# Natomas East Main Drainage Canal

# Water Quality Investigation

**INITIAL TECHNICAL REPORT**

**The Municipal Water Quality Investigations Program**
**Urban Sources and Loads Project**

**October 2003**

*The photo shows ...*

*The middle photo ...*

*The bottom photo ...*

Photos taken by Mike Zanoli of DWR's Municipal Water Quality Investivations Program.

State of California
The Resources Agency
Department of Water Resources
Division of Environmental Services
Office of Water Quality

Municipal Water Quality Investigations Program
Urban Sources and Loads Project

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Initial Technical Report

Prepared for the State Water Contractors

November 2003

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Governor
State of California

Michael Chrisman
Secretary of Resources
The Resources Agency

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# Errata

*This is a revised edition. Below is note # followed by date of revision and text from previous edition.*

N1 07-20-06—**Table 6**. Changed 2nd table note from "All nitrogen values reported as N; all phosphate values reported as P."

N2 07-20-06—**Figure 10**. Changed title from "Nitrate concentrations (as N) by method, 1997-2000"

N3 07-20-06—**Figure 10**. Changed note from "Nitrate MCL = 10 mg/L"

N4 07-20-06—**Figure 10**. Deleted heavy line denoting incorrectly nitrate MCL at 10 mg/L

# Abbreviations and Acronyms

| | |
|---|---|
| CDEC | California Data Exchange Center |
| CDHS | California Department of Health Services |
| cfs | cubic feet per second |
| CFU | colony forming units |
| CUWA | California Urban Water Agencies |
| CWA | Clean Water Act |
| DBPs | disinfection byproduct(s) |
| DCC | Dry Creek Conservancy |
| Delta | Sacramento-San Joaquin Delta |
| DFG | California Department of Fish and Game |
| DOC | dissolved organic carbon |
| DSM2 | Delta Simulation Model 2 |
| EC | electrical conductivity |
| EPA | US Environmental Protection Agency |
| FLIMS | Field and Laboratory Information Management System |
| GIS | Geographic Information System |
| HAAFP | haloacetic acid formation potential |
| HAAs | haloacetic acid(s) |
| L | liter |
| LCS | laboratory control sample |
| MCL(s) | maximum contaminant level(s) |
| MF | membrane infiltration |
| mg | milligrams |
| MPN | most probable number |
| MTBE | methyl tertiary-butyl ether |
| MTF | multiple tube fermentation |
| MWQI | Municipal Water Quality Investigations |
| NCS | Newcastle-Pineview School (CDEC precipitation station) |
| NEMDC | Natomas East Main Drainage Canal |
| NPDES | National Pollutant Discharge Elimination System |
| NTU(s) | nephelometric turbidity unit(s) |
| QC | quality control |
| RPD | relative percent difference |
| SPO | Sacramento Post Office (CDEC precipitation station) |
| SRWTP | Sacramento Regional Wastewater Treatment Plant |
| SUVA | specific ultraviolet absorbance |
| SWP | State Water Project |
| SWRCB | State Water Resources Control Board |
| TDS | total dissolved solids |
| THM(s) | trihalomethane(s) |
| THMFP | trihalomethane formation potential |
| TOC | total organic carbon |

| | |
|---|---|
| TSS | total suspended solids |
| $UVA_{254}$ | ultraviolet absorbance measured at a wavelength of 254 nanometers |
| WDL | water data library |
| WTP | water treatment plant |
| WWTP | wastewater treatment plant |
| | |
| µg/L | micrograms per liter |
| µS/cm | microseimens per centimeter |

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# Chapter 1  Introduction

This report presents initial findings of the Natomas East Main Drainage Canal (NEMDC) Water Quality Investigation.  The study is part of the Municipal Water Quality Investigations (MWQI) Urban Sources and Loads Project.

The project was adopted and undertaken as part of MWQI work plans for 2001/2003 and 2002/2004 (version July 23, 2002).  The purpose of the project is to:

- Identify existing and potential sources of drinking water quality pollutants in the Sacramento-San Joaquin Delta (the Delta) and the State Water Project (SWP) from urban sources such as urban runoff and wastewater treatment plants,
- Identify data gaps,
- Estimate loads of selected sources, and
- Assess water quality problems—their severity and their impact on drinking water quality at intake sites.

NEMDC, also known as Steelhead Creek, is a potentially significant cumulative source of urban loads of drinking water contaminants to the Delta.  It is one of several in the rapidly urbanizing metropolitan areas of Sacramento and Stockton and in rapidly growing smaller communities along the San Joaquin River and in the Delta such as Lathrop, Manteca, Tracy, and Brentwood.

This report presents a summary and analysis of all water quality data collected at NEMDC beginning in 1997 through June 2002.  The data analysis focuses on organic carbon and its relationship to other water quality parameters and watershed factors such as precipitation (rainfall) and streamflow.

# Chapter 2 Background

## California Bay-Delta Authority Water Quality Program Plan

The Drinking Water section of the California Bay-Delta Authority (formerly CALFED) *Water Quality Program Plan* (2000) states that increased urban runoff associated with urbanization of land and expansion of wastewater treatment facilities is a potential source of increased loads of parameters of concern. The California Bay-Delta Authority specifically identified the Natomas East Main Drainage Canal (NEMDC) as a priority site for assessment of sources and loads of drinking water parameters of concern. NEMDC represents a data gap and a potentially important node for modeling inputs in the overall contribution of key drinking water contaminants to the State Water Project (SWP) Harvey O. Banks Pumping Plant and other Delta intakes.

This Bay-Delta plan (CALFED 2000) was initiated for the following reasons:

- Tremendous population growth in watersheds tributary to the Delta is increasing urban discharges to surface waters, effluent from municipal wastewater treatment plants, urban storm water, and other discharges regulated under the Clean Water Act NPDES permit program.
- Organic carbon contained in these discharges is known to form disinfection byproducts (DBPs) during drinking water treatment processes. DBPs include trihalomethanes and bromate, which are suspected carcinogens, and haloacetic acids, which also may have carcinogenic properties.
- Most drinking water parameters of concern are not currently addressed under NPDES permit programs administered by the California Regional Water Quality Control Board.
- Monitoring conducted under both storm water and wastewater NPDES permits is frequently inadequate to address drinking water quality concerns.

For urban runoff and other urban sources, the San Francisco Bay-Sacramento-San Joaquin Delta (Bay-Delta) program includes a large range of Delta watershed sources as well as other regions and sites to be addressed. These include the Sacramento and Stockton metropolitan areas, Discovery Bay, Clifton Court Forebay, the California Aqueduct, and the Southern California reservoirs. The Bay-Delta program has recommended that source identification and control program actions be phased over a 30-year period.

## State Water Resources Control Board Proposition 13 Grant Proposal

The State Water Resources Control Board (SWRCB) and the Bay-Delta program awarded a Proposition 13 grant for a June 2002 proposal from the Municipal Water Quality Investigations program (MWQI) in partnership with the Dry Creek Conservancy (DCC). Contract negotiations are expected to begin the end of 2003. The SWRCB grant process contract is expected to be completed in 2004. Meanwhile, activities at NEMDC for event-based monitoring continues as described in the 2002/2004 MWQI work plan.

The grant project will contribute further understanding of urban sources and loads by expanding monitoring equipment and water quality data. A new permanent flow monitoring station will provide a continuous stage record at the El Camino Avenue bridge to calculate flow rates. A downstream backwater station may also be added. The project will include developing and maintaining a new rating curve, processing stage data on a monthly basis, and maintaining and repairing the station. An additional autosampler will allow more samples to be collected over longer periods of time during important events such as storms, other discharges, and low flows. MWQI already has and uses several autosamplers at its field unit.

The grant project will add flow, sediment, and erosion monitoring to existing monitoring programs by DCC in the upper watershed. It will provide information for developing actions such as best management practices and habitat restoration and help formulate site-specific actions for the Dry Creek Watershed Management Plan being developed and will allow continued development of management strategies by the Dry Creek Coordinated Resource Management Plan. The project will build on a substantial foundation of existing, ongoing work provided as matching funds for the grant and will provide additional information in the form of a GIS database to evaluate water quality and land use change detection related to urban growth in the upper watershed.

Results of the proposal selection process and a link to the full proposal text are available at the California Bay-Delta Authority website http://calwater.ca.gov/Programs/DrinkingWater/SWRCB_RFP.shtml.

## Geographic Area and Growth Trends

The NEMDC watershed comprises approximately 180 square miles of land in the greater Sacramento Metropolitan Area that includes significant portions of the Natomas area, northeastern Sacramento County, southern Placer County, and a small portion of Sutter County (Figure 1). About 55% of the area in the NEMDC watershed is in the Dry Creek watershed, which includes Roseville, Rocklin, Loomis, and Granite Bay in Folsom. Dry Creek is the main tributary stream to NEMDC. The watershed's northern boundary extends to just south of the town of Newcastle. The watershed elevation ranges from about 1,000 feet near Newcastle to near sea level at NEMDC.

**Figure 1 NEMDC watershed (map)**

The NEMDC watershed is significant because it drains runoff from a large rapidly urbanizing metropolitan area, including Dry Creek, Arcade Creek, Robla and Magpie creeks, and a large portion of the Natomas area north of the confluence with Dry Creek up to Sankey Road.

Estimates of the total size of the greater Sacramento Metropolitan Area were not well defined at the time of this report. One estimate of the local urban areas discharging runoff in the City and County of Sacramento, including the cities of Roseville and Folsom, totaled about 226,000 acres or about 353 square miles (Archibald & Wallberg and others 1996). This estimate is most likely low and probably does not include significant portions of north Natomas, south Sacramento, and other outlying areas. Using U.S. Geological Survey maps, MWQI staff estimate the Sacramento urban drainage area to be at least 500 to 550 square miles.

640 acres = 1 square mile

Using this higher unconfirmed estimate, the NEMDC watershed may constitute 33% to 36% of the total Sacramento urban drainage area. Another major conveyance of Sacramento area urban runoff, the Morrison Creek watershed, comprises about 120 square miles in the central and southern portions of Sacramento. The NEMDC and Morrison Creek watersheds total about 300 square miles (192,000 acres) or about 55% to 60% of the total Sacramento urban drainage area.

In addition to being large, the urban area drained by NEMDC is rapidly urbanizing. Placer County was among the top 2 fastest-growing counties in California for 3 consecutive years, according to the California Department of Finance (2002, 2003). Three other Sacramento-area counties and Sacramento County itself made the list of top 10 fastest growing counties. High growth rates in the entire watershed, and Placer County in particular, have also been projected and acknowledged by several other sources (Montgomery Watson 2000; Archibald & Wallberg and others 1996; Craig 2002).

Significant growth is also occurring—with much more planned—in north and south Natomas areas. The population in Natomas is projected to grow from its current level of about 38,000 to more than 103,000 by 2015, with 15 subdivisions formally planned for north Natomas and another 8 in south Natomas (Craig 2002). This substantial growth will contribute a significant amount of additional urban runoff to NEMDC and its tributaries, although storm water management practices required for developments may mitigate some impacts.

## Watershed Hydrology

The MWQI NEMDC monitoring site is at the El Camino Avenue bridge just below Arcade Creek confluence. The location was selected because it drains urban runoff via several major creeks from a large metropolitan area (Figure 2). There are 4 streams and associated subwatersheds (in order from north to south: the upper NEMDC draining north Natomas above the Dry Creek/NEMDC confluence, Dry Creek, Robla/Magpie creeks, and Arcade Creek). Dry Creek has 2 main tributaries, Secret Ravine and Miners Ravine, which collect runoff from the Rocklin/Loomis and Hidden Valley areas, respectively (see Figure 1).

**Figure 2 NEMDC monitoring site and vicinity (map)**

NEMDC drains a large portion of north Natomas west of NEMDC and north of the confluence with Dry Creek up to Sankey Road at the upper northwest corner of the watershed (see Figure 1). Runoff is controlled by a Sacramento County pump station (D15 pump station) immediately above the confluence with Dry Creek.

The El Camino Avenue bridge monitoring site captures all runoff from the entire watershed. However, during certain storm periods the bridge site can be affected by flows from the Sacramento River. Once river stage at the I Street Bridge station on the Sacramento River exceeds about 13 feet, backwater conditions can develop and flows at NEMDC can be affected.

No data on overall flow contributions of the respective NEMDC tributaries have been collected. However, Dry Creek and its tributaries constitute about 55% of the total watershed area and probably contribute an equal or greater amount of the flow at the El Camino Avenue bridge. The flow from Dry Creek contains urban runoff, wastewater treatment plant effluent from the City of Roseville, natural drainage from open space, and, probably, limited runoff from small remaining agricultural areas. Periodically, significant flow is contributed by Reclamation District 1000 (RD1000) pumps just north of Interstate 80 on Northgate Boulevard. This pump station contributes agricultural drainage for several weeks every year during late August-September. RD1000 also contributes excess storm flow to NEMDC during heavy rainfall periods when its other drains, which are normally pumped into the Sacramento River, are at capacity.

## Water Quality Concerns

The SWRCB is required under the Clean Water Act (CWA) section 303(d) to prepare a list of water bodies (also known as the 303(d) list) that do not meet applicable water quality standards and a priority ranking for development of total maximum daily loads for each water body. Arcade Creek, one of the major tributary streams on NEMDC, is listed as a high-priority impaired water body due to copper and organophosphate pesticides chlorpyrifos and diazinon. NEMDC is on the 303(d) list as a medium priority for diazinon.

These contaminants are in low concentrations and, therefore, not a current concern for drinking water sources. However, other contaminants such as organic carbon and pathogens, which are carried in urban runoff, are of concern. Organic carbon is the primary contaminant of concern not regulated under the CWA. Organic carbon forms DBPs that are known carcinogens such as trihalomethanes and haloacetic acids upon disinfection with chlorine during the drinking water treatment process. DBPs and their precursors are regulated under the federal Safe Drinking Water Act and by the California Department of Health Services (CDHS). Detail on the regulatory background and framework for drinking water quality contaminants is presented in other documents (DWR 2001, Montgomery Watson 2000).

There are several significant sources of organic carbon and other drinking water contaminants in the Sacramento River and the Delta besides urban runoff, including agricultural drainage, wastewater treatment plant effluent, combined sewer overflows, and algal productivity. A study of the relative contribution of these contaminant sources to organic carbon loads in the Sacramento and San Joaquin rivers found that nonpoint pollution sources such as urban runoff constituted the major unidentified source of loading in the Sacramento River at Greenes Landing (CUWA and others 1995). From 70% to 87% of the load at this location could not be explained by known sources evaluated in the study (Figure 3). The Colusa Basin Drain and Sacramento Slough and the Sacramento Regional Wastewater Treatment Plant (SRWTP) were the largest known individual contributors, ranging from 8% to 21% and 2% to 9%, respectively, of the total load in the Sacramento River during both wet and dry years and wet and dry seasons (CUWA and others 1995).

**Figure 3 Relative contribution of organic carbon from Delta tributaries**

Individual samples from these sources showed total organic carbon (TOC) and dissolved organic carbon (DOC) concentrations ranged from 3 to 42 mg/L. The SRWTP, the largest inland treated wastewater discharge in the Central Valley, has an average TOC concentration of around 15 mg/L. A study of water quality data collected at fixed sites in the Sacramento River Basin from 1996 through 1998 found that median DOC concentrations were between 1.5 and 2.0 mg/L along the Sacramento River and its major eastern tributaries—Feather and Yuba rivers. DOC concentrations of 2.0 mg/L and below are less likely to form DBPs approaching or exceeding drinking water standards. As expected, DOC concentrations were higher at the 2 large agricultural drains, the Colusa Basin Drain and Sacramento Slough. However, in the 1996–1998 study the highest DOC concentrations ranged from about 6 to 8 mg/L and were found in Arcade Creek, indicating that urban runoff is also a source of this contaminant (Domagalski and others 2000). For background comparison, TOC averaged 1.9 mg/L with a median of 1.6 mg/L in the Sacramento River at West Sacramento Bryte Bend WTP Intake. In the Sacramento River at Hood downstream of the Sacramento Metropolitan Area, TOC averaged 2.1 mg/L, with a median of 1.8 mg/L (http://wdl.water.ca.gov/ MWQI WDL database 1998–2001).

Besides organic carbon, drinking water parameters of concern in urban runoff include turbidity, total dissolved solids, nutrients, and pathogens. Sacramento urban runoff may contain human pathogens because the urban environment contains both humans and wild and domestic animals that can transmit these pathogens as indicated by the presence of total and fecal coliform and *E. coli* bacteria (Montgomery Watson 2000). High levels of coliform bacteria have been found consistently in Sacramento area storm water monitoring programs and are the principal reason why coliform bacteria, as an indicator of other pathogens such as *Giardia* sp. and *Cryptosporidium* sp., were identified in 1996 as one of the top target pollutants of concern (Archibald & Wallberg 1998, Montgomery Watson 2000).

The concern for drinking water contaminants from urban sources, especially organic carbon, does not stem from the contribution of a single source rather from the cumulative loads from multiple urban sources—combined with the high growth rates in these areas over time—at drinking water intake sites such as Banks Pumping Plant. Historically, neither NEMDC nor total Sacramento area storm water runoff has been thought to be a significant source of organic carbon at drinking water intakes. However, urban sources can have an impact at water quality intake sites when combined with the SRWTP, Stockton Wastewater Treatment Plant and urban runoff, and the combined effluents and urban runoff from high-growth cities along the upper San Joaquin River and in the Delta.

To assess both these individual and cumulative potential impacts, the California Department of Water Resources' DSM2 model will be used as part of the ongoing project at NEMDC and the Proposition 13 grant project. NEMDC and other urban sources will be important nodes on the model, and the data collected will be used for contaminant loads estimation.

DSM2 = Delta Simulation Model 2

As part of the Proposition 13 grant project by MWQI and DCC, total loads of organic carbon and other contaminants of concern will be compared to land use matrix totals to provide an assessment of contamination over time related to quantified land use change. This information will then be available for use in the California Department of Water Resources (DWR) effort to model contaminant loads and transport from urban, agricultural, and watershed sources. The potential contaminant load will be entered into DWR's DSM2 model as a node, and the impact to drinking water intakes will be calculated to determine the total and seasonal relevance of urban runoff contamination to drinking water quality over a minimum 5-year period.

The relative contribution of the NEMDC watershed can then be calculated as a percentage of the total contribution of contaminants at Delta export facilities. These data can also be used as a surrogate measurement for gross level study of other urbanizing watersheds to roughly estimate the potential for contamination from those sources within the Delta watershed.

# Chapter 3 Materials and Methods

Monitoring at the Natomas East Main Drainage Canal (NEMDC) began in November 1997 with sample collection and analysis for total organic carbon (TOC), dissolved organic carbon (DOC), ultraviolet absorbance, total dissolved solids (TDS), general minerals, and nutrients. As noted, the Municipal Water Quality Investigations' (MWQI) water quality monitoring site at the El Camino Avenue bridge was chosen because of its location in the lower watershed prior to NEMDC discharging into the Sacramento River at Discovery Park (see Figure 2). Some parameters were monitored intermittently or are no longer monitored because they were not detected, such as synthetic organic compounds and some metals.

Report data cover several time periods and may be organized under specific classifications:

- July 1999–June 2002. NEMDC stage measurements taken at El Camino Avenue bridge.
- Late summer/fall 2001–June 3, 2002. Expanded event-based monitoring. See Chapter 4.
- Rainfall period (July 1, 2001–June 30, 2002). See Chapter 4.
- Seasonal data comparison:
  - Wet season (November-April) vs. dry season (May–October).
  - Water year (October 1–September 30). Example: water year 2002 includes data collected October 1, 2001, through September 30, 2002.

Prior to the 2001/2002 event-based monitoring season, samples were collected at NEMDC on a monthly basis as part of the regular MWQI north Delta run. Criteria for the event-based monitoring were developed in 2001 for the Proposition 13 grant project. Samples were collected approximately weekly if one or more of the following criteria were met and field staff was available:

- Initial fall storms ~ 0.5 inches rainfall or greater
- During storm events > 0.5–1.0 inches rainfall and generating significant runoff
- Dry season, low-flow period (July, late September-October)
- RD1000 agricultural drainage releases (approximately late August-early September)

During the wet season, approximately November to April, weekly grab sampling was conducted to coincide as closely as possible with significant storm events. Storms were tracked using the National Weather Service and California Data Exchange Center (CDEC) websites. Sample collection was timed to follow storms that produced 0.5–1.0 inches of precipitation and significant stage changes at NEMDC. Sampling teams were set up in advance.

Hydrologic monitoring consisted of stage measurement, channel surveys, and development of a preliminary flow rating table. It included rainfall data collection and analysis. Stage is a measurement (in feet) of the water surface elevation relative to a known benchmark elevation. Stage measurements provide data that are converted to flow estimates using a flow rating table developed from channel flow surveys. In July 1999, MWQI installed a wire weight gage and began monitoring stage at the El Camino Avenue bridge. MWQI contracted with Central District of the California Department of Water Resources (DWR) to install the gage, conduct channel surveys and initial stage monitoring, and develop a rating curve to estimate flows from stage data. Between 1999 and June 2002, stage measurements and 8 channel surveys were performed. Stage and flow data were plotted on log–log paper to provide the best fit for a rating curve. A software program, "Computation of Surface Water Records" by Western Hydrologic Systems, generated flow values for the rating table. The table provided a discharge in cubic feet per second (cfs) for each 0.01 feet of stage height, which was used to calculate NEMDC flow.

These data were used along with TOC data to calculate loads in pounds per day (lbs/day). Details of the methods and data used for TOC loads are presented in Chapter 4 Results under "TOC Load Estimates." The rating table is preliminary and somewhat limited due to the relatively small number of flow measurements taken during channel surveys. Therefore, TOC loads are rough estimates and are used for relative comparison purposes only in this initial report.

Included in the expanded event-based monitoring begun in late summer-fall 2001 was the evaluation of precipitation data stations in the watershed and collection of data during storms. All data were obtained from the CDEC website (http://cdec.water.ca.gov/). During the event-based monitoring, precipitation data stations in CDEC that were either in or immediately adjacent to the NEMDC watershed were evaluated. Twelve stations in or immediately adjacent to the watershed were identified; 2 were considered primary stations. These stations are discussed in Chapter 4 Results.

Water quality parameters included in event-based monitoring for this project were:

- TOC and DOC,
- Turbidity,
- Total suspended solids,
- Total trihalomethane formation potential,
- Minerals (for example, electrical conductivity, TDS, chloride, sulfate, calcium, magnesium, and bromide),
- Nutrients (for example, dissolved ammonia, total Kjeldahl nitrogen, nitrate, nitrate+nitrite, total phosphorus, orthophosphate),
- Selected metals, including arsenic,
- Total and fecal coliform and *E. coli*, and
- Organophosphate pesticides (for example, diazinon and chlorpyrifos).

Diazinon and chlorpyrifos were monitored because they are major environmental water quality concerns in Arcade Creek and because the data are valuable to the Arcade Creek watershed group, the Dry Creek Conservancy, the City of Sacramento, and other stakeholders in the area. These compounds are not drinking water concerns at observed levels.

For seasonal data comparison, November–April was defined as the wet season and May–October as the dry season. Data analyses involving comparisons by water year (that is, October 1–September 30) used the DWR Sacramento Valley Index, which divides runoff into 5 categories: wet, above normal, below normal, dry, and critical. The Sacramento Valley Index is based on the sum of unimpaired flow at the Sacramento River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake (Stephens 2002 pers comm).

All field procedures and analyses were conducted according to the MWQI *Program Field Manual* (DWR 1995). Grab samples were collected from the downstream side of the El Camino Avenue bridge using a stainless steel bucket. Filtration for applicable analyses (for example, DOC) was done in the field. All other field procedures were the same as those used for other MWQI monitoring sites. All laboratory analyses except bacteria analyses were conducted by DWR's Bryte Laboratory according to standard operating procedures and applicable quality assurance and quality control guidelines (DWR 2002).

Organic carbon analyses at NEMDC were performed using 2 methods, wet chemical oxidation and combustion. The 2 methods are variations in analytical instrumentation using the same U.S. Environmental Protection Agency method (EPA Method 415.1). While most State Water Contractor water treatment plants use the wet oxidation method, there is no clear preference. This is a complex and controversial subject and is currently being researched in a DOC/TOC method comparison study by the QA/QC Unit of the Office of Water Quality. A status report is expected to be available in early 2004.

BioVir Laboratories performed all total and fecal bacteria and *E. coli* analyses presented in this report. Two methods were used for bacterial analyses: multiple tube fermentation (MTF) (Method SM18;9221B&E Modified MUG), which reports results as the most probable number of cells (MPN)/100 mL, and membrane filtration (MF) (Method SM18;9222B&D Modified MUG), which reports results as colony forming units (CFU)/100 mL. Both methods are equivalent for reporting and regulatory purposes according to California Department of Health Services (CDHS). All samples were transported from DWR's Bryte Laboratory to BioVir Laboratories (on ice) under chain-of-custody procedures within 24 hours of sample collection.

Summary statistics can be determined for individual MPN sample results, but due to the nature of the measurement, formal statistical analyses (for example, hypothesis testing) cannot by conducted with MPN values. In contrast, CFU data can be used for statistical analyses. Samples analyzed by the 2 methods were used in comparisons with regulatory levels and for future statistical analyses between NEMDC and other sites. Both methods will continue to be used in the current event-based monitoring year.

Either *Enterococcus* sp. or *E. coli* can be used as an indicator organism, but the use of *Enterococcus* sp. is currently debated. Inclusion of this organism in pathogen analyses is being evaluated by DWR and other agencies and is not being performed at this site at this time.

## Statistical Analysis

Basic summary statistics were calculated using Excel Office Pro XP. Statistical analyses and significance (hypothesis) tests were performed using the SAS® System for Windows Version 8.2.

# Chapter 4 Results

This section presents the results of hydrologic and water quality monitoring at Natomas East Main Drainage Canal (NEMDC) from inception in 1997 up to and including the expanded event-based monitoring performed from late summer/fall 2001 to June 3, 2002.

## Hydrology

### Stage Monitoring

Stage monitoring data are presented in Figure 4(a). During the summer and early fall of 1999, stage levels were steady at approximately 12.5 to 13 feet at the El Camino Avenue bridge. The highest readings of about 22 feet and 24 to 25 feet were recorded during large storms in January and early March of 2000, respectively. There is a large gap in monitoring from fall 2000 to fall 2001 because staff and field resources were focused on other projects (see Figure 4(a). Stage measurements for both the entire reporting period and by wet and dry season are summarized in Table 1. A total of 66 measurements were taken during this period, ranging from 12.47 to 25.55 feet. The median value was 13.28 feet.

**Figure 4 Stage monitoring data**

**Table 1 Stage monitoring data summary (feet), Jul 1999–Jun 2002**

Similar minimum levels of 12.5 feet to almost 13 feet were measured in the wet season, but wet season levels rose substantially higher and had a higher number of measurements. This higher number of measurements reflects intensified event-based monitoring efforts during 2001/2002. Dry period summary statistics in Table 1 were skewed higher because a maximum of 18.9 feet was recorded during an unusually large storm that struck the area on May 21, 2002. Stage measurements for the 2001/2002 event-monitoring period are presented in Figure 4(b). The baseline stage level during the dry period was approximately 12.7 to 12.8 feet (or about the median for the dry period). The stage increased to over 16 feet after the first storms in early November. The three highest levels in Figure 4(b) correspond to strong responses to significant storms in the watershed, including the unusually high level on May 21, 2002.

Stage data collected since 1999 and corresponding flow estimates from the channel surveys were used to develop a preliminary flow rating table (see Chapter 3). The rating table and flow estimates are discussed further in subsection “Total Organic Carbon Load Estimates” under “Water Quality.”

### Rainfall Data

For 2001/2002, data from 12 California Data Exchange Center (CDEC) stations in or immediately adjacent to the NEMDC watershed were evaluated. Rainfall data were analyzed at these stations during significant storms, especially those occurring on or around sampling days. Stations and rainfall data for each storm are presented in Table 2. Data for 2 stations, the Roseville Fire Station and Royer Park-Dry Creek, were suspect and therefore not included in the analyses.

**Table 2 NEMDC watershed sample dates and precipitation station amounts (inches), 2001/2002**

Excluding these stations, precipitation on and around sampling times ranged from 12.4 inches at the Sacramento Post Office (SPO) to 17.3 inches at Newcastle-Pineview School (NCS). Total precipitation at SPO and NCS from October 2001 to June 3, 2002, was 16.75 inches and 24.1 inches, respectively. These 2 stations are near the most southwestern (SPO) and northeastern (NCS) boundaries of the watershed and, therefore, were considered representative of watershed rainfall affecting flows at the NEMDC site. Other stations will be evaluated over the next year to see if a watershed rainfall "index" can be developed using several of these stations to better predict flows at NEMDC.

Daily and monthly total rainfall data for the 2001/2002 period were collected at SPO and NCS stations (Figure 5). Rainfall was consistently higher at the NCS station. Recorded rainfall at one station was almost always accompanied by rainfall at the other, and they appear to "bracket" rainfall conditions in the watershed, which makes them a good pair to use for this initial report on NEMDC monitoring. A summary of total 48-hour rainfall amounts on and around sample days, stage data, and monthly totals at the SPO and NCS stations are presented in Table 3. The highest total amounts of rainfall occurred during December 2001, followed by March 2002, November 2001, and January and May of 2002.

**Figure 5 Rainfall data for NEMDC watershed, 2001/2002**

**Table 3 NEMDC hydrologic monitoring data summary, 2001/2002**

## Stage/Precipitation Relationships

Stage and daily rainfall for SPO and NCS stations during the 2001/2002 rainfall period are shown in Figure 6. Sampling dates are indicated along the top x axis. Stage levels generally responded to rainfall events with sharp increases evident in the first large storm in November, early January and March, and the May 21 storm (see Table 3). Stage levels decreased to near baseline levels (that is, approximately 13 feet) during January because of a long dry spell. Stage levels did not increase on January 27 even though there was significant rainfall. The reason is not known, but it could be due to the lag time between the rainfall and peak flow period on January 27 and sample collection on January 28. Actual stage levels were probably much higher. Anecdotal information suggests that although the watershed is large, stream levels rise and fall rapidly depending on rainfall intensity, which is also known as having a "flashy" hydrograph (Bates 2002 pers comm).

**Figure 6 NEMDC stage vs. daily rainfall, 2001/2002**

Although stage levels appear generally to have increased and decreased with daily rainfall, correlations between the 2 at both stations were very weak ($r \ll 0.7$), and no further statistical analyses were conducted.

Given this information, stage data were also compared to rainfall in the 48-hour period prior to and including each sample day at the SPO and NCS stations (Figure 7). Increases in stage levels clearly accompanied significant 48-hour rainfall events, with the exception of December 5. This apparent lack of response could be due to the lag time between event and sample collection or because stage decreased between major storms and then increased to the same level of 16.7 feet when both stations received more than an inch of precipitation. Rainfall events in November, January, March, and May show sharp jumps in stage levels, the highest being on January 2 with a stage of 20.44 feet and 1.17 inches and 1.77 inches of rainfall at the SPO and NCS stations, respectively (see Table 3). The data appear to

**Figure 7 Stage and 48-hour rainfall, 2001/2002**

indicate general success at conducting sampling events according to the event-based criteria established for the study. However, correlations between NEMDC stage levels and 48-hour rainfall at the 2 stations were weak ($r$ = <<0.7), and no further statistical analyses were conducted.

## Water Quality

The results of water quality monitoring at NEMDC from 1997 to June 2002 for all parameters are presented in this section. The results of inorganic and organic parameters are summarized and discussed first, followed by discussion of organic carbon and, finally, a discussion of pathogen data. The report focuses on total organic carbon (TOC) and dissolved organic carbon (DOC) and relationships with hydrology and other drinking water parameters of concern.

### Inorganic, Nutrient, and Organic Analyses

#### *General Minerals and Inorganic Analyses*

Summary statistics for general minerals and inorganic analyses are presented in Table 4. Electrical conductivity (EC) was relatively high and ranged from 81 to 561 µS/cm, with a mean and median of 350 and 353 µS/cm, respectively. Total dissolved solids (TDS) levels ranged from 58 to 338 mg/L, with a mean and median of 211 and 219 mg/L, respectively. EC and TDS values over time are presented in Figure 8. EC values generally followed the typical seasonal pattern seen at many other stations, with sharp decreases noted during winter storm periods. TDS values also generally followed this pattern. The EC/TDS ratio for the period of record ranged from 0.55 to 0.72 and averaged 0.61.

**Table 4 Summary statistics for minerals and inorganic analyses, Nov 1997–Jun 2002**

**Figure 8 EC and TDS, 1997–2002**

EC and TDS at NEMDC were compared to Sacramento area urban runoff and other stations monitored by MWQI (Table 5). EC was not monitored in the Sacramento Stormwater Program annual monitoring reports data used for this comparison. TDS levels at NEMDC were higher overall than Sacramento area urban runoff, although the range of values was similar. Concentrations of both parameters were much higher in NEMDC than in the American and Sacramento rivers but were similar to values at Banks Pumping Plant.

**Table 5 Comparison of inorganic parameters in selected receiving waters**

Bromide levels averaged 0.054 mg/L, with a high value of 0.11 mg/L. Bromide was detected in every sample (64 out of 64). These concentrations are noteworthy because they were at or above the Bay-Delta program target of concern of 0.05 mg/L for drinking water sources.

Turbidity and total suspended solids (TSS) concentration data are presented in Table 4 and Figure 9. Turbidity ranged from 7 to 109 NTU and averaged 31.6 NTU. The median value was 21.2 NTU. Turbidity values varied seasonally and increased sharply during significant storm events. TSS values ranged from 17 to 57 mg/L and averaged 34 mg/L, with a median value of 31 mg/L. Turbidity was much higher at NEMDC than at the 3 receiving water sites shown in Table 5. Turbidity and its relationship with the watershed hydrology are discussed later in section "Organic Carbon and Disinfection Byproduct Formation Potential."

**Figure 9 Turbidity and TSS, 1997–2002**

Arsenic values were well below the new maximum contaminant level (MCL) of 0.010 mg/L. All other parameters in this category appear to have been within the ranges of freshwater streams typical of runoff from urban areas.

### *Nutrients*

Summary statistics for nutrient analyses are presented in Table 6. Nitrate is the only parameter in Table 6 with an MCL (10 mg/L as N). Nitrate was analyzed by 2 methods from 1997 to 2002. Both yielded roughly similar means and ranges, given the variability of urban runoff quality. Combined nitrate values were very high, often exceeding the MCL. Of the total 64 combined samples, 22 exceeded the MCL with high values of 22.8 mg/L and 16.3 mg/L with the 2 methods (Figure 10).

**Table 6 Summary statistics for nutrient analyses, Nov 1997–Jun 2002**

**Figure 10 Nitrate concentrations (as N03) by method, 1997–2002**

Nitrate data from NEMDC were compared with data from the 1999/2000 and 2000/2001 annual monitoring reports for the City and County of Sacramento and other area cities (Larry Walker Associates 2000, Larry Walker Associates 2001). For these reports, the firm collects samples from 3 sites considered to be representative of urban runoff in the Sacramento area: Strong Slough, Sump 111, and Sump 104. Nitrate values for samples collected during both wet and dry weather events during these 2 periods from all 3 sites ranged from <0.1 to 2.3 mg/L. The NEMDC nitrate values (see Figure 10) were much higher than values in the 2 referenced monitoring reports; however, fewer samples were collected in the city/county program than at NEMDC. Other reports of Sacramento storm water nitrate values were also lower, ranging from 0.6 to 7.5 mg/L with a median of 1.4 mg/L (nitrate plus nitrite) (DWR 2001).

Ammonia levels at the 3 city/county sites ranged from 0.1 to 0.9 mg/L and were higher than those at NEMDC (see Table 6). Unlike nitrate and ammonia, total phosphorus levels at the city/county sites were very similar, ranging from 0.2 to 1.2 mg/L compared to 0.26 to 1.5 mg/L at NEMDC.

### *Organic Compounds*

Summary statistics for analyses of all organic compounds (except organic carbon) are presented in Table 7 and include both purgeable organic compounds (EPA method 502_2) and phosphorus/nitrogen pesticides (EPA method 614). Purgeable organic compounds include more than 50 analytes. Some common examples of these compounds include benzene, toluene, xylene, trichloroethylene, tetrachloroethene, vinyl chloride, hexachlorobutadiene, carbon tetrachloride, methylene chloride, and methyl tert-butyl ether (MTBE). With the exception of MTBE, none of the purgeable compounds were detected in any of the 6 samples collected from December 1997 to May 1998. Therefore, analysis of these compounds was discontinued.

**Table 7 Summary statistics for selected organic analyses, Nov 1997–Jun 2002**

MTBE was monitored regularly from November 1997 to October 2001 but was detected only twice out of 48 samples. Both samples were at 1.1 µg/L. This value is well below the MCL of 13 µg/L. MTBE monitoring was discontinued after October 2001.

Monitoring for phosphorus/nitrogen pesticides began with the 2001/2002 event season. Chlorpyrifos and diazinon are the main concerns in this group because of their aquatic toxicity. A total of 14 samples were collected and analyzed. Only 2 compounds were detected—diazinon and malathion (see Table 7). Malathion, which has no MCL, was detected only once at 0.03 µg/L.

Chlorpyrifos was not detected in any of the 14 samples (detection limit 0.01 µg/L). Diazinon was detected in 9 of 14 samples ranging from <0.01 µg/L to 0.19 µg/L. The average was 0.06 µg/L, and the median was 0.03 µg/L. These data are not surprising given historically high concentrations and the level of concern about this pesticide in the Arcade Creek watershed. There is no MCL for diazinon; however, it is on the U.S. Environmental Protection Agency's Candidate Contaminant List. This list contains contaminants that are a priority to evaluate and determine whether to regulate under the federal Safe Drinking Water Act.

The California Department of Fish and Game (DFG) has developed acute and chronic toxicity criteria for diazinon. The acute exposure criterion is 0.08 µg/L (criterion maximum concentration), and the chronic exposure criterion is 0.05 µg/L (criterion continuous concentration) (Siepmann and Finlayson 2000). Five of the 9 samples with diazinon detected exceeded the chronic criterion of 0.05 µg/L, and 3 of these also exceeded the acute criterion of 0.08 µg/L. (Comparisons to the chronic criterion were based on single grab sample results and, therefore, are not necessarily exceedances.)

## Organic Carbon and Disinfection Byproduct Formation Potential

This section presents detailed analyses of organic carbon and related parameters as well as a summary of disinfection byproduct (DBP) formation potential (for example, trihalomethanes and haloacetic acids). An overall discussion of the data is presented, followed by several different analyses of organic carbon, turbidity, and hydrologic data considered relevant to the NEMDC site and the watershed.

### *Organic Carbon Analytical Methods*

Organic carbon monitoring at NEMDC began in November 1997 with DOC by the wet oxidation method. TOC by wet oxidation method was added in September 1998. TOC monitoring switched from wet oxidation to combustion in November 2000, while DOC by wet oxidation continued. In November 2001, monitoring of TOC and DOC using both methods was begun and is continuing (see Chapter 3). This change was also made at all other MWQI stations beginning in September 2001.

### *Organic Carbon—Overall Data Summary*

Summary statistics for TOC and DOC and $UVA_{254}$ analyses are presented in Table 8. Turbidity and TSS are also included because they are used in subsequent analyses of organic carbon data.

**Table 8 Summary statistics for organic carbon and $UVA_{254}$ analyses, Nov 1997–Jun 2002**

By definition, DOC is a fraction of TOC and therefore should be lower than TOC. The vast majority of DOC data were below TOC, but a few values were higher. Quality control analyses were performed on the data set as described in Chapter 5. These values were within acceptable error ranges associated with laboratory analytical methods and had no significant effect on the overall summary statistics or other analyses (see Chapter 5). Therefore, these data were included in the analysis.

Figure 11 shows the range and variation of TOC and DOC by both methods over time. Concentrations of these parameters and methods generally increase and decrease during wet and dry periods associated with stream flows. Both high values for TOC of 12.7 mg/L (wet oxidation) and 13.1 mg/L (combustion) occurred on November 13, 2001, after an intense 24-hour storm event. The low values for TOC of 3.1 mg/L (wet oxidation) and 5.1 mg/L (combustion) occurred after extended dry periods in early October 1998 and September 2001, respectively (Figure 11(a)). Results for DOC were similar, except that the high value for DOC oxidation of 10.6 mg/L occurred after the same storm as the high TOC, but the high DOC combustion value of 11.2 mg/L occurred on January 7, 2002, after a much less intense period of rainfall the previous 2 days (Figure 11(b)). Organic carbon and rainfall are discussed later in this section under "Organic Carbon, Turbidity, and Rainfall."

**Figure 11 TOC and DOC data by method, 1997–2002**

Seasonal variation of TOC and DOC concentrations can also be seen in monthly average data, particularly for TOC by the combustion method (Figure 12). This figure also indicates that both TOC and DOC results were consistently higher when using the combustion method than the wet oxidation method, especially during wet season months. This finding is considered to be indicative of higher capture of particulate content yielded by the combustion method.

**Figure 12 Monthly average TOC and DOC concentrations (± 1 *s*), 1997–2002**

Seasonality and the differences between wet and dry periods are discussed later in this section under "Organic Carbon Concentrations by Season and Water Year." TOC and DOC by wet oxidation had a relatively large sample size ($n$ = 44), and their values were very similar, which indicates that TOC comprised mainly DOC. This can be seen in Figure 11(c). The proportion of TOC as DOC is discussed later in this section under "Total Organic Compounds vs. Dissolved Organic Compound."

Cumulative probability distribution plots for TOC and DOC are shown in Figures 13 and 14. For TOC wet oxidation, more than 50% of the data were over 5 mg/L, with 30% of the data (13 out of 44 samples) between 5 and 5.5 mg/L (Figure 13(a)). There was another grouping of the data to the right (about 16% of data) that was mostly between 8.5 and 10.5 mg/L. This group represents the effects of flushing during wet season. The TOC combustion distribution was spread over a larger range, with about 87% of the data greater than 5.5 mg/L and 25% over 10.5 mg/L (Figure 13(b)). The distribution of DOC wet oxidation data was very similar to TOC oxidation. Almost 60% of data were above 5 mg/L, with nearly 30% of the data (18 of 64 samples) being between 5 and 5.5 mg/L (Figure 14(a)). About 53% of the data DOC wet oxidation were between 5 and 6.5 mg/L. Another distribution was observed between 7.5 and 9.5 mg/L, with the majority of data between 8 and 9 mg/L, which also reflects wet season flushing effects. The data set for DOC by the combustion method was much smaller but exhibited a pattern

**Figure 13 Cumulative probability distribution of TOC (mg/L), 1997–2002**

**Figure 14 Cumulative probability distribution of DOC (mg/L), 1997–2002**

similar to TOC by combustion (Figure 14(b)). Exactly 50% of the data were above 7.5 mg/L. Distributions were associated more with the method than the parameter; that is, distributions of TOC and DOC by wet oxidation were similar—see figures 13(a) and 14(a)—as were those of combustion values—see figures 13(b) and 14(b).

The distributions for TOC and DOC as charted in histogram figures 13 and 14 appear to be non-normal. Additional statistical analyses (Ryan-Joiner analysis) were conducted to verify parametric assumptions. It was determined that the majority of the data were not normally distributed, and therefore nonparametric statistics were used for statistical analyses presented below.

### *Comparison with Sacramento Area Urban Runoff and Receiving Water Data*

TOC and DOC concentrations (by wet oxidation only) for NEMDC and event mean concentrations from the Sacramento area urban runoff sites and selected receiving waters are presented in Table 9. As expected, TOC and DOC values for the 3 receiving water stations—American River at Fairbairn WTP, West Sacramento Bryte Bend WTP Intake, and Banks Pumping Plant—were substantially lower than data for NEMDC or Sacramento urban runoff.

**Table 9 Comparison of organic carbon data for NEMDC, Sacramento area urban runoff, and receiving waters (mg/L)**

640 acres = 1 square mile

NEMDC TOC and DOC concentrations were lower than the selected Sacramento urban runoff stations. The highest Sacramento urban runoff value for TOC of 56 mg/L occurred during a period of intense rainfall in January 2001 captured by an autosampler at Sump 104 near the beginning, middle, and end of the storm. The high DOC value of 46 mg/L occurred during a dry-weather event in June of 2001 (Larry Walker Associates 2001). However, NEMDC drains a much larger area (approximately 180 square miles) that is still in the process of infilling with urban development, and a larger number of samples were collected manually by grab methods as opposed to autosamplers. The 3 Sacramento urban runoff sites drain areas that are largely developed and/or industrialized and are much smaller in size. The 3 sites comprise approximately 8 square miles (Strong Ranch Slough), 3.4 square miles (Sump 104), and 0.7 square miles (Sump 111) each (Larry Walker Associates 2001). It must also be noted that different analytical laboratories performed these analyses and that there can be considerable variability with organic carbon results between laboratories even with the same samples. Also, the NEMDC site reflects dilution from its several large tributaries. Other reported concentrations of TOC in Sacramento urban runoff have ranged from 2.9 to 42 mg/L and a median of 9 mg/L (DWR 2001). Arcade Creek TOC concentrations have ranged from 6 to 8 mg/L (Domagalski and others 2000).

**Figure 15 TOC concentrations by season, 1997–2002**

### *Organic Carbon Concentrations by Season and Water Year*

**Figure 16 DOC concentrations by season, 1997–2002**

TOC and DOC concentrations for wet and dry seasons from 1997 through 2002 are presented in figures 15 and 16. The wet season is defined as the period from November through April, and the dry season is from May through October. The Wilcoxon rank-sum test was used to compare wet and dry season data. Average TOC concentrations by the wet oxidation method were significantly higher during the wet season than during the dry season

($p$ = 0.002). DOC concentrations by the wet oxidation method were also significantly higher during the wet season ($p$ = 0.0002). TOC concentrations by the combustion method were also significantly higher during the wet season ($p$ = 0.02). DOC dry season data by the combustion method were not analyzed because the sample size was too small ($n$ = 3).

TOC and DOC concentrations by water year classification from 1997 through 2002 are presented in Figure 17. Using the California Department of Water Resources' (DWR) water year classification system, water years 1997 to 1999 were classified as wet years in the Sacramento Valley; water year 2000 was above normal; and water years 2001 and 2002 were classified as dry (Stephens 2002 pers comm). A total of 38 samples were collected during wet and above normal years; 26 samples collected during dry years. The Wilcoxon rank-sum test was used to compare data from wet and above normal years and dry years. Only wet oxidation method values were used because there were insufficient data using this classification for the combustion method. There was no significant difference in average values for either TOC or DOC between water years.

**Figure 17 Monthly TOC and DOC concentrations by water year, 1997–2002**

Hydrologic classification:
http://cdec.water.ca.gov/cgi-progs/iodir/wsihist

Although water year data were limited for this analysis, these data suggest that season and specific storm events, rather than water year type, have stronger influence on organic carbon concentrations at NEMDC.

### *Total Organic Carbon, Turbidity, and Total Suspended Solids*

TOC (by wet oxidation and combustion methods) and turbidity from 1997 through 2002 are presented in figures 18 and 19 (see also Table 8). Variation of TOC and turbidity by season is readily apparent in these figures. Large variations can be seen in turbidity with higher levels ranging from 83 to 109 NTU during 1998 and 1999 and 76 and 89 NTU during winter 2001. The highest values are associated with winter storms during the wet years of 1998 and 1999, and the 2 smaller values from larger storm events in January and March of 2001, a dry water year. TSS monitoring was not performed at NEMDC until the beginning of the event-based period in November 2001. TOC, turbidity, and TSS data from this period during water year 2002 are presented in Figure 20`.

**Figure 18 TOC (wet oxidation) and turbidity, 1997–2002**

**Figure 19 TOC (combustion) and turbidity, 1997–2002**

**Figure 20 TOC (combustion), turbidity, and TSS, 2001/2002**

### *Correlations Between Total Organic Carbon, Turbidity, and Total Suspended Solids*

All data were first visually examined using scatter plots. Because most of the data were determined to be non-normally distributed, data were statistically analyzed using the nonparametric Spearman's rank correlation test.

There was a strong correlation between TOC by the combustion method and turbidity during 1997–2002 (Figure 21) and the 2001/2002 event periods (Figure 22). Correlations were significant with Spearman-ranked $r$ values ($r_s$) of 0.78 ($p$ <0.0001) and 0.80 ($p$ = 0.001), respectively, for the 2 periods. TOC by the oxidation method and turbidity were weakly correlated ($r_s$ <0.5) (data not presented).

**Figure 21 TOC (combustion) and turbidity, 1997–2002**

**Figure 22 TOC (combustion) vs. turbidity, 2001/2002**

Correlations between TOC and TSS were also weak, with Spearman-ranked $r$ values in the 0.5–0.6 range (data not shown). The reason for the weak correlation is unknown. It could be related to sample timing and flow travel time along with erosion and soil runoff conditions in the upper watershed. It could also be because TSS had a high mineral content and low organic carbon. Turbidity and TSS appear to have tracked each other fairly well (see Figure 9); however, this correlation was also weak ($r_s \sim 0.6$).

Examination of TOC and turbidity by season shows that both TOC oxidation and combustion were correlated with turbidity during the wet season from 1997 to 2002. Correlations were significant with Spearman-ranked *r* values for TOC by combustion method of 0.71 ($p = 0.002$) (Figure 23) and 0.68 ($p = 0.0001$) for TOC by wet oxidation method (Figure 24). TOC combustion was also fairly well correlated with turbidity during the dry season from 1997 to 2002 ($r_s = 0.74$; $p = 0.036$) (Figure 25). There was no correlation with TOC by wet oxidation during dry season ($r_s \sim 0.1$). Several findings are suggested by these data:

- TOC and turbidity may be controlled by similar flushing processes
- TOC and turbidity come from similar sources
- TOC sources could also be from rural areas of the watershed not just from primarily urban areas

**Figure 23 TOC (combustion) and turbidity, wet season 1997–2002**

**Figure 24 TOC (wet oxidation) and turbidity, wet season 1997–2002**

**Figure 25 TOC (combustion) and turbidity, dry season 1997–2002**

### *Total Organic Carbon vs. Dissolved Organic Carbon*

The proportion of TOC that is DOC is an important indicator of organic carbon dynamics at a given site and time period. Table 10 shows the proportion (in percent) of DOC/TOC by wet oxidation and combustion methods from 1997 to 2002 and for wet and dry seasons, along with summary statistics for each. For TOC analyses, the combustion method always yielded higher results than the wet oxidation method (14 of 14 samples where both were analyzed). The combustion method for DOC usually yielded higher results than wet oxidation (9 of 13 samples). The average proportion of TOC composed of DOC remained relatively constant for the entire monitoring period, wet and dry seasons, and the 2001/2002 event season. Average values for DOC/TOC percent by wet oxidation ranged from 94% to 98%. Average values for DOC/TOC percent by combustion ranged from about 70% to 74%. These results indicate that seasonality had no effect on relative proportions for either method.

**Table 10 Summary statistics and DOC/TOC proportion by method**

Municipal Water Quality Investigations (MWQI) began monitoring organic carbon by both wet oxidation and combustion methods in November 2001, which coincided with the start of the first event-based monitoring at NEMDC during 2001/2002. For this period the DOC/TOC combustion proportion was calculated using DOC data by combustion method instead of by wet oxidation as has been commonly done in other reports. The percent DOC/TOC combustion proportion for the 2001/2002 period (calculated using DOC data by combustion method) was about 81%, which reflects the higher values yielded by this method, as opposed to about 70% by the wet oxidation method.

The ratio of DOC/TOC for both wet oxidation and combustion methods and daily rainfall for the 2001/2002 period is presented in Figure 26. For DOC/TOC by wet oxidation method, the proportion varied less than 20% during storm periods. About the same level of variation was observed in the DOC/TOC by combustion ratio. The contribution of particulates in

**Figure 26 Ratio of DOC/TOC and daily rainfall, 2001/2002**

combustion values can be seen during storms in November 13, March 7, and May 21. The lack of a notable decrease in DOC/TOC by wet combustion proportions during other storm periods such as January 2 and 28 may be because the sampling occurred later in the event hydrograph.

## *Dissolved Organic Carbon and UVA$_{254}$ Relationships*

The relationship between DOC and UVA$_{254}$ tends to be site-specific and can vary seasonally. UVA$_{254}$ has been used as a surrogate measure of DOC in surface waters and, more recently, as a possible predictor of DBP precursors. UVA$_{254}$ was a very good predictor of DOC at NEMDC. Correlations between DOC wet oxidation and UVA$_{254}$ were high for both periods, 1997–2002 (Figure 27) and 2001/2002 (Figure 28), with significant Spearman-ranked *r* values of 0.93 ($p < 0.0001$) and 0.83 ($p < 0.0001$), respectively. DOC combustion was also correlated with UVA$_{254}$ but less strongly than DOC wet oxidation, with a significant Spearman-ranked *r* value of 0.76 ($p < 0.002$) (Figure 29).

**Figure 27 DOC (wet oxidation) and UVA$_{254}$, 1997–2002**

**Figure 28 DOC (wet oxidation) and UVA$_{254}$, 2001/2002**

**Figure 29 DOC (combustion) vs. UVA$_{254}$, 2001/2002**

Further examination of DOC wet oxidation and UVA$_{254}$ by season from 1997 to 2002 found that correlations for both wet and dry seasons were significant but were somewhat stronger for the wet season (Figure 30) than the dry season (Figure 31). Spearman-ranked *r* values were 0.93 ($p < 0.0001$) for the wet season and 0.82 ($p < 0.0001$) for the dry season.

**Figure 30 DOC (wet oxidation) vs. UVA$_{254}$, wet seasons 1997–2002**

Although UVA$_{254}$ has been used extensively to predict levels of DBP precursors, it has limitations for this purpose that must be noted. There is to date insufficient evidence that all or even most UV-active organic compounds are DBP precursors, nor is there sufficient evidence to show that UV-inactive compounds are not significant DBP precursors (DWR 2003).

**Figure 31 DOC (wet oxidation) vs. UVA$_{254}$, dry seasons 1997–2002**

The specific UV absorbance (SUVA), which is the ratio of the UVA$_{254}$ reading (nm/cm) and the DOC concentration (mg/L), is used as a qualitative relative indicator of carbon quality and character, specifically the humic fraction of DOC in water. Humic substances such as those in DOC are characteristic of aromatic compounds thought to form carcinogenic DBPs such as trihalomethanes. SUVA values are sometimes expressed as a fraction or can be multiplied by 100. SUVA values above 0.03 (or 3.0) generally indicate highly aromatic DOC from terrestrial sources such as agricultural drainage.

Summary statistics for SUVA measurements for 1997–2002 wet and dry season, and the 2001/2002 event period at NEMDC are presented in Table 11. The average and median SUVA for all periods were below 3.0, except for the average of 3.08 during the 2001/2002 event period. The highest SUVA was 4.19 for both the overall period and the wet season. Dry season and event period maximum SUVA values were about the same at 3.93. The lowest overall values were found during the dry season, with only 10% of the values at 3.0 or above. For the overall period, wet season, and 2001/2002 event period, SUVA values exceeded 3.0 at least 25% of the time.

**Table 11 Summary statistics for SUVA (absorb/cm) x100**

### *Organic Carbon, Turbidity, and Rainfall*

Three different types of rainfall data from the SPO and NCS stations were evaluated and compared for the 2001/2002 wet season: daily, cumulative (total for season), and 48-hour totals. These data and organic carbon and turbidity data were evaluated to see if rainfall affected organic carbon and turbidity levels.

TOC (by wet oxidation and combustion methods) and daily rainfall are presented in figures 32 and 33. TOC combustion concentrations appear to increase with major rainfall events (for example, >1.0 inch) in November, early January, March, and May. The highest TOC values of 13.1 mg/L (combustion) and 12.7 mg/L (wet oxidation) occurred on November 13 after the second largest storm of 1.69 inches on November 12 (NCS station). The next highest TOC combustion value of 12.5 mg/L occurred on January 2 during the largest single storm event of 1.73 inches at NCS station. TOC concentrations decreased markedly on January 28, despite a 1.14-inch storm (NCS station). However, the lower concentrations on January 28 when NEMDC was sampled were likely because most of the rainfall occurred on January 26. The next high TOC concentrations of 11.7 mg/L on March 7 and 10.6 mg/L on May 21 were associated with significant storm events of 1.34 inches on March 6 and 1.42 inches on May 20 (see Figure 33).

**Figure 32 TOC and daily rainfall: SPO station**

**Figure 33 TOC and daily rainfall: NCS station**

TOC combustion values varied more than TOC wet oxidation values probably because particulate levels were flushed into streams during these storm events. Although TOC concentrations appear to have tracked larger storm events, correlations between wet oxidation and combustion values and daily rainfall at both stations were weak ($r_s$ = 0.2- <0.5) and were not analyzed further statistically. The lowest correlations were found between DOC and daily rainfall ($r_s$ = < 0.2); these data were not presented. Concentrations decreased or remained relatively stable during periods of low to moderate rainfall and no rain.

Turbidity levels and daily rainfall are presented in figures 34 and 35. Turbidity increased steadily from the first significant storms in November through early January, then decreased to near dry season levels (approximately 10 to 15 NTU) during January when there was no rainfall. The 3 highest turbidity levels were 53 NTU on January 2, 61 NTU on March 7, and 51 NTU on May 21. All were accompanied by significant amounts of rainfall, with 1.73 inches, 1.34 inches, and 1.42 inches, respectively, of rainfall (NCS station) occurring on the day of or immediately prior to sample collection.

**Figure 34 Turbidity and daily rainfall: SPO station**

**Figure 35 Turbidity and daily rainfall: NCS station**

Turbidity remained at 50 NTU on January 7, 5 days after significant rainfall when a value of 53 NTU was observed; the reason is unknown. Conversely, the reason for a lack of an observed turbidity increase on January 28 is also unknown, but it could be because significant rainfall occurred mostly on January 26. As with TOC, turbidity levels remained stable during relatively dry periods in February to early March. The highest turbidity of 61 NTU on March 7 with 1.34 inches of rainfall occurred after a long dry period, as did the other high value of 51 NTU on May 21.

Although turbidity appears to have tracked daily rainfall better than did TOC, correlations were weak ($r_s$ ~ 0.5) and therefore were not analyzed statistically. To further evaluate the lack of correlation, TOC and turbidity were compared with 48-hour rainfall prior to and including the day of sample collection. Again, correlations were very weak ($r_s$ = 0.1–<0.5). Although attempts were made to sample during or within 24 hours of significant rainfall events, the lack of correlation for both TOC and turbidity could possibly be due to the lag time between rainfall, subsequent stage increase, and grab sample timing. Also, data were based on instantaneous grab sampling and gage readings, and it is unknown where on the event hydrograph the samples were collected.

TOC and turbidity were also compared to cumulative rainfall at SPO and NCS from November 2001 to May 2002. Cumulative rainfall shows both the timing and magnitude of rainfall over the entire wet season and whether water quality parameters respond to the level of watershed saturation and runoff. The cumulative rainfall increase pattern was the same for both stations, so only data for the NCS stations are presented. TOC and cumulative rainfall are presented in Figure 36. The highest TOC concentrations occurred during the fall-early winter period when the sharpest increase in cumulative rainfall was observed. As expected from the discussion above, TOC concentrations do not appear to have tracked cumulative rainfall but tended more to track individual large storm events, even though correlations were weak.

**Figure 36 TOC and cumulative rainfall: NCS station, 2001/2002**

**Figure 37 Turbidity and cumulative rainfall: NCS station, 2001/2002**

Turbidity and cumulative rainfall are presented in Figure 37. Turbidity increased sharply along with cumulative rainfall from November to early January from dry weather baseline levels of approximately 10 to 15 NTU to the second highest value of 53 NTU on January 2. The amounts of cumulative rainfall and rainfall for the entire period are presented in Table 12. During the period from November to January 2 at the NCS station there was a total of 13 inches of rainfall, or 54% of the rainfall for the entire wet season. By March 7, more than 70% of the total rainfall for the season had occurred and the cumulative rainfall remained relatively stable until the unusually large storm on May 20–21 (see Figure 37). The high turbidity levels seen on March 7 and May 21 event were related to individual storms after long dry periods, rather than the gradual increase seen during November to January 2.

**Table 12 Cumulative rainfall (inches) by period, Nov 2001–May 2002**

It appears that TOC and turbidity levels were more affected by individual rainfall events and exhibit somewhat of a “first-flush” effect commonly seen in storm water data, with less flushing of TOC and turbidity toward the end of the runoff period. Sustained elevated turbidity levels appear to have occurred along with cumulative rainfall amounts up to 10–12 inches. This cumulative amount could have provided the soil saturation point that resulted in bank sloughing, overland flow, or runoff from similarly affected sources. However, turbidity, like TOC, also appears to have responded more to individual storm events after dry periods suggesting a first-flush effect. This effect could be related to erosive conditions at construction sites or other areas with exposed, disturbed soils or where streambank conditions are unstable combined with watershed streamflows that are highly responsive to rainfall, also commonly known as being “flashy.” These and other effects related to watershed hydrology are discussed later in "Total Organic Carbon Load Estimates."

### SUVA and Cumulative Rainfall

SUVA and cumulative rainfall for 2001/2002 are presented in Figure 38. SUVA exhibited a relationship with cumulative rainfall similar to that of turbidity and rainfall, increasing steadily from 2.2 in November to nearly 4 on January 2. SUVA values crossed the 3.0 threshold, an indicator of probable terrestrial influence, early in this period (around November 12) and remained above 3.0 until late January. However, levels may have decreased much sooner because sharp changes (in the form of increases) can be seen when sample collection times were close together, for example, November 7 and 13; March 4 and 7. SUVA values remained below or close to 3.0 for the remainder of the period except for the March and May storm events discussed above under "Organic Carbon, Turbidity, and Rainfall" when a response similar to that of turbidity was observed.

**Figure 38 SUVA and cumulative rainfall: NCS station**

### Organic Carbon, Turbidity, and Stage

TOC, DOC, and stage from July 2001 to June 2002 are presented in Figures 39 and 40. Both figures show a stable baseline stage of about 12 to 13 feet and TOC and DOC concentrations of 4.5 to 6 mg/L from July to early November. Both TOC and DOC concentrations (by wet oxidation and combustion methods) track stage levels beginning with the first storm on November 12–13 and during most subsequent storms. An exception to this pattern occurred on December 3 when concentrations decreased while stage remained consistent. A possible explanation for the observed decrease in TOC and DOC concentrations on December 3 could be that the high TOC/DOC values in the previous sample on November 13 were preceded the day before by a storm of 1.69 inches at NCS, whereas the day before the December 3 sample NCS rainfall was only 0.94 inches. The high TOC/DOC concentrations observed on November 13 were preceded by a long dry period and could reflect a first-flush effect; there were several rainfall events between then and December 3.

**Figure 39 TOC and stage, 2001/2002**

**Figure 40 DOC and stage, 2001/2002**

Contributions from particulates, as indicated by TOC combustion values, initially appeared to be small but increased as the difference between TOC combustion and TOC wet oxidation values was evident at stage increases in January, March, April, May, and June.

**Figure 41 TOC (wet oxidation) vs. stage, 2001/2002**

**Figure 42 TOC (combustion) vs. stage, 2001/2002**

**Figure 43 DOC (wet oxidation) vs. stage, 2001/2002**

Correlations between TOC and DOC and stage for both wet oxidation and combustion methods were all significant, although those for TOC and DOC wet oxidation were stronger (figures 41-44). TOC and DOC by wet oxidation method had highly significant Spearman-ranked $r$ values of 0.80 ($p = 0.0003$) and 0.80 ($p = 0.0001$) (see figures 41 and 43), respectively. TOC and DOC combustion had significant Spearman-ranked $r$ values of 0.65 ($p = 0.006$) and 0.62 ($p = 0.025$) (see figures 42 and 44), respectively.

**Figure 44 DOC (combustion) vs. stage, 2001/2002**

Turbidity, TSS, and stage from July 2001 to June 2002 are presented in Figure 45. Similar to TOC and DOC above, turbidity remained relatively stable during the dry period from July until the first storm on November 12. Turbidity levels tracked stage, increasing as stage increased above 14 feet. The 4 highest turbidity values of 53, 50, 61, and 51 NTU occurred with the

**Figure 45 Turbidity, TSS, and stage, 2001/2002**

4 highest stage levels on January 2 and 7 and in March and May, respectively. Correlation between turbidity and stage was highly significant, with a Spearman-ranked $r$ value of 0.78 ($p = 0.0002$) (Figure 46). Correlation between TSS and stage was weak and not significant (not shown).

**Figure 46 Turbidity vs. stage, 2001/2002**

### *Total Organic Carbon Load Estimates*

Stage measurements collected since 1999 using the wire weight gage at the El Camino Avenue bridge were performed manually. Readings were limited to one daily during dry weather and a maximum of 2 to 3 a day during storms. These data were of value in evaluating the hydrology of the watershed and NEMDC in general, but they were limited for load calculations because they only provided instantaneous load estimates. More reliable load estimates are obtained using continuous stage data that can then be converted to daily average flows using the flow rating table.

During data analysis and preparation of this report, MWQI staff learned of a real-time stage monitoring station just upstream of the NEMDC site at its confluence with Arcade Creek (see Figure 1). This station is operated by the City of Sacramento and is part of the Sacramento County Rainfall and Stream Level Information System, also known as the ALERT system. The station is called “NEMDC at Arcade Creek” (ID #1692) and consists of a Keller PSI stream gage pressure transducer (4-20 milliamp signal calibrated to 0–25.5 feet output range) and a NovaLinx 5095 transmitter providing digitized data that is telemetered to the Sacramento County ALERT system computer. The Arcade Creek sensor takes readings about every 60 seconds and transmits a signal when the difference between the current reading and the previously transmitted value exceeds 0.05 feet. The control units are also programmed to transmit a signal every 60 minutes whether there is a change or not. Computer software converts this input to real-time data for output to the ALERT system website.

Real-time stage data from the Arcade station were available from July 2001 to December 2002. These data were matched with corresponding NEMDC stage data on the same date and time and used for regression analysis. A total of 92 pairs of stage data were obtained, and the analysis yielded a strong linear correlation between the two data sets (Figure 47(a)). Even though this report only covers data through June 3, 2002, the additional Arcade and NEMDC stage data through December were included because they serve to strengthen the relationship and the robustness of the correlation between the 2 sites.

**Figure 47 NEMDC stage, Arcade stage, and flow rating curve**

NEMDC stage data (in feet) were calculated from daily Arcade stage data using the regression equation in Figure 47(a). Calculated daily NEMDC stage data were then converted to flow in cubic feet per second (cfs) using the regression equation from the flow rating table (Figure 47(b)). Daily Arcade stage data ranged from 2 to 3 readings during dry periods up to 30 readings during storm events. Average daily NEMDC flows from July 1, 2001, to June 3, 2002, were calculated (see Appendix A). To calculate loads, actual TOC sample data by the wet oxidation method were used for the sample days on which they were collected:

TOC load [lbs/day] = TOC ox [mg/L]*Q [cfs]*0.64632*8.34

There were a total of 17 samples in the 12-month period. TOC concentrations for days between actual samples were extrapolated from data based on rainfall, stage, and change in stage.

The calculated daily average NEMDC TOC loads are presented in Figure 48. TOC loads were seasonally quite variable but remained relatively low during the dry period from July to October, generally in the range of 1,000 to 1,200 lbs/day. During storm events in November, December, March, and a 2-day storm in May, TOC loads increased dramatically ranging from 20,000 to 45,000 lbs/day. During the larger storms of January 2002, loads were even higher ranging from around 50,000 lbs/day to over 70,000 lbs/day. Daily NEMDC flow, concentration, and TOC load data by month are summarized in Figure 49(a–c). Figures 49(a) and 49(b) illustrate the range of values used for load calculations (minimum, maximum, and average). As expected, flow and concentration varied considerably between dry and wet seasons, dramatically increasing in wet months in response to large storm events. TOC loads shown in Figure 49(c), including a data table, also reflect large increases during November, December, January, March, and May, as discussed in Figure 48. TOC concentrations and daily average NEMDC loads during the period are also presented in Appendix A.

**Figure 48 Daily average NEMDC TOC loads, 2001/2002**

**Figure 49 Daily NEMDC: flow, concentration, and load by month, 2001/2002**

Daily NEMDC TOC loads were compared to daily Sacramento River TOC loads to determine the contribution from NEMDC. Sacramento River loads were calculated using the daily average flow at Hood (cfs) and the daily average TOC wet oxidation concentration from Siever's TOC Analyzer data. The percent contribution of the daily TOC load in the Sacramento River from NEMDC was then calculated (NEMDC TOC load/Sac R TOC load [both in lbs/day] X 100%). These data are summarized by month in Table 13 and Figure 50(a). In Figure 50(a) the load axis on the left is a logarithmic scale, and the columns are overlapped and not stacked (that is, the maximum height of each column type is its value). Daily data for the Sacramento River and NEMDC used in this analysis are also presented in Appendix B.

**Table 13 Summary statistics for daily TOC load: Sacramento River vs. NEMDC, Jul 2001–Jun 2002**

**Figure 50 NEMDC and Sacramento River (at Hood) daily TOC load by month, Jul 2001–Jun 2002**

TOC concentrations at Sacramento River also varied by season but less than those at NEMDC; however, flows increased substantially during wet season months, especially January. Accordingly, TOC loads in the Sacramento River at Hood ranged from an average of about 150,000 to 160,000 lbs/day during July–September to about 750,000 to 1 million lbs/day in December and January, with a maximum of almost 2.40 million lbs/day in January. The percentage of daily TOC load in the Sacramento River contributed by

NEMDC by month is presented in Table 13 and Figure 50(b). A substantial contribution from NEMDC was found in 5 of 12 months, with maximum values (see Table 13) ranging from about 4% to 21%. The lowest value of about 4% was considered substantial because it occurred on January 3 when the Sacramento River TOC load was over 1.80 million lbs/day and NEMDC contributed its maximum load of 71,000 lbs/day (see Appendix B). The highest value of 21% occurred on May 21 after the very large rainfall event on May 20, as discussed in a previous section "Organic Carbon, Turbidity, and Rainfall." The highest daily NEMDC TOC loads (~ 5% or more) to the Sacramento River are presented in Figure 51 (*n*=15). This figure shows both Sacramento River and NEMDC TOC loads and NEMDC's percent contribution. Nine of the 15 highest values were over 5% with 5 near or above 10%. Even during the wettest periods with the highest Sacramento River loads, there were 6 NEMDC values close to 5%.

**Figure 51 Summary of highest daily NEMDC TOC loads to the Sacramento River**

These findings suggest that NEMDC makes substantial contributions to the Sacramento River TOC load, especially during periods when local rainfall events (that is, fall and late winter/spring storms) increase NEMDC watershed flows and TOC loads but Sacramento River flows are still low either due to its watershed size, limited dam releases, or both.

To further evaluate potential impacts of urban sources on Sacramento River TOC loads, daily NEMDC TOC loads were added to estimates of the combined Sacramento Metropolitan Area urban runoff TOC loads. The combined Sacramento area urban runoff load was conservatively estimated at twice the NEMDC load (assumed to represent most if not all of the metropolitan area including runoff into the American River, the 3 major City of Sacramento storm water sumps, and the Morrison Creek watershed). The combined urban runoff TOC loads were then compared to Sacramento River loads. The TOC load from the major urban sources in the Sacramento Metropolitan Area was then estimated by adding combined urban runoff values with data from the Sacramento Regional Wastewater Treatment Plant (SRWTP). The median daily TOC load from actual SRWTP data from September 1991 to June 1998 (18,080 lbs/day) was used and compared with Sacramento River loads. The City of West Sacramento WWTP also discharges to the Sacramento River in the vicinity of the SRWTP, but it was not included in this analysis because its flow and load are very small in comparison to the combined urban sources and the SRWTP.

**Figure 52 Daily Sacramento River TOC load from combined Sacramento Metropolitan Area urban runoff and SRWTP, 2001/2002**

**Table 14 TOC loads from combined Sacramento Metropolitan Area urban runoff and SRWTP vs. Sacramento River**

Daily Sacramento River TOC loads contributed by both the combined Sacramento Metropolitan Area urban runoff and also the combined urban runoff load plus SRWTP loads from July 2001 to June 2002 are presented in Figure 52 and also in Appendix C. Combined urban runoff TOC loads remained relatively low, generally about 2% or less, from July to October. Substantial increases of from 7% to 8% up to 25% were found during the same storm periods discussed above for NEMDC loads, namely November, December, January, and March. The highest increases found in load contribution to the Sacramento River from combined Sacramento Metropolitan Area urban runoff were around 30% and 40% during the large storm on May 20 and 21, respectively. These data are also summarized by month in Table 14 and Figure 53(a).

**Figure 53 Daily TOC load by month from combined urban sources and SRWTP to the Sacramento River**

Adding the TOC load from the SRWTP substantially increased the TOC contribution from Sacramento area urban sources over the entire time period, except December and January. This was because the increased urban load was masked by the magnitude of the flow and load in the Sacramento River during these months (see Figure 52, Figure 53(b), and Table 14). As expected, the additional load from the SRWTP substantially increased the percent TOC load contribution from urban sources during the same wet months discussed above, especially November, March, and May (see Figure 52). Ten of 12 months (minus December and January) had average values around or above 10%, and all months had maximum values well above 10%. Maximum values exceeded 20% during the months of October, November, March, April, and May (see Figure 53(b) and Table 14).

Of particular interest was the increase in TOC loads during the dry season and late spring periods when adding the SRWTP TOC load. The period from July to October and the months of April, May, and June had the highest minimum and average values, including 2 of the highest maximum values (October and April). As observed above with NEMDC, the impact of urban TOC loads appears most pronounced when Sacramento River flows are low and urban drainage and discharges occur due to local storms and continual discharge from the SRWTP.

**Table 15 Percent contribution and number of days by source of TOC load to the Sacramento River, 2001/2002**

The impact of TOC loads from Sacramento area urban sources on the Sacramento River is further illustrated in Table 15. This table compares the number of days a specific urban source was near or above 5%, 10%, and 20% of the contribution to the total TOC load in the Sacramento River. There were a total of 320 days from July 2001 to June 2002 with calculated data (see appendices). For NEMDC alone, 15 days were near or above 5% of the total TOC load contribution to the Sacramento River, with 4 days at 10%, and only a day at 20%. When adding the combined Sacramento Metropolitan Area urban runoff, the number of days at 5% and 10% doubled and the number days at 20% quadrupled from 1 to 4. Adding the continual daily discharge from the SRWTP, there were 301 days when all urban sources were near or above 5% of the total TOC load in the Sacramento River (about 95% of the 320-day period). There were 228 days, or 71% of the period, when the TOC load was greater than 10% and a substantial increase in the number of days at 20% or more (44 days). Much of the increase in the incidence of these load levels was attributable to the contribution from the SRWTP during dry periods, as discussed above.

### *Disinfection Byproduct Formation Potential*

As at other MWQI sites, DBP formation potential was not monitored regularly at NEMDC. Thirteen samples were collected for trihalomethane formation potential (THMFP) and haloacetic acid formation potential (HAAFP) from 1997 to 1998, and sampling began again in May 2002. Only values from the DWR THMFP (Buffered) method are presented because it is considered by MWQI to be the preferred and most reliable method for this analysis for source waters with higher carbon concentrations.

**Table 16 Summary statistics for THMFP and HAAFP analyses, Nov 1997–Jun 2002**

Summary statistics for THMFP and HAAFP analyses are presented in Table 16. Chloroform was detected at high levels in all samples, ranging from 335 to 1,000 µg/L. Bromoform was not detected and dibromochloromethane was detected only once at 5.6 µg/L. Total trihalomethane formation potential (TTHMFP) values are presented in Table 16. Using average and median values, over 90% of TTHMFP was comprised of chloroform, which is commonly the predominant trihalomethane (THM) at MWQI sites due to relatively low levels of bromide present.

A comparison of TTHMFP values at NEMDC and other selected sites is presented in Table 17. TTHMFP values at NEMDC are high compared to the North Bay Aqueduct pumping plant, another MWQI site considered to have high TTHMFP values, and are in the range of some agricultural drains. Haloacetic acids (HAAs) by the DWR HAAFP reactivity method were dominated by dichloroacetic acid and trichloroacetic acid, which comprised more than 90% of the total HAAFP. For more information on DBP formation potential, *Delta Island Drainage Investigation Report* (DWR 1990) presents a comprehensive analysis of THM, HAAs, and TTHMFP.

**Table 17 Summary statistics for TTHMFP data from selected sites (µg/L)**

## Pathogens

This section presents analytical results for total and fecal coliform bacteria and *E. coli* samples collected at NEMDC from November 2001 to June 2002. Summary statistics for total and fecal coliform bacteria and *E.coli* densities in both most probable number (MPN) and colony forming units (CFU) are presented Table 18 and Table 19. Unfortunately, many MPN maximum results were capped at >1,600 because of detection limits, and therefore full quantification was not possible. This issue is being rectified in current samples by having the analytical laboratory perform appropriate dilutions on samples to provide an actual result. CFU values were high for all bacteria, especially *E. coli* at 48,000. For *E. coli* CFU data, 2 samples were above detection limits of >20,000 and >4,000 CFU, respectively. The large variation between means and medians, especially CFU data, is due to extreme range of values, which tends to skew the average. This is why median values (or geometric means) rather than averages are considered a better estimate of central tendency for bacteria data.

**Table 18 Summary statistics for bacteria densities (MPN) at NEMDC, Nov 2001–Jun 2002**

**Table 19 Summary statistics for bacteria densities (CFU) at NEMDC, Nov 2001–Jun 2002**

Bacterial data are presented in box plots in Figure 54. The left side of the figure shows MPN data capped at a maximum of >1,600 due to method detection limits. For bacterial densities from MPN results above 1,600, maximum values are unknown; however, summary statistics of densities below 1,600 are valid so the MPN summary data are still presented. A more representative range was seen in the CFU data. *E. coli* values were higher than fecal coliform for both median and quartile ranges. The magnitude and range of *E. coli* values was from several hundred to almost 10,000 CFU. Monthly median data are presented in Figure 55. The highest MPN values for all bacteria were found in November, December, and January. Fecal coliform and *E. coli* values were also still high in March and May. The lowest values were in February. There were no CFU data for December. Otherwise, values were similar, except for March, which had the highest overall results (*E. coli* median = 24,002 CFU). There is no explanation for this occurrence because corresponding March MPN values were less than detection limits.

**Figure 54 NEMDC bacteria densities, Nov 2001–Jun 2002**

**Figure 55 Median bacteria densities in NEMDC by month, Nov 2001–Jun 2002**

Regulatory guidelines have been established for bacteria by the California Department of Health Services in its *Draft Guidance for Fresh Water Beaches* (CDHS 2001). For single sample values, the applicable category for this data, beach posting is recommended when indicator organisms exceed any of the following levels:

- Total coliforms – 10,000/100 mL
- Fecal coliforms – 400/100 mL
- *E. coli* – 235/100 mL

A regulatory level for *E. coli* has also been specified as a water quality objective for bacteria in an amendment to the Regional Water Quality Control Board Basin Plan and is the same as the CDHS value above.

Cumulative probability plots for CFU results for total and fecal coliform and *E. coli* are presented in Figure 56 (a–c). For CFU results, approximately 10% of fecal coliforms were above the level of 10,000/100 mL. For fecal coliform CFU results, 42% of the data were above the regulatory level of 400/100 mL. For *E. coli* CFU results, 70% of the data were above the single sample water quality objective of 235/100 mL.

**Figure 56 Cumulative probability distribution of bacteria densities (CFU), total and fecal coliform, and *E. coli*, Nov 2001–Jun 2002**

The bacterial densities at NEMDC, although very high and often exceeding regulatory guidance and water quality objectives, are not uncommon for storm water.

Data collected from the Sacramento area storm water sites discussed earlier in the report over 3 different periods also found very high bacteria levels, much higher than those found so far at NEMDC. Fecal coliform levels from 1990 to 1999 at Sump 104, Sump 111, and Strong Ranch Slough were commonly in the hundreds of thousands of cells (MPN/100 mL) and ranged as high as over a million cells (Larry Walker Associates 1999). Average levels (geometric means) ranged from 22,000 to 57,000 to 85,000 cells/100 mL. The most recent studies (Larry Walker Associates 2000; Larry Walker Associates 2001) included total coliform, fecal coliform, and *E coli* data from samples collected during individual wet and dry weather events. These data were not as high as the historical fecal coliform results, but were still high and commonly within the 10,000 to 100,000 cells/100 mL range for fecal coliform and *E. coli*. Maximum values were 170,000 and 900,000 cells/100 mL during the 2 sampling periods covered in the reports.

Figure 57 presents NEMDC bacteria data and daily rainfall at the NCS station.

**Figure 57 Bacteria densities vs. rainfall: NCS station**

Wet and dry periods were not compared because only 3 sample values were in the dry period. Total coliform levels appeared to be consistently high for both MPN and CFU regardless of rainfall. Fecal coliform and *E. coli* levels were more variable, but there was still no clear pattern with rainfall. These results are consistent with the most recent Sacramento area storm water bacteria levels discussed above, although it is a smaller data set than the historical 1991 to 2000 data discussed above. High values were found during both wet and dry weather events, indicating some other mechanism besides high flows causing elevated bacteria levels to occur.

Other historical data for bacteria in Sacramento urban runoff collected from 1991 to 2000 have shown considerable variation in wet and dry weather total and fecal coliform levels. Wet weather medians were an order of magnitude higher than dry weather medians for total coliform bacteria and 2 orders of magnitude higher for fecal coliform bacteria (Montgomery Watson 2000). Dry weather ranges and medians were similar to those reported above, but wet weather high ranges for both total and fecal coliform were in the 10 million to 20 million MPN/100 mL range.

# Chapter 5
# Quality Assurance/Quality Control

This quality assurance/quality control review covers data collected by the Municipal Water Quality Investigations program (MWQI) from the Natomas East Main Drainage Canal (NEMDC) El Camino Avenue bridge site during the reporting period of November 13, 1997, to June 3, 2002. The data review was performed using available quality control data stored in the Field and Laboratory Information Management System (FLIMS) database of the California Department of Water Resources (DWR). The database was used to retrieve the data and flag the analyses that were outside established control limits.

The review indicated that overall the data collected from 1997 to 2002 at the NEMDC site were of acceptable quality. A few analyses were outside the control limits, but they were not considered to have a significant impact on the overall data quality of the project. The results of the review are presented below in 2 sections, Field Procedures Quality Control and Internal Laboratory Quality Controls.

## Field Procedures Quality Control

### Field Duplicates

Field duplicates are replicate samples taken at a randomly selected station during each field run to evaluate precision of field procedures. The results of field duplicate analyses are evaluated by calculating relative percent differences and comparing the RPDs with established control limits. During the study period, 205 field duplicate analyses were performed, and 9 of the RPDs exceeded the acceptable control limits (4.4%) (Table 20). The results indicate that field procedures were of acceptable precision for the project.

**Table 20 Summary of field duplicates**

### Field Blanks

Field blanks are purified water samples taken to the field and filtered or left unfiltered. Filtered blanks help check for contamination from field sample processing procedures. Unfiltered blanks check for contamination from containers and preservatives.

During the study period, 10 field blanks were performed, and none exceeded the control limit.

## Internal Laboratory Quality Controls

Internal quality controls (QC) are procedures used in the laboratory to ensure that the analytical methods are in control. Environmental samples are grouped together in “batches,” with approximately 20 samples per batch. Generally, one of each QC measure such as method blank and matrix spike is performed with each batch. In some cases the laboratory performs more than one of each of the QC measures to insure the quality of the batch. The total number of internal QC analyses performed per analyte is shown in Table 21. The following is a review of the internal QC for the project.

**Table 21 Total internal QC batches grouped by analyte**

## Sample Holding Times

Holding time is the period during which a sample can be stored after collection and preservation without significantly affecting the accuracy of its analysis. During the 1997–2001 study period, 2,049 environmental analyses were conducted, and only 2 analyses (0.09%) exceeded the holding time. Analyses exceeding the holding times are listed in Table 22. The only analyte that exceeded the holding time was orthophosphate on January 2 and 7, 2002. Although the frequency of these exceedances was low, the results of the specific analysis should be interpreted with caution.

**Table 22 Holding time exceedances**

## Method Blanks

The purpose of method blanks is to detect and quantify contamination introduced through sample preparation or analytical procedures in the laboratory (some “background noise” is allowed). A total of 2,385 method blanks were performed, and of those 18 (0.7 %) exceeded the control limits (Table 23).

**Table 23 Method blank exceedances**

Table 24 shows the frequency of method blank exceedances for the specific analytes. The frequency of method blanks out of the control limits was 7% for alkalinity, 5.4% for dissolved organic carbon (DOC) by wet oxidation and 4.7% for total organic carbon (TOC) by wet oxidation. The method blanks for organic carbon were not significantly higher than the reporting limit of 0.1 mg/L as C. There were 4 method blanks performed for chloroform, and all 4 were higher than the reporting limit. Because chloroform is so prevalent in the laboratory environment and so few method blanks were performed, the results are not considered to have a significant impact on the overall data quality of the project. Samples affected by method blank exceedances are shown in Table 25.

**Table 24 Number of batches with method blank exceedances**

**Table 25 Environmental samples associated with method blank exceedances**

## Laboratory Control Samples

Laboratory control sample (LCS) recoveries are used to assess the accuracy of the analytical method especially when matrix interference occurs in the analyses of the environmental samples. An LCS is prepared by adding a known concentration of analyte of interest into a clean medium. The LCS is then analyzed, and the results are compared to the laboratory’s control limits. During the study, 2,241 LCS analyses were performed, and only 2 of the results exceeded the control limits (Table 26). The analytes were Kjeldahl nitrogen and potassium. A total of 18 LCS recoveries were performed in batches for Kjeldahl nitrogen, and one (5.5%) was outside of the control limits. Out of 118 LCS recoveries for potassium only one (0.8%) result was below the control limit (Table 27). These results indicate that the laboratory analyses for the project were of acceptable accuracy. The environmental samples in these batches are shown in Table 28.

**Table 26 LCS sample recovery exeedances**

**Table 27 Frequency of QC batches with LCS sample recovery exceedances**

**Table 28 Environmental samples with LCS recovery exceedances**

## Matrix Spike Recovery

Matrix spike recoveries indicate the accuracy of recovering a known concentration of substance in a matrix of interest. The results of matrix spike recoveries indicate the accuracy of analysis given the interference peculiar to a given matrix. Matrix spikes are prepared by adding a known concentration of method analytes to an environmental sample with known background concentration. The percent recovery must fall within acceptable limits. During the study period, 4,092 matrix spike recoveries were performed. Only 40 (0.97%) matrix spikes exceeded the control limits. The matrix spike recoveries outside the control limits are shown in Table 29. The analytes that had matrix spike exceedances were alkalinity, ammonia, bromide, bromoform, calcium, Kjeldahl nitrogen, magnesium, phosphorus, sodium, and trichloroacetic acid. Alkalinity had a frequency of exceedance of 6.8%. Some of the recoveries were high, but the RPDs for those batches were in control. Recoveries that were lower than the control limits can be attributed to matrix interference, but the LCS for those batches were in control. The analyte with the highest frequency of exceedance was phosphorus. Very few matrix spikes were performed for this analyte, and the LCS recoveries were within limits. The results are not considered to have a significant impact on the overall data quality of the project. Trichloroacetic acid is out of recovery limits for both matrix spike and spike duplicate suggesting a matrix interference, although the RPD and LCS are in limits.

**Table 29 Matrix spike recovery exceedances**

The low frequency of recoveries outside the control limits for the remaining analytes was considered insignificant to the overall data quality of the project (Table 30). The LCS recoveries for these analytes were within limits, and the batches were in control. Therefore, the laboratory analyses were of acceptable accuracy, and matrix interference did not have significant effects on the analyses. The environmental samples in these batches are shown in Table 31.

**Table 30 Frequency of QC batches with matrix spike recovery exceedances**

**Table 31 Environmental samples with matrix spike recovery exceedances**

## Matrix Spike Duplicates

Matrix spike duplicate results indicate the precision of the analytical method in a given matrix. The difference between the duplicate samples is reported as a RPD. This difference is compared against the laboratory’s control limits as a conservative approach to determining precision. During the study period, 1,526 matrix spike duplicates were performed. Only 5 matrix spike duplicates exceeded the control limits (0.3%) (Table 32). The analytes were calcium, sodium, Kjeldahl nitrogen, and phosphorus. Kjeldahl nitrogen and phosphorus had the highest percent of matrix spike duplicates out of limits (Table 33). In both cases the matrix spikes also failed, and the samples had to be rerun. Overall matrix interference had no significant effects in the precision of the laboratory analysis of the environmental samples. The environmental samples with matrix spike duplicate exceedances are shown in (Table 34).

**Table 32 Matrix spike duplicate exceedances**

**Table 33 Number of matrix spike duplicate recovery exceedances**

**Table 34 Matrix spike duplicate exceedances**

## Sample Duplicates

Sample duplicates are environmental samples that are divided into 2 aliquots in the laboratory and analyzed independently to determine the repeatability of the analytical method. The RPD for the duplicate results must fall within the established control limits. During the study period, there were 813 RPD sample duplicates performed. Only 2 RPD sample duplicates (0.2%) exceeded the control limits. The environmental sample duplicates outside of the control limits are shown in Table 35.

**Table 35 Duplicate exceedances**

A total of 140 sample duplicate analyses were performed for DOC, and only one (0.7%) was outside the control limits.  Out of 99 sample duplicates analyses performed for total dissolved solids, only one (1%) was outside the control limits (Table 36).  These results indicate the laboratory had acceptable precision in its analysis of the project samples.  The environmental samples with sample duplicate exceedances are shown in Table 37.

**Table 36  Number of environmental sample duplicate exceedances**

**Table 37  Sample duplicate exceedances**

# Chapter 6 Summary, Conclusions, and Recommendations

## Summary and Conclusions

As part of the Municipal Water Quality Investigations' Urban Sources and Loads Project, the purpose of the Natomas East Main Drainage Canal (NEMDC) water quality investigation is to identify and evaluate drinking water quality pollutants contributed by this source and estimate loads of key pollutants of concern to the Delta and State Water Project drinking water intakes. This report analyzes and summarizes all water quality data collected at NEMDC beginning in 1997 through June 3, 2002. The report focuses on organic carbon and related parameters.

NEMDC hydrology was also evaluated beginning with the 2001/2002 event-based monitoring period. Two California Data Exchange Center precipitation stations—Sacramento Post Office [SPO] and Pineview School at Newcastle [NCS] —were selected at the upper and lower geographic bounds to estimate incident precipitation over the watershed area. Data from these stations were used to evaluate relationships with precipitation, stage, and water quality at the NEMDC monitoring site. Anecdotal information suggested that (1) even though the watershed is large, stream levels rise and fall rapidly along with rainfall intensity and (2) the watershed has a "flashy" hydrograph. Stage levels appear to have generally increased and decreased with daily rainfall, but correlations between stage and precipitation at both stations were weak. However, the data appear to indicate that sample collection according to event-based criteria established for the study (for example, rainfall amount and frequency) was generally successful.

Electrical conductivity (EC) and total dissolved solids (TDS) were relatively high at NEMDC, with TDS levels higher overall than in Sacramento area urban runoff, although the range of values was similar. Concentrations of both parameters were much higher in NEMDC than in the American and Sacramento rivers but were similar to values at Banks Pumping Plant. Bromide levels averaged 0.054 mg/L (with high value of 0.11 mg/L) and were detected in every sample. These concentrations were noteworthy because they were at or above the California Bay-Delta program's target of concern of 0.05 mg/L for drinking water sources. NEMDC nitrate levels were very high, often exceeding the maximum contaminant level (of 64 samples collected, 22 exceeded the MCL - as N). Nitrate data from NEMDC were much higher than urban runoff data from the City and County of Sacramento and other area cities. However, the city/county program collected a much smaller number of samples than were used for this study.

No purgeable organic compounds, pesticides, or other synthetic compounds were detected from 1997 to 2002, except MTBE and diazinon. MTBE was detected only twice out of 48 samples at 1 µg/L, well below the MCL of 13 µg/L. Diazinon was detected in 9 of 14 samples; 5 samples exceeded the chronic toxicity criterion of 0.05 µg/L (set by the California Department of

Fish and Game). Three samples exceeded the DFG's acute toxicity criterion of 0.08 µg/L.

Concentrations of total organic carbon (TOC) and dissolved organic carbon (DOC) by both wet oxidation and combustion methods generally increased and decreased during wet and dry periods associated with streamflows. High values for TOC of 12.7 mg/L (wet oxidation) and 13.1 mg/L (combustion) occurred after intense storm events. Low values for TOC of 3.1 mg/L (wet oxidation) and 5.1 mg/L (combustion) occurred after extended dry periods in early October 1998 and September 2001, respectively. Results for DOC were similar. Average TOC wet oxidation and combustion concentrations were significantly higher during the wet season than during the dry season. DOC concentrations were also significantly higher during the wet season.

There was a significant correlation between TOC and turbidity during the 1997–2002 and the 2001/2002 event periods. TOC by wet oxidation and turbidity were only weakly correlated. Correlations between TOC and total suspended solids (TSS) were also weak. The reason for the weak correlation is unknown, but it could be related to sample timing and flow travel time, along with erosion and soil runoff conditions in the upper watershed. Or it could be because TSS had a high mineral content and low organic carbon. Turbidity and TSS appear to have tracked each other; however, this correlation was also weak. Examination of TOC and turbidity by season showed that TOC both by wet oxidation and by combustion method was significantly correlated with turbidity during the wet season from 1997 to 2002. TOC combustion was also fairly well correlated with turbidity during the dry season from 1997 to 2002. There was no correlation between TOC by wet oxidation and turbidity during the dry season. Several findings were suggested by this data:

- TOC and turbidity may be controlled by similar flushing processes
- TOC and turbidity come from similar sources
- TOC sources may not be just primarily urban parts of the watershed but could also include rural portions

Comparing methods for TOC and DOC analyses, the combustion method always yielded higher results than wet oxidation. Values of TOC by combustion varied more than wet oxidation values because particulate levels were flushed into streams during storm events. Values for the combustion method also were usually higher than wet oxidation for DOC analyses. The average proportion of TOC composed of DOC remained relatively constant for the entire monitoring period, wet and dry seasons, and the 2001/2002 event season. Average values for DOC/TOC percent by wet oxidation ranged from 94% to 98%. Average values for DOC/TOC percent by combustion ranged from about 70% to 74%. Although DOC and TOC concentrations appear to have tracked larger storm events, correlations were weak between wet oxidation and combustion values and rainfall. Correlations also were weak between turbidity and rainfall and turbidity and TOC.

It appears that TOC and turbidity levels were more affected by individual rainfall events and exhibit somewhat of a "first-flush" effect commonly seen in storm water data, with less flushing of TOC and turbidity toward the end of the runoff period. Cumulative rainfall through the wet season could have saturated the soil and resulted in bank sloughing, overland flow, or runoff from similarly affected sources. This effect could be related to erosive conditions at construction sites or other areas with exposed, disturbed soils or where streambank conditions are unstable and watershed streamflows are highly responsive to rainfall or flashy. Stage was a better predictor than precipitation for TOC and DOC concentrations. Correlations were significant between TOC and DOC and stage for both wet oxidation and combustion methods, although those for TOC and DOC wet oxidation were stronger. The correlation was highly significant between turbidity and stage; however, the correlation was weak between TSS and stage.

Analysis of TOC loads contributed by NEMDC and other Sacramento area urban sources to the Sacramento River provided the most significant findings of this investigation. From July 2001 to June 2002, the TOC load contribution to the Sacramento River was frequently substantial from NEMDC, combined urban runoff sources, and combined urban runoff plus the Sacramento Regional Wastewater Treatment Plant (SRWTP). The percentage of daily TOC load in the Sacramento River contributed by NEMDC by month was found to be substantial in 5 of 12 months with significant storms during July 2001 to June 2002—namely, November, December, January, and March. Maximum values ranged from 4% to 21%. Adding the combined Sacramento urban sources increased NEMDC loads from 7% to 8% up to 25% during the significant storm periods.

Adding the TOC load from combined urban runoff and the SRWTP substantially increased the TOC contribution during much of the wet season, especially during winter storms. Ten of 12 months (minus December and January) had average values near or above 10%, and all months had maximum values well above 10%. Maximum values exceeded 20% during the months of October, November, March, April, and May. Also, the increase in Sacramento River TOC loads by adding the SRWTP TOC load during the dry season and late spring periods yielded the highest minimum and average values, including 2 of the highest maximum values (October, April). As observed above with NEMDC, the impact of urban TOC loads appears most pronounced when Sacramento River flows are low and urban drainage and discharges occur due to local storms and continual discharge from the SRWTP. Although this analysis strongly suggests that NEMDC and urban sources provide substantial TOC loads to the Sacramento River, it must be noted that the data presented are rough estimates based on correlated stage data and a preliminary flow rating table for NEMDC.

For pathogen analyses, total and fecal coliform and *E. coli* were analyzed using both most probable number (MPN) and colony forming units (CFU) methods (see Chapter 3 for description). As with other urban runoff results, coliform data were generally high. Bacteria densities were much higher during the wet season than the dry season. The highest MPN values for all bacteria were found in November, December, and January. MPN data were capped at a maximum of >1,600/100 mL due to method detection limits. A more representative range was seen in the CFU data. *E. coli* values were higher than fecal coliform for both median and quartile ranges. The magnitude and range of *E. coli* values was from several hundred to almost

10,000 CFU/100 mL. Fecal coliform and *E. coli* values were also still high in March and May. The lowest values were in February. For CFU results, approximately 10% of fecal coliforms were above the California Department of Health Services' regulatory guidance level of 10,000/100 mL; 42% of the data were above 400/100 mL. For *E. coli* CFU results, 70% of the data were above the single sample water quality objective of 235/100 mL.

## Recommendations

The method used in this report for the 2001/2002 season estimated stage and flow using the correlation with the upstream city sensor at Arcade Creek. The method was found to be adequate for rough preliminary estimates of total organic carbon (TOC) loads from the Natomas East Main Drainage Canal (NEMDC). However, a permanent continuous stage recorder and data logger are needed at the NEMDC site to provide a daily hydrograph during high flow periods and accurate daily flow measurements. Automated sample collection, proposed as part of the grant project, is also needed to provide flow-weighted TOC concentrations and accurate load estimates.

Upstream activities and sources of organic carbon in the watershed need to be identified and studied further. This work is part of the upcoming grant project, in partnership with the Dry Creek Conservancy.

The cumulative effects of TOC loads from urban sources on drinking water intakes (for example, Banks and Tracy pumping plants) from the Sacramento Metropolitan Area, the Stockton Metropolitan Area, the upper San Joaquin River, and the South Delta must be considered in future modeling efforts to adequately assess sources and loads of organic carbon. The upcoming grant project will help contribute to these efforts.

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# Metric Conversion Factors

| *Quantity* | *To Convert from Metric Unit* | *To Customary Unit* | *Multiply Metric Unit By* | *To Convert to Metric Unit Multiply Customary Unit By* |
|---|---|---|---|---|
| Length | millimeters (mm) | inches (in) | 0.03937 | 25.4 |
| | centimeters (cm) for snow depth | inches (in) | 0.3937 | 2.54 |
| | meters (m) | feet (ft) | 3.2808 | 0.3048 |
| | kilometers (km) | miles (mi) | 0.62139 | 1.6093 |
| Area | square millimeters ($mm^2$) | square inches ($in^2$) | 0.00155 | 645.16 |
| | square meters ($m^2$) | square feet ($ft^2$) | 10.764 | 0.092903 |
| | hectares (ha) | acres (ac) | 2.4710 | 0.40469 |
| | square kilometers ($km^2$) | square miles ($mi^2$) | 0.3861 | 2.590 |
| Volume | liters (L) | gallons (gal) | 0.26417 | 3.7854 |
| | megaliters | million gallons (10*) | 0.26417 | 3.7854 |
| | cubic meters ($m^3$) | cubic feet ($ft^3$) | 35.315 | 0.028317 |
| | cubic meters ($m^3$) | cubic yards ($yd^3$) | 1.308 | 0.76455 |
| | cubic dekameters ($dam^3$) | acre-feet (ac-ft) | 0.8107 | 1.2335 |
| Flow | cubic meters per second ($m^3/s$) | cubic feet per second ($ft^3/s$) | 35.315 | 0.028317 |
| | liters per minute (L/mn) | gallons per minute (gal/mn) | 0.26417 | 3.7854 |
| | liters per day (L/day) | gallons per day (gal/day) | 0.26417 | 3.7854 |
| | megaliters per day (ML/day) | million gallons per day (mgd) | 0.26417 | 3.7854 |
| | cubic dekameters per day ($dam^3$/day) | acre-feet per day (ac-ft/day) | 0.8107 | 1.2335 |
| Mass | kilograms (kg) | pounds (lbs) | 2.2046 | 0.45359 |
| | megagrams (Mg) | tons (short, 2,000 lb.) | 1.1023 | 0.90718 |
| Velocity | meters per second (m/s) | feet per second (ft/s) | 3.2808 | 0.3048 |
| Power | kilowatts (k/W) | horsepower (hp) | 1.3405 | 0.746 |
| Pressure | kilopascals (kPa) | pounds per square inch (psi) | 0.14505 | 6.8948 |
| | kilopascals (kPa) | feet head of water | 0.32456 | 2.989 |
| Specific capacity | liters per minute per meter drawdown | gallons per minute per foot drawdown | 0.08052 | 12.419 |
| Concentration | milligrams per liter (mg/L) | parts per million (ppm) | 1.0 | 1.0 |
| Electrical conductivity | microsiemens per centimeter (µS/cm) | micromhos per centimeter | 1.0 | 1.0 |
| Temperature | degrees Celsius (°C) | degrees Fahrenheit (°F) | (1.8X°C)+32 | 0.56(°F-32) |

# Tables

**Table 1  Stage monitoring data summary (feet), Jul 1999—Jun 2002**

| | Average | Median | Minimum | Maximum | *n* |
|---|---|---|---|---|---|
| Entire period | 15.00 | 13.28 | 12.47 | 25.55 | 66 |
| By season | | | | | |
| Dry (May–Oct) | 13.20 | 12.83 | 12.47 | 18.90 | 27 |
| Wet (Nov–Apr) | 16.25 | 14.55 | 12.87 | 25.55 | 39 |

**Table 2 Natomas East Main Drainage Canal watershed sample dates and precipitation station amounts (inches), 2001/2002**

| Date start - stop | Sample taken | Precipitation station ID[a] SPO | AMC | CHG | RLN | VNM | ORN | RSV | RYP | RTP | CPR | NCS | LMO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/30 | | 0.35 | 0.47 | 0.55 | 0.43 | 0.51 | 0.47 | 0.43 | 0.47 | 0.43 | 0.48 | 0.36 | 0.44 |
| 11/6 | 11/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/10 | | 0.06 | 0.06 | 0.04 | 0.08 | 0 | 0 | 0 | err | 0 | 0 | 0 | 0 |
| 11/11 | | 0.06 | 0.12 | 0.04 | 0.04 | 0.12 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 |
| 11/12 | 11/13 | 0.73 | 1.73 | 1.5 | 1.06 | 1.85 | 1.73 | 1.57 | 1.65 | 1.54 | 1.42 | 1.69 | 1.54 |
| 12/1 | | 0.59 | 0.63 | 0.63 | 0.51 | 0.55 | 0.59 | 0.43 | err | 0.48 | 0.39 | 0.4 | 0.31 |
| 12/2 | | 1.07 | 1.22 | 1.23 | 0.91 | 1.22 | 1.15 | 1.06 | err | 1.1 | 1.02 | 0.94 | 0.75 |
| 12/3 | 12/3 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | 0.08 | 0.03 | 0.08 | 0.04 | 0 | 0.08 | 0.06 |
| 12/28 | | 1.14 | 1.16 | 0.94 | 1.07 | 0.99 | 0.83 | 0.94 | 0.87 | 0.75 | 0.7 | 0.75 | 0.75 |
| 12/29 | | 0.33 | 0.59 | 0.55 | 0.39 | 0.47 | 0.59 | 0.48 | 0.47 | 0.51 | 0.67 | 0.71 | 0.67 |
| 12/30 | | 0.42 | 0.47 | 0.52 | 0.43 | 0.43 | 0.47 | 0.47 | 0.47 | 0.47 | 0.67 | 0.67 | 0.51 |
| 12/31 | | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0.04 |
| 1/1 | | 0.11 | 0.19 | 0.11 | 0.12 | 0.16 | 0.08 | 0.12 | 0.12 | 0.04 | 0.08 | 0.04 | 0.04 |
| 1/2 | 1/2 | 1.06 | 1.31 | 1.46 | 1.03 | 1.34 | 1.42 | 1.1 | 1.24 | 1.34 | 1.54 | 1.73 | 1.26 |
| 1/5 | | 0.36 | 0.36 | 0.28 | 0.39 | 0.31 | 0 | 0.26 | 0.26 | 0.2 | 0.27 | 0.24 | 0.24 |
| 1/6 | 1/7 | 0.03 | 0.07 | 0.04 | 0.08 | 0.04 | 0.27 | 0.02 | 0.03 | 0.04 | 0.04 | 0.04 | 0 |
| 1/26 | | 0.54 | 0.63 | 0.7 | 0.55 | 0.63 | 0.67 | 0.62 | 0.55 | 0.67 | 0.91 | 1.14 | 0.99 |
| 1/27 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1/28 | 1/28 | 0.09 | 0.08 | 0.08 | 0.08 | 0.12 | 0.12 | 0.07 | 0.08 | 0.11 | 0.07 | 0.11 | 0.08 |
| 2/3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2/4 | 2/4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2/16 | | 0.3 | 0.24 | 0.59 | 0.32 | 0.4 | 0.2 | 0.25 | 0.28 | 0.19 | 0.19 | 0.35 | 0.48 |
| 2/17 | | 0.21 | 0.16 | 0.27 | 0.07 | 0.12 | 0.27 | 0.08 | 0.14 | 0.27 | 0.12 | 0.28 | 0.27 |
| 2/19 | | 0.19 | 0.31 | 0.4 | 0.2 | 0.27 | 0.28 | 0.24 | 0.19 | 0.31 | 0.59 | 0.77 | 0.71 |

Note: Precipitation (rainfall) amounts are for 24-hour period from start date.

*Table continued on next page*

**Table 2 continued**

| Date start - stop | Sample taken | Precipitation station ID[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SPO | AMC | CHG | RLN | VNM | ORN | RSV | RYP | RTP | CPR | NCS | LMO |
| 3/5 | 3/4 | 0.08 | 0.11 | 0.12 | 0.08 | 0.12 | 0.11 | 0.15 | 0.12 | 0.08 | 0.24 | 0.26 | 0.23 |
| 3/6 | 3/7 | 1.01 | 1.18 | 1.45 | 0.91 | 1.18 | 1.46 | 1.3 | 1.1 | 1.34 | 1.57 | 1.34 | 1.15 |
| 3/7 | | 0.19 | 0.16 | 0.36 | 0.08 | 0.12 | 0.24 | 0.04 | 0.06 | 0.36 | 0.08 | 0.18 | 0.27 |
| 3/10 | | 0.51 | 0.47 | 0.63 | 0.51 | 0.51 | 0.67 | 0.43 | 0.44 | 0.63 | 0.63 | 0.66 | 0.55 |
| 3/22 | | 0.6 | 0.47 | 0.59 | 0.67 | 0.39 | 0.52 | 0.51 | 0.4 | 0.55 | 0.51 | 0.75 | 0.75 |
| 3/23 | | 0.38 | 0.24 | 0.36 | 0.67 | 0.24 | 0.35 | 0.24 | 0.23 | 0.44 | 0.83 | 0.79 | 0.51 |
| 3/31 - 4/2 | 4/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4/9 | | 0.03 | 0.08 | 0 | 0.04 | 0.04 | 0 | 0.08 | 0 | 0 | 0.04 | 0.04 | 0 |
| 4/15 | | 0 | 0.12 | 0.19 | 0 | 0.15 | 0.16 | 0.04 | 0 | 0.04 | 0.04 | 0 | 0 |
| 4/16 | | 0.04 | 0.07 | 0.2 | 0.08 | 0.12 | 0.16 | 0.11 | 0 | 0.15 | 0.19 | 0.23 | 0.12 |
| 4/17 | | 0 | 0.28 | 0.2 | 0.16 | 0.36 | 0.35 | 0.28 | 0.12 | 0.52 | 0.08 | 0.12 | 0.20 |
| 4/20 - 4/25 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4/26 | | 0.08 | 0 | 0 | 0 | 0.03 | 0.04 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4/29 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 | 0.08 | 0.03 |
| 4/30 | | 0 | 0 | 0 | 0 | 0.04 | 0 | 0 | 0 | 0 | 1.38 | 0.27 | 0.12 |
| 5/1-5/5 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5/6 | 5/6 | 0 | 0 | 0 | 0 | 0 | 0 | end data | 0 | 0 | 0 | 0 | 0 |
| 5/19 | | 0.35 | 0.35 | 0.23 | 0.39 | 0.39 | 0.43 | * | err | 0.51 | 0.43 | 0.4 | 0.40 |
| 5/20 | | 1.19 | 1.50 | 1.46 | 1.06 | 1.81 | 1.42 | | 1.26 | 1.00 | 1.18 | 1.42 | 1.33 |
| 5/21 | 5/21 | 0.24 | 0.27 | 0.12 | 0.08 | 0.24 | 0.16 | | | 0.26 | 0.40 | 0.39 | 0.60 |
| 5/22 | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |
| 6/2 | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |
| 6/3 | 6/3 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |
| | Totals | 12.39 | 15.14 | 15.88 | 12.52 | 15.31 | 15.33 | 11.39 | 10.67 | 14.45 | 16.8 | 17.31 | 15.45 |

Note: Precipitation (rainfall) amounts are for 24-hour period from start date.

a. Station legend:
SPO Sacramento Post Office
AMC Arcade Creek @ American River College
CHG Chicago Street
RLN Rio Linda WC
VNM Van Maren
ORN Orangevale WC
RSV Roseville Fire Station
RYP Royer Park - Dry Creek
RTP Roseville Water Treatment Plant
CPR Caperton Reservoir
NCS Newcastle - Pineview School
LMO Loomis Observatory

* No data available on CDEC after this date.

## Table 3 Natomas East Main Drainage Canal hydrologic monitoring data summary, 2001/2002

| Date | Sample day | Stage (feet) | Rainfall (inches) [a] SPO | Rainfall (inches) [a] NCS | Month | Rainfall totals (inches) SPO | Rainfall totals (inches) NCS |
|---|---|---|---|---|---|---|---|
| 10/1/01 | X | 13.41 | 0 | 0 | October | 0.35 | 0.36 |
| 11/7/01 | X | 13.20 | 0 | 0 | November | 2.33 | 3.42 |
| 11/13/01 | X | 16.64 | 0.73 | 1.73 | December | 6.00 | 7.84 |
| 12/3/01 | X | 16.67 | 1.11 | 1.02 | January | 2.25 | 3.38 |
| 12/30/01 | | 16.98 | 0.75 | 1.38 | February | 1.04 | 1.93 |
| 1/2/02 | X | 20.44 | 1.17 | 1.77 | March | 2.85 | 4.18 |
| 1/6/02 | | 20.35 | 0.39 | 0.28 | April | 0.15 | 0.74 |
| 1/7/02 | X | 19.11 | 0.04 | 0.04 | May | 1.78 | 2.21 |
| 1/28/02 | X | 13.75 | 0.09 | 0.11 | | | |
| 2/4/02 | X | 13.35 | 0 | 0 | | | |
| 3/4/02 | X | 13.11 | 0 | 0 | | | |
| 3/7/02 | X | 17.31 | 1.20 | 1.54 | | | |
| 3/10/02 | | 15.71 | 0.51 | 0.66 | | | |
| 3/11/02 | | 15.11 | 0 | 0 | | | |
| 4/2/02 | X | 13.13 | 0 | 0 | | | |
| 5/6/02 | X | 12.72 | 0 | 0 | | | |
| 5/18/02 | | 12.68 | 0 | 0 | | | |
| 5/20/02 | | 15.64 | 0.35 | 0.40 | | | |
| 5/21/02 | X | 18.90 | 1.43 | 1.81 | | | |
| 6/3/02 | X | 12.63 | 0 | 0 | | | |

a. Total 48-hour rainfall ending sampling day.
Note: Stage measurements taken at El Camino Avenue bridge.
SPO - Sacramento Post Office CDEC station
NCS - Newcastle-Pineview School CDEC station

## Table 4 Summary statistics for minerals and inorganic analyses, Nov 1997–Jun 2002

| Parameter | Mean | Median | Min | Max | Percentile 10%–90% | # detects/ # samples |
|---|---|---|---|---|---|---|
| Conductivity (EC) (µS/cm) - Std Method 2510-B | 350 | 353 | 81 | 561 | 192–485 | 64/64 |
| Dissolved boron (mg/L) - EPA 200_7 (D) | 0.15 | 0.15 | 0.10 | 0.24 | 0.1–0.2 | 48/64 |
| Dissolved bromide (mg/L) - EPA 300.0 28d Hold | 0.054 | 0.060 | 0.010 | 0.110 | 0.029–0.08 | 64/64 |
| Dissolved calcium (mg/L) - EPA 200_7 (D) | 21.6 | 21.6 | 7.0 | 33.0 | 13.3–30 | 64/64 |
| Dissolved chloride (mg/L) - EPA 300_0 28d Hold | 36 | 38 | 3 | 71 | 12–56 | 64/64 |
| Dissolved potassium (mg/L) - EPA 200_7 (D) | 4.4 | 4.4 | 2.4 | 7.2 | 2.6–6.5 | 64/64 |
| Dissolved sodium (mg/L) - EPA 200_7 (D) | 31.8 | 34.0 | 4.2 | 50.0 | 13.1–46.7 | 64/64 |
| Dissolved sulfate (mg/L) - EPA 300_0 28d Hold | 21 | 21 | 4 | 34 | 10–29 | 64/64 |
| Hardness (mg/L as $CaCO_3$) - Std Method 2340 B | 93 | 85 | 27 | 165 | 56–138 | 64/64 |
| pH - Std Method 5910B | 7.6 | 7.6 | 6.5 | 8.3 | 7.2–8.0 | 60/60 |
| Total alkalinity (mg/L as $CaCO_3$) - Std Method 2320 B | 85.1 | 74.0 | 28.0 | 169.2 | 49.3–137.6 | 64/64 |
| Total dissolved solids (mg/L) - Std Method 2540 C | 211 | 219 | 58 | 338 | 126–279 | 64/64 |
| Total suspended solids (mg/L) - EPA 160_2 | 34 | 31 | 17 | 57 | 19–57 | 13/13 |
| Turbidity (NTU) - EPA 180_1 | 31.6 | 21.2 | 7.0 | 109.0 | 12.3–60.7 | 64/64 |
| Dissolved aluminum (mg/L) - EPA 200.8 (D) | 0.063 | 0.019 | 0.010 | 0.391 | 0.01–0.195 | 49/61 |
| Dissolved arsenic (mg/L) - EPA 200.8 (D) | 0.003 | 0.003 | 0.001 | 0.006 | 0.002–0.004 | 59/61 |
| Dissolved copper (mg/L) - EPA 200.8 (D) | 0.003 | 0.003 | 0.001 | 0.006 | 0.002–0.004 | 60/61 |
| Dissolved iron (mg/L) - EPA 200.8 (D) | 0.090 | 0.065 | 0.005 | 0.342 | 0.02–0.225 | 58/61 |
| Dissolved magnesium (mg/L) - EPA 200_7 (D) | 9.35 | 7.19 | 2.33 | 20.00 | 5.0–15.70 | 64/64 |
| Dissolved manganese (mg/L) - EPA 200_8 (D) | 0.037 | 0.034 | 0.005 | 0.104 | 0.015–0.057 | 60/61 |

Note: For summary calculations, detection limit (DL) substituted for values < DL.

## Table 5 Comparison of inorganic parameters at selected receiving waters

| | NEMDC | Sac UR | American | WSacInt | Banks PP |
|---|---|---|---|---|---|
| EC (µS/cm) | | | | | |
| Minimum | 81 | no | 40 | 112 | 215 |
| Maximum | 561 | data | 71 | 241 | 725 |
| Average | 350 | | 55 | 161 | 408 |
| Median | 353 | | 54 | 155 | 384 |
| TDS (mg/L) | | | | | |
| Minimum | 58 | 42 | 30 | 71 | 123 |
| Maximum | 338 | 360 | 54 | 148 | 388 |
| Average | 211 | 151 | 39 | 100 | 228 |
| Median | 219 | no data | 39 | 97 | 220 |
| Turbidity (NTUs) | | | | | |
| Minimum | 7.0 | no | 1 | 6 | 3 |
| Maximum | 109.0 | data | 11 | 65 | 68 |
| Average | 31.6 | | 3 | 15 | 16 |
| Median | 21.2 | | 2 | 13 | 12 |

Receiving water data source: MWQI 1998-2001
EC = electrical conductivity; TDS = total dissolved solids
Sac UR = combined wet and dry weather monitoring, 3 Sacramento urban runoff sites, 1999/2000 and 2000/2001 Sacramento Stormwater Program Annual Monitoring Reports.
American = American River at Fairbairn WTP
WSacInt = Sacramento River at W.Sacramento Bryte Bend WTP Intake
Banks PP = Banks Pumping Plant (State Water Project)

## Table 6 Summary statistics for nutrient analyses, Nov 1997–Jun 2002

| Parameter (mg/L) | Mean | Median | Min | Max | Percentile 10%–90% | # detects/ # samples |
|---|---|---|---|---|---|---|
| Dissolved ammonia - EPA 350_1 | 0.08 | 0.08 | 0.01 | 0.21 | 0.02–0.13 | 25/26 |
| Dissolved nitrate - EPA 300_0 [a] | 9.7 | 8.7 | <0.1 | 22.8 | 2.8–18.0 | 25/26 |
| Dissolved nitrate - Std Method 4500-$NO_3$-F | 8.8 | 8.1 | 1.8 | 16.3 | 4.6–14.9 | 38/38 |
| Dissolved nitrite + nitrate - Std Method 4500-$NO_3$-F | 1.82 | 1.40 | 0.63 | 5.40 | 0.77–2.88 | 13/13 |
| Total Kjeldahl nitrogen - EPA 351_2 | 0.92 | 0.80 | 0.50 | 1.50 | 0.62–1.28 | 13/13 |
| Dissolved orthophosphate - Std Method 4500-P, F | 0.42 | 0.32 | 0.18 | 1.30 | 0.2–0.71 | 13/13 |
| Total phosphorus - EPA 365_4 | 0.55 | 0.44 | 0.26 | 1.50 | 0.29–0.89 | 13/13 |

a. Includes 28-day hold and 48 hour ($N0_3$, orthoP) methods.
Note: Nitrate values from Nov 1997–Oct 2000 by Std Method 4500; values from Nov 2000 on EPA 300_0.
All nitrate values reported as NO3; nitrate+nitrite values reported as N; all phosphate values reported as P.
(Revised. See N1 07-20-06 in Errata)
For summary calculations, DL substituted for values < DL.

## Table 7 Summary statistics for selected organic analyses, Nov 1997–Jun 2002

| Parameter (µg/L) | Mean | Median | Min | Max | Percentile 10%–90% | # detects/ # samples |
|---|---|---|---|---|---|---|
| EPA method 614 (phosphorus/nitrogen pesticides)[a] | | | | | | |
| Chlorpyrifos | - | | | | | 0/14 |
| Diazinon | 0.06 | 0.03 | 0.01 | 0.19 | 0.01–0.17 | 9/14 |
| Azinphos methyl (Guthion) | - | | | | | 0/14 |
| Benfluralin | - | | | | | 0/14 |
| Bromacil | - | | | | | 0/14 |
| Carbophenothion (Trithion) | - | | | | | 0/14 |
| Cyanazine | - | | | | | 0/14 |
| Demeton (Demeton O + Demeton S) | - | | | | | 0/14 |
| Dimethoate | - | | | | | 0/14 |
| Disulfoton | - | | | | | 0/14 |
| Ethion | - | | | | | 0/14 |
| Malathion | - | | | 0.030 | (*) | 1/14 |
| Methidathion | - | | | | | 0/14 |
| Mevinphos | - | | | | | 0/14 |
| Naled | - | | | | | 0/14 |
| Napropamide | - | | | | | 0/14 |
| Norflurazon | - | | | | | 0/14 |
| Parathion (Ethyl) | - | | | | | 0/14 |
| Parathion, Methyl | - | | | | | 0/14 |
| Pendimethalin | - | | | | | 0/14 |
| Phorate | - | | | | | 0/14 |
| Phosalone | - | | | | | 0/14 |
| Phosmet | - | | | | | 0/14 |
| Profenofos | - | | | | | 0/14 |
| Prometryn | - | | | | | 0/14 |
| Propetamphos | - | | | | | 0/14 |
| s,s,s-Tributyl Phosphorotrithioate (DEF) | - | | | | | 0/14 |
| Trifluralin | - | | | | | 0/14 |
| EPA method 502_2 (Purgeable organics) | | | | | | |
| Methyl tert-butyl ether (MTBE)[b] | - | | 1.1 | 1.1 | | 2/48 |
| All others[c] (benzene, toluene, xylene, TCE, TCA, etc.) | - | | | | | 0/6 |

a. Analyzed Nov 1999 and Nov 2001–Jun 2002.
b. Analyzed Nov 1997–Oct 2001.
c. Analyzed Dec 1997–May 1998.
(*) Single result. Summary calculations N/A.
Note: For summary calculations, DL substituted for values < DL.

## Table 8 Summary statistics for organic carbon and $UVA_{254}$ analyses, Nov 1997–Jun 2002

| Parameter | Mean | Median | Min | Max | Percentile 10%–90% | # detects/ # samples |
|---|---|---|---|---|---|---|
| Total organic carbon (mg/L) - EPA 415.1 (T) ox | 6.16 | 5.20 | 3.10 | 12.70 | 4.26–9.25 | 44/44 |
| Total organic carbon (mg/L) - EPA 415.1 (T) comb | 8.60 | 8.20 | 5.10 | 13.10 | 5.50–12.26 | 24/24 |
| Dissolved organic carbon (mg/L) - EPA 415.1 (D) ox | 5.85 | 5.35 | 3.10 | 10.60 | 4.36–8.17 | 64/64 |
| Dissolved organic carbon (mg/L) - EPA 415.1 (D) comb | 7.82 | 7.50 | 4.90 | 11.20 | 5.58–10.22 | 13/13 |
| UV absorbance @254 nm - Std Method 5910B | 0.17 | 0.14 | 0.08 | 0.34 | 0.12–0.30 | 64/64 |
| SUVA - (using EPA 415.1 (D) ox) | 0.0290 | 0.0280 | 0.0198 | 0.0419 | 0.0246–0.0372 | N/A |
| Turbidity (NTU) - EPA 180_1 | 31.6 | 21.2 | 7.0 | 109.0 | 12.3–60.7 | 64/64 |
| Total suspended solids (mg/L) - EPA 160_2 | 34 | 31 | 17 | 57 | 19–57 | 13/13 |

## Table 9 Comparison of organic carbon data for Natomas East Main Drainage Canal, Sacramento area urban runoff, and receiving waters (mg/L)

| | NEMDC | | Sac UR[a] | | American R | | Sac WSI | | Banks PP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TOC | DOC | TOC | DOC | TOC | DOC | TOC | DOC | TOC | DOC |
| Maximum | 12.7 | 10.6 | 56 | 46 | 2.0 | 2.2 | 2.8 | 3.5 | 6.6 | 6.2 |
| Minimum | 3.1 | 3.1 | 10.6 | 1 | 1.1 | 0.9 | 1.2 | 1.2 | 0.0 | 2.3 |
| Average | 6.2 | 5.85 | - | - | 1.4 | 1.4 | 1.7 | 1.7 | 4.0 | 4.0 |
| Median | 5.2 | 5.35 | 11 | 9 | 1.4 | 1.3 | 1.6 | 1.5 | 4.0 | 4.0 |

Source: Three receiving water station data from Aug 1998–October 2001: MWQI database. See Sac UR below.
a. Median calculated with DL substituted for values < DL.
Note: All values by wet oxidation method; TOC = total organic carbon; DOC = dissolved organic carbon.
( - ) = Calculation of mean not applicable.
Sac UR = Sacramento area urban runoff (combined data from wet and dry weather events; Source: Larry Walker Associates 2000 and 2001)
American R = American River at Fairbairn WTP
Sac WSI = West Sacramento Bryte Bend WTP Intake
Banks PP = Banks Pumping Plant

**Table 10 Summary statistics and dissolved organic carbon/total organic carbon proportion by method**

| Total period 1997–2002 | TOC ox (mg/L) | TOC comb (mg/L) | DOC ox (mg/L) | DOC comb (mg/L) | DOC/TOC ox (%) | DOC/TOC comb (%)[a] | |
|---|---|---|---|---|---|---|---|
| Average | 6.16 | 8.60 | 5.85 | 7.82 | 96.0% | 72.8% | |
| Minimum | 3.10 | 5.10 | 3.10 | 4.90 | | | |
| Maximum | 12.70 | 13.10 | 10.60 | 11.20 | | | |
| Count | 44 | 24 | 64 | 13 | 42 | 24 | |
| **Wet seasons 1997–2002** | **TOC ox** | **TOC comb** | **DOC ox** | **DOC comb** | **DOC/TOC ox (%)** | **DOC/TOC comb (%)[a]** | |
| Average | 6.98 | 9.40 | 6.45 | 8.13 | 94.3% | 72.2% | |
| Minimum | 3.60 | 5.40 | 3.60 | 4.90 | | | |
| Maximum | 12.70 | 13.10 | 10.60 | 11.20 | | | |
| Count | 25 | 16 | 37 | 10 | 24 | 16 | |
| **Dry seasons 1997–2002** | **TOC ox** | **TOC comb** | **DOC ox** | **DOC comb** | **DOC/TOC ox (%)** | **DOC/TOC comb (%)[a]** | |
| Average | 5.09 | 6.99 | 5.03 | 6.80 | 98.1% | 73.9% | |
| Minimum | 3.10 | 5.10 | 3.10 | 5.50 | | | |
| Maximum | 8.50 | 10.60 | 8.00 | 7.60 | | | |
| Count | 19 | 8 | 27 | 3 | 18 | 8 | |
| **Event season 2001/2002** | **TOC ox** | **TOC comb** | **DOC ox** | **DOC comb** | **DOC/TOC ox (%)** | **DOC/TOC comb (%)[a]** | **DOC/TOC comb (%)[b]** |
| Average | 6.82 | 9.37 | 6.27 | 7.82 | 94.0% | 69.7 | 81.3% |
| Minimum | 4.20 | 5.10 | 4.30 | 4.90 | | | |
| Maximum | 12.70 | 13.10 | 10.60 | 11.20 | | | |
| Count | 15 | 14 | 15 | 13 | 15 | 14 | 13 |

a. Calculated using DOC wet oxidation values.
b. Calculated using DOC combustion values because this parameter not monitored until 2001/2002 event season.
DOC = dissolved organic carbon
TOC = total organic carbon

**Table 11 Summary statistics for specific UV absorbance (absorb/cm) X100**

| | Average | Median | Minimum | Maximum | Percentiles 10–90 | Percentiles 25–75 | Count |
|---|---|---|---|---|---|---|---|
| 1997–2002 | 2.90 | 2.80 | 1.98 | 4.19 | 2.46–3.72 | 2.58–3.13 | 64 |
| Wet season | 2.98 | 2.97 | 1.98 | 4.19 | 2.22–3.83 | 2.54–3.41 | 37 |
| Dry season | 2.79 | 2.71 | 2.48 | 3.93 | 2.50–3.00 | 2.60–2.85 | 27 |
| Event 2001/2002 | 3.08 | 2.93 | 2.18 | 3.93 | 2.51–3.85 | 2.71–3.52 | 15 |

**Table 12 Cumulative rainfall (inches) by period, Nov 2001–May 2002**

| | Oct 30 | Nov–Jan 2 | Jan 2–Feb | Mar–May | Total |
|---|---|---|---|---|---|
| Sacramento Post Office (SPO) | 0.35 | 9.5 | 2.5 | 4.8 | 17.2 |
| Newcastle-Pineview School (NCS) | 0.36 | 13.0 | 3.6 | 7.1 | 24.1 |

## Table 13 Summary statistics for daily total organic carbon load: Sacramento River vs. Natomas East Main Drainage Canal, Jul 2001–Jun 2002

| | Sac R flow@Hood (cfs) | | | Daily avg TOC[a] (mg/L) | | | Sac R TOC load (lbs/day) | | | NEMDC TOC load (lbs/day) | | | % Daily TOC load from NEMDC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month-year | Avg | Min | Max | Avg | Min | Max | Avg | Min | Max | Avg | Min | Max | Min | Max |
| Jul-2001 | 14,846 | 13,735 | 16,062 | 2.00 | 1.71 | 2.25 | 159,953 | 134,669 | 179,970 | 1,172 | 1,060 | 1,254 | 0.64% | 0.88% |
| Aug-2001 | 13,153 | 11,728 | 14,996 | 2.07 | 2.03 | 2.53 | 146,421 | 128,332 | 179,659 | 1,084 | 993 | 1,186 | 0.58% | 0.85% |
| Sep-2001 | 12,340 | 11,600 | 13,323 | 2.20 | 1.90 | 2.47 | 146,377 | 118,802 | 162,414 | 1,016 | 789 | 1,142 | 0.56% | 0.89% |
| Oct-2001 | 8,264 | 6,700 | 11,100 | 2.19 | 1.76 | 3.17 | 97,016 | 71,718 | 141,300 | 1,023 | 927 | 1,275 | 0.71% | 1.51% |
| Nov-2001 | 12,079 | 8,720 | 22,204 | 4.93 | 3.38 | 5.69 | 327,288 | 174,341 | 681,016 | 5,640 | 896 | 44,032 | 0.32% | 12.73% |
| Dec-2001 | 26,912 | 17,813 | 36,204 | 5.19 | 4.25 | 6.69 | 757,203 | 456,230 | 1,166,822 | 8,480 | 1,491 | 46,601 | 0.17% | 7.45% |
| Jan-2002 | 41,014 | 20,080 | 65,552 | 4.16 | 2.47 | 6.94 | 1,033,063 | 266,805 | 2,389,521 | 20,308 | 1,437 | 71,220 | 0.40% | 3.89% |
| Feb-2002 | 18,219 | 14,395 | 31,119 | 2.22 | 1.62 | 4.02 | 226,783 | 133,940 | 594,768 | 1,514 | 868 | 3830 | 0.15% | 2.02% |
| Mar-2002 | 21,801 | 17,805 | 28,868 | 2.04 | 1.78 | 2.69 | 243,454 | 170,355 | 378,237 | 3,524 | 760 | 25,146 | 0.41% | 12.17% |
| Apr-2002 | 14,496 | 10,946 | 16,999 | 1.33 | 0.67 | 1.73 | 101,013 | 57,242 | 143,434 | 947 | 768 | 1,083 | 0.60% | 1.84% |
| May-2002 | 12,936 | 9,641 | 20,295 | 1.93 | 1.57 | 2.05 | 135,859 | 81,563 | 224,177 | 3,905 | 879 | 44,074 | 0.59% | 21.05% |
| Jun-2002 | 12,643 | 12,454 | 12,918 | 1.67 | 1.65 | 1.69 | 113,855 | 111,903 | 116,001 | 958 | | 958 | 0.83% | 0.86% |

a. Total organic carbon (TOC) by wet oxidation data from Sievers unit at Hood

**Table 14 Total organic carbon loads from combined Sacramento Metropolitan Area urban runoff and Sacramento Regional Wastewater Treatment Plant vs. Sacramento River**

| | % Sac R TOC load w/total Sac Metro Area UR load[a] (% - lbs/day) | | | Total % Sac R TOC load w/SRWTP and UR loads[b] (% - lbs/day) | | | % Upper Sac R TOC load (% - lbs/day) | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Avg | Min | Max | Avg | Min | Max | Avg | Min | Max |
| Jul-01 | 1.47% | 1.29% | 1.76% | 12.86% | 11.44% | 15.19% | 85.66% | 83.05% | 87.17% |
| Aug-01 | 1.49% | 1.16% | 1.71% | 13.91% | 11.23% | 15.79% | 84.60% | 82.50% | 87.61% |
| Sep-01 | 1.40% | 1.12% | 1.77% | 13.87% | 12.38% | 16.98% | 84.73% | 81.25% | 86.37% |
| Oct-01 | 2.20% | 1.42% | 3.02% | 21.67% | 14.22% | 28.23% | 76.12% | 68.75% | 84.36% |
| Nov-01 | 3.44% | 0.65% | 25.47% | 9.60% | 3.30% | 30.69% | 86.97% | 43.84% | 96.05% |
| Dec-01 | 2.50% | 0.33% | 14.90% | 5.07% | 2.12% | 17.79% | 92.44% | 67.31% | 97.38% |
| Jan-02 | 2.85% | 0.80% | 7.77% | 5.82% | 2.94% | 11.46% | 91.33% | 83.47% | 96.08% |
| Feb-02 | 1.59% | 0.31% | 4.04% | 10.86% | 3.35% | 14.99% | 87.55% | 82.30% | 96.34% |
| Mar-02 | 3.05% | 0.81% | 24.34% | 10.99% | 6.01% | 33.09% | 85.96% | 42.57% | 92.99% |
| Apr-02 | 2.08% | 1.21% | 3.68% | 22.10% | 14.12% | 34.93% | 75.82% | 61.49% | 84.60% |
| May-02 | 4.73% | 1.18% | 42.11% | 19.19% | 9.49% | 50.75% | 76.08% | 7.14% | 89.27% |
| Jun-02 | 1.68% | 1.65% | 1.71% | 17.57% | 17.24% | 17.87% | 80.75% | 80.42% | 81.11% |

a. Assumes 2X NEMDC load to estimate all Sac Metro area urban runoff.
b. Based on median SRWTP load of 18,080 lbs/day, Sept 1991–Jun 1998.
TOC = total organic carbon
UR = urban runoff
SRWTP = Sacramento Regional Wastewater Treatment Plant

**Table 15 Percent contribution and number of days by source of total organic carbon load to the Sacramento River, 2001/2002**

| | Number of days by source | | |
|---|---|---|---|
| Percent contribution | NEMDC load | Combined Sac Metro Area UR load | Combined UR load plus SRWTP load |
| 5 | 15 | 32 | 301 |
| 10 | 4 | 9 | 228 |
| 20 | 1 | 4 | 44 |

Note: Jul 2001–Jun 2002, *n* = 320
SRWTP = Sacramento Regional Wastewater Treatment Plant
UR = urban runoff

**Table 16 Summary statistics for trihalomethane and haloacetic acid formation potential analyses, Nov 1997–Jun 2002**

| Parameter (µg/L) | Mean | Median | Low | High | Percentile 10–90% | # detects/ # samples |
|---|---|---|---|---|---|---|
| THMs | | | | | | |
| Bromodichloromethane - DWR THMFP (Buffered) | 40.31 | 44 | 10 | 56 | 19.6–52 | 12/13 |
| Bromoform - DWR THMFP (Buffered) | - | | | | | 0/13 |
| Chloroform - DWR THMFP (Buffered) | 636 | 579 | 335 | 1,000 | 407–938 | 13/13 |
| Dibromochloromethane - DWR THMFP (Buffered) | - | - | - | 5.6 | - | 1/13[a] |
| Total THMFP | 696 | 631 | 401 | 1,062 | 476–995 | N/A |
| HAAs | | | | | | |
| Bromochloroacetic Acid (BCAA) - DWR HAAFP (Reactivity) | 11.83 | 13 | 2 | 18.5 | 2.00–18.1 | 7/9 |
| Dibromoacetic Acid (DBAA) - DWR HAAFP (Reactivity) | - | - | <1 | 4 | - | 1/9[b] |
| Dichloroacetic Acid (DCAA) - DWR HAAFP (Reactivity) | 101.5 | 104.3 | 47 | 180 | 55.8–148 | 9/9 |
| Monobromoacetic Acid (MBAA) - DWR HAAFP (Reactivity) | - | | | | | 0/9 |
| Monochloroacetic Acid (MCAA) - DWR HAAFP (Reactivity) | - | | | | | 0/9 |
| Trichloroacetic Acid (TCAA) - DWR HAAFP (Reactivity) | 131.7 | 114.1 | 66 | 200 | 66.0–192 | 9/9 |
| Total HAAs | 250 | 240 | 140 | 404 | 147–354 | N/A |

a. One detect of 5.6 µg/L - reporting limit of 5 µg/L.
b. One detect of 4.0 µg/L - reporting limit of 1 µg/L.
Notes: Only trihalomethane formation potential (THMFP) buffered results presented because method now preferred by MWQI for most analyses.
Haloacetic acid (HAA) reactivity method results presented because most data were in this form.
For summary calculations, DL substituted for values < DL.

**Table 17 Summary statistics for total trihalomethane formation potential data at selected sites (µg/L)**

| | Mean | Median | Low | High | Percentile 10–90% | *n* |
|---|---|---|---|---|---|---|
| NEMDC | 696 | 631 | 401 | 1062 | 476–995 | 13 |
| Sac River WSI | 208 | 182 | <1 | 816 | 121–334 | 62 |
| Banks PP | 395 | 358 | 272 | 698 | 293–568 | 18 |
| NBA PP[a] | 884 | 845 | 560 | 1500 | 600–1,240 | 16 |

a. Total Ttrihalomethane (TTHMFP) unavailable. 1997/1998 Chloroform presented. It is the highly predominant THM.
Note: Sac River WSI = Sacramento River at West Sacramento WTP Intake 1994–1998
Banks PP = Banks Pumping Plant 1998–2000
NBA PP = North Bay Aqueduct Pumping Plant

## Table 18 Summary statistics for bacteria densities (MPN) at Natomas East Main Drainage Canal, Nov 2001–Jun 2002

| | Mean | Median | Minimum | Maximum | 10% | 90% | # Detected/ count | # above DL |
|---|---|---|---|---|---|---|---|---|
| Total coliform | 1362 | >1600 | 300 | >1600 | 580 | 1600 | 13/13 | 8 |
| Fecal coliform | 807 | 500 | 23 | > 1600 | 148 | 1600 | 13/13 | 4 |
| *E. coli* | 824 | 300 | 23 | > 1600 | 130 | 1600 | 11/11 | 3 |

MPN = most probable number

## Table 19 Summary statistics for bacteria densities (CFU) at Natomas East Main Drainage Canal, Nov 2001–Jun 2002

| | Mean | Median | Minimum | Maximum | 10% | 90% | # Detected/ count | # above DL |
|---|---|---|---|---|---|---|---|---|
| Total coliform | 9,308 | 1,750 | 600 | 57,000 | 630 | 20,000 | 12/12 | 3 |
| Fecal coliform | 1,372 | 260 | 8 | 6,550 | 19 | 3,980 | 12/12 | 1 |
| *E. coli* | 8,211 | 1,050 | < 4 | 48,000 | 9 | 22,800 | 10/10 | 2 |

CFU = colony forming units

## Table 20 Summary of field duplicates

| Analyte | Collection date | Sample number | Sample duplicate | Result 1 | Result 2 | RPD | RPD limit |
|---|---|---|---|---|---|---|---|
| Bromochloroacetic acid | 4/6/1998 | CB0498A0337 | CB0498A0341 | 16 | 0 | 200 | 30 |
| Bromodichloromethane | 1/7/1998 | CB0198A0001 | CB0198A0005 | 22 | 36 | 48.28 | 20 |
| Chloroform | 1/7/1998 | CB0198A0001 | CB0198A0005 | 170 | 430 | 86.67 | 20 |
| Dissolved aluminum | 12/1/1998 | CB1298A4300 | CB1298A4304 | 0.491 | 0.367 | 28.9 | 25 |
| Dissolved boron | 12/1/1998 | CB1298A4300 | CB1298A4304 | 0.111 | 0 | 200 | 25 |
| Dissolved copper | 4/6/1998 | CB0498A0337 | CB0498A0341 | 0.0041 | 0.006 | 37.62 | 25 |
| Dissolved iron | 12/1/1998 | CB1298A4300 | CB1298A4304 | 0.384 | 0.295 | 26.22 | 25 |
| Dissolved manganese | 12/1/1998 | CB1298A4300 | CB1298A4304 | 0.026 | 0.019 | 31.11 | 25 |
| Dissolved potassium | 1/7/1998 | CB0198A0001 | CB0198A0005 | 3.3 | 4.32 | 26.77 | 25 |

RPD = relative percent difference

## Table 21 Total internal quality control batches grouped by analyte

| Analyte | Method | LCS recovery | RPD-LCS duplicate | Matrix spike | RPD- matrix spike duplicate | Method blank | RPD sample duplicate | Surrogate recovery |
|---|---|---|---|---|---|---|---|---|
| EC | Std Method 2510-B | | | | | 37 | 84 | |
| Boron | EPA 200.7 (D) | 114 | 56 | 228 | 90 | 74 | | |
| Bromide | EPA 300.0 28d Hold | 127 | 57 | 252 | 105 | 55 | | |
| Calcium | EPA 200.7 (D) | 114 | 56 | 234 | 92 | 74 | | |
| Chloride | EPA 300.0 28d Hold | 73 | 24 | 192 | 78 | 24 | | |
| Potassium | EPA 200.7 (D) | 114 | 56 | 220 | 86 | 74 | | |
| Soduim | EPA 200.7 (D) | 114 | 56 | 232 | 91 | 74 | | |
| Sulfate | EPA 300.0 28d Hold | 50 | 24 | 162 | 78 | 24 | | |
| pH | Std Method 5910B | | | | | | 6 | |
| Alkalinity | Std Method 2320 B | 107 | 52 | 219 | 85 | 71 | 14 | |
| TDS | Std Method 2540 C | | | | | 57 | 99 | |
| TSS | EPA 160.2 | | | | | 13 | 22 | |
| Turbidity | EPA 180.1 | 116 | 58 | | | 78 | 87 | |
| Aluminum | EPA 200.8 (D) | 102 | 51 | 154 | 77 | 51 | | |
| Arsenic | EPA 200.8 (D) | 102 | 51 | 154 | 77 | 51 | | |
| Copper | EPA 200.8 (D) | 102 | 51 | 164 | 82 | 51 | | |
| Iron | EPA 200.8 (D) | 102 | 51 | 164 | 82 | 51 | | |
| Manganese | EPA 200.8 (D) | 102 | 54 | 160 | 80 | 51 | | |
| Magnesium | EPA 200.7 (D) | 114 | 56 | 234 | 92 | 74 | | |
| | | | | | | | | |
| TOC | EPA 415.1 (T) ox | 86 | 43 | | | 43 | 103 | |
| TOC | EPA 415.1 (T) comb | 40 | 20 | | | 20 | 30 | |
| DOC | EPA 415.1 (D) Oo | 113 | 55 | | | 56 | 140 | |
| DOC | EPA 415.1 (D) comb | 20 | 10 | | | 10 | 1 | |
| UVA | Std Method 5910B | 110 | 55 | | | 72 | 120 | |

LCS = laboratory control sample
RPD = relative percent difference

*Table continued on next page*

## Table 21 continued

| Analyte | Method | LCS recovery | RPD-LCS duplicate | Matrix spike | RPD- matrix spike duplicate | Method blank | RPD sample duplicate | Surrogate recovery |
|---|---|---|---|---|---|---|---|---|
| Trichloroacetic acid (TCAA) | DWR HAAFP (Reactivity) | 2 | 1 | 22 | 1 | 1 | | 133 |
| Monochloroacetic acid (MCAA) | DWR HAAFP (Reactivity) | | 1 | 22 | 1 | 1 | | 132 |
| Monobromoacetic acid (MBAA) | DWR HAAFP (Reactivity) | 2 | 1 | 22 | 1 | 1 | | 133 |
| Dichloroacetic acid (DCAA) | DWR HAAFP (Reactivity) | 2 | 1 | 22 | 1 | 1 | | 133 |
| Dibromoacetic acid (DBAA) | DWR HAAFP (Reactivity) | 2 | 1 | 22 | 1 | 1 | | 133 |
| Bromochloroacetic acid (BCAA) | DWR HAAFP (Reactivity) | 2 | 1 | 22 | 1 | 1 | | 133 |
| | | | | | | | | |
| Bromodichloromethane | DWR THMFP (Buffered) | | | 24 | 4 | 4 | | 108 |
| Bromoform | DWR THMFP (Buffered) | | | 24 | 4 | 4 | | 107 |
| Chloroform | DWR THMFP (Buffered) | | | 24 | 4 | 4 | | 108 |
| Dibromochloromethane | DWR THMFP (Buffered) | | | 24 | 4 | 4 | 107 | |
| | | | | | | | | |
| Ammonia | EPA 350.1 | 32 | 16 | 63 | 19 | 18 | | |
| Nitrate | EPA 300.0 28d Hold | 32 | 14 | 36 | 18 | 16 | | |
| nitrate | EPA 300.0 48 hr (N03, OP) | 52 | 26 | 98 | 49 | 24 | | |
| Nitrate | Std Method 4500-$NO_3$-F | 66 | 33 | 78 | 28 | 63 | | |
| Nitrite + nitrate | Std Method 4500-$NO_3$-F Modified | 18 | 9 | 32 | 16 | 9 | | |
| Kjeldahl nitrogen | EPA 351.2 | 18 | 9 | 4 | 2 | 9 | | |
| Orthophosphate | Std Method 4500-P, F | 21 | 10 | 10 | 5 | 11 | | |
| Phosphorus | EPA 365.4 | 18 | 9 | 8 | 4 | 9 | | |
| | | | | | | | | |
| Methyl tert-butyl ether (MTBE) | EPA 502.2 | | | 124 | 50 | 44 | | 163 |

LCS = laboratory control sample
RPD = relative percent difference

*Table continued on next page*

## Table 21 continued

| Analyte | Method | LCS recovery | RPD-LCS duplicate | Matrix spike | RPD-matrix spike duplicate | Method blank | RPD sample duplicate | Surrogate recovery |
|---|---|---|---|---|---|---|---|---|
| Azinphos methyl (Guthion) | EPA 614 | 2 | 1 | 2 | 1 | 12 | | |
| Benfluralin | EPA 614 | | | | | 12 | | |
| Bromacil | EPA 614 | | | | | 12 | | |
| Carbophenothion (Trithion) | EPA 614 | | | | | 12 | | |
| Chlorpyrifos | EPA 614 | | | | | 12 | | |
| Cyanazine | EPA 614 | 24 | 12 | 24 | 12 | 12 | | |
| Demeton (Demeton O + Demeton S) | EPA 614 | | | | | 12 | | |
| Diazinon | EPA 614 | 2 | 1 | 2 | 1 | 12 | | |
| Dimethoate | EPA 614 | | | | | 12 | | |
| Disulfoton | EPA 614 | | | | | 12 | | |
| Ethion | EPA 614 | | | | | 12 | | |
| Malathion | EPA 614 | | | | | 12 | | |
| Methidathion | EPA 614 | 2 | 1 | 2 | 1 | 12 | | |
| Mevinphos | EPA 614 | | | | | 12 | | |
| Naled | EPA 614 | | | | | 12 | | |
| Napropamide | EPA 614 | | | | | 12 | | |
| Norflurazon | EPA 614 | | | | | 12 | | |
| Parathion (Ethyl) | EPA 614 | | | | | 12 | | |
| Parathion, Methyl | EPA 614 | | | | | 12 | | |
| Pendimethalin | EPA 614 | | | | | 12 | | |
| Phorate | EPA 614 | | | | | 12 | | |
| Phosalone | EPA 614 | | | | | 12 | | |
| Phosmet | EPA 614 | | | | | 12 | | |
| Profenofos | EPA 614 | | | | | 12 | | |
| Prometryn | EPA 614 | | | | | 12 | | |
| Propetamphos | EPA 614 | | | | | 12 | | |
| s,s,s-Tributyl Phosphorotrithioate (DEF) | EPA 614 | | | | | 12 | | |
| Trifluralin | EPA 614 | 22 | 11 | 22 | 11 | 12 | | |
| Volatile organics (all)[a] | | | | 590 | 92 | 639 | | 1,746 |
| TOTALS | | 2,241 | 1,094 | 4,092 | 1,526 | 2,385 | 813 | 3,029 |

a. Not including MTBE
LCS = laboratory control sample
RPD = relative percent difference

## Table 22 Holding time exceedances

| Analyte | Collection date | Sample number | Holding time | Limit |
|---|---|---|---|---|
| Orthophosphate (dissolved) | 1/2/2002 12:15 | CC0102B0098 | 286 hours | 48 |
| Orthophosphate (dissolved) | 1/7/2002 14:25 | CC0102B0034 | 164 hours | 48 |

## Table 23 Method blank exceedances

| Analyte | Method | Batch number | Result | Reporting limit | Units |
|---|---|---|---|---|---|
| Alkalinity | Std Method 2320 B | BL00B5899 | 1.07 | 1 | mg/L as $CaCO_3$ |
| Alkalinity | Std Method 2320 B | BL00B6206 | 1.6 | 1 | mg/L as $CaCO_3$ |
| Alkalinity | Std Method 2320 B | BL00B6344 | 1.5 | 1 | mg/L as $CaCO_3$ |
| Alkalinity | Std Method 2320 B | BL00B6487 | 1.4 | 1 | mg/L as $CaCO_3$ |
| Alkalinity | Std Method 2320 B | BL00B6487 | 1.5 | 1 | mg/L as $CaCO_3$ |
| Chloroform | DWR THMFP (Buffered) | BL02B10842 | 3.2 | 1 | µg/L |
| Chloroform | DWR THMFP (Buffered) | BL02B11206 | 1.6 | 1 | µg/L |
| Chloroform | DWR THMFP (Buffered) | BL98A2214 | 8.04 | 1 | µg/L |
| Chloroform | DWR THMFP (Buffered) | BL98A972 | 5 | 1 | µg/L |
| Organic carbon | EPA 415.1 (D) Ox | BL00B5805 | 0.15 | 0.1 | mg/L as C |
| Organic carbon | EPA 415.1 (D) Ox | BL97A720 | 0.12 | 0.1 | mg/L as C |
| Organic carbon | EPA 415.1 (D) Ox | BL99A4552 | 0.12 | 0.1 | mg/L as C |
| Organic carbon | EPA 415.1 (T) Comb | BL00B7334 | 0.19 | 0.1 | mg/L as C |
| Organic carbon | EPA 415.1 (T) Ox | BL00B5804 | 0.15 | 0.1 | mg/L as C |
| Organic carbon | EPA 415.1 (T) Ox | BL99A4553 | 0.12 | 0.1 | mg/L as C |
| Potassium | EPA 200.7 (D) | BL00B5780 | 0.526 | 0.5 | mg/L |
| Total dissolved solids | Std Method 2540 C | BL00B5900 | 9 | 1 | mg/L |
| Total dissolved solids | Std Method 2540 C | BL00B6022 | 4 | 1 | mg/L |

**Table 24 Number of batches with method blank exceedances**

| Analyte | Total batches | Batches with method blanks out of limits | Frequency of samples out of limits (%) |
|---|---|---|---|
| Alkalinity | 71 | 5 | 7 |
| Chloroform | 4 | 4 | 100 |
| Dissolved organic carbon (ox) | 56 | 3 | 5.4 |
| Pottassium | 74 | 1 | 1.4 |
| Total dissolved solids | 57 | 2 | 3.5 |
| Total organic carbon (ox) | 43 | 2 | 4.7 |

ox = wet oxidation

**Table 25 Environmental samples associated with method blank exceedances**

| Analyte | Method | Batch number | Sample number | Collection date |
|---|---|---|---|---|
| Alkalinity | Std Method 2320 B | BL00B5899 | CD0400B1277 | 4/3/2000 |
| Alkalinity | Std Method 2320 B | BL00B6206 | CD0600B1406 | 6/5/2000 |
| Alkalinity | Std Method 2320 B | BL00B6344 | CD0700B1464 | 7/3/2000 |
| Alkalinity | Std Method 2320 B | BL00B6487 | CD0800B1552 | 8/1/2000 |
| Chloroform | DWR THMFP (Buffered) | BL02B10842 | CC0502B1822 | 5/6/2002 |
| Chloroform | DWR THMFP (Buffered) | BL02B11206 | CC0302B1666 | 5/21/2002 |
| Chloroform | DWR THMFP (Buffered) | BL02B11206 | CB0602B0451 | 6/3/2002 |
| Chloroform | DWR THMFP (Buffered) | BL02B10842 | CB0402B0342 | 4/2/2002 |
| Chloroform | DWR THMFP (Buffered) | BL98A972 | CB0198A0005 | 1/7/1998 |
| Chloroform | DWR THMFP (Buffered) | BL98A2214 | CB0898A2528 | 8/4/1998 |
| Organic carbon | EPA 415.1 (D) Ox | BL99A4552 | CB0999A2564 | 9/7/1999 |
| Organic carbon | EPA 415.1 (D) Ox | BL97A720 | CB1297A1500 | 12/1/1997 |
| Organic carbon | EPA 415.1 (D) Ox | BL00B5805 | CD0300B0716 | 3/6/2000 |
| Organic carbon | EPA 415.1 (T) Ox | BL00B5804 | CD0300B0716 | 3/6/2000 |
| Organic carbon | EPA 415.1 (T) Ox | BL99A4553 | CB0999A2564 | 9/7/1999 |
| Potassium | EPA 200.7 (D) | BL00B5780 | CD0300B0716 | 3/6/2000 |
| Total dissolved solids (TDS) | Std Method 2540 C | BL00B5900 | CD0400B1277 | 4/3/2000 |
| Total dissolved solids (TDS) | Std Method 2540 C | BL00B6022 | CD0500B1335 | 5/1/2000 |

**Table 26 Laboratory control sample recovery exceedances**

| Analyte | Method | Batch number | Recovery (%) | Control limits (%) |
|---|---|---|---|---|
| Kjeldahl nitrogen | EPA 351.2 | BL02B9841 | 124.10 | 80–120 |
| Potassium | EPA 200.7 (D) | BL98A835 | 83.48 | 85–115 |

**Table 27 Frequency of quality control batches with laboratory control sample recovery exceedances**

| Analyte | Total LCS recoveries | LCS recoveries out of limits | Frequency of samples out of limits (%) |
|---|---|---|---|
| Kjeldahl nitrogen | 18 | 1 | 5.5 |
| Potassium | 114 | 1 | 0.8 |

LCS = laboratory control sample

**Table 28 Environmental samples with laboratory control sample recovery exceedances**

| Analyte | Method | Batch number | Sample number | Collection date |
|---|---|---|---|---|
| Kjeldahl nitrogen | EPA 351.2 | BL02B9841 | CC0102B0098 | 1/2/2002 |
| Potassium | EPA 200.7 (D) | BL98A835 | CB0198A0001 | 1/7/1998 |

## Table 29 Matrix spike recovery exceedances

| Analyte | Method | Batch number | Recovery (%) | Control limits (%) |
|---|---|---|---|---|
| Alkalinity | Std Method 2320 B | BL98A2725 | 116.4 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A3184 | 115.3 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A3373 | 118.59 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A3722 | 73.33 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A3722 | 52.33 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A3900 | 115.7 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4136 | 116.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4345 | 117.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4565 | 115.8 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4736 | 118.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4736 | 118.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4736 | 123.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4736 | 121.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4882 | 116.89 | 85–115 |
| Alkalinity | Std Method 2320 B | BL99A4882 | 115.9 | 85–115 |
| Ammonia | EPA 350.1 | BL98A2161 | 134 | 85–118 |
| Ammonia | EPA 350.1 | BL98A2161 | 126 | 85–118 |
| Bromide | EPA 300.0 28d Hold | BL99A3133 | 74 | 82–118 |
| Bromide | EPA 300.0 28d Hold | BL99A3133 | 75 | 82–118 |
| Bromoform | DWR THMFP (Buffered) | BL98A2214 | 122.11 | 80–120 |
| Calcium | EPA 200.7 (D) | BL01B9580 | 70.7 | 80–120 |
| Calcium | EPA 200.7 (D) | BL02B9810 | 135.77 | 80–120 |
| Calcium | EPA 200.7 (D) | BL02B9810 | 132.77 | 80–120 |
| Kjeldahl nitrogen | EPA 351.2 | BL02B9901 | 52.13 | 70–130 |
| Magnesium | EPA 200.7 (D) | BL02B9810 | 126.54 | 80–120 |
| Phosphorus | EPA 365.4 | BL02B10072 | 79 | 80.70–120.70 |
| Phosphorus | EPA 365.4 | BL02B10072 | 74 | 80.70–120.70 |
| Phosphorus | EPA 365.4 | BL02B10431 | 39 | 80.70–120.70 |
| Phosphorus | EPA 365.4 | BL02B10431 | 42 | 80.70–120.70 |
| Phosphorus | EPA 365.4 | BL02B9900 | 52 | 80.70–120.70 |
| Phosphorus | EPA 365.4 | BL02B9900 | 133 | 80.70–120.70 |
| Sodium | EPA 200.7 (D) | BL00B6395 | 125.8 | 80–120 |
| Sodium | EPA 200.7 (D) | BL00B6395 | 142.8 | 80–120 |
| Sodium | EPA 200.7 (D) | BL01B9580 | 70.88 | 80–120 |
| Sodium | EPA 200.7 (D) | BL02B10000 | 121 | 80–120 |
| Sodium | EPA 200.7 (D) | BL02B10885 | 132.2 | 80–120 |
| Sodium | EPA 200.7 (D) | BL02B9810 | 129.85 | 80–120 |
| Sodium | EPA 200.7 (D) | BL02B9810 | 122.85 | 80–120 |
| TCAA | DWR HAAFP (Reactivity) | BL98A2318 | 66.92 | 70–130 |
| TCAA | DWR HAAFP (Reactivity) | BL98A2318 | 69.32 | 70–130 |

TCAA = Trichloroacetic acid

**Table 30 Frequency of quality control batches with matrix spike recovery exceedances**

| Analyte | Total matrix spikes | Matrix spike recoveries out of limits | Frequency of samples out of limits (%) |
|---|---|---|---|
| Alkalinity | 219 | 15 | 6.8 |
| Ammonia | 63 | 2 | 3.2 |
| Bromide | 252 | 2 | 0.8 |
| Bromoform | 24 | 1 | 4.2 |
| Calcium | 234 | 3 | 1.3 |
| Kjeldahl nitrogen | 32 | 1 | 3.1 |
| Magnesium | 234 | 1 | 0.4 |
| Phosphorous | 8 | 6 | 75 |
| Sodium | 232 | 7 | 3 |
| Trichloroacetic acid (TCAA) | 22 | 2 | 9 |

**Table 31 Environmental samples with matrix spike recovery exceedances**

| Analyte | Method | Batch number | Sample number | Collection date |
|---|---|---|---|---|
| Alkalinity | Std Method 2320 B | BL99A3184 | CB0299A0873 | 2/2/1999 |
| Alkalinity | Std Method 2320 B | BL99A3373 | CB0399A1295 | 3/2/1999 |
| Alkalinity | Std Method 2320 B | BL99A3722 | CB0599A1849 | 5/4/1999 |
| Alkalinity | Std Method 2320 B | BL99A3900 | CB0699A2027 | 6/1/1999 |
| Alkalinity | Std Method 2320 B | BL99A4136 | CB0799A2239 | 7/7/1999 |
| Alkalinity | Std Method 2320 B | BL99A4345 | CB0899A2436 | 8/4/1999 |
| Alkalinity | Std Method 2320 B | BL99A4565 | CB0999A2564 | 9/7/1999 |
| Alkalinity | Std Method 2320 B | BL99A4736 | CB1099A2814 | 10/6/1999 |
| Alkalinity | Std Method 2320 B | BL98A2725 | CB1198A3844 | 11/3/1998 |
| Alkalinity | Std Method 2320 B | BL99A4882 | CB1199A2891 | 11/2/1999 |
| Ammonia | EPA 350.1 | BL98A2161 | CB0898A2528 | 8/4/1998 |
| Bromide | EPA 300.0 28d Hold | BL99A3133 | CB0199A0561 | 1/15/1999 |
| Bromoform | DWR THMFP (Buffered) | BL98A2214 | CB0898A2528 | 8/4/1998 |
| Calcium | EPA 200.7 (D) | BL01B9580 | CB1101B1181 | 11/13/2001 |
| Calcium | EPA 200.7 (D) | BL02B9810 | CB1201B1187 | 12/3/2001 |
| Kjeldahl nitrogen | EPA 351.2 | BL02B9901 | CC0102B0034 | 1/7/2002 |
| Magnesium | EPA 200.7 (D) | BL02B9810 | CB1201B1187 | 12/3/2001 |
| Phosphorus | EPA 365.4 | BL02B9900 | CC0102B0034 | 1/7/2002 |
| Phosphorus | EPA 365.4 | BL02B10431 | CB0302B0233 | 3/4/2002 |
| Phosphorus | EPA 365.4 | BL02B10431 | CB0302B0328 | 3/7/2002 |
| Phosphorus | EPA 365.4 | BL02B10072 | CC0102B0665 | 1/28/2002 |
| Phosphorus | EPA 365.4 | BL02B10072 | CB0202B0003 | 2/4/2002 |
| Sodium | EPA 200.7 (D) | BL02B10885 | CC0502B1822 | 5/6/2002 |
| Sodium | EPA 200.7 (D) | BL02B10000 | CC0102B0665 | 1/28/2002 |
| Sodium | EPA 200.7 (D) | BL00B6395 | CD0700B1464 | 7/3/2000 |
| Sodium | EPA 200.7 (D) | BL01B9580 | CB1101B1181 | 11/13/2001 |
| Sodium | EPA 200.7 (D) | BL02B9810 | CB1201B1187 | 12/3/2001 |
| TCAA | DWR HAAFP (Reactivity) | BL98A2318 | CB0898A2528 | 8/4/1998 |

TCCA = Trichloroacetic Acid

**Table 32 Matrix spike duplicate exceedances**

| Analyte | Method | Batch number | Result | Control limits |
|---|---|---|---|---|
| Calcium | EPA 200.7 (D) | BL01B9580 | 24.783 | 0–20 |
| Kjeldahl nitrogen | EPA 351.2 | BL02B9901 | 52.128 | 0–25 |
| Phosphorus | EPA 365.4 | BL02B9900 | 87.568 | 0–25 |
| Sodium | EPA 200.7 (D) | BL01B7832 | 23.668 | 0–20 |
| Sodium | EPA 200.7 (D) | BL02B9810 | 20.877 | 0–20 |

**Table 33 Number of matrix spike duplicate recovery exceedances**

| Analyte | Total matrix spike duplicates | Matrix spike duplicate recoveries out of limits | Frequency of samples out of limits (%) |
|---|---|---|---|
| Calcium | 92 | 1 | 1.1 |
| Kjeldahl nitrogen | 2 | 1 | 50 |
| Phosphorus | 4 | 1 | 25 |
| Sodium | 91 | 2 | 2.2 |

### Table 34 Matrix spike duplicate exceedances

| Analyte | Method | Batch number | Sample number | Collection date |
|---|---|---|---|---|
| Calcium | EPA 200.7 (D) | BL01B9580 | CB1101B1181 | 11/13/2001 |
| Kjeldahl nitrogen | EPA 351.2 | BL02B9901 | CC0102B0034 | 1/7/2002 |
| Phosphorus | EPA 365.4 | BL02B9900 | CC0102B0034 | 1/7/2002 |
| Sodium | EPA 200.7 (D) | BL01B7832 | CB0301B0162 | 3/5/2001 |
| Sodium | EPA 200.7 (D) | BL02B9810 | CB1201B1187 | 12/3/2001 |

### Table 35 Duplicate exceedances

| Analyte | Method | Batch number | Result % | Limit % |
|---|---|---|---|---|
| Dissolved organic carbon | EPA 415.1 (D) Ox | BL00B6787 | 75.41 | 0-30 |
| Total dissolved solids | Std Method 2540 C | BL00B6022 | 15.054 | 0-15 |

### Table 36 Number of environmental sample duplicate exceedances

| Analyte | Method | Total sample duplicates | Sample duplicates out of limits | Frequency of samples out of limits (%) |
|---|---|---|---|---|
| Dissolved organic carbon | EPA 415.1 (D) Ox | 140 | 1 | 0.7 |
| Total dissolved solids | Std Method 2540 C | 99 | 1 | 1 |

### Table 37 Sample duplicate exceedances

| Analyte | Method | Batch number | Sample number | Collection date |
|---|---|---|---|---|
| Dissolved organic carbon | EPA 415.1 (D) Ox | BL00B6787 | CD0900B1654 | 9/5/2000 |
| Total dissolved solids | Std Method 2540 C | BL00B6022 | CD0500B1335 | 5/1/2000 |

# Figures

**Figure 1 Natomas East Main Drainage Canal watershed**

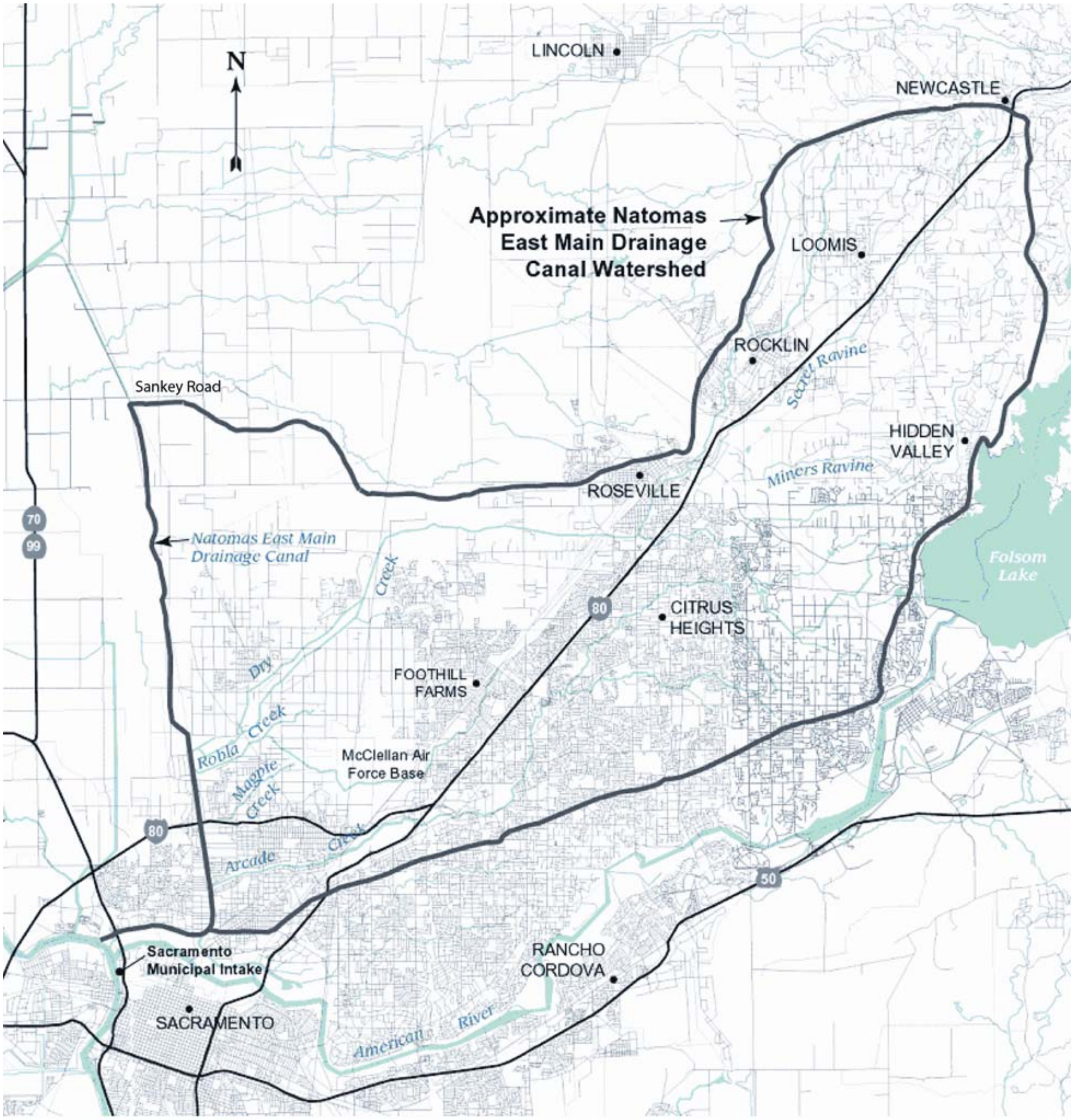


**Figure 2  Natomas East Main Drainage canal monitoring site and vicinity**

## Figure 3 Relative contribution of organic carbon from Delta tributaries

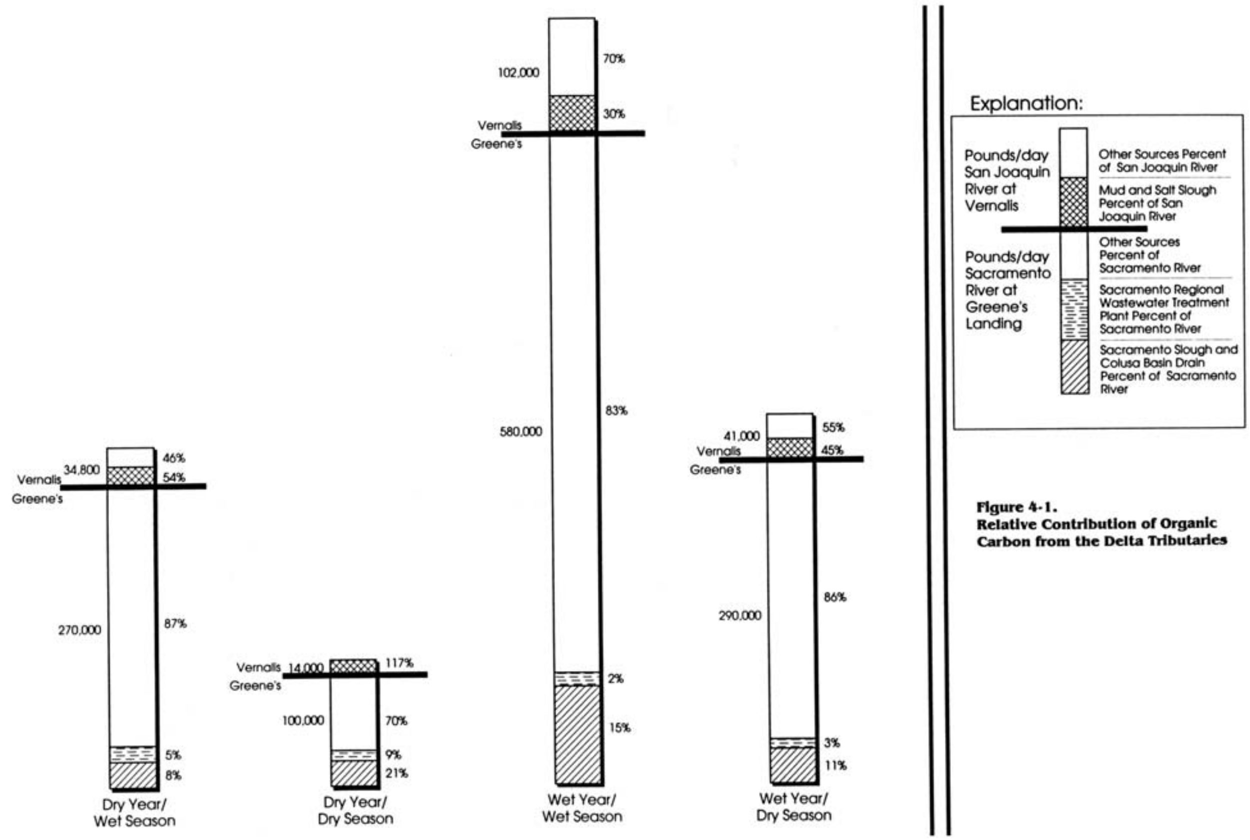
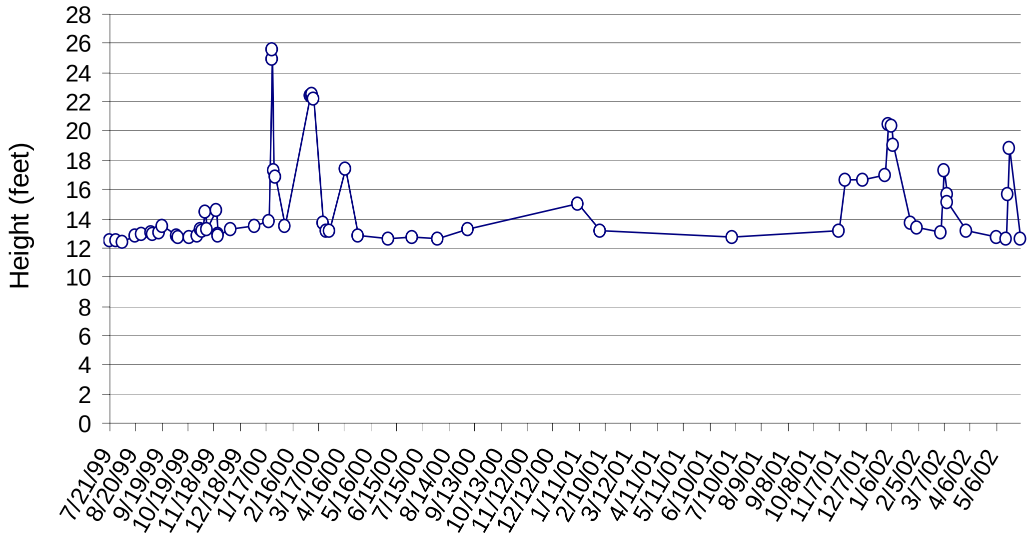


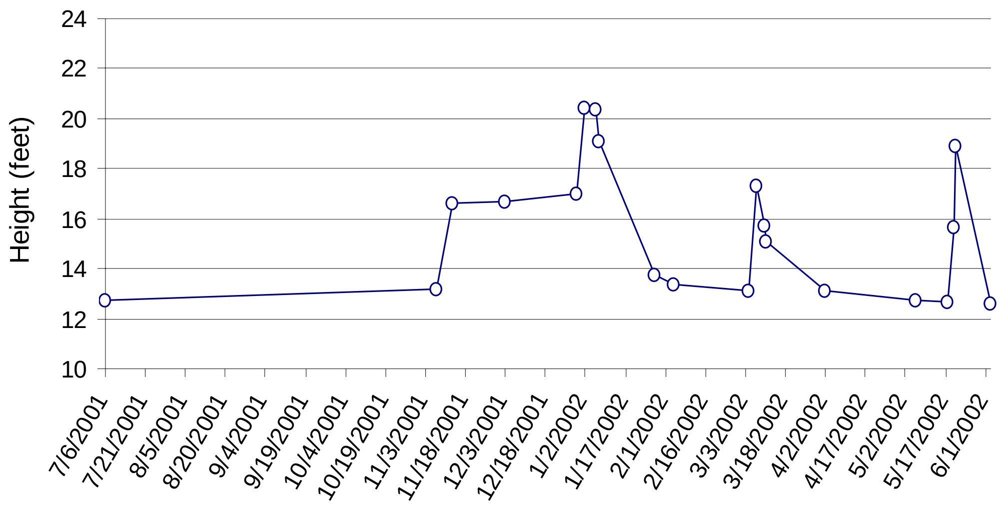

Figure from California Urban Water Agencies, May 1995, *Study of Drinking Water Quality in Delta Tributaries.*

# Figure 4  Stage monitoring data

a) 1999-2002

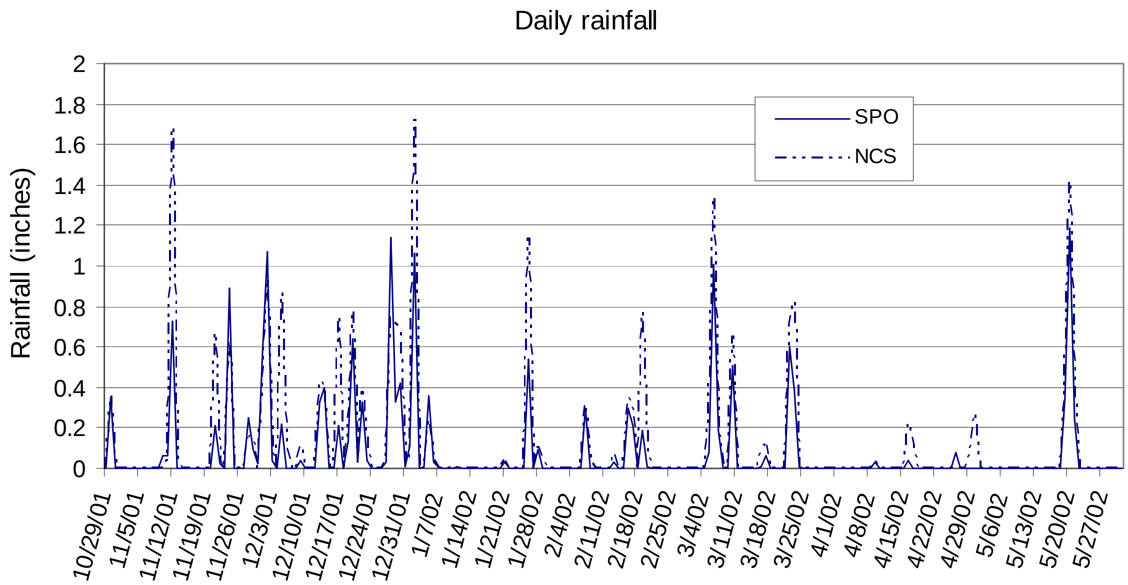


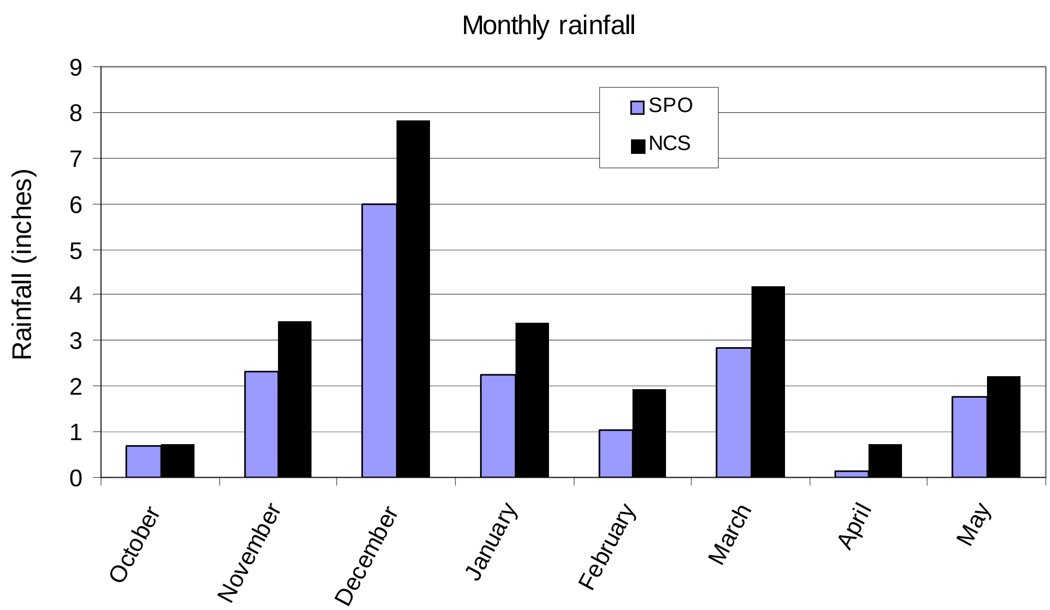

b) 2001/2002 events monitoring




Note:  Stage measurements taken at the El Camino Avenue bridge

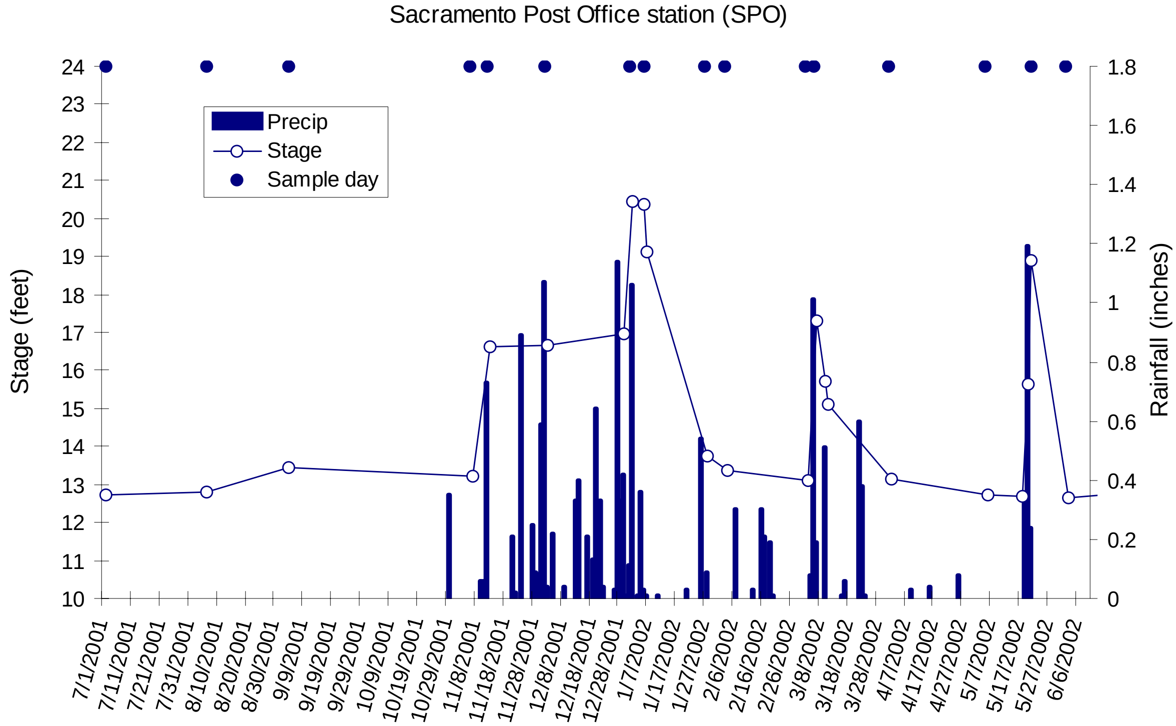
**Figure 5 Rainfall data for Natomas East Main Drainage Canal watershed, 2001/2002**

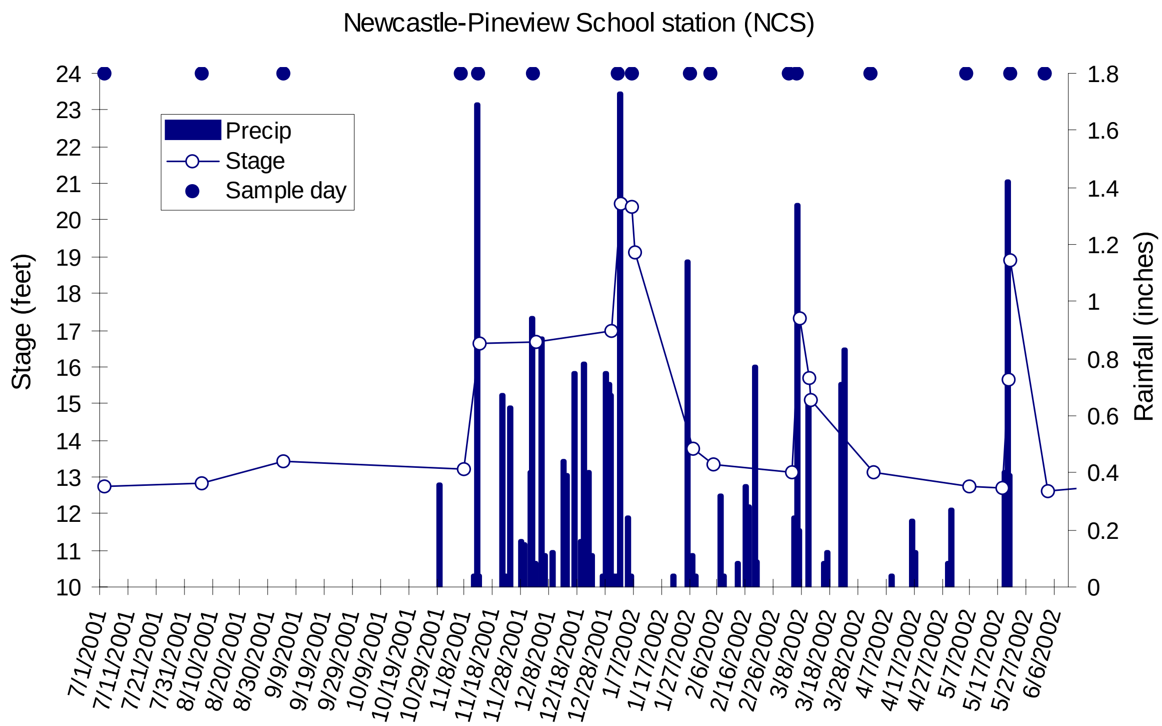



SPO = Sacramento Post Office
NCS = Newcastle-Pineview School

**Figure 6 Natomas East Main Drainage Canal stage vs. daily rainfall, 2001/2002**

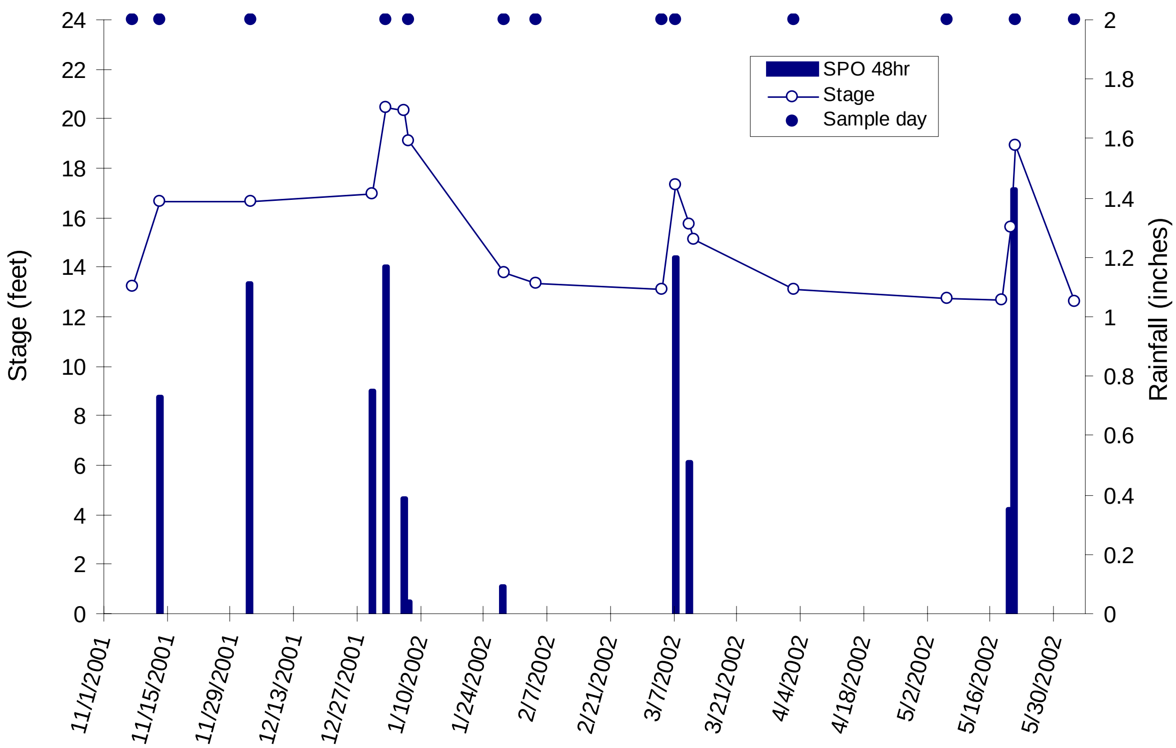


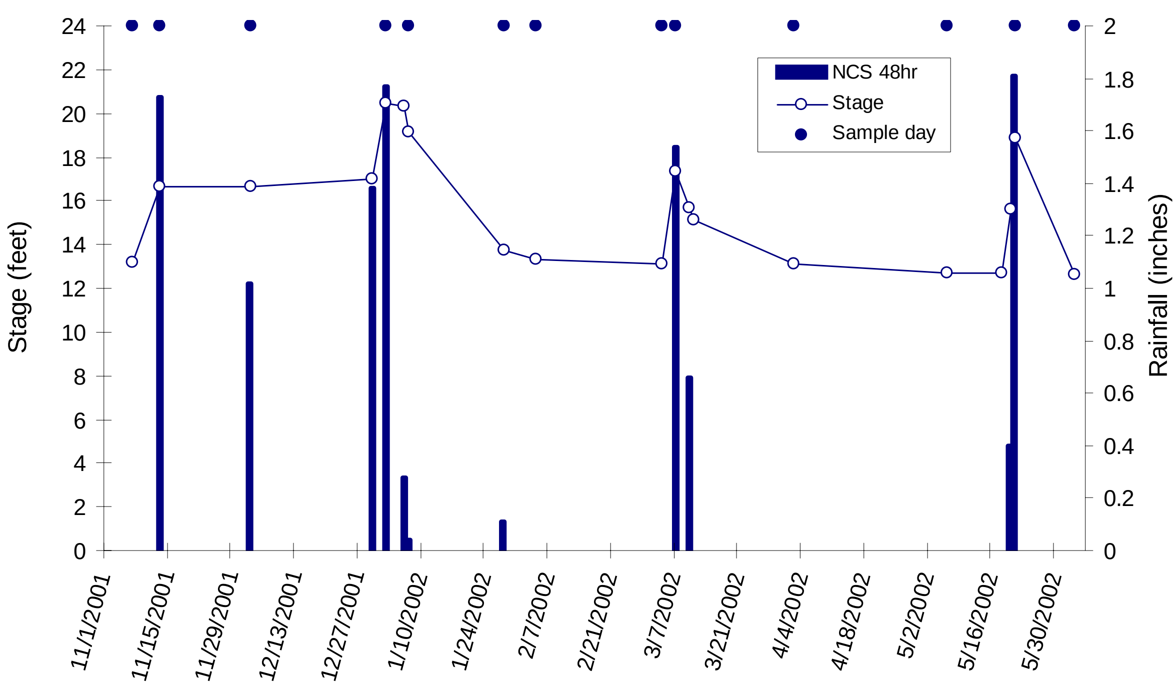

NEMDC stage monitoring at El Camino Avenue bridge

**Figure 7 Natomas East Main Drainage stage vs. 48-hour rainfall, 2001/2002**

Sacramento Post Office (SPO) station

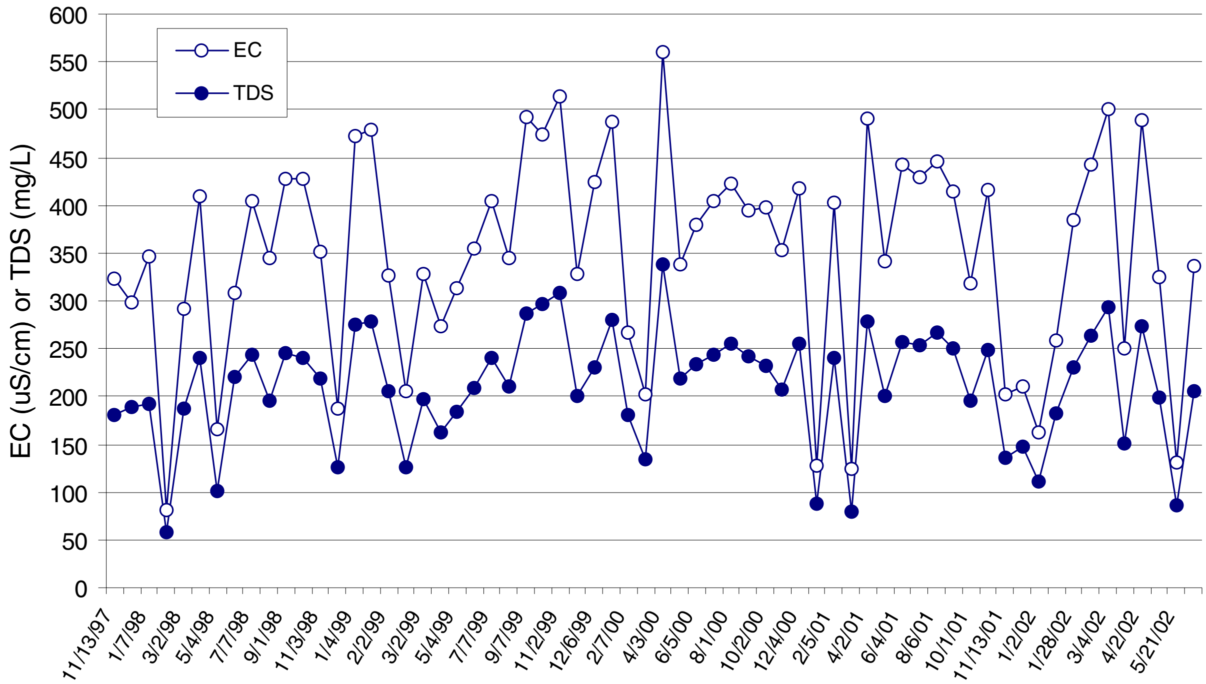



Newcastle-Pineview School (NCS) station



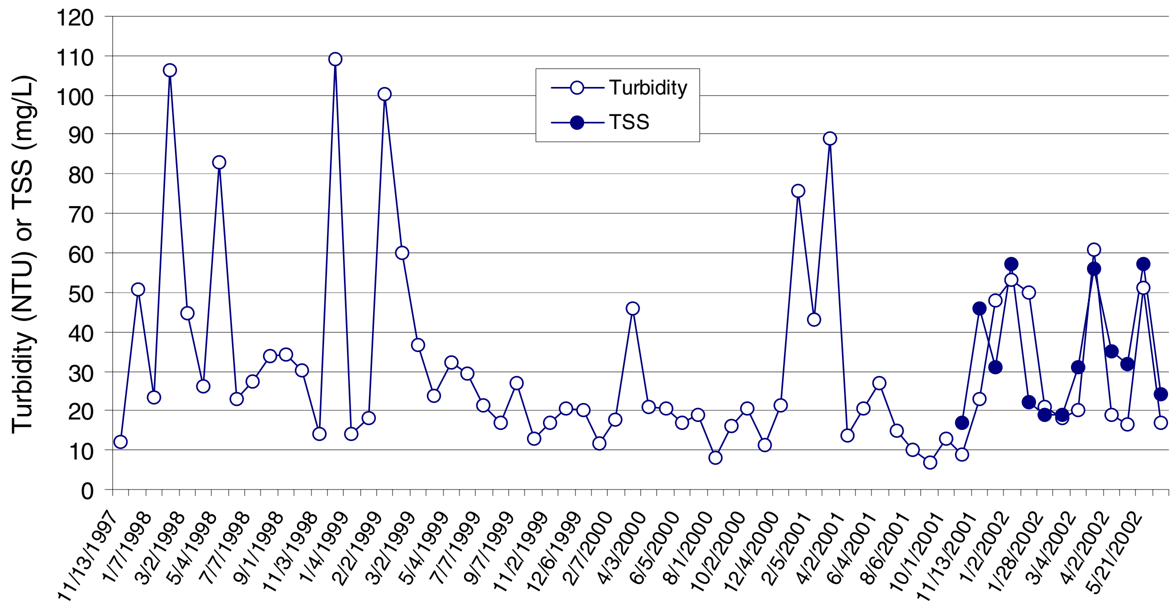

Rainfall amount includes the 48-hour period ending sample day stage measured.
Stage measured at El Camino Avenue bridge.

# Figure 8 Electrical conductivity and total dissolved solids, 1997–2002



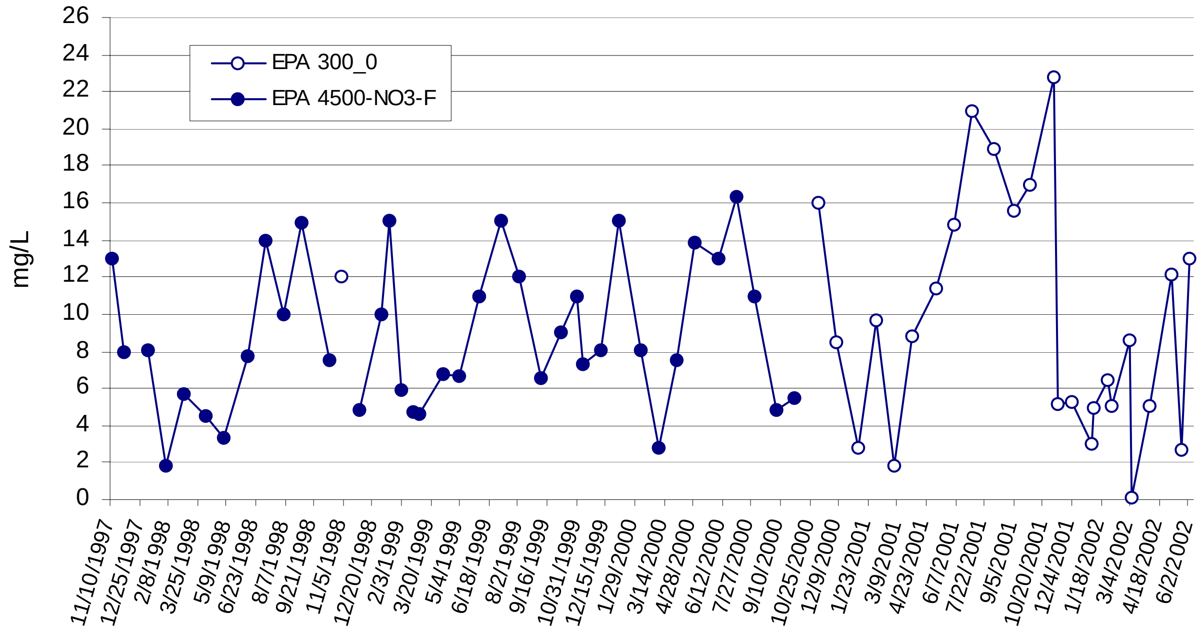

EC = electrical conductivity
TDS = total dissolved solids

**Figure 9 Turbidity and total suspended solids, 1997–2002**




Total suspended solids (TSS) not monitored until event monitoring Nov 2001.

**Figure 10 Nitrate concentrations (as N03) by method, 1997–2002**

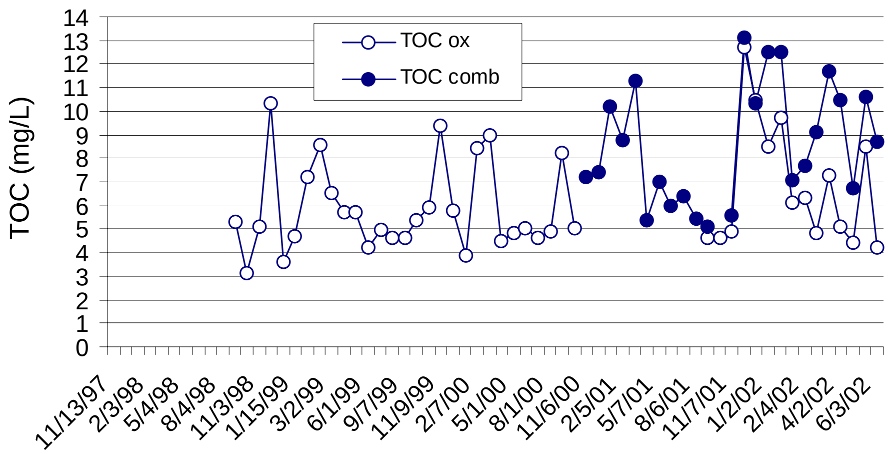



Nitrate MCL = 45 mg/L (as NO3)

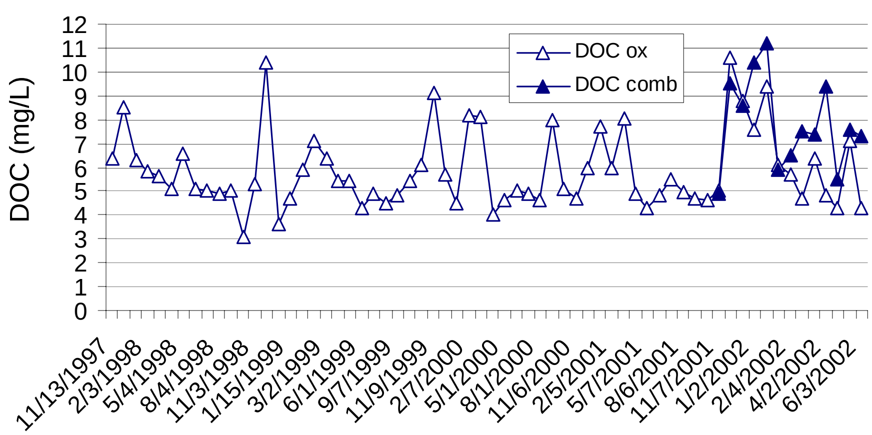
Revised. See N2 07-20-06, N3 07-20-06, N4 07-20-06 in Errata

**Figure 11 Total organic carbon and dissolved organic carbon data by method, 1997–2002**

a) TOC by wet oxidation and combustion methods




b) DOC by wet oxidation and combustion methods




c) TOC and DOC by wet oxidation method

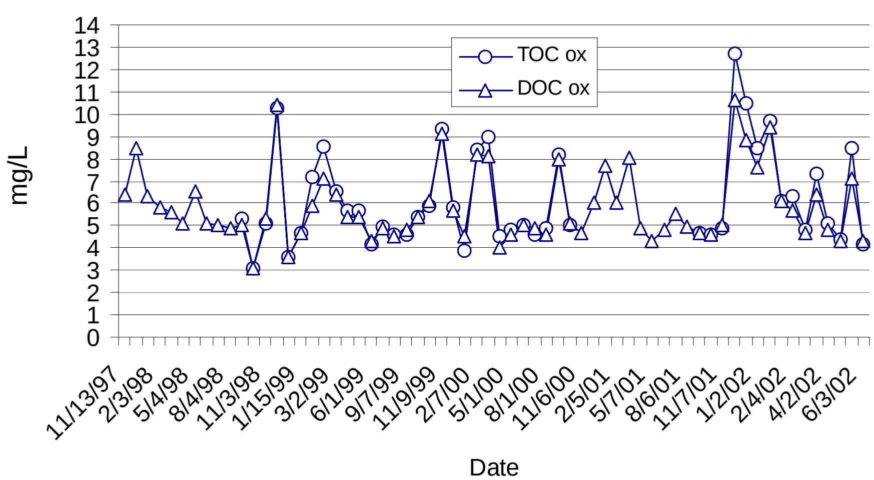
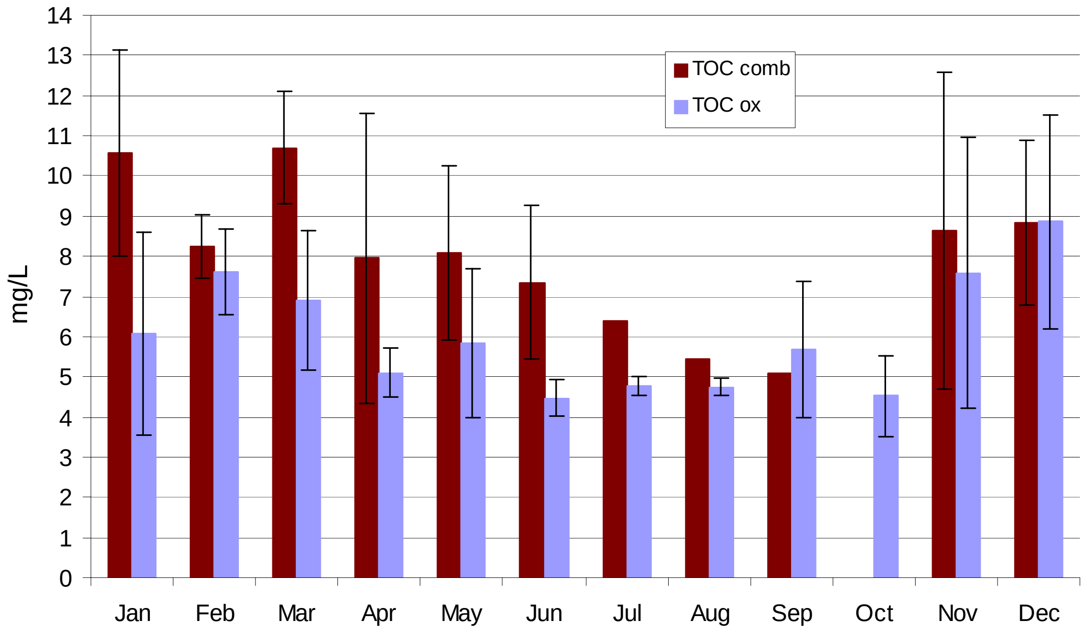
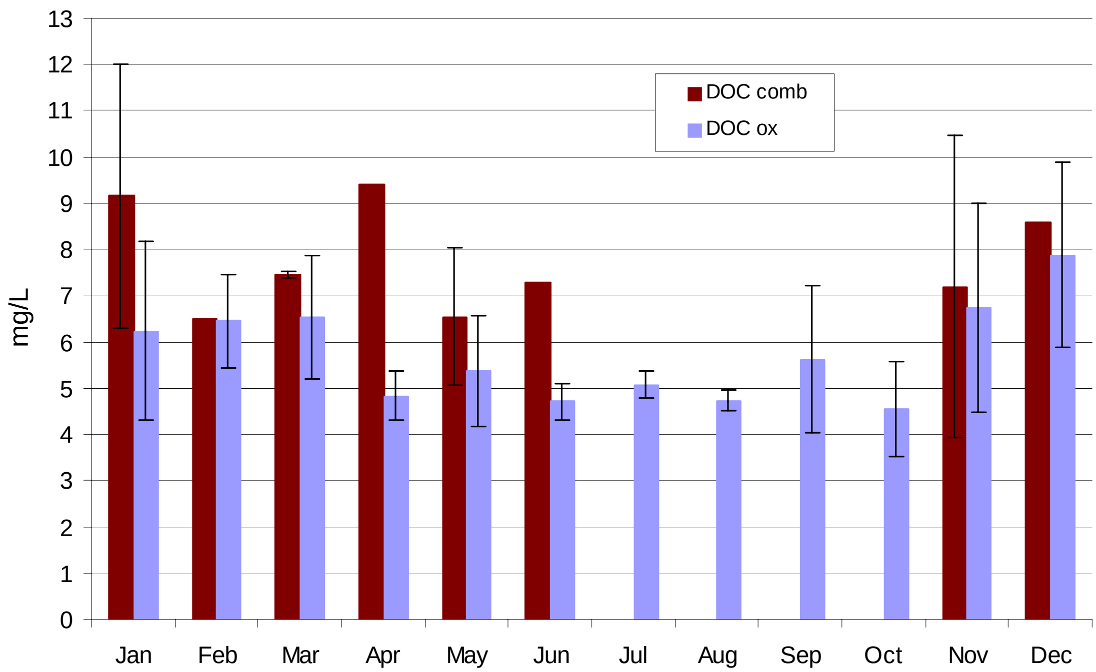


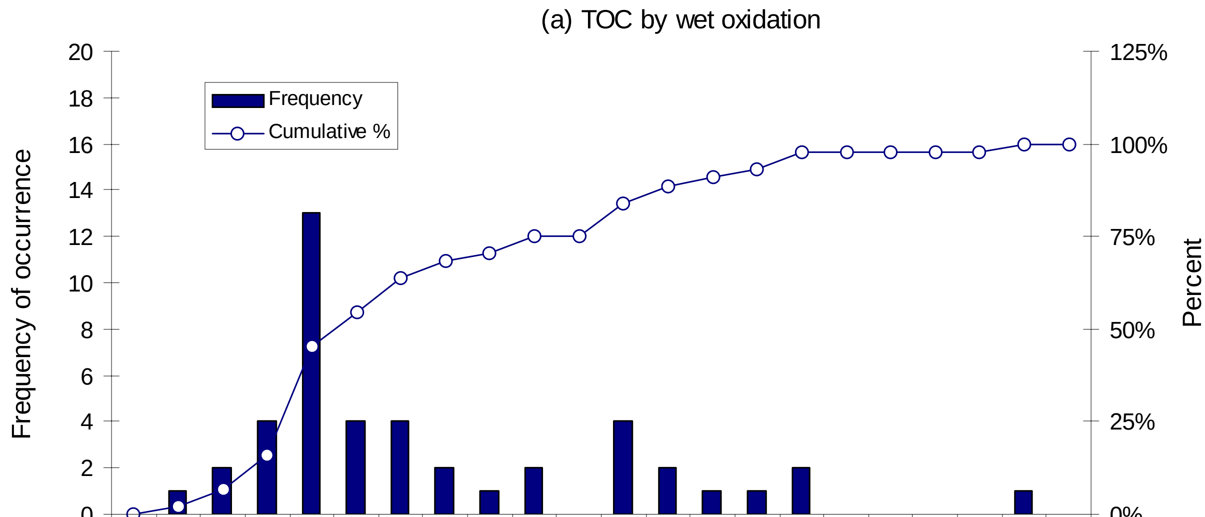
**Figure 12 Monthly average total organic carbon and dissolved organic carbon concentrations (± 1 *s*), 1997–2002**



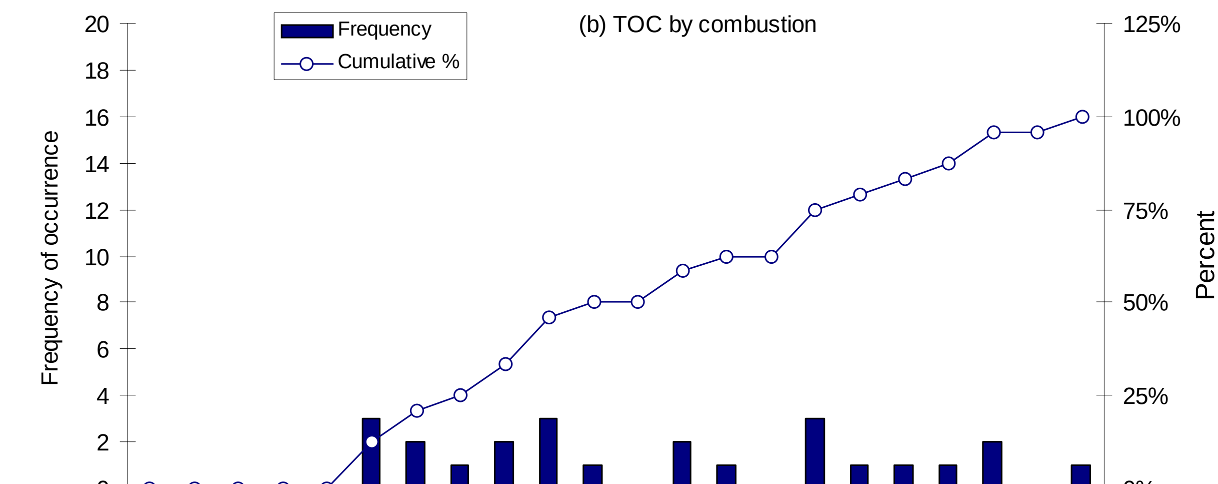




Mar DOC (comb) standard deviation <0.1
TOC = total organic carbon
DOC = dissolved organic carbon

## Figure 13 Cumulative probability distribution of total organic carbon (mg/L), 1997–2002

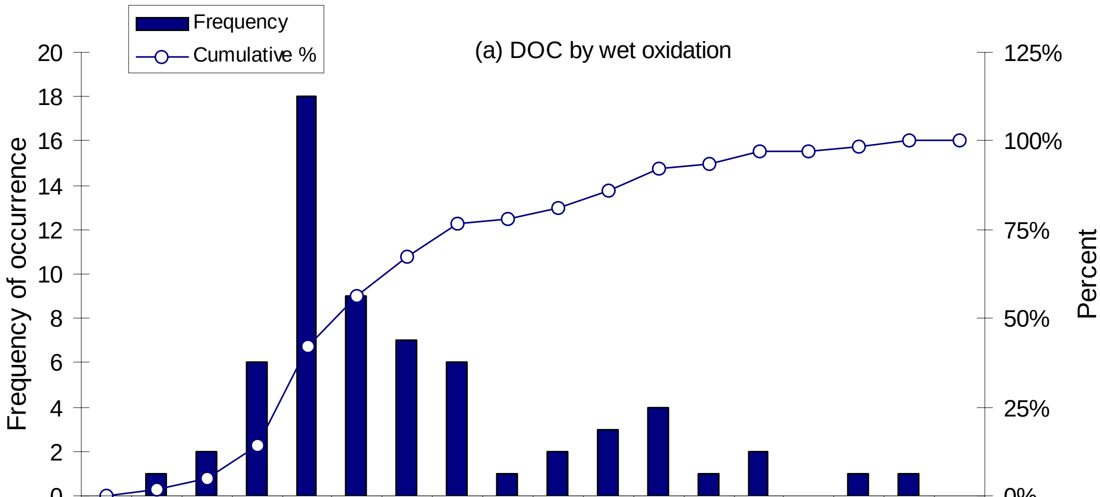



| | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 | 9 | 9.5 | 10 | 10.5 | 11 | 11.5 | 12 | 12.5 | 13 | 13.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 1 | 2 | 4 | 13 | 4 | 4 | 2 | 1 | 2 | 0 | 4 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cumulative % | 0% | 2% | 7% | 16% | 45% | 55% | 64% | 68% | 70% | 75% | 75% | 84% | 89% | 91% | 93% | 98% | 98% | 98% | 98% | 98% | 100% | 100% |

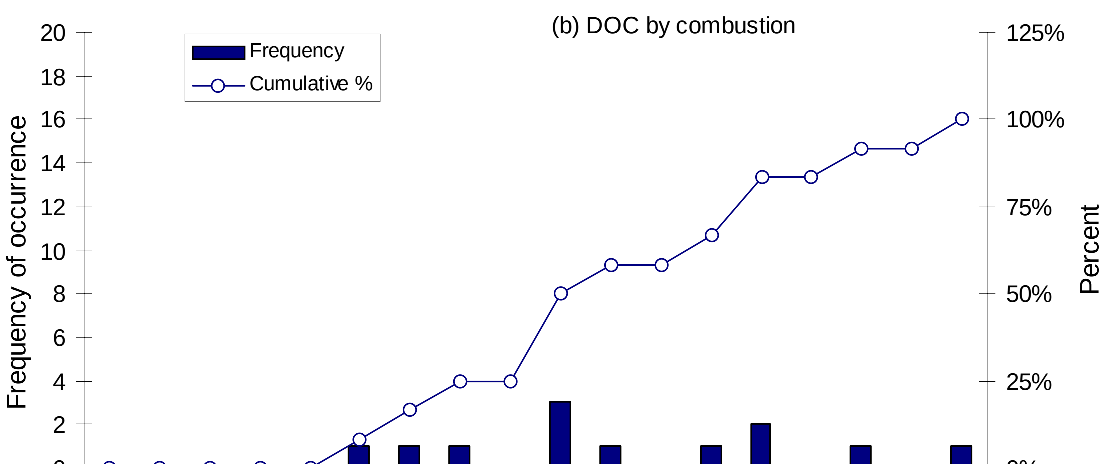



| | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 | 9 | 9.5 | 10 | 10.5 | 11 | 11.5 | 12 | 12.5 | 13 | 13.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 1 | 2 | 3 | 1 | 0 | 2 | 1 | 0 | 3 | 1 | 1 | 1 | 2 | 0 | 1 |
| Cumulative % | 0% | 0% | 0% | 0% | 0% | 13% | 21% | 25% | 33% | 46% | 50% | 50% | 58% | 63% | 63% | 75% | 79% | 83% | 88% | 96% | 96% | 100% |

**Figure 14 Cumulative probability distribution of dissolved organic carbon (mg/L), 1997–2002**

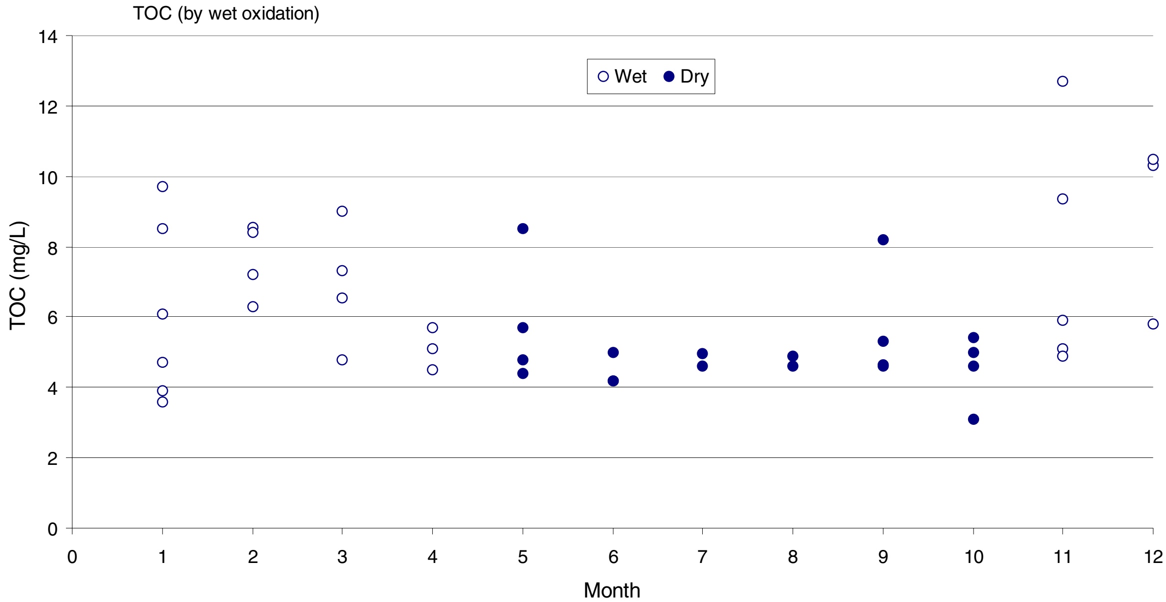


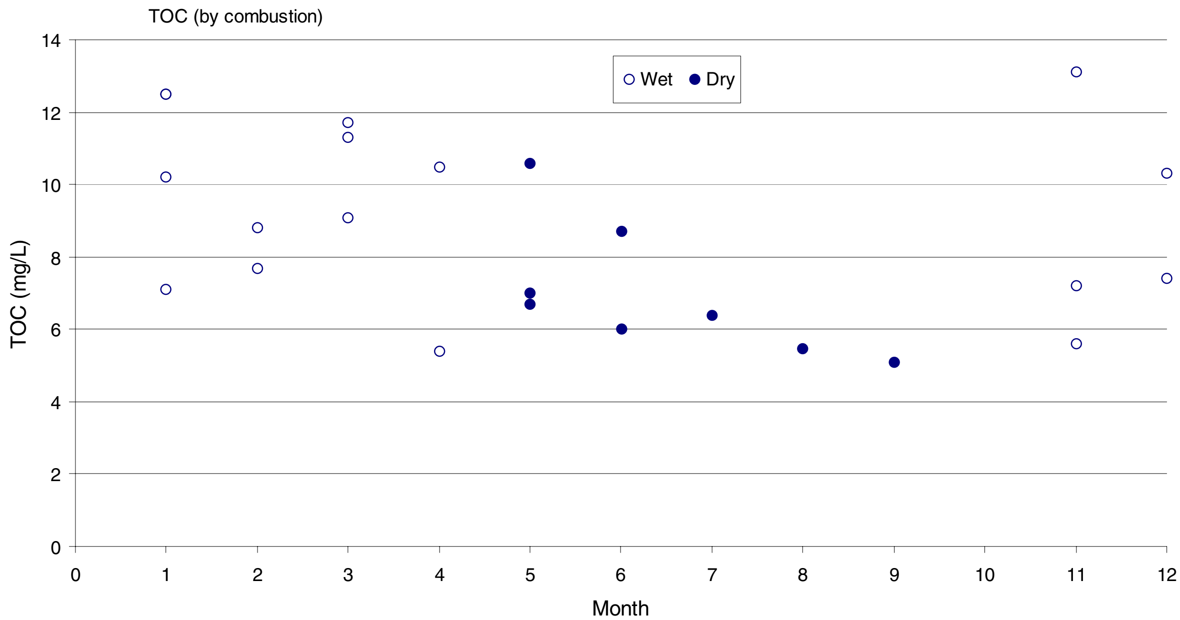

| | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 | 9 | 9.5 | 10 | 10.5 | 11 | 11.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 1 | 2 | 6 | 18 | 9 | 7 | 6 | 1 | 2 | 3 | 4 | 1 | 2 | 0 | 1 | 1 | 0 |
| Cumulative % | 0% | 2% | 5% | 14% | 42% | 56% | 67% | 77% | 78% | 81% | 86% | 92% | 94% | 97% | 97% | 98% | 100% | 100% |




| | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 | 9 | 9.5 | 10 | 10.5 | 11 | 11.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 3 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 1 |
| Cumulative % | 0% | 0% | 0% | 0% | 0% | 8% | 17% | 25% | 25% | 50% | 58% | 58% | 67% | 83% | 83% | 92% | 92% | 100% |

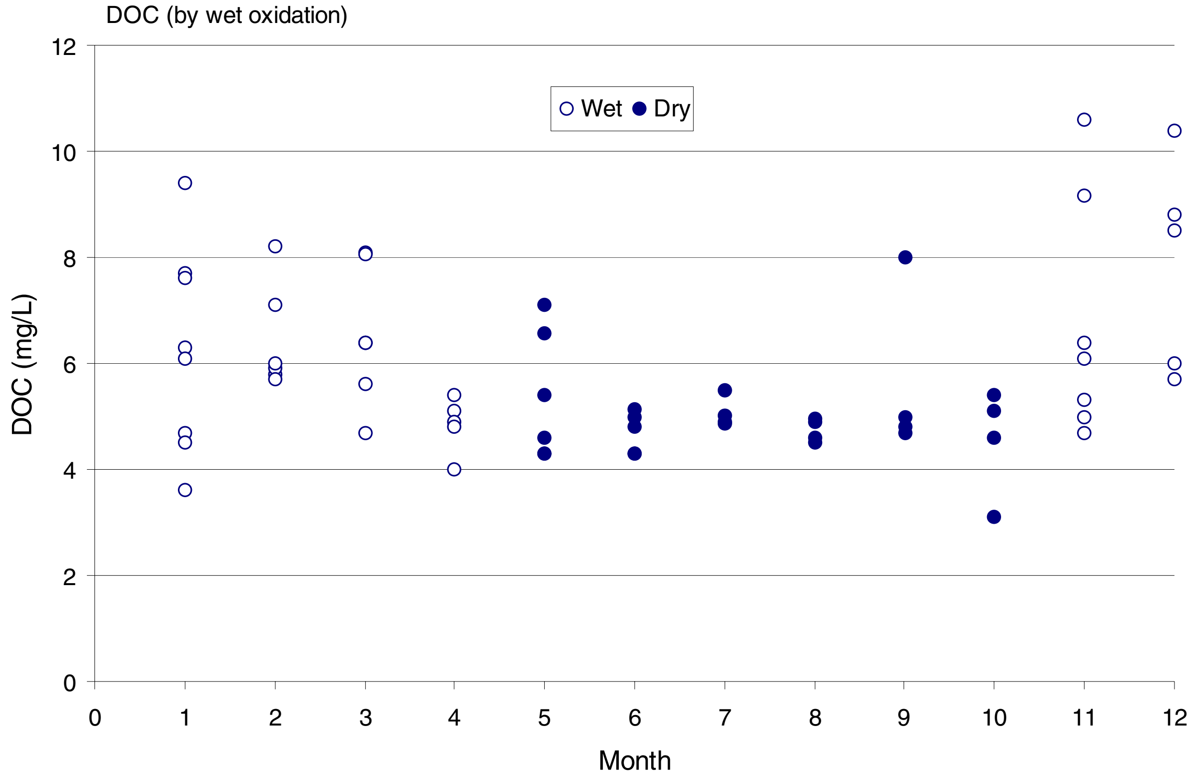
## Figure 15 Total organic carbon concentrations by season, 1997–2002

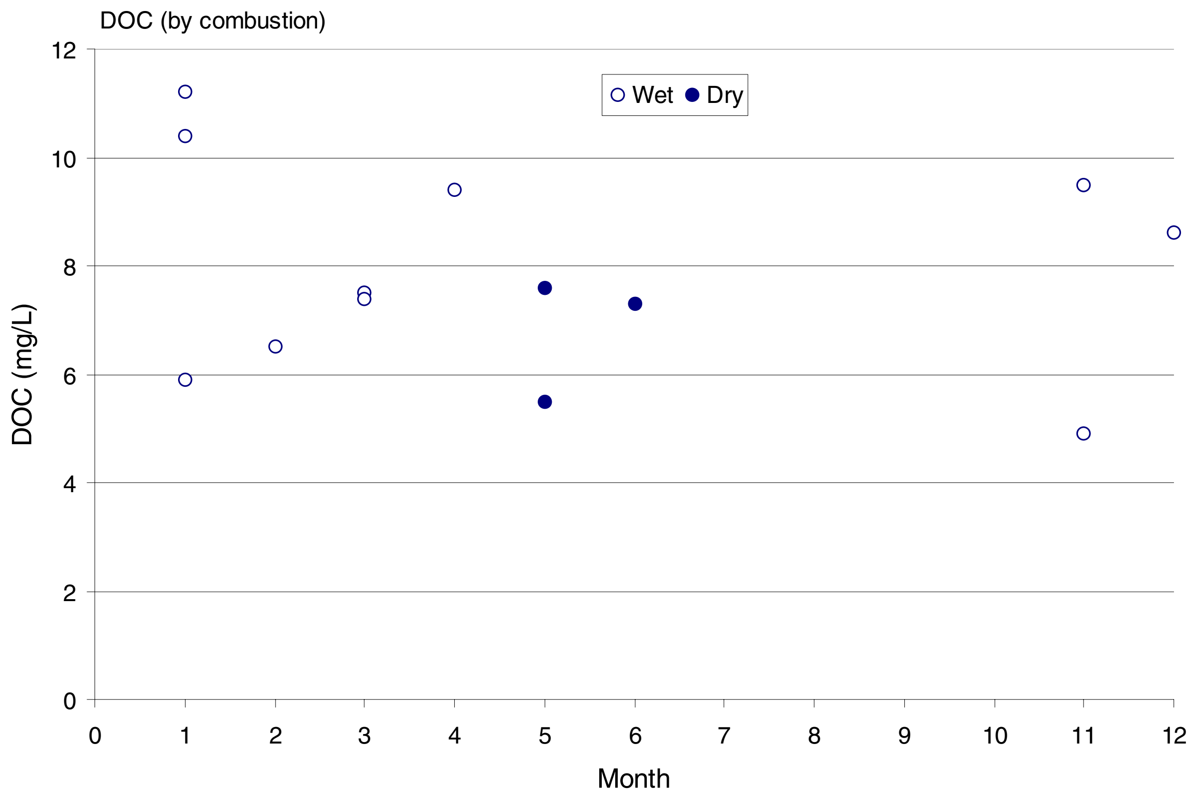



Wet season = Nov - Apr
Dry season = May - Oct

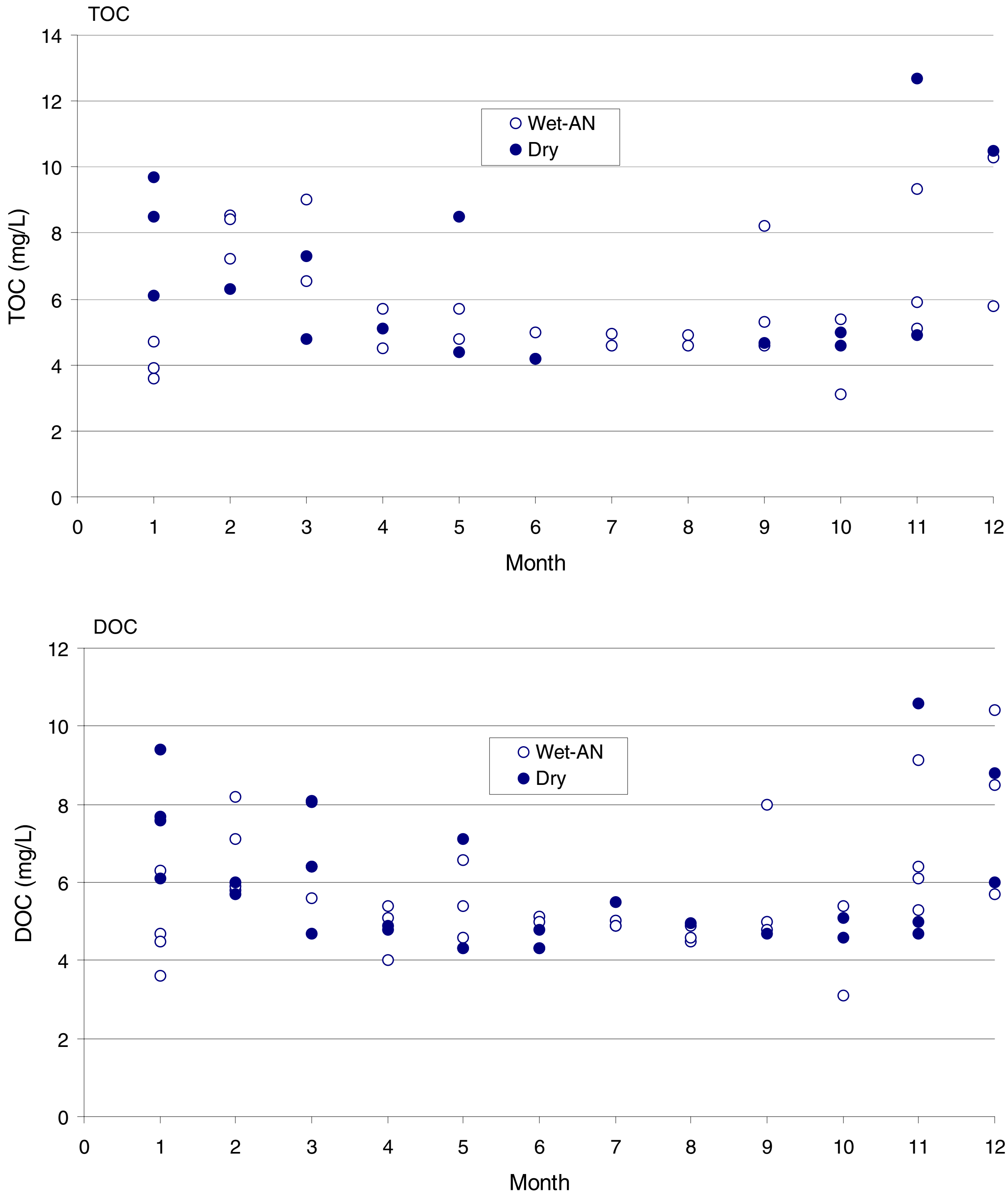
**Figure 16 Dissolved organic carbon concentrations by season, 1997–2002**




Wet season = Nov - Apr
Dry season = May - Oct

# Figure 17 Monthly total organic carbon and dissolved organic carbon concentrations by water year, 1997–2001




Wet oxidation method values used due to insufficient data for combustion method.
Wet-AN = wet and above normal water years based on DWR classification system for Sacramento Basin
DOC = dissolved organic carbon
TOC = total organic carbon

**Figure 18 Total organic carbon (wet oxidation) and turbidity, 1997–2002**

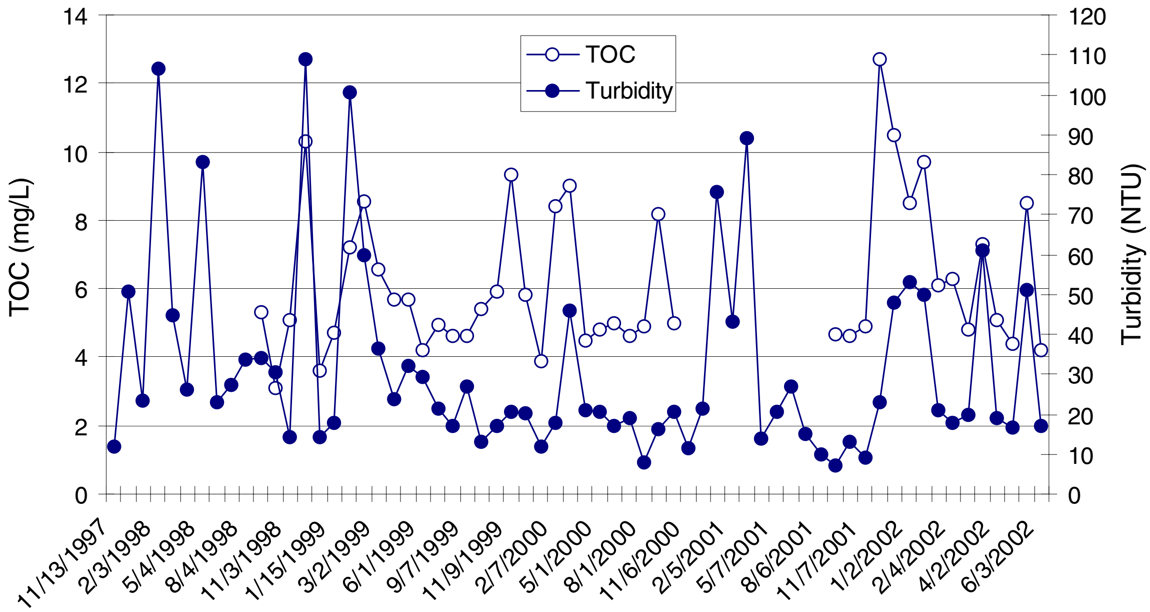
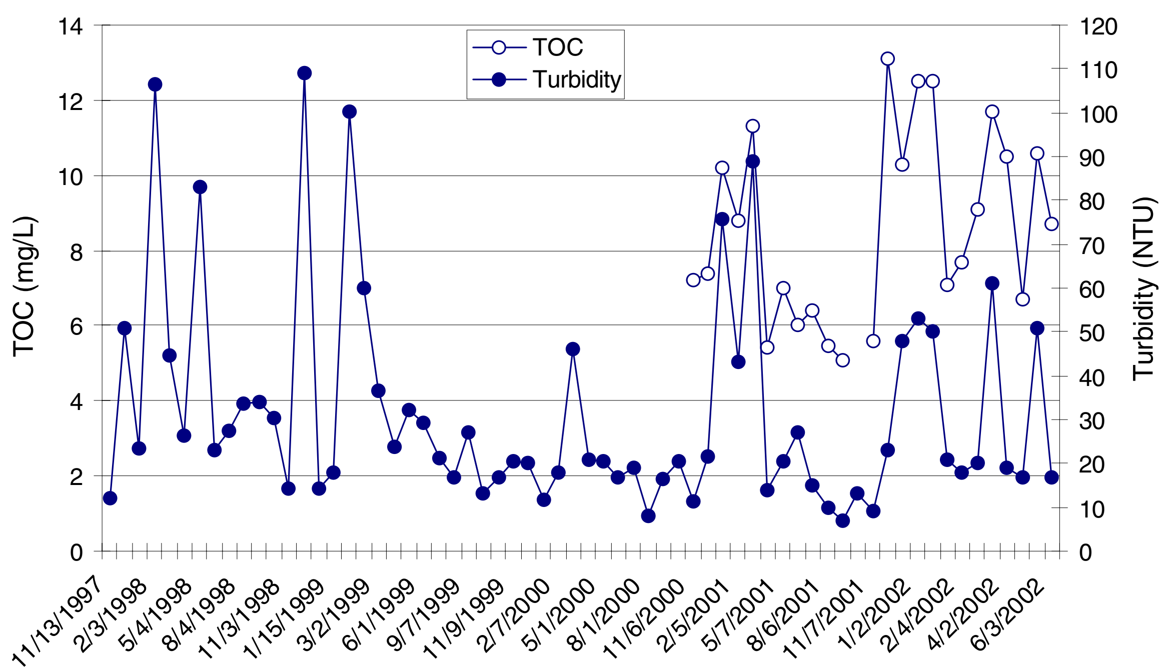



**Figure 19 Total organic carbon (combustion) and turbidity, 1997–2002**




TOC by combustion monitoring begun Nov 2000.

**Figure 20 Total organic carbon (combustion), turbidity, and total suspended solids, Nov 2001–Jun 2002**

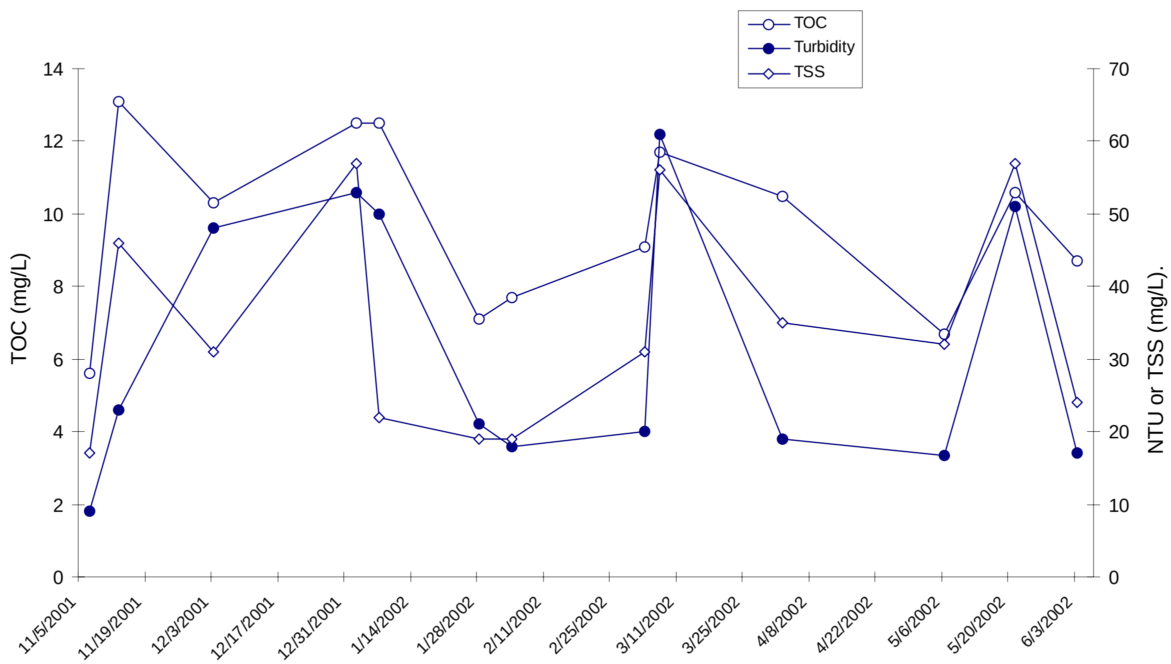


**Figure 21 Total organic carbon (combustion) and turbidity, 1997–2002**

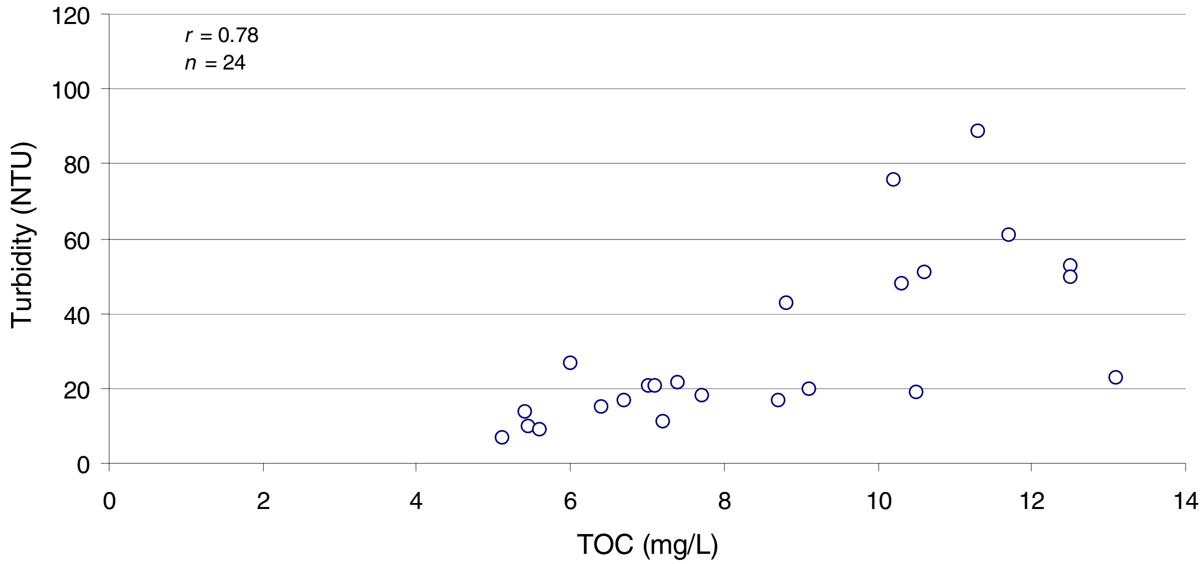



**Figure 22 Total organic carbon (combustion) and turbidity, 2001/2002**

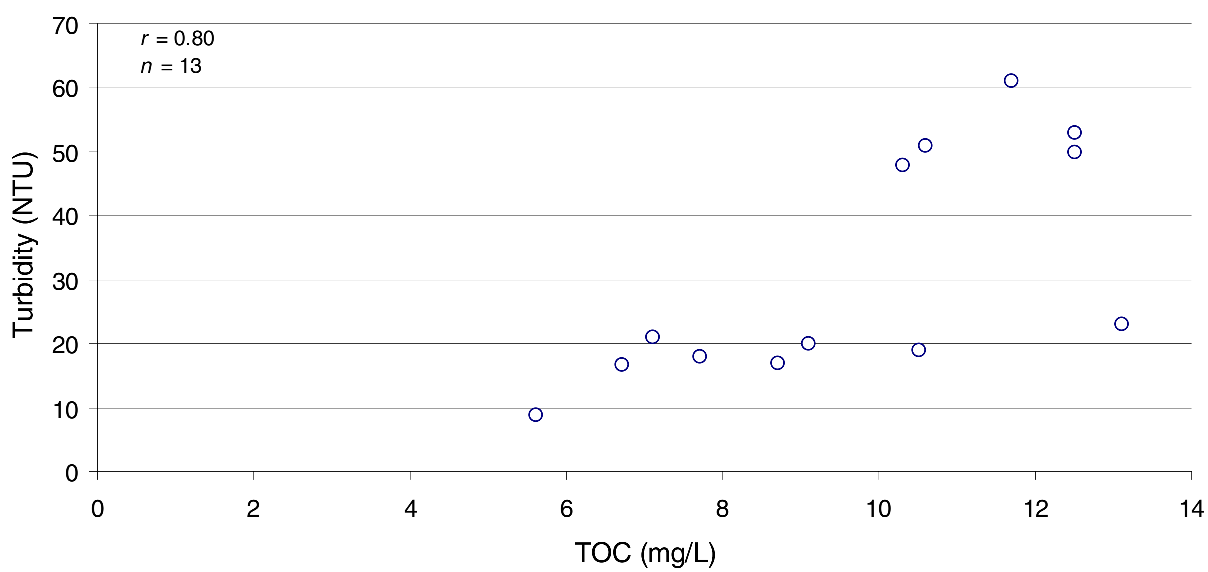
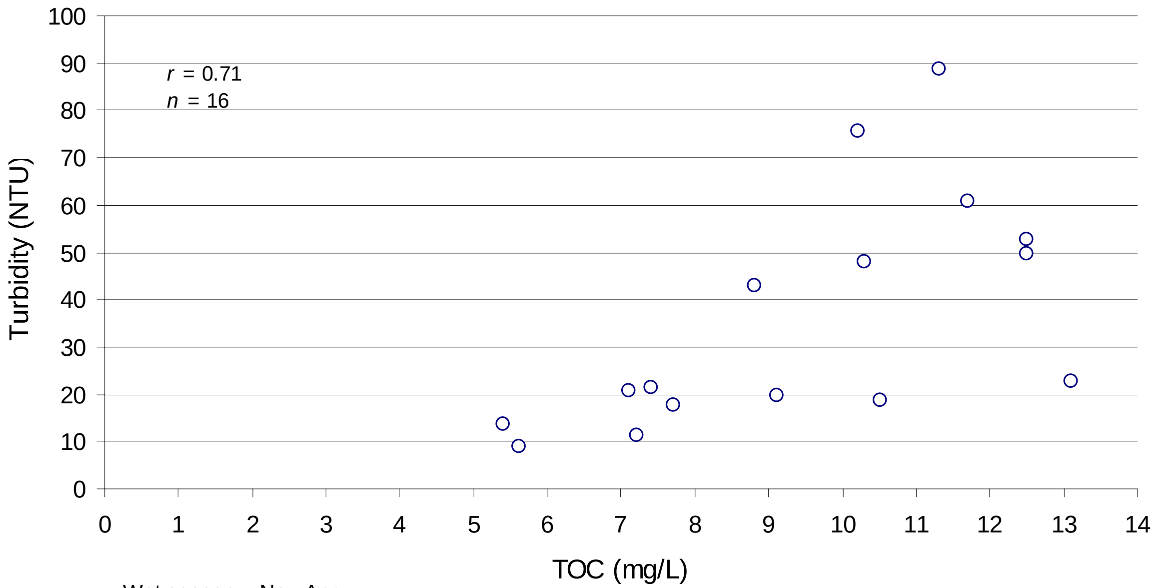
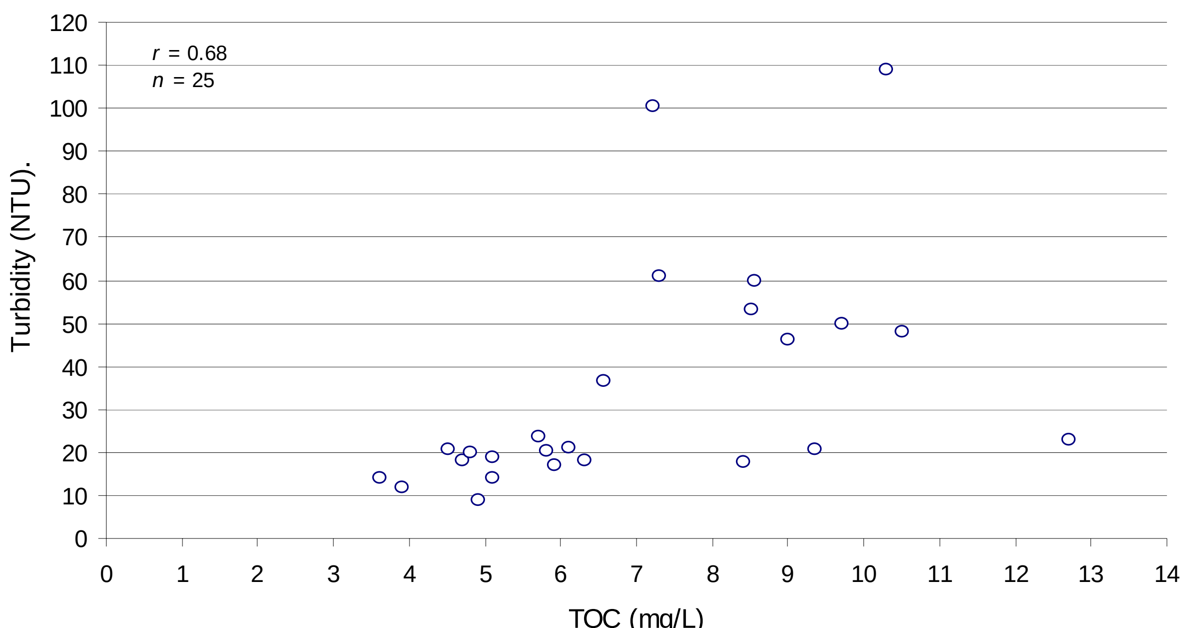


**Figure 23  Total organic carbon (combustion) and turbidity, wet season 1997–2002**



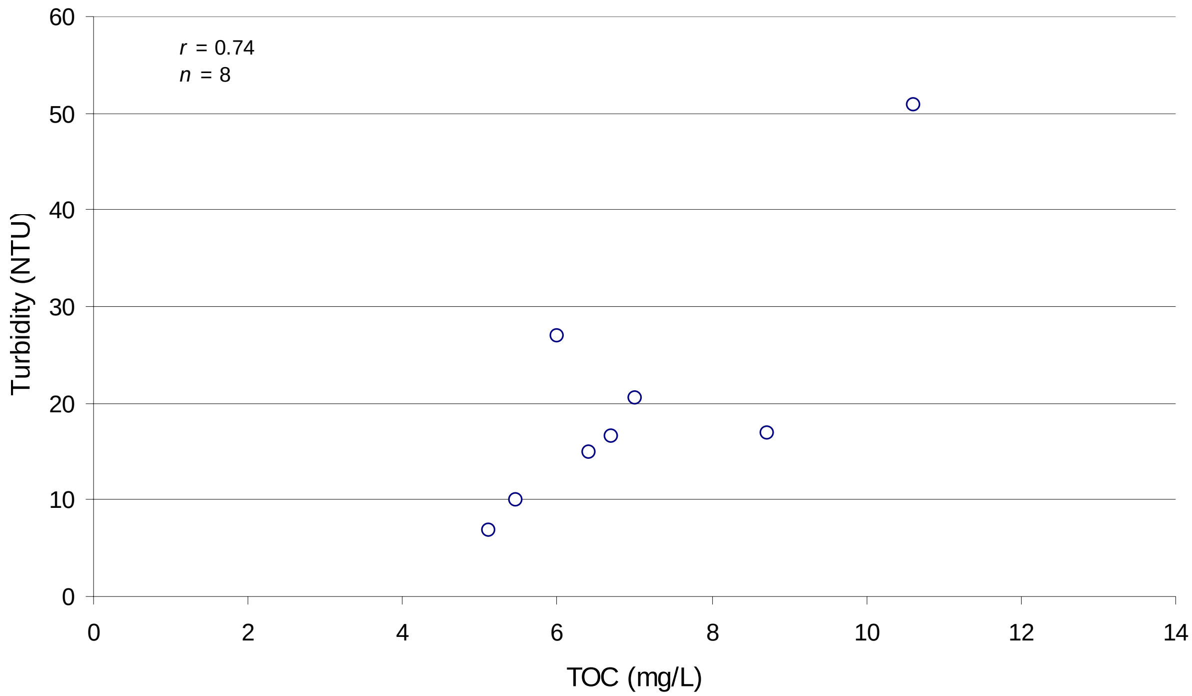

Wet season = Nov-Apr

**Figure 24  Total organic carbon (wet oxidation) and turbidity, wet season 1997–2002**



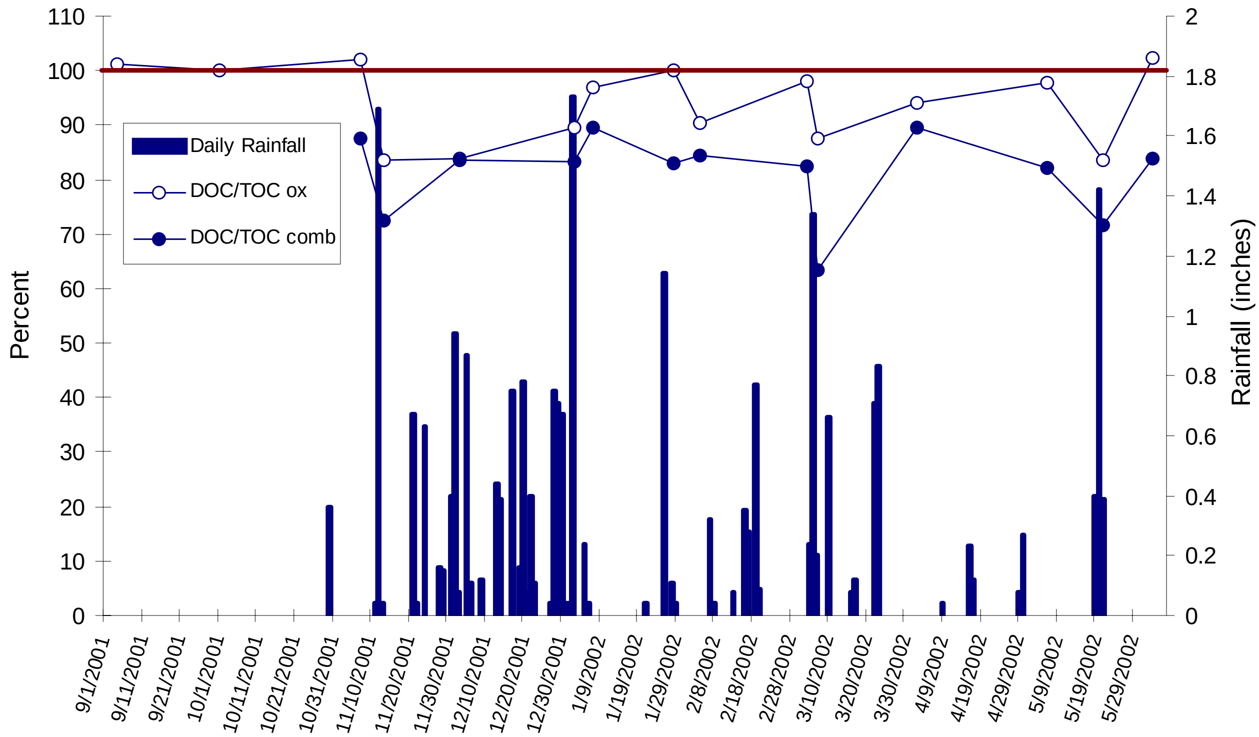

Wet season = Nov-Apr

**Figure 25 Total organic carbon (combustion) and turbidity, dry season 1997–2002**




Dry season = May-Oct

**Figure 26 Ratio of dissolved organic carbon/total organic carbon and daily rainfall, 2001/2002**




Notes: Horizontal line represents TOC completely composed of DOC.
Three values where DOC>TOC by <3%.
Rainfall from Newcastle-Pineview School (NCS) station.

**Figure 27 Dissolved organic carbon (wet oxidation) and $UVA_{254}$, 1997–2002**

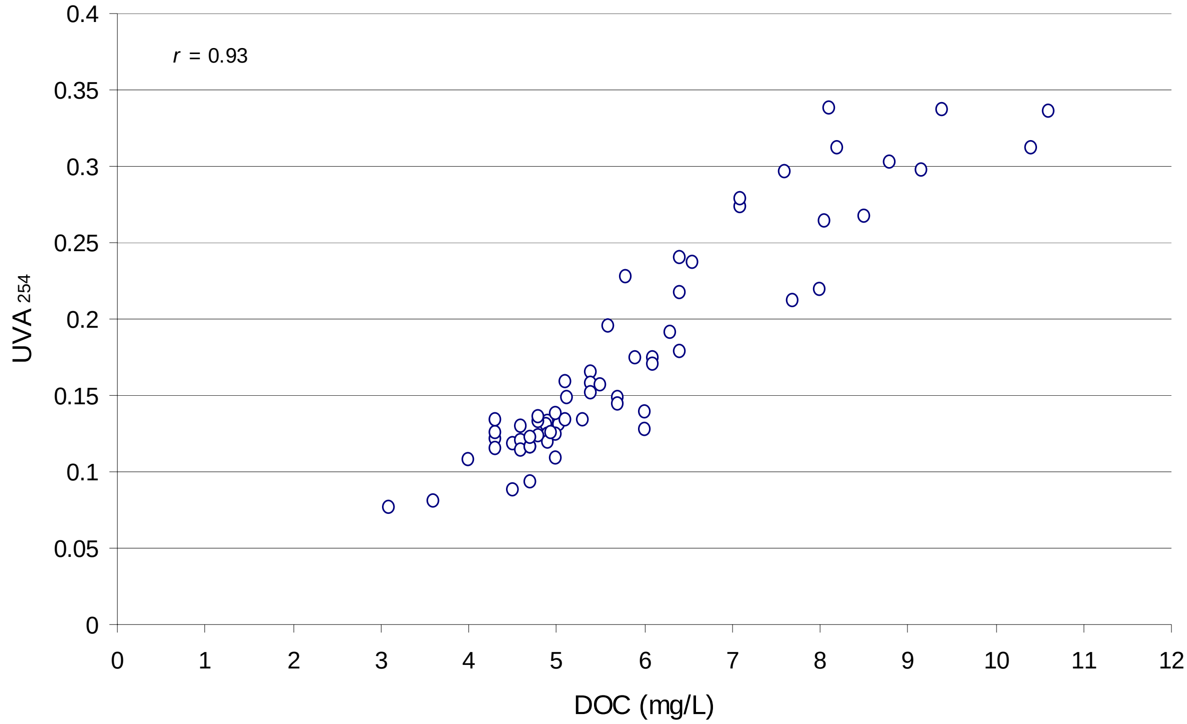



**Figure 28 Dissolved organic carbon (wet oxidation) and $UVA_{254}$, 2001/2002**

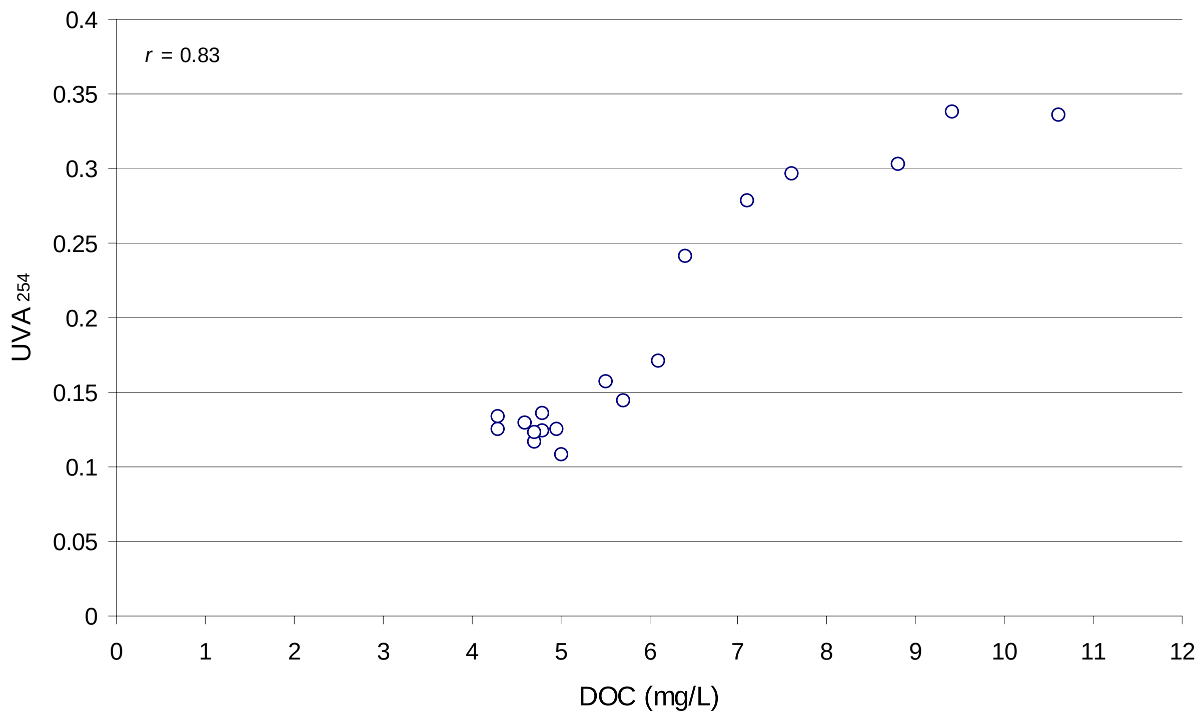
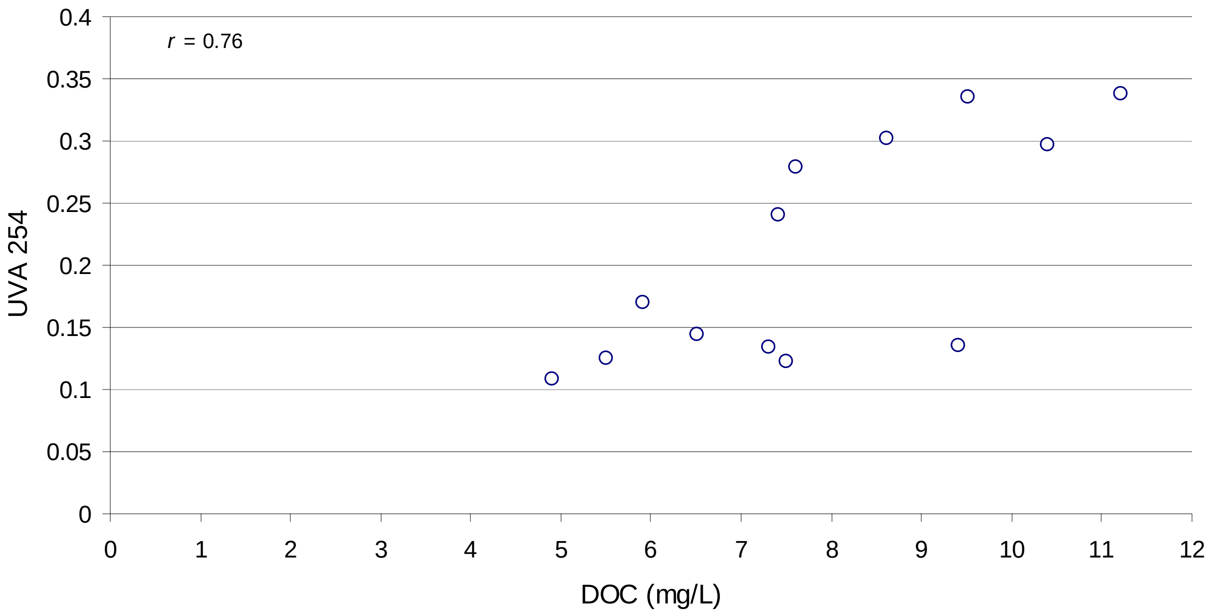
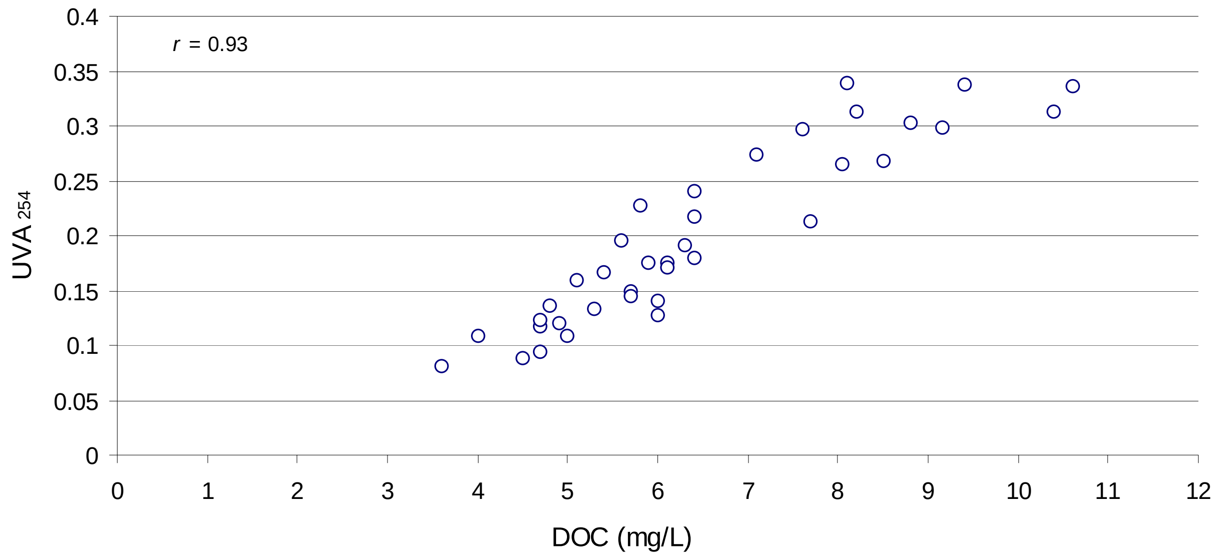


**Figure 29 Dissolved organic carbon (combustion) vs. $UVA_{254}$, 2001/2002**



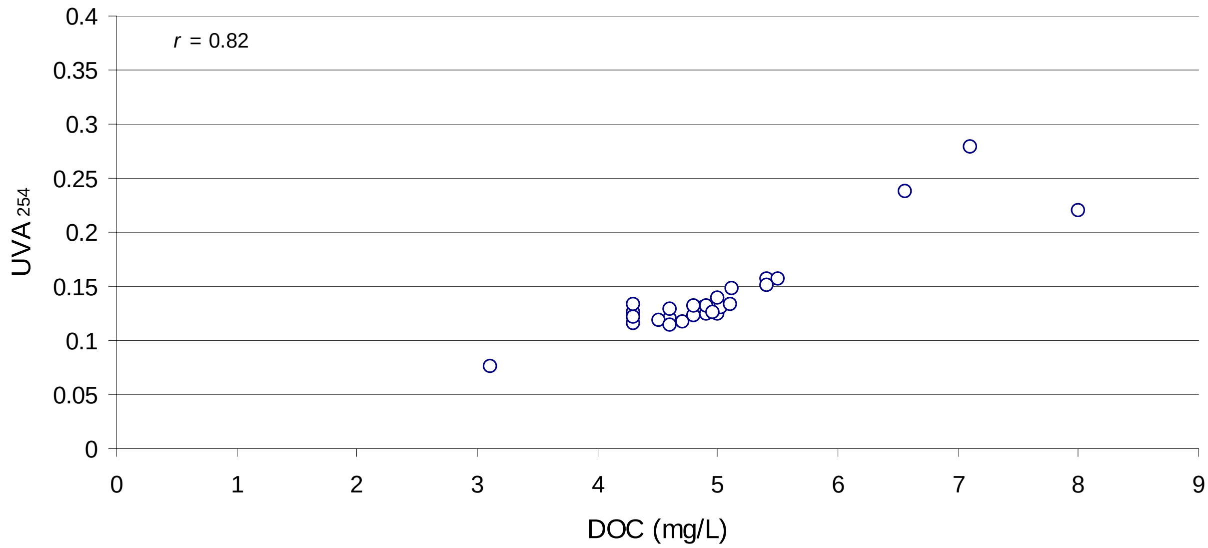

DOC = dissolved organic carbon

**Figure 30 Dissolved organic carbon (wet oxidation) and $UVA_{254}$, wet season 1997–2002**



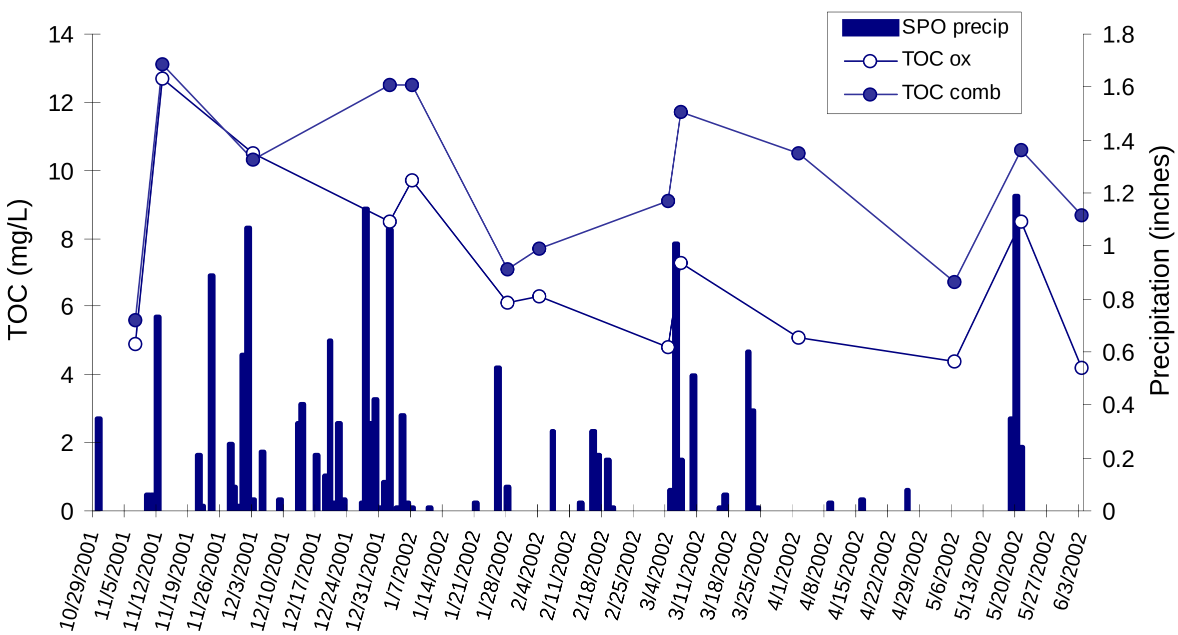

Wet season = Nov - Apr
DOC = dissolved organic carbon

**Figure 31 Dissolved organic carbon (wet oxidation) and $UVA_{254}$, dry season 1997–2002**



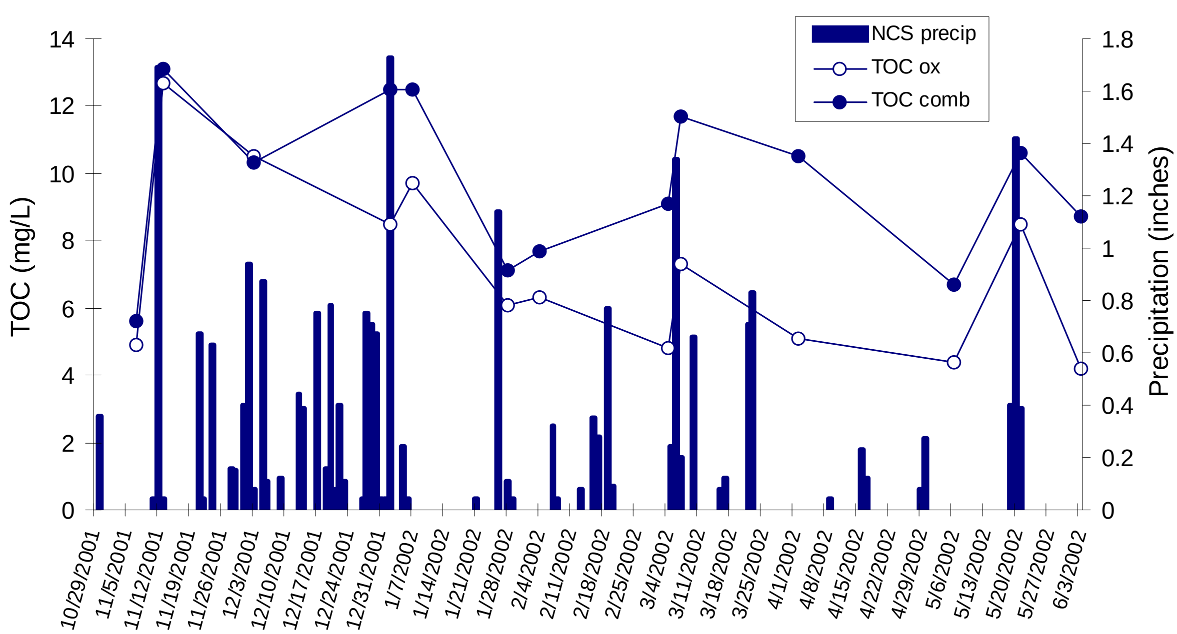

Dry season = May-Oct
DOC = dissolved organic carbon

## Figure 32 Total organic carbon and daily rainfall: SPO station



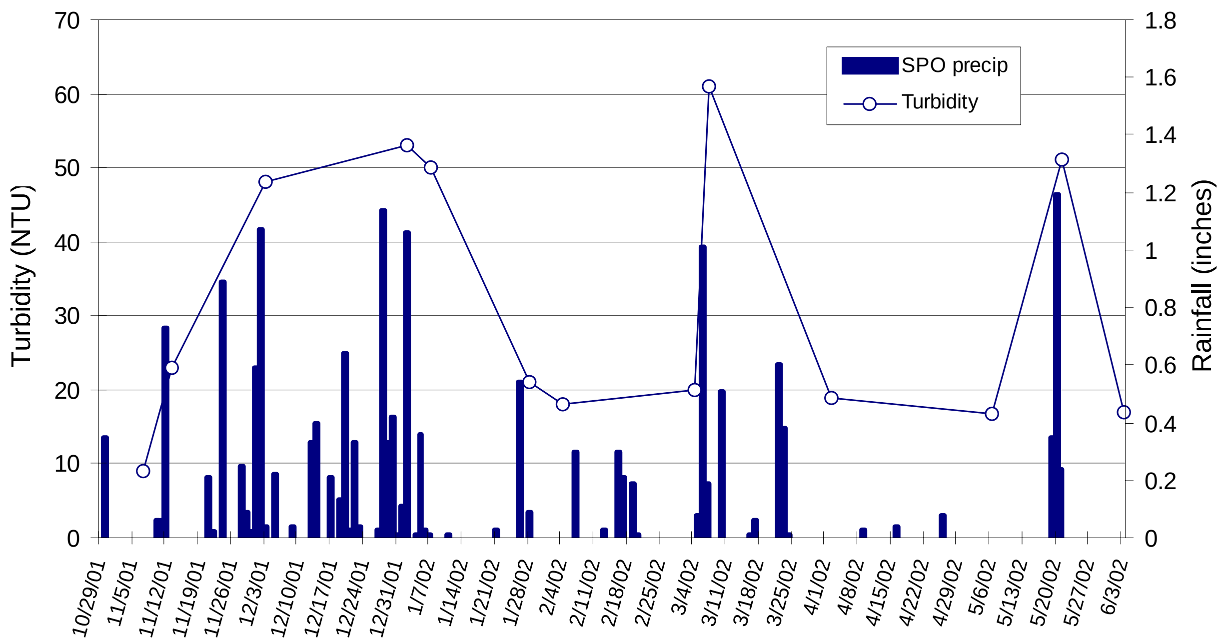

SPO = Sacramento Post Office
TOC = total organic carbon

## Figure 33 Total organic carbon and daily rainfall: NCS station



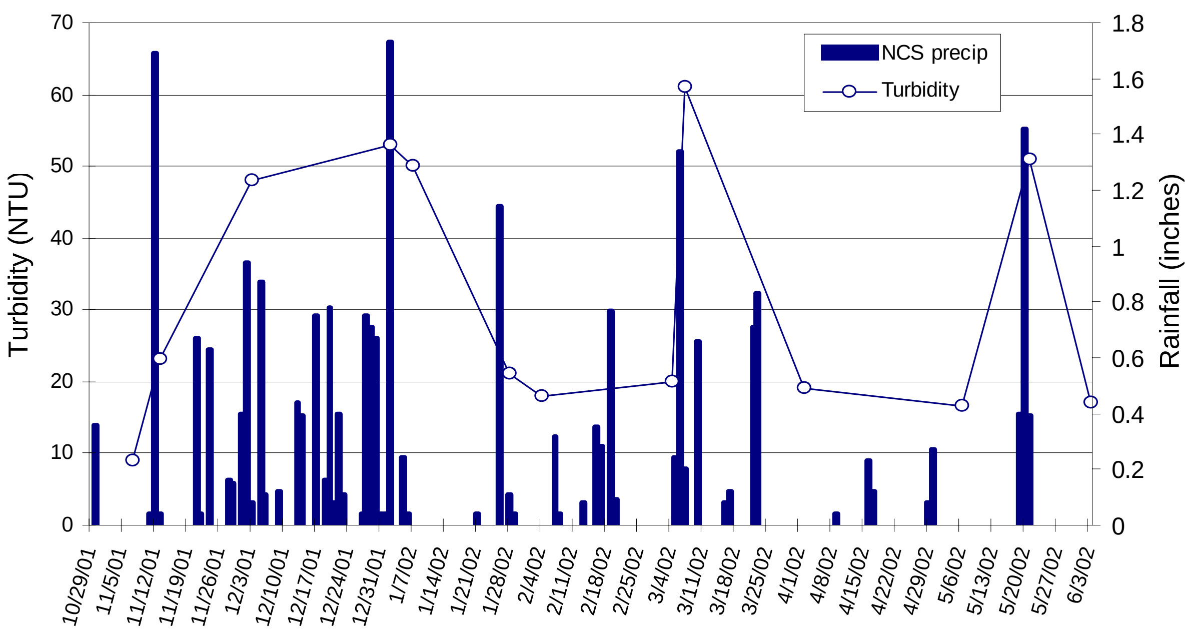

NCS = Newcastle-Pineview School
TOC = total organic carbon

**Figure 34 Turbidity and daily rainfall: SPO station**



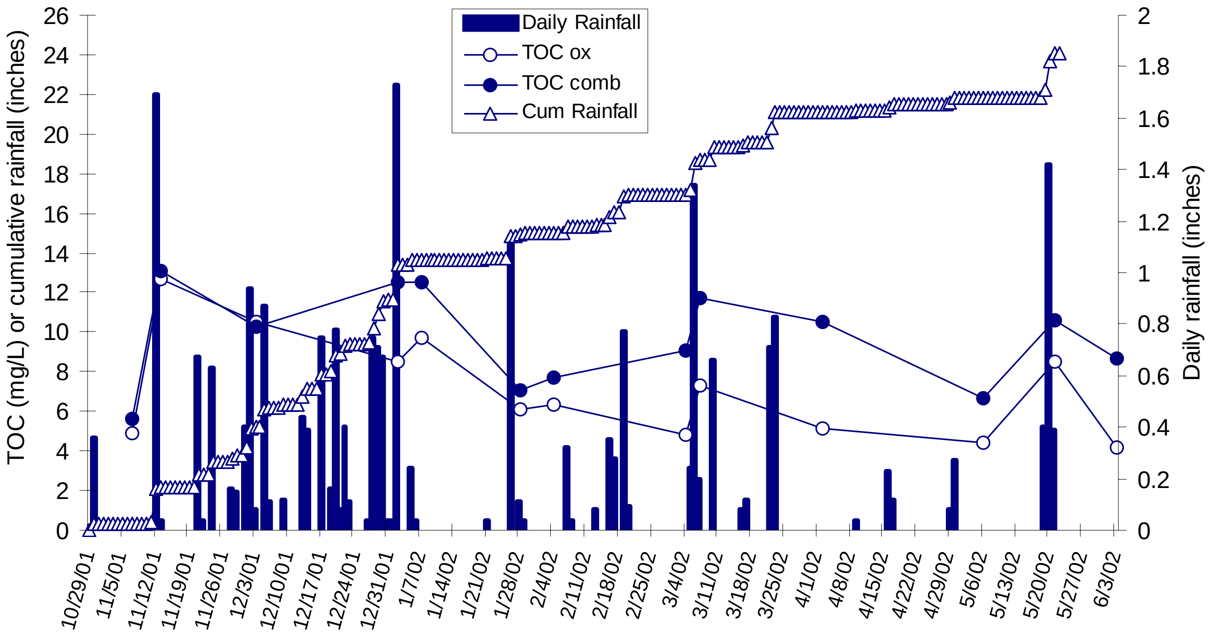

SPO = Sacramento Post Office

**Figure 35 Turbidity and daily rainfall: NCS station**



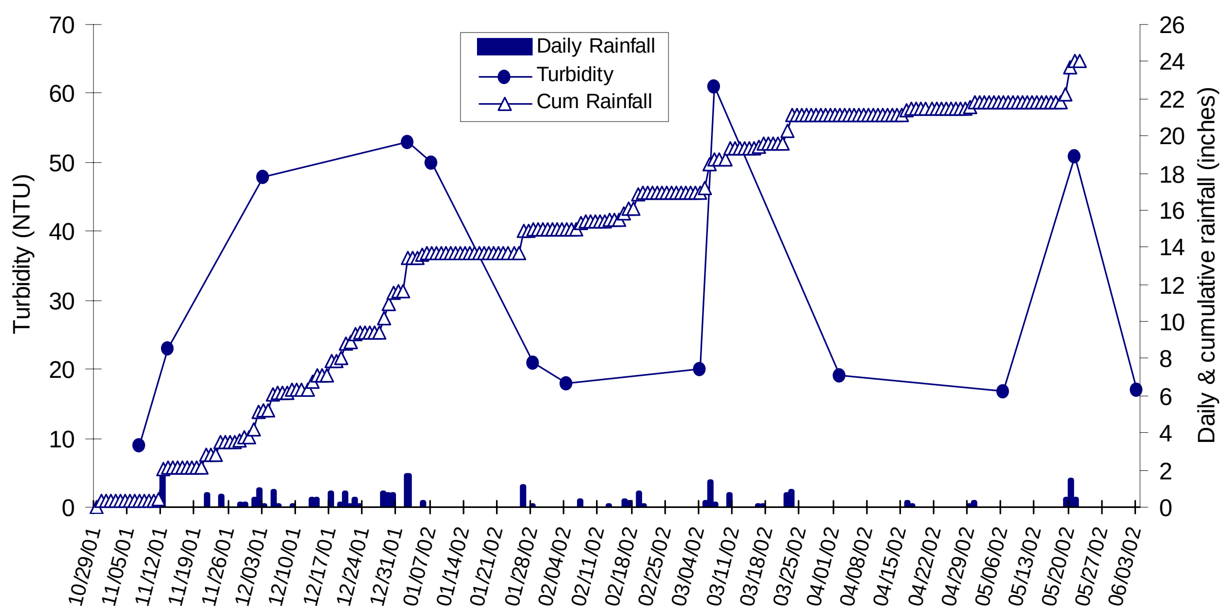

NCS = Newcastle-Pineview School

## Figure 36 Total organic carbon and cumulative rainfall: NCS station, 2001/2002



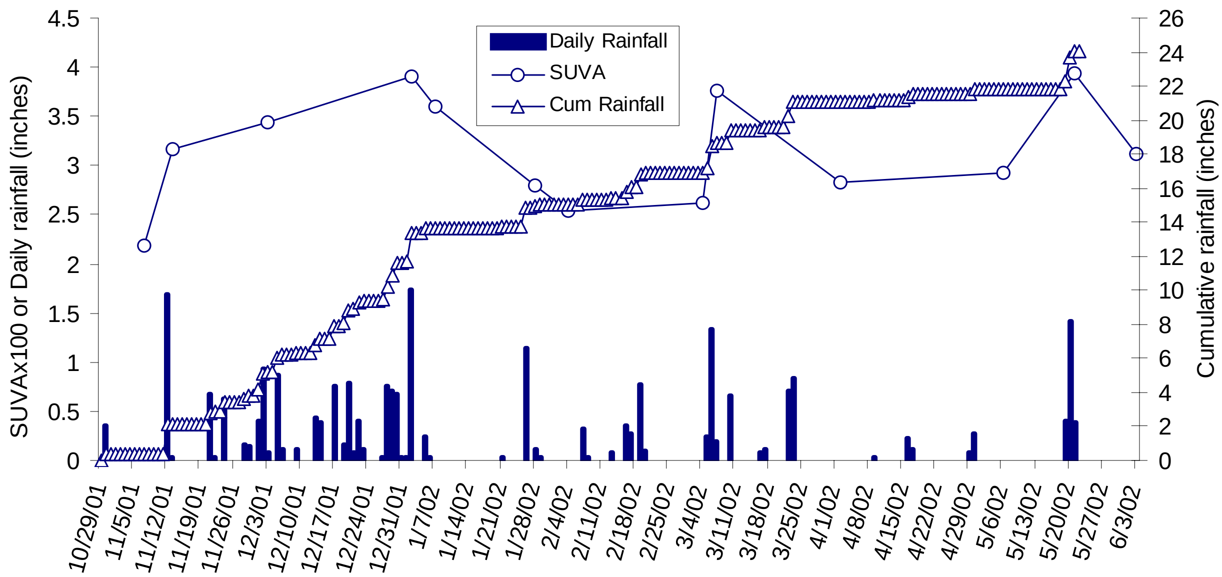

TOC = total organic carbon
NCS = Newcastle-Pineview School

## Figure 37 Turbidity and cumulative rainfall: NCS station, 2001/2002

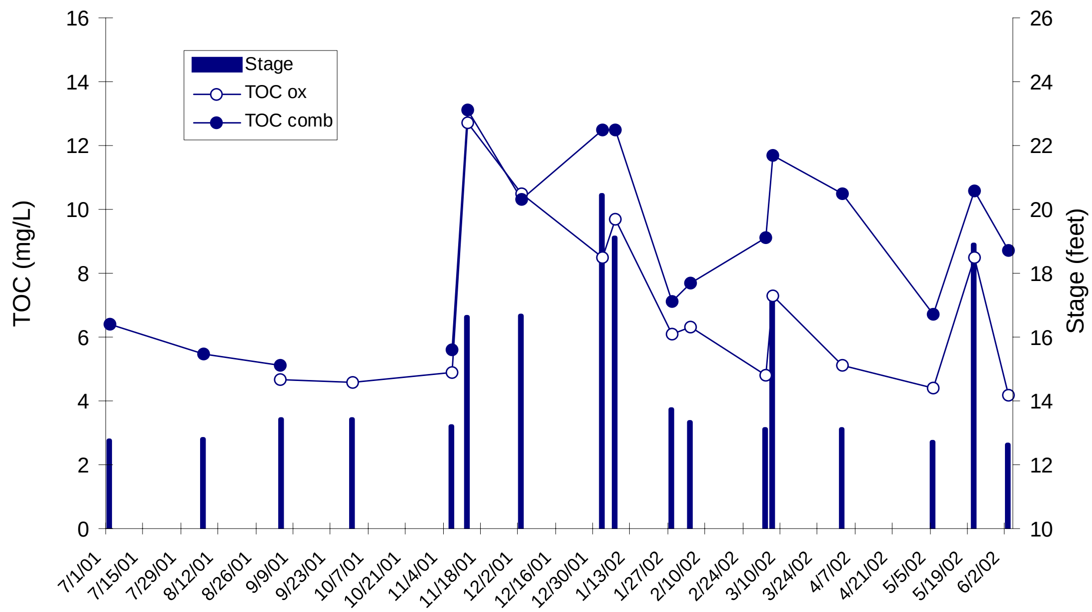



NCS = Newcastle-Pineview School

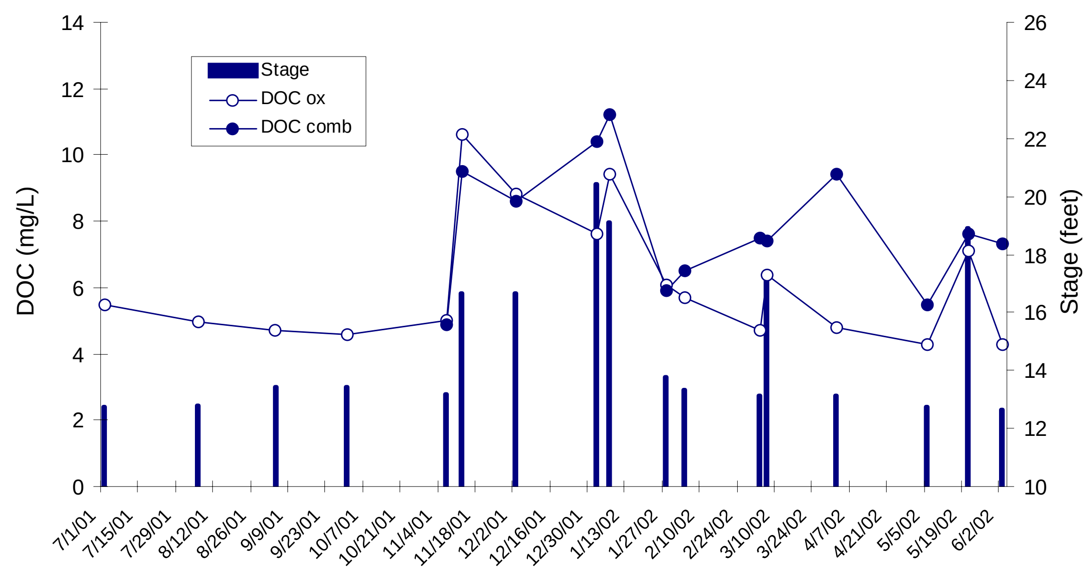
## Figure 38 Specific absorbance (SUVA) and cumulative rainfall: NCS station



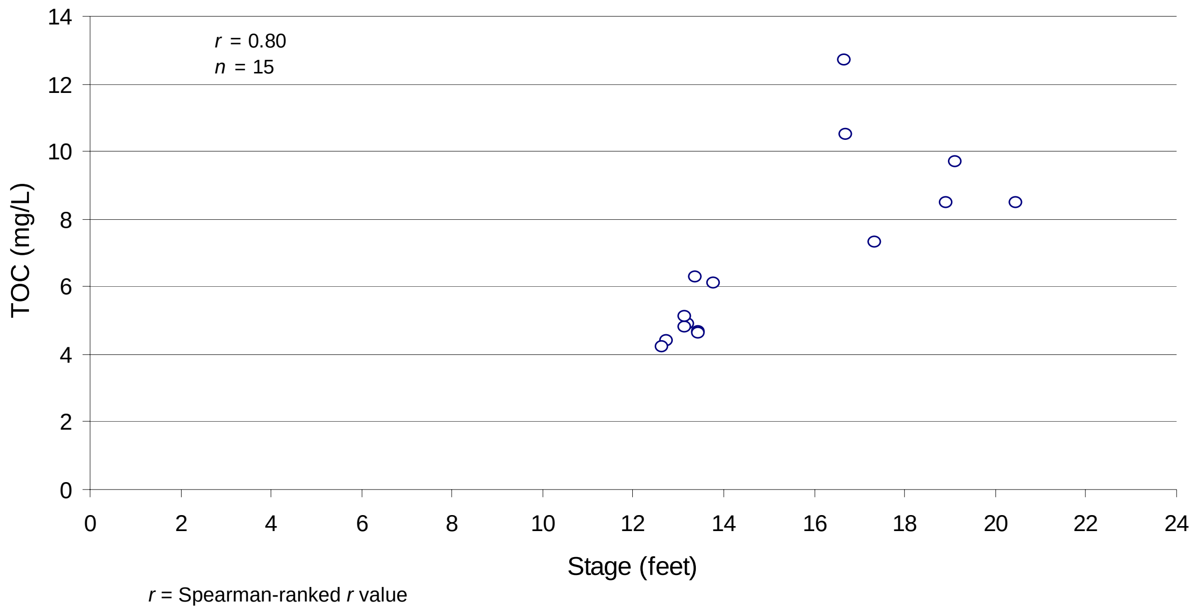
## Figure 39 Total organic carbon and stage, 2001/2002




## Figure 40 Dissolved organic carbon and stage, 2001/2002



## Figure 41 Total organic carbon (wet oxidation) vs. stage, 2001/2002




## Figure 42 Total organic carbon (combustion) vs. stage, 2001/2002

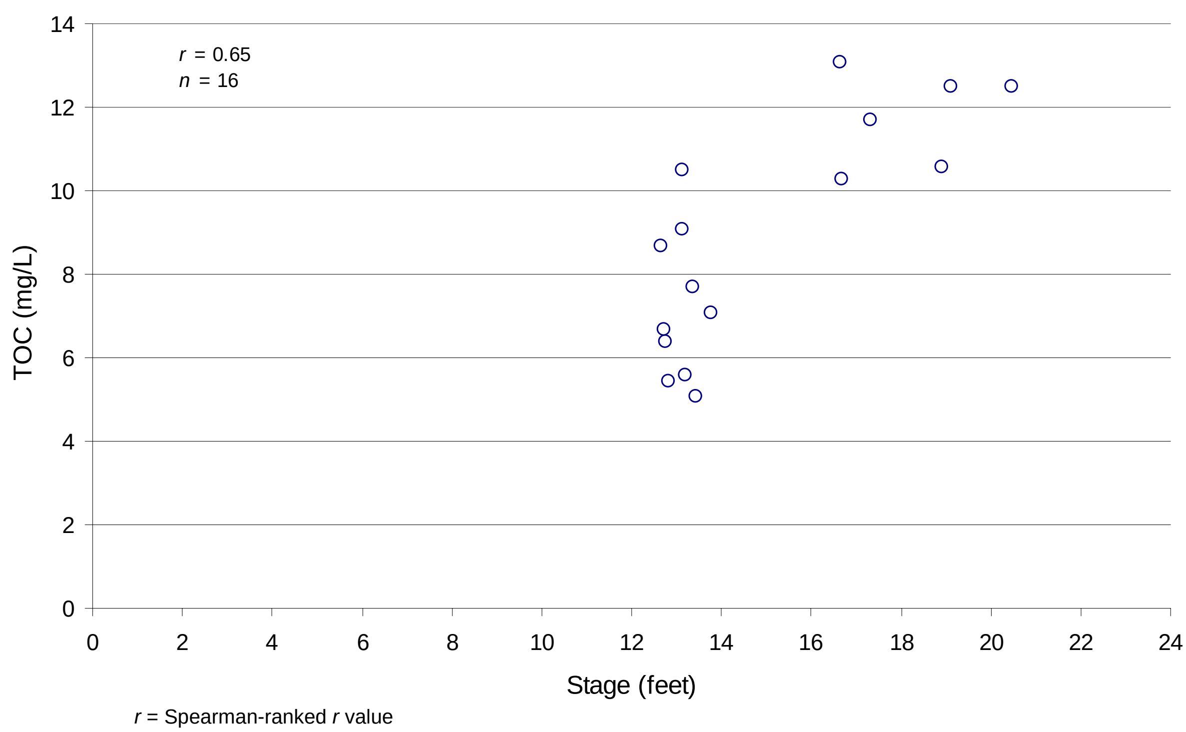
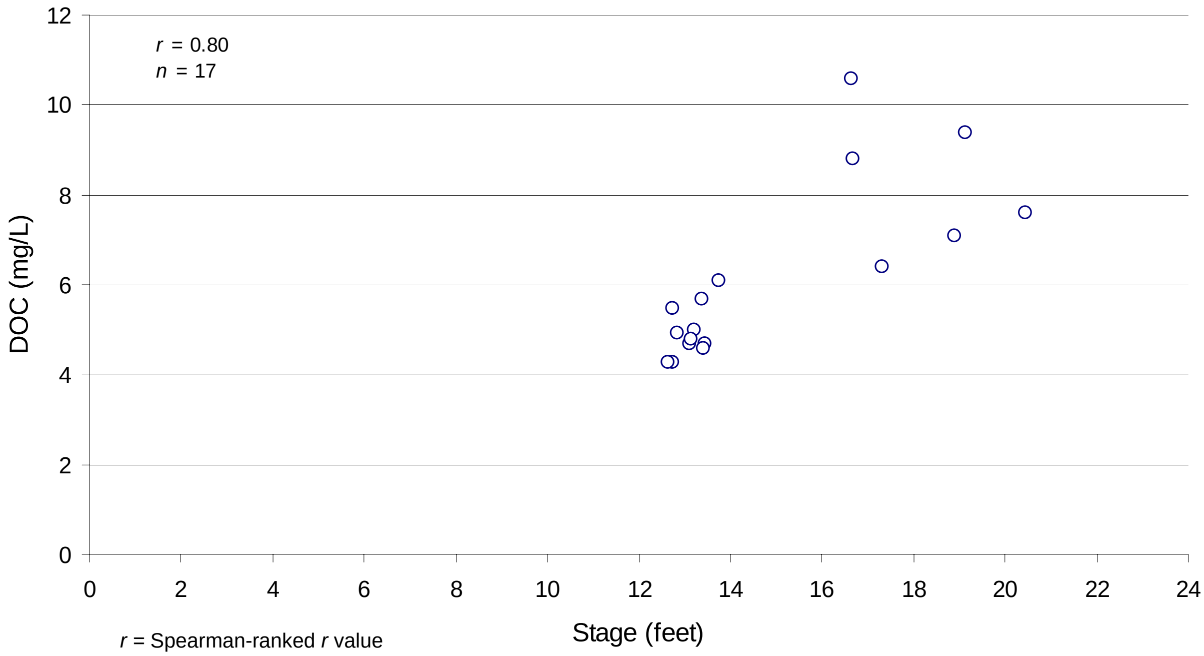
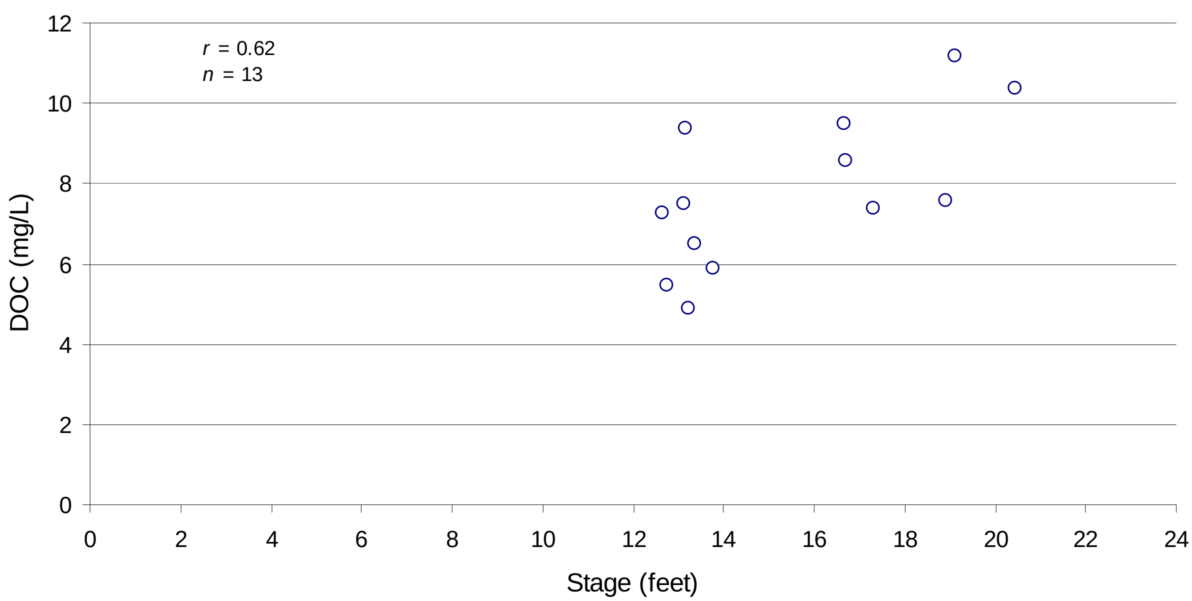


**Figure 43 Dissolved organic carbon (wet oxidation) vs. stage, 2001/2002**




*r* = Spearman-ranked *r* value

**Figure 44 Dissolved organic carbon (combustion) vs. stage, 2001/2002**




*r* = Spearman-ranked *r* value

**Figure 45 Turbidity, total suspended solids, and stage, 2001/2002**

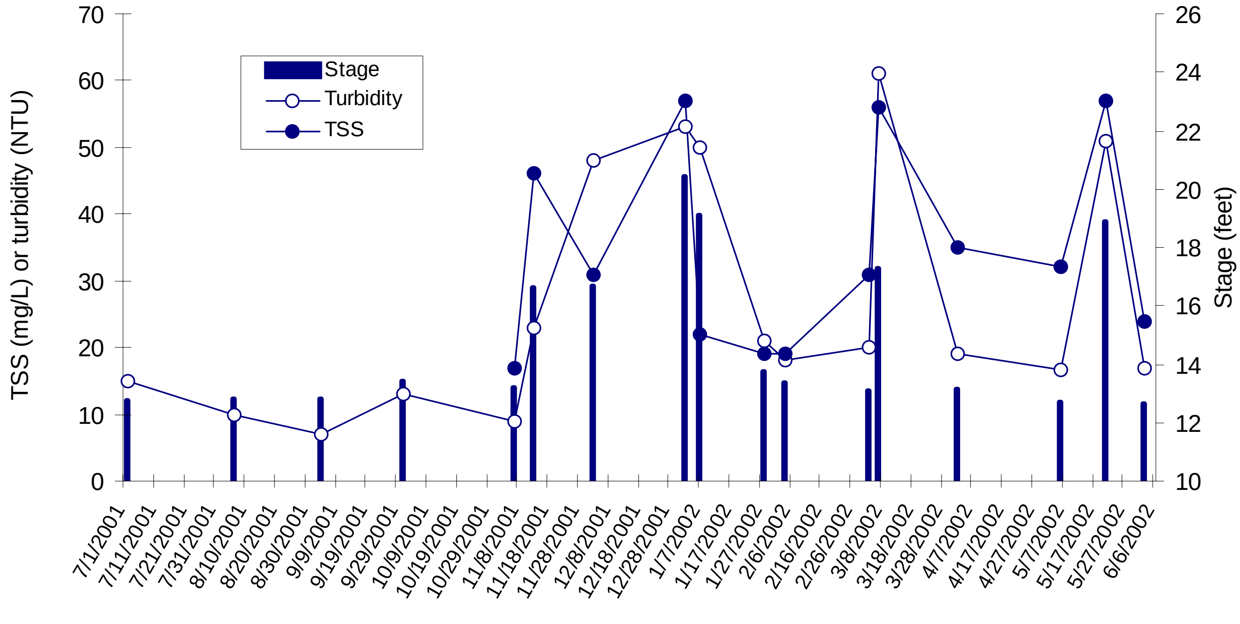
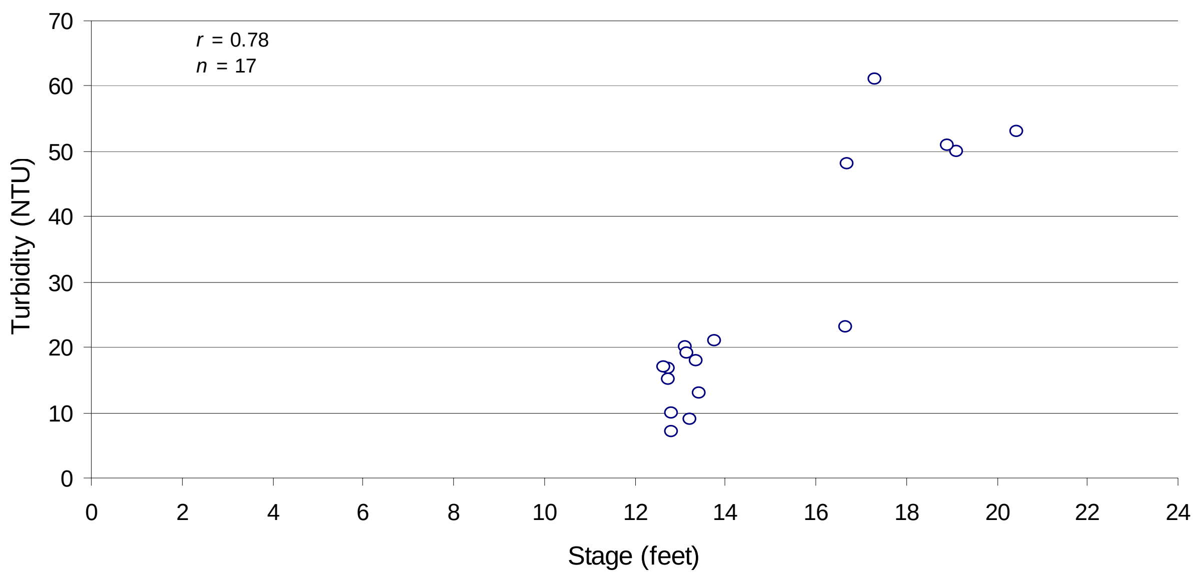
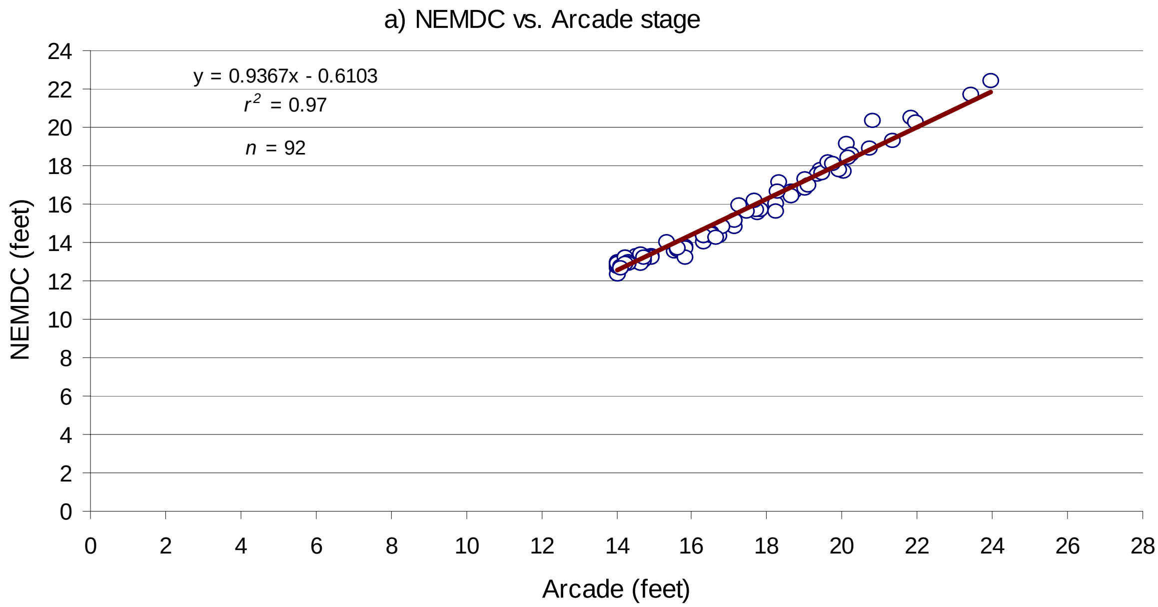



**Figure 46 Turbidity vs. stage, 2001/2002**

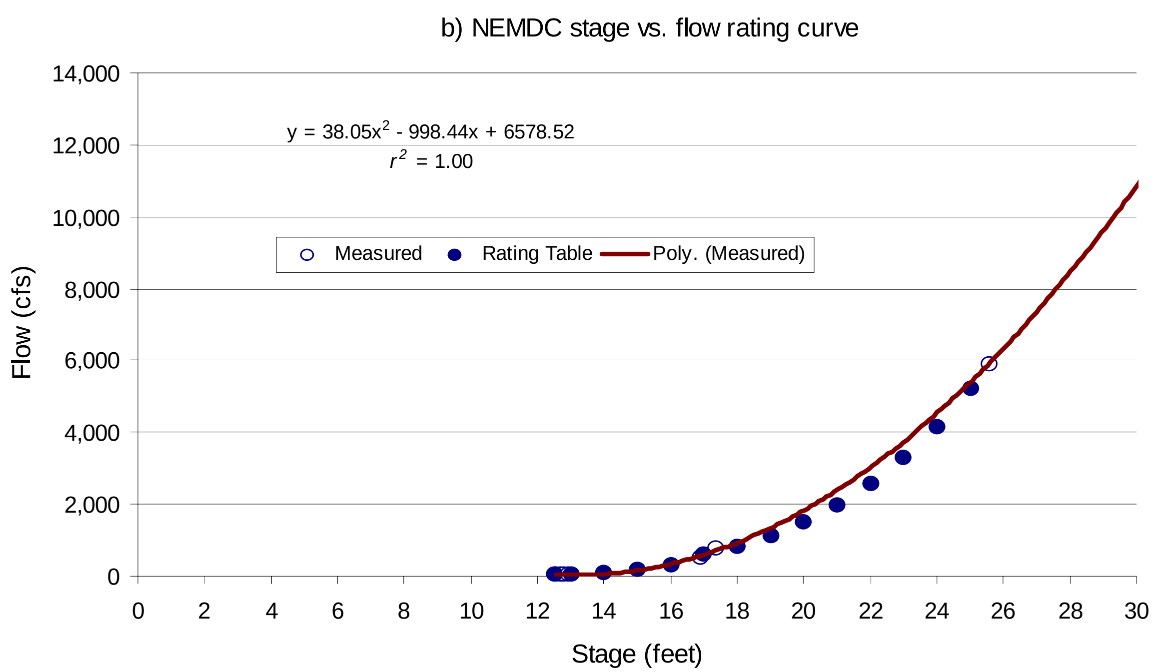



*r* = Spearman-ranked *r* value

**Figure 47 Natomas East Main Drainage stage, Arcade stage, and flow rating curve**




Sacramento Co. ALERT System Arcade sensor #1692




Based on eight survey readings July 1999 to July 2002. No readings 2001

**Figure 48 Daily average Natomas East Main Drainage Canal total organic carbon loads, Jul 2001–Jun 2002**

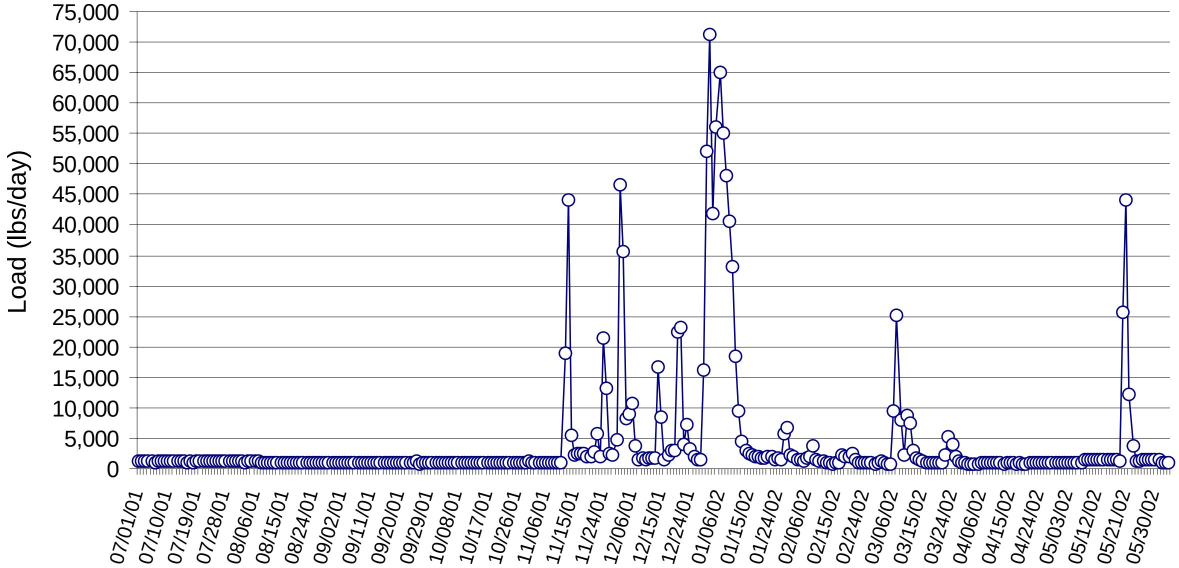
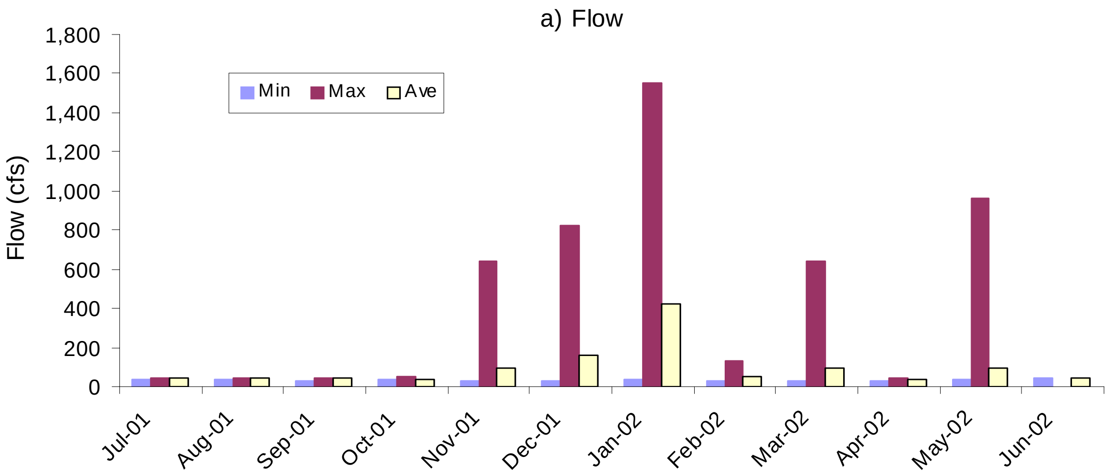
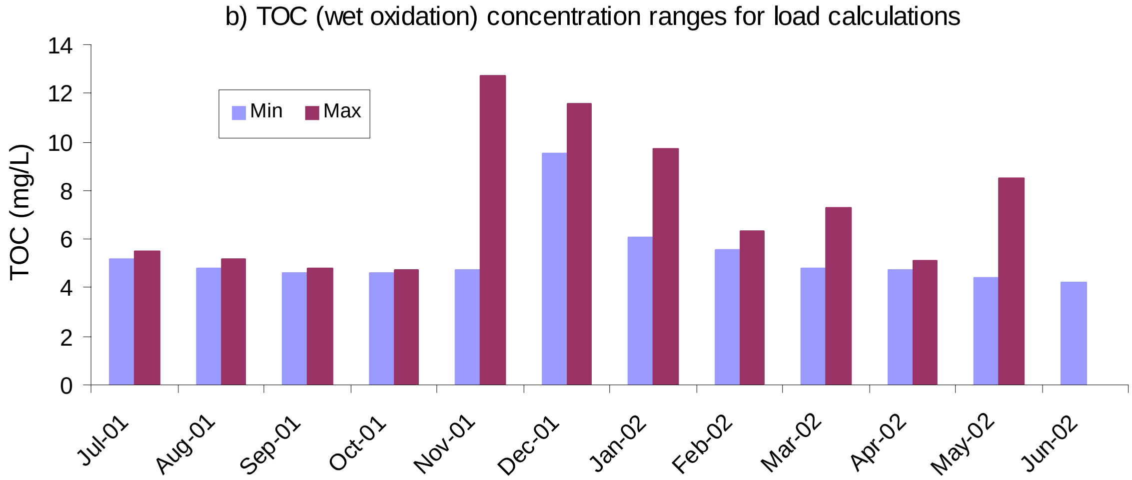
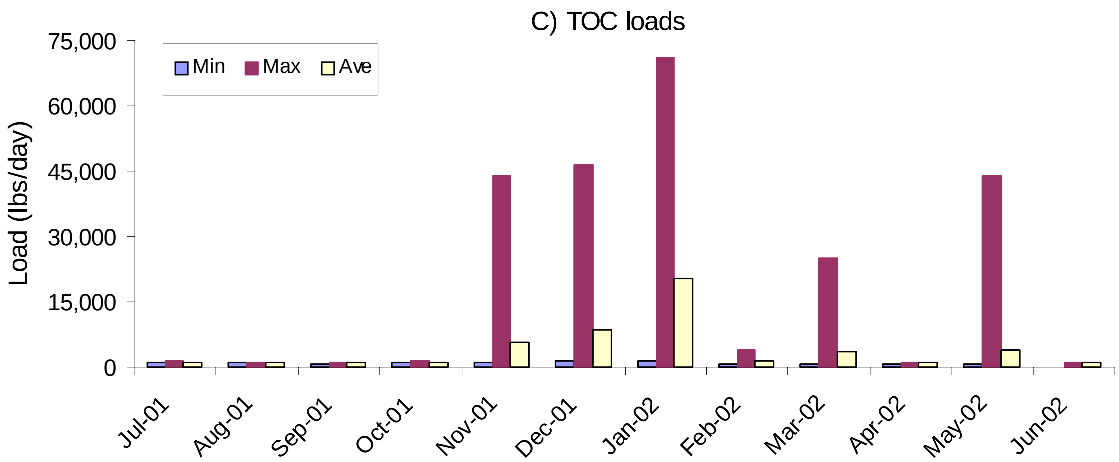


**Figure 49 Daily Natomas East Main Drainage Canal: flow, concentration, and load by month, Jul 2001–Jun 2002**

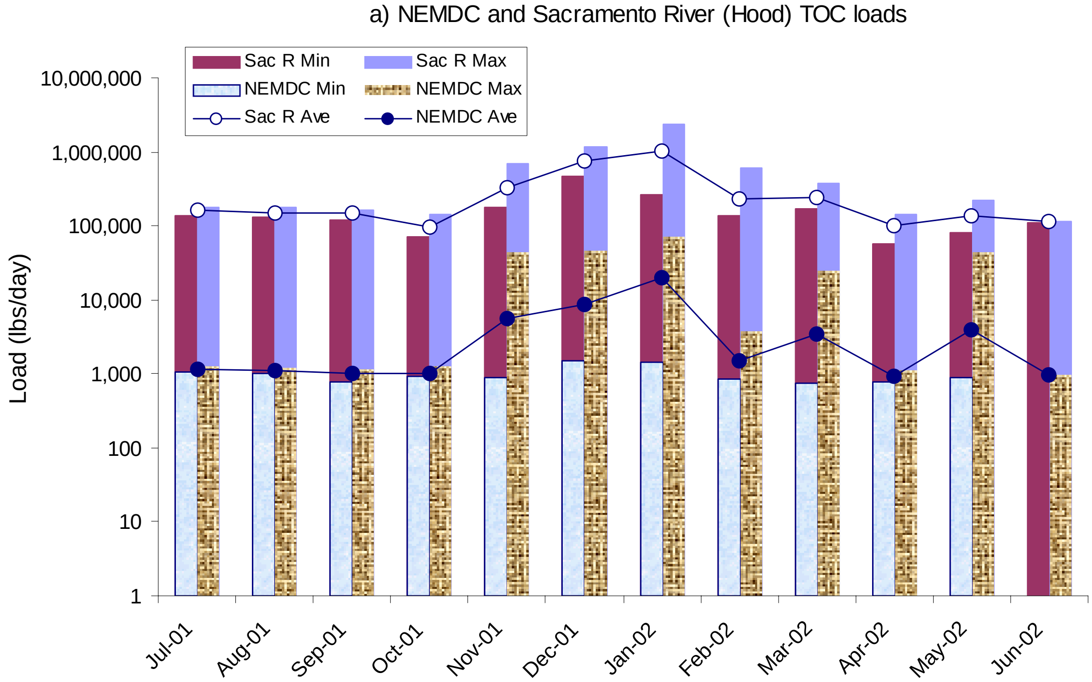



| | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 | May-02 | Jun-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 1060 | 993 | 789 | 927 | 896 | 1491 | 1437 | 868 | 760 | 768 | 879 | 0 |
| Max | 1254 | 1186 | 1142 | 1275 | 44032 | 46601 | 71220 | 3830 | 25146 | 1083 | 44074 | 958 |
| Ave | 1172 | 1084 | 1016 | 1023 | 5640 | 8480 | 20308 | 1514 | 3524 | 947 | 3905 | 958 |

**Figure 50 Natomas East Main Drainage Canal and Sacramento River (at Hood) daily total organic carbon load by month, Jul 2001–Jun 2002**



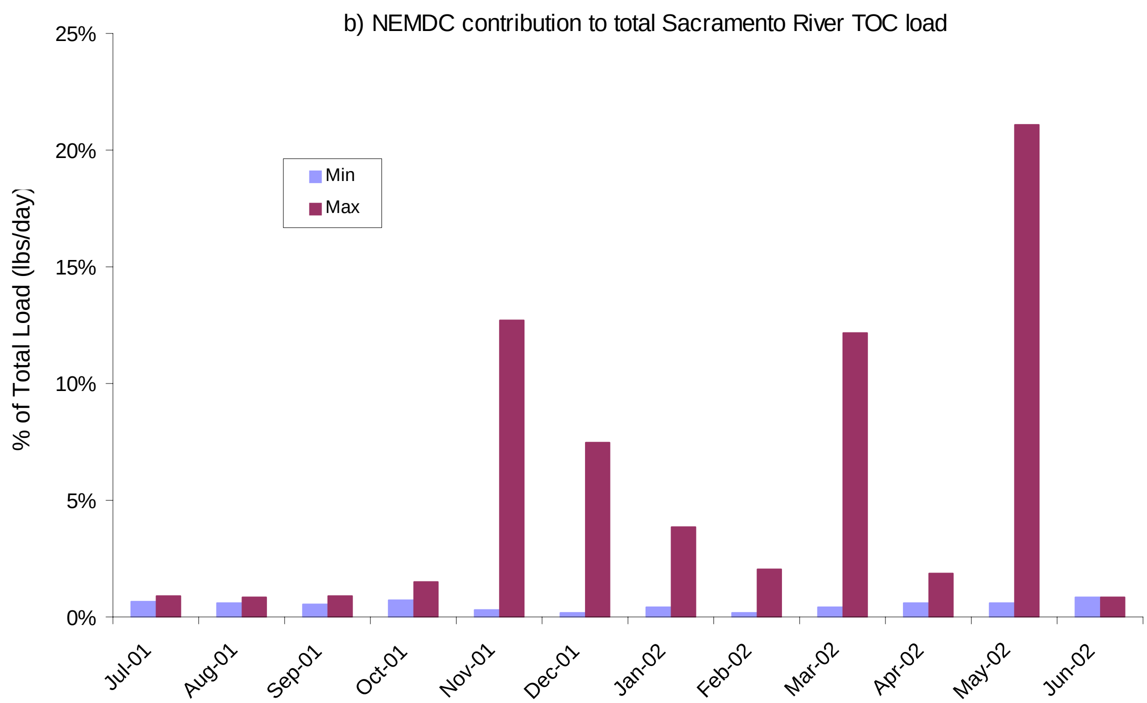



**Figure 51 Summary of highest daily Natomas East Main Drainage Canal total organic carbon loads to the Sacramento River**

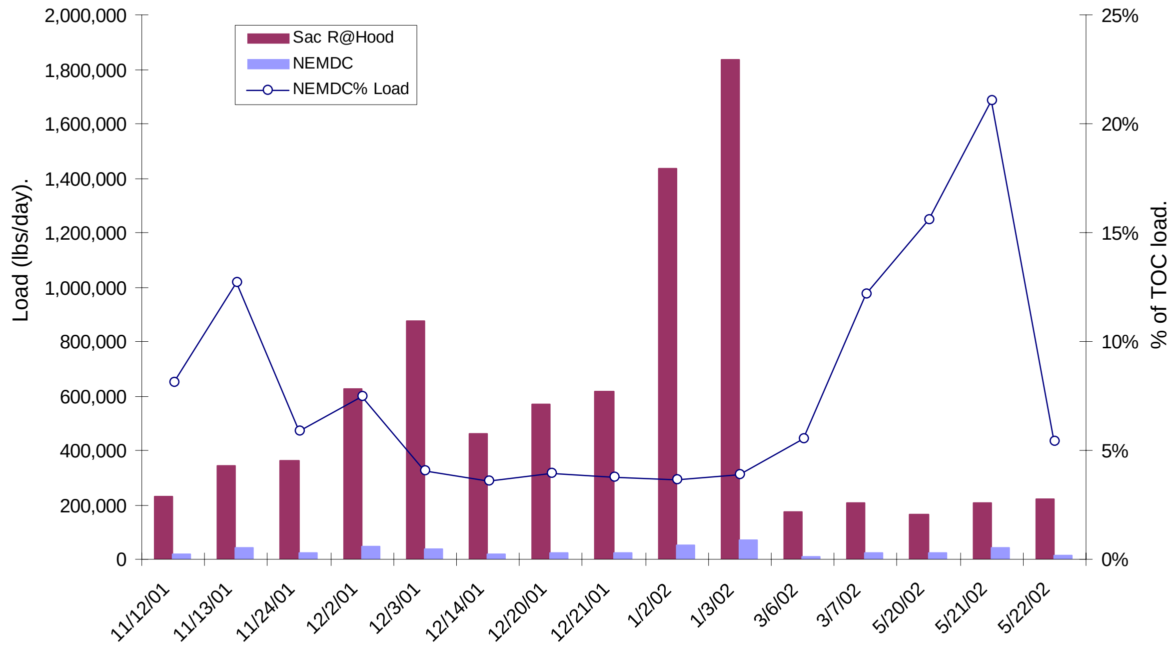
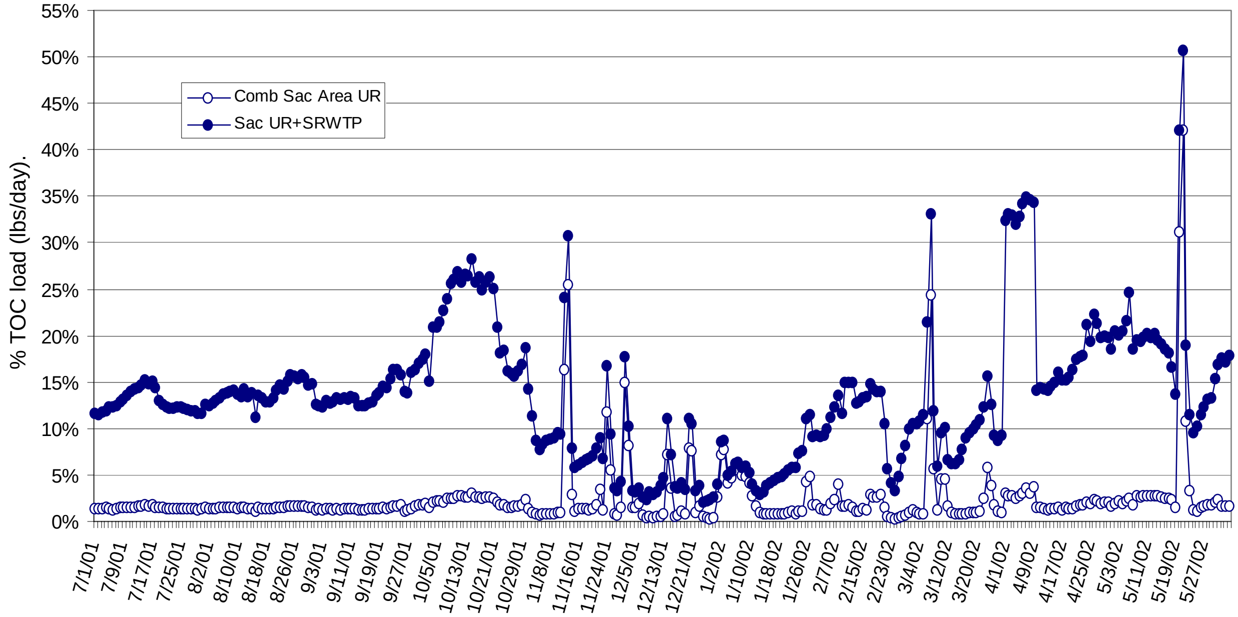


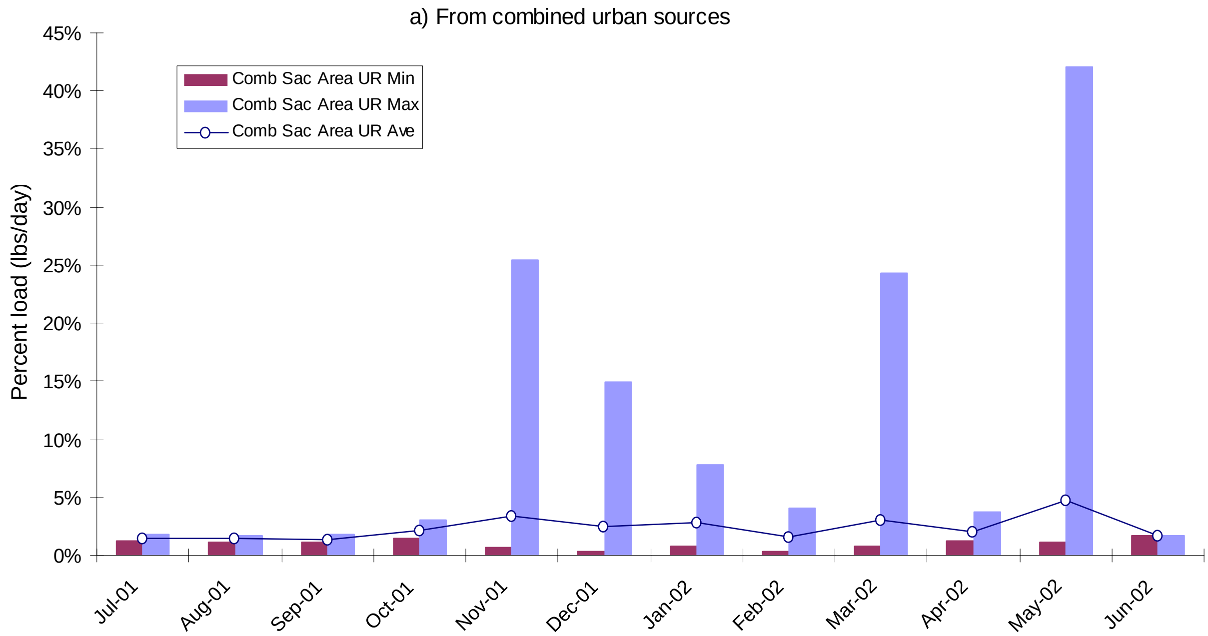
**Figure 52 Daily Sacramento River total organic carbon load from combined Sacramento Metropolitan Area urban runoff and Sacramento Regional Wastewater Treatment Plant effluent, 2001/2002**




a. Assumes 2X NEMDC load for all Sac Metro area urban runoff

b. Based on median Sacramento Regional Wastewater Treatment Plant (SRWTP) load of 18,080 lbs/day, Sep 1991-Jun 1998

# Figure 53 Daily total organic carbon load by month from combined urban sources and Sacramento Regional Wastewater Treatment Plant effluent to the Sacramento River



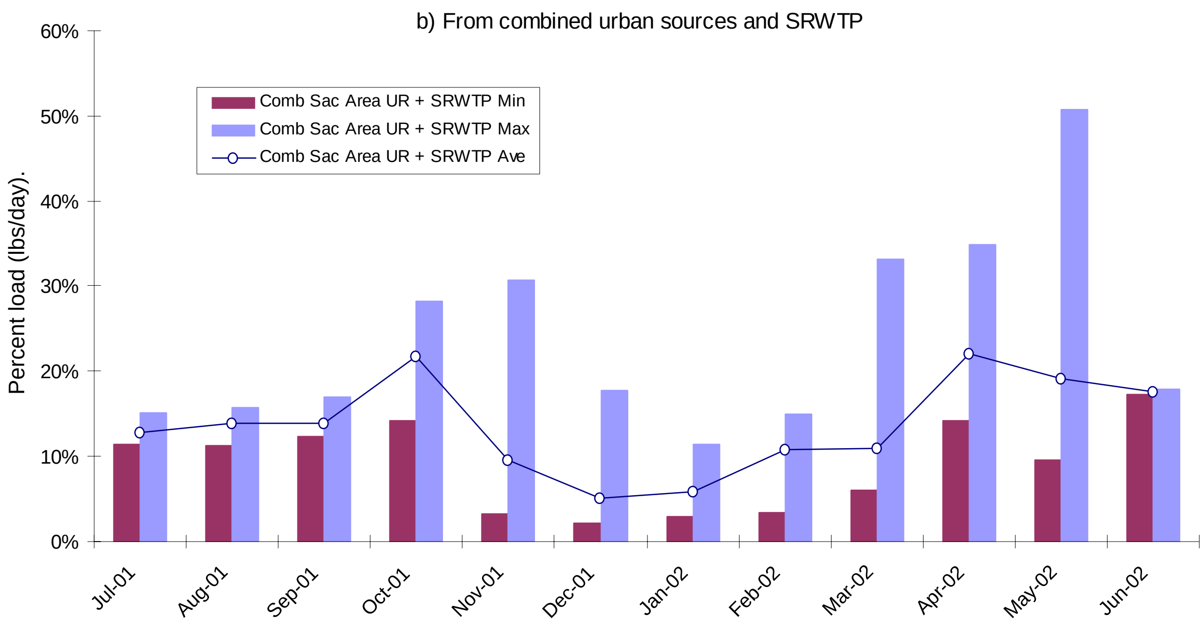
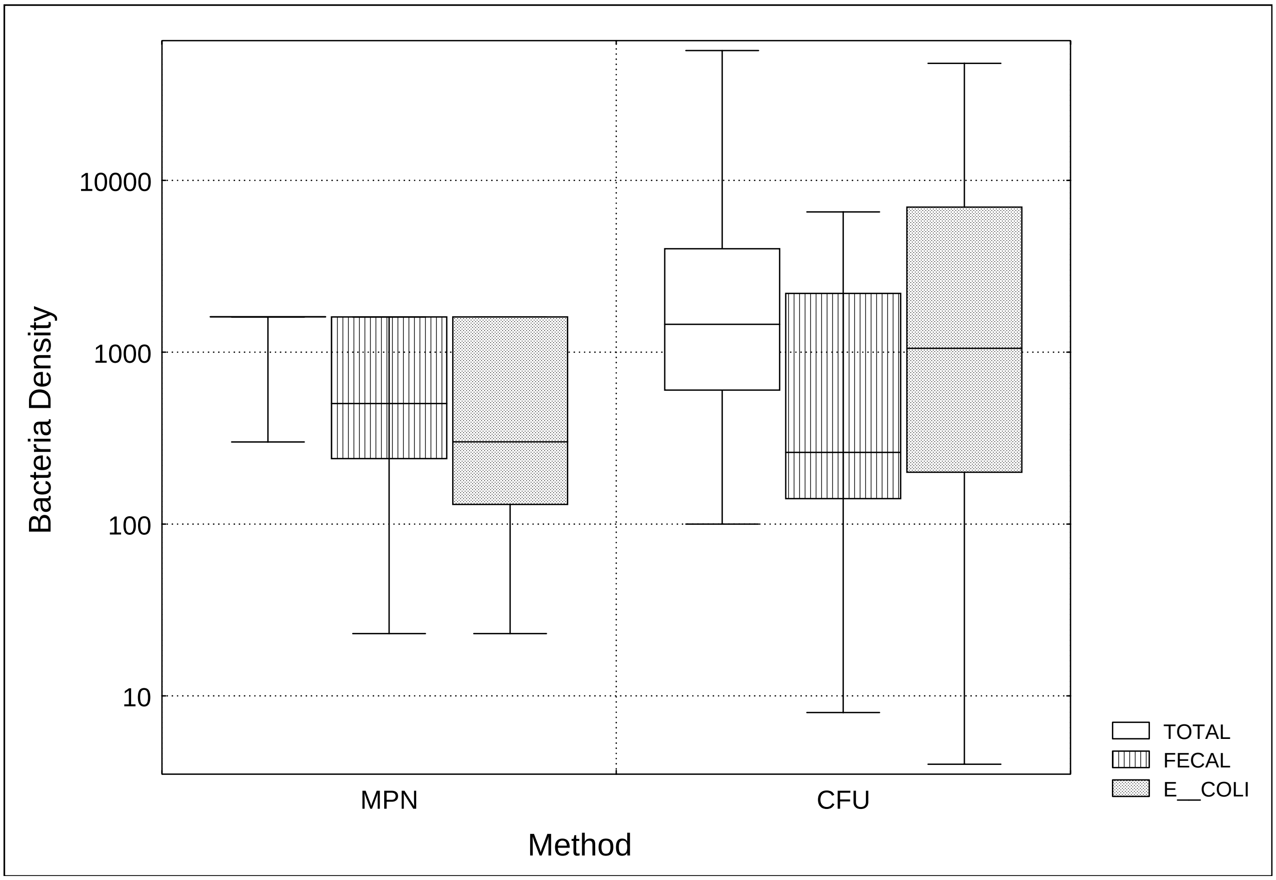
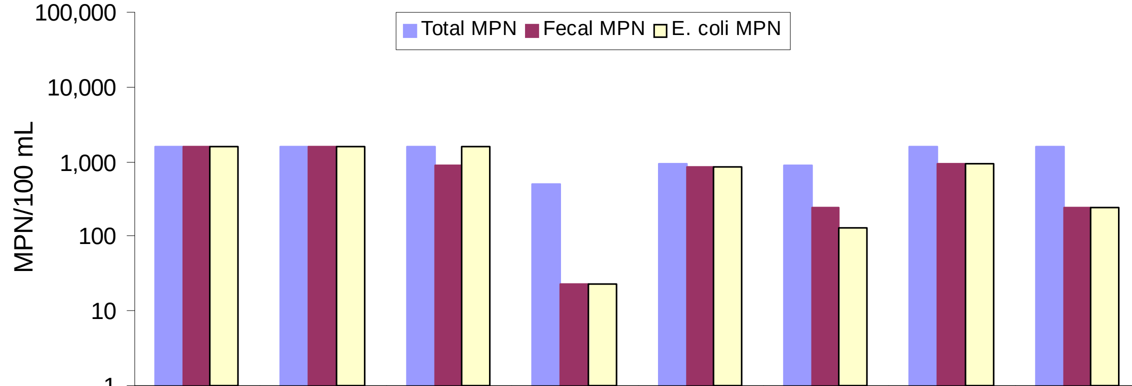



**Figure 54 Natomas East Main Drainage Canal bacteria densities, Nov 2001–Jun 2002**

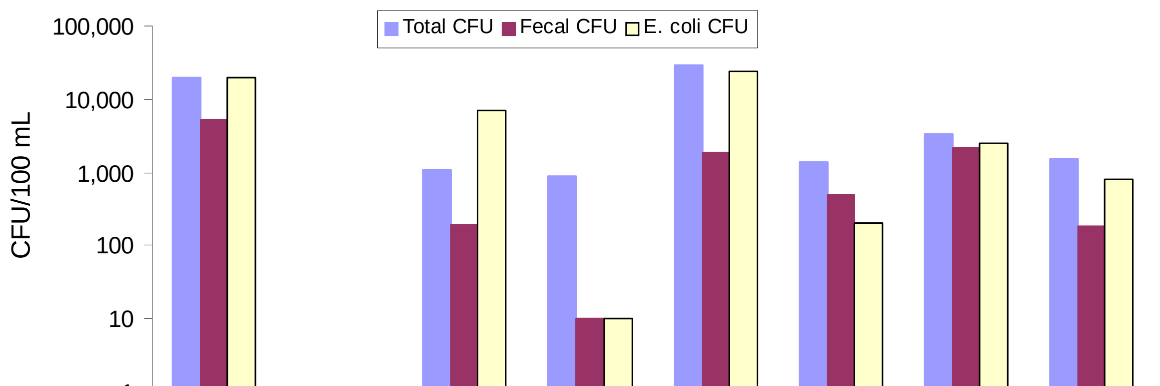



Horizontal line within box represents the median
Upper and lower boundary of box represents the 25th and 75th percentile respectively
Upper and lower whiskers represent the minimum and maximum values, respectively

# Figure 55 Median bacteria densities in Natomas East Main Drainage Canal by month, Nov 2001–Jun 2002



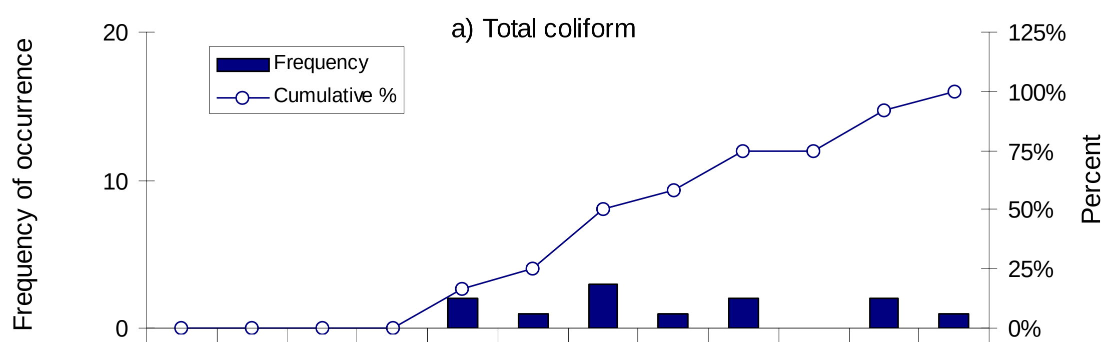

| | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun |
|---|---|---|---|---|---|---|---|---|
| Total MPN | 1600 | 1600 | 1600 | 500 | 950 | 900 | 1600 | 1600 |
| Fecal MPN | 1600 | 1600 | 900 | 23 | 865 | 240 | 920 | 240 |
| E. coli MPN | 1600 | 1600 | 1600 | 23 | 865 | 130 | 920 | 240 |



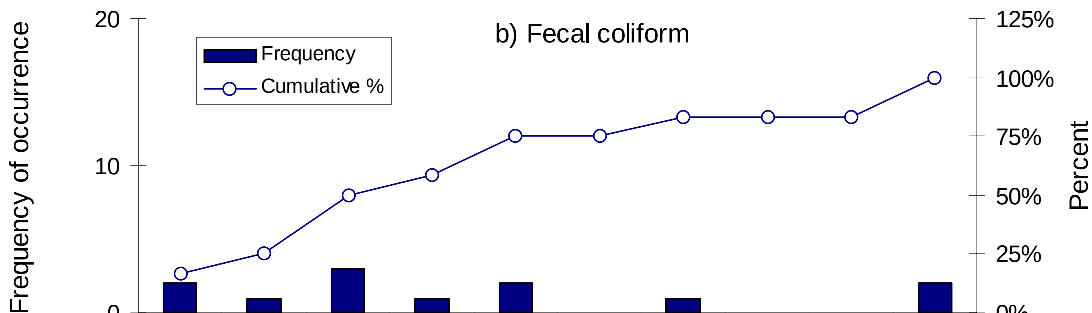

| | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun |
|---|---|---|---|---|---|---|---|---|
| Total CFU | 20000 | | 1100 | 900 | 28800 | 1400 | 3300 | 1500 |
| Fecal CFU | 5300 | | 190 | 10 | 1904 | 500 | 2140 | 180 |
| E. coli CFU | 20000 | | 7000 | 10 | 24002 | 200 | 2450 | 800 |

Note: Samples reported as > 1.6 x 103 MPN/100 mL reported as 1.6 x 103 MPN/100 mL.
Detection limits substituted for values above or below the detection limit.

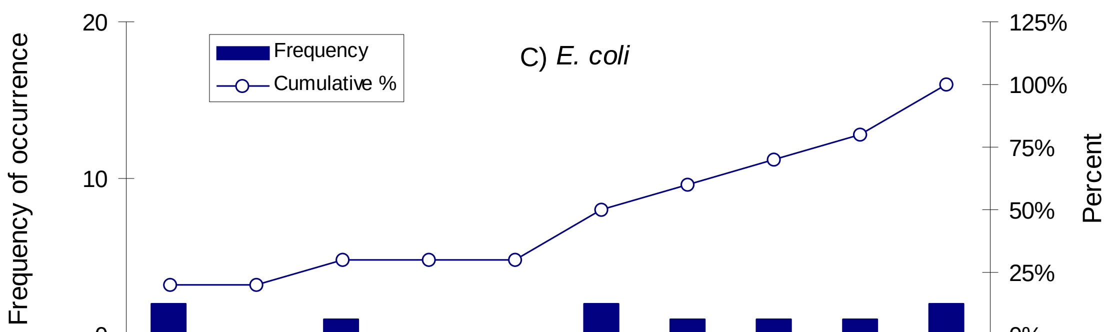
**Figure 56 Cumulative probability distribution of bacteria densities (CFU), Nov 2001–Jun 2002**




| | 10 | 100 | 250 | 500 | 750 | 1000 | 1500 | 2000 | 5000 | 10000 | 20000 | 57000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 1 | 2 | 0 | 2 | 1 |
| Cumulative % | 0% | 0% | 0% | 0% | 17% | 25% | 50% | 58% | 75% | 75% | 92% | 100% |

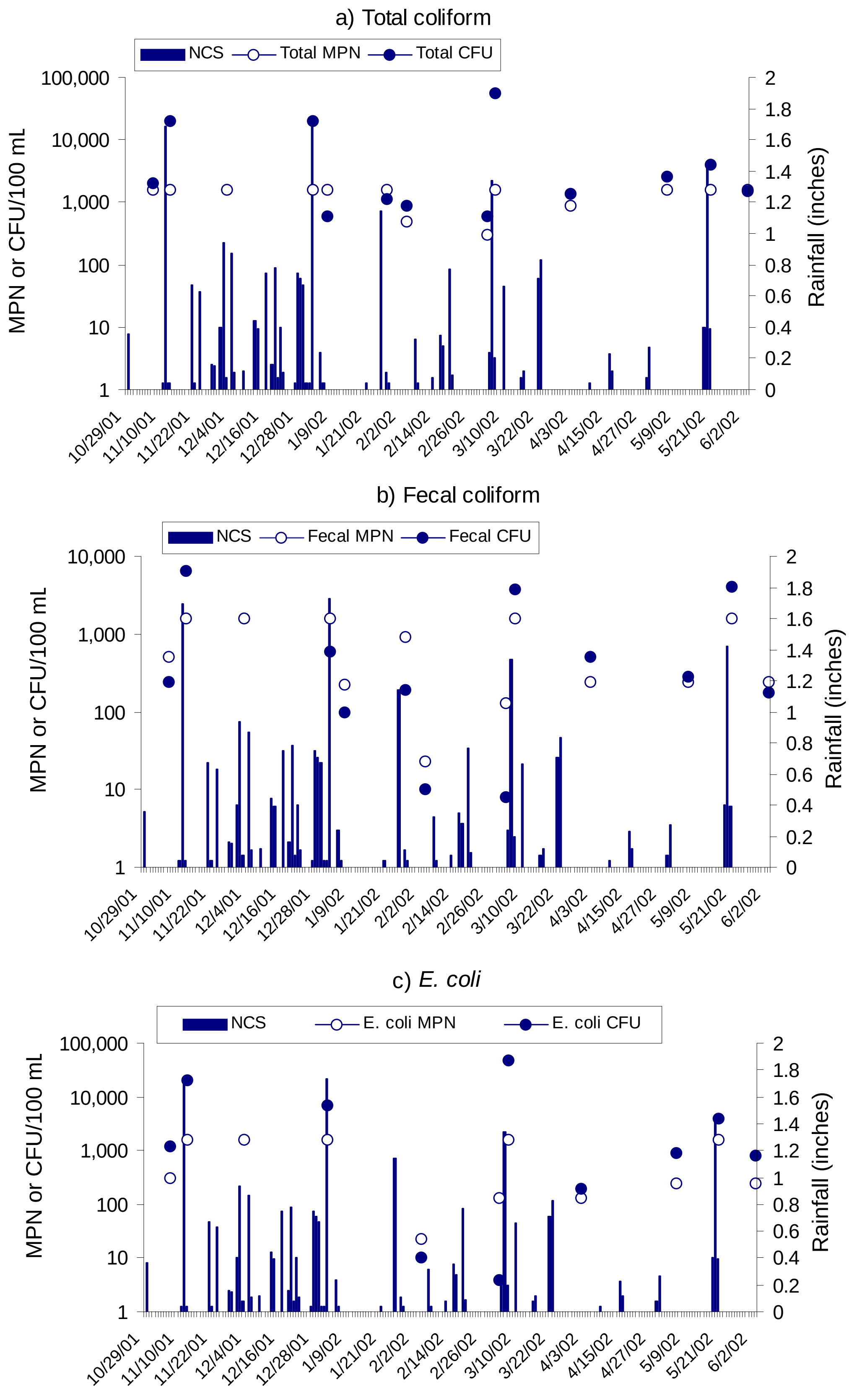



| | 10 | 100 | 250 | 400 | 750 | 1000 | 1500 | 2000 | 3000 | 4000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 2 | 1 | 3 | 1 | 2 | 0 | 1 | 0 | 0 | 2 |
| Cumulative % | 17% | 25% | 50% | 58% | 75% | 75% | 83% | 83% | 83% | 100% |




| | 10 | 100 | 235 | 500 | 750 | 1000 | 1500 | 4000 | 10000 | 50000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 2 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 1 | 2 |
| Cumulative % | 20% | 20% | 30% | 30% | 30% | 50% | 60% | 70% | 80% | 100% |

# Figure 57 Bacteria densities vs. rainfall: NCS station




NCS = Newcastle-Pineview School

# Appendix A NEMDC Daily Flow, TOC Concentration, and TOC Loads Jul 2001–Jun 2002

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 7/1/2001 | 42.30 | 5.50 | 1254 |
| 7/2/2001 | 42.30 | **5.50** | 1254 |
| 7/3/2001 | 42.30 | 5.50 | 1254 |
| 7/4/2001 | 42.30 | 5.50 | 1254 |
| 7/5/2001 | 42.30 | 5.2 | 1186 |
| 7/6/2001 | 37.81 | 5.2 | 1060 |
| 7/7/2001 | 40.34 | 5.2 | 1131 |
| 7/8/2001 | 42.30 | 5.2 | 1186 |
| 7/9/2001 | 42.30 | 5.2 | 1186 |
| 7/10/2001 | 42.30 | 5.2 | 1186 |
| 7/11/2001 | 40.34 | 5.2 | 1131 |
| 7/12/2001 | 40.51 | 5.2 | 1135 |
| 7/13/2001 | 40.51 | 5.2 | 1135 |
| 7/14/2001 | 42.30 | 5.2 | 1186 |
| 7/15/2001 | 42.30 | 5.2 | 1186 |
| 7/16/2001 | 39.52 | 5.2 | 1108 |
| 7/17/2001 | 42.30 | 5.2 | 1186 |
| 7/18/2001 | 39.52 | 5.2 | 1108 |
| 7/19/2001 | 42.30 | 5.2 | 1186 |
| 7/20/2001 | 42.30 | 5.2 | 1186 |
| 7/21/2001 | 40.51 | 5.2 | 1135 |
| 7/22/2001 | 40.34 | 5.2 | 1131 |
| 7/23/2001 | 42.30 | 5.2 | 1186 |
| 7/24/2001 | 42.30 | 5.2 | 1186 |
| 7/25/2001 | 42.30 | 5.2 | 1186 |
| 7/26/2001 | 42.30 | 5.2 | 1186 |
| 7/27/2001 | 42.30 | 5.2 | 1186 |
| 7/28/2001 | 40.51 | 5.2 | 1135 |
| 7/29/2001 | 42.30 | 5.2 | 1186 |
| 7/30/2001 | 40.34 | 5.2 | 1131 |
| 7/31/2001 | 42.30 | 5.2 | 1186 |
| 8/1/2001 | 42.30 | 5.2 | 1186 |
| 8/2/2001 | 42.30 | 5.2 | 1186 |
| 8/3/2001 | 40.34 | 4.95 | 1076 |
| 8/4/2001 | 42.30 | 4.95 | 1129 |
| 8/5/2001 | 42.30 | 4.95 | 1129 |
| 8/6/2001 | 42.30 | **4.95** | 1129 |
| 8/7/2001 | 42.30 | 4.95 | 1129 |
| 8/8/2001 | 42.30 | 4.8 | 1095 |
| 8/9/2001 | 40.34 | 4.8 | 1044 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 8/10/2001 | 40.51 | 4.8 | 1048 |
| 8/11/2001 | 42.30 | 4.8 | 1095 |
| 8/12/2001 | 40.51 | 4.8 | 1048 |
| 8/13/2001 | 39.52 | 4.8 | 1023 |
| 8/14/2001 | 40.34 | 4.8 | 1044 |
| 8/15/2001 | 40.34 | 4.8 | 1044 |
| 8/16/2001 | 42.30 | 4.8 | 1095 |
| 8/17/2001 | 42.30 | 4.8 | 1095 |
| 8/18/2001 | 42.30 | 4.8 | 1095 |
| 8/19/2001 | 42.30 | 4.8 | 1095 |
| 8/20/2001 | 42.30 | 4.8 | 1095 |
| 8/21/2001 | 40.34 | 4.8 | 1044 |
| 8/22/2001 | 40.51 | 4.8 | 1048 |
| 8/23/2001 | 40.51 | 4.8 | 1048 |
| 8/24/2001 | 42.30 | 4.8 | 1095 |
| 8/25/2001 | 42.30 | 4.8 | 1095 |
| 8/26/2001 | 42.30 | 4.8 | 1095 |
| 8/27/2001 | 42.30 | 4.8 | 1095 |
| 8/28/2001 | 42.30 | 4.8 | 1095 |
| 8/29/2001 | 42.30 | 4.8 | 1095 |
| 8/30/2001 | 38.37 | 4.8 | 993 |
| 8/31/2001 | 40.34 | 4.8 | 1044 |
| 9/1/2001 | 39.52 | 4.8 | 1023 |
| 9/2/2001 | 42.30 | 4.8 | 1095 |
| 9/3/2001 | 40.51 | 4.65 | 1015 |
| 9/4/2001 | 42.30 | **4.65** | 1060 |
| 9/5/2001 | 42.30 | 4.65 | 1060 |
| 9/6/2001 | 40.34 | 4.6 | 1000 |
| 9/7/2001 | 40.34 | 4.6 | 1000 |
| 9/8/2001 | 40.34 | 4.6 | 1000 |
| 9/9/2001 | 42.30 | 4.6 | 1049 |
| 9/10/2001 | 40.51 | 4.6 | 1004 |
| 9/11/2001 | 40.34 | 4.6 | 1000 |
| 9/12/2001 | 42.30 | 4.6 | 1049 |
| 9/13/2001 | 40.51 | 4.6 | 1004 |
| 9/14/2001 | 40.34 | 4.6 | 1000 |
| 9/15/2001 | 42.30 | 4.6 | 1049 |
| 9/16/2001 | 42.30 | 4.6 | 1049 |
| 9/17/2001 | 42.30 | 4.6 | 1049 |
| 9/18/2001 | 42.30 | 4.6 | 1049 |
| 9/19/2001 | 42.30 | 4.6 | 1049 |
| 9/20/2001 | 42.30 | 4.6 | 1049 |
| 9/21/2001 | 39.25 | 4.6 | 973 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 9/22/2001 | 40.34 | 4.6 | 1000 |
| 9/23/2001 | 42.30 | 4.6 | 1049 |
| 9/24/2001 | 39.52 | 4.6 | 980 |
| 9/25/2001 | 46.05 | 4.6 | 1142 |
| 9/26/2001 | 31.83 | 4.6 | 789 |
| 9/27/2001 | 36.31 | 4.6 | 900 |
| 9/28/2001 | 36.18 | 4.6 | 897 |
| 9/29/2001 | 42.30 | 4.6 | 1049 |
| 9/30/2001 | 42.30 | 4.6 | 1049 |
| 10/1/2001 | 40.34 | **4.6** | 1000 |
| 10/2/2001 | 42.30 | 4.6 | 1049 |
| 10/3/2001 | 40.34 | 4.75 | 1033 |
| 10/4/2001 | 39.52 | 4.75 | 1012 |
| 10/5/2001 | 42.30 | 4.75 | 1083 |
| 10/6/2001 | 39.52 | 4.75 | 1012 |
| 10/7/2001 | 36.20 | 4.75 | 927 |
| 10/8/2001 | 40.08 | 4.75 | 1026 |
| 10/9/2001 | 38.54 | 4.75 | 987 |
| 10/10/2001 | 38.37 | 4.75 | 983 |
| 10/11/2001 | 40.34 | 4.75 | 1033 |
| 10/12/2001 | 42.30 | 4.75 | 1083 |
| 10/13/2001 | 38.64 | 4.75 | 989 |
| 10/14/2001 | 39.52 | 4.75 | 1012 |
| 10/15/2001 | 42.30 | 4.75 | 1083 |
| 10/16/2001 | 40.34 | 4.75 | 1033 |
| 10/17/2001 | 40.34 | 4.75 | 1033 |
| 10/18/2001 | 38.37 | 4.75 | 983 |
| 10/19/2001 | 40.34 | 4.75 | 1033 |
| 10/20/2001 | 38.71 | 4.75 | 991 |
| 10/21/2001 | 39.91 | 4.75 | 1022 |
| 10/22/2001 | 38.54 | 4.75 | 987 |
| 10/23/2001 | 38.37 | 4.75 | 983 |
| 10/24/2001 | 38.37 | 4.75 | 983 |
| 10/25/2001 | 38.37 | 4.75 | 983 |
| 10/26/2001 | 38.37 | 4.75 | 983 |
| 10/27/2001 | 40.34 | 4.75 | 1033 |
| 10/28/2001 | 40.34 | 4.75 | 1033 |
| 10/29/2001 | 40.34 | 4.75 | 1033 |
| 10/30/2001 | 49.78 | 4.75 | 1275 |
| 10/31/2001 | 39.24 | 4.75 | 1005 |
| 11/1/2001 | 35.00 | 4.75 | 896 |
| 11/2/2001 | 38.60 | 4.75 | 988 |
| 11/5/2001 | 36.75 | 4.75 | 941 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 11/6/2001 | 38.37 | 4.9 | 1014 |
| 11/7/2001 | 37.51 | **4.9** | 991 |
| 11/8/2001 | 36.91 | 4.9 | 975 |
| 11/9/2001 | 37.73 | 4.9 | 996 |
| 11/10/2001 | 38.64 | 4.9 | 1021 |
| 11/11/2001 | 38.66 | 4.9 | 1021 |
| 11/12/2001 | 276.28 | 12.7 | 18913 |
| 11/13/2001 | 643.21 | **12.7** | 44032 |
| 11/14/2001 | 79.19 | 12.7 | 5421 |
| 11/15/2001 | 36.30 | 11.6 | 2270 |
| 11/16/2001 | 40.34 | 11.6 | 2522 |
| 11/17/2001 | 40.34 | 11.6 | 2522 |
| 11/18/2001 | 38.64 | 11.6 | 2416 |
| 11/19/2001 | 31.71 | 11.6 | 1983 |
| 11/20/2001 | 33.41 | 11.6 | 2089 |
| 11/21/2001 | 44.35 | 11.6 | 2773 |
| 11/22/2001 | 90.78 | 11.6 | 5676 |
| 11/23/2001 | 31.32 | 11.6 | 1958 |
| 11/24/2001 | 343.68 | 11.6 | 21489 |
| 11/25/2001 | 212.98 | 11.6 | 13317 |
| 11/26/2001 | 40.86 | 11.6 | 2555 |
| 11/27/2001 | 35.38 | 11.6 | 2212 |
| 12/1/2001 | 76.77 | 11.6 | 4800 |
| 12/2/2001 | 823.36 | 10.5 | 46601 |
| 12/3/2001 | 628.19 | **10.5** | 35555 |
| 12/4/2001 | 146.65 | 10.5 | 8300 |
| 12/5/2001 | 158.94 | 10.5 | 8996 |
| 12/6/2001 | 187.55 | 10.5 | 10615 |
| 12/7/2001 | 70.81 | 9.5 | 3626 |
| 12/8/2001 | 30.41 | 9.5 | 1557 |
| 12/9/2001 | 35.12 | 9.5 | 1798 |
| 12/10/2001 | 31.09 | 9.5 | 1592 |
| 12/11/2001 | 33.31 | 9.5 | 1706 |
| 12/12/2001 | 32.86 | 9.5 | 1683 |
| 12/13/2001 | 34.91 | 9.5 | 1787 |
| 12/14/2001 | 325.06 | 9.5 | 16645 |
| 12/15/2001 | 167.72 | 9.5 | 8589 |
| 12/16/2001 | 31.26 | 9.5 | 1601 |
| 12/17/2001 | 42.55 | 9.5 | 2179 |
| 12/18/2001 | 60.65 | 9.5 | 3106 |
| 12/19/2001 | 58.79 | 9.5 | 3010 |
| 12/20/2001 | 436.27 | 9.5 | 22341 |
| 12/21/2001 | 454.93 | 9.5 | 23296 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 12/22/2001 | 77.31 | 9.5 | 3959 |
| 12/23/2001 | 142.46 | 9.5 | 7295 |
| 12/24/2001 | 64.75 | 9.5 | 3316 |
| 12/25/2001 | 39.65 | 9.5 | 2031 |
| 12/26/2001 | 29.16 | 9.5 | 1493 |
| 12/27/2001 | 29.12 | 9.5 | 1491 |
| 1/1/2002 | 353.68 | 8.5 | 16205 |
| 1/2/2002 | 1136.89 | **8.5** | 52090 |
| 1/3/2002 | 1554.42 | 8.5 | 71220 |
| 1/4/2002 | 855.15 | 9.1 | 41947 |
| 1/5/2002 | 1140.68 | 9.1 | 55953 |
| 1/6/2002 | 1242.27 | 9.7 | 64953 |
| 1/7/2002 | 1051.65 | **9.7** | 54987 |
| 1/8/2002 | 918.53 | 9.7 | 48026 |
| 1/9/2002 | 775.42 | 9.7 | 40543 |
| 1/10/2002 | 636.12 | 9.7 | 33260 |
| 1/11/2002 | 435.18 | 7.9 | 18531 |
| 1/12/2002 | 223.83 | 7.9 | 9531 |
| 1/13/2002 | 106.85 | 7.9 | 4550 |
| 1/14/2002 | 73.08 | 7.9 | 3112 |
| 1/15/2002 | 57.77 | 7.9 | 2460 |
| 1/16/2002 | 53.71 | 7.9 | 2287 |
| 1/17/2002 | 46.71 | 7.9 | 1989 |
| 1/18/2002 | 48.29 | 7.9 | 2057 |
| 1/19/2002 | 43.32 | 7.9 | 1845 |
| 1/20/2002 | 41.28 | 7.9 | 1758 |
| 1/21/2002 | 44.67 | 7.9 | 1902 |
| 1/22/2002 | 48.41 | 7.9 | 2061 |
| 1/23/2002 | 33.74 | 7.9 | 1437 |
| 1/24/2002 | 39.46 | 7.9 | 1680 |
| 1/25/2002 | 36.35 | 7.9 | 1548 |
| 1/26/2002 | 175.86 | 6.1 | 5783 |
| 1/27/2002 | 201.05 | **6.1** | 6611 |
| 2/1/2002 | 63.53 | 6.2 | 2123 |
| 2/2/2002 | 62.69 | 6.2 | 2095 |
| 2/3/2002 | 46.03 | 6.2 | 1538 |
| 2/4/2002 | 43.65 | **6.3** | 1482 |
| 2/5/2002 | 39.46 | 6.3 | 1340 |
| 2/6/2002 | 54.60 | 6.3 | 1854 |
| 2/7/2002 | 70.16 | 5.55 | 2099 |
| 2/8/2002 | 128.04 | 5.55 | 3830 |
| 2/9/2002 | 52.64 | 5.55 | 1575 |
| 2/10/2002 | 39.46 | 5.55 | 1180 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 2/11/2002 | 41.14 | 5.55 | 1231 |
| 2/12/2002 | 33.29 | 5.55 | 996 |
| 2/13/2002 | 29.16 | 5.55 | 872 |
| 2/14/2002 | 29.05 | 5.55 | 869 |
| 2/15/2002 | 33.43 | 5.55 | 1000 |
| 2/16/2002 | 31.95 | 5.55 | 956 |
| 2/17/2002 | 74.16 | 5.55 | 2218 |
| 2/18/2002 | 67.40 | 5.55 | 2016 |
| 2/19/2002 | 70.60 | 5.55 | 2112 |
| 2/20/2002 | 82.07 | 5.55 | 2455 |
| 2/21/2002 | 49.93 | 5.55 | 1494 |
| 2/22/2002 | 33.40 | 5.55 | 999 |
| 2/23/2002 | 32.22 | 5.55 | 964 |
| 2/24/2002 | 30.74 | 5.55 | 920 |
| 2/25/2002 | 30.62 | 5.55 | 916 |
| 2/26/2002 | 29.55 | 5.55 | 884 |
| 2/27/2002 | 29.02 | 5.55 | 868 |
| 3/1/2002 | 31.22 | 5.55 | 934 |
| 3/2/2002 | 38.60 | 5.55 | 1155 |
| 3/3/2002 | 33.75 | 4.8 | 873 |
| 3/4/2002 | 29.98 | **4.8** | 776 |
| 3/5/2002 | 29.36 | 4.8 | 760 |
| 3/6/2002 | 242.07 | 7.3 | 9525 |
| 3/7/2002 | 639.05 | **7.3** | 25146 |
| 3/8/2002 | 205.77 | 7.3 | 8097 |
| 3/9/2002 | 59.16 | 7.3 | 2328 |
| 3/10/2002 | 218.58 | 7.3 | 8601 |
| 3/11/2002 | 186.83 | 7.3 | 7352 |
| 3/12/2002 | 90.32 | 6.2 | 3019 |
| 3/13/2002 | 51.34 | 6.2 | 1716 |
| 3/14/2002 | 41.04 | 6.2 | 1372 |
| 3/15/2002 | 37.97 | 6.2 | 1269 |
| 3/16/2002 | 32.60 | 6.2 | 1089 |
| 3/17/2002 | 29.81 | 6.2 | 996 |
| 3/18/2002 | 30.96 | 6.2 | 1035 |
| 3/19/2002 | 30.49 | 6.2 | 1019 |
| 3/20/2002 | 29.02 | 6.2 | 970 |
| 3/21/2002 | 29.16 | 6.2 | 975 |
| 3/22/2002 | 66.54 | 6.2 | 2224 |
| 3/23/2002 | 160.15 | 6.2 | 5352 |
| 3/24/2002 | 121.56 | 6.2 | 4062 |
| 3/25/2002 | 62.27 | 6.2 | 2081 |
| 3/26/2002 | 39.57 | 6.2 | 1322 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 3/27/2002 | 32.60 | 6.2 | 1089 |
| 4/1/2002 | 33.41 | 5.1 | 919 |
| 4/2/2002 | 30.13 | **5.1** | 828 |
| 4/3/2002 | 29.37 | 5.1 | 807 |
| 4/4/2002 | 29.98 | 4.75 | 768 |
| 4/5/2002 | 32.20 | 4.75 | 824 |
| 4/6/2002 | 35.03 | 4.75 | 897 |
| 4/7/2002 | 40.34 | 4.75 | 1033 |
| 4/8/2002 | 34.71 | 4.75 | 889 |
| 4/9/2002 | 42.30 | 4.75 | 1083 |
| 4/10/2002 | 42.30 | 4.75 | 1083 |
| 4/11/2002 | 42.30 | 4.75 | 1083 |
| 4/12/2002 | 36.65 | 4.75 | 938 |
| 4/13/2002 | 32.87 | 4.75 | 842 |
| 4/14/2002 | 36.93 | 4.75 | 946 |
| 4/15/2002 | 34.65 | 4.75 | 887 |
| 4/16/2002 | 38.54 | 4.75 | 987 |
| 4/17/2002 | 30.80 | 4.75 | 789 |
| 4/18/2002 | 37.98 | 4.75 | 973 |
| 4/19/2002 | 33.19 | 4.75 | 850 |
| 4/20/2002 | 33.19 | 4.75 | 850 |
| 4/21/2002 | 35.63 | 4.75 | 912 |
| 4/22/2002 | 40.34 | 4.75 | 1033 |
| 4/23/2002 | 40.34 | 4.75 | 1033 |
| 4/24/2002 | 38.06 | 4.75 | 974 |
| 4/25/2002 | 40.34 | 4.75 | 1033 |
| 4/26/2002 | 42.30 | 4.75 | 1083 |
| 4/27/2002 | 40.34 | 4.75 | 1033 |
| 4/28/2002 | 38.37 | 4.75 | 983 |
| 4/29/2002 | 40.34 | 4.75 | 1033 |
| 4/30/2002 | 40.34 | 4.75 | 1033 |
| 5/1/2002 | 34.34 | 4.75 | 879 |
| 5/2/2002 | 37.73 | 4.75 | 966 |
| 5/3/2002 | 42.30 | 4.75 | 1083 |
| 5/4/2002 | 40.34 | 4.4 | 957 |
| 5/5/2002 | 42.30 | 4.4 | 1003 |
| 5/6/2002 | 42.30 | **4.4** | 1003 |
| 5/7/2002 | 42.30 | 4.4 | 1003 |
| 5/8/2002 | 42.30 | 6.45 | 1471 |
| 5/9/2002 | 40.34 | 6.45 | 1402 |
| 5/10/2002 | 42.30 | 6.45 | 1471 |
| 5/11/2002 | 42.30 | 6.45 | 1471 |
| 5/12/2002 | 42.30 | 6.45 | 1471 |

| Date | Daily Avg Flow | TOC ox conc (mg/L) | TOC load (lbs/day) |
|---|---|---|---|
| 5/13/2002 | 42.30 | 6.45 | 1471 |
| 5/14/2002 | 42.30 | 6.45 | 1471 |
| 5/15/2002 | 42.30 | 6.45 | 1471 |
| 5/16/2002 | 40.34 | 6.45 | 1402 |
| 5/17/2002 | 42.30 | 6.45 | 1471 |
| 5/18/2002 | 42.30 | 6.45 | 1471 |
| 5/19/2002 | 33.12 | 6.45 | 1152 |
| 5/20/2002 | 562.57 | 8.5 | 25776 |
| 5/21/2002 | 961.94 | **8.5** | 44074 |
| 5/22/2002 | 264.26 | 8.5 | 12108 |
| 5/23/2002 | 82.40 | 8.5 | 3775 |
| 5/24/2002 | 39.57 | 6.36 | 1357 |
| 5/25/2002 | 34.23 | 6.36 | 1174 |
| 5/26/2002 | 42.30 | 6.36 | 1450 |
| 5/27/2002 | 42.30 | 6.36 | 1450 |
| 5/28/2002 | 42.30 | 6.36 | 1450 |
| 5/29/2002 | 42.30 | 6.36 | 1450 |
| 5/30/2002 | 42.30 | 6.36 | 1450 |
| 5/31/2002 | 42.30 | 6.36 | 1450 |
| 6/1/2002 | 42.30 | 4.2 | 958 |
| 6/2/2002 | 42.30 | 4.2 | 958 |
| 6/3/2002 | 42.30 | **4.2** | 958 |

Notes: Actual sample concentrations in bold.
Jul 2 and Aug 6 values are DOC ox. No TOC ox data avail;
(DOC is 98% of TOC in dry season)

# Appendix B
# Comparison of Daily NEMDC TOC Loads with Sacramento River Loads (lbs/day)

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 7/1/2001 | 15077 | 2.18 | 176965 | 1254 | 0.71% |
| 7/2/2001 | 14872 | 2.25 | 179970 | 1254 | 0.70% |
| 7/3/2001 | 14436 | 2.25 | 174694 | 1254 | 0.72% |
| 7/4/2001 | 14200 | 2.25 | 172220 | 1254 | 0.73% |
| 7/5/2001 | 13735 | 2.25 | 166211 | 1186 | 0.71% |
| 7/6/2001 | 14004 | 2.16 | 163050 | 1060 | 0.65% |
| 7/7/2001 | 14631 | 2.07 | 163055 | 1131 | 0.69% |
| 7/8/2001 | 14612 | 2.02 | 158708 | 1186 | 0.75% |
| 7/9/2001 | 14718 | 1.96 | 155099 | 1186 | 0.76% |
| 7/10/2001 | 14740 | 1.90 | 150961 | 1186 | 0.79% |
| 7/11/2001 | 14547 | 1.85 | 144672 | 1131 | 0.78% |
| 7/12/2001 | 14727 | 1.80 | 142890 | 1135 | 0.79% |
| 7/13/2001 | 14466 | 1.82 | 141917 | 1135 | 0.80% |
| 7/14/2001 | 14208 | 1.81 | 138811 | 1186 | 0.85% |
| 7/15/2001 | 14155 | 1.77 | 134669 | 1186 | 0.88% |
| 7/16/2001 | 14354 | 1.77 | 137207 | 1108 | 0.81% |
| 7/17/2001 | 14732 | 1.71 | 135990 | 1186 | 0.87% |
| 7/18/2001 | 14735 | 1.77 | 140849 | 1108 | 0.79% |
| 7/19/2001 | 14408 | 2.03 | 157657 | 1186 | 0.75% |
| 7/20/2001 | 14762 | 2.03 | 161531 | 1186 | 0.73% |
| 7/21/2001 | 15054 | 2.03 | 164726 | 1135 | 0.69% |
| 7/22/2001 | 15249 | 2.03 | 166860 | 1131 | 0.68% |
| 7/23/2001 | 15312 | 2.03 | 167549 | 1186 | 0.71% |
| 7/24/2001 | 15095 | 2.03 | 165174 | 1186 | 0.72% |
| 7/25/2001 | 15116 | 2.03 | 165404 | 1186 | 0.72% |
| 7/26/2001 | 15395 | 2.03 | 168457 | 1186 | 0.70% |
| 7/27/2001 | 15490 | 2.03 | 169497 | 1186 | 0.70% |
| 7/28/2001 | 15698 | 2.03 | 171773 | 1135 | 0.66% |
| 7/29/2001 | 15656 | 2.03 | 171313 | 1186 | 0.69% |
| 7/30/2001 | 16062 | 2.03 | 175756 | 1131 | 0.64% |
| 7/31/2001 | 15984 | 2.03 | 174902 | 1186 | 0.68% |
| 8/1/2001 | 14879 | 2.03 | 162811 | 1186 | 0.73% |
| 8/2/2001 | 14996 | 2.03 | 164091 | 1186 | 0.72% |
| 8/3/2001 | 14576 | 2.03 | 159495 | 1076 | 0.67% |
| 8/4/2001 | 14320 | 2.03 | 156694 | 1129 | 0.72% |
| 8/5/2001 | 13970 | 2.03 | 152864 | 1129 | 0.74% |
| 8/6/2001 | 13608 | 2.03 | 148903 | 1129 | 0.76% |
| 8/7/2001 | 13362 | 2.03 | 146211 | 1129 | 0.77% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 8/8/2001 | 13220 | 2.03 | 144658 | 1095 | 0.76% |
| 8/9/2001 | 13106 | 2.03 | 143410 | 1044 | 0.73% |
| 8/10/2001 | 13443 | 2.03 | 147098 | 1048 | 0.71% |
| 8/11/2001 | 13733 | 2.03 | 150271 | 1095 | 0.73% |
| 8/12/2001 | 12916 | 2.03 | 141331 | 1048 | 0.74% |
| 8/13/2001 | 13676 | 2.03 | 149647 | 1023 | 0.68% |
| 8/14/2001 | 13270 | 2.03 | 145205 | 1044 | 0.72% |
| 8/15/2001 | 13200 | 2.53 | 179659 | 1044 | 0.58% |
| 8/16/2001 | 13398 | 2.07 | 149675 | 1095 | 0.73% |
| 8/17/2001 | 13463 | 2.10 | 152396 | 1095 | 0.72% |
| 8/18/2001 | 13447 | 2.18 | 157652 | 1095 | 0.69% |
| 8/19/2001 | 13270 | 2.19 | 156649 | 1095 | 0.70% |
| 8/20/2001 | 12809 | 2.21 | 152243 | 1095 | 0.72% |
| 8/21/2001 | 13040 | 2.03 | 142688 | 1044 | 0.73% |
| 8/22/2001 | 12607 | 2.03 | 137950 | 1048 | 0.76% |
| 8/23/2001 | 12890 | 2.03 | 141047 | 1048 | 0.74% |
| 8/24/2001 | 12296 | 2.03 | 134547 | 1095 | 0.81% |
| 8/25/2001 | 11728 | 2.03 | 128332 | 1095 | 0.85% |
| 8/26/2001 | 11849 | 2.03 | 129656 | 1095 | 0.84% |
| 8/27/2001 | 12043 | 2.03 | 131778 | 1095 | 0.83% |
| 8/28/2001 | 11766 | 2.03 | 128747 | 1095 | 0.85% |
| 8/29/2001 | 11962 | 2.03 | 130892 | 1095 | 0.84% |
| 8/30/2001 | 12460 | 2.03 | 136341 | 993 | 0.73% |
| 8/31/2001 | 12439 | 2.03 | 136112 | 1044 | 0.77% |
| 9/1/2001 | 12218 | 2.42 | 159378 | 1023 | 0.64% |
| 9/2/2001 | 12213 | 2.47 | 162275 | 1095 | 0.67% |
| 9/3/2001 | 12336 | 2.44 | 162414 | 1015 | 0.63% |
| 9/4/2001 | 12298 | 2.34 | 155119 | 1060 | 0.68% |
| 9/5/2001 | 12698 | 2.31 | 158111 | 1060 | 0.67% |
| 9/6/2001 | 12765 | 2.27 | 155849 | 1000 | 0.64% |
| 9/7/2001 | 12676 | 2.22 | 151346 | 1000 | 0.66% |
| 9/8/2001 | 12551 | 2.25 | 152221 | 1000 | 0.66% |
| 9/9/2001 | 12528 | 2.26 | 152448 | 1049 | 0.69% |
| 9/10/2001 | 12915 | 2.19 | 152285 | 1004 | 0.66% |
| 9/11/2001 | 12680 | 2.19 | 149514 | 1000 | 0.67% |
| 9/12/2001 | 12751 | 2.21 | 151983 | 1049 | 0.69% |
| 9/13/2001 | 13323 | 2.26 | 161943 | 1004 | 0.62% |
| 9/14/2001 | 12928 | 2.32 | 161671 | 1000 | 0.62% |
| 9/15/2001 | 12403 | 2.42 | 161792 | 1049 | 0.65% |
| 9/16/2001 | 12336 | 2.39 | 158756 | 1049 | 0.66% |
| 9/17/2001 | 12505 | 2.32 | 156213 | 1049 | 0.67% |
| 9/18/2001 | 12427 | 2.23 | 149210 | 1049 | 0.70% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 9/19/2001 | 12223 | 2.20 | 144949 | 1049 | 0.72% |
| 9/20/2001 | 11910 | 2.16 | 138508 | 1049 | 0.76% |
| 9/21/2001 | 12255 | 2.11 | 139383 | 973 | 0.70% |
| 9/22/2001 | 12098 | 2.00 | 130587 | 1000 | 0.77% |
| 9/23/2001 | 11624 | 1.98 | 123904 | 1049 | 0.85% |
| 9/24/2001 | 11842 | 1.92 | 122398 | 980 | 0.80% |
| 9/25/2001 | 12354 | 1.93 | 128689 | 1142 | 0.89% |
| 9/26/2001 | 11920 | 2.19 | 140874 | 789 | 0.56% |
| 9/27/2001 | 11924 | 2.24 | 143974 | 900 | 0.63% |
| 9/28/2001 | 12000 | 1.91 | 123384 | 897 | 0.73% |
| 9/29/2001 | 11900 | 1.92 | 123318 | 1049 | 0.85% |
| 9/30/2001 | 11600 | 1.90 | 118802 | 1049 | 0.88% |
| 10/1/2001 | 11100 | 1.93 | 115477 | 1000 | 0.87% |
| 10/2/2001 | 10750 | 1.93 | 111835 | 1049 | 0.94% |
| 10/3/2001 | 10405 | 2.37 | 132924 | 1033 | 0.78% |
| 10/4/2001 | 9447 | 1.88 | 95797 | 1012 | 1.06% |
| 10/5/2001 | 9848 | 1.82 | 96553 | 1083 | 1.12% |
| 10/6/2001 | 9793 | 1.78 | 93697 | 1012 | 1.08% |
| 10/7/2001 | 9216 | 1.77 | 87928 | 927 | 1.05% |
| 10/8/2001 | 8802 | 1.77 | 83860 | 1026 | 1.22% |
| 10/9/2001 | 8157 | 1.78 | 78319 | 987 | 1.26% |
| 10/10/2001 | 8142 | 1.76 | 77133 | 983 | 1.27% |
| 10/11/2001 | 7647 | 1.82 | 74917 | 1033 | 1.38% |
| 10/12/2001 | 7968 | 1.83 | 78721 | 1083 | 1.38% |
| 10/13/2001 | 7719 | 1.82 | 75518 | 989 | 1.31% |
| 10/14/2001 | 7542 | 1.87 | 76022 | 1012 | 1.33% |
| 10/15/2001 | 7115 | 1.87 | 71718 | 1083 | 1.51% |
| 10/16/2001 | 7075 | 2.05 | 77989 | 1033 | 1.32% |
| 10/17/2001 | 7389 | 1.92 | 76571 | 1033 | 1.35% |
| 10/18/2001 | 7381 | 2.02 | 80367 | 983 | 1.22% |
| 10/19/2001 | 7344 | 1.97 | 78084 | 1033 | 1.32% |
| 10/20/2001 | 7160 | 1.97 | 76031 | 991 | 1.30% |
| 10/21/2001 | 7220 | 2.06 | 80074 | 1022 | 1.28% |
| 10/22/2001 | 7698 | 2.30 | 95615 | 987 | 1.03% |
| 10/23/2001 | 8146 | 2.53 | 110871 | 983 | 0.89% |
| 10/24/2001 | 7648 | 2.64 | 108731 | 983 | 0.90% |
| 10/25/2001 | 7964 | 2.88 | 123527 | 983 | 0.80% |
| 10/26/2001 | 8130 | 2.87 | 125663 | 983 | 0.78% |
| 10/27/2001 | 8085 | 2.96 | 128999 | 1033 | 0.80% |
| 10/28/2001 | 8192 | 2.81 | 123862 | 1033 | 0.83% |
| 10/29/2001 | 8122 | 2.72 | 119228 | 1033 | 0.87% |
| 10/30/2001 | 6700 | 3.05 | 110151 | 1275 | 1.16% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 10/31/2001 | 8278 | 3.17 | 141300 | 1005 | 0.71% |
| 11/1/2001 | 9562 | 3.38 | 174341 | 896 | 0.51% |
| 11/2/2001 | 9540 | 4.50 | 231535 | 988 | 0.43% |
| 11/5/2001 | 10607 | 4.50 | 257430 | 941 | 0.37% |
| 11/6/2001 | 9935 | 4.50 | 241121 | 1014 | 0.42% |
| 11/7/2001 | 9486 | 4.50 | 230224 | 991 | 0.43% |
| 11/8/2001 | 9262 | 4.50 | 224787 | 975 | 0.43% |
| 11/9/2001 | 9123 | 4.50 | 221414 | 996 | 0.45% |
| 11/10/2001 | 8720 | 4.50 | 211633 | 1021 | 0.48% |
| 11/11/2001 | 8819 | 4.50 | 214036 | 1021 | 0.48% |
| 11/12/2001 | 9566 | 4.50 | 232166 | 18913 | 8.15% |
| 11/13/2001 | 12082 | 5.31 | 345818 | 44032 | 12.73% |
| 11/14/2001 | 12868 | 5.31 | 368315 | 5421 | 1.47% |
| 11/15/2001 | 13599 | 5.31 | 389238 | 2270 | 0.58% |
| 11/16/2001 | 13254 | 5.31 | 379363 | 2522 | 0.66% |
| 11/17/2001 | 12607 | 5.31 | 360844 | 2522 | 0.70% |
| 11/18/2001 | 11916 | 5.31 | 341066 | 2416 | 0.71% |
| 11/19/2001 | 11424 | 5.31 | 326984 | 1983 | 0.61% |
| 11/20/2001 | 10951 | 5.31 | 313445 | 2089 | 0.67% |
| 11/21/2001 | 10493 | 5.31 | 300336 | 2773 | 0.92% |
| 11/22/2001 | 11432 | 5.31 | 327213 | 5676 | 1.73% |
| 11/23/2001 | 11778 | 5.15 | 326958 | 1958 | 0.60% |
| 11/24/2001 | 13675 | 4.95 | 364692 | 21489 | 5.89% |
| 11/25/2001 | 18160 | 4.88 | 477204 | 13317 | 2.79% |
| 11/26/2001 | 20900 | 5.69 | 641021 | 2555 | 0.40% |
| 11/27/2001 | 22204 | 5.69 | 681016 | 2212 | 0.32% |
| 12/1/2001 | 18884 | 6.43 | 654514 | 4800 | 0.73% |
| 12/2/2001 | 22830 | 5.08 | 625456 | 46601 | 7.45% |
| 12/3/2001 | 28968 | 5.60 | 874030 | 35555 | 4.07% |
| 12/4/2001 | 33944 | 5.80 | 1060303 | 8300 | 0.78% |
| 12/5/2001 | 32800 | 6.42 | 1134186 | 8996 | 0.79% |
| 12/6/2001 | 30055 | 6.69 | 1083413 | 10615 | 0.98% |
| 12/7/2001 | 27336 | 6.54 | 963297 | 3626 | 0.38% |
| 12/8/2001 | 27896 | 5.94 | 893562 | 1557 | 0.17% |
| 12/9/2001 | 26952 | 4.78 | 694437 | 1798 | 0.26% |
| 12/10/2001 | 24320 | 5.56 | 728218 | 1592 | 0.22% |
| 12/11/2001 | 22275 | 5.53 | 663382 | 1706 | 0.26% |
| 12/12/2001 | 20900 | 4.87 | 548867 | 1683 | 0.31% |
| 12/13/2001 | 18988 | 4.46 | 456230 | 1787 | 0.39% |
| 12/14/2001 | 17813 | 4.82 | 462997 | 16645 | 3.60% |
| 12/15/2001 | 19043 | 4.73 | 485010 | 8589 | 1.77% |
| 12/16/2001 | 24138 | 4.41 | 573465 | 1601 | 0.28% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 12/17/2001 | 24947 | 4.56 | 612924 | 2179 | 0.36% |
| 12/18/2001 | 23448 | 4.56 | 576095 | 3106 | 0.54% |
| 12/19/2001 | 24130 | 5.34 | 694239 | 3010 | 0.43% |
| 12/20/2001 | 24743 | 4.27 | 569500 | 22341 | 3.92% |
| 12/21/2001 | 26835 | 4.25 | 614469 | 23296 | 3.79% |
| 12/22/2001 | 31836 | 4.56 | 782523 | 3959 | 0.51% |
| 12/23/2001 | 35232 | 4.45 | 844631 | 7295 | 0.86% |
| 12/24/2001 | 36138 | 5.99 | 1166822 | 3316 | 0.28% |
| 12/25/2001 | 36204 | 5.12 | 998196 | 2031 | 0.20% |
| 12/26/2001 | 34580 | 4.85 | 903559 | 1493 | 0.17% |
| 12/27/2001 | 31396 | 4.61 | 780169 | 1491 | 0.19% |
| 1/1/2002 | 40063 | 5.85 | 1263859 | 16205 | 1.28% |
| 1/2/2002 | 44072 | 6.03 | 1433091 | 52090 | 3.63% |
| 1/3/2002 | 50652 | 6.71 | 1833123 | 71220 | 3.89% |
| 1/4/2002 | 57660 | 6.54 | 2031112 | 41947 | 2.07% |
| 1/5/2002 | 63876 | 6.94 | 2389521 | 55953 | 2.34% |
| 1/6/2002 | 65552 | 6.66 | 2353281 | 64953 | 2.76% |
| 1/7/2002 | 64512 | 5.72 | 1990230 | 54987 | 2.76% |
| 1/8/2002 | 63184 | 5.72 | 1949260 | 48026 | 2.46% |
| 1/9/2002 | 62021 | 4.98 | 1664875 | 40543 | 2.44% |
| 1/10/2002 | 60264 | 4.98 | 1617711 | 33260 | 2.06% |
| 1/11/2002 | 57447 | 4.39 | 1359395 | 18531 | 1.36% |
| 1/12/2002 | 52660 | 3.95 | 1121222 | 9531 | 0.85% |
| 1/13/2002 | 46804 | 3.67 | 925266 | 4550 | 0.49% |
| 1/14/2002 | 40908 | 3.44 | 759094 | 3112 | 0.41% |
| 1/15/2002 | 36632 | 2.99 | 589609 | 2460 | 0.42% |
| 1/16/2002 | 33804 | 2.99 | 544091 | 2287 | 0.42% |
| 1/17/2002 | 31000 | 2.99 | 498959 | 1989 | 0.40% |
| 1/18/2002 | 29000 | 2.99 | 466768 | 2057 | 0.44% |
| 1/19/2002 | 27648 | 2.99 | 445007 | 1845 | 0.41% |
| 1/20/2002 | 26096 | 2.99 | 420027 | 1758 | 0.42% |
| 1/21/2002 | 24412 | 2.99 | 392922 | 1902 | 0.48% |
| 1/22/2002 | 23432 | 2.99 | 377149 | 2061 | 0.55% |
| 1/23/2002 | 22416 | 2.99 | 360796 | 1437 | 0.40% |
| 1/24/2002 | 21788 | 2.47 | 289500 | 1680 | 0.58% |
| 1/25/2002 | 20848 | 2.47 | 277010 | 1548 | 0.56% |
| 1/26/2002 | 20080 | 2.47 | 266805 | 5783 | 2.17% |
| 1/27/2002 | 20548 | 2.47 | 273024 | 6611 | 2.42% |
| 2/1/2002 | 18728 | 2.42 | 244298 | 2123 | 0.87% |
| 2/2/2002 | 18364 | 2.42 | 239055 | 2095 | 0.88% |
| 2/3/2002 | 18140 | 2.36 | 230761 | 1538 | 0.67% |
| 2/4/2002 | 17657 | 2.38 | 226045 | 1482 | 0.66% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 2/5/2002 | 17000 | 2.26 | 207325 | 1340 | 0.65% |
| 2/6/2002 | 16611 | 2.17 | 194298 | 1854 | 0.95% |
| 2/7/2002 | 16037 | 2.08 | 179977 | 2099 | 1.17% |
| 2/8/2002 | 16032 | 2.19 | 189470 | 3830 | 2.02% |
| 2/9/2002 | 15691 | 2.16 | 182691 | 1575 | 0.86% |
| 2/10/2002 | 15757 | 1.62 | 137170 | 1180 | 0.86% |
| 2/11/2002 | 15819 | 1.62 | 137710 | 1231 | 0.89% |
| 2/12/2002 | 15386 | 1.62 | 133940 | 996 | 0.74% |
| 2/13/2002 | 15162 | 1.91 | 156305 | 872 | 0.56% |
| 2/14/2002 | 14858 | 1.91 | 153171 | 869 | 0.57% |
| 2/15/2002 | 14689 | 1.91 | 151428 | 1000 | 0.66% |
| 2/16/2002 | 14395 | 1.91 | 148398 | 956 | 0.64% |
| 2/17/2002 | 14602 | 1.94 | 152302 | 2218 | 1.46% |
| 2/18/2002 | 14901 | 1.93 | 155220 | 2016 | 1.30% |
| 2/19/2002 | 15111 | 1.97 | 160055 | 2112 | 1.32% |
| 2/20/2002 | 15714 | 1.95 | 164960 | 2455 | 1.49% |
| 2/21/2002 | 19558 | 1.90 | 200041 | 1494 | 0.75% |
| 2/22/2002 | 28563 | 2.28 | 350267 | 999 | 0.29% |
| 2/23/2002 | 31119 | 2.90 | 486868 | 964 | 0.20% |
| 2/24/2002 | 27482 | 4.02 | 594768 | 920 | 0.15% |
| 2/25/2002 | 23615 | 3.23 | 410835 | 916 | 0.22% |
| 2/26/2002 | 21284 | 2.57 | 294562 | 884 | 0.30% |
| 2/27/2002 | 19648 | 2.28 | 241207 | 868 | 0.36% |
| 3/1/2002 | 18064 | 2.07 | 201070 | 934 | 0.46% |
| 3/2/2002 | 17993 | 1.99 | 192763 | 1155 | 0.60% |
| 3/3/2002 | 18472 | 1.90 | 189432 | 873 | 0.46% |
| 3/4/2002 | 18236 | 1.85 | 181359 | 776 | 0.43% |
| 3/5/2002 | 17805 | 1.78 | 170355 | 760 | 0.45% |
| 3/6/2002 | 17902 | 1.79 | 172489 | 9525 | 5.52% |
| 3/7/2002 | 19679 | 1.95 | 206636 | 25146 | 12.17% |
| 3/8/2002 | 23792 | 2.25 | 287913 | 8097 | 2.81% |
| 3/9/2002 | 26134 | 2.69 | 378237 | 2328 | 0.62% |
| 3/10/2002 | 27477 | 2.51 | 371755 | 8601 | 2.31% |
| 3/11/2002 | 27995 | 2.14 | 322326 | 7352 | 2.28% |
| 3/12/2002 | 28868 | 2.32 | 360231 | 3019 | 0.84% |
| 3/13/2002 | 27899 | 2.31 | 347388 | 1716 | 0.49% |
| 3/14/2002 | 25862 | 2.41 | 335964 | 1372 | 0.41% |
| 3/15/2002 | 23990 | 2.42 | 312939 | 1269 | 0.41% |
| 3/16/2002 | 22781 | 2.12 | 260329 | 1089 | 0.42% |
| 3/17/2002 | 21539 | 1.93 | 224367 | 996 | 0.44% |
| 3/18/2002 | 20862 | 1.87 | 210286 | 1035 | 0.49% |
| 3/19/2002 | 19894 | 1.87 | 200529 | 1019 | 0.51% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 3/20/2002 | 19068 | 1.87 | 192203 | 970 | 0.50% |
| 3/21/2002 | 18255 | 1.87 | 184008 | 975 | 0.53% |
| 3/22/2002 | 18048 | 1.87 | 181922 | 2224 | 1.22% |
| 3/23/2002 | 18284 | 1.87 | 184300 | 5352 | 2.90% |
| 3/24/2002 | 20526 | 1.87 | 206900 | 4062 | 1.96% |
| 3/25/2002 | 23805 | 1.87 | 239951 | 2081 | 0.87% |
| 3/26/2002 | 23687 | 1.87 | 238762 | 1322 | 0.55% |
| 3/27/2002 | 21710 | 1.87 | 218834 | 1089 | 0.50% |
| 4/1/2002 | 16998 | 0.67 | 61388 | 919 | 1.50% |
| 4/2/2002 | 16487 | 0.67 | 59543 | 828 | 1.39% |
| 4/3/2002 | 16537 | 0.67 | 59723 | 807 | 1.35% |
| 4/4/2002 | 16999 | 0.67 | 61392 | 768 | 1.25% |
| 4/5/2002 | 16623 | 0.67 | 60034 | 824 | 1.37% |
| 4/6/2002 | 16065 | 0.67 | 58019 | 897 | 1.55% |
| 4/7/2002 | 15970 | 0.67 | 57676 | 1033 | 1.79% |
| 4/8/2002 | 15850 | 0.67 | 57242 | 889 | 1.55% |
| 4/9/2002 | 16309 | 0.67 | 58900 | 1083 | 1.84% |
| 4/10/2002 | 16544 | 1.61 | 143434 | 1083 | 0.76% |
| 4/11/2002 | 16186 | 1.61 | 140330 | 1083 | 0.77% |
| 4/12/2002 | 16203 | 1.61 | 140478 | 938 | 0.67% |
| 4/13/2002 | 16063 | 1.61 | 139264 | 842 | 0.60% |
| 4/14/2002 | 14938 | 1.71 | 137749 | 946 | 0.69% |
| 4/15/2002 | 15631 | 1.57 | 132642 | 887 | 0.67% |
| 4/16/2002 | 15149 | 1.53 | 124554 | 987 | 0.79% |
| 4/17/2002 | 14794 | 1.62 | 129356 | 789 | 0.61% |
| 4/18/2002 | 15309 | 1.59 | 131033 | 973 | 0.74% |
| 4/19/2002 | 14717 | 1.61 | 128046 | 850 | 0.66% |
| 4/20/2002 | 13871 | 1.62 | 121359 | 850 | 0.70% |
| 4/21/2002 | 13641 | 1.56 | 114441 | 912 | 0.80% |
| 4/22/2002 | 13203 | 1.59 | 113403 | 1033 | 0.91% |
| 4/23/2002 | 12402 | 1.68 | 112573 | 1033 | 0.92% |
| 4/24/2002 | 10948 | 1.60 | 94574 | 974 | 1.03% |
| 4/25/2002 | 11137 | 1.73 | 103565 | 1033 | 1.00% |
| 4/26/2002 | 11027 | 1.53 | 91041 | 1083 | 1.19% |
| 4/27/2002 | 10946 | 1.60 | 94536 | 1033 | 1.09% |
| 4/28/2002 | 11405 | 1.65 | 101443 | 983 | 0.97% |
| 4/29/2002 | 11207 | 1.67 | 101087 | 1033 | 1.02% |
| 4/30/2002 | 11706 | 1.61 | 101573 | 1033 | 1.02% |
| 5/1/2002 | 11878 | 1.67 | 106640 | 879 | 0.82% |
| 5/2/2002 | 11143 | 1.63 | 97695 | 966 | 0.99% |
| 5/3/2002 | 11255 | 1.66 | 100465 | 1083 | 1.08% |
| 5/4/2002 | 10722 | 1.68 | 97354 | 957 | 0.98% |

| Date | Sac R Flow @ Hood (cfs) | Daily Ave. TOC (1) (mg/L) | Sac R TOC Load (lbs/day) | NEMDC TOC load (lbs/day) | % TOC Load from NEMDC |
|---|---|---|---|---|---|
| 5/5/2002 | 10209 | 1.69 | 92777 | 1003 | 1.08% |
| 5/6/2002 | 9641 | 1.57 | 81563 | 1003 | 1.23% |
| 5/7/2002 | 10132 | 1.98 | 108004 | 1003 | 0.93% |
| 5/8/2002 | 10061 | 1.98 | 107247 | 1471 | 1.37% |
| 5/9/2002 | 10106 | 1.98 | 107727 | 1402 | 1.30% |
| 5/10/2002 | 9956 | 1.98 | 106128 | 1471 | 1.39% |
| 5/11/2002 | 9745 | 1.98 | 103879 | 1471 | 1.42% |
| 5/12/2002 | 9948 | 1.98 | 106043 | 1471 | 1.39% |
| 5/13/2002 | 9747 | 1.98 | 103900 | 1471 | 1.42% |
| 5/14/2002 | 10110 | 1.98 | 107770 | 1471 | 1.36% |
| 5/15/2002 | 10348 | 1.98 | 110307 | 1471 | 1.33% |
| 5/16/2002 | 10547 | 1.98 | 112428 | 1402 | 1.25% |
| 5/17/2002 | 10872 | 1.98 | 115892 | 1471 | 1.27% |
| 5/18/2002 | 11851 | 1.98 | 126328 | 1471 | 1.16% |
| 5/19/2002 | 13406 | 2.05 | 148076 | 1152 | 0.78% |
| 5/20/2002 | 14960 | 2.05 | 165247 | 25776 | 15.60% |
| 5/21/2002 | 18951 | 2.05 | 209331 | 44074 | 21.05% |
| 5/22/2002 | 20159 | 2.05 | 222675 | 12108 | 5.44% |
| 5/23/2002 | 20295 | 2.05 | 224177 | 3775 | 1.68% |
| 5/24/2002 | 19830 | 2.05 | 219041 | 1357 | 0.62% |
| 5/25/2002 | 18076 | 2.05 | 199666 | 1174 | 0.59% |
| 5/26/2002 | 16586 | 2.05 | 183208 | 1450 | 0.79% |
| 5/27/2002 | 15416 | 2.05 | 170284 | 1450 | 0.85% |
| 5/28/2002 | 14488 | 2.05 | 160033 | 1450 | 0.91% |
| 5/29/2002 | 14232 | 2.05 | 157206 | 1450 | 0.92% |
| 5/30/2002 | 13467 | 1.88 | 136283 | 1450 | 1.06% |
| 5/31/2002 | 12888 | 1.79 | 124272 | 1450 | 1.17% |
| 6/1/2002 | 12454 | 1.69 | 113661 | 958 | 0.84% |
| 6/2/2002 | 12918 | 1.67 | 116001 | 958 | 0.83% |
| 6/3/2002 | 12558 | 1.65 | 111903 | 958 | 0.86% |

(1) TOC ox data from Sievers unit at Hood. Ave of actual Jul-Aug 2001 data of 2.03 mg/L substituted where no Jul-Aug data available.

# Appendix C
# Comparison of NEMDC and Combined Sacramento Metro Area Urban Runoff (UR) and Sacramento Regional Wastewater Treatment Plant (SRWTP) TOC Loads with Sacramento River Loads

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 7/1/2001 | 1.42% | 11.63% | 86.95% |
| 7/2/2001 | 1.39% | 11.44% | 87.17% |
| 7/3/2001 | 1.44% | 11.79% | 86.78% |
| 7/4/2001 | 1.46% | 11.95% | 86.59% |
| 7/5/2001 | 1.43% | 12.30% | 86.27% |
| 7/6/2001 | 1.30% | 12.39% | 86.31% |
| 7/7/2001 | 1.39% | 12.48% | 86.14% |
| 7/8/2001 | 1.49% | 12.89% | 85.62% |
| 7/9/2001 | 1.53% | 13.19% | 85.28% |
| 7/10/2001 | 1.57% | 13.55% | 84.88% |
| 7/11/2001 | 1.56% | 14.06% | 84.38% |
| 7/12/2001 | 1.59% | 14.24% | 84.17% |
| 7/13/2001 | 1.60% | 14.34% | 84.06% |
| 7/14/2001 | 1.71% | 14.73% | 83.56% |
| 7/15/2001 | 1.76% | 15.19% | 83.05% |
| 7/16/2001 | 1.61% | 14.79% | 83.59% |
| 7/17/2001 | 1.74% | 15.04% | 83.22% |
| 7/18/2001 | 1.57% | 14.41% | 84.02% |
| 7/19/2001 | 1.50% | 12.97% | 85.52% |
| 7/20/2001 | 1.47% | 12.66% | 85.87% |
| 7/21/2001 | 1.38% | 12.35% | 86.27% |
| 7/22/2001 | 1.36% | 12.19% | 86.45% |
| 7/23/2001 | 1.42% | 12.21% | 86.38% |
| 7/24/2001 | 1.44% | 12.38% | 86.18% |
| 7/25/2001 | 1.43% | 12.36% | 86.20% |
| 7/26/2001 | 1.41% | 12.14% | 86.45% |
| 7/27/2001 | 1.40% | 12.07% | 86.53% |
| 7/28/2001 | 1.32% | 11.85% | 86.83% |
| 7/29/2001 | 1.38% | 11.94% | 86.68% |
| 7/30/2001 | 1.29% | 11.57% | 87.14% |
| 7/31/2001 | 1.36% | 11.69% | 86.95% |
| 8/1/2001 | 1.46% | 12.56% | 85.98% |
| 8/2/2001 | 1.45% | 12.46% | 86.09% |
| 8/3/2001 | 1.35% | 12.69% | 85.96% |
| 8/4/2001 | 1.44% | 12.98% | 85.58% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 8/5/2001 | 1.48% | 13.30% | 85.22% |
| 8/6/2001 | 1.52% | 13.66% | 84.83% |
| 8/7/2001 | 1.54% | 13.91% | 84.55% |
| 8/8/2001 | 1.51% | 14.01% | 84.48% |
| 8/9/2001 | 1.46% | 14.06% | 84.48% |
| 8/10/2001 | 1.42% | 13.72% | 84.86% |
| 8/11/2001 | 1.46% | 13.49% | 85.05% |
| 8/12/2001 | 1.48% | 14.28% | 84.24% |
| 8/13/2001 | 1.37% | 13.45% | 85.18% |
| 8/14/2001 | 1.44% | 13.89% | 84.67% |
| 8/15/2001 | 1.16% | 11.23% | 87.61% |
| 8/16/2001 | 1.46% | 13.54% | 85.00% |
| 8/17/2001 | 1.44% | 13.30% | 85.26% |
| 8/18/2001 | 1.39% | 12.86% | 85.75% |
| 8/19/2001 | 1.40% | 12.94% | 85.66% |
| 8/20/2001 | 1.44% | 13.31% | 85.25% |
| 8/21/2001 | 1.46% | 14.13% | 84.40% |
| 8/22/2001 | 1.52% | 14.63% | 83.85% |
| 8/23/2001 | 1.49% | 14.30% | 84.21% |
| 8/24/2001 | 1.63% | 15.06% | 83.31% |
| 8/25/2001 | 1.71% | 15.79% | 82.50% |
| 8/26/2001 | 1.69% | 15.63% | 82.68% |
| 8/27/2001 | 1.66% | 15.38% | 82.96% |
| 8/28/2001 | 1.70% | 15.74% | 82.56% |
| 8/29/2001 | 1.67% | 15.49% | 82.84% |
| 8/30/2001 | 1.46% | 14.72% | 83.83% |
| 8/31/2001 | 1.53% | 14.82% | 83.65% |
| 9/1/2001 | 1.28% | 12.63% | 86.09% |
| 9/2/2001 | 1.35% | 12.49% | 86.16% |
| 9/3/2001 | 1.25% | 12.38% | 86.37% |
| 9/4/2001 | 1.37% | 13.02% | 85.61% |
| 9/5/2001 | 1.34% | 12.78% | 85.88% |
| 9/6/2001 | 1.28% | 12.88% | 85.83% |
| 9/7/2001 | 1.32% | 13.27% | 85.41% |
| 9/8/2001 | 1.31% | 13.19% | 85.49% |
| 9/9/2001 | 1.38% | 13.24% | 85.39% |
| 9/10/2001 | 1.32% | 13.19% | 85.49% |
| 9/11/2001 | 1.34% | 13.43% | 85.23% |
| 9/12/2001 | 1.38% | 13.28% | 85.34% |
| 9/13/2001 | 1.24% | 12.40% | 86.35% |
| 9/14/2001 | 1.24% | 12.42% | 86.34% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 9/15/2001 | 1.30% | 12.47% | 86.23% |
| 9/16/2001 | 1.32% | 12.71% | 85.97% |
| 9/17/2001 | 1.34% | 12.92% | 85.74% |
| 9/18/2001 | 1.41% | 13.52% | 85.07% |
| 9/19/2001 | 1.45% | 13.92% | 84.63% |
| 9/20/2001 | 1.51% | 14.57% | 83.92% |
| 9/21/2001 | 1.40% | 14.37% | 84.24% |
| 9/22/2001 | 1.53% | 15.38% | 83.09% |
| 9/23/2001 | 1.69% | 16.29% | 82.02% |
| 9/24/2001 | 1.60% | 16.37% | 82.03% |
| 9/25/2001 | 1.77% | 15.82% | 82.40% |
| 9/26/2001 | 1.12% | 13.95% | 84.92% |
| 9/27/2001 | 1.25% | 13.81% | 84.94% |
| 9/28/2001 | 1.45% | 16.11% | 82.44% |
| 9/29/2001 | 1.70% | 16.36% | 81.94% |
| 9/30/2001 | 1.77% | 16.98% | 81.25% |
| 10/1/2001 | 1.73% | 17.39% | 80.88% |
| 10/2/2001 | 1.88% | 18.04% | 80.08% |
| 10/3/2001 | 1.55% | 15.16% | 83.29% |
| 10/4/2001 | 2.11% | 20.99% | 76.90% |
| 10/5/2001 | 2.24% | 20.97% | 76.79% |
| 10/6/2001 | 2.16% | 21.46% | 76.38% |
| 10/7/2001 | 2.11% | 22.67% | 75.22% |
| 10/8/2001 | 2.45% | 24.01% | 73.55% |
| 10/9/2001 | 2.52% | 25.60% | 71.88% |
| 10/10/2001 | 2.55% | 25.99% | 71.46% |
| 10/11/2001 | 2.76% | 26.89% | 70.35% |
| 10/12/2001 | 2.75% | 25.72% | 71.53% |
| 10/13/2001 | 2.62% | 26.56% | 70.82% |
| 10/14/2001 | 2.66% | 26.44% | 70.89% |
| 10/15/2001 | 3.02% | 28.23% | 68.75% |
| 10/16/2001 | 2.65% | 25.83% | 71.52% |
| 10/17/2001 | 2.70% | 26.31% | 70.99% |
| 10/18/2001 | 2.45% | 24.94% | 72.61% |
| 10/19/2001 | 2.65% | 25.80% | 71.55% |
| 10/20/2001 | 2.61% | 26.39% | 71.01% |
| 10/21/2001 | 2.55% | 25.13% | 72.32% |
| 10/22/2001 | 2.06% | 20.97% | 76.96% |
| 10/23/2001 | 1.77% | 18.08% | 80.15% |
| 10/24/2001 | 1.81% | 18.44% | 79.76% |
| 10/25/2001 | 1.59% | 16.23% | 82.18% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 10/26/2001 | 1.56% | 15.95% | 82.48% |
| 10/27/2001 | 1.60% | 15.62% | 82.78% |
| 10/28/2001 | 1.67% | 16.26% | 82.07% |
| 10/29/2001 | 1.73% | 16.90% | 81.37% |
| 10/30/2001 | 2.31% | 18.73% | 78.96% |
| 10/31/2001 | 1.42% | 14.22% | 84.36% |
| 11/1/2001 | 1.03% | 11.40% | 87.57% |
| 11/2/2001 | 0.85% | 8.66% | 90.48% |
| 11/5/2001 | 0.73% | 7.75% | 91.51% |
| 11/6/2001 | 0.84% | 8.34% | 90.82% |
| 11/7/2001 | 0.86% | 8.71% | 90.43% |
| 11/8/2001 | 0.87% | 8.91% | 90.22% |
| 11/9/2001 | 0.90% | 9.07% | 90.03% |
| 11/10/2001 | 0.96% | 9.51% | 89.53% |
| 11/11/2001 | 0.95% | 9.40% | 89.64% |
| 11/12/2001 | 16.29% | 24.08% | 59.63% |
| 11/13/2001 | 25.47% | 30.69% | 43.84% |
| 11/14/2001 | 2.94% | 7.85% | 89.20% |
| 11/15/2001 | 1.17% | 5.81% | 93.02% |
| 11/16/2001 | 1.33% | 6.10% | 92.57% |
| 11/17/2001 | 1.40% | 6.41% | 92.19% |
| 11/18/2001 | 1.42% | 6.72% | 91.87% |
| 11/19/2001 | 1.21% | 6.74% | 92.05% |
| 11/20/2001 | 1.33% | 7.10% | 91.57% |
| 11/21/2001 | 1.85% | 7.87% | 90.29% |
| 11/22/2001 | 3.47% | 8.99% | 87.54% |
| 11/23/2001 | 1.20% | 6.73% | 92.07% |
| 11/24/2001 | 11.78% | 16.74% | 71.47% |
| 11/25/2001 | 5.58% | 9.37% | 85.05% |
| 11/26/2001 | 0.80% | 3.62% | 95.59% |
| 11/27/2001 | 0.65% | 3.30% | 96.05% |
| 12/1/2001 | 1.47% | 4.23% | 94.30% |
| 12/2/2001 | 14.90% | 17.79% | 67.31% |
| 12/3/2001 | 8.14% | 10.20% | 81.66% |
| 12/4/2001 | 1.57% | 3.27% | 95.16% |
| 12/5/2001 | 1.59% | 3.18% | 95.23% |
| 12/6/2001 | 1.96% | 3.63% | 94.41% |
| 12/7/2001 | 0.75% | 2.63% | 96.62% |
| 12/8/2001 | 0.35% | 2.37% | 97.28% |
| 12/9/2001 | 0.52% | 3.12% | 96.36% |
| 12/10/2001 | 0.44% | 2.92% | 96.64% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 12/11/2001 | 0.51% | 3.24% | 96.25% |
| 12/12/2001 | 0.61% | 3.91% | 95.48% |
| 12/13/2001 | 0.78% | 4.75% | 94.47% |
| 12/14/2001 | 7.19% | 11.10% | 81.71% |
| 12/15/2001 | 3.54% | 7.27% | 89.19% |
| 12/16/2001 | 0.56% | 3.71% | 95.73% |
| 12/17/2001 | 0.71% | 3.66% | 95.63% |
| 12/18/2001 | 1.08% | 4.22% | 94.71% |
| 12/19/2001 | 0.87% | 3.47% | 95.66% |
| 12/20/2001 | 7.85% | 11.02% | 81.13% |
| 12/21/2001 | 7.58% | 10.52% | 81.89% |
| 12/22/2001 | 1.01% | 3.32% | 95.67% |
| 12/23/2001 | 1.73% | 3.87% | 94.40% |
| 12/24/2001 | 0.57% | 2.12% | 97.31% |
| 12/25/2001 | 0.41% | 2.22% | 97.38% |
| 12/26/2001 | 0.33% | 2.33% | 97.34% |
| 12/27/2001 | 0.38% | 2.70% | 96.92% |
| 1/1/2002 | 2.56% | 3.99% | 93.44% |
| 1/2/2002 | 7.27% | 8.53% | 84.20% |
| 1/3/2002 | 7.77% | 8.76% | 83.47% |
| 1/4/2002 | 4.13% | 5.02% | 90.85% |
| 1/5/2002 | 4.68% | 5.44% | 89.88% |
| 1/6/2002 | 5.52% | 6.29% | 88.19% |
| 1/7/2002 | 5.53% | 6.43% | 88.04% |
| 1/8/2002 | 4.93% | 5.86% | 89.22% |
| 1/9/2002 | 4.87% | 5.96% | 89.17% |
| 1/10/2002 | 4.11% | 5.23% | 90.66% |
| 1/11/2002 | 2.73% | 4.06% | 93.22% |
| 1/12/2002 | 1.70% | 3.31% | 94.99% |
| 1/13/2002 | 0.98% | 2.94% | 96.08% |
| 1/14/2002 | 0.82% | 3.20% | 95.98% |
| 1/15/2002 | 0.83% | 3.90% | 95.26% |
| 1/16/2002 | 0.84% | 4.16% | 95.00% |
| 1/17/2002 | 0.80% | 4.42% | 94.78% |
| 1/18/2002 | 0.88% | 4.75% | 94.36% |
| 1/19/2002 | 0.83% | 4.89% | 94.28% |
| 1/20/2002 | 0.84% | 5.14% | 94.02% |
| 1/21/2002 | 0.97% | 5.57% | 93.46% |
| 1/22/2002 | 1.09% | 5.89% | 93.02% |
| 1/23/2002 | 0.80% | 5.81% | 93.40% |
| 1/24/2002 | 1.16% | 7.41% | 91.43% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 1/25/2002 | 1.12% | 7.64% | 91.24% |
| 1/26/2002 | 4.33% | 11.11% | 84.55% |
| 1/27/2002 | 4.84% | 11.46% | 83.69% |
| 2/1/2002 | 1.74% | 9.14% | 89.12% |
| 2/2/2002 | 1.75% | 9.32% | 88.93% |
| 2/3/2002 | 1.33% | 9.17% | 89.50% |
| 2/4/2002 | 1.31% | 9.31% | 89.38% |
| 2/5/2002 | 1.29% | 10.01% | 88.69% |
| 2/6/2002 | 1.91% | 11.21% | 86.88% |
| 2/7/2002 | 2.33% | 12.38% | 85.29% |
| 2/8/2002 | 4.04% | 13.59% | 82.37% |
| 2/9/2002 | 1.72% | 11.62% | 86.66% |
| 2/10/2002 | 1.72% | 14.90% | 83.38% |
| 2/11/2002 | 1.79% | 14.92% | 83.30% |
| 2/12/2002 | 1.49% | 14.99% | 83.53% |
| 2/13/2002 | 1.12% | 12.68% | 86.20% |
| 2/14/2002 | 1.13% | 12.94% | 85.93% |
| 2/15/2002 | 1.32% | 13.26% | 85.42% |
| 2/16/2002 | 1.29% | 13.47% | 85.24% |
| 2/17/2002 | 2.91% | 14.78% | 82.30% |
| 2/18/2002 | 2.60% | 14.25% | 83.16% |
| 2/19/2002 | 2.64% | 13.94% | 83.43% |
| 2/20/2002 | 2.98% | 13.94% | 83.09% |
| 2/21/2002 | 1.49% | 10.53% | 87.98% |
| 2/22/2002 | 0.57% | 5.73% | 93.70% |
| 2/23/2002 | 0.40% | 4.11% | 95.49% |
| 2/24/2002 | 0.31% | 3.35% | 96.34% |
| 2/25/2002 | 0.45% | 4.85% | 94.71% |
| 2/26/2002 | 0.60% | 6.74% | 92.66% |
| 2/27/2002 | 0.72% | 8.22% | 91.06% |
| 3/1/2002 | 0.93% | 9.92% | 89.15% |
| 3/2/2002 | 1.20% | 10.58% | 88.22% |
| 3/3/2002 | 0.92% | 10.47% | 88.61% |
| 3/4/2002 | 0.86% | 10.82% | 88.32% |
| 3/5/2002 | 0.89% | 11.50% | 87.60% |
| 3/6/2002 | 11.04% | 21.53% | 67.43% |
| 3/7/2002 | 24.34% | 33.09% | 42.57% |
| 3/8/2002 | 5.62% | 11.90% | 82.47% |
| 3/9/2002 | 1.23% | 6.01% | 92.76% |
| 3/10/2002 | 4.63% | 9.49% | 85.88% |
| 3/11/2002 | 4.56% | 10.17% | 85.27% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 3/12/2002 | 1.68% | 6.69% | 91.63% |
| 3/13/2002 | 0.99% | 6.19% | 92.82% |
| 3/14/2002 | 0.82% | 6.20% | 92.99% |
| 3/15/2002 | 0.81% | 6.59% | 92.60% |
| 3/16/2002 | 0.84% | 7.78% | 91.38% |
| 3/17/2002 | 0.89% | 8.95% | 90.17% |
| 3/18/2002 | 0.98% | 9.58% | 89.43% |
| 3/19/2002 | 1.02% | 10.03% | 88.95% |
| 3/20/2002 | 1.01% | 10.42% | 88.57% |
| 3/21/2002 | 1.06% | 10.88% | 88.06% |
| 3/22/2002 | 2.44% | 12.38% | 85.17% |
| 3/23/2002 | 5.81% | 15.62% | 78.57% |
| 3/24/2002 | 3.93% | 12.67% | 83.41% |
| 3/25/2002 | 1.73% | 9.27% | 89.00% |
| 3/26/2002 | 1.11% | 8.68% | 90.21% |
| 3/27/2002 | 1.00% | 9.26% | 89.75% |
| 4/1/2002 | 2.99% | 32.44% | 64.56% |
| 4/2/2002 | 2.78% | 33.15% | 64.07% |
| 4/3/2002 | 2.70% | 32.98% | 64.32% |
| 4/4/2002 | 2.50% | 31.95% | 65.55% |
| 4/5/2002 | 2.75% | 32.86% | 64.39% |
| 4/6/2002 | 3.09% | 34.25% | 62.65% |
| 4/7/2002 | 3.58% | 34.93% | 61.49% |
| 4/8/2002 | 3.10% | 34.69% | 62.21% |
| 4/9/2002 | 3.68% | 34.37% | 61.95% |
| 4/10/2002 | 1.51% | 14.12% | 84.37% |
| 4/11/2002 | 1.54% | 14.43% | 84.03% |
| 4/12/2002 | 1.34% | 14.21% | 84.46% |
| 4/13/2002 | 1.21% | 14.19% | 84.60% |
| 4/14/2002 | 1.37% | 14.50% | 84.13% |
| 4/15/2002 | 1.34% | 14.97% | 83.69% |
| 4/16/2002 | 1.58% | 16.10% | 82.32% |
| 4/17/2002 | 1.22% | 15.20% | 83.58% |
| 4/18/2002 | 1.48% | 15.28% | 83.23% |
| 4/19/2002 | 1.33% | 15.45% | 83.23% |
| 4/20/2002 | 1.40% | 16.30% | 82.30% |
| 4/21/2002 | 1.59% | 17.39% | 81.01% |
| 4/22/2002 | 1.82% | 17.76% | 80.41% |
| 4/23/2002 | 1.83% | 17.90% | 80.27% |
| 4/24/2002 | 2.06% | 21.18% | 76.76% |
| 4/25/2002 | 1.99% | 19.45% | 78.55% |

| Date | % Sac R TOC load w/total Sac metro area urban runoff load[1] | Total % Sac R TOC load w/SRWTP and UR loads[2] (% - lbs/day) | % Upper Sac R TOC load |
|---|---|---|---|
| 4/26/2002 | 2.38% | 22.24% | 75.38% |
| 4/27/2002 | 2.19% | 21.31% | 76.50% |
| 4/28/2002 | 1.94% | 19.76% | 78.30% |
| 4/29/2002 | 2.04% | 19.93% | 78.03% |
| 4/30/2002 | 2.03% | 19.83% | 78.13% |
| 5/1/2002 | 1.65% | 18.60% | 79.75% |
| 5/2/2002 | 1.98% | 20.48% | 77.54% |
| 5/3/2002 | 2.16% | 20.15% | 77.69% |
| 5/4/2002 | 1.97% | 20.54% | 77.50% |
| 5/5/2002 | 2.16% | 21.65% | 76.19% |
| 5/6/2002 | 2.46% | 24.63% | 72.91% |
| 5/7/2002 | 1.86% | 18.60% | 79.54% |
| 5/8/2002 | 2.74% | 19.60% | 77.66% |
| 5/9/2002 | 2.60% | 19.39% | 78.01% |
| 5/10/2002 | 2.77% | 19.81% | 77.42% |
| 5/11/2002 | 2.83% | 20.24% | 76.93% |
| 5/12/2002 | 2.77% | 19.82% | 77.40% |
| 5/13/2002 | 2.83% | 20.23% | 76.94% |
| 5/14/2002 | 2.73% | 19.51% | 77.76% |
| 5/15/2002 | 2.67% | 19.06% | 78.28% |
| 5/16/2002 | 2.49% | 18.58% | 78.93% |
| 5/17/2002 | 2.54% | 18.14% | 79.32% |
| 5/18/2002 | 2.33% | 16.64% | 81.03% |
| 5/19/2002 | 1.56% | 13.77% | 84.68% |
| 5/20/2002 | 31.20% | 42.14% | 26.67% |
| 5/21/2002 | 42.11% | 50.75% | 7.14% |
| 5/22/2002 | 10.87% | 18.99% | 70.13% |
| 5/23/2002 | 3.37% | 11.43% | 85.20% |
| 5/24/2002 | 1.24% | 9.49% | 89.27% |
| 5/25/2002 | 1.18% | 10.23% | 88.59% |
| 5/26/2002 | 1.58% | 11.45% | 86.97% |
| 5/27/2002 | 1.70% | 12.32% | 85.98% |
| 5/28/2002 | 1.81% | 13.11% | 85.08% |
| 5/29/2002 | 1.84% | 13.35% | 84.81% |
| 5/30/2002 | 2.13% | 15.39% | 82.48% |
| 5/31/2002 | 2.33% | 16.88% | 80.78% |
| 6/1/2002 | 1.69% | 17.59% | 80.72% |
| 6/2/2002 | 1.65% | 17.24% | 81.11% |
| 6/3/2002 | 1.71% | 17.87% | 80.42% |

1. Assumes 2X NEMDC load for all Sac Metro area urban runoff
2. Based on median SRWTP load of 18080 lbs/day, Sept 1991-June 1998

State of California
The Resources Agency
Department of Water Resources
**Division of Environmental Services**
Office of Water Quality
Municipal Water Quality Investigations Unit