1	-1	-3	-2
1951	-2	-0	-35	-0	-1	-1	1	1	-11	-3	-1	-20	-7
1952	-1	0	-29	-1	-2	0	0	0	-3	-1	1	1	-3
1953	1	0	-3	-1	-1	-1	1	1	49	68	1	-1	11
1954	1	2	2	-40	-3	1	1	2	22	6	-0	-15	-2
1955	0	1	4	-8	25	25	2	2	26	-1	0	0	6
1956	1	1	1	11	-0	-0	1	1	2	-0	-0	-2	1
1957	5	10	4	10	-4	-0	1	2	38	-0	3	-7	5
1958	0	1	15	-9	-0	-1	0	0	-3	-0	1	-0	0
1959	2	2	2	-1	-1	9	1	1	19	9	-1	-2	3
1960	-1	-0	-0	-0	1	1	1	1	-3	-2	-1	-1	-0
1961	-0	1	1	0	-8	13	0	0	-3	-3	-0	-0	-0
1962	-0	-0	1	1	-26	-0	0	1	63	21	0	4	4
1963	1	1	-7	1	1	1	0	1	3	-0	-1	-4	-0
1964	-7	-10	10	-0	0	-1	0	0	28	4	-1	-2	1
1965	-1	1	0	-30	-0	-0	1	1	-4	-1	-1	-14	-5
1966	-8	16	8	-0	-1	-1	1	0	45	31	-0	0	6
1967	1	1	-34	0	-0	-0	0	0	-3	-1	1	1	-3
1968	1	1	-1	-1	-1	-1	1	1	14	10	-1	-0	2
1969	0	1	0	-33	0	0	0	0	0	-0	2	0	-3
1970	0	-0	-1	0	0	-1	1	1	-10	-1	-1	-0	-1
1971	-0	-0	-21	-0	-3	-5	0	1	7	-1	-1	-2	-2
1972	-0	-7	55	9	0	1	1	1	49	32	0	0	12
1973	2	2	-12	-4	0	-0	1	1	7	0	-15	-2	-2
1974	-0	-25	-0	-0	-1	-1	1	1	38	11	25	6	5
1975	3	4	2	0	0	-1	1	1	-2	10	21	7	4
1976	1	3	2	1	-1	46	1	1	45	-1	-0	0	7
1977	1	1	1	3	1	-2	-0	-10	-3	-3	-1	-0	0
1978	1	0	2	-0	-28	-6	0	0	-0	-1	-1	-2	-5
1979	-0	-0	-0	-0	2	-1	1	1	-1	16	-20	-0	0
1980	1	1	56	-9	0	0	1	0	55	49	1	-1	13
1981	1	1	2	-70	-0	0	1	1	-16	-32	-2	-2	-8
1982	-1	-1	-21	-1	-1	0	0	0	-3	-0	1	-1	-2
1983	-1	-1	0	0	0	0	0	0	0	-1	-1	-1	-0
1984	0	0	0	0	0	-1	1	2	20	8	-1	-2	3
1985	0	0	-9	9	-10	1	1	1	-44	-44	-2	-3	-6
1986	-2	-2	-0	-15	0	0	0	0	13	13	-0	-2	-0
1987	-0	0	0	-0	-16	1	-0	-1	14	-2	-1	-1	-1
1988	-0	-0	1	-30	9	9	-0	-1	-2	-1	-1	-0	-4
1989	-0	-0	-0	-1	-3	1	-0	-0	-3	-2	-1	-3	-1
1990	-2	-1	-1	-1	-0	-1	-1	-1	-2	-2	-1	-1	-1
1991	-0	-0	-0	-1	-6	2	-1	-1	-7	-5	-2	-1	-0
1992	-1	-1	-1	-1	-1	2	-1	-3	-3	-3	-3	-1	-1
1993	-1	-1	1	-26	-1	-1	0	1	-3	-1	-0	-2	-4
1994	-0	-0	1	-0	-7	-0	-0	1	48	52	-0	1	6
Minimum	-8	-25	-35	-70	-58	-24	-2	-10	-44	-44	-20	-20	-8
Average	-0	1	-1	-4	-4	2	0	0	11	4	-1	-1	0
Maximum	5	36	56	18	57	83	2	3	95	68	25	7	13

Note: Difference is Proposed Project minus No-Project.

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Table 4-19. Differences in Export Chloride Concentrations between Proposed Project and Simulated No-Project (mg/l)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	-0.0	-0.0	0.3	6.6	-3.6	-0.1	0.1	0.3	-0.5	4.3	-2.3	-3.4	0.05
1923	-0.0	0.1	-4.4	-0.1	-0.2	-0.0	0.1	0.2	9.3	-0.3	-4.5	-0.8	-0.26
1924	-0.3	-0.2	-0.1	-0.3	-0.2	-0.4	-0.3	-0.5	-0.5	-0.3	0.0	-0.0	-0.24
1925	-0.1	-0.1	0.5	0.2	-4.6	23.9	0.1	0.4	23.6	0.3	0.3	0.3	2.59
1926	0.3	0.3	0.2	0.2	-4.3	7.6	0.2	0.3	-0.9	-0.5	-0.3	-0.1	-0.04
1927	-0.1	0.1	0.3	-6.1	-0.7	-0.1	0.1	0.2	6.0	1.9	-0.5	-0.6	-0.19
1928	-0.0	12.0	3.7	-3.0	-0.0	-0.0	0.1	0.2	7.7	4.5	-0.0	0.1	2.23
1929	0.1	0.1	0.6	0.0	-0.0	-0.2	0.0	-0.2	-0.4	-0.2	0.0	-0.0	0.06
1930	-0.0	-0.0	0.5	2.6	20.9	0.4	0.1	0.2	2.2	-0.6	-0.3	-0.1	2.26
1931	-0.1	-0.0	-0.0	-0.3	-0.1	-0.3	-0.5	0.2	-0.9	-0.4	-0.2	-0.1	-0.16
1932	-0.1	-0.1	0.0	2.9	0.1	-2.5	0.1	0.1	-0.4	-0.3	-0.1	-0.0	0.39
1933	-0.1	-0.1	-0.1	-0.4	-0.4	-0.4	-0.0	-0.2	-0.7	-0.4	-0.2	-0.1	-0.22
1934	-0.1	-0.1	0.6	-0.1	-0.2	-0.6	-0.2	-0.7	-0.5	-0.4	-0.2	-0.1	-0.08
1935	-0.1	-0.1	-0.1	-0.0	-0.2	0.2	0.1	0.1	-0.1	-0.2	-0.2	-0.1	-0.06
1936	-0.1	-0.1	-0.1	-0.0	-7.7	-0.4	0.0	0.2	-0.0	-3.0	-0.2	-0.8	-1.40
1937	-0.4	-0.3	-0.2	-0.3	-7.9	0.0	0.1	0.0	13.7	7.8	0.2	0.2	0.42
1938	0.1	0.1	-5.4	0.1	0.0	0.0	0.0	0.0	-0.6	-0.0	-0.1	-0.3	-0.63
1939	0.6	0.8	-0.0	-0.1	-0.1	0.1	0.1	-0.0	-7.6	-5.5	-0.4	-0.2	-0.86
1940	-0.2	-0.2	-0.2	-0.1	-5.5	-0.5	0.1	0.2	0.7	-0.3	-6.4	-0.8	-1.43
1941	-0.4	-0.2	-0.1	-4.5	-0.1	0.0	0.0	0.0	-0.3	-0.1	4.3	2.1	0.03
1942	1.2	1.1	-0.1	0.0	0.0	-0.1	0.1	0.2	-0.5	-0.0	0.0	-0.6	0.13
1943	-0.0	1.3	-0.0	0.0	0.0	0.0	0.1	0.0	3.7	2.1	0.0	-0.6	0.53
1944	0.0	0.0	0.6	0.2	-10.6	-0.6	0.1	-0.0	1.2	-3.2	-6.1	-0.1	-1.40
1945	-0.1	0.2	0.3	-0.1	-6.4	-1.5	0.1	0.0	9.6	1.0	-3.1	0.0	-0.14
1946	0.2	0.4	-5.5	0.0	4.1	-1.0	0.2	0.2	15.3	-0.3	0.9	0.0	0.81
1947	0.1	0.4	0.5	0.3	0.2	0.2	0.1	-0.0	-1.1	-0.6	0.1	-0.5	0.04
1948	-0.2	-0.1	-0.1	-0.3	-0.1	0.0	0.1	0.2	-0.1	-0.3	-0.2	-0.8	-0.21
1949	-0.4	-0.2	0.4	-0.1	-0.2	-1.0	0.1	0.1	2.9	-0.6	-0.3	-0.2	-0.03
1950	-0.1	-0.1	-0.0	-0.0	-3.4	2.4	0.1	0.2	-0.3	-0.4	-0.3	-0.9	-0.37
1951	-0.5	-0.0	-7.5	-0.1	-0.1	-0.1	0.1	0.1	-3.9	-1.4	-0.2	-7.3	-1.93
1952	-0.3	0.1	-5.2	-0.2	-0.3	0.0	0.0	0.0	-0.6	-0.1	0.3	0.3	-0.57
1953	0.3	0.2	-0.6	-0.1	-0.2	-0.1	0.1	0.2	12.8	17.1	0.2	-0.4	2.89
1954	0.2	0.3	0.5	-6.8	-0.5	0.1	0.1	0.3	6.9	1.3	-0.1	-5.7	-0.44
1955	0.0	0.3	3.9	-1.1	8.7	9.3	0.2	0.3	7.0	-0.3	-0.0	0.0	2.29
1956	0.1	0.1	0.1	1.7	-0.0	-0.1	0.2	0.3	0.3	-0.1	-0.1	-0.6	0.17
1957	2.1	2.7	1.0	3.2	-0.7	-0.1	0.1	0.3	8.2	-0.2	-1.1	-4.0	0.95
1958	0.0	0.2	7.2	-1.6	-0.0	-0.3	0.0	0.0	-0.6	0.1	0.4	-0.1	0.51
1959	0.6	0.7	0.5	-0.2	-0.1	3.1	0.1	0.2	3.1	1.2	-0.3	-0.8	0.56
1960	-0.4	-0.2	-0.1	-0.3	0.1	0.1	0.1	0.1	-0.9	-0.6	-0.3	-0.2	-0.20
1961	-0.1	0.3	0.4	-0.0	-1.3	3.7	-0.0	-0.1	-1.1	-0.7	0.0	0.0	0.11
1962	-0.0	-0.0	0.4	0.2	-5.2	-0.0	0.1	0.1	15.7	4.4	-0.0	0.1	0.94
1963	0.1	0.2	0.4	1.4	0.1	0.2	0.1	0.2	0.9	-0.1	-0.5	-1.4	0.11
1964	-2.6	-1.4	3.1	-0.0	-0.0	-0.2	-0.0	-0.1	6.7	-0.9	-0.3	-0.7	0.12
1965	-0.3	0.2	-0.0	-6.5	-0.1	-0.1	0.1	0.2	-2.2	-0.3	-0.2	-5.6	-1.38
1966	-3.3	8.1	3.7	-0.0	-0.1	-0.1	0.1	0.0	13.1	8.5	-0.2	-0.0	2.29
1967	0.1	0.2	-6.0	0.0	-0.0	-0.1	0.0	0.0	-0.7	-0.2	0.4	0.4	-0.55
1968	0.3	0.4	0.0	-0.1	-0.1	-0.1	0.1	0.1	1.4	0.6	-0.2	-0.1	0.17
1969	-0.0	0.3	0.1	-7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1	-0.75
1970	0.2	0.0	-0.2	0.0	0.0	-0.1	0.1	0.2	-5.4	-2.8	-0.2	-0.1	-0.66
1971	-0.1	-0.0	-3.7	-0.1	-0.5	-0.9	0.1	0.1	1.1	-0.2	-0.2	-0.5	-0.47
1972	-0.0	-2.6	19.0	2.6	0.1	0.2	0.1	0.1	13.1	7.6	-0.0	-0.2	3.45
1973	0.3	0.3	-0.9	-0.7	-0.0	-0.1	0.1	0.2	1.2	-0.2	-5.9	-0.7	-0.53
1974	-0.1	-4.4	-0.1	-0.0	-0.1	-0.2	0.1	0.2	11.1	3.9	8.0	1.9	1.87
1975	0.8	0.8	0.5	0.4	-0.0	-0.1	0.1	0.2	-0.5	2.5	6.8	2.1	1.31
1976	0.3	0.7	0.6	0.1	-0.1	11.8	0.1	-0.2	8.1	-0.5	-0.2	-0.1	1.58
1977	0.1	0.1	0.1	0.4	0.1	-0.1	-0.3	-1.5	-0.6	-0.3	-0.1	-0.0	0.02
1978	-0.1	-0.0	0.6	-0.0	-5.6	-1.3	0.0	0.0	-0.1	-0.3	-0.1	-0.6	-0.97
1979	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	0.1	0.2	-0.2	-1.0	-11.7	-0.1	-0.86
1980	0.2	0.4	19.9	-2.0	0.0	0.0	0.2	0.0	17.0	15.3	0.0	-0.5	4.25
1981	0.1	0.2	0.3	-12.5	-0.0	0.1	0.1	0.1	-7.0	-11.8	-0.4	-0.3	-2.18
1982	-0.2	-0.1	-3.6	-0.2	-0.1	0.0	0.0	0.0	-0.6	-0.0	0.4	-0.1	-0.41
1983	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.1	-0.3	-0.10
1984	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	0.3	1.2	-0.3	-1.5	-0.6	-0.16
1985	-0.0	0.0	-0.3	2.5	-1.6	0.2	0.1	0.2	-13.4	-13.3	-0.5	-0.7	-1.47
1986	-0.5	-0.3	0.1	-0.8	0.0	0.0	0.0	0.0	3.6	2.8	-0.1	-0.6	0.24
1987	-0.0	-0.0	-0.0	-0.2	-2.4	0.1	-0.0	-0.3	2.6	-0.6	-0.4	-0.2	-0.16
1988	-0.1	-0.1	0.4	-4.3	11.5	7.4	-0.1	-0.5	-0.4	-0.3	-0.1	-0.1	0.41
1989	-0.1	-0.0	-0.0	-0.4	-0.4	0.1	-0.0	-0.1	-0.9	-0.5	-0.3	-1.0	-0.31
1990	-0.5	-0.3	-0.2	-0.2	-0.0	-0.4	-0.3	-0.4	-0.4	-0.3	-0.2	-0.1	-0.26
1991	-0.1	-0.1	-0.1	-0.1	-1.0	0.3	-0.1	-0.4	-1.0	-0.5	-0.3	-0.2	-0.05
1992	-0.2	-0.2	-0.2	-0.1	-0.1	0.3	-0.2	-0.6	-0.6	-0.4	-0.3	-0.2	-0.13
1993	-0.2	-0.2	0.4	-5.0	-0.2	-0.1	0.0	0.2	-0.5	-0.1	0.1	-0.6	-0.71
1994	-0.0	-0.0	0.3	-0.1	-1.2	-0.1	-0.1	-0.0	11.9	10.1	-0.3	-0.0	1.23
Minimum	-3.3	-4.4	-7.5	-12.5	-10.6	-2.5	-0.5	-1.5	-13.4	-13.3	-11.7	-7.3	-2.2
Average	-0.1	0.3	0.4	-0.6	-0.5	0.8	0.0	0.0	2.5	0.6	-0.4	-0.5	0.17
Maximum	2.1	12.0	19.9	6.6	20.9	23.9	0.2	0.4	23.6	17.1	8.0	2.1	4.2

Note: Difference is Proposed Project minus No-Project.

Table 4-20. Differences in Export DOC (mg/l) between Proposed Project and Simulated No-Project (mg/l) Assuming Long-Term DOC Load (1 g/m²/month)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0.0	0.0	-0.0	-0.2	-0.1	-0.0	0.0	0.0	-0.0	0.2	0.1	0.1	-0.0
1923	0.0	0.0	-0.1	0.0	-0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0
1924	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1925	0.0	0.0	-0.0	0.0	-0.3	0.7	-0.0	0.0	1.3	0.0	0.0	0.0	0.1
1926	0.0	0.0	0.0	0.0	-0.6	0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.1
1927	-0.0	-0.0	-0.0	-0.9	-0.0	-0.0	-0.0	-0.0	0.3	0.2	0.1	0.0	-0.1
1928	0.0	-0.1	-0.0	-0.6	-0.0	0.0	-0.0	-0.0	0.2	0.3	-0.0	-0.0	-0.0
1929	0.0	0.0	-0.0	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1930	-0.0	-0.0	-0.0	-0.7	-0.7	0.0	-0.0	-0.0	0.2	-0.0	-0.0	-0.0	-0.1
1931	-0.0	-0.0	-0.0	-0.0	-0.0	-0.1	-0.0	-0.1	-0.0	-0.1	-0.0	-0.0	-0.0
1932	-0.0	-0.0	-0.0	-0.5	-0.0	0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.1
1933	-0.0	-0.0	-0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0
1934	-0.0	-0.0	-0.0	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0
1935	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1936	-0.0	-0.0	-0.0	-0.0	-0.4	-0.0	-0.0	-0.0	0.7	0.5	0.0	0.0	0.1
1937	0.0	0.0	0.0	0.0	-0.4	0.0	-0.0	0.0	0.6	0.6	0.0	0.0	0.1
1938	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1939	-0.0	-0.0	-0.0	0.0	-0.0	0.1	-0.0	-0.0	0.8	0.4	0.0	0.0	0.1
1940	0.0	0.0	0.0	0.0	-0.2	-0.0	-0.0	-0.0	1.0	0.0	0.8	0.0	0.1
1941	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1942	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1943	-0.0	-0.1	-0.0	0.0	0.0	0.0	-0.0	0.0	1.6	1.3	0.0	0.0	0.2
1944	0.0	0.0	0.0	0.1	-0.2	-0.0	0.0	0.0	0.6	0.3	0.3	0.0	0.1
1945	0.0	0.0	0.0	0.0	-0.2	-0.0	-0.0	0.0	0.5	0.1	0.4	0.0	0.1
1946	0.0	0.0	-0.2	0.0	-0.1	-0.1	0.0	0.0	0.2	0.0	0.3	0.0	0.0
1947	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1948	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0
1949	0.0	0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	0.5	-0.0	-0.0	-0.0	0.0
1950	0.0	0.0	0.0	0.0	-0.4	0.2	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1951	-0.0	-0.0	-0.3	-0.0	0.0	-0.0	-0.0	-0.0	0.2	0.1	-0.0	0.3	0.0
1952	0.0	0.0	-0.4	-0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1953	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.5	0.8	0.0	0.0	0.1
1954	0.0	0.0	0.0	-1.0	-0.0	0.0	-0.0	-0.0	0.1	0.1	-0.0	0.3	-0.0
1955	0.0	0.0	-0.3	-0.3	-0.2	-0.4	-0.0	-0.0	0.3	-0.0	-0.0	-0.0	-0.1
1956	-0.0	-0.0	-0.0	0.8	0.0	-0.0	0.0	0.0	0.1	-0.0	-0.0	0.0	0.1
1957	-0.0	0.1	0.1	-0.1	-0.0	-0.0	-0.0	0.0	0.9	0.0	0.4	0.4	0.2
1958	0.0	0.0	-0.3	-0.3	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.1
1959	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	-0.0	-0.0	0.9	0.6	0.0	0.0	0.1
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	0.0
1961	0.0	0.0	0.0	0.0	-0.2	0.1	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0
1962	0.0	0.0	-0.0	0.0	-0.2	-0.0	-0.0	-0.0	0.8	0.4	0.0	0.2	0.1
1963	0.0	0.0	-0.3	-0.3	0.0	0.0	0.0	-0.0	0.1	-0.0	0.0	0.0	-0.0
1964	0.1	-0.2	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.6	0.6	0.0	0.0	0.0
1965	0.0	0.0	-0.0	-0.2	0.0	-0.0	0.0	0.0	0.3	0.0	0.0	0.2	0.0
1966	0.2	-0.4	-0.2	0.0	0.0	-0.0	-0.0	-0.0	0.3	0.3	0.0	0.0	-0.0
1967	0.0	0.0	-0.6	-0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.1
1968	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.9	0.8	0.0	0.0	0.1
1969	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1970	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	0.9	0.7	0.0	0.0	0.1
1971	0.0	0.0	-0.1	0.0	-0.1	-0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
1972	0.0	0.1	-0.3	0.0	-0.0	0.0	-0.0	-0.0	0.6	0.5	0.0	0.0	0.1
1973	0.0	0.0	-0.4	-0.0	0.0	0.0	-0.0	0.0	0.4	0.1	0.4	0.0	0.0
1974	0.0	-0.2	-0.0	0.0	-0.0	0.0	0.0	0.0	0.2	-0.1	-0.1	-0.0	-0.0
1975	-0.0	0.0	-0.0	-0.1	-0.0	0.0	-0.0	-0.0	-0.0	0.1	-0.1	-0.0	-0.0
1976	-0.0	-0.0	-0.0	-0.0	-0.1	0.4	-0.0	-0.0	1.3	0.0	0.0	0.0	0.1
1977	0.0	0.0	0.0	0.1	0.0	-0.1	-0.0	-0.7	-0.0	-0.1	-0.0	-0.0	0.0
1978	-0.0	-0.0	-0.0	-0.0	-0.2	-0.1	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1979	-0.0	-0.0	-0.0	-0.0	1.0	-0.0	0.0	0.0	0.0	1.3	1.4	0.0	0.3
1980	0.0	0.0	-0.3	-0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	-0.0
1981	0.0	0.0	0.0	-0.7	-0.0	0.0	-0.0	-0.0	0.4	0.4	-0.0	-0.0	0.0
1982	0.0	0.0	-0.2	0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1983	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1984	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	1.3	0.7	0.4	0.0	0.3
1985	0.0	0.0	-0.3	0.0	-0.2	0.1	-0.0	-0.0	0.3	0.3	0.0	0.0	-0.0
1986	0.0	0.0	0.0	-0.7	0.0	0.0	0.0	0.0	0.3	0.4	-0.0	0.0	-0.0
1987	0.0	0.0	0.0	0.0	-0.3	0.1	-0.0	-0.0	0.5	-0.0	-0.0	-0.0	0.0
1988	0.0	0.0	-0.0	-0.8	-1.5	-0.8	-0.1	-0.1	-0.0	-0.1	-0.1	-0.0	-0.3
1989	-0.0	-0.0	-0.0	-0.0	-0.1	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0
1990	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1991	-0.0	-0.0	-0.0	-0.0	-0.1	0.1	-0.0	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0
1992	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	-0.0	-0.1	-0.0	-0.1	-0.1	-0.0	-0.0
1993	-0.0	-0.0	-0.0	-0.2	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1994	-0.0	-0.0	-0.0	0.0	-0.2	-0.0	-0.0	-0.0	0.6	1.2	0.0	0.0	0.1
Minimum	-0.03	-0.36	-0.64	-1.05	-1.48	-0.82	-0.08	-0.67	-0.07	-0.08	-0.08	-0.04	-0.31
Average	0.01	-0.01	-0.06	-0.09	-0.08	0.01	-0.01	-0.02	0.29	0.17	0.06	0.02	0.02
Maximum	0.19	0.13	0.08	0.84	0.97	0.72	0.02	0.01	1.65	1.29	1.39	0.44	0.27

Note: Difference is Proposed Project minus No-Project.

Table 4-21. Differences in Export DOC (mg/l) between Proposed Project and Simulated No-Project (mg/l) Assuming Initial-Filling DOC Load (4 g/m²/month)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0.0	0.0	-0.0	-0.2	-0.1	-0.0	0.0	0.0	-0.0	0.8	0.3	0.3	0.1
1923	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.6	0.0	0.3
1924	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0
1925	0.0	0.0	-0.0	0.0	-0.3	0.8	0.0	0.0	2.2	0.0	0.0	0.0	0.2
1926	0.0	0.1	0.0	0.1	-0.6	0.2	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1927	0.0	0.0	0.0	-0.9	-0.0	-0.0	-0.0	-0.0	0.7	0.5	0.3	0.0	0.0
1928	0.0	-0.1	0.0	-0.6	-0.0	0.0	-0.0	-0.0	1.0	0.8	0.0	0.0	0.1
1929	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0
1930	0.0	0.0	0.0	-0.7	-0.5	0.0	-0.0	-0.0	0.7	-0.0	-0.0	-0.0	-0.1
1931	-0.0	0.0	0.0	0.0	0.0	-0.1	-0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0
1932	-0.0	-0.0	-0.0	-0.5	-0.0	0.7	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1933	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1934	-0.0	0.0	-0.0	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0
1935	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1936	-0.0	-0.0	-0.0	-0.0	-0.4	-0.0	-0.0	-0.0	1.1	0.9	0.0	0.0	0.1
1937	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	1.0	1.2	0.0	0.0	0.2
1938	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1939	-0.0	-0.0	-0.0	0.0	-0.0	0.8	0.0	0.0	2.9	1.3	0.1	0.1	0.5
1940	0.1	0.1	0.1	0.1	-0.1	0.0	0.0	0.0	1.4	0.0	1.4	0.0	0.3
1941	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1942	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1943	-0.0	-0.1	-0.0	0.0	0.0	0.0	-0.0	0.0	4.5	3.5	0.1	0.1	0.7
1944	0.1	0.1	0.1	0.2	-0.1	0.1	0.0	0.0	1.0	0.6	0.8	0.1	0.3
1945	0.1	0.0	0.0	0.1	-0.2	-0.0	0.0	0.0	0.8	0.3	1.0	0.0	0.2
1946	0.0	0.0	-0.2	0.0	-0.1	-0.0	0.0	0.0	0.8	0.0	1.1	0.0	0.2
1947	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	0.0	0.0
1948	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0
1949	0.0	0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	1.0	0.0	-0.0	0.0	0.1
1950	0.0	0.0	0.0	0.0	-0.4	0.3	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0
1951	0.0	0.0	-0.3	0.0	0.0	-0.0	-0.0	-0.0	0.8	0.3	0.0	0.8	0.1
1952	0.0	0.0	-0.4	0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1953	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	1.4	2.5	0.0	0.0	0.4
1954	0.0	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.9	0.1
1955	0.0	0.0	-0.3	-0.3	-0.1	-0.1	0.0	-0.0	1.0	0.0	0.0	0.0	0.0
1956	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
1957	-0.0	0.2	0.2	-0.0	0.0	-0.0	-0.0	0.0	2.3	0.0	1.1	1.2	0.5
1958	0.0	0.0	-0.3	-0.2	0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1959	-0.0	-0.0	-0.0	0.0	-0.0	0.6	0.0	-0.0	3.1	2.0	0.1	0.1	0.5
1960	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1961	0.0	0.0	0.0	0.0	-0.1	0.3	0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	-0.2	-0.0	-0.0	-0.0	1.2	0.6	0.0	0.5	0.2
1963	0.0	0.0	-0.3	-0.2	0.0	0.1	0.0	-0.0	0.2	0.0	0.1	0.1	-0.0
1964	0.2	-0.2	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	2.5	2.3	0.0	0.1	0.4
1965	0.1	0.0	0.0	-0.2	0.0	0.1	0.0	0.0	0.9	0.0	0.0	0.6	0.1
1966	0.6	-0.3	-0.2	0.1	0.0	0.0	0.0	0.0	1.2	1.2	0.0	0.0	0.2
1967	0.0	0.0	-0.6	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.1
1968	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	2.9	2.7	0.1	0.1	0.5
1969	0.1	0.1	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1970	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	-0.0	2.7	2.1	0.1	0.1	0.5
1971	0.1	0.1	-0.0	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.1
1972	0.0	0.4	-0.3	0.0	0.0	0.0	0.0	0.0	2.1	1.8	0.0	0.1	0.3
1973	0.1	0.1	-0.4	0.0	0.0	0.0	0.0	0.0	0.9	0.2	1.0	0.0	0.2
1974	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	-0.1	-0.1	-0.0	0.0
1975	0.0	0.1	0.0	-0.1	0.0	0.0	-0.0	-0.0	-0.0	0.4	-0.1	-0.0	0.0
1976	-0.0	-0.0	-0.0	-0.0	-0.0	2.2	0.0	0.0	4.5	0.1	0.1	0.1	0.6
1977	0.1	0.1	0.1	0.2	0.2	0.1	0.1	-0.6	0.0	-0.0	0.0	0.0	0.1
1978	0.0	0.0	0.0	0.0	-0.2	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1979	-0.0	-0.0	-0.0	-0.0	1.0	-0.0	0.0	0.0	0.0	2.7	3.1	0.1	0.6
1980	0.1	0.0	-0.3	-0.0	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.0	0.1
1981	0.0	0.0	0.0	-0.7	0.0	0.1	-0.0	-0.0	0.9	1.1	0.0	0.0	0.1
1982	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1983	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1984	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	3.9	2.1	1.1	0.1	0.9
1985	0.1	0.1	-0.3	0.1	-0.2	0.2	0.0	0.0	1.1	1.0	0.0	0.0	0.2
1986	0.1	0.0	0.0	-0.6	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.0	0.1
1987	0.0	0.0	0.0	0.0	-0.3	0.1	-0.0	-0.0	1.3	0.0	0.0	0.0	0.1
1988	0.0	0.0	0.0	-0.8	-1.3	-0.4	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	-0.3
1989	-0.0	-0.0	-0.0	0.0	-0.1	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1990	-0.0	-0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1991	-0.0	-0.0	-0.0	-0.0	-0.1	0.1	-0.0	-0.1	-0.1	-0.1	-0.0	-0.0	-0.0
1992	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	-0.0	-0.1	-0.0	-0.1	-0.1	-0.0	-0.0
1993	-0.0	-0.0	-0.0	-0.2	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1994	-0.0	-0.0	-0.0	0.0	-0.2	-0.0	-0.0	-0.0	1.7	3.6	0.1	0.1	0.4
Minimum	-0.03	-0.34	-0.62	-1.01	-1.28	-0.39	-0.06	-0.64	-0.06	-0.08	-0.08	-0.03	-0.29
Average	0.03	0.01	-0.05	-0.07	-0.06	0.09	0.00	-0.01	0.82	0.53	0.18	0.08	0.14
Maximum	0.60	0.38	0.19	0.85	0.97	2.18	0.07	0.04	4.53	3.60	3.11	1.15	0.92

Note: Difference is Proposed Project minus No-Project.

Table 4-22. Differences in Export DOC (mg/l) between Proposed Project and Simulated No-Project (mg/l) Assuming High Initial-Filling DOC Load (9 g/m²/month)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0.0	0.0	-0.0	-0.2	-0.1	-0.0	0.0	0.0	-0.0	1.8	0.7	0.6	0.2
1923	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	3.1	0.0	3.5	0.1	0.6
1924	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1
1925	0.0	0.0	-0.0	0.1	-0.2	1.1	0.0	0.0	3.6	0.1	0.1	0.1	0.4
1926	0.1	0.1	0.1	0.1	-0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1927	0.0	0.0	0.0	-0.8	-0.0	-0.0	-0.0	0.0	1.5	1.1	0.7	0.0	0.2
1928	0.0	-0.1	0.0	-0.5	0.0	0.0	0.0	0.0	2.2	1.8	0.0	0.1	0.3
1929	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	0.0	0.0	0.0	-0.6	-0.3	0.1	-0.0	-0.0	1.5	0.0	0.0	0.0	-0.0
1931	0.0	0.0	0.0	0.0	0.0	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1932	0.0	0.0	-0.0	-0.5	-0.0	1.7	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1934	0.0	0.0	-0.0	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0
1935	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1936	-0.0	-0.0	-0.0	-0.0	-0.4	-0.0	-0.0	-0.0	1.7	1.5	0.0	0.0	0.3
1937	0.0	0.0	0.0	0.1	-0.3	0.0	0.0	0.0	1.7	2.0	0.1	0.0	0.3
1938	0.0	0.0	-0.2	0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	-0.0
1939	-0.0	-0.0	-0.0	0.0	-0.0	2.0	0.0	0.0	6.4	2.9	0.1	0.2	1.0
1940	0.2	0.3	0.2	0.3	-0.1	0.0	0.0	0.0	2.0	0.0	2.3	0.1	0.5
1941	0.1	0.1	0.1	-0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0
1942	-0.0	0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1943	-0.0	-0.1	-0.0	0.0	0.0	0.0	-0.0	0.0	9.3	7.2	0.2	0.2	1.5
1944	0.2	0.2	0.2	0.4	0.1	0.2	0.1	0.1	1.7	1.1	1.5	0.2	0.5
1945	0.1	0.1	0.1	0.2	-0.1	0.0	0.0	0.0	1.4	0.5	2.1	0.1	0.4
1946	0.1	0.0	-0.1	0.1	0.1	-0.0	0.0	0.0	1.6	0.0	2.3	0.1	0.4
1947	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1948	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1949	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	1.8	0.0	0.0	0.0	0.2
1950	0.0	0.0	0.0	0.0	-0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1951	0.0	0.0	-0.3	0.0	0.0	-0.0	0.0	-0.0	1.8	0.7	0.0	1.7	0.3
1952	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1953	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	3.0	5.3	0.1	0.1	1.0
1954	0.1	0.1	0.1	-0.9	0.1	0.1	0.0	0.0	1.5	0.6	0.0	1.9	0.3
1955	0.1	0.1	-0.3	-0.2	0.2	0.4	0.0	0.0	2.3	0.1	0.1	0.1	0.2
1956	0.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1
1957	-0.0	0.3	0.4	-0.0	0.0	-0.0	0.0	0.0	4.6	0.1	2.2	2.3	0.9
1958	0.1	0.1	-0.3	-0.1	0.1	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	-0.0
1959	-0.0	0.0	-0.0	0.0	0.0	1.4	0.0	0.0	6.7	4.5	0.1	0.2	1.0
1960	0.2	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.1
1961	0.1	0.0	0.0	0.1	-0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1962	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.0	1.9	1.1	0.0	1.0	0.4
1963	0.0	0.0	-0.3	-0.2	0.0	0.1	0.0	0.0	0.4	0.0	0.2	0.2	0.0
1964	0.5	-0.2	0.0	0.0	0.0	-0.0	-0.0	-0.0	5.5	5.1	0.1	0.1	0.8
1965	0.2	0.1	0.1	-0.2	0.1	0.2	0.0	0.0	1.8	0.0	0.0	1.3	0.3
1966	1.3	-0.3	-0.1	0.1	0.1	0.0	0.0	0.0	2.6	2.6	0.1	0.1	0.5
1967	0.1	0.1	-0.6	0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1968	-0.0	0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	6.4	6.0	0.1	0.2	1.1
1969	0.2	0.1	0.1	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	5.8	4.4	0.1	0.1	1.1
1971	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.0	1.5	0.0	0.0	0.0	0.2
1972	0.0	0.8	-0.3	0.1	0.1	0.1	0.0	0.0	4.6	3.9	0.1	0.1	0.8
1973	0.1	0.1	-0.3	0.1	0.0	0.0	0.0	0.0	1.8	0.4	2.0	0.0	0.4
1974	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0	-0.1	-0.0	0.0	0.1
1975	0.0	0.3	0.0	-0.1	0.0	0.0	0.0	0.0	-0.0	0.8	-0.1	0.0	0.1
1976	-0.0	0.0	0.0	0.0	-0.0	5.1	0.1	0.1	9.8	0.3	0.2	0.2	1.4
1977	0.2	0.2	0.2	0.5	0.5	0.4	0.2	-0.6	0.1	0.1	0.1	0.1	0.2
1978	0.1	0.1	0.0	0.1	-0.2	-0.0	0.0	0.0	0.0	-0.0	-0.0	0.0	-0.0
1979	-0.0	0.0	0.0	0.0	1.0	-0.0	0.0	0.0	0.0	5.0	6.0	0.1	1.0
1980	0.1	0.1	-0.3	-0.0	0.0	0.0	0.0	0.0	1.6	2.2	0.0	0.1	0.3
1981	0.0	0.1	0.1	-0.6	0.1	0.1	0.0	0.0	1.9	2.2	0.1	0.1	0.4
1982	0.1	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0
1983	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
1984	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	8.3	4.4	2.4	0.2	2.0
1985	0.2	0.2	-0.2	0.3	-0.0	0.3	0.1	0.1	2.5	2.3	0.1	0.1	0.4
1986	0.1	0.1	0.1	-0.5	0.0	0.0	0.0	0.0	1.5	2.1	0.1	0.0	0.3
1987	0.0	0.1	0.0	0.1	-0.3	0.1	0.0	0.0	2.6	0.1	0.0	0.1	0.2
1988	0.1	0.1	0.0	-0.8	-0.9	0.3	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.2
1989	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0
1990	-0.0	-0.0	-0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1991	-0.0	-0.0	0.0	-0.0	-0.1	0.1	-0.0	-0.1	-0.1	-0.1	-0.0	-0.0	-0.0
1992	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	-0.0	-0.1	-0.0	-0.1	-0.1	-0.0	-0.0
1993	-0.0	-0.0	-0.0	-0.2	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
1994	-0.0	-0.0	-0.0	0.0	-0.2	-0.0	-0.0	-0.0	3.6	7.6	0.1	0.2	0.9
Minimum	-0.03	-0.32	-0.58	-0.94	-0.94	-0.07	-0.04	-0.60	-0.06	-0.07	-0.08	-0.03	-0.18
Average	0.07	0.05	-0.02	-0.03	-0.02	0.22	0.01	0.00	1.70	1.11	0.38	0.17	0.33
Maximum	1.26	0.79	0.36	0.86	0.97	5.14	0.19	0.11	9.83	7.56	5.98	2.35	1.96

Note: Difference is Proposed Project minus No-Project.

Table 4-23. Differences in Estimated THM Concentrations between Proposed Project and No-Project (µg/l)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Flow Weighted Average
1922	0.0	0.0	0.0	-1.2	-1.9	-0.1	0.0	0.1	-0.3	2.8	0.9	0.7	-0.06
1923	0.0	0.0	-2.3	0.0	-0.1	0.1	0.0	0.1	5.5	-0.0	5.5	0.1	0.57
1924	0.1	0.2	0.1	0.3	0.1	-0.6	-0.3	-0.5	-0.3	-0.6	-0.8	-0.2	0.02
1925	0.0	0.1	-0.5	0.3	-3.8	13.4	0.0	0.1	19.9	0.3	0.3	0.3	1.64
1926	0.5	0.5	0.3	0.5	-7.3	1.8	-0.0	-0.0	-0.1	-0.3	-0.1	-0.2	-0.73
1927	-0.0	-0.0	0.0	-10.7	-0.5	-0.3	-0.0	0.0	3.6	2.5	1.1	-0.0	-0.67
1928	0.0	-0.3	0.5	-7.1	-0.2	0.2	-0.1	-0.2	3.9	3.7	-0.1	-0.1	-0.22
1929	0.0	0.0	0.0	0.2	-0.0	-0.7	-0.2	-0.3	-0.3	-0.6	-0.7	-0.2	-0.09
1930	-0.0	-0.0	0.0	-7.2	-3.5	0.5	-0.5	-0.6	2.6	-0.5	-0.3	-0.4	-1.15
1931	-0.2	-0.2	-0.1	-0.1	-0.1	-1.7	-0.8	-0.7	-0.9	-1.1	-0.7	-0.4	-0.35
1932	-0.2	-0.2	-0.4	-5.0	-0.1	0.6	-0.1	-0.1	-0.3	-0.5	-0.3	-0.2	-1.05
1933	-0.1	-0.1	-0.0	-0.0	-0.2	0.1	-0.2	-0.3	-0.7	-0.9	-0.6	-0.2	-0.12
1934	-0.1	-0.0	0.0	0.1	-0.2	-1.1	-0.4	-0.8	-0.4	-0.9	-0.7	-0.3	-0.23
1935	-0.1	-0.1	-0.0	-0.0	-0.3	0.5	0.3	-0.1	-0.2	-0.2	-0.4	-0.3	-0.05
1936	-0.2	-0.2	-0.1	-0.1	-5.3	-0.4	-0.1	-0.0	8.2	6.0	0.1	0.1	0.43
1937	0.2	0.2	0.2	0.3	-5.5	0.0	0.0	0.0	9.2	8.9	0.2	0.2	0.68
1938	0.2	0.1	-2.8	0.2	0.0	0.0	0.0	0.0	-0.5	-0.1	-0.1	-0.1	-0.30
1939	-0.2	0.1	-0.2	0.0	-0.2	0.7	-0.0	-0.1	9.0	4.2	0.1	0.3	1.01
1940	0.4	0.5	0.5	0.4	-2.9	-0.2	0.0	0.0	11.3	0.1	10.1	0.2	1.49
1941	0.3	0.2	0.1	-1.9	-0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.2	-0.17
1942	0.0	0.1	-0.2	0.0	0.0	-0.2	0.2	0.0	-0.5	-0.1	-0.1	-0.1	-0.08
1943	-0.0	-0.4	-0.1	0.0	0.0	0.0	-0.0	0.0	20.0	15.5	0.4	0.4	2.69
1944	0.4	0.5	0.4	0.9	-4.8	-0.2	0.2	0.1	7.6	4.1	3.8	0.4	1.23
1945	0.5	0.3	0.2	0.5	-3.4	-0.5	0.0	0.0	6.6	1.7	5.7	0.1	0.79
1946	0.2	0.1	-2.7	0.2	-0.8	-0.9	0.1	0.1	4.9	-0.0	4.9	0.1	0.39
1947	0.2	0.2	0.1	0.4	0.4	0.2	-0.1	-0.2	-0.3	-0.3	-0.1	-0.1	0.08
1948	-0.0	0.0	0.1	-0.0	-0.3	0.2	-0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.03
1949	-0.0	-0.0	0.0	0.2	0.3	-0.1	-0.2	-0.3	5.7	-0.1	-0.2	-0.1	0.41
1950	-0.0	0.0	0.0	0.1	-4.6	2.6	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.34
1951	-0.1	-0.0	-4.6	-0.0	-0.0	-0.2	-0.0	-0.0	1.8	1.1	-0.0	2.9	-0.02
1952	0.0	0.0	-5.3	-0.1	-0.1	0.0	0.0	0.0	-0.4	-0.1	-0.1	-0.1	-0.61
1953	-0.0	-0.1	-0.5	-0.0	-0.1	-0.2	-0.0	0.0	6.9	11.8	0.1	0.2	1.79
1954	0.2	0.2	0.2	-12.8	-0.2	0.3	-0.0	-0.1	2.4	1.1	-0.1	3.6	-0.47
1955	0.0	0.0	-3.4	-3.8	-1.1	-2.5	-0.2	-0.2	4.3	-0.2	-0.2	-0.1	-0.86
1956	-0.0	0.0	-0.1	10.0	0.1	-0.0	0.1	0.2	0.6	-0.0	-0.0	-0.0	1.18
1957	-0.1	1.5	1.3	-0.1	-0.2	-0.1	-0.0	0.1	11.5	0.1	5.7	6.2	2.20
1958	0.2	0.2	-2.7	-3.6	-0.1	-0.1	0.0	0.0	-0.4	-0.1	-0.1	-0.0	-0.66
1959	-0.1	0.0	-0.0	-0.1	-0.1	1.2	-0.1	-0.1	11.8	7.7	0.1	0.2	1.36
1960	0.3	0.3	0.2	0.6	0.4	0.2	0.0	-0.0	0.0	-0.2	-0.1	-0.0	0.19
1961	0.1	0.1	0.1	0.2	-2.0	2.2	-0.2	-0.3	-0.1	-0.3	-0.1	-0.1	-0.07
1962	0.0	0.0	0.0	0.2	-3.0	-0.0	-0.0	-0.1	11.6	5.3	0.1	3.5	1.29
1963	0.1	0.1	-3.3	-2.7	0.1	0.5	0.1	-0.0	0.7	-0.1	0.2	0.1	-0.39
1964	0.8	-2.5	0.3	-0.1	-0.1	-0.4	-0.2	-0.3	9.0	8.0	0.1	0.1	0.77
1965	0.2	0.2	-0.0	-3.8	0.0	-0.1	0.1	0.1	3.2	0.0	0.0	2.8	0.06
1966	2.5	-3.1	-1.5	0.2	0.1	-0.2	0.0	-0.1	5.6	5.4	0.0	0.1	0.41
1967	0.2	0.1	-7.9	-0.1	-0.1	0.1	0.0	0.0	-0.6	-0.2	-0.1	-0.1	-0.81
1968	-0.1	-0.0	-0.4	-0.1	-0.0	-0.3	-0.1	-0.2	11.2	10.4	0.1	0.2	1.36
1969	0.3	0.2	0.1	-5.3	0.0	0.0	0.0	0.0	0.0	-0.1	-0.0	-0.0	-0.56
1970	-0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	9.5	7.9	0.2	0.3	1.46
1971	0.3	0.2	-1.2	0.4	-0.8	-0.3	0.1	0.1	2.8	0.0	0.0	0.0	0.12
1972	0.1	1.5	-1.3	0.7	-0.0	0.2	-0.1	-0.1	9.2	7.8	0.1	0.2	1.22
1973	0.3	0.1	-4.7	-0.2	0.0	0.1	0.0	0.0	4.9	1.0	4.4	0.0	0.33
1974	0.1	-3.1	-0.1	0.1	-0.0	0.1	0.0	0.1	3.0	-0.5	0.1	0.1	-0.04
1975	0.1	0.6	0.0	-1.2	-0.0	0.0	-0.1	-0.0	-0.5	1.6	-0.1	0.2	0.08
1976	-0.1	0.0	0.0	-0.1	-0.6	7.2	-0.1	-0.3	18.4	0.1	0.2	0.3	1.75
1977	0.4	0.5	0.5	1.2	0.2	-1.0	-0.2	-9.8	-0.6	-0.9	-0.6	-0.4	0.05
1978	-0.1	-0.1	-0.0	-0.2	-3.1	-0.9	0.0	0.0	-0.1	-0.3	-0.2	-0.1	-0.60
1979	-0.1	-0.1	-0.1	-0.1	11.6	-0.1	0.1	0.1	0.0	15.6	17.5	0.4	3.23
1980	0.4	0.4	-1.2	-1.2	0.0	0.0	0.1	0.0	4.0	4.9	0.0	0.0	0.42
1981	0.1	0.2	0.1	-11.1	-0.2	0.4	-0.1	-0.3	3.5	3.3	-0.1	-0.0	-0.29
1982	0.0	0.0	-2.1	-0.0	-0.0	0.0	0.0	0.0	-0.4	-0.2	-0.1	-0.1	-0.27
1983	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	-0.2	-0.08
1984	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	14.8	8.1	4.4	0.3	3.16
1985	0.4	0.2	-3.4	1.0	-2.9	1.1	0.0	-0.0	1.7	1.6	-0.0	0.0	-0.16
1986	0.1	0.1	0.1	-7.8	0.0	0.0	0.0	0.0	3.8	5.6	-0.0	0.0	-0.19
1987	0.0	0.1	0.1	0.2	-4.4	0.7	-0.3	-0.5	6.3	-0.2	-0.1	-0.1	0.10
1988	0.0	0.0	0.0	-10.3	-15.4	-8.1	-1.1	-1.4	-0.7	-0.8	-1.1	-0.8	-3.58
1989	-0.5	-0.4	-0.3	-0.3	-1.5	0.1	-0.4	-0.7	-0.5	-0.5	-0.3	-0.3	-0.33
1990	-0.2	-0.2	-0.1	-0.0	0.1	-0.1	-0.5	-0.7	-0.4	-0.6	-0.7	-0.3	-0.23
1991	-0.1	-0.1	-0.1	-0.7	-1.3	0.8	-0.4	-0.9	-1.1	-1.3	-0.9	-0.5	-0.14
1992	-0.2	-0.3	-0.2	-0.1	-0.1	0.8	-0.5	-1.0	-0.6	-1.0	-1.4	-0.6	-0.17
1993	-0.3	-0.3	-0.5	-2.8	-0.2	0.1	-0.0	0.0	-0.4	-0.2	-0.1	-0.1	-0.51
1994	-0.1	-0.1	-0.0	0.0	-2.0	-0.1	-0.3	-0.3	9.4	19.8	0.2	0.3	1.65
Minimum	-0.5	-3.1	-7.9	-12.8	-15.4	-8.1	-1.1	-9.8	-1.1	-1.3	-1.4	-0.8	-3.6
Average	0.1	-0.0	-0.7	-1.1	-1.0	0.2	-0.1	-0.3	3.8	2.2	0.8	0.3	0.28
Maximum	2.5	1.5	1.3	10.0	11.6	13.4	0.3	0.2	20.0	19.8	17.5	6.2	3.2

Note: Difference is Proposed Project minus No-Project.

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Table 4-24. Comparison between Delta Wetlands Project Impacts on Water Quality in the 1995 DEIR/EIS and the 2000 REIR/EIS

Impacts and Mitigation Measures of 1995 DEIR/EIS Alternatives 1 and 2	Comparison between 1995 DEIR/EIS and 2000 REIR/EIS
CHAPTER 3C. WATER QUALITY	
Impact C-1: Salinity (EC) Increase at Chipps Island during Months with Applicable EC Objectives (S) • **Mitigation Measure C-1:** Restrict DW Diversions to Limit EC Increases at Chipps Island (LTS)	**Salinity Increase at Chipps Island.** As a result of incorporating the FOC terms into proposed project operations, estimated project effects on EC concentrations at Chipps Island are less than those reported in the 1995 DEIR/EIS. Simulated changes in EC concentrations do not exceed the significance criteria. Therefore, this impact is considered less than significant, and no mitigation is required. (LTS)
Impact C-2: Salinity (EC) Increase at Emmaton during April-August (S) • **Mitigation Measure C-2:** Restrict DW Diversions to Limit EC Increases at Emmaton (LTS) **Impact C-3:** Salinity (EC) Increase at Jersey Point during April-August (S) • **Mitigation Measure C-3:** Restrict DW Diversions to Limit EC Increases at Jersey Point (LTS)	**Salinity Increase at Emmaton and Jersey Point.** Estimated effects of project diversions on EC at these locations are less than those reported in the 1995 DEIR/EIS. The EC significance criterion of a 20% change from No-Project Alternative conditions would still be exceeded; such exceedances would be infrequent. As reported in the 1995 DEIR/EIS, this impact is considered significant. (S) The same mitigation is recommended to reduce this impact to a less-than-significant level. (LTS)
Impact C-4: Salinity (Chloride) Increase in Delta Exports (S) • **Mitigation Measure C-4:** Restrict DW Diversions or Discharges to Limit Chloride Concentrations in Delta Exports (LTS)	**Salinity Increase in Delta Exports.** As a result of incorporating the FOC terms into proposed project operations, estimated project effects on EC concentrations at these locations are less than those reported in the 1995 DEIR/EIS. Simulated changes in EC concentrations do not exceed the significance criteria. Therefore, this impact is considered less than significant, and no mitigation is required. (LTS)

Note: S = Significant; SU = Significant and unavoidable; LTS = Less than significant; B = Beneficial.

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Table 4-24. Continued

Impacts and Mitigation Measures of 1995 DEIR/EIS Alternatives 1 and 2	Comparison between 1995 DEIR/EIS and 2000 REIR/EIS
Impact C-5: Elevated DOC Concentrations in Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) (S) • **Mitigation Measure C-5:** Restrict DW Discharges to Prevent DOC Increases of Greater Than 0.8 mg/l in Delta Exports (LTS)	**Increases in DOC Concentrations in Delta Exports.** Changes in DOC concentrations of greater than 0.8 mg/l were simulated under the initial-fill and long-term DOC loading assumptions. As reported in the 1995 DEIR/EIS, this impact is considered significant. (S) The same mitigation is recommended to reduce the impact to a less-than-significant level. (LTS)
Impact C-6: Elevated THM Concentrations in Treated Drinking Water from Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) (S) • **Mitigation Measure C-6:** Restrict DW Discharges to Prevent Increases of More Than 20 μg/l in THM Concentrations or THM Concentrations of Greater than 90 μg/l in Treated Delta Export Water (LTS)	**Increase in THM Concentrations in Treated Drinking Water.** Where project operations were simulated to result in monthly increases of THM concentrations in treated water, the increases were almost always less than the criterion of 16 μg/l. These results are similar to those predicted in the 1995 DEIR/EIS in which the largest monthly increase was less than the previous criterion of 20 μg/l. Effects on THM concentrations are considered a significant impact because the 20% change threshold would be exceeded in some months. (S) The mitigation measure has been revised to reflect the new standards for THM. Implementation would be the same as described in the 1995 DEIR/EIS except for the difference in the numerical thresholds: • Restrict Delta Wetlands Discharges to Prevent Increases of More Than 16 μg/l in THM Concentrations or THM Concentrations of Greater than 72 μg/l in Treated Delta Export Water (LTS)
Impact C-7: Changes in Other Water Quality Variables in Delta Channel Receiving Waters (S) • **Mitigation Measure C-7:** Restrict DW Discharges to Prevent Adverse Changes in Delta Channel Water Quality (LTS)	These effects were not reassessed in the REIR/EIS. Project effects on temperature and dissolved oxygen have been addressed through the Endangered Species Act consultation process, and no new information on other variables (e.g., suspended sediment and chlorophyll) has been presented.

Note: S = Significant; SU = Significant and unavoidable; LTS = Less than significant; B = Beneficial.

Table 4-24. Continued

Impacts and Mitigation Measures of 1995 DEIR/EIS Alternatives 1 and 2	Comparison between 1995 DEIR/EIS and 2000 REIR/EIS
Impact C-8: Potential Contamination of Stored Water by Pollutant Residues (S) • **Mitigation Measure C-8:** Conduct Assessments of Potential Contamination Sites and Rededicate as Necessary (LTS)	This potential project effect was not reassessed in the REIR/EIS. The impact and mitigation remain the same as presented in the 1995 DEIR/EIS.
Cumulative Impacts	
Impact C-17: Salinity (EC) Increase at Chipps Island during Months with Applicable EC Objectives under Cumulative Conditions (S) • **Mitigation Measure C-1:** Restrict DW Diversions to Limit EC Increases at Chipps Island (LTS) **Impact C-18:** Salinity (EC) Increase at Emmaton during April-August under Cumulative Conditions (S) • **Mitigation Measure C-2:** Restrict DW Diversions to Limit EC Increases at Emmaton (LTS) **Impact C-19:** Salinity (EC) Increase at Jersey Point during April-August under Cumulative Conditions (S) • **Mitigation Measure C-3:** Restrict DW Diversions to Limit EC Increases at Jersey Point (LTS) **Impact C-20:** Salinity (Chloride) Increase in Delta Exports under Cumulative Conditions (S) • **Mitigation Measure C-4:** Restrict DW Diversions or Discharges to Limit Chloride Concentrations in Delta Exports (LTS)	**Increase in Salinity under Cumulative Conditions.** The proposed project would be operated in fewer years under cumulative conditions than under existing conditions because of limited availability of water for Delta Wetlands diversions. However, it is assumed under the cumulative future scenario that export pumping capacity at Banks Pumping Plant would be greater. Therefore, simulated exports are greater in several years than under the proposed project. Changes in water quality conditions under cumulative future conditions would be similar to those described for the proposed project and therefore would be smaller than the changes described for cumulative conditions in the 1995 DEIR/EIS. Changes in project operations resulting from the FOC terms reduce the impact on salinity at Chipps Island and in Delta exports to less-than-significant levels. (LTS) Effects on EC at Emmaton and Jersey Point are still considered a significant impact. (S) The same mitigation is recommended to reduce these impacts to less-than-significant levels. (LTS)

Note: S = Significant; SU = Significant and unavoidable; LTS = Less than significant; B = Beneficial.

Table 4-24. Continued

Impacts and Mitigation Measures of 1995 DEIR/EIS Alternatives 1 and 2	Comparison between 1995 DEIR/EIS and 2000 REIR/EIS
Impact C-21: Elevated DOC Concentrations in Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) under Cumulative Conditions (S)	**Increase in DOC Concentrations in Delta Exports under Cumulative Conditions.** Because DOC loads are proportional to period of storage, it is possible that DOC loads under cumulative conditions could be somewhat less than for the proposed project because greater export pumping capacity would provide more frequent opportunities for discharge of Delta Wetlands Project water. However, as reported in the 1995 DEIR/EIS, the significance criteria would be exceeded in some years, so the impact is considered significant. (S)
• **Mitigation Measure C-5:** Restrict DW Discharges to Prevent DOC Increases of Greater Than 0.8 mg/l in Delta Exports (LTS)	The same mitigation is recommended to reduce the impact to a less-than-significant level. (LTS)
Impact C-22: Elevated THM Concentrations in Treated Drinking Water from Delta Exports (CCWD Rock Slough, SWP Banks, CVP Tracy) under Cumulative Conditions (S) • **Mitigation Measure C-6:** Restrict DW Discharges to Prevent Increases of More Than 20 μg/l in THM Concentrations or THM Concentrations of Greater than 90 μg/l in Treated Delta Export Water (LTS)	**Increase in THM Concentrations in Treated Drinking Water under Cumulative Conditions.** Changes would be similar to those described for the proposed project. Because DOC loads are proportional to period of storage, it is possible that DOC loads under cumulative conditions could be somewhat less than for the proposed project and that changes in THM concentrations in treated water would be less than for the proposed project. However, the impact is significant. (S) • Restrict Delta Wetlands Discharges to Prevent Increases of More Than 16 μg/l in THM Concentrations or THM Concentrations of Greater than 72 μg/l in Treated Delta Export Water (LTS)
Impact C-23: Changes in Other Water Quality Variables in Delta Channel Receiving Waters under Cumulative Conditions (S) • **Mitigation Measure C-7:** Restrict DW Discharges to Prevent Adverse Changes in Delta Channel Water Quality (LTS)	See discussion of Impact C-7 above.

Note: S = Significant; SU = Significant and unavoidable; LTS = Less than significant; B = Beneficial.

Table 4-24. Continued

Impacts and Mitigation Measures of 1995 DEIR/EIS Alternatives 1 and 2	Comparison between 1995 DEIR/EIS and 2000 REIR/EIS
Impact C-24: Increase in Pollutant Loading in Delta Channels (SU) • **Mitigation Measure C-9:** Clearly Post Waste Discharge Requirements, Provide Waste Collection Facilities, and Educate Recreationists regarding Illegal Discharges of Waste (SU)	No change from 1995 DEIR/EIS.

Notes:

Impacts C-9 through C-16 of the 1995 DEIR/EIS describe impacts of Alternative 3, the four-reservoir-island alternative. There is no change to the assessment of Alternative 3; therefore, the impacts and mitigation measures have not changed.

S = Significant; SU = Significant and unavoidable; LTS = Less than significant; B = Beneficial.

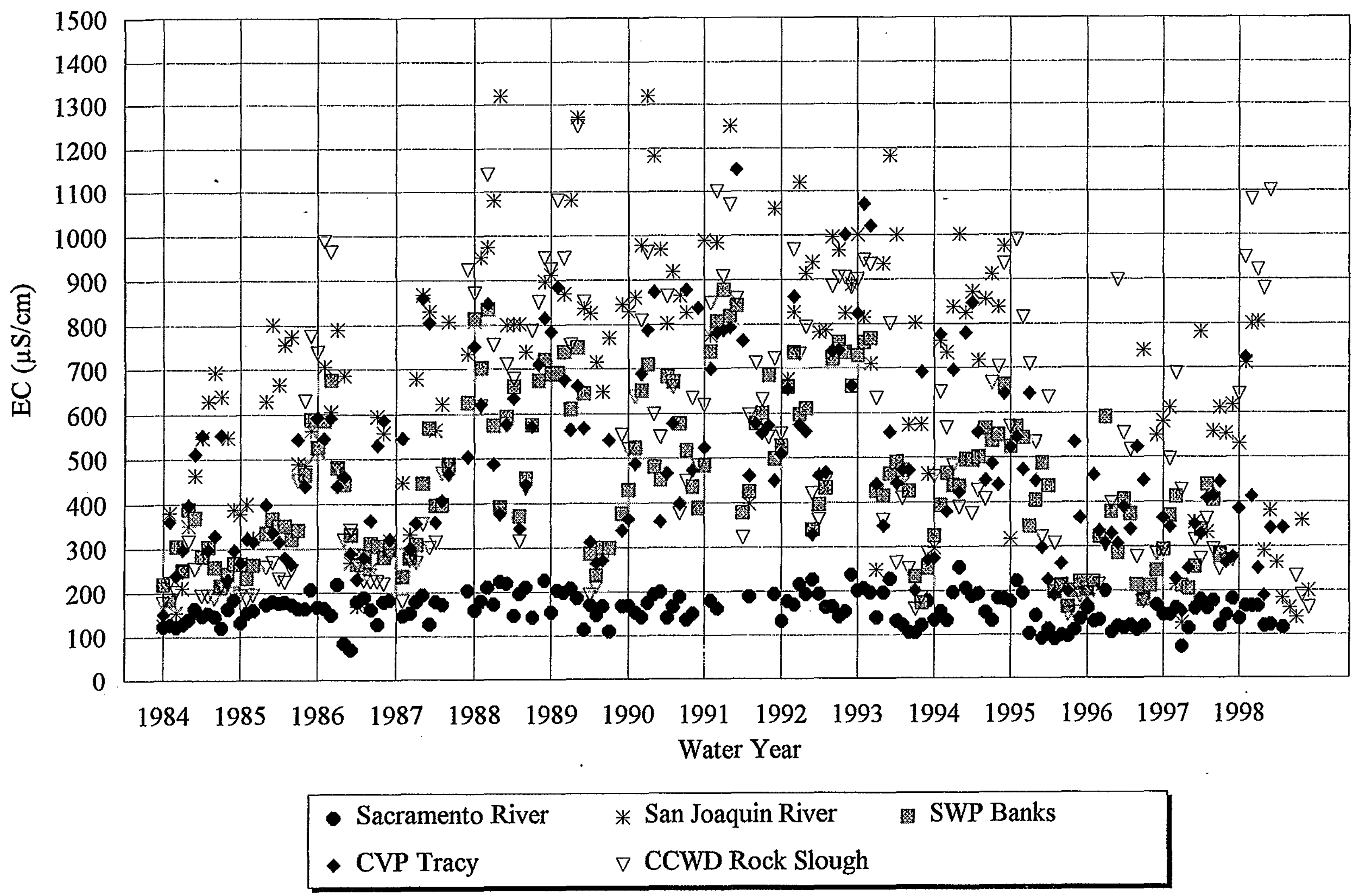

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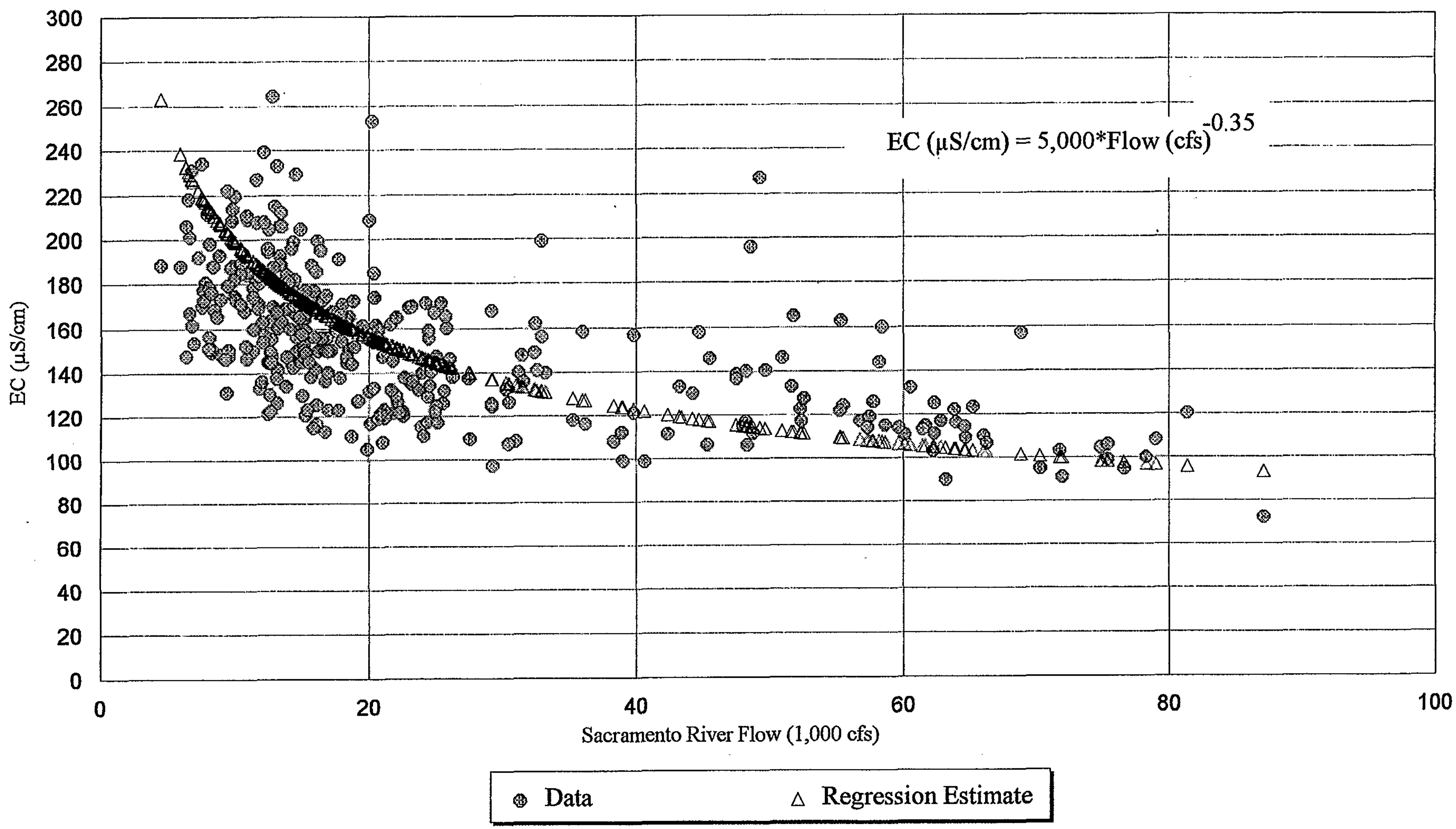
Figure 4-1
1984-1998 MWQI Monthly EC Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

C-062805



C-062805

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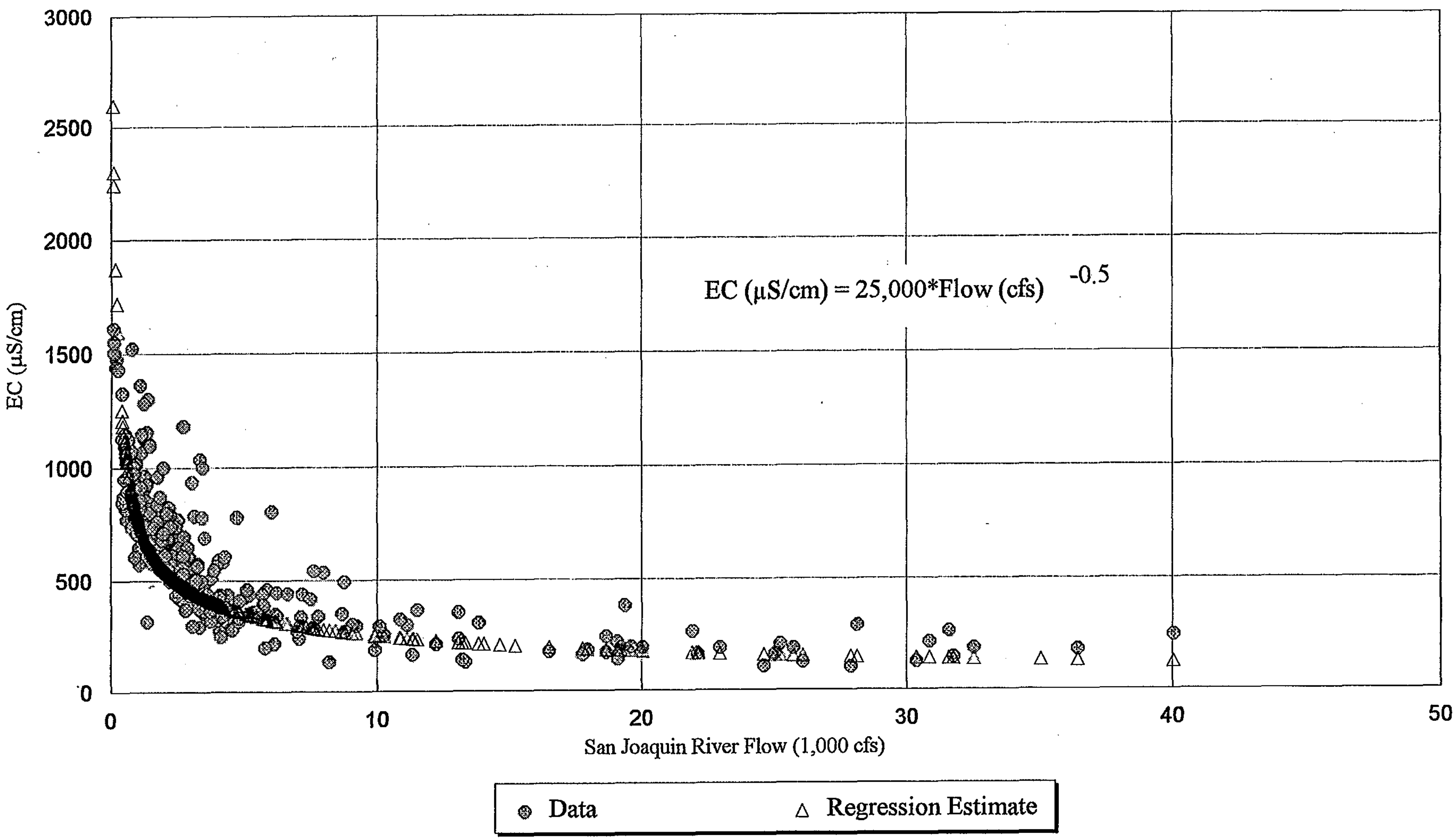
Figure 4-2
Relationship between Measured Mean Monthly EC at Greene's Landing and Sacramento River Flow for 1968-1998



C-062806

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Figure 4-3
Relationship between Measured Mean Monthly EC at Vernalis and San Joaquin River Flow for 1968-1998

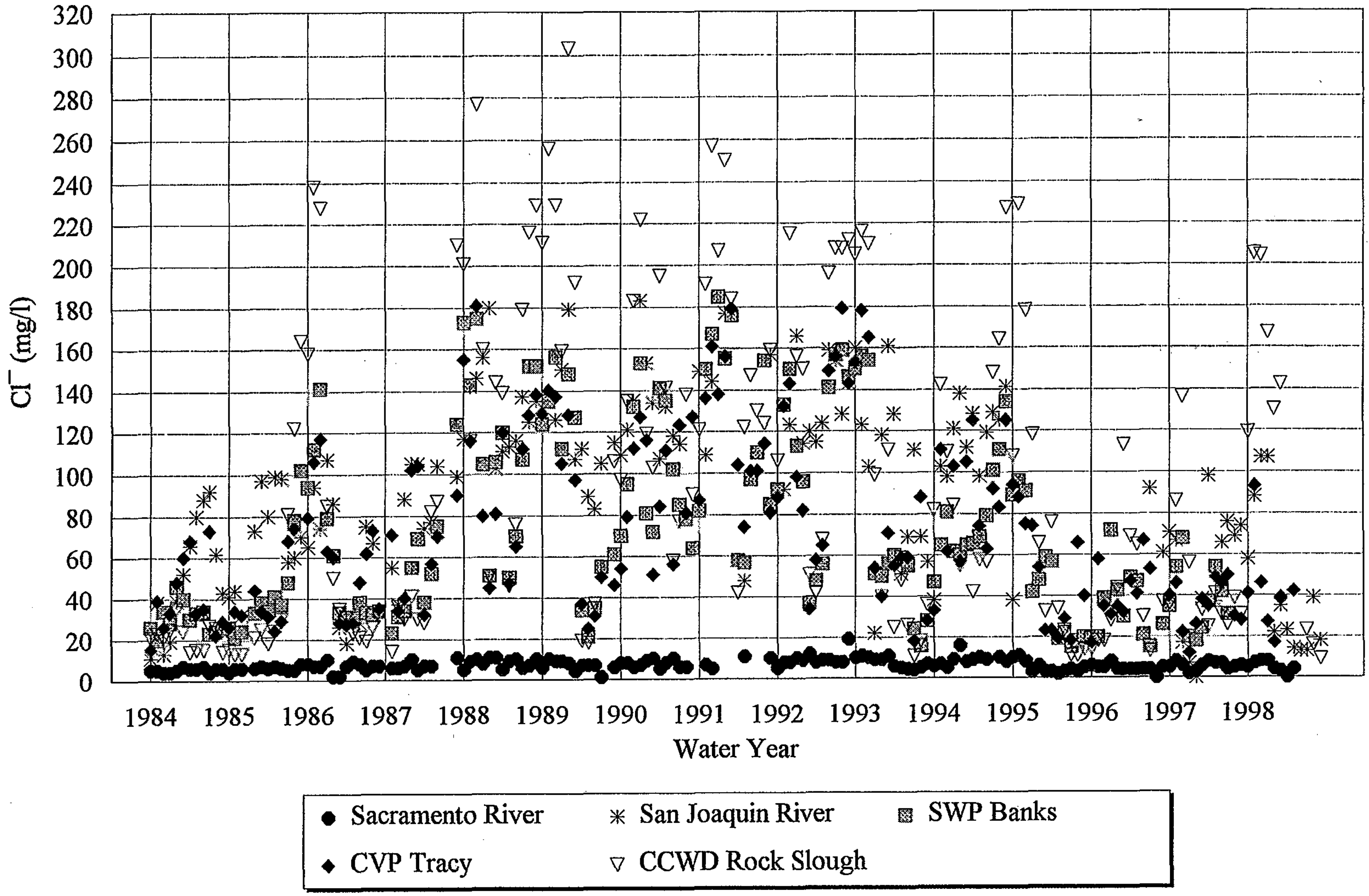

Figure 4-4
1984-1998 MWQI Monthly Cl^- Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

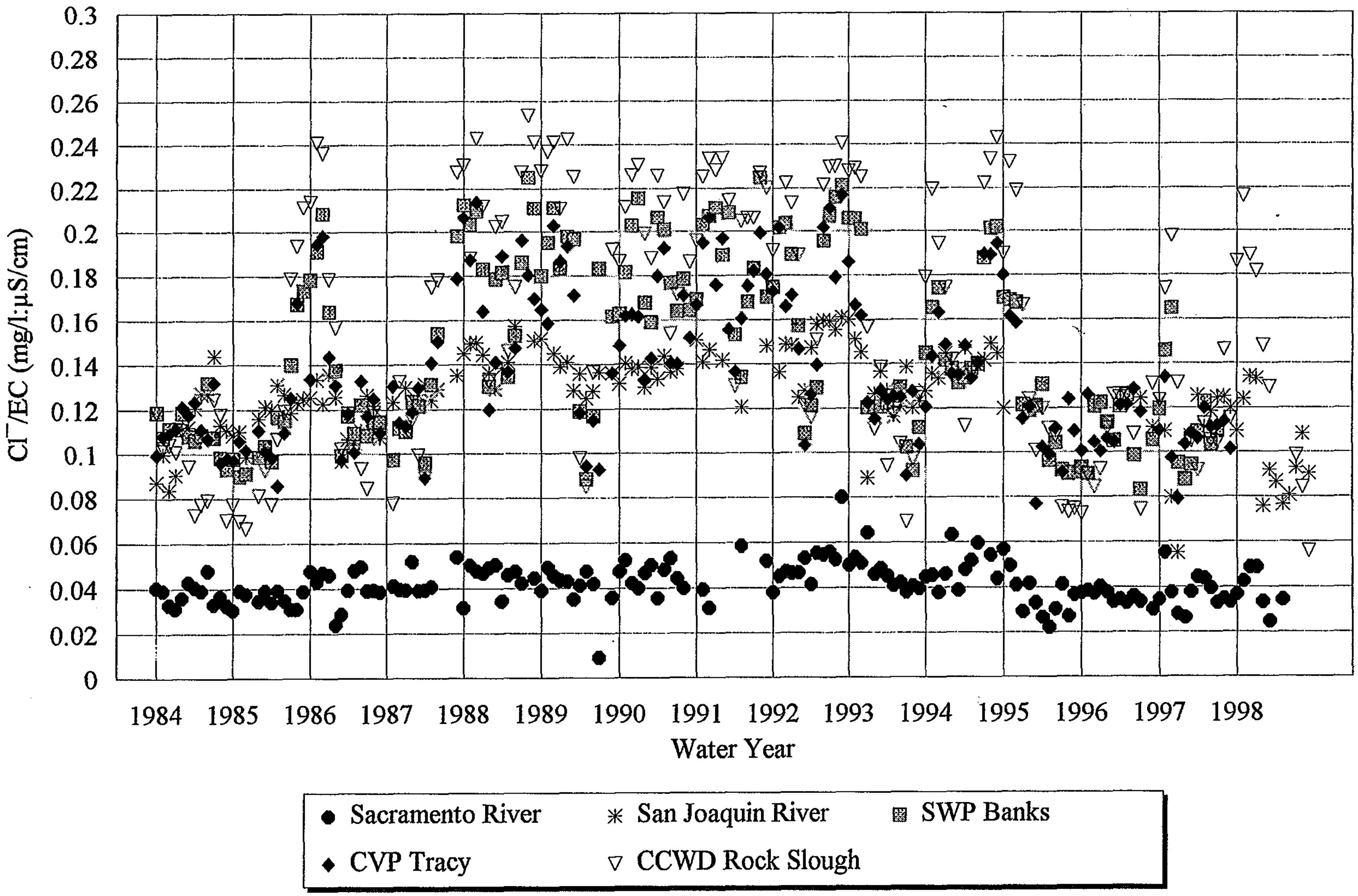

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Figure 4-5
1984-1998 MWQI Monthly Cl⁻ :EC Ratio Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

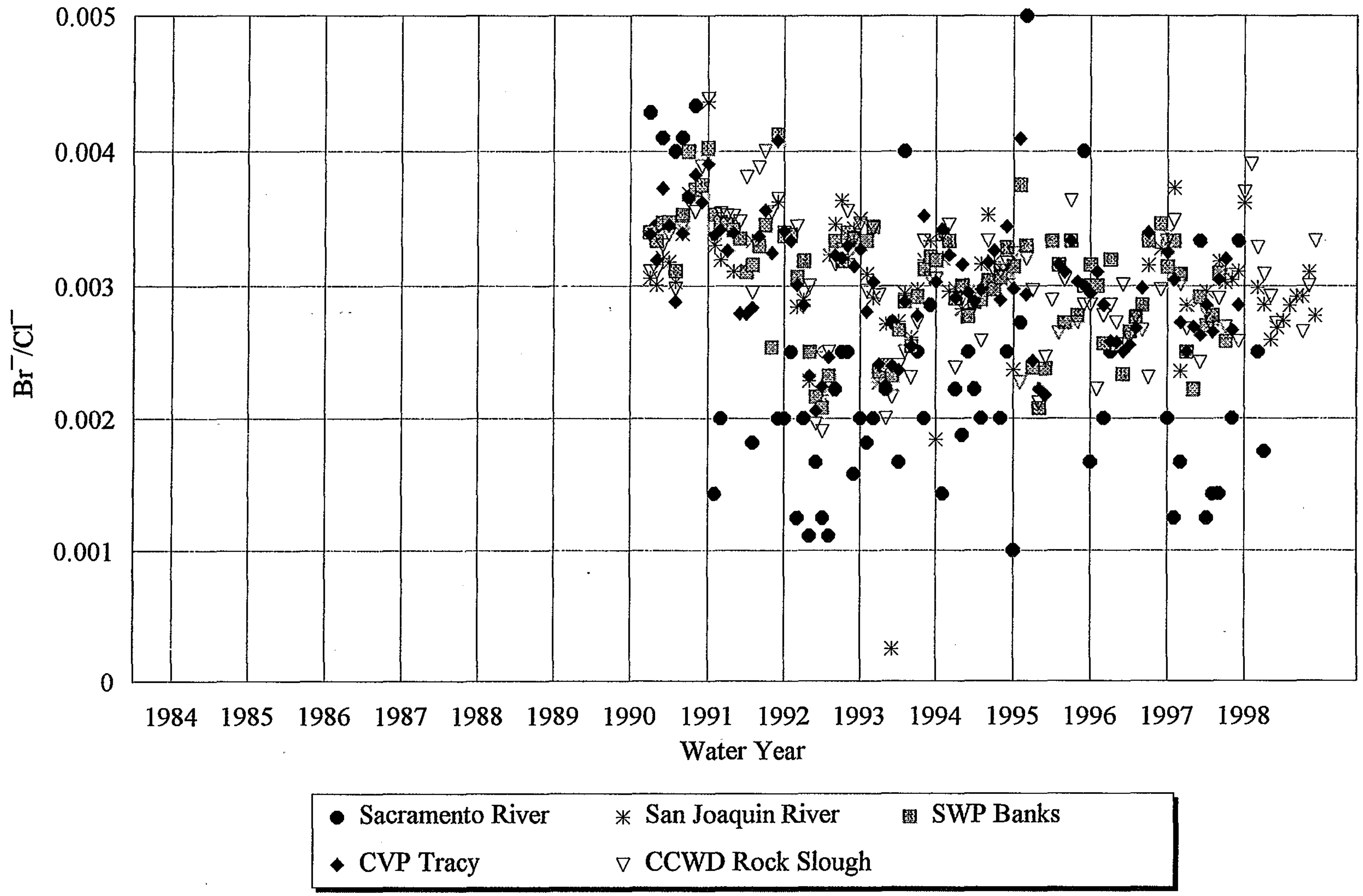

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Figure 4-6
1984-1998 MWQI Monthly Br^-:Cl^- Ratio Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

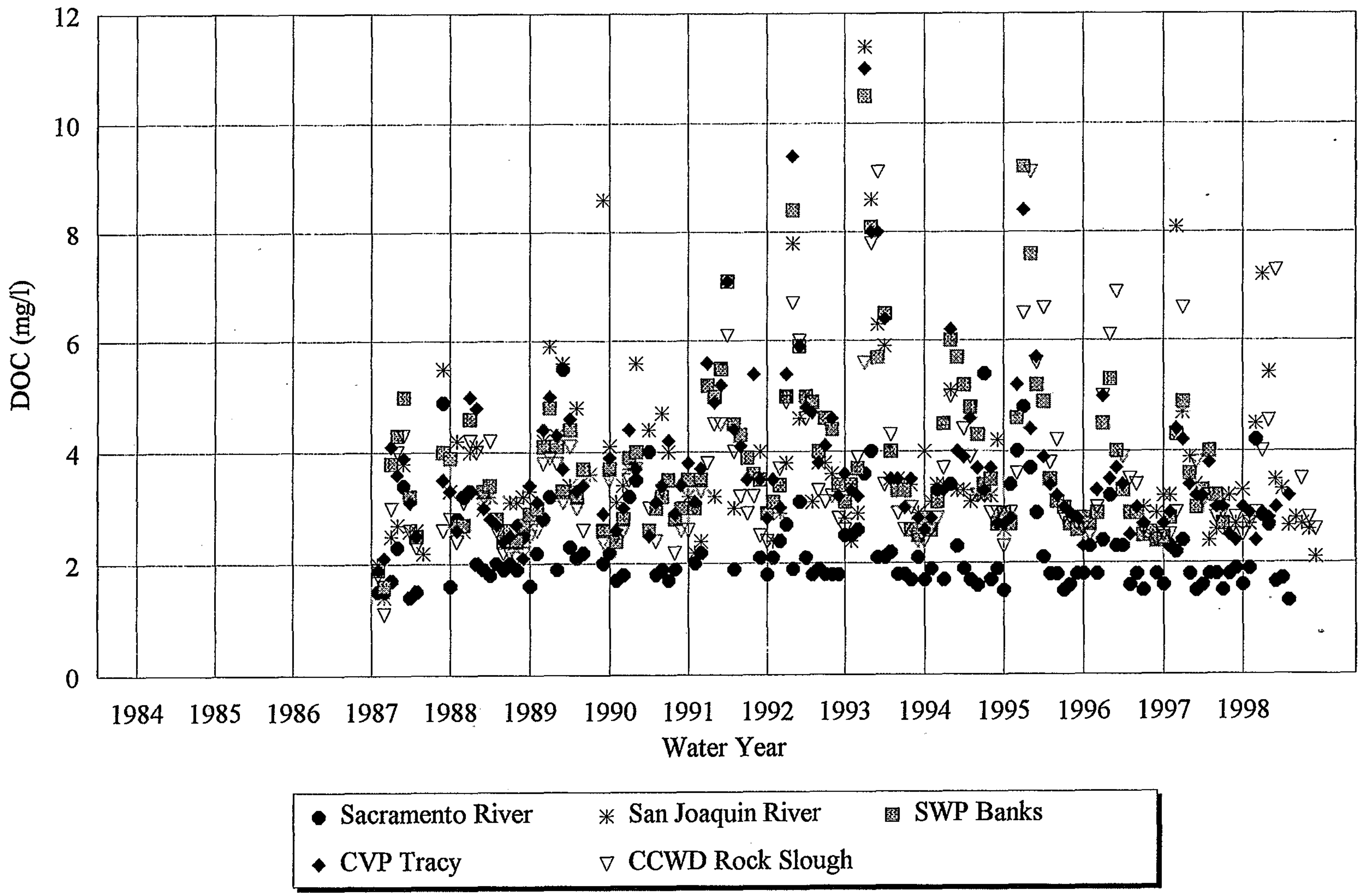

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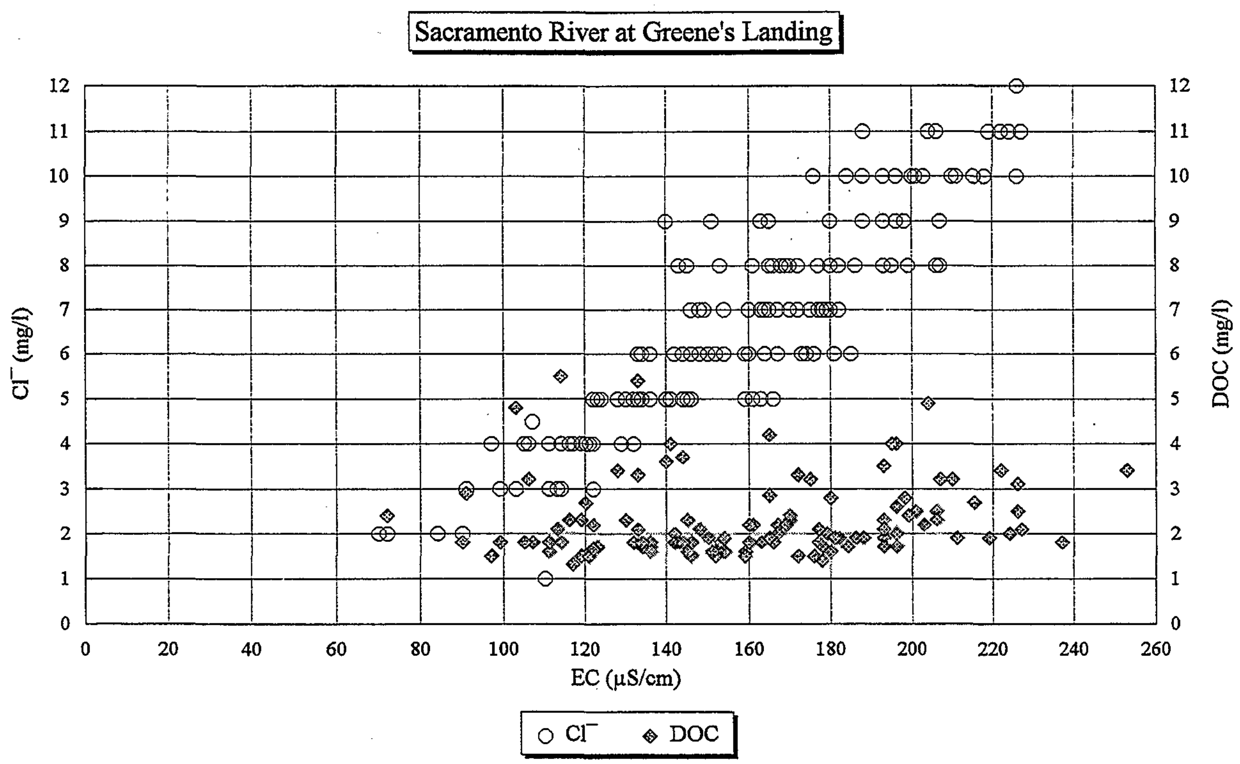
Figure 4-7
1984-1998 MWQI Monthly DOC Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations



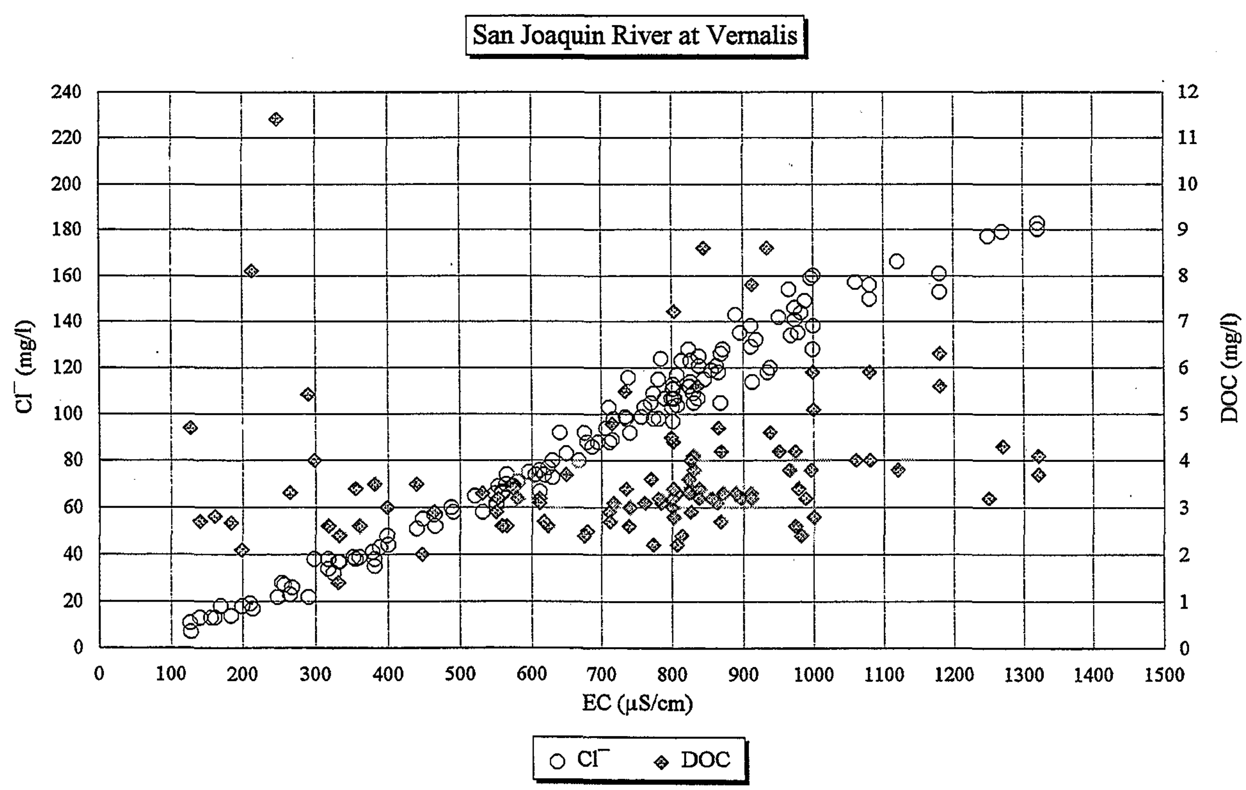


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Figure 4-8
DOC and Cl^- Compared to EC Values in 1984-1998 Monthly Sacramento and San Joaquin River Samples

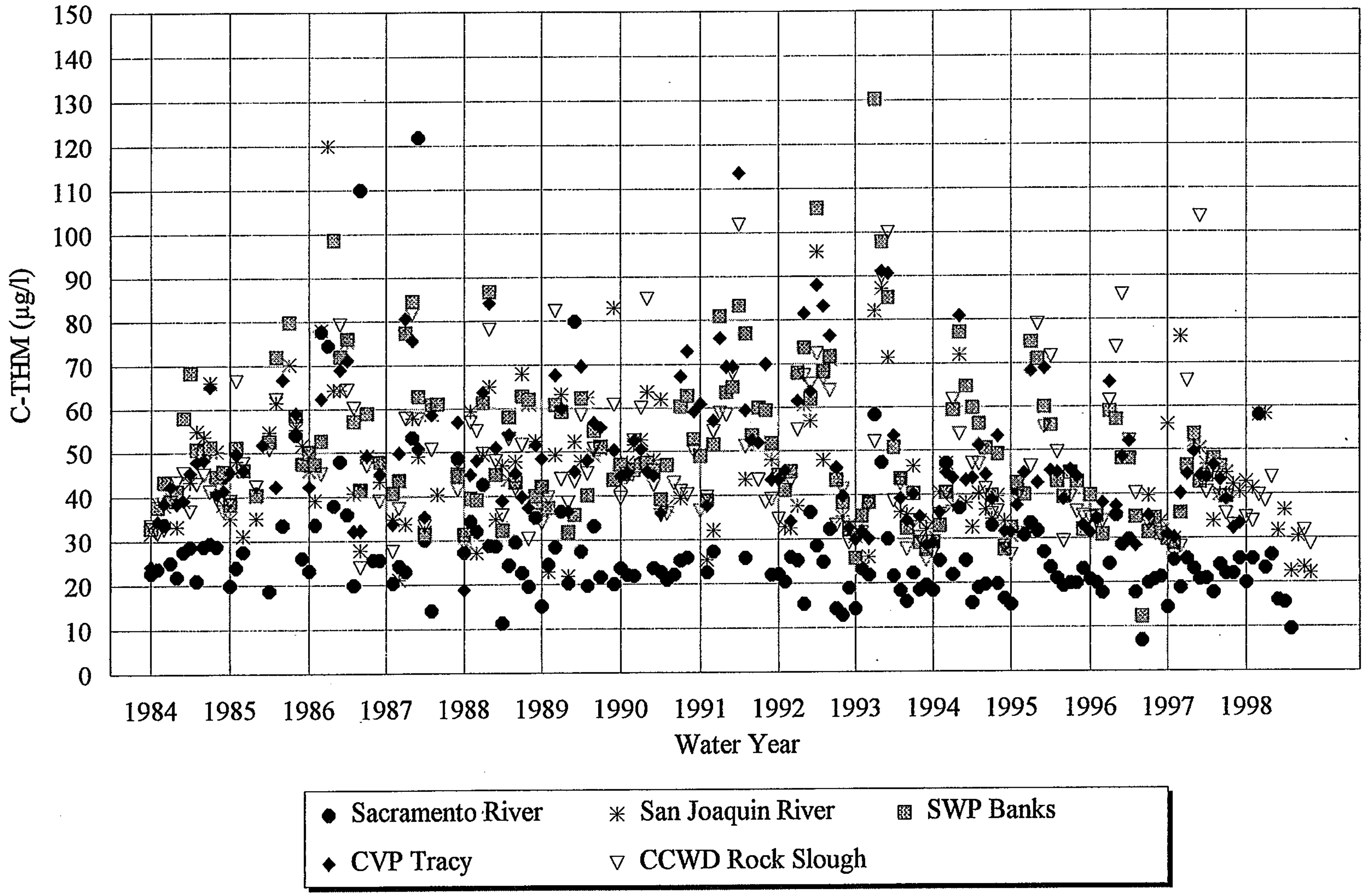

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Figure 4-9
1984-1998 MWQI Monthly C-THM Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

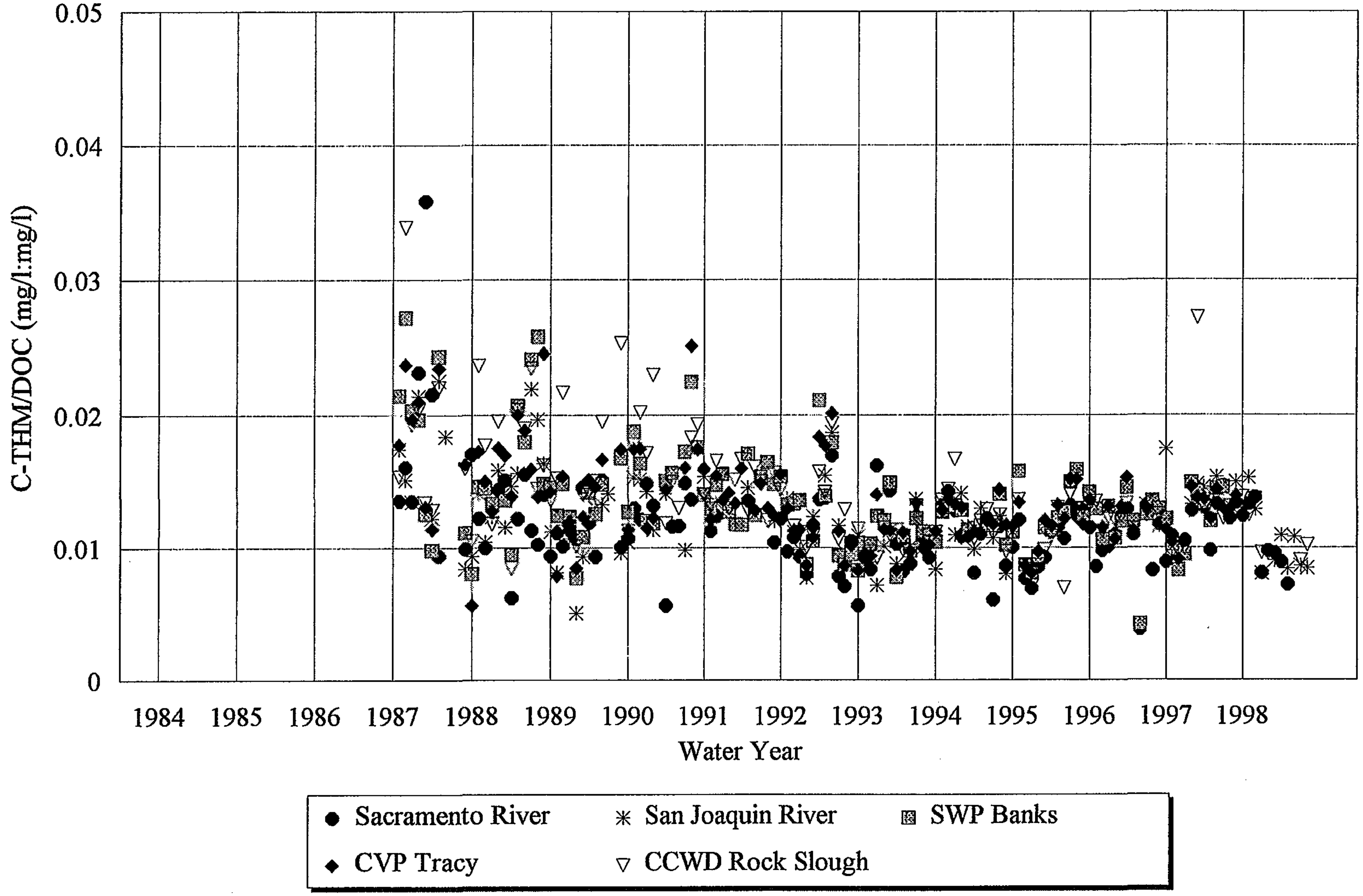

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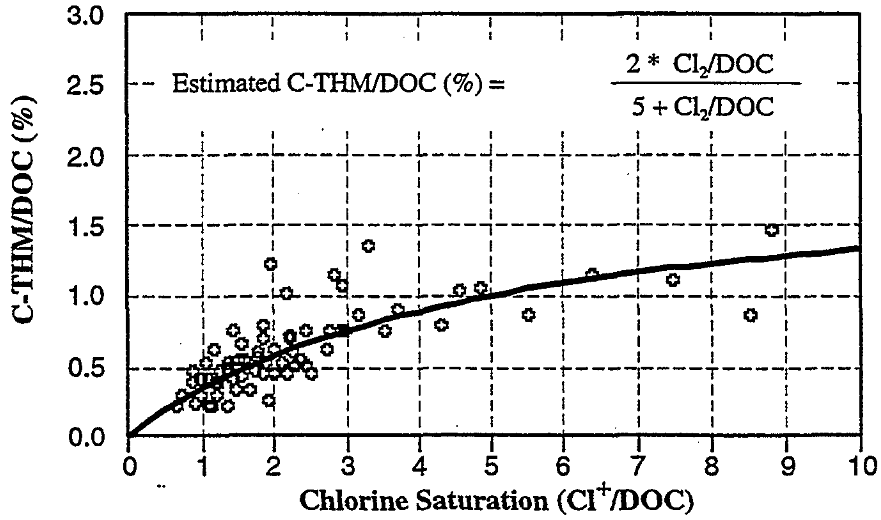
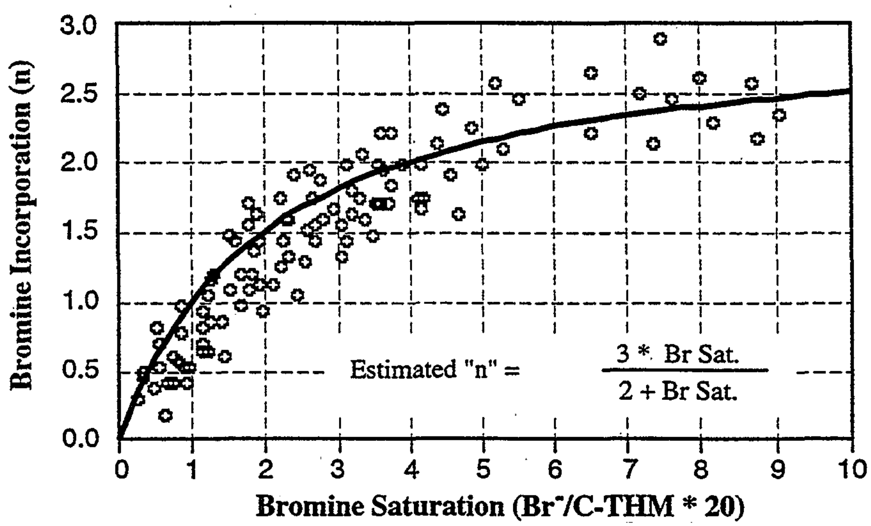
Figure 4-10
1984-1998 MWQI Monthly C-THM:DOC Ratio Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

Step 1: From measured DOC and chlorine dose, estimate the THM yield (the fraction of DOC that will become C-THM):



Step 2: From calculated bromide (chloride * 0.0035) and estimated C-THM, estimate bromine saturation and bromine incorporation (n):



Step 3: Estimate the THM molar weight and the distribution of THM species as a function of "n":

THM (Molar Weight) = 119 + 44.5 * n

$$CHCl_3 = (1 - \frac{1}{3}n)^3 = 1 - n + \frac{1}{3}n^2 - \frac{1}{27}n^3$$

$$CHCl_2Br = 3 * (1 - \frac{1}{3}n)^2 * \frac{1}{3}n = n - \frac{2}{3}n^2 + \frac{1}{9}n^3$$

$$CHClBr_2 = 3 * (1 - \frac{1}{3}n) * (\frac{1}{3}n)^2 = \frac{1}{3}n^2 - \frac{1}{9}n^3$$

$$CHBr_3 = (\frac{1}{3}n)^3 = \frac{1}{27}n^3$$

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Figure 4-11
General THM Prediction Model

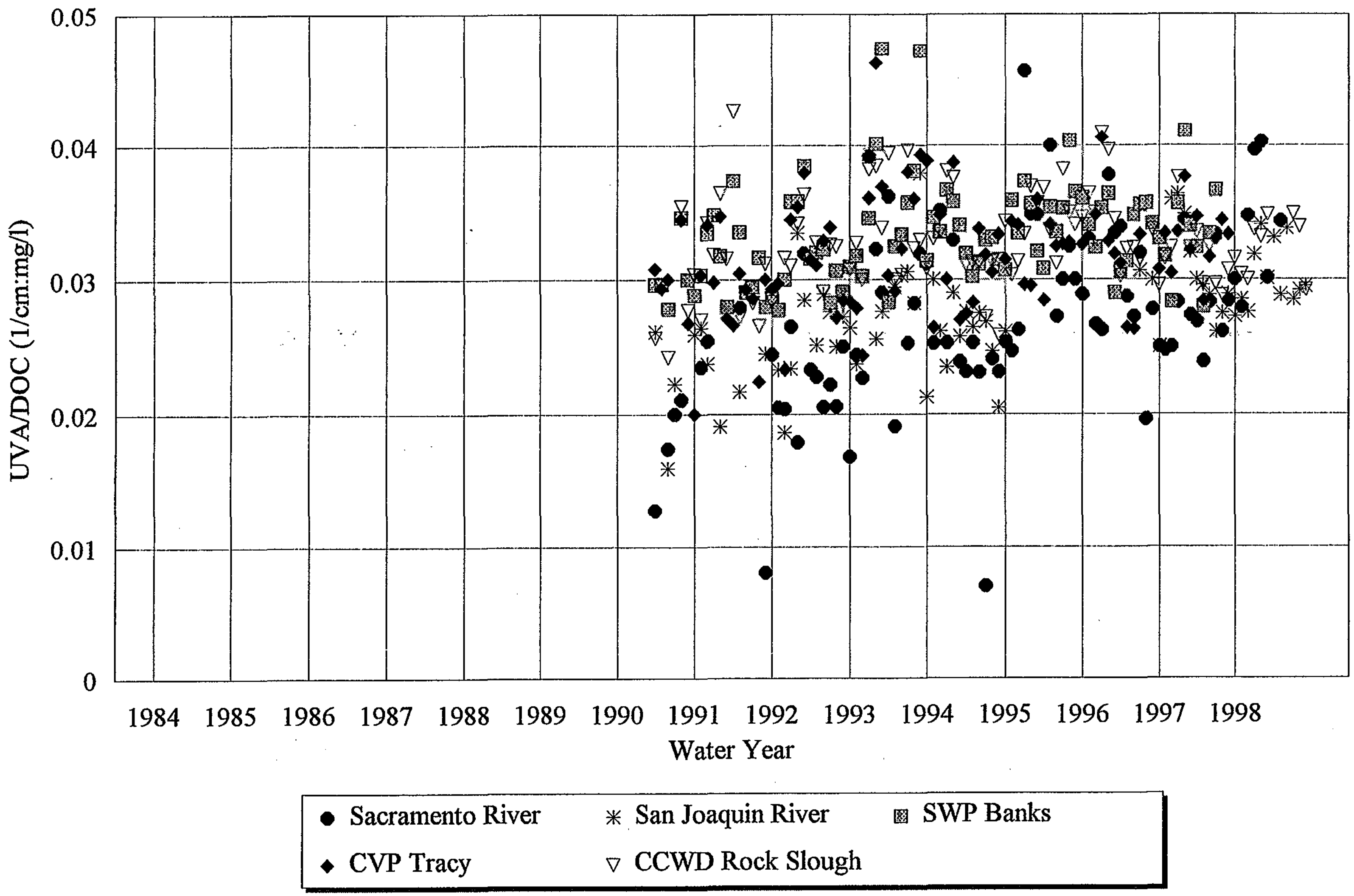

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Figure 4-12
1984-1998 MWQI Monthly UVA:DOC Ratio Values from the Sacramento and San Joaquin Rivers and at Delta Export Locations

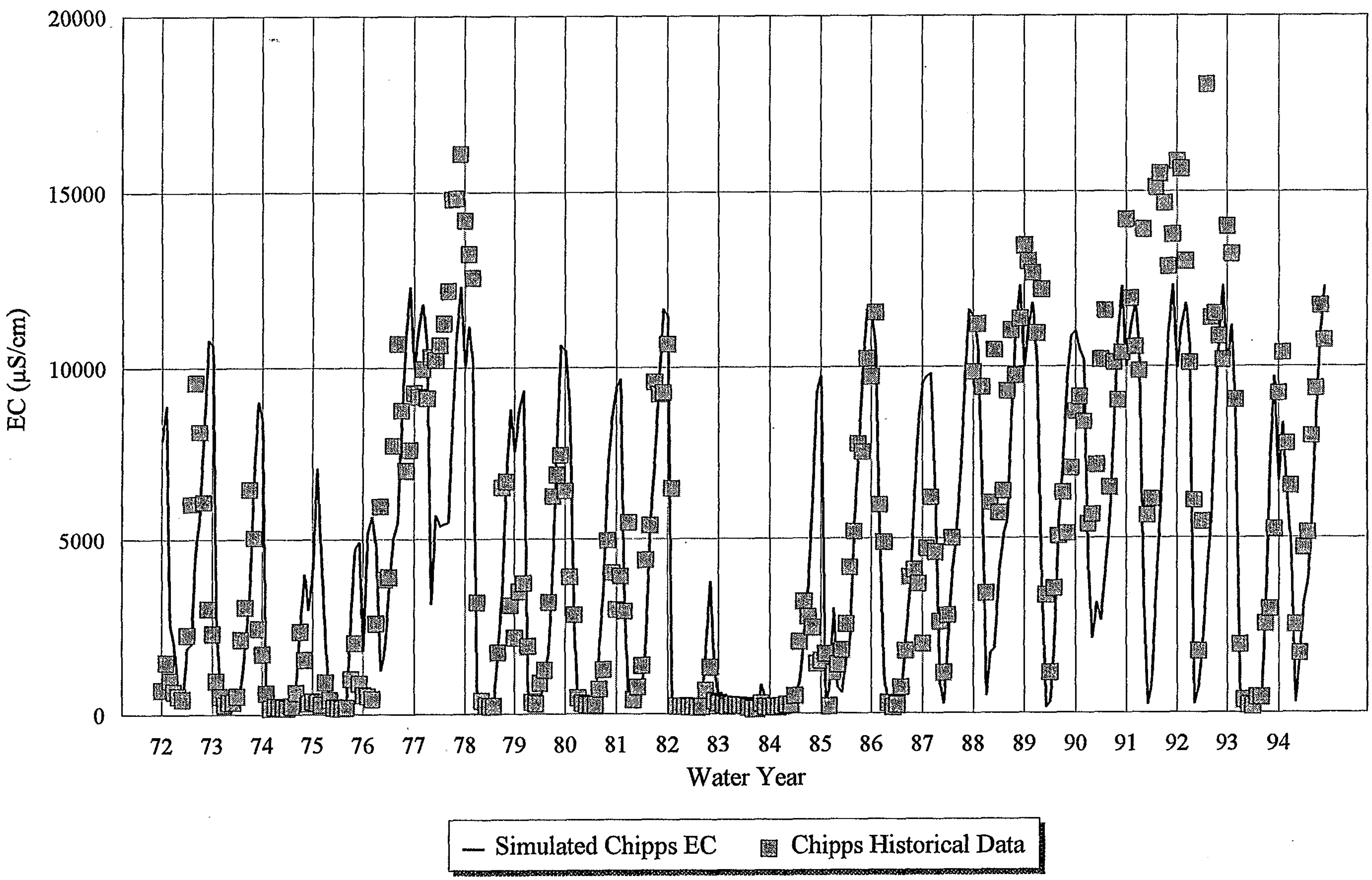

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Figure 4-13
Simulated No-Project Chipps Island EC Compared to Historical EC Data

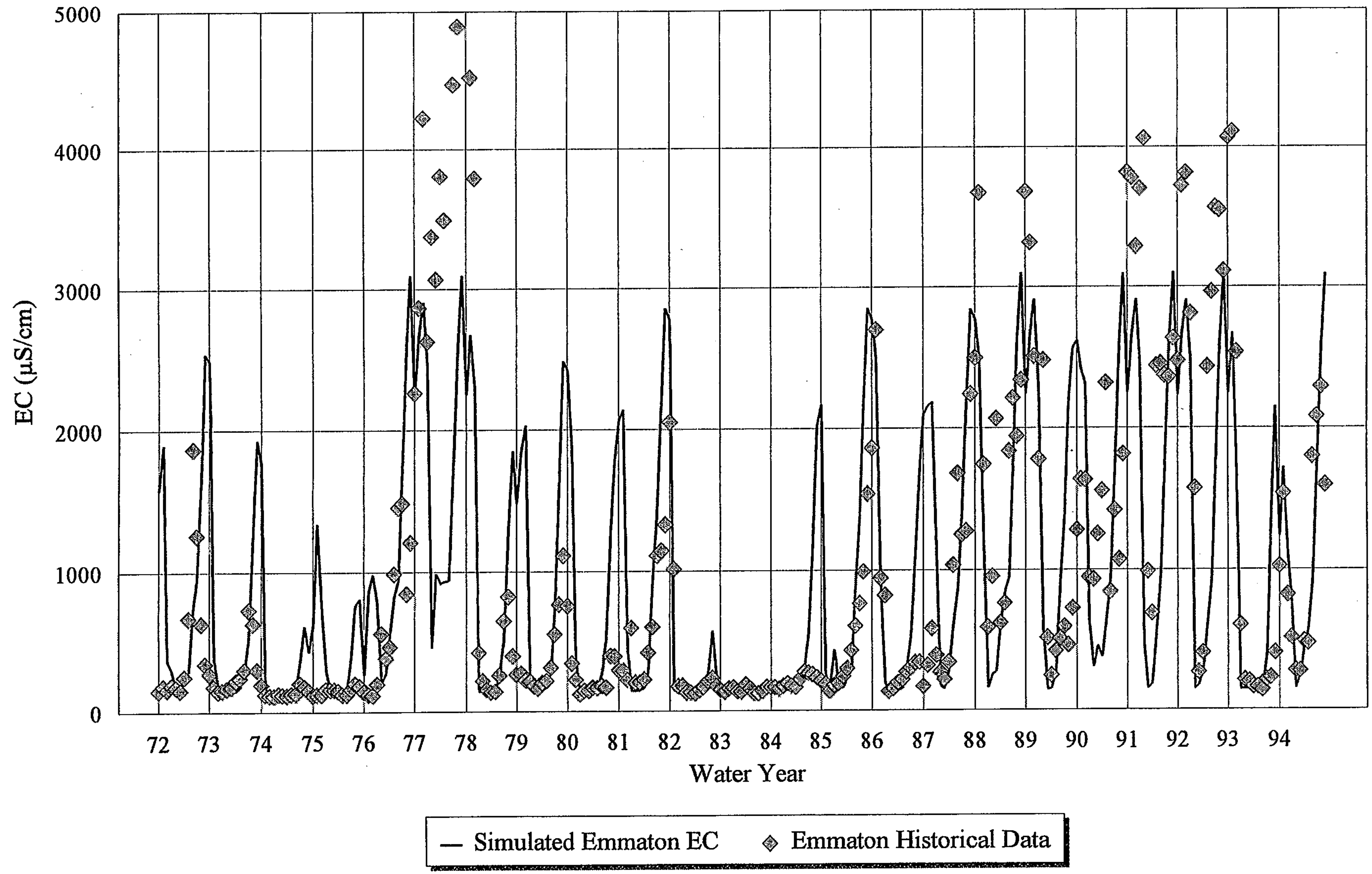

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Figure 4-14
Simulated No-Project Emmaton EC Compared to Historical EC Data

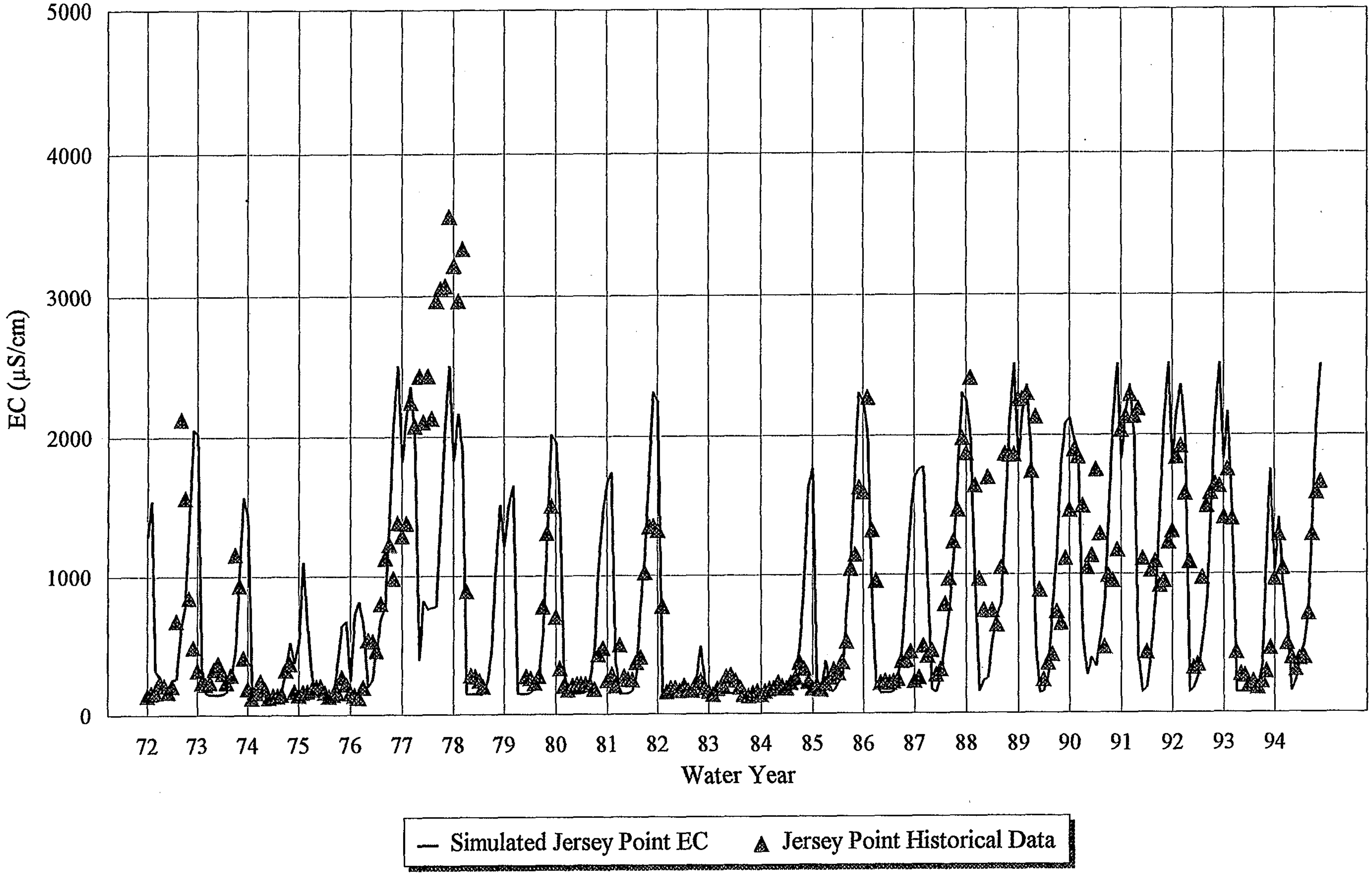

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Figure 4-15
Simulated No-Project Jersey Point EC Compared to Historical EC Data

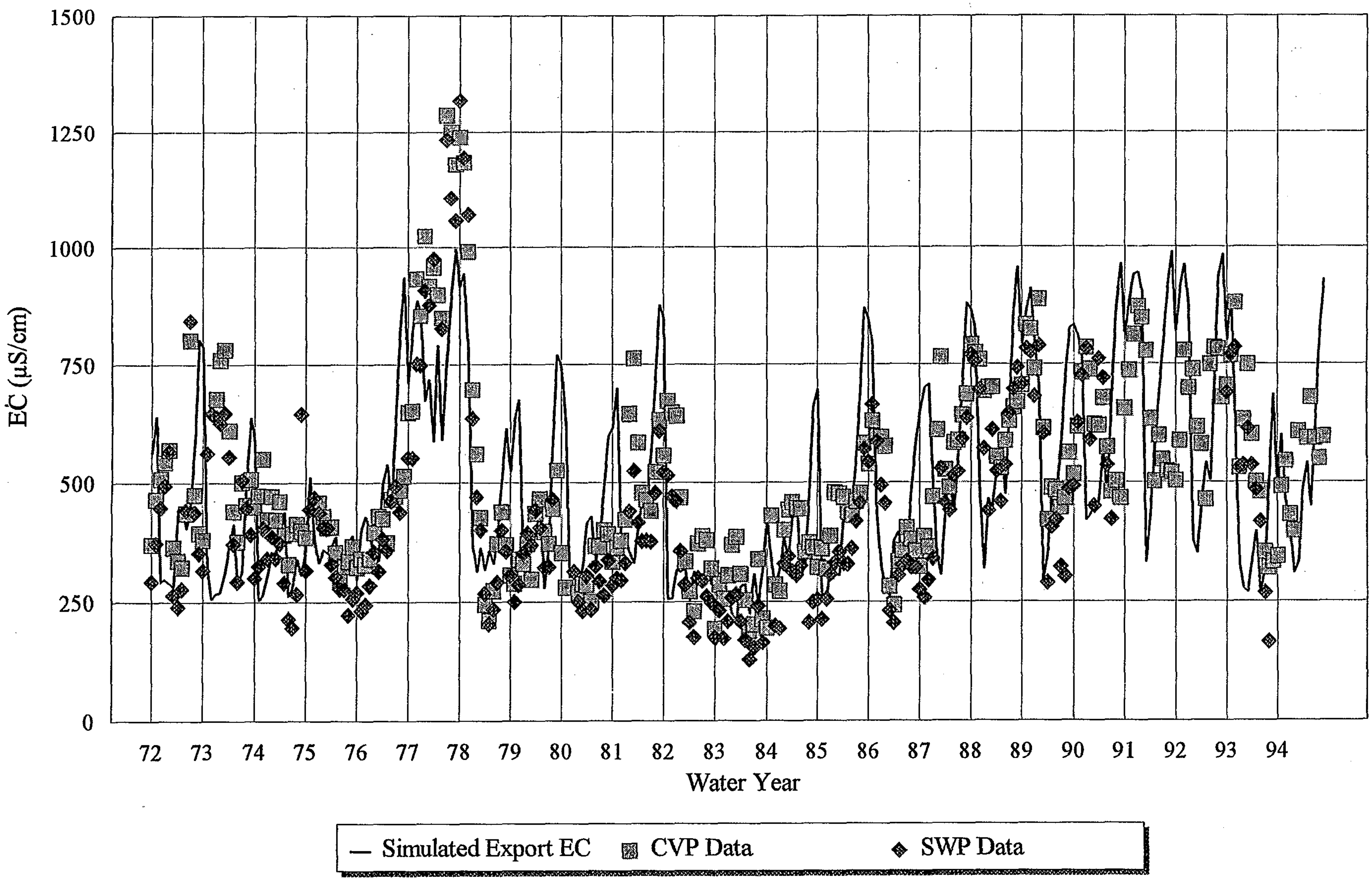

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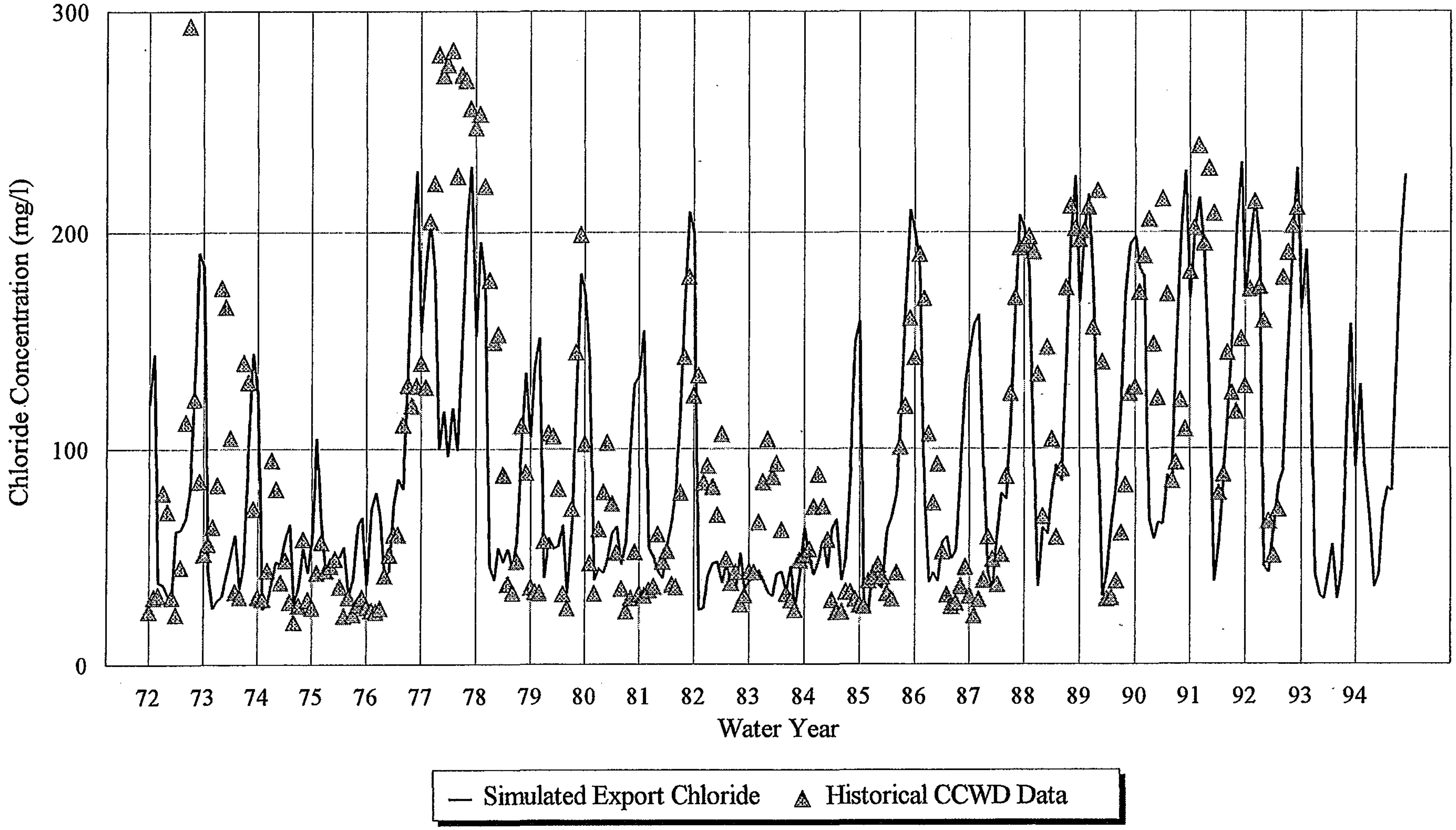
Figure 4-16
Comparison of Simulated No-Project Export EC with Historical MWQI Export EC Values



Note: CCWD data not available for 1993-1994.

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Figure 4-17
Estimated Export Cl^- Concentration for No-Project and Historical CCWD Rock Slough Cl^- Values

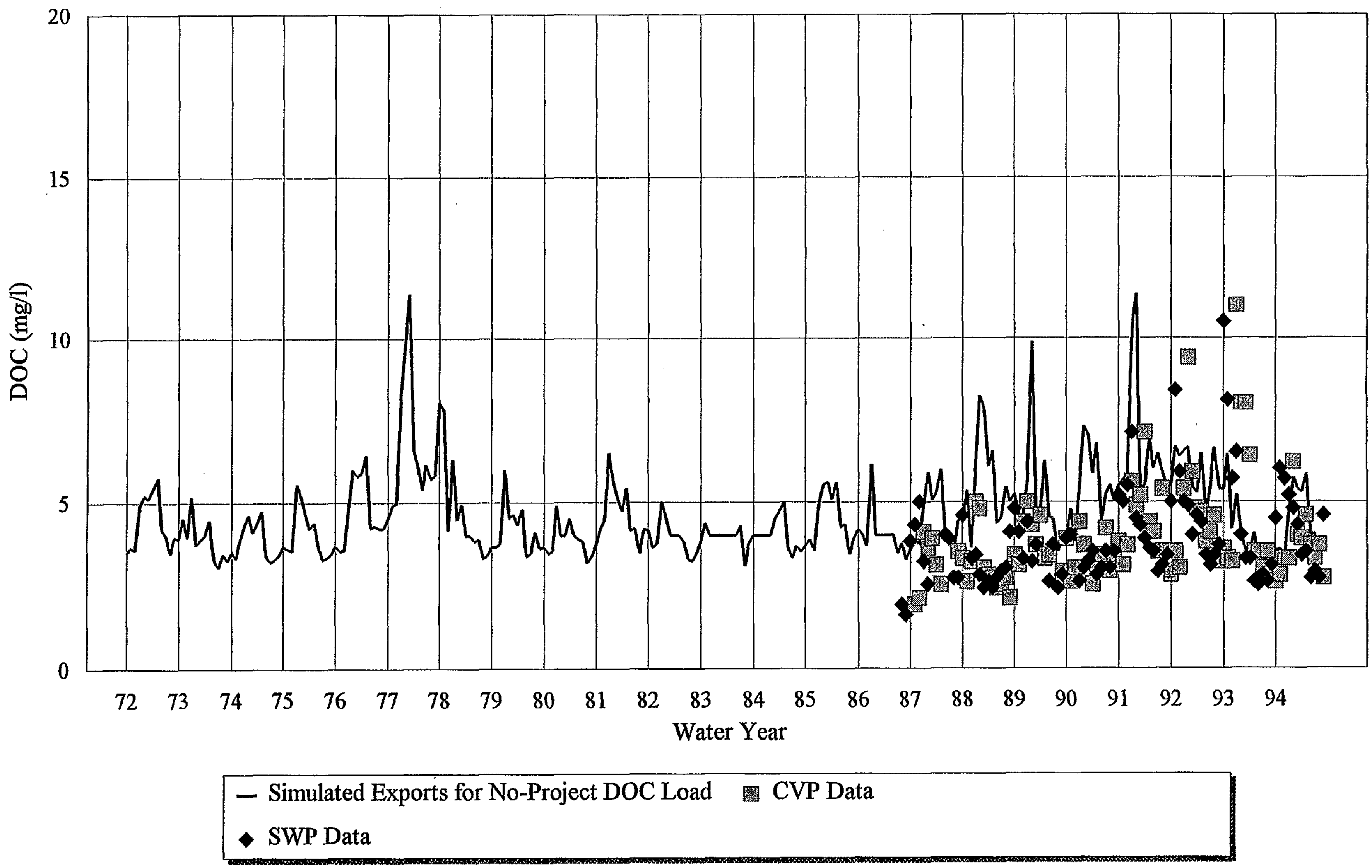

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Figure 4-18
Simulated No-Project Delta Export DOC Concentrations with MWQI Drainage DOC Measurements

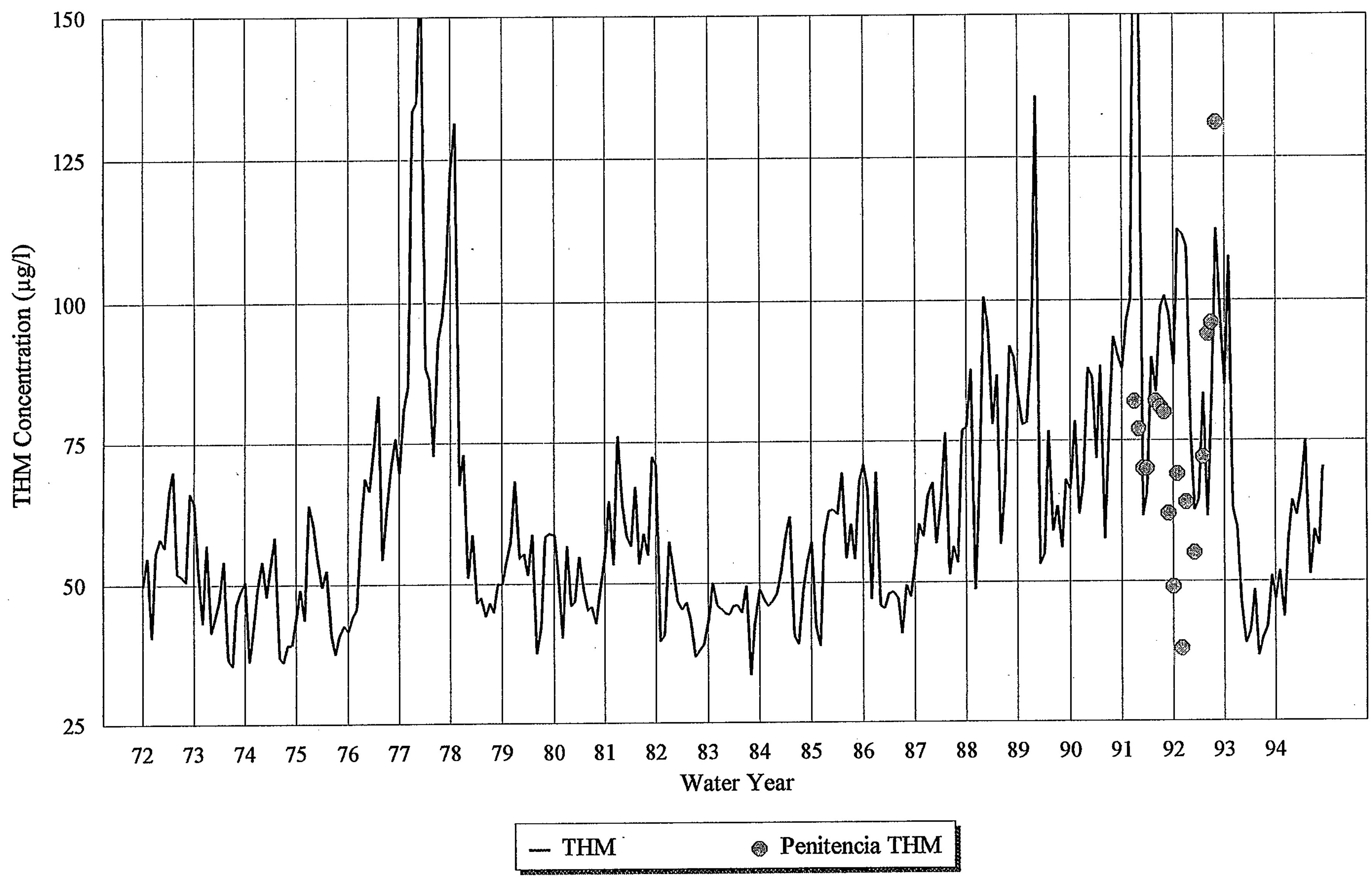

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Figure 4-19
Simulated Treated Water THM Concentration for the No-Project Condition

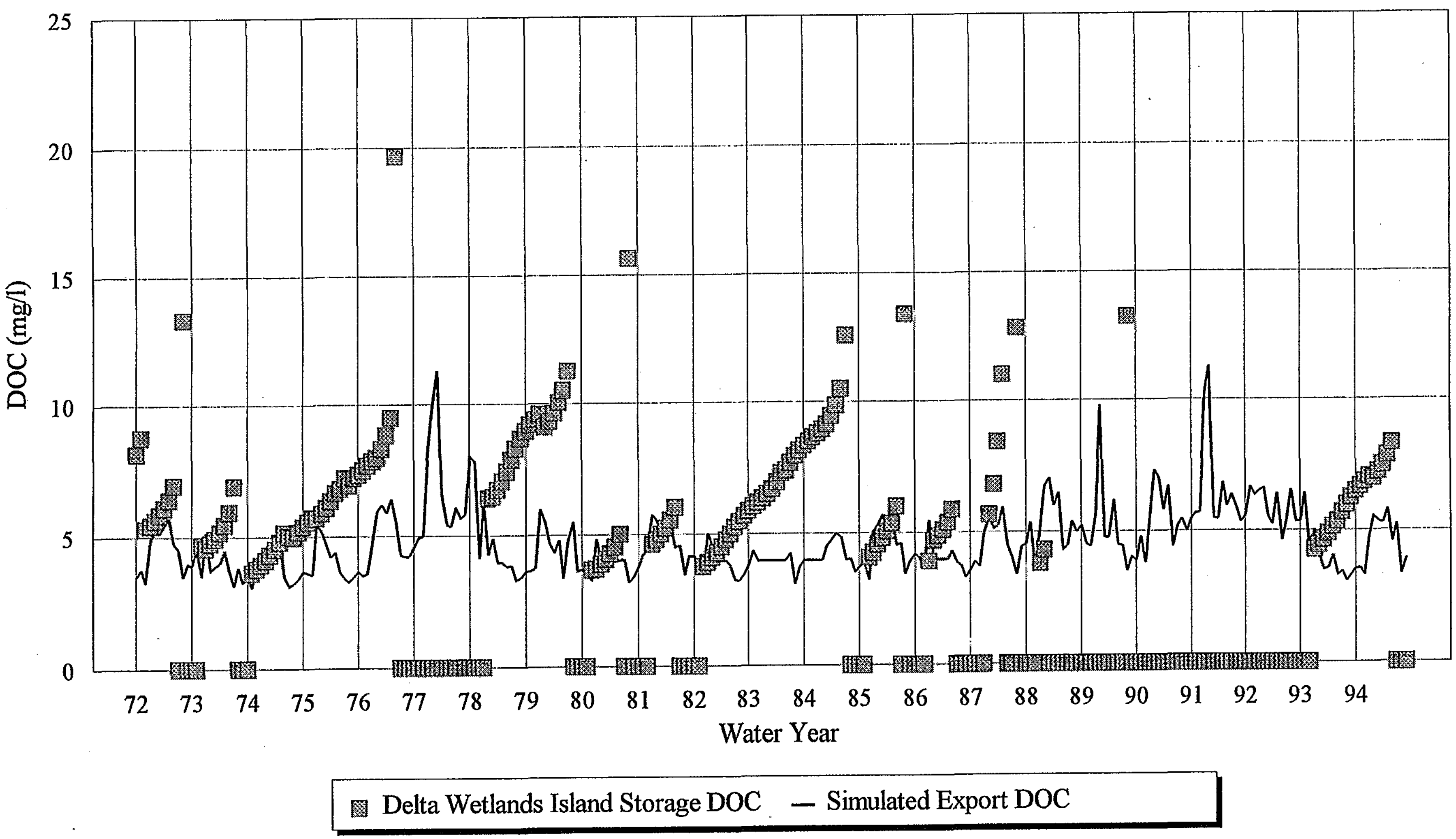

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Figure 4-20
Simulated Export DOC and Delta Wetlands Reservoir Island Storage DOC with Assumed Long-Term DOC Load (1 $g/m^2/mo$)

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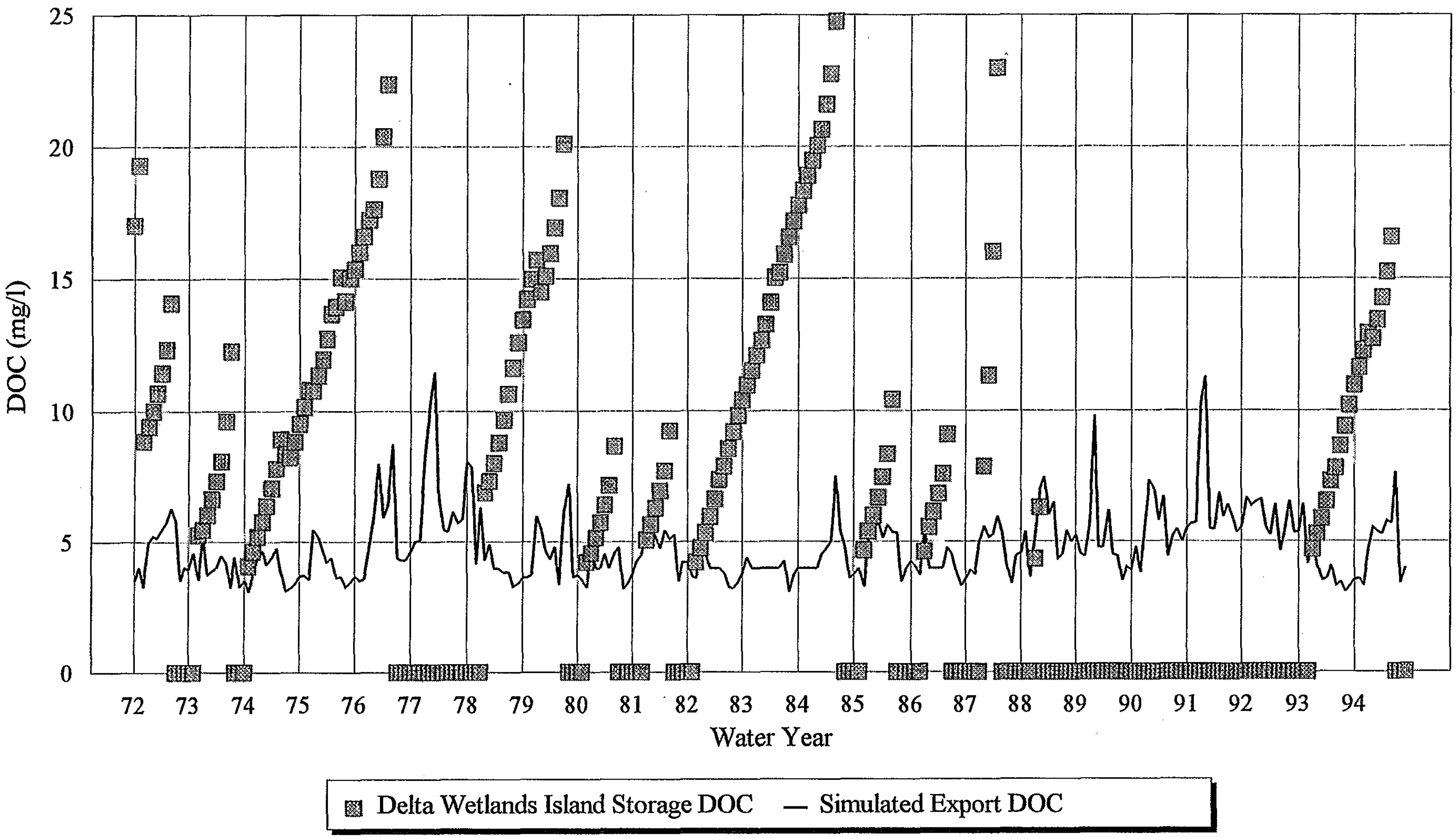

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Figure 4-21
Simulated Export DOC and Delta Wetlands Reservoir Island Storage DOC with Assumed Initial DOC Load (4 g/m^2/mo)

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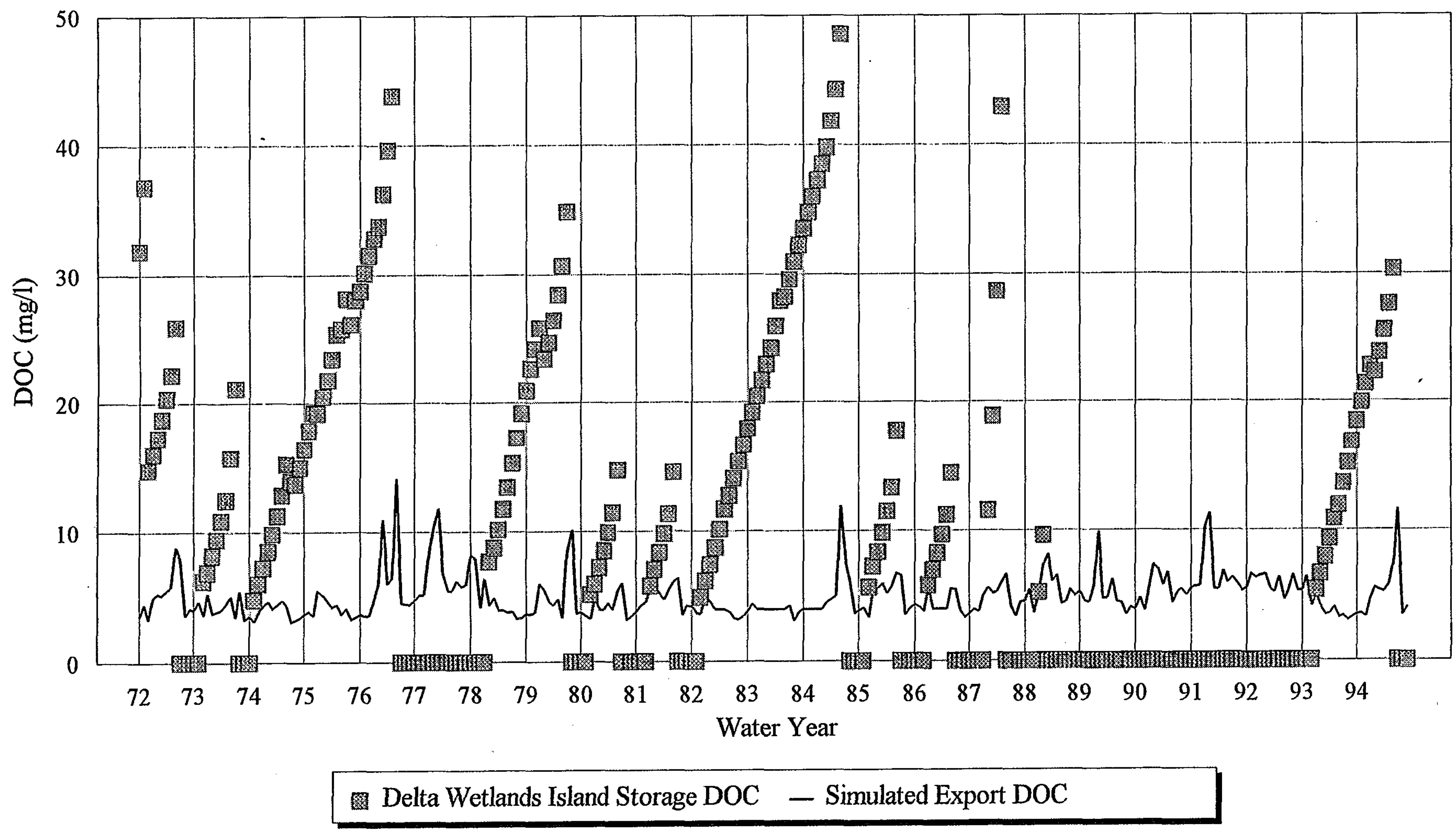

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Figure 4-22
Simulated Export DOC and Delta Wetlands Reservoir Island Storage DOC with Assumed High Initial DOC Load (9 $g/m^2/mo$)

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