DRAINAGE AREA MANAGEMENT PLAN (DAMP)

Exhibit 11.I San Diego Region Wet Weather Monitoring Program

July 1, 2003

A COOPERATIVE PROJECT OF THE COUNTY
OF ORANGE, THE CITIES OF ORANGE COUNTY
AND THE ORANGE COUNTY FLOOD CONTROL
DISTRICT

Exhibit 11.I

San Diego Region Wet Weather Water Quality Monitoring Program:

Past Monitoring and Future Recommendations Report

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EXECUTIVE SUMMARY

This report fulfills the requirements of Attachments B.2.a (Previous Monitoring and Future Recommendations Report) and B.2.b.8 (Receiving Waters Monitoring Program) of Permit CAS0108740, Order No. R9-2002-0001, from the San Diego Regional Water Quality Control Board to the Orange County Stormwater Program Permittees[1]. As specified in these Attachments, it:

- Reviews wet weather stormwater monitoring (samples collected during storm events) findings since the initiation of the municipal urban stormwater runoff permit in 1990
- Describes the design and implementation of the Second Term Permit monitoring plan (99-04) within the San Diego region of the County
- Documents how monitoring results have been used by the Permittees
- Describes the design of the new Third Term Permit monitoring plan that was implemented beginning in October 2002.

The cumulative analysis identified a series of declines and increases in certain pollutants at some monitoring stations, in addition to some consistent differences in overall median pollutant levels between stations. Some of these trends and patterns could be explained by localized disturbances, such as fires, or by the nature of the surrounding land use. However, many others could not be explained. Not all trends increased or decreased at the same time, nor did all pollutants at a particular station change in concert. The interpretation of these cumulative data was limited to some extent by changes in methods, management and monitoring questions, and sampling designs over time. The report therefore concludes that tracking trends and patterns over the longer term requires maintaining a spatially dispersed and consistent monitoring plan over many years.

In addition to these site-specific findings, more general conclusions apparent in the data including the following:

- There is a close relationship between the amount of total suspended solids (TSS) and the levels (concentrations) of total metals and phosphate in the water
- If there is a high potential for erosion, either from landuse practices, undeveloped areas, or from earthen channels themselves, there will be a correspondingly high probability of elevated TSS and metals and phosphate levels

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[1] The Orange County Stormwater Program Permittees under the San Diego Regional Water Quality Control Board include the Cities of Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Laguna Woods, Lake Forest, Mission Viejo, Rancho Santa Margarita, San Clemente, and San Juan Capistrano, as well as the County of Orange and the Orange County Flood Control District.

- Patterns of metals and phosphate loads over time are strongly influenced by the amount of flow and the erosion potential of the surrounding watershed

- Despite these relationships, there is no apparent consistent connection between overall yearly rainfall and the levels (as opposed to the loads) of contaminants in runoff or in the sediments at the channel stations

- While there is a positive correlation between the levels of total and dissolved metals, the bulk of metals is consistently found in the particulate fraction

- Though metals may be at higher levels in the first flush, these waters may not necessarily exceed the California Toxic Rule (CTR) freshwater criteria, because of the elevated hardness of first-flush water, which reduces the effective toxicity

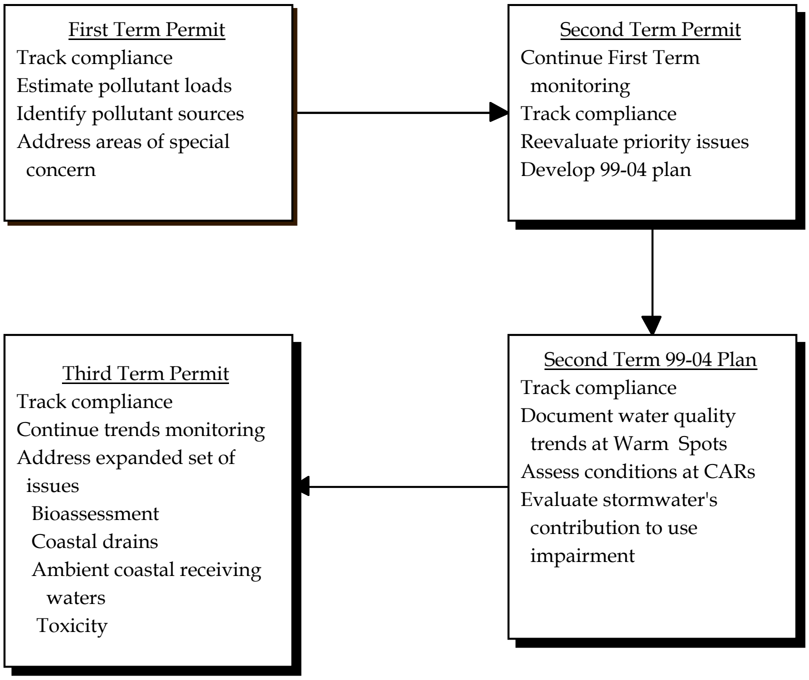
- The first flush, however, *may* show more exceedances of the California Toxic Rule (CTR) saltwater criteria at the freshwater/saltwater interface (assuming no dilution), because there are no hardness qualifiers for marine toxicity

- While there are apparent increasing or decreasing trends over time for some metals at some stations, it is not clear what may be causing these

- Sediment from nearly every site in Dana Point Harbor was anthropogenically enriched with copper and zinc and, to a somewhat lesser extent, lead, although all values were below NOAA's Effects Range Median (ERM) guidelines

- A reduction in the levels of several metals in Dana Point Harbor sediments after 1998 may be related to the fact that the El Niño year of 1997 / 98 was the wettest of the 1990 – 2000 period and the following year, 1998 /99 was the driest.

Throughout the period from 1990 to the present, the Permittees' monitoring program has evolved, as illustrated in the following figure:



Warm spots refers to sites with pollutant levels that are elevated relative to the long-term County average (see Section 2.2.2 for more detail).
CARs refers to critical aquatic resources, sites with greater beneficial use potential (see Section 2.2.2 for more detail).

The current, Third Term, permit is most comprehensive to date. It extends stormwater monitoring to a broader range of locations and to a wider array of methods for measuring impacts. For example, the new monitoring plan will more completely examine storm drains that discharge directly to the coast and pose a potential health risk to swimmers and bathers. In addition, the new plan will for the first time investigate the effects of stormwater plumes on the nearshore marine environment. Inland, the new monitoring plan is expanding to include bioassessment studies of creeks, along with the more consistent use of toxicity testing. Combined with the existing measurement of chemical parameters, this "triad" approach is intended to describe impacts more fully, more accurately identify their sources, and target follow-up studies and BMPs more effectively.

While this report reviews the findings of past wet weather stormwater monitoring, it does not address routine dry weather monitoring or the special studies that have been carried out to help resolve particular issues or problems. A list of reports describing these other activities is contained in the References section (Section 6.0). The design of the dry weather reconnaissance element will be completed in February 2003.

1.0 PAST MONITORING, FUTURE RECOMMENDATION, AND RECEIVING WATERS PROGRAM INTRODUCTION

1.1 Introduction

This report fulfills the requirements of Attachments B.2.a (Previous Monitoring and Future Recommendations Report) and B.2.b.8 (Receiving Waters Monitoring Program) of Permit CAS0108740, Order No. R9-2002-0001, from the San Diego Regional Water Quality Control Board to the Orange County Stormwater Program Permittees. As specified in these Attachments, it:

- Reviews wet weather stormwater monitoring (samples collected during storm events) findings since the initiation of the municipal urban stormwater runoff permit in 1990
- Describes the design and implementation of the Second Term Permit monitoring plan (99-04) within the San Diego region of the County
- Documents how monitoring results have been used by the Permittees
- Describes the design of the new Third Term Permit monitoring plan that was implemented beginning October 2002.

In addition, this report makes recommendations for the design and use of data from future monitoring efforts in the San Diego Regional Board area of the County. The report is structured in two main sections that, together, address each of the ten specific requirements in Attachment B.2.a of the Permit, as well as the requirements in Attachment B.2.b for describing the specifics of the Third Term Permit monitoring program (see **Table 1-1**).

1.2 Report Overview

This report contains two main sections:

- Section 2.0, which describes past NPDES wet weather monitoring efforts and summarizes their findings
- Section 3.0, which makes recommendations about future monitoring and describes the details of the new, Third Term Permit receiving waters monitoring program.

It is important to understand what this report does and does not address. It does review, in Section 2.0, all wet weather monitoring efforts in the San Diego Regional Board area of the County under the NPDES permits granted to the Permittees since 1990. This focus reflects the Board's request, in Attachment B.2.a, to address wet weather monitoring findings. *For purposes of this report, "wet weather" is understood to refer specifically to samples collected during storm events.* In addition to these efforts, however, the Permittees have carried out extensive dry weather monitoring over this period, with the goals of:

- Identifying illegal connections and other sources of pollution

- Characterizing the nature of persistent bacterial contamination at certain sites

- Evaluating potential areas for implementation of Best Management Practices (BMPs) and assessing BMP effectiveness.

These and other related dry weather monitoring and assessment efforts are not included in this report, but are described in the additional reports listed in the References section (Section 6.0). Interested readers should see the relevant sections of each Annual Status Report, the 205J study on the Aliso Creek watershed, the series of five quarterly progress reports on studies at Aliso Creek, the series of ten quarterly progress reports related to the clean up and abatement order on stormdrain J03P02, and the report by the County Health Care Agency on the bacterial source identification study on San Juan Creek.

Section 3.0:

- Explains the Permittees' approach to the design and implementation of receiving waters monitoring

- States explicit monitoring objectives

- Describes the features of four main elements of the new receiving waters monitoring program

- States how monitoring information will be used in decision making

- Summarizes recommendations for future monitoring.

Section 3.0 reviews monitoring program elements, e.g., coastal storm drain monitoring, that will be implemented in both wet and dry weather. In that sense, the focus of this section is broader than that of Section 2.0. However, Section 3.0 does not include the dry weather reconnaissance monitoring program element, which will be described in a subsequent report due February 13, 2003.

The detailed structure of the report, and its compliance with the detailed requests in Permit Attachments B.2.a and B.2.b, are shown in **Table 1-1**.

Table 1-1 Report Sections and Reporting Requirements

Permit Requirement	**Report Section**	*Page*
B.2.a.1 Summarize cumulative findings of wet weather monitoring	2.4.2 Analysis Results	
B.2.a.2 Identify detectable trends in water quality data and receiving water quality	2.4.2 Analysis Results Patterns and Trends in channels Patterns and Trends in Dana Point Harbor Discussion	
B.2.a.3 Interpret cumulative findings	2.4.2 Analysis Results Patterns and Trends in channels Patterns and Trends in Dana Point Harbor Discussion	
B.2.a.4 Describe design and methods in 99-04 plan	2.2 Second Term Permit Monitoring Objectives and Design Methods Detail	
B.2.a.5 Describe how CARs and warm spots identified and how they will be addressed in monitoring program	2.2 Second Term Permit Monitoring Objectives and Design 3.0 Recommendations for Future Monitoring	
B.2.a.6 Draw conclusions from cumulative findings	2.4.2 Analysis Results Patterns and Trends in channels Patterns and Trends in Dana Point Harbor Discussion	
B.2.a.7 Describe how monitoring findings have been used in implementing the 1993 DAMP	2.4.3 Uses of Monitoring Results	
B.2.a. 8 Describe how monitoring data will be used to help implement Urban Runoff Management Plans	3.7 How Monitoring Data Will be Used in Urban Runoff Management Plans	
B.2.a 9 Recommend future monitoring, including detailed design specifics	3.0 Recommendations for Future Monitoring	
B.2.a 10 Include Executive Summary, Introduction, Conclusion, and Summary of Recommendations	Executive Summary 1.0 Introduction 4.0 Conclusion 3.8 Summary of recommendations	
B.2.b.8.a Urban stream bioassessment	3.3.1 Urban Stream Bioassessment	
B.2.b.8.b Long-term mass loading	3.3.2 Long-Term Mass Loading	
B.2.b.8.c Coastal storm drain outfalls	3.3.3 Coastal Storm Drain Outfalls	
B.2.b.8.d Ambient coastal receiving waters	3.3.4 Ambient Coastal Receiving Waters	

1.3 Permit and Monitoring Background

Passage of an amendment to the Clean Water Act in 1987, the Water Quality Act, brought stormwater discharges into the NPDES Program and subsequent EPA regulations required municipal NPDES Permit applicants to develop a management program to effectively address the requirements of the Act.

In response to these regulations, the County of Orange (the Principal Permittee), the Orange County Flood Control District and incorporated cities (all three collectively referred to as Permittees) obtained NPDES Stormwater Permits No. CA 8000180 and No. CA 0108740 (subsequently referred to as the First Term Permits) from the Santa Ana and San Diego Regional Water Quality Control Boards. In 1996, the First Term Permits were replaced by Permits Nos. CAS0108740 and CAS618030 (subsequently referred to as the Second Term Permits).

In response to the First Term Permits, the Permittees developed and implemented a water quality monitoring program that focused on:

- Resolving problems with field sampling and laboratory analysis methods related to program startup
- Estimating pollutant loads in urban stormwater runoff
- Searching for sources of pollutants
- Tracking compliance with water quality objectives
- Addressing impacts on areas of special concern.

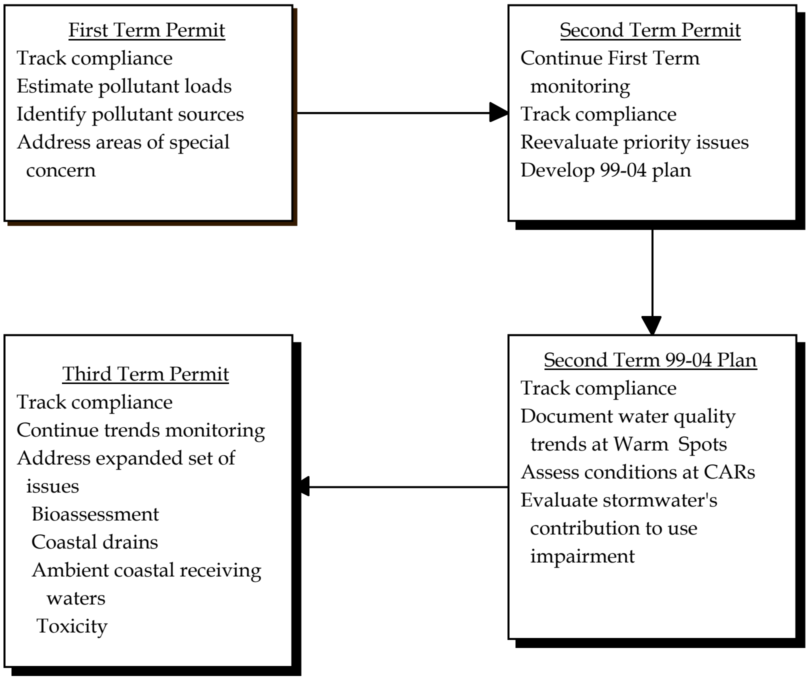
Monitoring under the Second Term Permits initially included some refinement of sampling and analysis methods. It also included a two-year reevaluation of priority issues facing the Program while the First Term monitoring plan was carried forward. This ultimately refocused the program on documenting trends in water quality at areas with higher-than-average pollutant levels and determining the contribution, if any, of urban stormwater discharges to the impairment of beneficial uses at high-priority sites. This phase of the program also provided technical information that supported an effective urban stormwater management program intended to reduce any beneficial use impairments determined to be associated with urban stormwater.

The Permittees also initiated several water quality planning efforts, conducted additional water quality evaluations in response to technical requests from the Regional Boards, and participated in various regional research and/or monitoring programs. The combination of these efforts assisted the Permittees in determining the extent and degree of the relationship between urban stormwater runoff and impairment of beneficial uses within the aquatic resources of Orange County.

The overall evolution of the Program's monitoring efforts during this period are illustrated in **Figure 1-1**. Overall, the Program's evolution is characterized by:

- Continued development of a longer-term perspective for tracking trends in key pollutants and at high-priority locations
- A specific focus on problem areas and issues
- Attention to an expanding set of concerns related to stormwater, e.g., bioassessment, ambient coastal receiving waters.

Figure 1-1 Receiving Waters Monitoring Program Evolution



Warm spots refers to sites with pollutant levels that are elevated relative to the long-term County average (see Section 2.2.2 for more detail).
CARs refers to critical aquatic resources, sites with greater beneficial use potential (see Section 2.2.2 for more detail).

2.0 PREVIOUS MONITORING

This section describes past wet weather monitoring conducted under the First and Second Term permits and summarizes the cumulative findings of these efforts.

2.1 First Term Permit Monitoring Under Order No. 90-38

Monitoring under the First Term Permit covered the period from 1990 – 1995.

2.1.1 Objectives and Design

Objectives

The First Term Permit monitoring program stemmed from a set of basic underlying questions about the nature and extent of stormwater flows and the transport and fate of the contaminants they mobilize and convey. These questions reflected the level of knowledge at the time about stormwater impacts and included issues such as:

- What pollutants are most commonly found in urban runoff?

- What are the loads of these pollutants?

- What is the magnitude of illegal connections and discharges to the stormwater system?

While the County had historically monitored flows, concentrations, and loads of certain contaminants at a number of sites in the County, these questions reflected the fact that overall knowledge about stormwater runoff and its impacts remained rather rudimentary. Some of these historical monitoring sites were located in the San Diego region of the County, under the jurisdiction of the San Diego Water Quality Control Board, including:

- Aliso Creek upstream of Pacific Coast Highway (ACJ01)
- San Juan Creek upstream Pacific Coast Highway (SJCL01)
- Trabuco Creek at Del Obispo (TCOL02)
- Oso Creek at Crown Valley Parkway (OSOL03)
- Salt Creek at the beach outlet (SCK01)
- Sulphur Creek upstream of Laguna Niguel Lake (SCBJ03).

Thus, the design of the First Term monitoring program was intended to:

- Continue the existing historical time series of monitoring data
- Expand the type of questions addressed by the Program
- Expand the Program's scope of operations in the southern part of the County.

2.1.1.1 Monitoring Design

Water quality monitoring was performed in natural waterbodies, and in constructed flood control facilities (channels and basins) and the Dana Point Harbor. The monitoring program consisted of the following four elements.

Field Screening

Field screening was performed to detect the presence of illegal discharges or illicit connections. Physical and chemical analyses are conducted in the field; positive tests for contamination are referred on for source identification and possible enforcement action.

Channel Monitoring

Monitoring in channels was conducted with automatic samplers to evaluate the average concentrations of nutrients and heavy metals in dry weather and stormwater discharges. From these average concentrations comparisons to water quality objectives are made. Data from these samplings were also used to compute mass loading of pollutants.

Harbor and Bay Monitoring

Harbor and bay monitoring provided information on the effects of tributary inputs to the Dana Point Harbor, the only such waterbody in the San Diego region of the County.

Sediment quality

Sediment monitoring in earthen channels and in Dana Point Harbor was evaluated prior and subsequent to the storm season to evaluate pollutant deposition through sedimentation or removal by scouring.

Sampling Sites

Sampling sites and types and for each category of sampling are illustrated in **Figure 2-1**.

In addition to these site-specific monitoring activities, needed background data on precipitation and streamflow data were obtained through the County's ALERT (Automated Local Evaluation in Real Time) flood detection system. This is a network of precipitation and water level sensors throughout the County that transmit data on rainfall accumulation or changes in water level to the base station computer at the

Katella yard. The ALERT data are used in deriving rainfall-runoff relationships, mass loading calculations, and evaluating sampling periods relative to rainfall in respective watersheds.

Data Produced

The monitoring program produced data that documented certain stormwater characteristics and impacts (see Section 2.4 for a description of monitoring results). These data also provided the impetus and support for specific management actions, primarily focused on improvements in the monitoring program itself (see Section 2.4.3 for more detail).

2.1.2 Methods Detail

This subsection describes the methods used to accomplish each of the four types of monitoring specified under the permit.

2.1.2.1 Field Screening

Field screening consisted of physical and chemical evaluations on site, conducted during both dry and wet weather. It was designed to be the most comprehensive with respect to numbers of monitoring sites and area encompassed. Monitoring locations were chosen using watershed drainage area and land uses as primary selection criteria. Those channels designated by the County as “Regional Facilities” (watershed greater than 1 square mile in area) were chosen if the land uses in the watershed were residential, commercial, light industrial as opposed to open space or undeveloped areas). “Local Facilities” (watersheds less than 1 square mile) were also selected if the corresponding land use was primarily commercial or industrial. The overall distribution of sites in the San Diego region of the County is shown below in **Table 2-1**.

Table 2-1 Field Screening Stations in the South County

Channel Name	Facility Number	Sampling Site Location	1994 Thom. Bros. Map Page
Laguna Canyon Channel	I02	at Woodland Ave.	950-H1
Aliso Creek Channel	J01	at Aliso Creek Rd.	951-E1
Aliso Creek Channel	J01	at Pacific Coast Highway	951-B7
Sulphur Creek Channel	J03	at Laguna Niguel Reg. Park	951-F1
Narco Channel	J04	at Laguna Niguel Reg. Park	951-F1
English Canyon Channel	J07	at Los Alisos Blvd.	892-F5
Salt Creek Channel	K01	at Pacific Coast Highway	971-E4
San Juan Creek Channel	L01	at Pacific Coast Highway	972-A6
San Juan Creek Channel	L01	at Ortega Hwy. Bridge/Caspers Park	ix
Trabuco Creek Channel	L02	at Camino Capistrano	952-B5
Trabuco Creek Channel	L02	at Trabuco Creek Rd.	863-E6
Oso Creek Channel	L03	at Crown Valley Pkwy.	922-A7
Oso Creek Channel	L03	at Alicia Pkwy.	892-E5
La Paz Channel	L04	u/s L03 confluence	922-B4
Cascadita Canyon Storm Ch.	M01S01	at Via Cascadita	992-F2
Marquita Storm Channel	M00S07	at Pacific Ocean	992-H5
Prima Deschecha Channel	M01	at Calle Grande Vista	992-E2
Segunda Deschecha Channel	M02	at El Camino Real	992-G3

The annual evaluation of each station included two dry weather samplings, at least four hours apart, and one storm sampling. Measurements types included the following:

- Physical measurements (performed with electroanalytical instruments)
  - electrical conductivity
  - temperature (air and water)
  - pH
  - dissolved oxygen
  - water discharge rate.
- Chemical tests
  - dissolved copper
  - dissolved hexavalent chromium
  - dissolved zinc
  - free cyanide
  - total chlorine
  - phenolic compounds
  - nitrate
  - hardness.
  - chemical oxygen demand.

2.1.2.2 Channel Monitoring

Site Selection

Channel monitoring focused on specific watercourses with beneficial uses identified in the Basin Plan. The land uses upstream of each of these channel locations are generally mixed.

Sampling Frequency

The frequency of channel monitoring was dependent on "Waters of the State" designation. "Waters of the State" are monitored monthly and during storms. Other channels are monitored during storms only. **Table 2-2** summarizes the annual monitoring frequencies.

Sample Collection

Channel monitoring was carried out with automatic samplers consisting of programmable peristaltic pumps which transported water from the channel to a collection reservoir in the sampler base. The collection reservoir was 24 1-liter high density polyethylene bottles. The sampler was programmed to collect time-weighted samples.

The discrete bi-hourly storm samples were time-composited using electrical conductivity measurements. The conductivity of each sample (in order of collection) was measured and a distinct change in conductivity was used to designate the last in the series of samples composited. Stream hydrographs from the ALERT (Automated Local Evaluation in Real Time) System (see Precipitation and Flow Measurements below for more detail) were also used to determine the point at which the set of samples were to be split for analyses. Conductivities tend to immediately decrease during the rise of the storm hydrograph and slowly rise after the recession. Samples were analyzed for:

- pH
- Electrical conductivity
- Turbidity
- Nitrate
- Ammonia
- Total Kjeldahl Nitrogen (TKN)
- Total phosphate
- Total suspended solids (TSS)
- Volatile suspended solids
- Total recoverable copper
- Total recoverable chromium
- Total recoverable lead
- Total recoverable cadmium
- Total recoverable zinc

- Total recoverable silver
- Total recoverable nickel.

Precipitation and Flow Measurements

The County's precipitation and streamgaging network consisted of recording and/or transmitting ALERT (Automated Local Evaluation in Real Time) gages. Mechanical recording raingages were weighing bucket type. Accumulated rainfall was recorded in analog format on drum charts. The ALERT precipitation gages are tipping bucket type with dataloggers. Data were recorded and transmitted in digital format; sensitivity was 1 mm (0.04 inches) of accumulated rainfall.

The County used several types of streamgages to monitor changes in water level. The oldest design was the stilling well with water level float; the newer types were manometer gages (mercury or aircraft bellows) or pressure transducers. Data (water level versus time) were recorded on stripcharts. The ALERT interface to these gages consisted of a connection from the recorder chart drive to an ALERT shaft encoder. ALERT information was recorded on a datalogger and transmitted to the County's Katella yard base station in digital format. Sensitivity of the transmitted and recorded ALERT record was user-variable with the greatest sensitivity being a change in water level of 0.01 foot.

2.1.2.3 Harbor/Bay Monitoring

Sites within Dana Point Harbor were chosen based on (1) proximity of major tributaries (or storm drain) inputs, (2) location of commercial boat maintenance operations, and (3) areas of ecological significance. Other stations were selected to evaluate the influence of runoff during storms.

Monitoring was conducted semiannually and during storms in Dana Point Harbor. The semiannual monitoring included sampling for nutrients in the water column, and trace metals and organics in the sediments. Storm monitoring consisted of surface water sampling for nutrient and heavy metal concentrations and depth-integrated sampling to evaluate the magnitude of heavy metal contamination of the water column. Each storm monitoring spanned a four-day period consisting of three site visits two days apart. **Table 2-3** shows the monitoring frequencies for stations in Dana Point Harbor.

2.1.2.4 Sediment Sampling

Sediment sampling was conducted semiannually from the channels designated as "Waters of the State" and several locations in the harbors and bays to evaluate concentrations of:

- Copper
- Chromium
- Cadmium
- Lead

- Zinc
- Silver
- Nickel
- Pesticides
- Herbicides
- Polychlorinated biphenyls (PCBs)
- Polynuclear aromatic hydrocarbons (PAHs).

Table 2-3 shows the monitoring frequencies for sediment monitoring.

2.1.2.5 Summary

Although weather and equipment problems prevented every proposed sampling from being completed, the efficiency (number of successful attempts) of sampling increased with each year of the permit. The most progress at overcoming operation problems was shown in the channel monitoring program. During the first season, most of the successful samplings were made in concrete-lined channels with low stream velocities. The earthen or sandy bottomed channels were prone to sampler tubing blockage and the high velocity channels were prone to strainer or strainer tubing loss. Station relocation, optimization of strainer placement and installation of tubing anchors increased effectiveness of sampling at these problem stations.

2.2 Second Term Permit Monitoring Under Order No. 96-03

Monitoring under the Second Term Permit (No. CAS0108740 from the San Diego Regional Water Quality Control Board) covered the period from 1996 – 2002. Monitoring from 1996 to 1999 continued the design and methods used in the First Term Permit period. During 1997 and 1998, the program began a transition to a revised structure based on a July 15, 1997 report and subsequent submittals. A final report outlining the revisions to the 1991-97 monitoring program was submitted to the Regional Board in May of 1999. The final transition to the 1999-2004 Monitoring Program was initiated at that time, with some elements of the revised program being implemented during the 98/99 monitoring year and the remaining elements during the 99/00 season.

2.2.1 Objectives and Design

2.2.1.1 Objectives

The evolution of knowledge about stormwater processes and impacts, stemming in large part from the results of the First Term monitoring program, led to more sophisticated questions about stormwater-related processes and to a restatement of the underlying goals of the Program, which were to:

- Determine the role, if any, of urban stormwater discharges to the impairment of beneficial uses, and

- Provide technical information to support an effective urban stormwater management program to reduce the beneficial use impairments determined to be associated with urban stormwater.

Addressing these objectives involved continuing to implement the First Term monitoring design during the period (1966 – 1999) when the program design was being reevaluated and revised. Thus, sampling stations (**Figure 2-1)** and methods remained the same, with the exceptions noted below in the description of methods; Section 2.2.2 Methods Detail).

2.2.1.2 Development of the Revised (99-04) Second Term Plan

In order to organize the vast array of monitoring activities needed to carry out the objectives stated above, the Permittees identified three separate key elements of a monitoring program, which were:

- A focus on known sites (or "warm spots") where constituents are substantially above system-wide averages
- A parallel (and somewhat overlapping) focus on areas of critical aquatic concern (termed "critical aquatic resources" or "CARs")
- A countywide reconnaissance program to identify specific sources of contamination from sub-watershed areas as well as specific land use investigations in order to evaluate the effectiveness of a variety of BMPs.

This approach differs from previous monitoring in the county because it focuses attention on waterbodies or watersheds that have been assessed as important aquatic resources or have shown some elevated constituent levels which may be attributable to stormwater

.

The revised Second Term monitoring plan, referred to as the 99-04 plan, and subsequent elements utilized a five-year timeline (1998/99 – 2002/03) for addressing the goals and objectives associated with each task. This timeline reflects the dynamic nature of the monitoring program and the fact that many of the objectives will require a substantial investment of resources before they are finalized.

Warm Spots

The monitoring objective for this segment of the program was to detect changes in the levels of the identified constituents of concern over the long term.

Warm spots were identified using two analysis methods. The first used the system-wide arithmetic average for each constituent of all data points across all sites and times. All site averages that were more than two standard deviations above this system-wide average were flagged for consideration. The second method used the same site averages to generate box plots. All site averages that were more than three interquartile ranges above the upper quartile of the distribution of site averages were then flagged for further examination. After further analysis for outliers and evaluation of other data related to each site, a set of 12 sites was selected for monitoring. Of these, three were in the southern region of the County (**Table 2-4**). It should be noted that no distinction was made between the northern and southern portions of the County when selecting warm spots; data from all historical monitoring sites was placed in a common dataset for evaluation. Of the 31 channel and 14 harbor locations evaluated, ten of the channels and four of the harbor locations were in the San Diego Regional Board area of the County.

Because of the availability of a time series of historical data for the constituents of concern at most sites, monitoring frequencies were based on power analyses that estimated the number of years sampling should continue and the number of samples within each year required to detect meaningful amounts of change (**Table 2-4**).

Critical Aquatic Resources (CARs)

Critical aquatic resources, or CARs, were selected from a compilation of important water-related resources in the County. A large number of candidate sites were prioritized using a set of criteria that encompassed issues related to both habitat value and human use. As shown in **Table 2-5**, candidate sites were grouped into three categories, enclosed bays and estuaries, coastal resources, and inland surface waters. Scoring each potential site across the range of criteria resulted in the final set of priority critical aquatic resources (CARs) (**Table 2-6**).

A preliminary impact assessment identified the beneficial use(s) associated with each critical aquatic resource (CAR), the indicators of probable impact on each use, the constituents of concern, and the sources of these constituents. Recognizing that a full impact assessment of the critical aquatic resources (CARs) was beyond the scope of the stormwater monitoring program, the May 1999 report also identified data on each critical aquatic resource (CAR) that were available from other sources (e.g., focused research efforts, other monitoring programs). It was envisioned that the program's role, in addition to monitoring basic parameters in the priority critical aquatic resources (CARs), would be to acquire and integrate relevant data from these other sources.

Because of the level of effort involved in fully examining the issues associated with each critical aquatic resource (CAR), the program is addressing them in priority order, according to the schedule shown in **Figure 2-2**, with a subset of new critical aquatic resources (CARs) being rotated into the monitoring program each year. A baseline monitoring program is being maintained for the higher-priority critical aquatic resources (CARs) until they are selected for more intensive and focused studies in the future. This baseline monitoring is the routine monitoring carried out at these sites under other elements of the Program.

Reconnaissance and Source Identification

Reconnaissance and source identification elements of the program focused on identifying problems and contaminant sources through a series of targeted reconnaissance studies and special investigations. This effort was intended to:

- Help determine the sources of pollutants impacting warm spots and critical aquatic resources (CARs)
- Monitor intermittent illegal discharges
- Assess the effectiveness of certain best management practices (BMPs).

In each case, this aspect of the program was designed to incorporate a flexible, adaptive response to information developed through other aspects of the monitoring program. Monitoring activities were intended to be targeted, relatively short-term efforts that would move through a priority list of specific problems.

The initial priority list of warm spots and critical aquatic resources (CARs) in the San Diego Regional Board area of the County identified for source identification studies is shown in **Table 2-7**. Of these, Aliso Creek was addressed in special studies designed to identify the source(s) of elevated bacterial indicator levels, and the elevated total dissolved solids (TDS) at Prima and Segunda Deschecha in dry weather was addressed in a special study carried out during the 2000 / 01 season. Investigation of the source(s) of elevated metals at Prima Deschecha (downstream of a landfill) in wet weather were carried out in 2002 and are continuing.

In addition to the priority list of warm spots and critical aquatic resources (CARs), the countywide Pollution, Notification, Investigation, and Response (PNIR) database was interrogated to identify channels or drainage areas that had high incidences of water pollution activity during the period from 1991 through 1998. This led to a second priority list for reconnaissance and source evaluation studies of sites that:

- Included channel reaches impacted by pollutants three or more times from January 1991 – April 1999
- Sites impacted 10 or more times in the same period, regardless of whether material reached the stormdrain system.

However, only one of these high-priority reconnaissance sites occurred in the San Diego Regional Board area of the County. This was in Lake Forest as a result of a series of discharges from Orange Avenue affecting the outlet of J01P05.

Sampling Sites

Figure 2-3 shows the location of warm spot, critical aquatic resource (CAR), and Reconnaissance sites in the San Diego Regional Board area of the County.

2.2.2 Methods Detail

2.2.2.1 Monitoring Approach to Problem and Issue Areas

Addressing the issues related to the identified warm spots, critical aquatic resources (CARs), and high priority sites for additional reconnaissance studies involved three distinct types of monitoring: channel monitoring, harbor/bay monitoring, and sediment monitoring. While these are the same generic monitoring approaches used in the First Term Permit monitoring program, their application to higher-level problem and issue areas in the Second Term (99-04) plan marked a distinct departure from the First Term Permit program. **Figure 2-4** shows how these monitoring approaches are applied to the warm spots, critical aquatic resources (CARs), and Reconnaissance sites in the Second Term plan.

Figure 2-4 Allocation of Monitoring Approaches to Issue Areas

	Channel Monitoring	Harbor/Bay Monitoring	Sediment Monitoring	Special Studies
Warm Spots	X		X	X
CARs	X	X	X	X
Recon Sites	X			X

2.2.2.2 Changes to Sampling and Laboratory Analysis Procedures

Sampling and laboratory analysis methods were consistent with those in the First Term permit, with the following exception.

For channel monitoring during wet weather, the frequency of collection during the first hour of the storm was set at 1 sample/15 minutes. After the fifth sample was collected at the one-hour mark, the collection frequency was decreased to once every 2 hours. The first five samples collected during a storm were composited and represent the first flush. With the measured water hardness, the concentrations of dissolved heavy metals in this sample can be compared to acute toxicity criteria. The remaining bi-hourly storm samples were used to prepare composite samples that are representative of the subsequent parts of the storm.

The samples used to prepare each composite sample were selected using the stage hydrograph or by evaluating the electrical conductivities of the discrete samples. Using the hydrograph from the Principal Permittee's Automated Local Evaluation in Real Time (ALERT) system, samples collected beyond the first flush and representing the storm peak and recession were composited into a single sample. In the absence of a streamgage hydrograph, the conductivity of each sample (in order of collection) was measured. Changes in conductivity usually denote the beginning or end of storm runoff. After the "first flush" of a storm, conductivities tend to immediately decrease during the rise of the storm hydrograph and slowly rise after the recession. Sample appearance (turbidity or fluvial sediment) were also used in the compositing process, since storm samples tend to be more turbid and contain more fluvial sediment.

The frequency of time composite monitoring was dependent on whether the waterbody is designated as a Water of the State. Waters of the State were monitored monthly and during storms. Other waterbodies are monitored during storms only.

2.2.2.3 Implementation of the Second Term Permit (99-04) Monitoring Program

Specifying both monitoring sites and frequencies was a part of the development process of the Second Term Permit (99-04) monitoring program (**Tables 2-5**, **2-8**, **Figure 2-2**). These were adjusted somewhat during 2000 and 2001 based on storm frequency and other constraints, as follows:

- Warm spot sampling frequency
- Dana Point Harbor sampling frequency
- Schedule for addressing other critical aquatic resources (CARs) in the San Diego Regional Board area of the County
- Reconnaissance frequency/schedule.

2.3 Methods of data analysis

A standard set of data analysis methods was developed during the First Term Permit and refined somewhat during the Second Term Permit. This section summarizes the data analysis methods in current use.

2.3.1 Toxicity

Acute and chronic aquatic toxicity criteria from the California Toxics Rule (CTR) were used as guidance to evaluate dissolved metals data collected from storm channels and harbors.

2.3.2 Sediment Quality

Sediment quality criteria from the National Oceanographic and Atmospheric Administration's (NOAA) Effects Range database were used as guidance to evaluate the toxicity of sediments in the harbors and bays. The Southern California Coastal Water Research Project's (SCCWRP) iron normalization procedure was also used evaluate harbor sediment quality relative to statistically predicted anthropogenic amounts of trace metals.

2.3.3 Comparison to Water Quality Guidance

California Water Code Section 13170 authorizes the State Water Resources Control Board (SWRCB) to adopt water quality control plans for waters where standards are required by the Federal Clean Water Act (CWA) and its 1987 amendments, the Water Quality Act (WQA). According to Section 303(c)(2)(B) of the CWA, these plans must contain water quality objectives for priority pollutants that could be reasonably expected to affect the beneficial uses of the waters of the State.

2.2.3.1 The California Toxics Rule (CTR)

On March 2, 2000, the State adopted an implementation plan for the United States Environmental Protection Agency's (USEPA) Rules establishing numeric water quality criteria for priority toxic pollutants (commonly referred to as the California Toxics Rule, or CTR) for the State of California. The California Toxics Rule sets criteria for dissolved heavy metals in freshwater that are based on water hardness and separate criteria for saltwater. The dissolved metals data were compared to the acute and chronic criteria for guidance purposes.

According to the California Toxics Rule , for waters with a hardness of 400 mg/l or less as calcium carbonate, the actual ambient hardness of the surface water shall be used in those equations. For waters with a hardness of over 400 mg/l as calcium carbonate, a hardness of 400 mg/l as calcium carbonate shall be used with a default Water-Effect Ratio (WER) of 1, or the actual hardness of the ambient surface water shall be used with a Water-Effect Ratio. For this program the former method was used.

In applying the California Toxics Rule criteria to freshwater, if the time period to which the guidance applies is less than the length of the sampled period, a measured concentration greater than that guidance value will constitute an exceedance. For example, if the 1-hour guidance for lead (at a hardness of 100 mg/L as $CaCO_3$) is 65 μg/L, a concentration of 68 μg/L during a 24-hour period will be considered an exceedance of the guidance criterion.

2.2.3.2 Treatment of Samples Below the Detection Limit

In computing the mean concentration during a sampled period with multiple composite samples, values below the detection limit were assumed to be zero. This assumption allows for a more consistent evaluation from year to year as detection limits are lowered with alternative methods of analysis or new technology. The assumption also gives greater confidence to a designation of an exceedance of a guidance criterion as it reduces the likelihood that the exceedance was caused by an erroneous estimation of a non-detected value.

2.2.3.3 Saltwater Samples

With respect to the saltwater guidance from the California Toxics Rule, the average concentrations of dissolved metals in depth-integrated samplings from each 4-day storm monitoring of the Harbors and Bays were compared to the 4-day guidance criteria. The dissolved metals concentrations in each grab sample were compared to the 1-hr acute toxicity guidance criteria. There is no chronic guidance criterion for silver so only the acute criterion was used. Since total chromium was analyzed only the chromium III criteria were used.

2.3.4 Mass Load Calculations

Mass loads were calculated using chemical and hydrographic data. Water level records from streamgaging stations at or near the sampling site were processed using Western Hydrologic Software. Water levels from the station's continuous stripchart recorder were digitized and converted to discharge rates using stage-discharge relationships (channel ratings). The digitized streamflow record was converted to ASCII format and imported to a Microsoft Excel file. The total discharge in acre-feet during each sampled period was then computed. By multiplying the total water discharge per sampled period by the pollutant concentration of the composite sample from the period and applying the proper conversion factors (acre-feet to lbs. of water), a mass load in pounds or tons of contaminant was calculated. For data reported as ND (non-detected), one-half of reported laboratory detection limits were used in the calculations.

2.3.5 Event mean concentrations (EMCs)

Event mean pollutant concentrations were calculated to produce a site mean event mean concentration (EMC) that could be used in the estimation of the mass loads from unsampled storms. To calculate the event mean concentration (EMC) of a monitored storm the sum of the mass load from each composite sampling during a storm was divided by the total sampled volume of water during the same period. After applying the appropriate conversion factors, an event mean concentration in mg/L or μg/L was calculated. The site mean event mean concentrations (EMCs) were updated each year with the event mean concentration (EMC) data from that year.

2.3.6 Statistical methods

Site mean event mean concentrations (EMCs) were used to estimate mass loads from unsampled storms. To estimate these mass loads, the site mean event mean concentration (EMC) for a stormwater contaminant from a particular station was multiplied by the total annual volume of water discharged during unsampled storms, and the appropriate conversion factors. The site mean event mean concentration (EMC) was calculated from the set of calculated event mean concentrations (EMCs) from each sampled storm from the beginning of the NPDES program. Only event mean concentrations (EMCs) in which the 75-120% of the total storm runoff volume was sampled were used in the calculation. Each year the site means were updated with the data from that year.

The distribution of each event mean concentration (EMC) dataset was first evaluated for normality using the W Test developed by Shapiro and Wilk (1965). The W statistic was compared to a tabled value for a given value of α. To calculate W, the data from each station was first ordered from smallest to largest to obtain the sample order statistics $x_1 \leq x_2 \ldots \leq x_n$. k was then calculated from n where:

$$k = \frac{n}{2} \text{ if n is even or}$$

$$k = \frac{n-1}{2} \text{ if n is odd}$$

$$W = \frac{1}{d}\left[\sum_{i=1}^{k} a_i\left(x_{(n-i+1)} - x_i\right)\right]^2$$

where $$d = \sum_{i=1}^{n}(x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$$

Values of a_i were found in Table A6[2]. If the calculated W was less than the tabled value at the α (0.05) significance level, the null hypothesis was rejected and the distribution was considered normal. If the distribution was not normal at the α significance level the data was log-transformed and the W test was repeated to test for log-normality. If the distribution was not lognormal, the dataset was inspected for possible outliers. The Dixon test (for $n < 25$) was used to determine if the suspected points were outliers to a normal distribution. The procedure was performed as follows:

The dataset was ordered from smallest to largest that is $X_1 < X_2 < X_3 < \ldots X_n$. The Dixon ratio r, which is a function of n was calculated.

Number of Points	**Ratio Calculated**
n = 3 to 7	r_{10}
n = 8 to 10	r_{11}
n = 11 to 13	r_{21}
n = 14 to 25	r_{22}

Depending on which point was suspected of being the outlier, the ratio was calculated in the following manner:

r	**If X_n is Suspect**	**If X_1 is Suspect**
r_{10}	$(X_n-X_{n-1})/(X_n-X_1)$	$(X_2-X_1)/(X_n-X_1)$
r_{11}	$(X_n-X_{n-1})/(X_n-X_2)$	$(X_2-X_1)/(X_{n-1}-X_1)$
r_{21}	$(X_n-X_{n-2})/(X_n-X_2)$	$(X_3-X_1)/(X_{n-1}-X_1)$
r_{22}	$(X_n-X_{n-2})/X_n-X_3)$	$(X3-X_1)/X_{n-2}-X_1)$

Using Table A.7[3], the calculated ratio was compared to the critical value at a confidence level of 95%. If the calculated value was greater than the tabled value the suspected point was rejected and the distribution was retested to confirm normality.

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[2] Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, p259.

[3] Taylor, John Keenan. Statistical Techniques for Data Analysis, 1990. Lewis Publishers, Inc., p168.

For normal distributions the mean is calculated as the arithmetic mean, that is

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

the confidence limits for the mean of a normal distribution with unknown variance is given by

$$\bar{x} - t_{(1-\alpha/2,n-1)}\frac{s}{\sqrt{n}} \le \mu \le \bar{x} + t_{(1-\alpha/2,n-1)}\frac{s}{\sqrt{n}}$$

where s is the standard deviation of the dataset and $t_{(1-\alpha/2,n-1)}$ is from table A2[4]. Using $\alpha = 0.05$ the upper and lower limits are calculated. The true mean μ will occur outside of this range 5% of the time.

For lognormal distributions the arithmetic mean and standard deviation of the log-transformed data were first computed. The estimate of the mean is given by the minimum variance unbiased estimate μ_l which is defined as

$$\mu_1 = [\exp(\bar{x})]\Psi_n\left(\frac{s^2}{2}\right)$$

where $\Psi_n(t)$ is the infinite series defined by

$$\Psi_n(t) = 1 + \frac{(n+1)t}{n} + \frac{(n+1)^3 t^2}{2!n^2(n+1)} + \frac{(n-1)^5 t^3}{3!n^3(n+1)(n+3)} + \frac{(n-1)^7 t^4}{4!n^4(n+1)(n+3)(n+5)} + \bullet\bullet\bullet$$

$\frac{s^2}{2}$ is substituted for t and values for Ψ_n are calculated using formulas in a Microsoft EXCEL 7.0 spreadsheet.

The lower confidence limit of the mean is given by

$$LL_\alpha = \exp\left(\bar{x} + 0.5s^2 + \frac{sH_\alpha}{\sqrt{n-1}}\right)$$

and the upper limit is given by

$$UL_{1-\alpha} = \exp\left(\bar{x} + 0.5s^2 + \frac{sH_{1-\alpha}}{\sqrt{n-1}}\right)$$

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[4] Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, p255.

The values of H_α and $H_{1-\alpha}$ were found in Table A10 - A13[5]

The sample median of each normal distribution was calculated by first ordering the sample population from smallest to largest.

$$\text{sample median} = x_{(n-1)/2} \qquad \text{if n is odd}$$

$$= \frac{1}{2}\left(x_{(n/2)} + x_{(n+2)/2}\right) \quad \text{if n is even}$$

The true median of a lognormal distribution can be estimated by

$$M_2 = \exp(\overline{x})\Psi_n(t)$$

where $\Psi_n(t)$ is the infinite series described above. In this case the value of $t = -s^2/[2(n-1)]$.

2.3.7 Assessing Anthropogenic Influence in Harbor Sediments

The Southern California Coastal Water Research Project (SCCWRP) database for iron normalization[6] was used to determine the presence of anthropogenic enrichment in sediments collected from Orange County harbors. SCCWRP developed regression equations for the each relationship between a heavy metal and the percentage of iron in sediments collected from non-impacted sites in the Southern California Bight. 99% confidence limits (2 standard deviations) were calculated for each regression equation. Concentrations of heavy metals greater than the upper confidence limits are considered to be the result of anthropogenic enrichment.

2.4 Results of Previous Monitoring

The objective of the analysis of past data presented in this section is to clearly summarize the cumulative spatial and temporal patterns in the available wet weather receiving water monitoring data from the San Diego Regional Board area of the County. As specified in the permit requirement mandating this report, *this analysis focuses on wet weather monitoring*. However, the monitoring conducted to date has included extensive dry weather monitoring and special studies, and the Permittees have implemented numerous BMPs focused on reducing the impacts of dry weather flows. A listing of reports from these and other related studies can be found in the References section. However, it should be noted that the monitoring program's primary focus, especially for dry weather issues, has been in the northern, more urbanized, portion of the County.

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[5] Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, pp264-265.

[6] Southern California Coastal Water Research Project. Annual Report,1996. Southern California Coastal Water Research Project Authority, pp68-76.

Wet weather monitoring results have been summarized in the two Reports of Waste Discharge (ROWD), produced in 1994 and 2000. These reports necessarily focus primarily on patterns that are more restricted in space and particularly in time and key findings are incorporated into the cumulative analysis presented below in the subsections entitled Patterns and Trends in Channels and Patterns and Trends at Dana Point Harbor. The subsection of 2.4.2 entitled Discussion provides an overview of these results and Section 2.4.3 summarizes how monitoring findings have enhanced basic understanding of stormwater processes and related water quality issues and have been used to improve monitoring methods and designs.

The charge to perform a "cumulative" analysis implies that there is more to be learned from examining the entire collection of monitoring data from 1991 through 2001 than is possible from analyzing smaller subsets, as was done in the Annual Reports and the periodic Reports of Waste Discharge (ROWD). Despite its apparent length, however, there are three aspects of this 12-year data set that limit our ability to search for temporal trends over the longer term and spatial patterns over the entire San Diego Regional Board area of the County. These are described here and also form the basis for recommendations about future monitoring contained in Section 3.5.

- First, some questions that motivated monitoring in the past may not produce data that lend themselves to cumulative analyses. For example, earlier phases of the Program concentrated on rotating sampling among individual watersheds in order to develop more complete characterizations of these areas. Though it produced valuable data, such a sampling pattern does not support consistent comparisons among the range of watersheds over time. Thus, data gathered to address previous questions of concern, while valid, do not necessarily lend themselves to addressing questions about long-term trends and/or widespread spatial patterns. Simultaneous sampling across all watersheds, repeated over a number of years, would be required for such an analysis.

- Second, changes in measurement and sample analysis techniques can create discontinuities that hamper comparisons over time. For example, detection limits for some chemical species have decreased significantly since 1990. This could yield a determination of an increasing trend as 0 values (used in past Annual Reports in some analyses for measurements below the detection limit[7]) were replaced by valid measurements greater than 0. In another example, the second-term permit

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[7] The Program used zero as the default value for measurements below the detection limit when comparing the data to water quality standards in past annual reports, because its goal was to identify the areas with the worst problems. If exceedances were found even when using zero as the default value, then it was fairly certain that exceedances were indicating a true problem. This strategy was adopted in the Program's early years in part because detection limits were so high that widespread exceedances would have been found, even where they did not exist, hampering the Program's ability to identify higher-priority areas of potential concern. This is much less of an issue now because detection limits have markedly improved. In contrast to the approach used when evaluating compliance, the Program used a default value of half the detection limit for generating the EMCs for calculating loads.

monitoring program improved measurement of the first flush by compositing five separate samples collected during the first hour of monitored storms. However, it is difficult to create a reliable trend of first-flush measurements extending back to 1990 because the first composite sample in these earlier years could encompass several hours.

- Third, changes in the monitoring program design from time to time mean that monitoring may be initiated at new sites and discontinued at old sites, new types of measurements may be added to the Program, or new questions asked. While they may in fact be improvements to the Program, all such changes reduce the ability to conduct a long-term, spatially broad analysis of cumulative results.

These constraints make it clear that the ability to perform long-term cumulative analyses depends on repeated measurements, using consistent methods, carried out simultaneously at a number of sites. The core monitoring component proposed in the model stormwater monitoring program currently under development by the Stormwater Monitoring Coalition (SMC) would provide this capability without sacrificing the ability to perform flexible special studies as needed (see Section 3.5 for further discussion).

2.4.1 Analysis methods

The cumulative analyses of past monitoring data attempted to answer two straightforward questions:

- Are there apparent trends over time in constituent levels at individual monitoring sites?

- Are there consistent differences in constituent levels among monitoring sites?

The answers to these questions help to:

- Evaluate changes in background conditions

- Better understand relationships between receiving water quality and watershed characteristics

- Evaluate the ultimate effectiveness of BMPs.

The two basic questions, addressed in Section 2.4.2, are evaluated with simple graphical displays that reveal patterns and trends in the San Diego Regional Board area of the County. *Many of the graphs and plots do not reveal meaningful trends or patterns for one or more of the reasons described above. Those graphs and plots that do portray meaningful results are explicitly mentioned in the text.*

2.4.1.1 Parameters Used in the Cumulative Analyses

Table 2-8 summarizes the measurements included in the analyses. Analyses of channel monitoring data focused on measurements taken early in monitored storms, on the assumption that the "first flush" generally has higher pollutant levels and thus represents the worst case for trend detection. "First flush" data indicated in **Table 2-8** are from composite samples from the first hour of monitored storms, while "first measurement" data are from the first composite sample during monitored storms, even though such samples may extend over several hours.

2.4.1.2 Values Below the Detection Limit

Parameter measurements that were below the analytical detection limit were replaced with a value of either half the stated detection limit or half the lowest valid value below the detection limit[8]. This was necessary because the log transformation, which preliminary analysis indicated was the most appropriate for displaying the data, does not readily accommodate a high proportion of zero values, which occurs for several parameters. In addition, some parameters whose data values consisted primarily of non-detects, or with widely varying detection limits, were dropped from the analysis.

2.4.1.3 Spatial Patterns

Spatial patterns were examined with Box and Whisker plots (Tukey, 1977, Venables and Ripley, 1999), which compare the distributions of data values at the different sampling locations (see example below). The "box" of the plot shows the extent of the 25th and 75th percentiles of the data, called the inter-quartile range, or IQ R, and the median is represented by the solid line within the box. The "whiskers" extend vertically to the extremes of the data, with very extreme values shown by an isolated line. By convention, values greater than three times the size of the box away from the box are considered very extreme.

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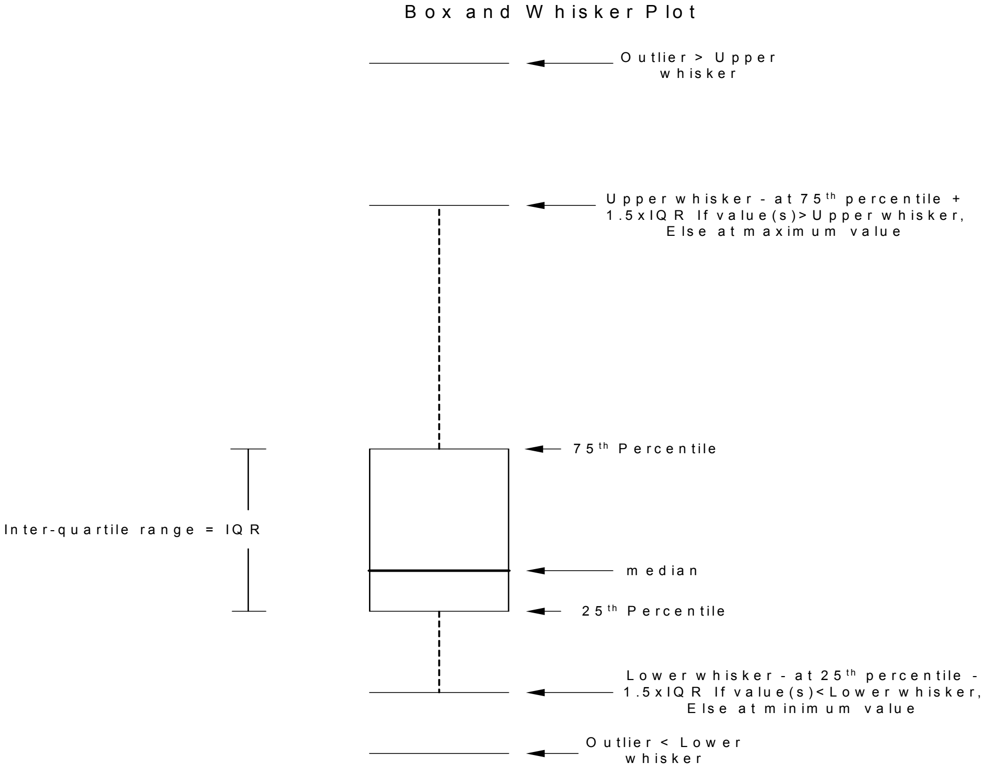
[8] Because the actual detection limit can increase or decrease from one test to another, valid values may sometimes occur that are below the stated detection limit.

Figure 2-5 Example Box and Whisker Plot



2.4.1.4 Temporal Patterns

Temporal patterns were examined with simple bivariate plots. For the first flush and first measurement water measurements, the data within a water year (October to May) were connected with a line to show trend within the water year. For the sediment data, the before-wet season data points are connected with a line, and similarly, the after-wet season data are connected with a separate line. Except for parameters expressed in units of percent, the vertical axes of the plots are on a log scale. While there are no established regulatory criteria for sediment contamination in freshwater, we have used the effects based sediment quality guidelines described in State of Wisconsin Department of Natural Resources (2002). Monitored values in channels that exceeded the PEC, or Probable Effect Concentration, are indicated on the plots. For the Dana Point Harbor sediment samples, we used NOAA's ERM, or Effects Range Median, values in a similar way.

2.4.2 Analysis Results

The following subsections present the results of cumulative analyses of channel monitoring data and data from Dana Point Harbor. All channel monitoring data are from either the first measurement (1992 – 1995) or the first flush (i.e., the first hour) (1996 – 2000) of the storm. Data from Dana Point Harbor storm samples are from the first day of the storm. The analysis focused on data from early in monitored storms on the assumption these would represent worst case situations and would also tend to reveal the largest differences among sites and times. As noted above, *many of the graphs and plots do not reveal meaningful trends or patterns. Those graphs and plots that do portray meaningful results are explicitly mentioned in the text.*

2.4.2.1 Patterns and Trends in Channels

Spatial Differences in Nutrients, 1992 – 1995

Figure 2-6 shows overall differences among the eight watersheds (see **Figure 2-1** for a map of the watersheds in this region) in the San Diego Regional Board area of the County for parameters that were consistently monitored during the First Term Permit period (1992 – 1995) and **Table 2-9** describes the sampling pattern for this period. These data indicate that the San Juan Creek Upstream station (SJOL01) had the lowest median values of nitrate, but the second highest values for total phosphate. There was extensive fire damage in the Upper San Juan Creek watershed in late 1993 and this resulted in very high concentrations of total suspended solids and associated total phosphate at station SJOL01 during the 1993-94 storm season. The relatively high median values for phosphate and TSS at this station, and the very high upper extreme values, are due to the fire damage. In contrast, Aliso Creek (ACJ01) and Sulphur Creek (SCDAM) had the lowest median values for total suspended solids and associated total phosphate. The reason for the low suspended solids at Aliso Creek is not readily apparent. However, the Sulphur Creek station is below the dam and few if any particulates come over the top of the dam. It should be noted, however, that these comparisons may not fully or accurately reflect true long-term differences among sites because sampling did not occur at the same time across all sites and the data in **Figure 2-5** only cover a range of a few years.

Temporal Patterns in Nutrients, 1992 – 1995

Figures 2-7, **2-8**, and **2-9** display trends over time at each site for the three primary variables of nitrate (**Figure 2-7**), phosphate (**Figure 2-8**), and total suspended solids (**Figure 2-9**). While it appears, during some years, that levels of these constituents decline through the storm season, other years show an increasing or indeterminate pattern. Overall, the data are too sparse to clearly identify temporal trends.

Spatial Differences in Total Metals, 1996 – 2001

A longer time period of consistently sampled parameters is available for the eight watersheds in the San Diego Regional Board area of the County during the Second Term Permit period from 1996 – 2001. The sampling pattern for this period is shown in **Table 2-10** and **Figure 2-10** illustrate the overall differences among the eight sites for first flush values for *total* cadmium, copper, nickel, lead, and zinc. San Juan Creek (upstream) consistently has lower levels than the other sites, as would be expected since this site was selected as a reference station. Prima (PDCM01) and Segunda Deschecha (SDCM02), and sometimes Laguna Canyon (LCWI02), typically have the highest levels. Previous reports have documented elevated levels of total suspended solids at Prima and Segunda Deschecha and this is related to the higher levels of metals at these stations. In addition, the high levels at Prima Deschecha, particularly for cadmium and nickel, may more specifically be due to the landfill upstream, which may contain NiCad batteries. A similar pattern of elevated metal levels occurs at a similar site in the northern part of the County, which also has a landfill upstream of it. The source of the elevated metals at the Laguna Canyon station is unknown, although there are numerous small businesses along Laguna Canyon Road (which parallels the creek) and there is runoff from their parking lots and work areas. The relatively sparse sampling at Laguna Canyon and the two San Juan Creek stations (see **Table 2-10**) suggests that results from these stations should be considered preliminary.

Temporal Patterns in Total Metals, 1996 – 2001

Figures 2-11 – 2-15 display trends over the 1996 – 2001 period at each site for each metal (total metals). Again, storms early in the season sometimes, but not always, have the highest values, but it should be remembered that the first storm sampled was not always the first storm of the season. There are no readily apparent trends over years in these data and there were no exceedances of the freshwater PEC guidelines.

Spatial Differences in Dissolved Metals, 1996 – 2001

Figure 2-16 summarizes overall differences among the eight sites for first flush values for *dissolved* cadmium, copper, nickel, lead, and zinc. As with the total metals, San Juan Upstream had the lowest values, but San Juan at La Novia (SJNL01) was also low. In addition, values at Prima and Segunda Deschecha were consistently among the highest, which is not surprising, given the fact that total and dissolved values of metals are generally positively correlated.

Temporal Patterns in Dissolved Metals, 1996 – 2001

Figures 2-17 – 21 display trends over the 1996 – 2001 period at each site for the dissolved fraction of each metal. There is an apparent increase in dissolved cadmium levels over time at Aliso Creek and Prima Deschecha (Figure 4.12) and in dissolved nickel at Prima Deschecha (**Figure 2-19**). There is an apparent decrease over time in dissolved copper at Aliso Creek (**Figure 2-18**) and in dissolved zinc at Aliso Creek, Prima Deschecha, and Segunda Deschecha (**Figure 2-21**). Exceedances of the California Toxics Rule guidelines, adjusted for water hardness, occurred only occasionally, for cadmium at Aliso Creek and Prima Deschecha, and for copper at Prima and Segunda Deschecha. There is no readily apparent relationship between these trends and overall rainfall patterns, with normal, below-normal, and above-normal rainfall years interspersed in both increasing and decreasing trends.

Spatial Differences in Sediment Parameters, 1991 – 2000

Figure 2-22 summarizes overall differences among the eight sites for sediment values of four key metals and **Table 2-11** illustrates the sampling pattern for this period, 1991 – 2000. The percent clay and percent silt/clay are included in this figure because of the strong correlation between the levels of clay and those of metals. Prima and Segunda

Deschecha, and Sulphur Creek, displayed the highest median values of cadmium, chromium, and copper, and Sulphur Creek has the highest values for clay and silt/clay.

Figures 2-23 – 31 display trends over the 1991 – 2000 period for sediment concentrations of a range of parameters at each site. Sampling occurred before and after the wet season and these samples are tracked separately on the plots. One working hypothesis is that contaminated sediment accumulates in the channels during the dry season and is flushed out during the rainy season, with the result that pollutant concentrations should tend to be higher in the "before" sample from each year. There is some evidence for this in the plots, e.g., cadmium at Trabuco Creek (TCOL02) (**Figure 2-24**), chromium at Trabuco Creek (**Figure 2-25**), and nickel at Sulphur Creek (**Figure 2-28**), but there are just as many instances in which this pattern does not hold true. Therefore, it is not possible to draw any conclusion about first-flush patterns from these data.

There was an apparent increasing trend at Aliso Creek in chromium (**Figure 2-24**) and zinc (**Figure 2-30**) and at Oso Creek in chromium after the rainy season (**Figure 2-25**) and zinc after the rainy season (**Figure 2-31**). There was also an apparent increasing trend in nickel at the San Juan upstream station (**Figure 2-28**). As with the dissolved metals, there was no apparent relationship between these trends and overall rainfall patterns. Exceedances of the State of Wisconsin's Probable Effect Concentration (PEC) guidelines occurred occasionally, for cadmium at Sulphur Creek above and below the lake, Prima and Segunda Deschecha (**Figure 2-23**), San Juan Upstream (**Figure 2-23**), and Trabuco Creek (**Figure 2-24**), and for nickel at Sulphur Creek above and below the lake, Prima Deschecha, and San Juan at La Novia (**Figure 2-28**).

2.4.2.2 Patterns and Trends in Dana Point Harbor

<u>Spatial Differences in Surface Water, 1993 – 2000</u>

Figure 2-32 shows overall differences among the five Dana Point Harbor monitoring stations for parameters that were consistently monitored in the surface water from 1993 – 2000 and **Table 2-12** describes the sampling pattern for this period. Data in **Figure 2-32** are from the first day's sampling of each storm. This "first flush" data would be expected to show the maximum differences among stations because continued flushing with progressively cleaner water would tend to homogenize values across stations. Although the range of nitrate values is large for all stations, median values of this parameter are much higher at the East Basin, East Channel, and West Basin stations, and very low at the Boatyard station. The Boatyard station is the only one of the five stations that is not near a stormdrain and therefore is much less directly influenced by urban runoff. There are no such apparent patterns for phosphate, and total suspended solids (TSS) are somewhat higher at the Boatyard station. The between-station differences in phosphate and total suspended solids (TSS) are relatively small compared to the between-station differences in nitrate and there is no ready explanation for the phosphate and total suspended solids patterns.

<u>Temporal Patterns in Surface Water, 1993 – 2000</u>

Figures 2-33 – 2-35 display trends over the 1993 – 2000 period for nutrients and total suspended solids. The sporadic nature of the storm sampling makes it difficult to observe longer-term trends, although there does appear to be a decrease in the phosphate peaks after 1994.

Spatial Differences in Sediment, 1992 – 2000

Figure 2-36 shows overall differences among the four Dana Point Harbor monitoring stations for parameters that were consistently monitored in the sediment from 1992 – 2000. The East Channel (DAPTLB) and Boatyard (DAPTLR) stations had the finest sediments, as indicated by their median values of % silt/clay. This is most probably because East Channel and Boatyard stations are the least influenced by stormwater flows, since the East Channel has a smaller stormdrain with lower flow and the Boatyard station has no stormdrain. Areas that are more influenced by stormwater tend to have coarser sediments. However, the higher level of fine sediments at these two stations did not clearly correlate with consistently elevated levels of pollutants, compared to the other stations.

There have been no spills in the harbor that might have been the source(s) of pollutants in the sediment. However, the harbor breakwater is permeable and there is sand input to the harbor from longshore transport southward from Salt Creek, which has been shown to have DDT in its watershed. In addition, during large storms, there is northward transport of fine sediments from the mouth of San Juan Creek. The characteristics of these coastal stormwater plumes will be further investigated during the Third Term Permit monitoring program. Finally, a marked reduction in sedimentation in the harbor since the mid 1990s has been noted by City staff, corresponding to the period when accelerated development reduced the amount of open space subject to erosion.

Temporal Patterns in Sediment, 1991 – 2000

Figures 2-37 – 2-42 display trends over the 1991 – 2000 period for sediment concentrations of a range of parameters at each site and **Table 2-13** shows the sampling pattern for this period. Sampling occurred before and after the wet season and these samples are tracked separately on the plots. As with the channel sediment samples, the “before” samples were not consistently higher than the “after” samples. There is an apparent decrease over time in chromium (**Figure 2-38**), copper (**Figures 2-38** and **2-39**), nickel (**Figure 2-40**), and zinc (**Figures 2-41** and **2-42**). These decreases may be related to decreases in the clay content of the sediment following 1998 (**Figure 2-28**). In addition, all these declines occur predominantly after 1998, which may be related to the fact that El Niño year of 1997 / 98 was the wettest during the 1991 – 2000 time period and the following year, 1998 / 99 was the driest. There were no exceedances of NOAA’s ERM guidelines.

2.4.2.3 Discussion

In addition to the specific findings identified in the preceding two subsections, there are more general conclusions that can be drawn from the monitoring data, including the following:

- There is a close relationship between the amount of total suspended solids (TSS) and the levels of total metals and phosphate in the water
- If there is a high potential for erosion, either from landuse practices, undeveloped areas, or from earthen channels themselves, there will be a correspondingly high probability of elevated TSS and metals and phosphate levels
- Patterns of metals and phosphate loads over time are strongly influenced by the amount of flow and the erosion potential of the surrounding watershed
- Despite these relationships, there is no apparent consistent connection between overall yearly rainfall and the levels (as opposed to the loads) of contaminants in runoff or in the sediments at the channel stations
- While there is a positive correlation between the levels of total and dissolved metals, the bulk of metals is consistently found in the particulate fraction
- Though metals may be at higher levels in the first flush, these waters may not necessarily exceed the California Toxic Rule (CTR) criteria, because of the elevated hardness of first-flush water, which reduces the effective toxicity
- The first flush, however, *may* show more exceedances of the California Toxic Rule (CTR) criteria, because there are no hardness qualifiers for marine toxicity
- While there are apparent increasing or decreasing trends over time for some metals at some stations, it is not clear what may be causing these
- Sediment from nearly every site in Dana Point Harbor was anthropogenically enriched with copper and zinc and, to a somewhat lesser extent, lead, although all values were below NOAA's Effects Range Median (ERM) guidelines
- A reduction in the levels of several metals in Dana Point Harbor sediments after 1998 may be related to the fact that the El Niño year of 1997 / 98 was the wettest of the 1990 – 2000 period and the following year, 1998 /99 was the driest.

The interpretation of larger spatial patterns and longer-term trends is complicated by the fact that the background conditions in the County continue to change over time. Increasing urbanization reduces the potential for land surface erosion but increases the runoff of anthropogenic pollutants and increases flow in channels, thereby leading to greater erosion of earthen channels. Regulatory changes, for example relating to water use practices or the use of certain pesticides, can change the amount and nature of urban runoff. Finally, the greater use of increasingly sophisticated best management practices (BMPs) can reduce the amount of runoff and/or pollutants in runoff over time. These and other changes that are due to human activity are often confounded with natural variability in the spatial and temporal distribution of rainfall. Such variability can cause sometimes large changes in the amount of runoff and in both the concentration and loads of pollutants in that runoff. As a result of these sources of anthropogenic and natural variability, the ability to detect longer-term trends will depend on maintaining a spatially diverse set of stations that are sampled consistently over a long period of time.

2.4.3 Uses of monitoring results

Monitoring results have been used in two primary ways, to improve and adapt the monitoring program itself and as a basis for targeting additional studies and best management practices (BMPs), such as CDS units and increased street sweeping, designed to address specific problems (see the Program's Annual Reports, listed in the References section, for more detail). However, without focused monitoring and evaluation studies on the effectiveness of individual best management practices (BMPS), it can be extremely difficult to establish a causal link between a suite of best management practices (BMPs) and patterns and trends in receiving water conditions. This is the rationale behind the Stormwater Monitoring Coalition's identification of focused best management practices (BMP) evaluation studies as part of its research plan (SCCWRP 2002).

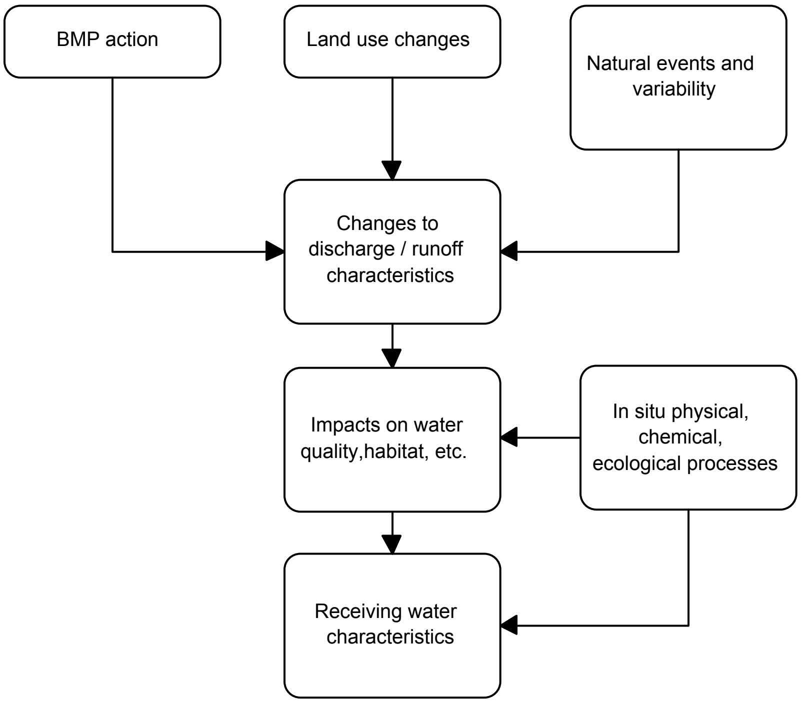
In parallel with the Stormwater Monitoring Coalition (SMC) studies of best management practices (BMPs), the Program and the Permittees use the existing reporting process and management structure to disseminate information about patterns of pollution, identify and discuss possibilities for more focused evaluations, develop collaborative study plans, and encourage the Permittees and other involved parties to implement such evaluations. Thus, the Program's Annual Status Report and reports on special studies, its Public Education component, its various committees and subcommittees, and its other ongoing interactions with the Permittees all provide abundant opportunities to discuss and encourage the development of projects to better evaluate best management practices (BMPs).

2.4.3.1 Improvements to Methods

In terms of the monitoring program, the ongoing evaluation of monitoring results has led to considerable improvement in methods for field measurements and laboratory and data analysis. These changes have steadily enhanced the quality and overall value of the Program's data and findings. For example, with regard to channel monitoring, the Program has learned how to better place the sample strainers in order to prevent their being covered with debris or buried in sediment and has documented that time-weighted sampling is much less problematic than flow weighted sampling, despite flow weighted sampling's theoretical benefits. In addition, detection limits have continued to improve and the Program routinely requires that analytical laboratories ensure that minimum detection limits (MDLs) are below applicable water quality compliance standards and/or California Toxics Rule (CTR) guidelines. In particular, the Program has improved and standardized its compositing approach for first flush samples to enable more precise and consistent sampling of the first flush of monitored storms.

These improvements have enhanced the accuracy and precision of monitoring and will permit patterns and trends in receiving waters to more reliably be documented. However, as the following figure (**Figure 2-43**) illustrates, there is a wide range of anthropogenic and natural processes that interact to create the ultimate receiving water characteristics that are measured by the receiving water monitoring program. Understanding the link between best management practices (BMPs) and receiving water characteristics will therefore require, at a minimum, tightly focused evaluations of the mode of action and effectiveness of such best management practices (BMPs). Thus, while receiving water monitoring is necessary, it is not sufficient to make this linkage.

Figure 2-43 Variety of Influences on Receiving Water Characteristics



2.4.3.2 Improvements to the Program's Approach to Monitoring

In addition, the increased knowledge about stormwater processes and impacts provided by the Program has stimulated significant changes in the Program's overall approach to monitoring (see **Figure 1-1**). This has evolved from an initial focus on describing the basic characteristics of stormwater runoff to a broader concern with describing and assessing stormwater-related impacts and identifying their sources. Thus, the 99-04 plan prioritized warm spots, sites with relatively elevated pollutant levels, for trend monitoring and initiated an assessment program for critical aquatic resources (CARs). It coupled these monitoring elements with a reconnaissance effort designed to discover potential sources of pollutants causing impacts at these two kinds of sites. The identification of warm spot sites, the prioritization of critical aquatic resources (CARs), and the identification of high-priority reconnaissance sites was all dependent on specific findings resulting from past monitoring efforts.

2.4.3.3 The Evolution of the Third Term Permit Monitoring Program

This evolution has continued with the third-term permit monitoring program described below (Section 3.0). It expands the measurement of impacts to include direct measures of ecological communities with a bioassessment element and utilizes a "triad" approach to combine these bioassessment results with simultaneous measures of chemical constituents and toxicity. The new program also covers the full range of areas affected by stormwater runoff by developing a new element to monitor stormwater plumes in the nearshore marine environment. In addition, the Program has responded to monitoring data on bacterial contamination along the shoreline with a program element that targets all coastal stormdrains meeting a specific set of selection criteria. Finally, monitoring results to date have helped make it clear that there are certain problems and questions that cannot effectively be addressed by the Program alone. As a result, the Program has become actively involved in the periodic Bight studies and in the Stormwater Monitoring Coalition (SMC).

2.4.3.4 Influence on the DAMP and BMP Studies

Monitoring results have also prompted modifications to the Drainage Area Management Plan (DAMP) and the implementation of additional studies and best management practices (BMPs) designed to address specific problems. The bulk of the effort devoted to best management practices (BMPs) has focused on dry weather conditions, where flows are more manageable and improvements are easier to achieve. These efforts are reviewed and summarized in the Program's Annual Reports listed in the References (Section 6.0).

The most significant example of focused effort on a specific problem is the suite of studies carried out on Aliso Creek in an attempt to identify sources of consistently elevated bacterial levels. Concerns about Aliso Creek stemmed from earlier monitoring data and the results of the 1998 205(j) planning study on Aliso Creek. The difficulties encountered in these studies in identifying the sources of bacterial contamination in the creek have helped prompt the Program's active support of the Stormwater Monitoring Coalition's project to evaluate improved methods for microbiological source identification as well as of regional monitoring of shoreline bacterial contamination conducted through the periodic Bight Study. Specific best management practices implemented in the Aliso Creek system include:

- The Munger Stormdrain infiltration device
- The Dairy Fork Biofiltration Basin
- The installation by Laguna Niguel of the Clear Creek filtration system with purification process on drain J03P02

- The wetlands capture and treatment (WetCAT) project on drain J03P02.

In addition to the relatively large effort on Aliso Creek, other best management practices (BMP) initiatives include the following:

- The County is working with the City of Aliso Viejo on improvements to the J01P28 drain
- The City of San Clemente is in the process of installing a diversion system on Prima Deschecha Channel to address elevated levels of bacterial indicators
- The County has evaluated the effectiveness of the Sulphur Creek Reservoir to reduce heavy metals, total suspended solids, and bacteria
- The City of Laguna Beach has begun an effort to divert to its sanitary sewer system all stormwater flow that would otherwise reach the shoreline
- The City of Dana Point has installed many catch basin inserts to absorb petroleum hydrocarbons in urban runoff.

Additional information on these and other efforts to implement best management practices (BMPs) is contained in the Program's most recent annual report and the other reports cited in the References section (Section 6.0).

3.0 RECOMMENDATIONS FOR FUTURE MONITORING

The Permittees' Receiving Waters Monitoring Program under Order No. R9-2002-0001 consists of four main elements:

- Urban stream bioassessment monitoring
- Long-term mass loading monitoring
- Coastal storm drain outfall monitoring
- Ambient coastal receiving water monitoring.

(The design for an additional program element, dry weather reconnaissance monitoring, is scheduled to be completed in February 2003.)

Each of these addresses a different aspect of characterizing urban stormwater runoff and its impact on the environment. The long-term mass loading and coastal storm drain outfall monitoring elements build on previous efforts in the First and Second Term Permit periods, while the bioassessment and ambient coastal receiving water monitoring elements are new. In addition, some of these elements, e.g., bioassessment, coastal storm drain outfalls, will be implemented in both wet and dry weather. The following sections describe the Permittees' overall approach to implementing these elements, relate them to the permit objectives, and describe their measurement and data analysis designs.

One recommendation we emphasize here relates to the mandated reporting period. We request that the reporting period be adjusted to July 1 to June 30 of the following year. This will allow the time needed to process the raw data so that it will be available in September in time to prepare the Annual Report by the November 15 deadline. If the reporting year ended on September 30, as currently specified, there would be insufficient time to process the raw data and still meet the November 15 due date.

It is important to recognize that the Permittees' overall Stormwater Management Program includes a wide range of elements that involve activities such as public education, inspections, and a variety of best management practices (BMPs). The Receiving Waters Monitoring Program described in this section will provide important feedback on the ultimate effects of such actions on receiving water quality. Combined with special studies and focused BMP evaluations, the Receiving Waters Monitoring Program will enhance the Program's ability to continually adapt its management approach as knowledge improves.

3.1 Approach to monitoring design and implementation

The Permittees' approach to the development of the Receiving Waters Monitoring Program is based on several widely recognized and fundamental principles of monitoring design. Monitoring should be:

- Focused on specific, answerable questions that are relevant to management concerns
- Based on the most current scientific and technological understanding
- Cost effective and statistically efficient
- Designed with adaptive feedback mechanisms that allow for appropriate adjustments to the program.

Continually assessing the four main monitoring program elements against these principles ensures that the program, and the information it produces, remain relevant and effective. In order to help accomplish this, the Permittees have considered each program element in terms of three kinds of monitoring activities, each with different implications for implementation and for the analysis and evaluation of resulting data:

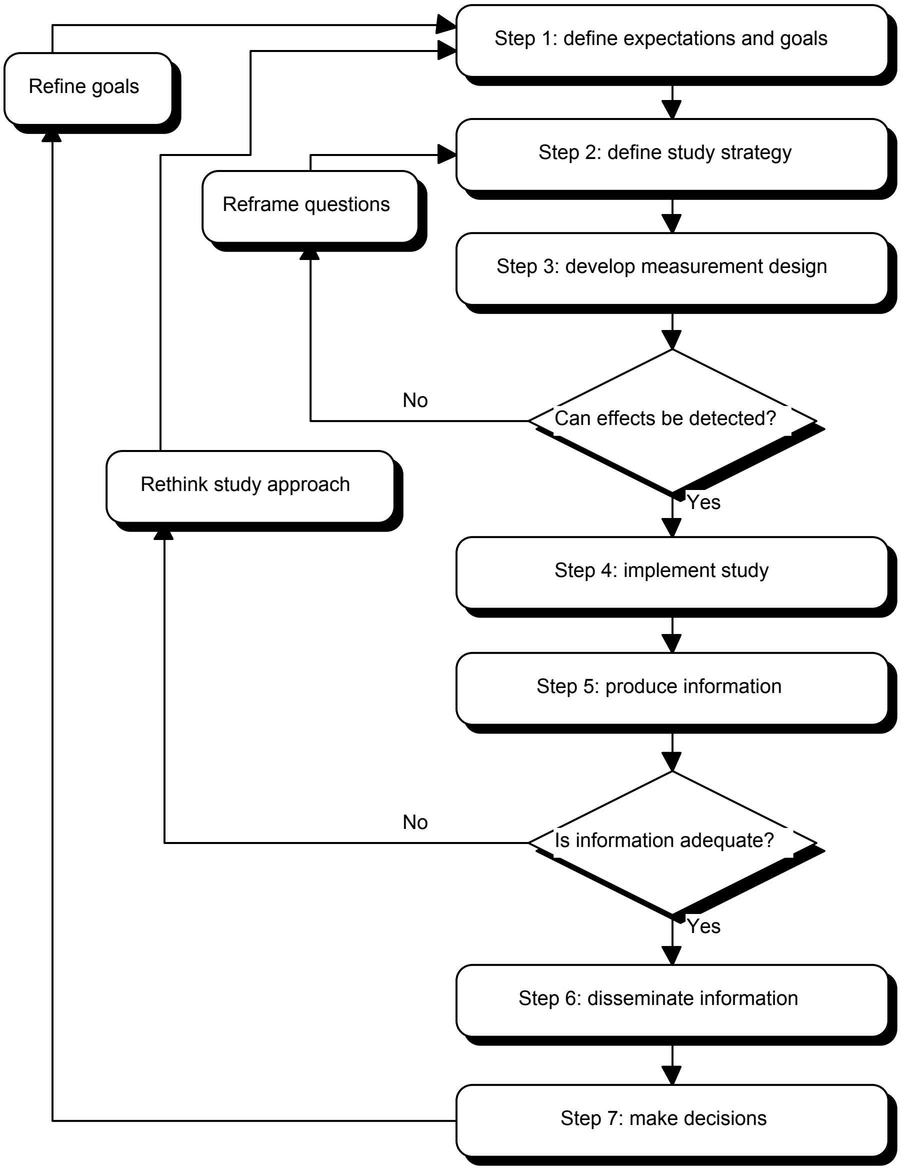
- Core monitoring – routine, ongoing measurements, analyzed with well-defined methods, that address clearly defined questions related to small-scale or site-specific problems and processes
- Regional monitoring – periodic, collaborative, and larger-scale surveys, e.g., the Bight Study carried out through SCCWRP, that use standardized sampling methods to collect a wide range of data across the entire region in both impacted and reference areas. Regional data can be analyzed with a variety of descriptive, hypothesis testing, and pattern analysis methods, as well as with indices designed to place sites on regional pollution or disturbance gradients.
- Special studies – tightly focused and relatively short-term studies, e.g., those carried out through the Stormwater Monitoring Coalition (SMC), often using exploratory data analysis methods, to investigate new measurement methods, improve basic understanding, characterize problems, or provide one-time measurements of important parameters or processes.

This three-part framework, which has been accepted by the Stormwater Monitoring Coalition (SMC) as a template for future program design, will help ensure that the various aspects of each program element utilize appropriate methods for sampling, data analysis, standardization, and flexibility. It will do by helping to adapt the design of specific monitoring studies (e.g., whether a long-term trend monitoring or a shorter-term experimental approach is used, the selection of parameters, the number and location of sites) to the particular questions being asked and/or problems being addressed. **Table 3-1** illustrates how these three monitoring categories were used in organizing more detailed designs for each program element.

Figure 3-1 provides an overall depiction of the role of monitoring information in the Program's decision making. A key aspect of this framework is the set of feedbacks that use information developed during the design and implementation of the monitoring program to refine not only technical study strategies but also more fundamental management expectations and goals.

These feedbacks occur in large part through the Program's existing reporting process and management structure, including the Public Education component. These provide ample opportunities to disseminate information about patterns of pollution and discuss their implications for the Program's objectives.

Figure 3-1 Role of Monitoring in the Program's Decision Making



Adapted from NRC, 1990. Managing Troubled Waters.

3.2 Objectives and Program Overview

The objectives of the Receiving Waters Monitoring Program, as stated in Attachment B.1 of the Third Term Permit, are to:

- Assess compliance
- Measure the effectiveness of Urban Runoff Management Plans

- Assess the chemical, physical, and biological impacts to receiving waters resulting from urban runoff

- Assess the overall health and evaluate long-term trends in receiving water quality.

The monitoring program described in the following sections (see **Table 3-2** for summary overview) meets these objectives (with the proviso, as discussed in Section 2.4.3, that measuring the effectiveness of Urban Runoff Management Plans also requires the implementation of focused evaluations of best management practices (BMPs)) by continuing and expanding the 99-04 plan's emphasis on assessing impacts on aquatic resources, documenting long-term trends in water quality, targeting problematic discharge sites for more focused monitoring, and adding additional monitoring elements. **Table 3-3** briefly summarizes the specific objectives of the four program elements in terms of management goals, monitoring strategies, and other aspects of monitoring program design. **Table 3-3** results in the following more detailed objectives for each program element:

Urban stream bioassessment:	Using a "triad" of indicators (bioassessment, chemistry, toxicity), describe impacts on stream communities and the relationship of any impacts to runoff, based on comparisons with reference locations on a year-to-year time frame.
Long-term mass loading:	Using measurements of key pollutants, loads shall decline over a time frame of years to decades, as compared with past and present levels.
Coastal storm drains:	Using a suite of bacterial indicators at high priority drain outfalls, track compliance with regulatory standards and any improvements due to BMP implementation.
Coastal receiving waters:	Using measure of runoff plume characteristics and extent, as well as measures of a suite of physical, chemical, and biological indicators, improve understanding of the impacts of runoff plumes on nearshore ecosystems.

The monitoring program will reflect the Program's continued evolution toward watershed management. As discussed in the following sections, monitoring sites in the various program elements have been located in specific watersheds, with the goal of improving the ability to understand stormwater processes and manage their impacts in a more functional manner.

3.3 Receiving Waters Monitoring Program Elements

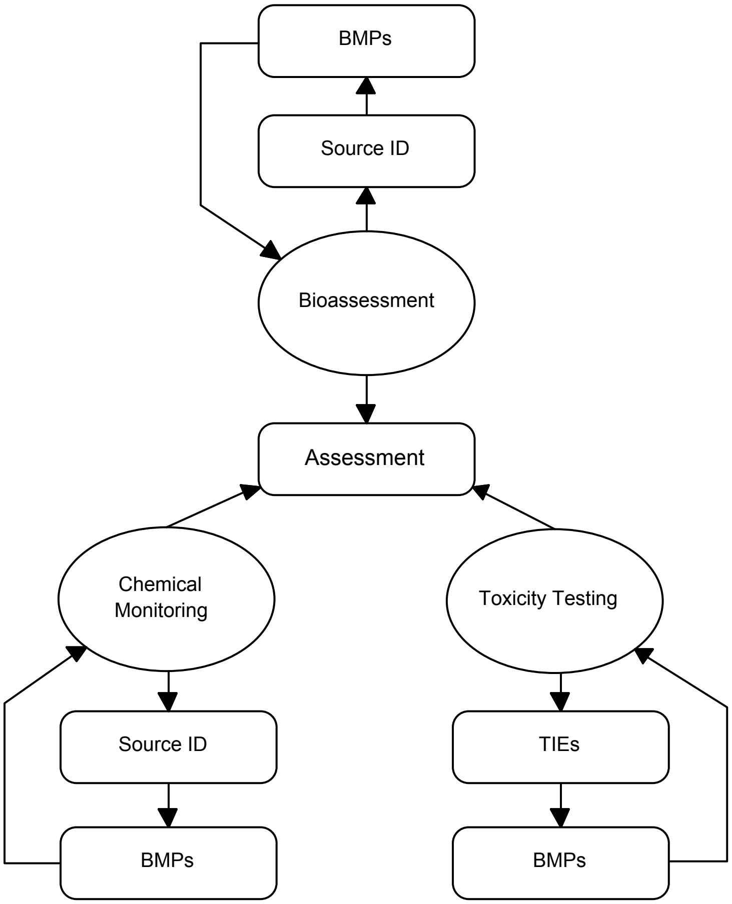
Table 3-2 summarizes the monitoring program elements that have been designed to address the objectives described above. Each element is then described in fuller detail in the following subsections.

3.3.1 Urban Stream Bioassessment

The goal of the urban stream bioassessment element of the program is to describe impacts on stream communities due to stormwater runoff and to track trends in such impacts over time. The combination of core monitoring aspects described below provides the urban bioassessment program element with the ability to use a "triad" approach to assessment that includes routinely collected biological and physical data, along with direct measures of toxicity. In addition, special studies aspects provide the ability to identify pollutant and disturbance sources more accurately, improving the knowledge base for implementing best management practices (BMPs).

This is illustrated in the following figure (**Figure 3-2**) that shows how bioassessment, chemical monitoring, and toxicity testing combine to create an overall assessment of condition. In addition, each portion of the "triad" can lead, as appropriate, to targeted source identification studies that, in turn, can suggest specific best management practices (BMPs). The effectiveness of these best management practices (BMPs) can then be evaluated, in part, through future monitoring efforts conducted by each portion of the "triad." However, establishing a causal linkage between best management practices (BMPs) and receiving water conditions also requires information from focused studies of the effectiveness of individual best management practices (BMPs) (see Section 3.4 for further discussion).

Figure 3-2 Structure of the "Triad" Approach to Urban Stream Bioassessment



3.3.1.1 Core monitoring

Core monitoring aspects of this program element include bioassessment, chemical monitoring, and toxicity testing at all sites (see **Table 3-2** for more detail). This will permit assessment of conditions based on a "triad" of complementary indicator groups that provide different kinds of insight into the action of runoff-related stressors. The inclusion of toxicity testing as an aspect of core monitoring exceeds the permit requirements described in Attachment B.2.b.8 of the permit. It is included because of its potential to enhance information from the other two legs of the "triad" (**Figure 3-2**) and provide additional guidance to source identification studies.

Bioassessment monitoring will be accomplished by using the California Department of Fish and Game's California Stream Bioassessment Procedure (CSBP) (CDFG 1999) and the associated Index of Biotic Integrity (IBI) developed for the San Diego Region. Impacts will be delineated based on Index scores and comparisons to reference sites. The potential relationship of impacts to urban stormwater runoff will be determined by comparison of runoff-related parameters to reference sites, correlations to water quality and loadings data where these are available, and inferences drawn from the nature of any impacts and an understanding of runoff-related processes.

A minimum of 12 bioassessment monitoring stations will be selected by the contractor, such that each site will:

- Be located within the jurisdiction of a Permittee
- Be located within one of the six watersheds specified in Section J, Table 4 of Order R9-2002-0001
- Be representative of urban stream conditions within one of these watersheds
- Meet the physical criteria of the California Stream Bioassessment Procedure
- To the extent feasible, coincide with the location of an already existing monitoring station used by the California Department of Fish and Game in the San Diego Regional Board's Ambient Bioassessment Program
- Be coincident with, or in close proximity to, a long-term mass loading monitoring site.

To the extent feasible, as many as possible of the monitoring sites will be in the six channels that contain mass loading sites (see Section 3.3.2). Although the bioassessment sites will most probably be upstream of the mass loading sites (which are situated as close to the mouths of their respective watersheds as possible) the availability of loadings data may help in interpreting bioassessment results from these watersheds. The contractor will also select three reference sites in accord with the criteria listed in Order No. R9-2002-0001.

In addition to the habitat and biological community parameters typical of bioassessment approaches, this element will include routine monitoring of:

- Nutrients
    - nitrate plus nitrite
    - total ammonia
    - total Kjeldahl nitrogen (TKN)
    - total phosphate
    - orthophosphate
- Total suspended solids (TSS)
- Volatile suspended solids
- Turbidity
- pH
- Oil and grease (if sheen is present)
- Temperature
- Dissolved oxygen
- Electrical conductivity
- Hardness
- Total and dissolved heavy metals

  - cadmium
  - chromium
  - copper
  - nickel
  - selenium
  - zinc
- Organophosphate pesticides
  - diazinon
  - chlorpyrifos
- Toxicity testing with the standard freshwater test organisms *Selenastrum*, *Hyallela azteca*, and *Ceriodaphnia*.

Sampling at the 15 sites will be conducted twice annually, in May and October, to coincide with the end and the beginning of the rainy season. Sites will be selected to ensure that adequate flow is present at these times of years in all but drought conditions. However, toxicity testing will not commence at the bioassessment stations until the May 2003 sampling period because the Program has not yet established the contract with the toxicity testing contractor for this program element.

3.3.1.2 Special studies

In addition to the core monitoring, there are three additional special studies aspects of this program element (see **Tables 3-1** and **3-2**):

- Toxicity identification evaluations (TIE)

- Design of a model stormwater monitoring program

- Development of an urban stream Index of Biotic Integrity (IBI).

Two of these, toxicity testing and toxicity identification evaluations (TIEs), will characterize impacts in more depth, while the index of biotic integrity (IBI) will provide a more standardized framework for interpreting bioassessment monitoring results.

Toxicity Identification Evaluations (TIEs)

Where toxicity tests show substantial toxicity, the program will carry out toxicity identification evaluations (TIEs) to identify sources of toxicity and thereby provide information needed for more focused source identification and control. While there are no widely accepted standards within stormwater monitoring for using toxicity test results to prompting toxicity identification evaluations (TIEs), a structured decision-making approach has been developed by San Diego County and will be applied here (**Table 3-4**). In general, where there is substantial evidence of toxicity in Year A, TIE's should be conducted in Year B (the following year). (In this context, we understand "substantial" to mean a level of toxicity greater than one toxic unit that occurs in two or more samples, for any of the test organisms, in any one year.)

In such cases, the Program will prepare to conduct both toxicity tests and toxicity identification evaluations (TIEs) in parallel in Year B. Toxicity tests will be started and, if their results confirm the Year A conclusions, toxicity identification evaluations (TIEs) will be run immediately, using water collected from the same storm. (Based on past monitoring results, the first storms in the wet season will be the most toxic.) Where the Year B toxicity tests do not confirm the Year A results, the water collected for the toxicity identification evaluations (TIEs) will simply be discarded. This approach runs the risk of incurring extra costs in those cases where the toxicity identification evaluations (TIEs) are not run. However, it may be possible to balance such extra costs by focusing the toxicity tests on the specific organisms that demonstrated toxicity in Year A. Depending on the results of the toxicity identification evaluations (TIEs), a variety of management actions, from further source identification to specific best management practices (BMPs) and source control actions, could be implemented. Again, because there are no commonly accepted standards for using toxicity identification evaluation (TIE) results to trigger management actions, the Program will work with SCCWRP and the Stormwater Monitoring Coalition's model monitoring program project during Year 1 of the Program to further the development of such standards.

Because of past evidence of toxicity in Aliso Creek, the Program will schedule TIEs at this location during the Year 1, coincident with the May 2003 toxicity testing.

Model Stormwater Monitoring Design

The Orange County Stormwater Program will participate in the Stormwater Monitoring Coalition project to develop a model stormwater monitoring design for the southern California region. This may involve establishing regionally consistent objectives and/or sampling and analysis approaches for bioassessment monitoring, as well as the criteria for prompting TIEs discussed in the preceding paragraph.

Urban Stream Index of Biotic Integrity

The Stormwater Program will also participate in any future efforts, through the SMC or other collaborative entities, to develop an urban stream Index of Biotic Integrity (IBI) that is consistent across the entire southern California region.

3.3.2 Long-Term Mass Loadings

The goal of the long-term mass loadings element of the program is to continue the time series of mass loading data at key stations. These data will be useful in assessing the effectiveness of urban runoff management programs. The inclusion of toxicity testing in this element will provide the ability to assess potential impacts on the coastal receiving waters and will also furnish a link to the coastal receiving waters element of the program (see Section 5.6). Where called for, toxicity identification evaluations (TIE)s carried out as special studies will provide additional information for further source identification and/or source control efforts.

3.3.2.1 Core monitoring

Monitored Parameters

Core monitoring aspects of this program element include chemical and flow monitoring, along with toxicity testing, at all sites (see the list of parameters above in Section 3.3.1 and **Table 3-2** for more detail). The list of parameters will be the same as that for the bioassessment element, with the following exceptions:

- The toxicity tests will use marine test organisms instead of freshwater test organisms, because the nearshore marine environment is the receiving water for these stations, which are situated at the mouths of creeks
- Polycyclic aromatic hydrocarbons (PAHs) will be collected at the Prima Deschecha station, which is downstream of a landfill and where there is prior evidence of such contamination
- Bacterial indicators will be measured
  - total coliform
  - fecal coliform
  - *Enterococcus*.

This program element will provide not only a basis for tracking loads over the long term, but also a link to the assessment of conditions in the coastal receiving waters (see Section 3.3.4). The inclusion of toxicity testing as a core monitoring component exceeds the permit requirements described in Attachment B.2.b.8 of the permit. It is included because of its potential to enhance information from the chemical monitoring and provide additional guidance to source identification studies.

Monitoring Sites

Monitoring will be conducted at the mass loading sites shown on **Figure 3-3** on three storms per year. Every attempt will be made to capture the first storm of each year. These include sites from the 99-04 monitoring program (Prima Deschecha Channel, Segunda Deschecha Channel, San Juan Creek at Novia, and Aliso Creek) as well as additional sites intended to ensure adequate coverage of Region 9 (Laguna Canyon Channel and Trabuco Creek). Sampling and analysis methods will remain as in the 99-04 plan. Analyses will include calculation of both loads and event mean concentrations. The latter parameter will permit comparisons of monitoring results across sites and times that are independent of rainfall and runoff volumes.

Toxicity Tests

In addition to chemical and flow measurements, routine toxicity tests with marine test organisms (sea urchin fertilization, sea urchin embryo development, *Mysidopsis* growth) will be conducted at each sampling time. This will provide an additional measure with which to determine if pollutant levels are causing biological impacts in the receiving water.

This program element will focus on marine organisms for two reasons. First, the bioassessment element (Section 3.3.1) will conduct toxicity tests with freshwater organisms, thus contributing to an assessment of freshwater ecosystem conditions. Second, the mass loading stations are near the bottoms of their respective watersheds (**Figure 3-3**), making the most relevant receiving water for these flows the nearshore coastal marine environment. Toxicity tests with marine organisms will therefore provide a preliminary assessment of the relative potential for impacts in this receiving water.

Although *Mysidopsis bahia* are not very sensitive to diazinon (LC_{50}~4500 ng/L) they are very sensitive to chlorpyrifos (LC_{50}~35 ng/L). Therefore, the *Mysidopsis* test has the potential to identify toxicity due to organophosphate pesticides and to complement the sea urchin tests, which are more sensitive to metals. Toxicity testing in this program element will use multiple dilutions of the sample water, adjusted for salinity. These dilutions will simulate dispersion of the stormwater runoff into the marine environment.

Collection of water samples for the toxicity tests will involve some reprogramming of the automated samplers to ensure that water samples are collected during the same phase of the storm at all stations. Sampling will occur during the first flush phase of the first monitored storm, during the middle of the second storm, and near the end of the third storm of each year. Over a number of years, these data will provide insight into patterns of toxicity throughout the hydrograph.

Grab Sampling for Oil and Grease and PAHs

The timing of grab sampling for oil and grease and polycyclic aromatic hydrocarbons (PAH) will be contingent on the sample holding time and the normal working hours of the contract laboratory

3.3.2.2 Special studies

While the sampling plan includes routine toxicity testing, toxicity identification evaluations (TIE')s will be carried out where the combination of toxicity test results, chemistry data, and bioassessment results from the bioassessment station in the same channel demonstrate the need to more accurately determine the source of toxicity. The Program will work with SCCWRP early in the first year of the program to define a set of criteria for deciding when toxicity identification evaluations (TIEs) should be carried out (see Section 5.3, Special Studies, for a more complete discussion).

3.3.3 Coastal Storm Drain Outfalls

The goal of the coastal storm drain element of the program is to track the levels of a suite of bacterial indicators, particularly during the wet season, at high-priority stormdrains along the coast and to target those drains most affected by runoff for further study.

Core monitoring will be conducted in Years 1 and 2 of the permit period, followed by an adaptive Special Study component to refocus monitoring as needed on high priority areas, based on the first two years of monitoring data.

3.3.3.1 Core monitoring

Site Selection Process

Core monitoring aspects of this program element include bacteriological sampling along the coastline at several subsets of stormdrains. Drains will be subset according to a hierarchy of criteria and different monitoring approaches applied to each (**Figure 3-4**). The rationale for each of the sorting criteria in **Figure 3-4** is as follows:

- Drains with equivalent diameters larger than 39 inches and/or whose dry season flow is greater than 100,000 gallons per day are more likely to be a source of significant contamination problems and this was the size threshold used in the recent Aliso Creek Directive studies

- Drains posted by the Health Care Agency are more likely to discharge to areas of public access where there may be a potential for human health risk

- Drains whose flow has been diverted to the sanitary sewer system do not warrant intensive monitoring in the surfzone; rather, monitoring will focus on documenting the effectiveness of the diversion

- Drains that outlet to the coast but whose flow does not reach the surfzone, even at high tide, are not likely to be affecting indicator levels in the surfzone and will not be monitored during the dry season; however, increased flows characteristic of the wet season have the potential for sometimes reaching the surfzone and warrant monitoring during this season

- Drains that are larger than 39 inches or have dry season flows of greater than 100,000 gallons per day, are posted by the Health Care Agency, whose flow is not diverted and reaches the surfzone are high priorities for monitoring and will be monitored weekly throughout the year, in the drain itself and in the surfzone 25 yards upcoast and downcoast of the drain/surfzone interface.

The set of drains meeting the criteria described above is currently being identified through a field reconnaissance being carried out in cooperation with the County Health Care Agency (HCA). The steps involved in this process include:

- Obtain list of beach areas posted by the County Health Care Agency (completed)

- Conduct reconnaissance of signed areas to measure stormdrain size and flowrate (ongoing)

- Contact local jurisdictions to identify stormdrains which are diverted to the local sanitation district; note period of diversion (completed)

- Compile list of stormdrains to be monitored (in process)

- Secure contract or interagency commitment for analytical services (in process)

- Begin monitoring (tentative start date October 2002).

Monitored Parameters

Monitoring will focus on total coliforms, fecal coliforms, and *Enterococcus*. The County Health Care Agency will continue to perform the necessary laboratory work, using the membrane filtration method and negotiations are currently underway between the Program and the Health Care Agency to establish a cooperative approach to performing the field sampling. This design will be carried out in Years 1 and 2 of the permit. Beginning in Year 3, additional drains will be evaluated with shorter-term studies. The design of these shorter-term studies will be based on results obtained in Years 1 and 2. Over time, the monitoring data will help to improve the ability to establish correlations between indicator levels in the surfzone and indicator levels in the stormdrains themselves.

Compliance Evaluation

Analyses of these surfzone data for core monitoring purposes will focus primarily on direct comparison to the AB411 standard. Exceedances will be reported to the County Health Care Agency, which posts bacterial indicator monitoring data on the Agency's website and emails a data spreadsheet to all local jurisdictions. The Health Care Agency also routinely reviews these data and notifies cities when problems occur.

3.3.3.2 Special studies

Analysis and Reprioritization

Special studies aspects of this program element include analyses needed to prioritize the drains for further study, based on the first two years of monitoring data. These analyses will include both the patterns of indicator levels (e.g., frequency of exceedance, average amount of exceedance) and measures of recreational water use to develop a site-specific risk measure. Prioritization criteria will be developed in collaboration with SCCWRP and the Stormwater Monitoring Coalition.

Prioritization criteria will then be used to identify the worst drains for additional IC/ID (Illegal Connections and Illicit Discharge) monitoring and for reconnaissance source identification studies to be carried out by the Permittees (these reconnaissance studies will be similar to those carried out on Aliso Creek). The results of such monitoring and source identification in turn could lead to further source identification efforts and/or management actions such as best management practice (BMP) implementation. In addition, the prioritization process could lead to reductions in monitoring effort on drains that are shown not to be a problem.

The Program will also identify a priority list of additional drains for assessment and monitoring activities in Years 3 – 5 of the permit period.

Correlations Between Stormdrain and Surfzone Indicator Levels

Another goal of the special studies analyses is to improve our understanding of the correlations between levels of indicator bacteria in the surfzone and levels in the stormdrains themselves. This will be accomplished through correlational analyses of data from the stormdrains and data collected in the surfzone.

Improved Indicators

In addition, the Program will participate, through the Stormwater Monitoring Coalition, in developing rapid bacteriological indicators that will provide managers with near-real-time measures of human health risk and microbiological source identification methods that will narrow the source(s) of contamination to specific human and non-human categories.

Although they are widely used, there are well-known shortcomings that limit the effectiveness of current bacteriological indicators, both for measuring human health risk and for identifying the sources of pathogen contamination. Two projects being managed by SCCWRP are currently underway that begin to address these shortcomings. The first, development of rapid bacteriological indicators, is focused on producing easily used field tests that would provide a reliable measure of bacteriological contamination within a few hours at most. The second, validation and comparison of alternative methods for identify the upstream sources of bacteriological contamination, will select those methods that provide the most dependable means of identifying and distinguishing among such sources. The Orange County Stormwater Program will participate in these and related projects as needed and appropriate.

3.3.3.3 Regional Monitoring

The regional monitoring aspect of this program element involves participation in the Bight '03 shoreline bacteriological assessment, which will use standardized methods throughout the Southern California Bight to create a picture of regional bacterial contamination patterns.

3.3.4 Ambient Coastal Receiving Waters

The goal of the coastal receiving waters element of the program is to begin documenting the nature and extent of stormwater impacts on the coastal marine environment and to improve our basic understanding of such impacts. Because of the rudimentary nature of knowledge about stormwater plumes in the coastal zone, this entire program element, with the exception of monitoring within Dana Point Harbor, is classified as a set of linked special studies and regional monitoring efforts. Thus, while there is core monitoring in Dana Point Harbor, there are no core monitoring aspects of this program element for the nearshore coastal zone.

3.3.4.1 Core Monitoring

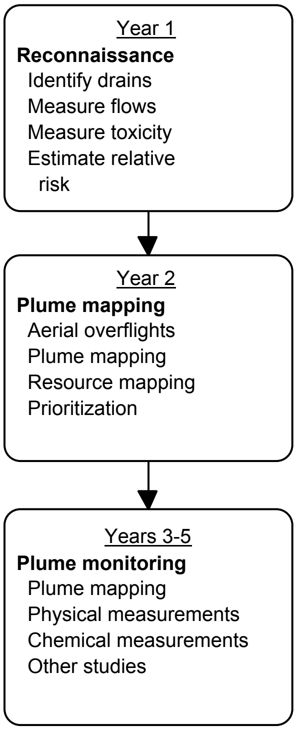
Core monitoring will take place at three sites in Dana Point Harbor (**Figure 3-5**). Sites will be situated at the outlets of the three major storm drains entering the Harbor. Sediment chemistry and toxicity tests (using the 10-day amphipod survival test) will be carried out twice per year, in May and October. The following parameters will be monitored in Dana Point Harbor during two storms per year:

- Nutrients
    - nitrate plus nitrite
    - total ammonia
    - total Kjeldahl nitrogen (TKN)
    - total phosphate
    - orthophosphate
- Total suspended solids (TSS)
- Volatile suspended solids
- Turbidity
- pH
- Oil and grease
- Temperature
- Dissolved oxygen
- Electrical conductivity
- Total and dissolved heavy metals
    - cadmium
    - chromium
    - copper
    - lead
    - zinc
- Organophosphate pesticides
    - diazinon
    - chlorpyrifos
- Polycyclic aromatic hydrocarbons (drop if not found in first year)
- Total petroleum hydrocarbons
- Toxicity testing
    - sea urchin fertilization
    - sea urchin embryo development
    - Mysidopsis growth.

Special Studies

The progression of special studies through the permit term is illustrated in **Figure 3-6**.

Figure 3-6 Progression of Special Studies Activities for Ambient Coastal Receiving Waters Element



Year 1 - Reconnaissance

In Year 1, the Program will conduct a reconnaissance at the coastal sites listed below:

- Dana Cove
- Dana Point Harbor (3 sites)
- Laguna Beach Marine Life Refuge
- Aliso Beach
- Aliso Creek Mouth
- Niguel Marine Life Refuge
- Doheny Beach
- San Juan Creek Mouth
- Salt Creek Mouth.

Most of these sites were previously identified as critical aquatic resources (**Table 2-5;** see also **Figure 3-7**).

This reconnaissance will consist of:

- Identifying the major stormdrains that outlet to each area

- Measuring or estimating their flow rates

- Measuring their chemical constituents, with the same set of parameters as measured at Dana Point Harbor
- Conducting toxicity tests on storm drain outflows.

Aliso Creek mouth, San Juan Creek mouth, and Salt Creek mouth represent single discharge points. For the other four coastal sites, we will use the same selection criteria as used in the Coastal Storm Drains element (i.e., 39 inches in diameter and/or 100,000 gallons per day of dry-weather flow). There may be some overlap between these drains and those addressed in the Coastal Storm Drains element of the Program (section 3.3.3). Such overlaps will be identified for improved efficiency. However, some of the sites listed above are in rocky intertidal areas with no signage and relatively low beach usage, and others may in fact have no storm drains. Thus, we are unsure at this point, prior to the reconnaissance, how much overlap may in fact occur.

This suite of measurements will be carried out twice in the wet season and twice in the dry season. Toxicity tests will be carried out with marine test organisms using multiple dilutions in order to better understand potential toxicity in the nearshore receiving water environment. This first-year reconnaissance will also include a qualitative risk assessment of the receiving water environment, based on its ability to assimilate runoff (e.g., size of area, amount of mixing), other sources of contamination, and presence of sensitive marine resources. The goal of this assessment will be to rank the sites in terms of the relative likelihood that stormwater runoff represents a risk to habitats, species, or important ecological processes. Based on these data, the coastal areas will be prioritized for further study.

Year 2 – Plume Mapping

In Year 2, special studies will concentrate on plume mapping to better understand the distribution and extent of the plumes under a range of storm conditions. Plume mapping will be conducted with aerial photography. Aerial photography will cover the entire coast in the San Diego Regional Board area of the County and will concentrate on documenting the maximum extent of the plumes, which is estimated to occur just after the rainfall stops. We will carry out two coastwide flights, one for a small storm (about 0.5 inch/24-hours) and one for a larger storm (>2.0 in/24-hours). The flights will be made as soon as the rain has stopped and we assume that there should be a few opportunities to complete such flights during daylight hours each year.

Maps of plume extent will then be overlaid on maps of sensitive areas in the coastal sites listed above. The results of the reconnaissance studies in Years 1 and 2 will be used to prioritize the plumes in terms of their size, severity, and potential impact on coastal resources and thus provide a tighter focus for the core monitoring scheduled for Years 3 – 5.

Years 3 – 5 – Plume Monitoring

In Years 3– 5, a high-priority subset of the coastal locations listed above will be monitored. This monitoring will consist of plume mapping with aerial overflights conducted at the time of maximum plume extent, as well as physical and chemical measurements in the plumes themselves. The high-priority subset of sites where core monitoring will occur will be defined by special studies in Years 1 and 2 of the permit (see following subsection). Similarly, the frequency of plume sampling, as well as the suite of parameters to be measured, will also depend on the results of the Year 1 and 2 studies, as well as on the availability and cost of the larger, ocean-going vessel required for plume sampling during storms.

In addition to helping to describe the effects of stormwater plumes in the coastal receiving waters, data from years 3 – 5 will also be used to help build causal linkages between upstream patterns of contamination and downstream effects. The ultimate goal of this effort is to improve the understanding of stormwater processes and impacts throughout entire watersheds and into the coastal receiving waters.

3.3.4.1 Regional Monitoring

Regional monitoring aspects of this program element include participation in the regional assessment of conditions at river mouths and in enclosed bays, harbors, and estuaries. These data will provide a description of regional background conditions that will help to place the Dana Point Harbor monitoring data in context.

In addition, the stormwater plume studies will be coordinated with the Bight ′03 study of nearshore plumes and its coastal resource assessment. In terms of the nearshore plumes study, the County, at a minimum, would like to repeat the Bight ′98 stations, with the possible addition of Salt Creek and Laguna Canyon. These represent larger plumes that are beyond the sampling capability of the County's smaller boats. However, the usefulness of this aspect of the Bight ′03 program may be limited because it is scheduled to take place in dry weather and the Program's plume monitoring efforts are focused on storm events during the wet weather season.

In terms of the coastal resource assessment, the County will work to focus sampling in the San Diego Regional Board area of the County on the coastal resources prioritized as most important in the Year 1 special study.

3.4 How Monitoring Data Will be Used in Urban Runoff Management Plans

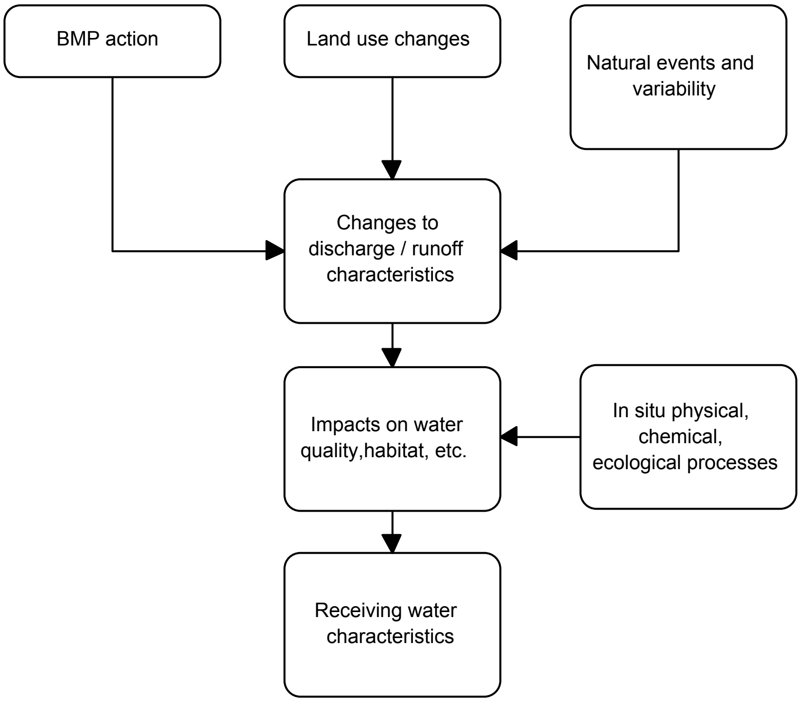
Monitoring data will play the following primary roles in the future. It will be used to:

- Identify possible pollutant sources
- Highlight and clarify other sources of disturbance related to stormwater
- Help track the long-term results of BMPs
- Develop recommendations for each Annual Status Report for changes to management measures needed to better target pollutants of concern.

These roles fit reflect the Program's fundamental mission, which is to follow the logical progression from characterizing storm water runoff, to identifying pollutants of concern, to determining appropriate management measures that should be implemented at the source to reduce or eliminate pollutants. Monitoring data will thus help prioritize problems, evaluate potential solutions, and provide feedback, on both local and regional scales, over both the short and long term. In addition, the monitoring program will continue to expand and improve its ability to quantify impacts and identify their sources, as with the "triad" approach (bioassessment, chemistry, toxicity testing) to stream assessment.

While an important Program goal is to help track the effectiveness of best management practices (BMPs), we believe it is important to clarify the constraints inherent in the use of receiving water monitoring data for this purpose. As discussed above in Section 2.4.3, there are a variety of factors that interact to determine receiving water characteristics, only one of which is the best management practices (BMPs) implemented to address pollutant sources. **Figure 2-43** (repeated here) illustrates this. Thus, a true assessment of the effectiveness of best management practices depends not only on receiving water monitoring but also on well designed evaluations of specific best management practices (BMPs).

Figure 2-43 Variety of Influences on Receiving Water Characteristics



Monitoring data will be used to help define short- and long-term actions in the watershed chapters of the revised Drainage Area Management Plan, guide the development and evaluation of best management practices (BMPs), and identify opportunities for retrofitting of existing flood-control infrastructure to improve water quality. An expanded emphasis on best management practice (BMP) effectiveness studies, potentially in partnership with the Stormwater Monitoring Coalition, will be an important part of this effort.

Information from the monitoring program's expanded emphasis on characterizing ecological impacts through bioassessment and toxicity testing will be important to the success of this suite of efforts. By helping to distinguish among the various sources of impact related to stormwater runoff (e.g., pesticide toxicity, heavy metal toxicity, nutrient enrichment, erosion, changes to the hydrograph, sedimentation) these program elements will help to target best management practices (BMP) implementation at those sources of impact whose reduction is most like to result in significant improvements not only in water quality but in overall ecosystem health.

A key aspect of these efforts is the Program's active participation in the regional Bight studies and the Stormwater Monitoring Coalition. Both provide valuable opportunities for the Program to leverage its investment in monitoring, cost-effectively develop new methods, and place the County in the larger regional perspective.

3.5 Summary of Recommendations

Our recommendations fall into three categories.

3.5.1 Program Philosophy

In terms of the overall philosophy underlying the monitoring program, the program will continue to improve its ability to assess compliance, document impacts, identify the sources of these impacts, and evaluate the effectiveness of best management practices (BMPs) and other management actions taken by the Permittees to reduce impacts. This means the Program should continue to improve its ability to:

- Assess compliance

- Describe the ultimate impact of stormwater runoff on ecosystems (e.g., by including bioassessment in routine monitoring)

- Target additional kinds of impact (e.g., that of stormwater plumes on the nearshore marine environment)

- Work with the Permittees to identify and evaluate effective methods for reducing pollutants and other stormwater-related sources of impact.

This will require the development of new monitoring tools and approaches.

3.5.2 Program Structure

In terms of the basic structure of the monitoring program, the program will formally adopt the three-part structure being considered by the Stormwater Monitoring Coalition – core monitoring, regional monitoring, and special studies. As **Table 3-2** shows, this is an effective way to organize the range of monitoring activities needed to fully address the objectives described in **Table 3-3**.

It also provides a means of avoiding the constraints on spatial pattern and temporal trend analyses stemming from shifts in methods, management and monitoring questions, and sampling designs. By providing mechanisms to address several different types of questions, it allows for core monitoring stations, spread throughout the southern region of the County, to be sampled with consistent methods over a period of many years. Such stable core monitoring elements reduce variance from extraneous sources, thereby enhancing the Program's ability to perform trend analyses and spatially extensive analyses without hampering the capacity to conduct a full range of shorter-term special studies.

This three-part structure also highlights the Program's growing involvement in regional monitoring and its opportunity to cost effectively develop new monitoring techniques, standardize approaches, and carry out monitoring efforts that are beyond the Program's capacity when acting alone.

3.5.3 Specific Program Elements

In terms of the specific elements of the monitoring program, the program will adopt the elements summarized in Section 3.3 for the ensuing five-year permit period.

These elements involve several interactions with the Stormwater Monitoring Coalition's efforts to improve and standardize methods. They also include three specific interactions with the upcoming regional Bight '03 study:

- Participation in the regional shoreline bacteriology study, which will place local data in a broader regional context
- Participation in the assessment of conditions in enclosed bays, harbors, and estuaries, which will provide a regional background for the evaluation of local conditions in Dana Point Harbor
- Participation in the coastal plumes study, which will provide data to complement the Program's studies of coastal stormwater plumes
- Participation in the assessment of coastal resources, which will furnish additional information useful in evaluating the potential impacts of stormwater plumes on nearshore resources.

3.5.4 Technical Change Orders to the Permit

The Permittees recommend two technical changes to the monitoring requirements of the Third Term Permit.

The first is an adjustment to modify the reporting year from its current period of October 1 to September 30 to July 1 to June 30. Under the current reporting period, the six-week interval between September 30 and the November 15 deadline for submitting the Annual Status Report is inadequate for obtaining and processing year-end raw data and then performing the needed data analysis and report preparation. The proposed reporting period, in contrast, will allow approximately four months for careful and thorough data processing and analysis and report preparation.

The second is a modification of wording that describes the location for surfzone sampling in the coastal storm drains program element. Rather than sample at the surfzone interface directly in front of the stormdrain, we recommend that surfzone sampling occur 25 yards upcoast and/or downcoast of the stormdrain outlet. Samples taken directly in front of the stormdrain will typically reflect the levels in the drain itself. Not only will such data be somewhat redundant, but they will not reflect the mixing and dispersion that takes place in the turbulent surfzone environment. Samples taken some distance upcoast and/or downcoast of the drain location will result in a better measurement of the actual levels of indicator bacteria swimmers and bathers are exposed to in the vicinity of the drain. For example, an extensive epidemiology study of swimming-related illnesses at beaches in Santa Monica Bay (SMBRP 1996) sampled in each stormdrain and 100 yards and 400 yards upcoast and downcoast of the drain in order to estimate the levels beach users might be exposed to. Our proposal for sampling 25 yards upcoast and/or downcoast is somewhat more conservative than this, while still enabling some realistic amount of mixing and dispersion to occur.

4.0 CONCLUSIONS

This report fulfills the requirements of Attachments B.2.a (Previous Monitoring and Future Recommendations Report) and B.2.b.8 (Receiving Waters Monitoring Program) of Permit CAS0108740, Order No. R9-2002-0001, from the San Diego Regional Water Quality Control Board to the Orange County Stormwater Program Permittees. As specified in these Attachments, it:

- Reviews wet weather stormwater monitoring (samples collected during storm events) findings since the initiation of the municipal urban stormwater runoff permit in 1990
- Describes the design and implementation of the Second Term Permit monitoring plan (99-04) within the San Diego Regional Board area of the County
- Documents how monitoring results have been used by the Permittees
- Describes the design of the new Third Term Permit monitoring plan to be implemented beginning August 2002.

In addition, this report makes recommendations for the design and use of data from future monitoring efforts in the San Diego Regional Board area of the County.

4.1 Review of Past Monitoring

The review and analysis of past wet weather monitoring results document the Program's continued improvement in sampling and analysis methods, which have increased the accuracy, precision, and reliability of the data. The cumulative analysis of past data revealed some persistent differences among sampling stations, as well as some increases and declines in specific pollutants at certain stations over time. Without a more complete analysis, it is not possible to directly relate such trends to possible explanations such as changes in land use in surrounding watersheds. However, some key conclusions include:

- There is a close relationship between the amount of total suspended solids (TSS) and the levels (concentrations) of total metals and phosphate in the water
- If there is a high potential for erosion, either from landuse practices, undeveloped areas, or from earthen channels themselves, there will be a correspondingly high probability of elevated TSS and metals and phosphate levels
- Patterns of metals and phosphate loads over time are strongly influenced by the amount of flow and the erosion potential of the surrounding watershed
- Despite these relationships, there is no apparent consistent connection between overall yearly rainfall and the levels (as opposed to the loads) of contaminants in runoff or in the sediments at the channel stations

- While there is a positive correlation between the levels of total and dissolved metals, the bulk of metals is consistently found in the particulate fraction

- Though metals may be at higher levels in the first flush, these waters may not necessarily exceed the California Toxic Rule (CTR) freshwater criteria, because of the elevated hardness of first-flush water, which reduces the effective toxicity

- The first flush, however, may show more exceedances of the California Toxic Rule (CTR) saltwater criteria at the point of discharge, because there are no hardness qualifiers for marine toxicity

- While there are apparent increasing or decreasing trends over time for some metals at some stations, it is not clear what may be causing these

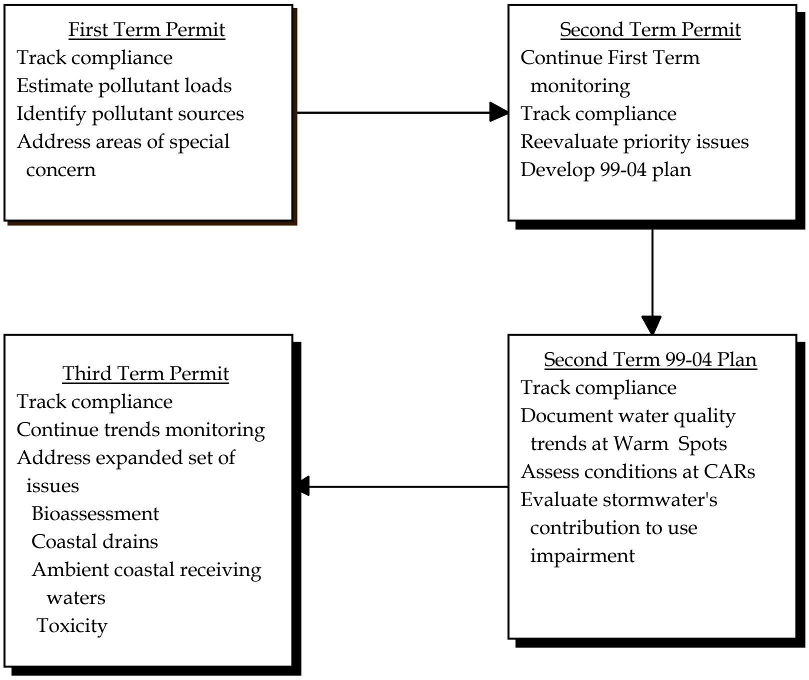
- Sediment from nearly every site in Dana Point Harbor was anthropogenically enriched with copper and zinc and, to a somewhat lesser extent, lead, although all values were below NOAA's Effects Range Median (ERM) guidelines

- A reduction in the levels of several metals in Dana Point Harbor sediments after 1998 may be related to the fact that the El Niño year of 1997 / 98 was the wettest of the 1990 – 2000 period and the following year, 1998 /99 was the driest.

4.2 Future Recommendations

This review also demonstrates the continued evolution of the Program's underlying philosophy and its basic goals and objectives. As **Figure 1-1** (repeated below) shows, the Program has evolved to a much more comprehensive approach to measuring receiving water characteristics, identifying sources of pollutants, and identifying potential management actions to remove or reduce such sources.

Figure 1-1 Receiving Waters Monitoring Program Evolution



Warm spots refer to sites with pollutant levels that are elevated relative to the long-term County average (see Section 2.2.2 for more detail).
CARs refers to critical aquatic resources, sites with greater beneficial use potential (see Section 2.2.2 for more detail).

The Third Term Permit monitoring program detailed in this report thus includes four major elements, with a fifth (dry weather reconnaissance) to be added in February 2003:

- Urban stream bioassessment
- Long-term mass loadings
- Coastal storm drains
- Ambient coastal receiving waters.

This new program is notable for the addition of routine bioassessment and toxicity testing, the provision for toxicity identification evaluations (TIEs), as well as for its extension to the coastal zone. These program elements significantly improve the Program's abilities to:

- characterize receiving waters throughout entire watersheds and into the coastal zone
- track compliance across a broad range of conditions
- measure impacts on ecological communities
- distinguish between impacts due to pollutants and those due to other disturbances

- identify sources of pollutants
- suggest management measures to remove or reduce sources of pollutants.

The sampling designs and rationale for the Third Term Permit monitoring program are described in detail in Section 3.0. The logistical details are summarized in the following Section 5.0.

5.0 LOGISTICAL DETAILS

[to be completed after further discussion with Board staff]

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Table 2-2 Intended Annual Stormwater Monitoring Frequencies for Channels

Monitoring Location	Period of Record	Flowrate	Nutrients (aqueous)	Metals (aqueous)	Metals (sed)	Organics (sed)	Particle Size (sed)
Laguna Canyon Channel at Woodland	92-99	Continuous	3-5 storms	3-5 storms			
Aliso Creek in Aliso/Wood Canyon	92-02	Gauge installed 4/02	3-5 storms	3-5 storms	semiann	semiannual	semiannual
Trabuco Creek at Camino Capistrano	94-96	Continuous	3-5 storms	3-5 storms	semiannual	semiannual	semiannual
San Juan Creek at La Novia	92-02	Continuous	3-5 storms	3-5 storms	semiannual	semiannual	semiannual
Prima Deschecha at Calle Vista Grande	92-02	water level only	3-5 storms	3-5 storms			
Segunda Deshecha at El Camino Real	92-02	water level only	3-5 storms	3-5 storms			

Nutrients include Nitrate, Ammonia, TKN, total Phosphate, TSS, and VSS
Metals (aqueous) include total recoverable (92-02) and dissolved (after 1997) Cu, Cd, Cr, Pb, Ni, Zn, Ag
Metals (sediment) include Cd, Cu, Cr, Pb, Ni, Zn, Ag, + Fe (added in 97)
Organics (sediment) include organochlorine pesticides, diazinon, malathion, 2,4-D, 2,4,5-TP Silvex, Simazine and PCBs; PAHs (91-97)
There is no sediment monitoring in Laguna Canyon, Prima Deschecha, and Segunda Deschecha because these channels are concrete lined

Table 2-3 Intended Annual Stormwater Monitoring Frequencies for Dana Point Harbor

Monitoring Location	Period of Record	Nutrients (aqueous)	Metals (aqueous)	Metals (sediment)	Organics (sediment)	Particle Size (sediment)
Outlet of 60″ RCP – East Basin	91-02	2 storms	2 storms	semiannual	semiannual	semiannual
Outlet of 51″ RCP – West Basin	91-02	2 storms	2 storms	semiannual	semiannual	semiannual
Outlet of 18″ RCP – Launch Ramp	91-02	2 storms	2 storms	semiannual	semiannual	semiannual
Near Shipyard	91-02	2 storms	2 storms	semiannual	semiannual	semiannual
At Harbor Entrance	91-02	2 storms	2 storms			

Nutrients include Nitrate, Ammonia, TKN, total Phosphate, TSS, VSS
Metals (aqueous) include total recoverable (91-02) and dissolved (added in 97) Cu, Cd, Cr, Pb, Ni, Zn, Ag
Metals (sediment) include Cd, Cu, Cr, Pb, Ni, Zn, Ag, + Fe (added in 97)
Organics (sediment) include organochlorine pesticides, diazinon, malathion, 2,4-D, 2,4,5-TP Silvex, Simazine and PCBs; PAHs (91-97)

Table 2-4 Warm Spot Constituents of Concern and Trends in Monitoring Frequencies

				from Power Analyses			
Warm Spot	**Location**	**STORET Code**	**Constituent(s) of Concern**	**Trend Detectable**	**Monitoring Frequency samples/yr**	**Term (years)**	**Min. reduction to show significant trend**
Sulphur Creek	d/s Sulphur Cr. Reservoir	SCDAM	Cd(s)	N	(2)		
Prima Deshecha Channel	@ Calle Vista Grande	PDCM01	EC(d)	Y	10	10, 20	42, 29
			Cd	Y	20	10, 20	50, 33
			Ni	Y	20	10, 20	53, 37
Segunda Deshecha Channel	@ El Camino Real	SDCM02	EC(d)	?	10	20	75

(s) – sediment concentrations; (d) dry weather measurements; all others stormwater concentrations
(#) – monitoring frequency not based on power analysis

Table 2-5 Ranking of Critical Aquatic Resources

SITE	CRITERIA									
	303(d) listed	Community interest	Aquatic habitat	Wildlife habitat	Designated reserve	Contact recreation	Non-contact recreation	Utility resource	Urban impact	Total
Enclosed Bays and Estuaries										
Upper Newport Bay	XX	XX	X	X	X	X	X		X	10
Lower Newport Bay	XX	XX	X	X		X	X		X	9
Talbert Channel		XX	X	X	X	X	X		X	8
Bolsa Bay		XX	X	X	X	X	X		X	8
Sunset Aquatic/ Anaheim Bay / Huntington H.	XX	XX	X	X		X	X		X	9
Dana Point Harbor *		XX	X	X		X	X		X	7
Coastal Resources										
Irvine Coast Marine Life Refuge		XX	X	X	X	X	X		X	8
Laguna Beach *	XX	XX				X	X		X	7
Laguna Beach Marine Life Refuge *		X	X		X	X	X		X	6
Newport Marine Life Refuge		X	X	X	X	X	X		X	7
Aliso Beach *	XX	XX				X	X		X	7
Aliso Creek Mouth *	XX	XX	X	X		X	X		X	9
Niguel Marine Life Refuge *		X	X		X	X	X		X	6
Doheny Beach *	XX	XX				X	X		X	7
Doheny Beach Marine Life Refuge *		X	X		X	X	X		X	6
Inland Surface Waters										
Aliso Creek *	XX	XX	X	X		X	X		X	9
Laguna Canyon Channel *		XX		X		X	X	X	X	7
Oso Creek *			X	X		X	X	X	X	6
Prima Deschecha *			X	X		X	X	X	X	6
San Diego Creek, Reach 1	XX	XX	X	X		X	X		X	9
San Diego Creek, Reach 2	XX	XX	X	X		X	X	X	X	10
San Juan Creek *	XX	XX	X	X		X	X	X	X	10
San Juan Creek, Lower *	XX	XX	X	X		X	X		X	9
Santa Ana River								X	X	2
Santiago Creek, Reach 4	XX		X	X		X	X	X		7
Segunda Deschecha *			X	X		X	X			4
Serrano Creek		XX	X	X		X	X		X	7
Silverado Creek	XX		X	X		X	X	X		7
Trabuco Creek *			X	X		X	X	X	X	6

* indicates CAR in the south County

Table 2-6 Critical Aquatic Resources Priority List

Number of "X"s	Candidate sites
	First priority
9 - 10	San Diego Creek, Reach 1& Reach 2
10	San Juan Creek *
10	Upper Newport Bay
9	Aliso Creek *
9	Aliso Creek Mouth *
9	Lower Newport Bay
9	San Juan Creek, Lower *
9	Sunset Aquatic/Anaheim Bay/Huntington Harbour
7	+ Dana Point Harbor (DPH) *
	Second priority
8	Bolsa Bay
8	Irvine Coast Marine Life Refuge
8	Talbert Channel
7	Aliso Beach *
7	Doheny Beach *
7	Laguna Beach *
7	Laguna Canyon Channel*
7	Newport Marine Life Reserve
7	Santiago Creek, Reach 4
7	Serrano Creek
7	Silverado Creek
	Third priority
6	Doheny Beach Marine Life Refuge *
6	Laguna Beach Marine Life Refuge *
6	Niguel Marine Life Reserve *
6	Oso Creek *
6	Prima Deschecha *
6	Trabuco Creek *
4	Segunda Deschecha *
2	Santa Ana River, Reach 2

Results of the ranking exercise for candidate monitoring sites. Overall ranking was based simply on the number of "X"s in each row of Table 3.4.
* indicates CAR in the south county
+ Dana Point Harbor is included as a first priority site because of the extensive amount of human use and community interest.

Table 2-7 Reconnaissance Rolling Priority List

Station	**Constituent of Concern**	**Dry/Wet Weather**	**Also Designated as Warm Spots/ CARs**
Prima Deschecha (PDCM01)	TDS	Dry	WS
Segunda Deschecha (SDCM02)	TDS	Dry	WS
Prima Deschecha (PDCM01)	Metals (Ni, Cd)	Wet	WS
Aliso Creek (ACJ01)	Coliform	Dry	CARs

Table 2-8 Parameters Analyzed in Cumulative Analysis

Sample Matrix	**Measurement Type**	**Parameters Analyzed**	**Comments**
Channel water	First measurement	NO_3, PO_4, TSS	First measurement is first composite sample for a storm. No control over length of time represented in composites. Data from south County watershed for years 1992-1995.
Channel water	First fllush	Dissolved Cd, Cu, Ni, Pb, Zn Total Cd, Cu, Ni, Pb, Zn	First flush measurement is from composite of samples taken during first hour of a storm event. Data from south County watersheds for years 1995-2001.
Harbor water	First measurement	NO_3, PO_4, TSS	First measurement is first composite sample for a storm. No control over length of time represented in composites. Data from Dana Point Harbor for years 1993-2000.
Bottom sediment – channels & harbor	Before / after wet season	Ag, Cd, Cu, Fe, Ni, Pb, Zn, % clay, % silt-clay, DDT, DDE, DDD, Endo I, Mthxy, 2,4,5-TP Silvex, 2,4-D, gamma BHC	Data from south County watersheds and Dana Point Harbor for years1991-2000.

Table 2-9 “First Measurement” Sampling Pattern in Channels

Date	ACJ01 Aliso Creek	SCDAM Sulfur Creek Channel	LCWI02 Laguna Canyon Channel	PDCM01 Prima Deschecha	SDCM02 Segunda Deschecha	OSOL03 Oso Creek	SJNL01 San Juan @ La Novia	SJOL01 San Juan Upstream
07 FEB 92							X	
02 MAR 92			X					
03 MAR 92				X	X			
05 MAR 92		X		X		X		
06 MAR 92					X		X	
08 MAR 92				X		X		
19 MAR 92		X						
20 MAR 92			X	X	X	X		
21 MAR 92		X						
22 MAR 92						X		
26 MAR 92						X		
28 MAR 92						X		
30 MAR 92				X				
17 JUN 92				X	X			
17 DEC 92						X		
29 DEC 92				X	X	X		
06 JAN 93		X	X	X		X		
08 JAN 93			X					
15 JAN 93		X	X	X				
07 FEB 93			X					
08 FEB 93		X					X	
18 FEB 93							X	
23 FEB 93							X	
11 NOV 93			X	X			X	X
14 NOV 93								X
19 DEC 93						X		

Date	ACJ01 Aliso Creek	SCDAM Sulfur Creek Channel	LCWI02 Laguna Canyon Channel	PDCM01 Prima Deschecha	SDCM02 Segunda Deschecha	OSOL03 Oso Creek	SJNL01 San Juan @ La Novia	SJOL01 San Juan Upstream
24 JAN 94			X					
25 JAN 94		X					X	
26 JAN 94								X
28 JAN 94			X					X
03 FEB 94		X			X	X		
04 FEB 94				X			X	
07 FEB 94	X		X	X	X	X	X	X
09 FEB 94		X	X					X
10 FEB 94					X			
17 FEB 94		X	X		X	X	X	
19 FEB 94							X	
18 MAR 94			X					
19 MAR 94					X			
24 MAR 94			X	X				
25 MAR 94		X			X			
28 MAR 94					X			
24 APR 94	X							
25 APR 94					X			
27 APR 94					X			
06 MAY 94	X							
10 NOV 94				X	X			
16 NOV 94						X		
02 MAR 95						X		
10 MAR 95			X			X		
12 MAR 95						X		

Table 2-10 “First Flush” Sampling Pattern in Channels

Date	ACJ01 Aliso Creek	LCWI02 Laguna Canyon Channel	PDCM01 Prima Deschecha	SDCM02 Segunda Deschecha	OSOL03 Oso Creek	SJNL01 San Juan @ La Novia	SJOL01 San Juan Upstream
30 OCT 96		X	X		X		
21 NOV 96	X						
09 JAN 98				X			
14 FEB 98			X	X			
25 MAR 98			X	X	X		
08 NOV 98	X		X		X		
28 NOV 98			X				
25 JAN 99					X		
09 FEB 99	X		X	X			
11 MAR 99		X	X	X	X		
15 MAR 99		X		X	X		
25 MAR 99	X		X				
06 APR 99				X			
03 MAR 00			X				
17 APR 00	X		X				
26 OCT 00	X						
24 JAN 01	X		X				
10 FEB 01			X				
12 FEB 01	X					X	
18 FEB 01			X				
19 FEB 01	X					X	
24 FEB 01	X		X				
25 FEB 01							X

Table 2-11 Sediment Sampling Pattern in Channels

Date	**ACJ01 Aliso Creek**	**SCBJ03 Sulfur Creek Above Lake**	**SCDAM Sulfur Creek Below Lake**	**PDCM01 Prima Deschecha**	**SDCM02 Segunda Deschecha**	**OHBL01 San Juan @ Caspers**	**OSOL03 Oso Creek**	**SJNL01 San Juan @ La Novia**	**SJOL01 San Juan Upstream**	**TCOL02 Trabuco Creek**
29 AUG 91	X		X				X	X		X
26 FEB 92						X				
18 JUN 92	X		X		X		X	X		
05 NOV 92	X		X				X			
14 JUN 93	X		X			X	X	X		X
06 OCT 93	X		X				X	X		X
08 APR 94	X									
04 MAY 94	X		X	X			X	X	X	X
08 NOV 94	X		X				X			X
17 APR 95			X							
25 MAY 95	X		X				X	X	X	X
19 OCT 95	X		X	X			X	X		X
17 APR 96	X					X	X	X		X
06 NOV 96	X		X				X	X		X
08 APR 97			X				X	X	X	X
09 OCT 97	X		X				X	X	X	X
19 JUN 98	X	X								
30 JUN 98							X	X	X	
19 OCT 98	X						X	X	X	
20 MAY 99	X	X		X			X	X	X	
27 OCT 99	X		X							
31 MAY 00	X		X					X	X	

Table 2-12 “First Measurement” Surface Water Sampling Pattern at Dana Point Harbor

Date	DAPTEB East Basin	DAPTHE Breakwater Opening	DAPTLB East Channel	DAPTLR Boatyard	DAPTWB West Basin
18FEB93	X	X	X	X	X
20FEB93	X	X	X	X	X
22FEB93	X	X	X	X	X
05JUN93	X	X	X	X	X
07JUN93	X	X	X	X	X
09JUN93	X	X	X	X	X
26APR94	X	X	X	X	X
28APR94	X	X	X	X	X
30APR94	X	X	X	X	X
23DEC95	X	X	X	X	X
25DEC95	X	X	X	X	X
27DEC95	X	X	X	X	X
21FEB96	X	X	X	X	X
23FEB96	X	X	X	X	X
25FEB96	X	X	X	X	X
15JAN97	X	X	X	X	X
17JAN97	X	X	X	X	X
19JAN97	X	X	X	X	X
17APR00	X	X	X	X	X

Table 2-13 Sediment Sampling Pattern at Dana Point Harbor

Date	DAPTEB East Basin	DAPTLB East Channel	DAPTLR Boatyard	DAPTWB West Basin
29 AUG 91	X	X	X	X
24 JUN 92	X	X	X	X
24 NOV 92	X	X	X	X
07 JUN 93	X	X	X	X
27 OCT 93	X	X	X	X
05 MAY 94	X	X	X	X
09 NOV 94	X	X	X	X
31 MAY 95	X	X	X	X
23 OCT 95	X	X	X	X
22 MAY 96	X	X	X	X
16 OCT 96				
14 NOV 96	X	X	X	X
30 APR 97	X	X	X	X
17 OCT 97	X	X	X	X
28 JUL 98	X	X	X	X
28 OCT 98	X	X	X	X
23 JUN 99	X	X	X	X
24 OCT 99				
28 OCT 99	X	X	X	X
07 JUN 00	X	X	X	X

Table 3-1 Distribution of Monitoring Types Across Program Elements

Program Element	Core Monitoring	Regional Monitoring	Special Studies
Bioassessment	routine monitoring with DFG methods routine chemical monitoring routine toxicity testing with freshwater organisms		TIEs where appropriate participation in regional methods development participation in SMC development of regional IBI
Mass Loading	routine monitoring with established methods toxicity testing with marine organisms		TIE's where appropriate participation in regional methods development
Coastal Outfalls	routine monitoring with existing methods	participation in Bight '03 shoreline bacteriological assessment	additional IC/ID monitoring for worst drains participation in development of source identification methods and rapid indicators
Ambient Coastal	Years 3, 4, 5 plume monitoring	participation in Bight '03 nearshore plumes study partiicipation in Bight '03 nearshore resource assessment (e.g., kelpbeds)	Year 1 reconnaissance and scoping Year 2 plume mapping

Table 3-2 Summary of Receiving Water Monitoring Program Elements

Program Element	Frequency	# Sites	Siting Criteria	Monitoring Parameters	Additional Studies
Urban Stream Bioassessment Monitoring	Twice annually: May, October	12 + 3 ref	Represent urban stream conditions within one of six watersheds in Section J, Table 4, Order R9-2002-0001. To extent feasible, coincide with current DFG bioassesment site in Region 9.	Bioassessments per DFG protocol Also: nutrients, TSS, suspended solids, turbidity, pH, oil & grease, temperature, dissolved O_2, electrical conductivity, hardness, total & dissolved metals, OP pesticides Toxicity testing (freshwater organisms)	TIEs in 2nd year where toxicity tests indicate substantial toxicity. Triggers to be evaluated with assistance from SCCWRP and SMC.
Long-Term Mass Loading	3 storms / year	6	Continue monitoring 99-04 sites (M01, M02, L01, J01). Add additional sites (I02, L02) to ensure adequate coverage of Region 9.	Flowrate, nutrients, TSS, suspended solids, turbidity, pH, oil & grease, temperature, dissolved O_2, electrical conductivity, hardness, total & dissolved metals, OP pesticides, PAH at Prima Deschecha, bacterial indicators toxicity (salt water organisms)	Use "triad" of chemistry, toxicity, and bioassessment results to determine need for TIEs. Triggers to be developed with assistance from SCCWRP and SMC.
Coastal Storm Drain Outfall Monitoring	Weekly	36	Drains > 39" or > 100K gpd, and posted by HCA. Flow reaches surfzone. Flow not diverted to sanitary sewer.	Total and fecal coliforms, enterococcus (wet and dry weather) Flow rate	Include worst drains in IC/ID monitoring program. Conduct relative risk assessment after Year 2. Expand program to additional

Program Element	Frequency	# Sites	Siting Criteria	Monitoring Parameters	Additional Studies
			Sample stormdrains (when flowing) and surfzone 25 yds up- and downcoast of the stormdrain / surfzone interface. (see Figure 5.2 for more detail)		drains in Year 3.
Ambient Coastal Receiving Water Monitoring	Varies by year – 1st: 2 storms, 2 dry-weather 2nd: 2 storms 3-5: TBD DPH: 2 per yr	8 3	Local assessment: Dana Cove, Dana Point Harbor, Laguna Beach Marine Life Refuge, Aliso Beach, Aliso Creek Mouth, Niguel Marine Life Refuge, Doheny Beach, San Juan Creek Mouth, Salt Creek Mouth. Bight 2003 sites for regional assessment.	1st yr: stormdrains for metals, OP pesticides, toxicity (salt water organisms), flowrate. 2nd yr: plume tracking on two storms with aerial photography 3rd: metals, toxicity, organics in high priority plumes and related stormdrains DPH: nutrients, TSS, suspended solids, turbidity, pH, oil & grease, temperature, dissolved O_2, electrical conductivity, hardness, total & dissolved metals, OP pesticides Toxicity (salt water organisms)	Prioritize areas based on 1st and 2nd year results Participate in regional Bight '03 survey

TBD: to be determined
DPH: Dana Point Harbor

Table 3-3 Specific Monitoring Objectives of the Program Elements

	Urban Stream Bioassessment	**Long-term Mass Loading**	**Coastal Storm Drains**	**Coastal Receiving Water**
Management goal(s)	describe conditions / impacts describe relationship to runoff	steady improvement	no levels in recreational waters greater than standard prioritize problems describe relationship to runoff	prioritize potential problems describe conditions / impacts
Monitoring strategy	measure suite of indicators	measure actual targets	measure suite of indicators	measure source of impact (plumes) measure suite of indicators of impact
Certainty / precision	moderate	moderate	moderate	moderate
Reference condition	reference watersheds (3)	historical data	compliance standards	reference locations reference times (low runoff)
Spatial scale	site specific	site specific	site specific	site specific
Temporal scale	year-to-year	years to decades	weekly	daily to seasonal

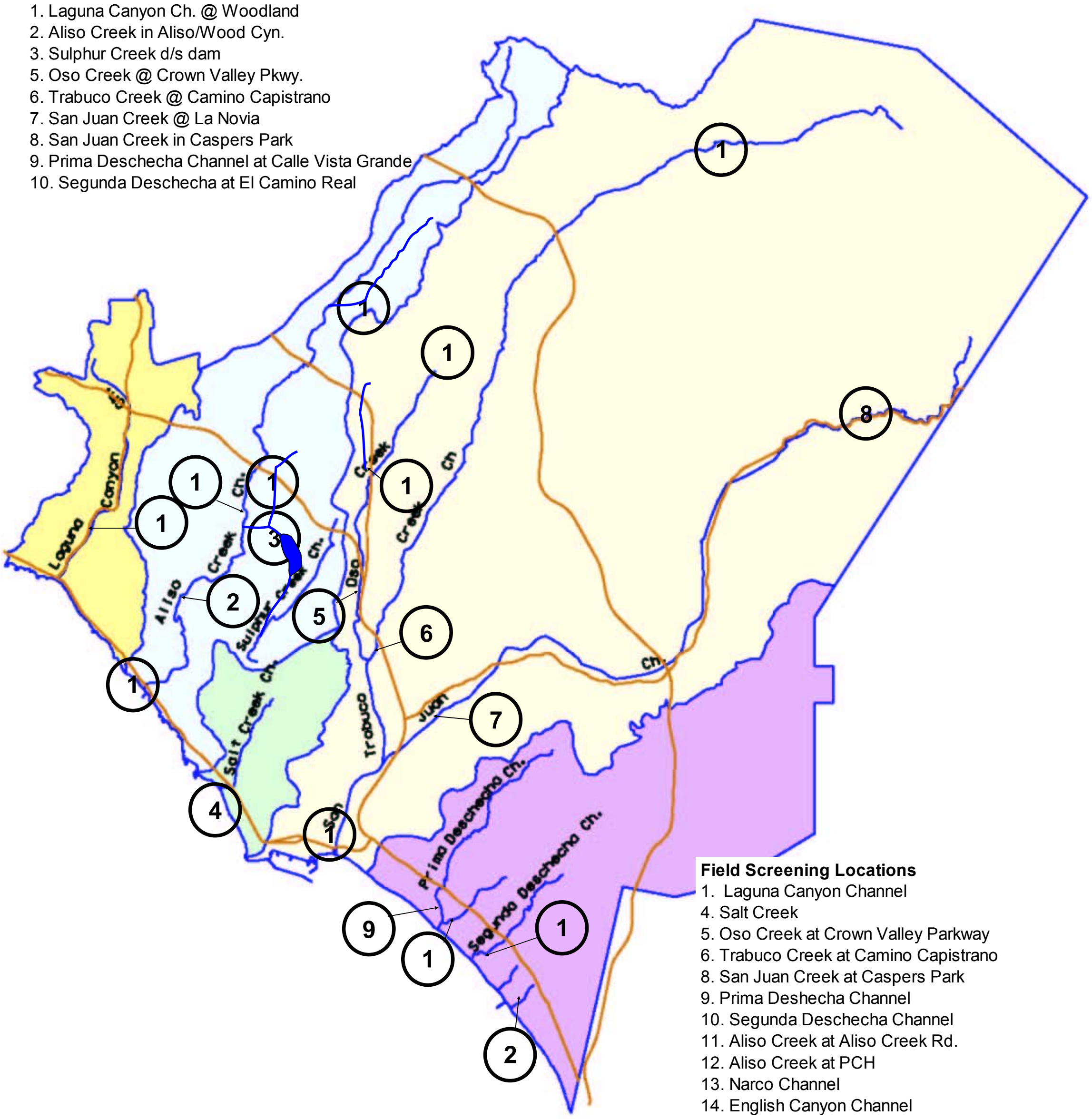
Table 3-4 Decision Framework for Implementing TIEs

Chemistry	Toxicity	Benthic Alteration	Possible Conclusion(s)	Possible Actions or Decisions
Exceedance of water qualtiy objectives	Evidence of toxicity *	Indications of alteration	Strong evidence of polllution-induced degradation	Use TIE to identify contaminants of concern
No persistent exceedances of water quality objectives	No evidence of toxicity	No indications of alteration	No evidence of pollution-induced degradataion	No action necessary
Exceedance of water quality objectives	No evidence of toxicity	No indications of alteration	Contaminants are not bioavailable	1. TIE would not provide useful information if there is no evidence of toxicity 2. Continue monitoring and attempt to identify source(s) of chemical(s) exceeding water quality objectives
No persistent exceedances of water quality objectives	Evidence of toxicity *	No indications of alteration	Unmeasured contaminant(s) or conditions have the potential to cause degradation	1. Recheck chemical analyses; verify toxicity test results 2. Consider additional advanced chemical analyses 3. Use TIE to identify contaminants of concern
No persistent exceedances of water quality objectives	No evidence of toxicity	Indications of alteration	Alteration is probably not due to toxic contamination	No action necessary due to toxic chemicals (action be necessary for other reasons, e.g., physical habitat changes)

Chemistry	Toxicity	Benthic Alteration	Possible Conclusion(s)	Possible Actions or Decisions
Exceedance of water quality objectives	Evidence of toxicity *	No indications of alteration	Toxic contaminants are biovailable, but in situ effects are not demonstrable	1. Determine if chemical and toxicity tests indicate persistent degradation 2. Recheck results from benthic analyses, consider additional data analyses 3. If recheck indicates benthic alteration, perform TIE to identify contaminant(s) of concern 4. If recheck shows no effect, use TIE to identify contaminants fo concern if evidence of toxicity is persistent
No persistent exceedances of water quality objectives	Evidence of toxicity *	Indications of alteration	Unmeasured toxic contaminants are causing degradation	1. Recheck chemical analyses and consider additional advanced analyses 2. Use TIE to identify pollutants of concern if toxicity is persistent
Exceedance of water quality objectives	No evidence of toxicity	Indications of alteration	Inconclusive	1. TIE would not provide useful information if there is no evidence of toxicity 2. Continue monitoring and attempt to identify source(s) of chemical(s) exceeding water quality objectives

* Evidence of toxicity, as defined in the text, means toxicity greater than one toxic unit that occurs in two or more samples, for any of the test organisms, in any one year.

Figure 2-1
First Term Monitoring Locations



Channel Monitoring Stations
1. Laguna Canyon Ch. @ Woodland
2. Aliso Creek in Aliso/Wood Cyn.
3. Sulphur Creek d/s dam
5. Oso Creek @ Crown Valley Pkwy.
6. Trabuco Creek @ Camino Capistrano
7. San Juan Creek @ La Novia
8. San Juan Creek in Caspers Park
9. Prima Deschecha Channel at Calle Vista Grande
10. Segunda Deschecha at El Camino Real

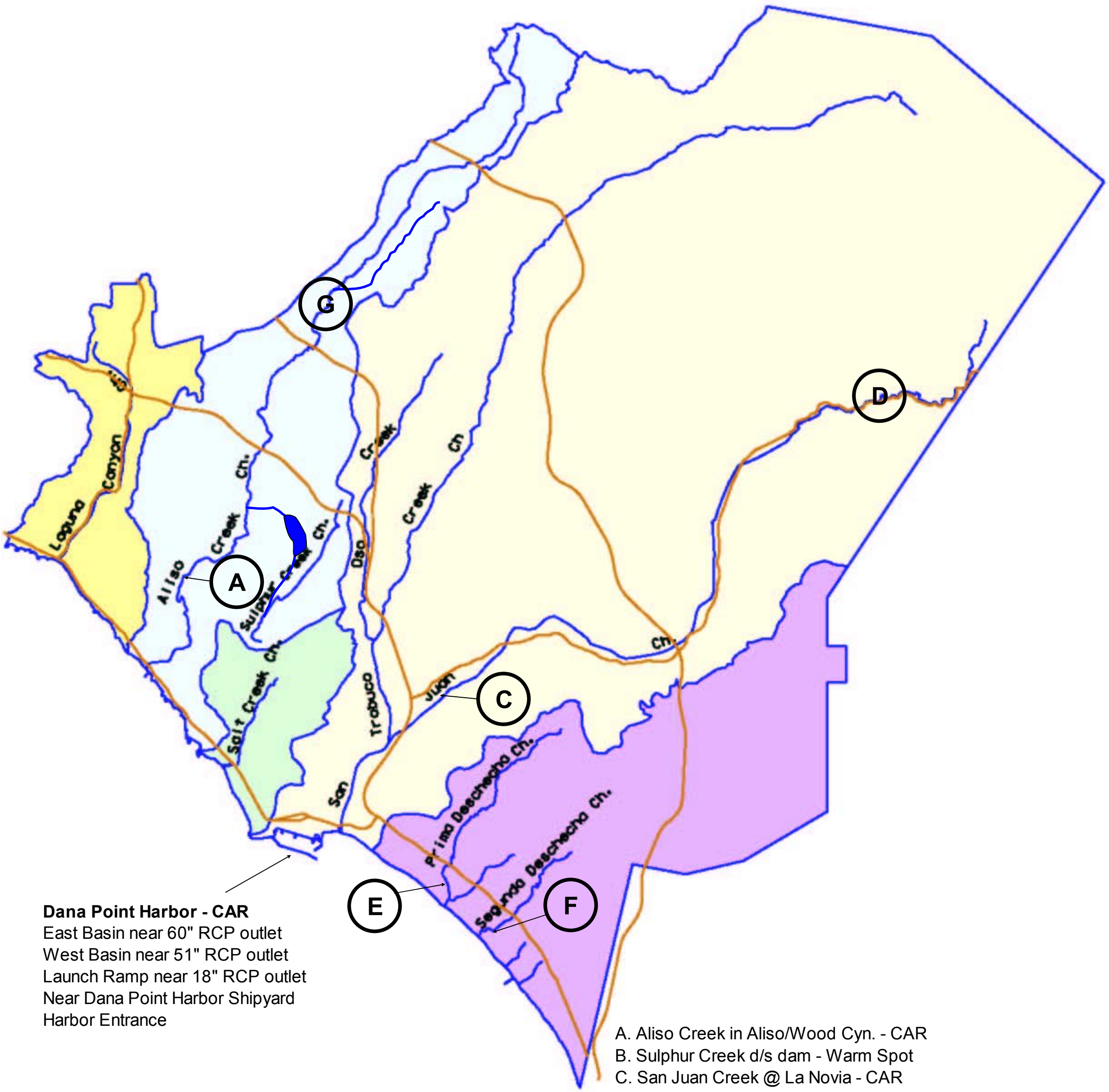
Field Screening Locations
1. Laguna Canyon Channel
4. Salt Creek
5. Oso Creek at Crown Valley Parkway
6. Trabuco Creek at Camino Capistrano
8. San Juan Creek at Caspers Park
9. Prima Deschecha Channel
10. Segunda Deschecha Channel
11. Aliso Creek at Aliso Creek Rd.
12. Aliso Creek at PCH
13. Narco Channel
14. English Canyon Channel
15. San Juan Creek at PCH
16. Trabuco Creek at Trabuco Creek Rd.
17. Oso Creek at Alicia Parkway
18. La Paz Channel
19. Cascadita Canyon Storm Channel
20. Marquita Storm Channel

Figure 2-2 Critical Aquatic Resources Monitoring Timeline

	1998	1999	2000	2001	2002	2003
Baseline Monitoring	▨	▨	▨	▨	▨	▨
Santa Ana Delhi	◨	▨	▨	▨	▨	▨
Costa Mesa Channel	◨	▨	▨	▨	▨	▨
Upper Newport Bay			▨	▨		
San Diego Creek			▨	▨		
Aliso Creek				▨	▨	
Lower Newport Bay			▨	▨		
Huntington Harbour					▨	▨
Dana Point						▨
San Juan Creek					▨	▨

Monitoring year = July 1 of prior year - June 30 of reporting year

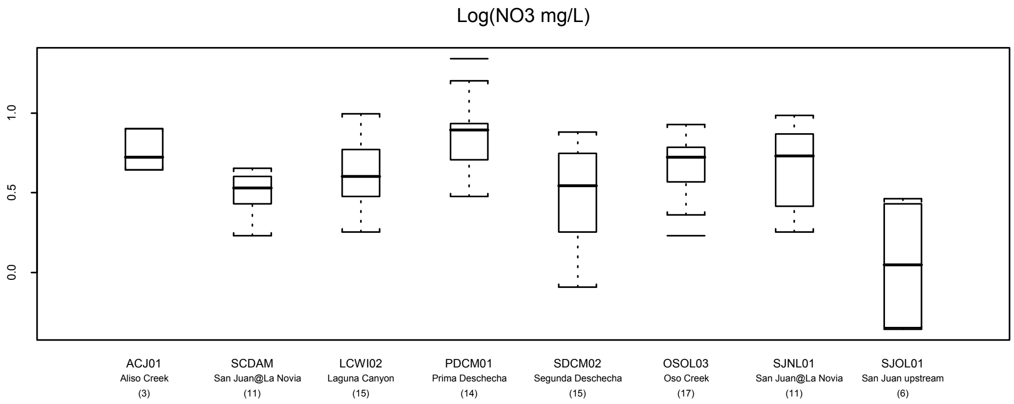
Figure 2-3
South County 99-04 Sites

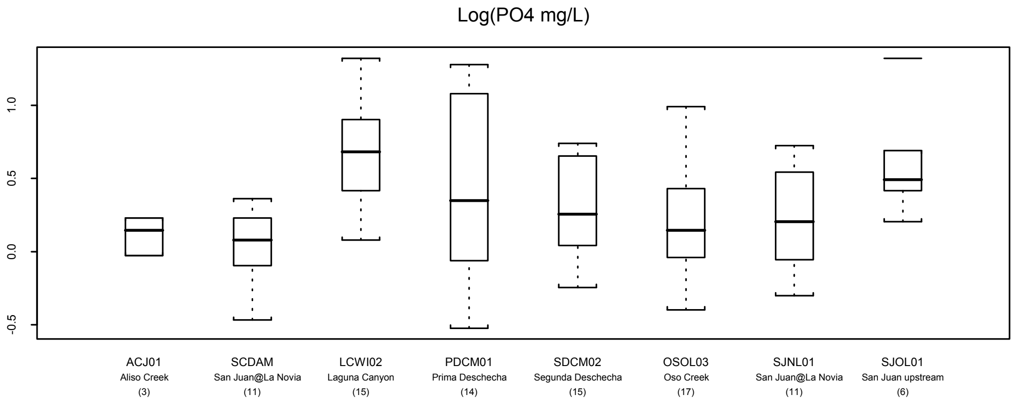


Dana Point Harbor - CAR
East Basin near 60" RCP outlet
West Basin near 51" RCP outlet
Launch Ramp near 18" RCP outlet
Near Dana Point Harbor Shipyard
Harbor Entrance

A. Aliso Creek in Aliso/Wood Cyn. - CAR
B. Sulphur Creek d/s dam - Warm Spot
C. San Juan Creek @ La Novia - CAR
D. San Juan Creek in Caspers Park - CAR
E. Prima Deschecha Channel at Calle Vista Grande - Warm Spot
F. Segunda Deschecha at El Camino Real - Warm Spot
G. Aliso Creek near Orange Avenue - Reconnaissance

Figure 2-6 Overall Values of Nutrients in "First Measurement" Samples from Channels, 1992 – 1995





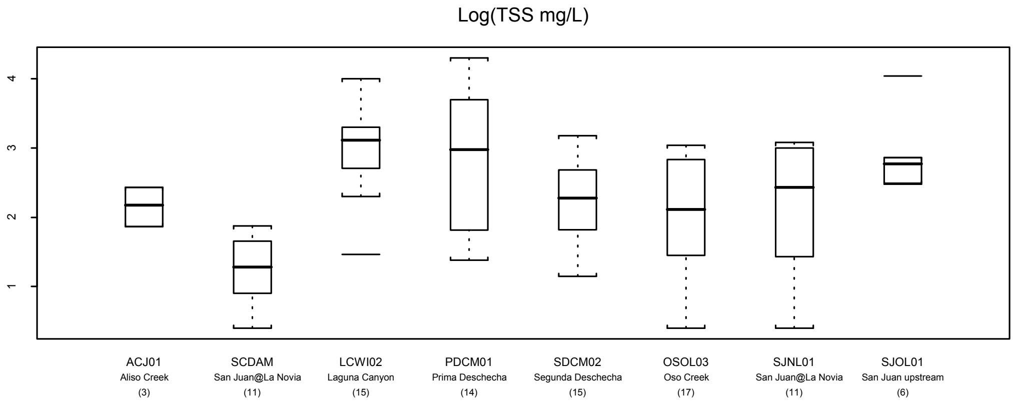


Figure 2-7 Trends of Nitrate in "First Measurement" Samples from Channel Stations, 1992 – 1995

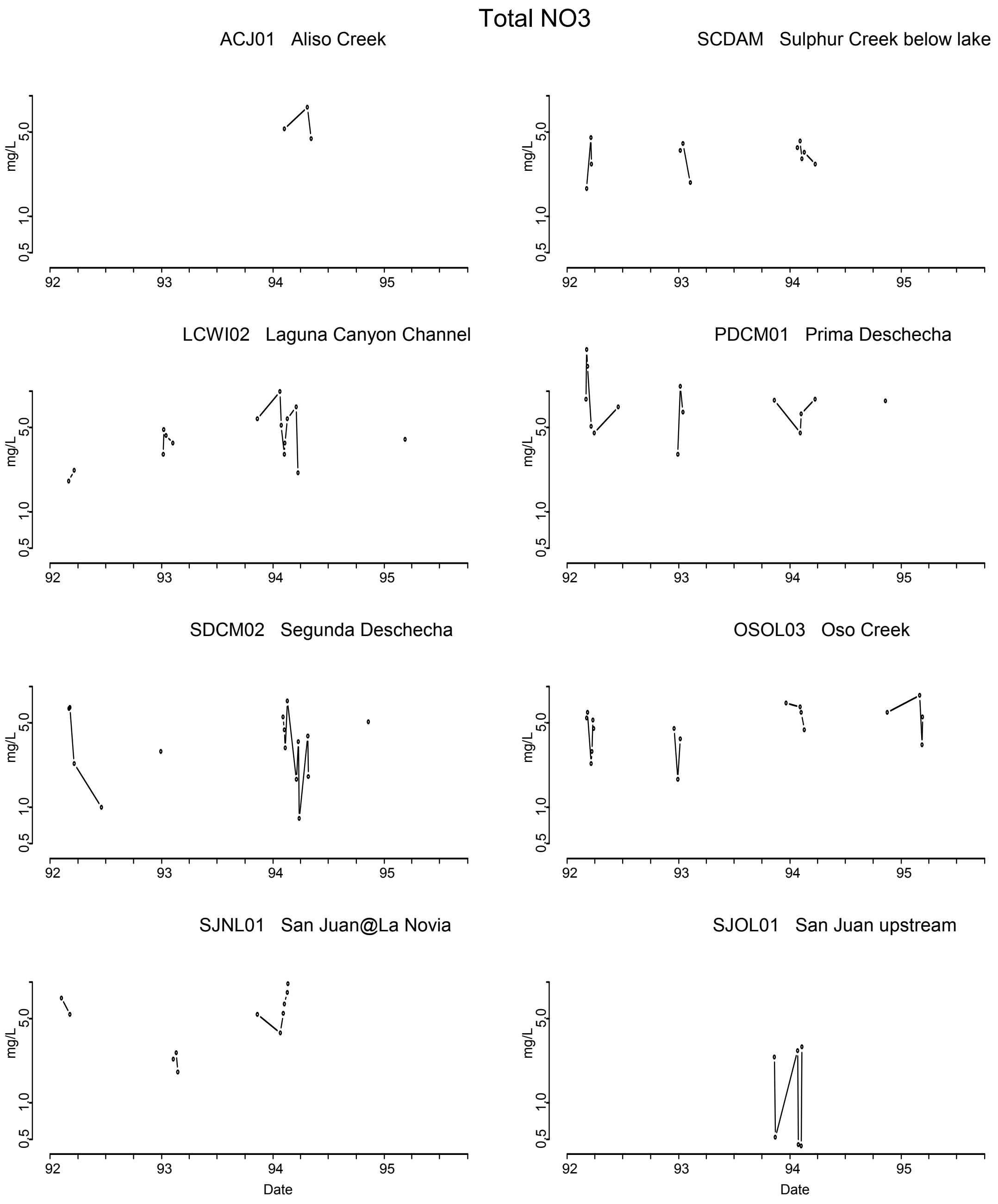


Figure 2-8 Trends of Phosphate in "First Measurement" Samples from Channel Stations from 1992 – 1995

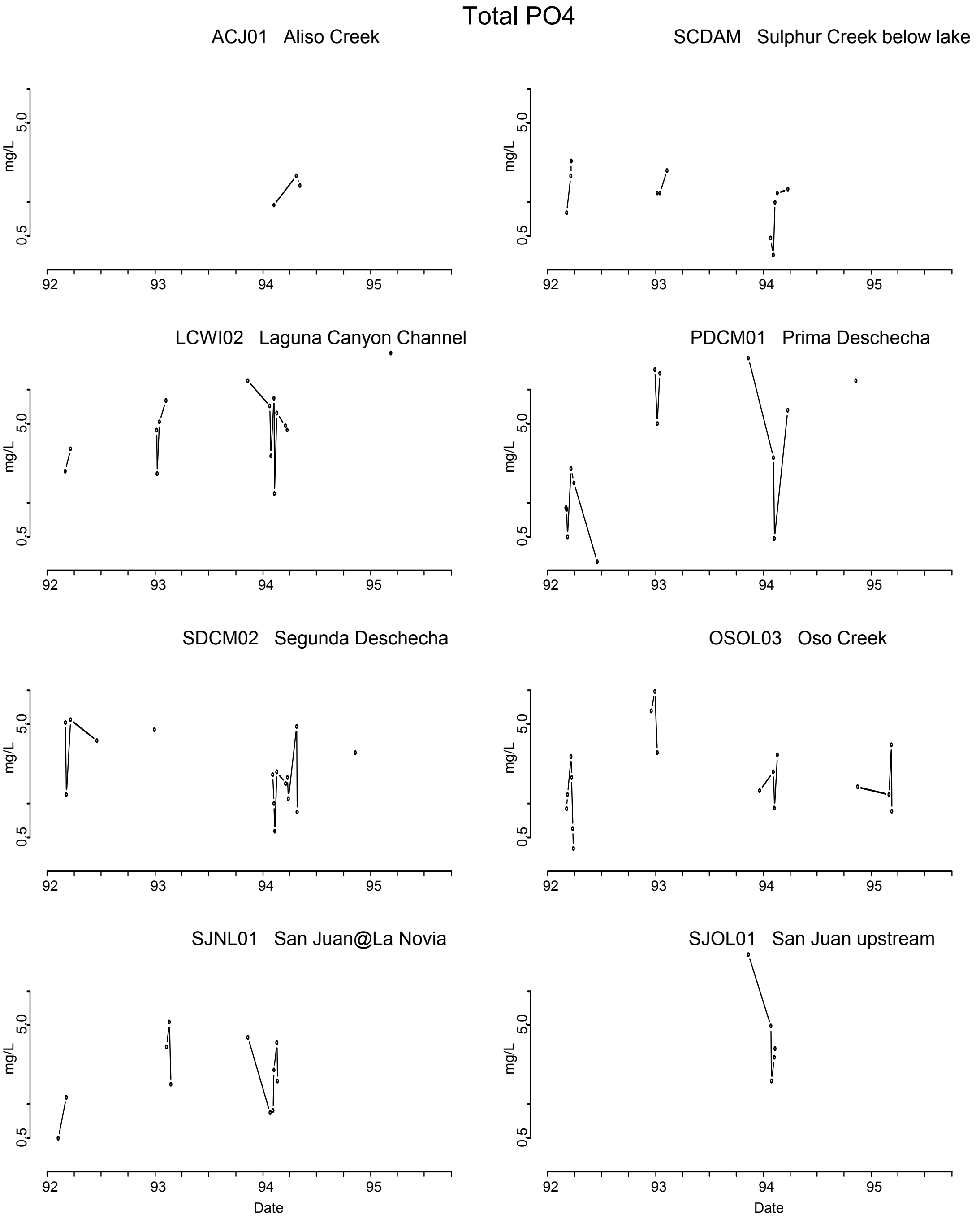


Figure 2-9 Trends of Total Suspended Solids in "First Measurement" Samples from Channel Stations, 1992 – 1995

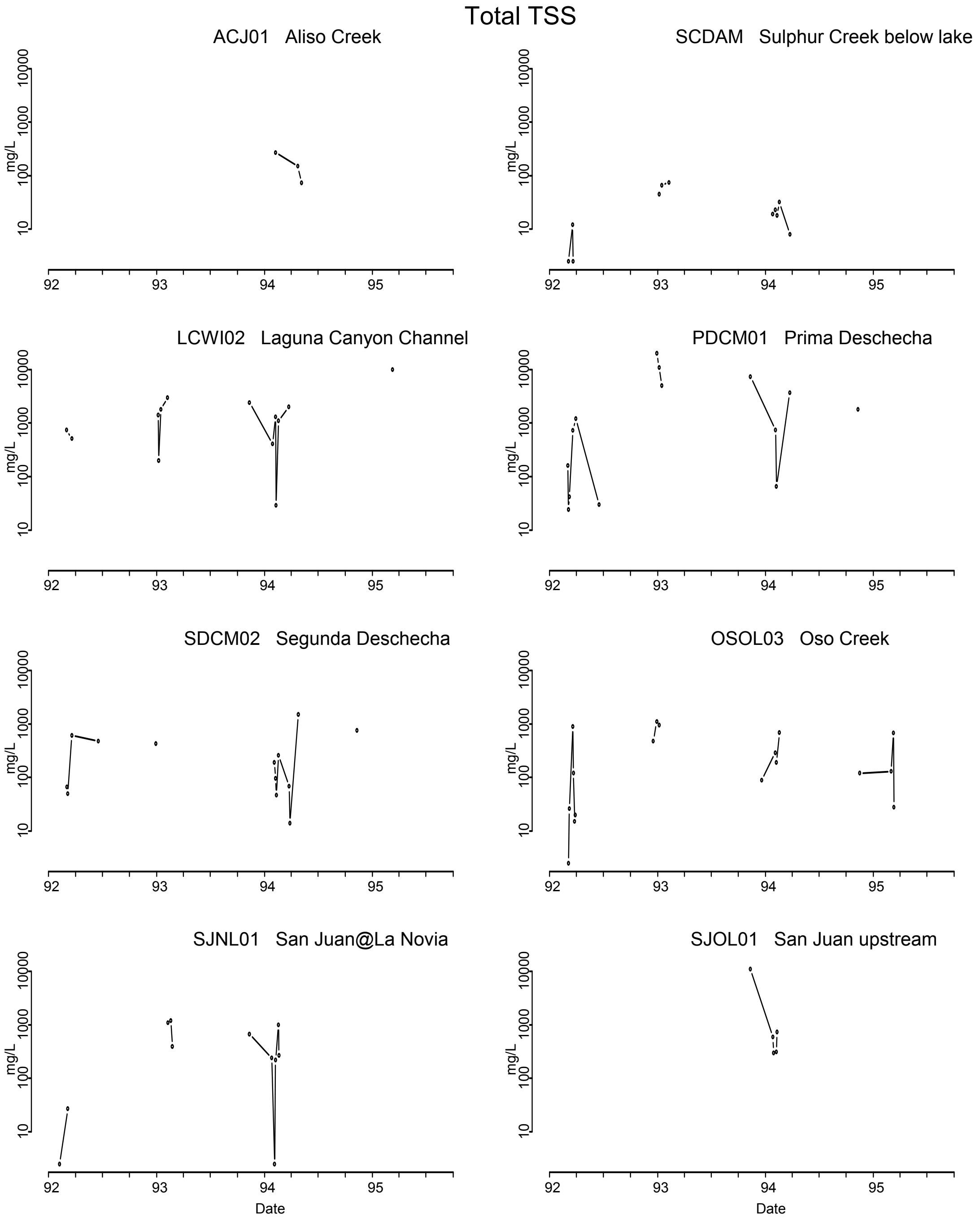


Figure 2-10 Overall Values of Total Metals in "First Flush" Samples from Channels, 1995 – 2001

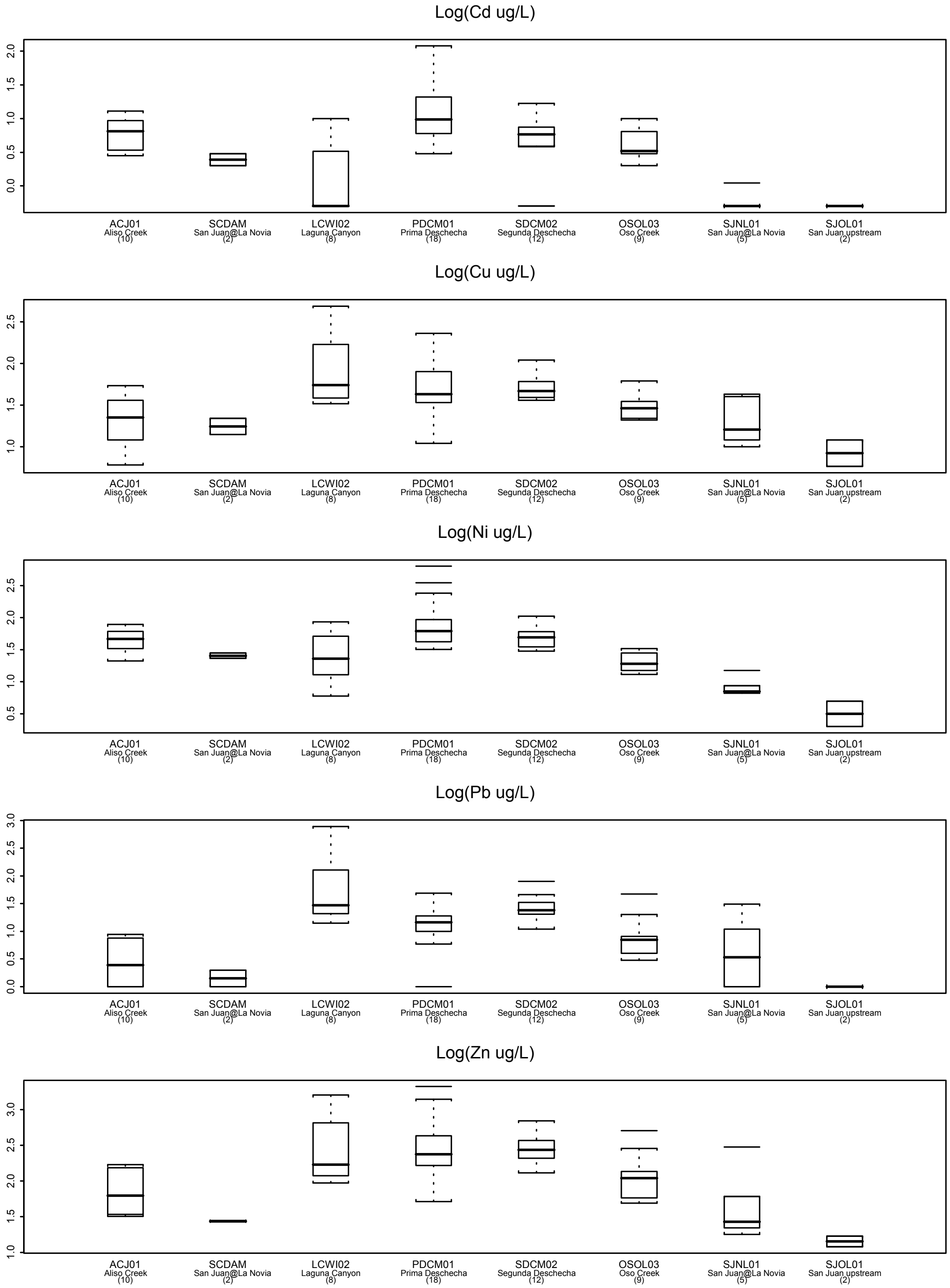


Figure 2-11 Trends of Total Cadmium in "First Flush" Samples from Channel Stations, 1995 – 2001

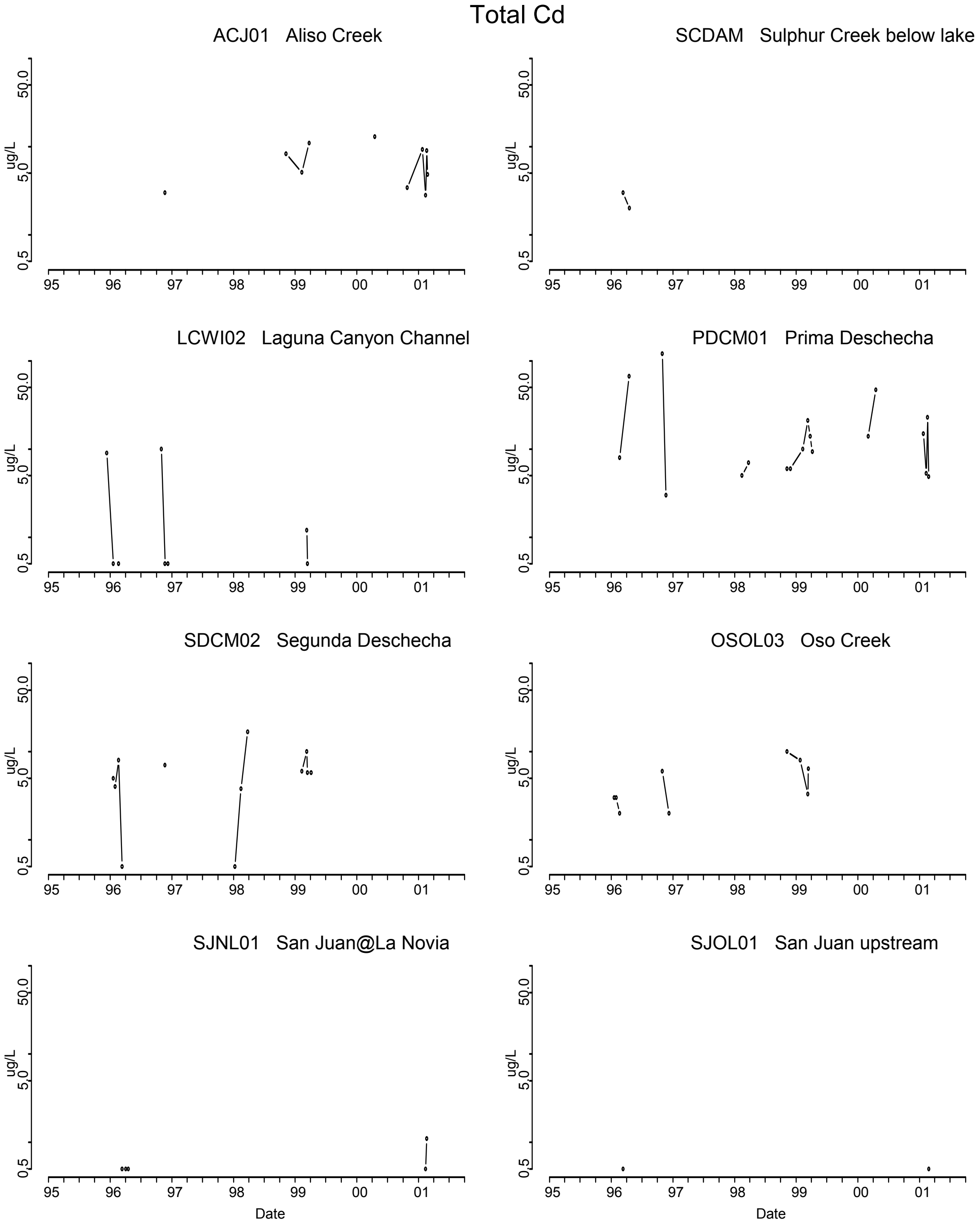


Figure 2-12 Trends of Total Copper in "First Flush" Samples from Channel Stations, 1995 – 2001

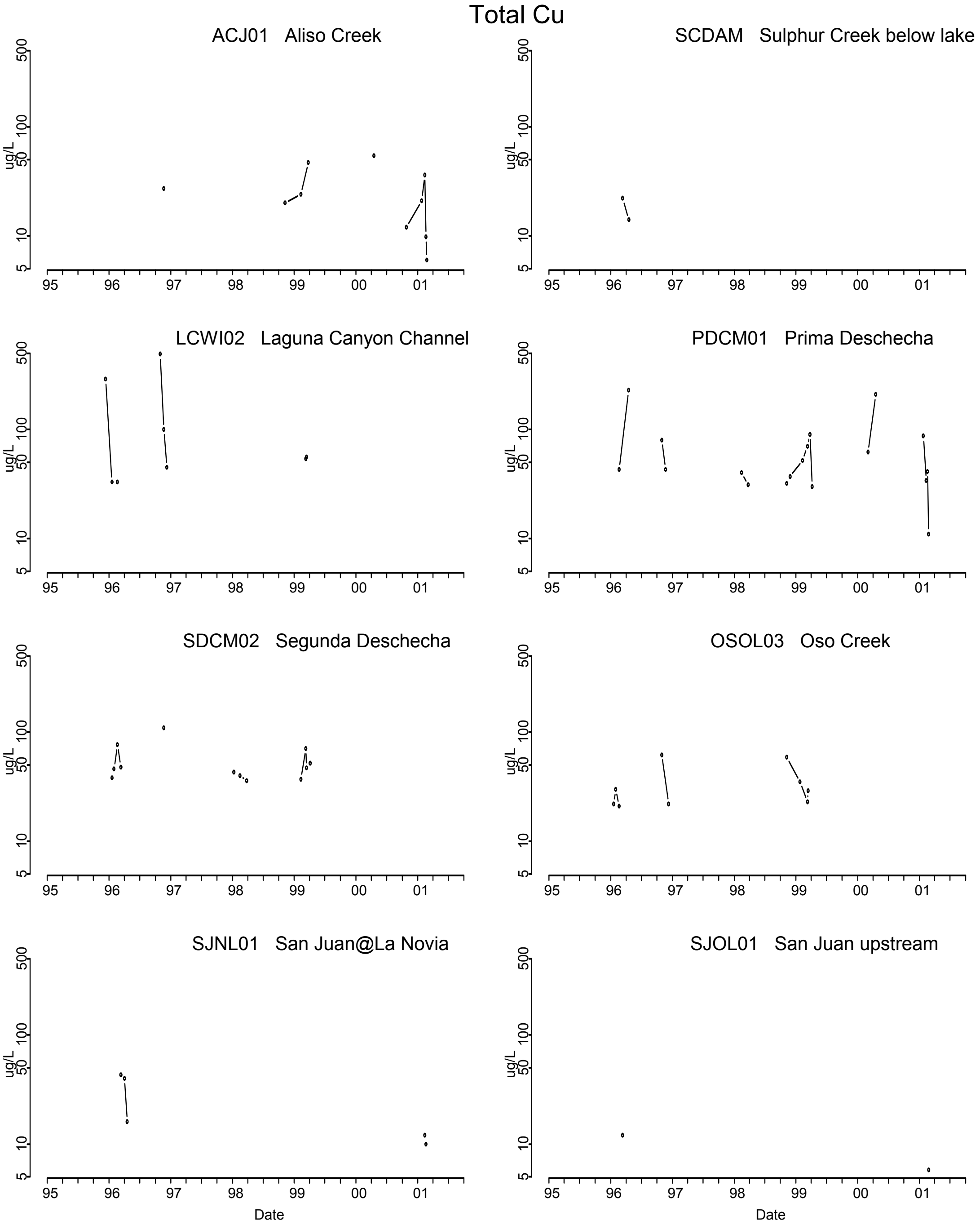


Figure 2-13 Trends of Total Nickel in "First Flush" Samples from Channel Stations, 1995 – 2001

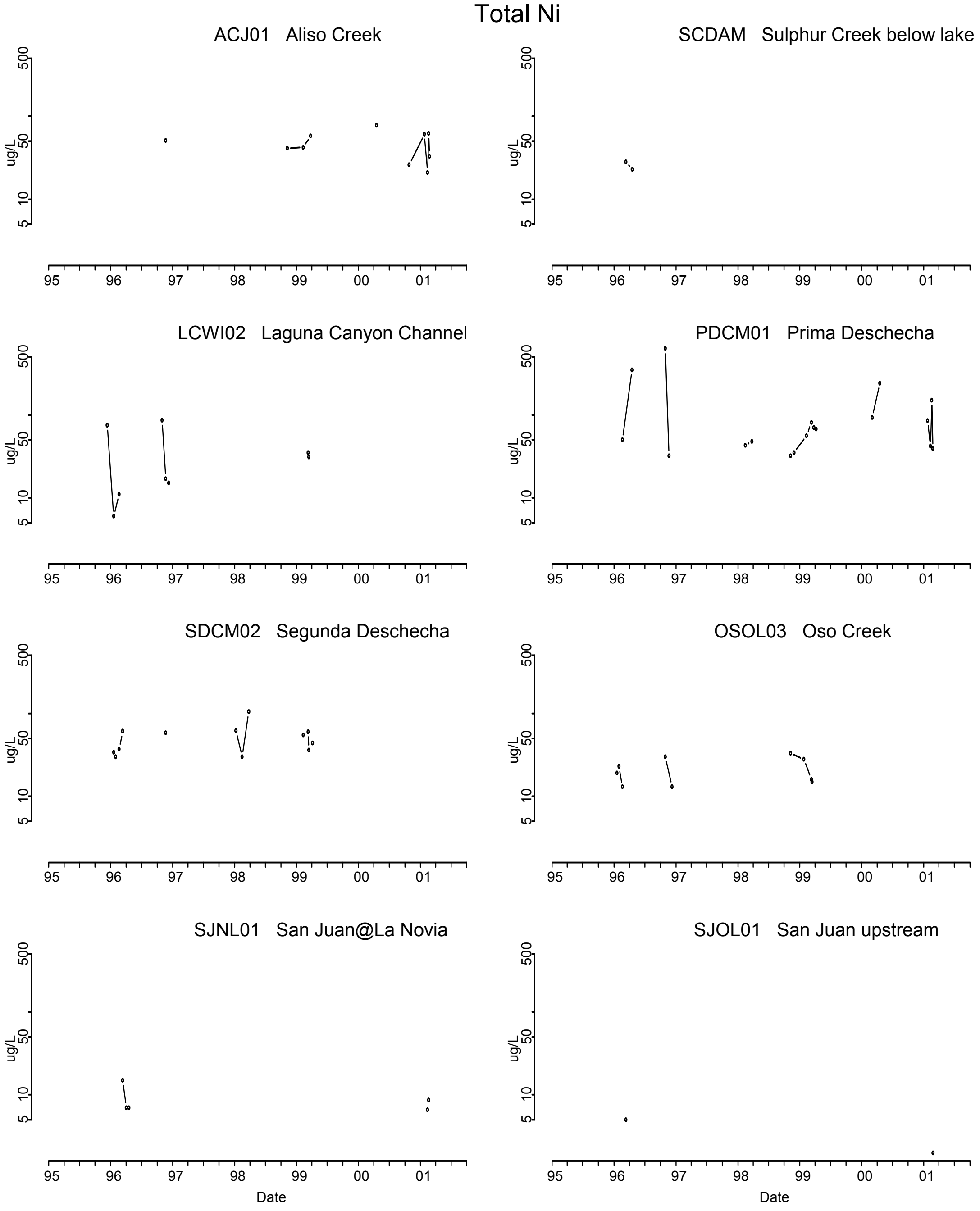


Figure 2-14 Trends of Total Lead in "First Flush" Samples from Channel Stations, 1995 – 2001

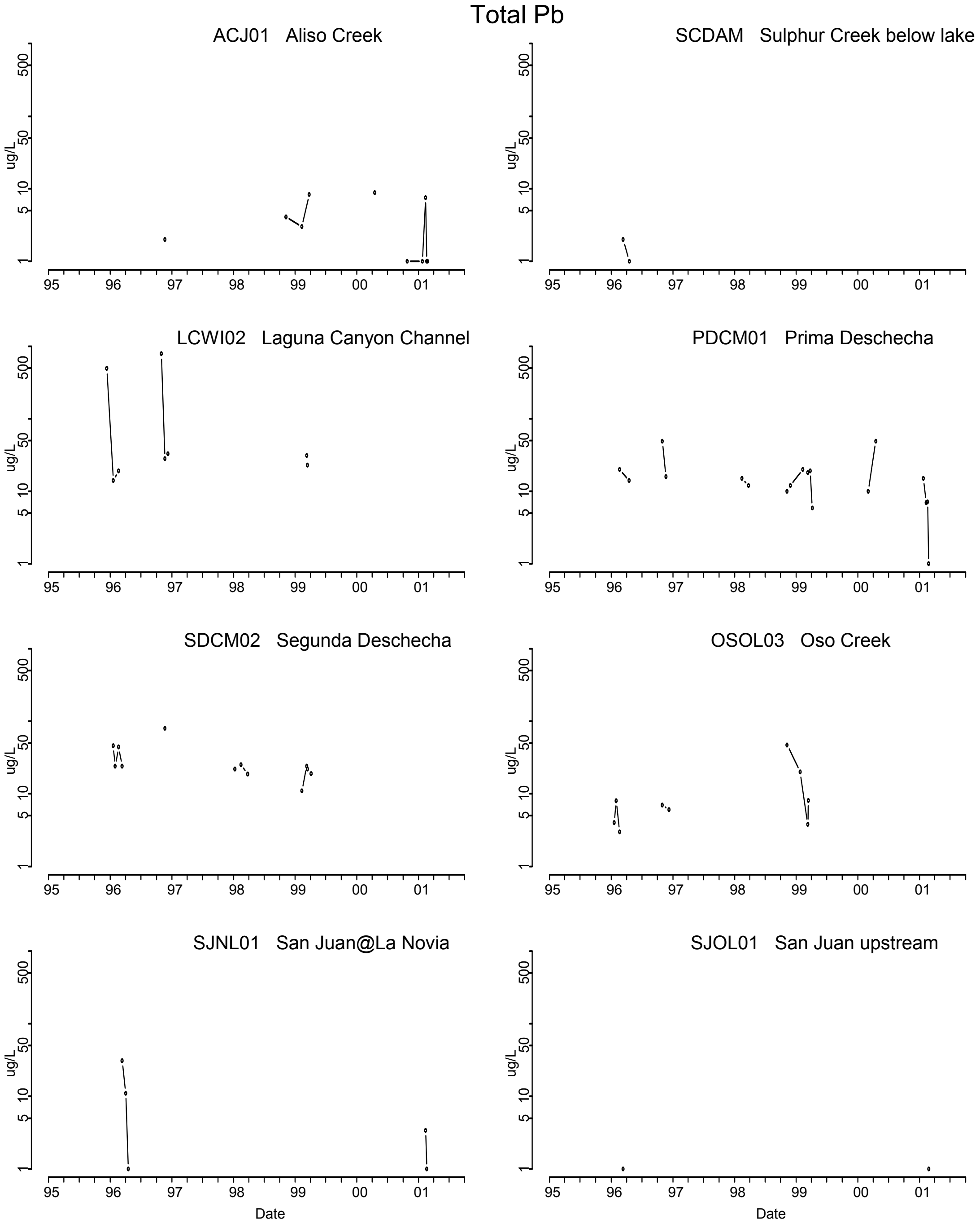


Figure 2-15 Trends of Total Zinc in “First Flush” Samples from Channel Stations, 1995 – 2001

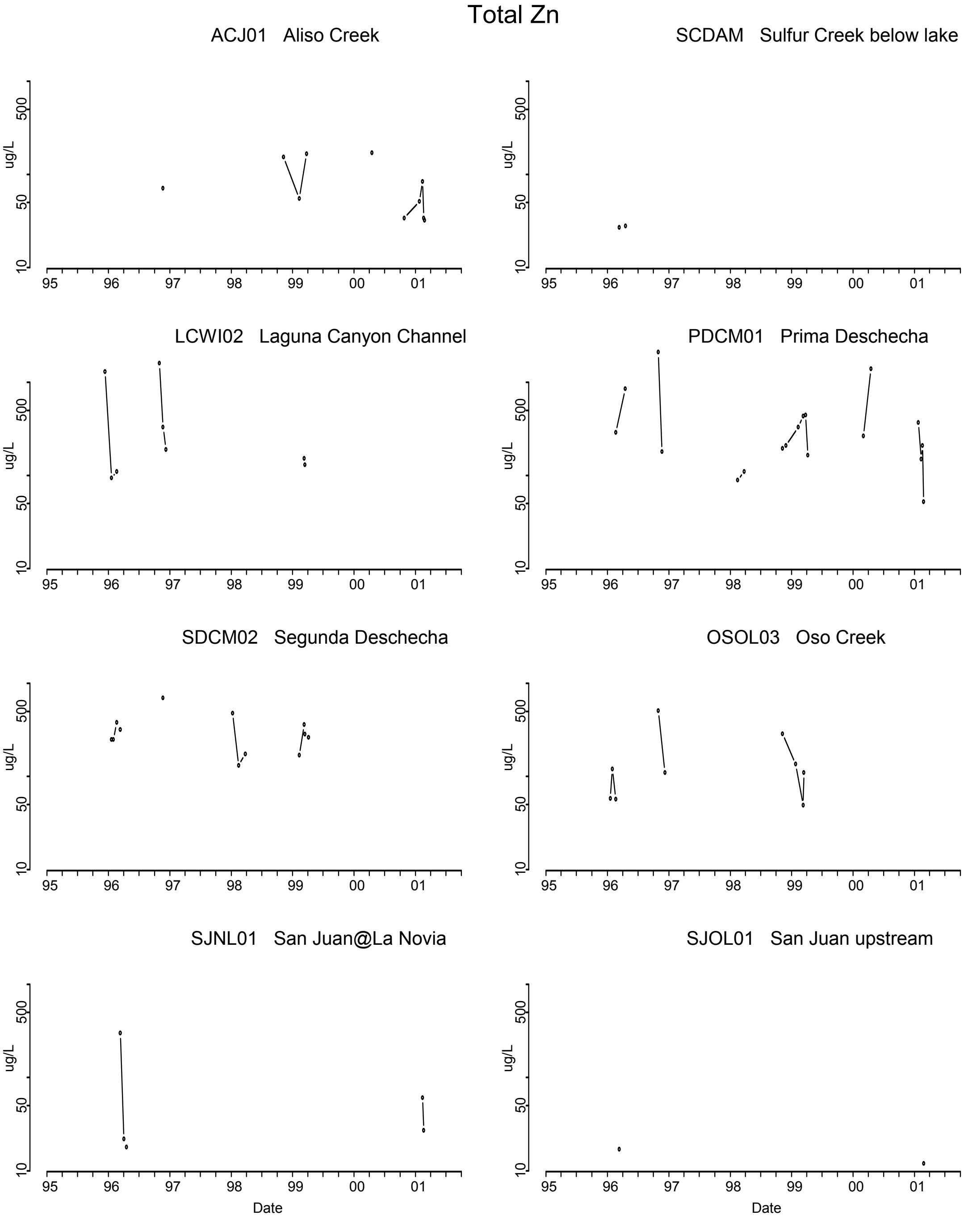


Figure 2-16 Overall Values of Dissolved Metals in "First Flush" Samples from Channels, 1995 – 2001

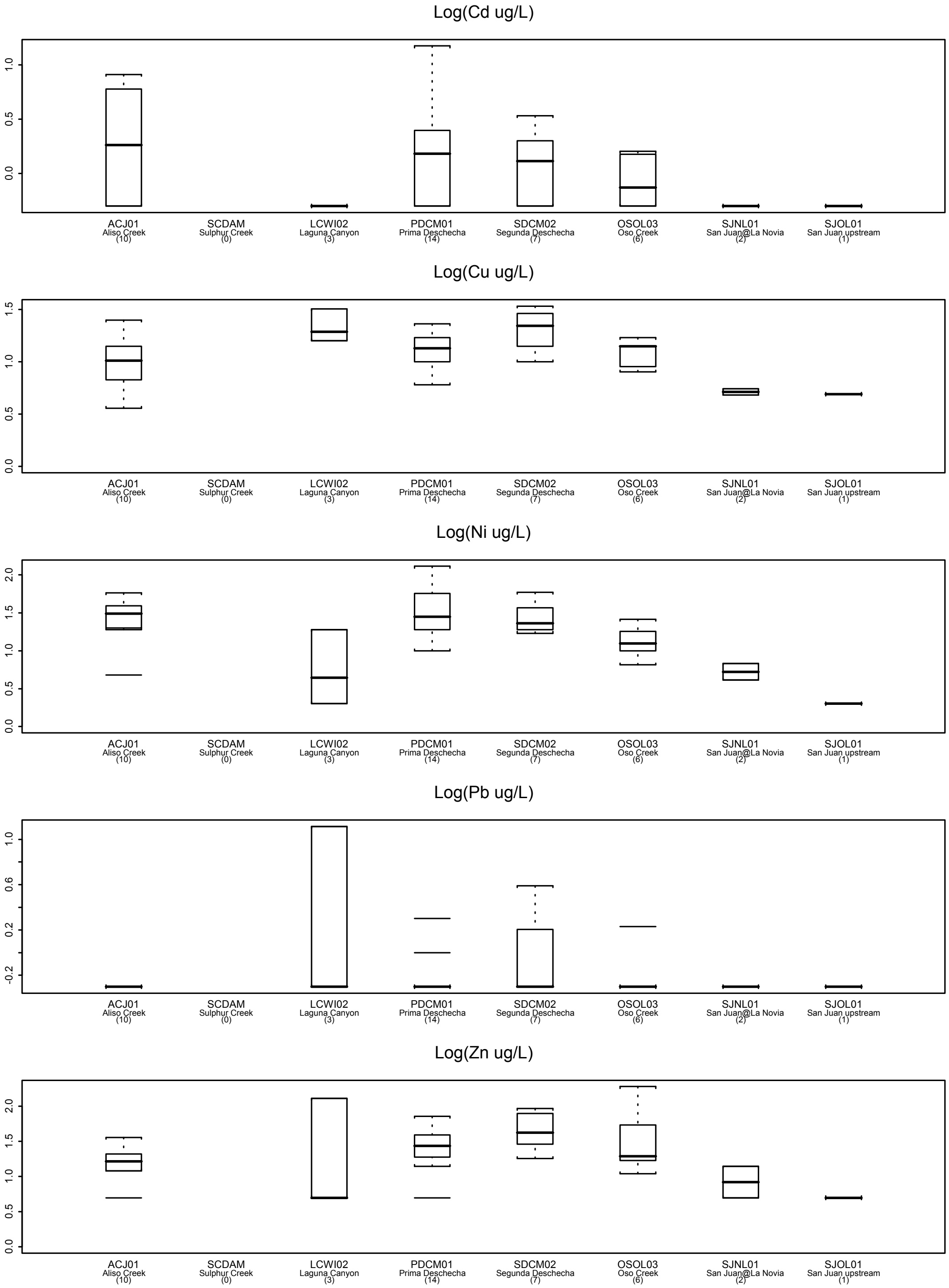
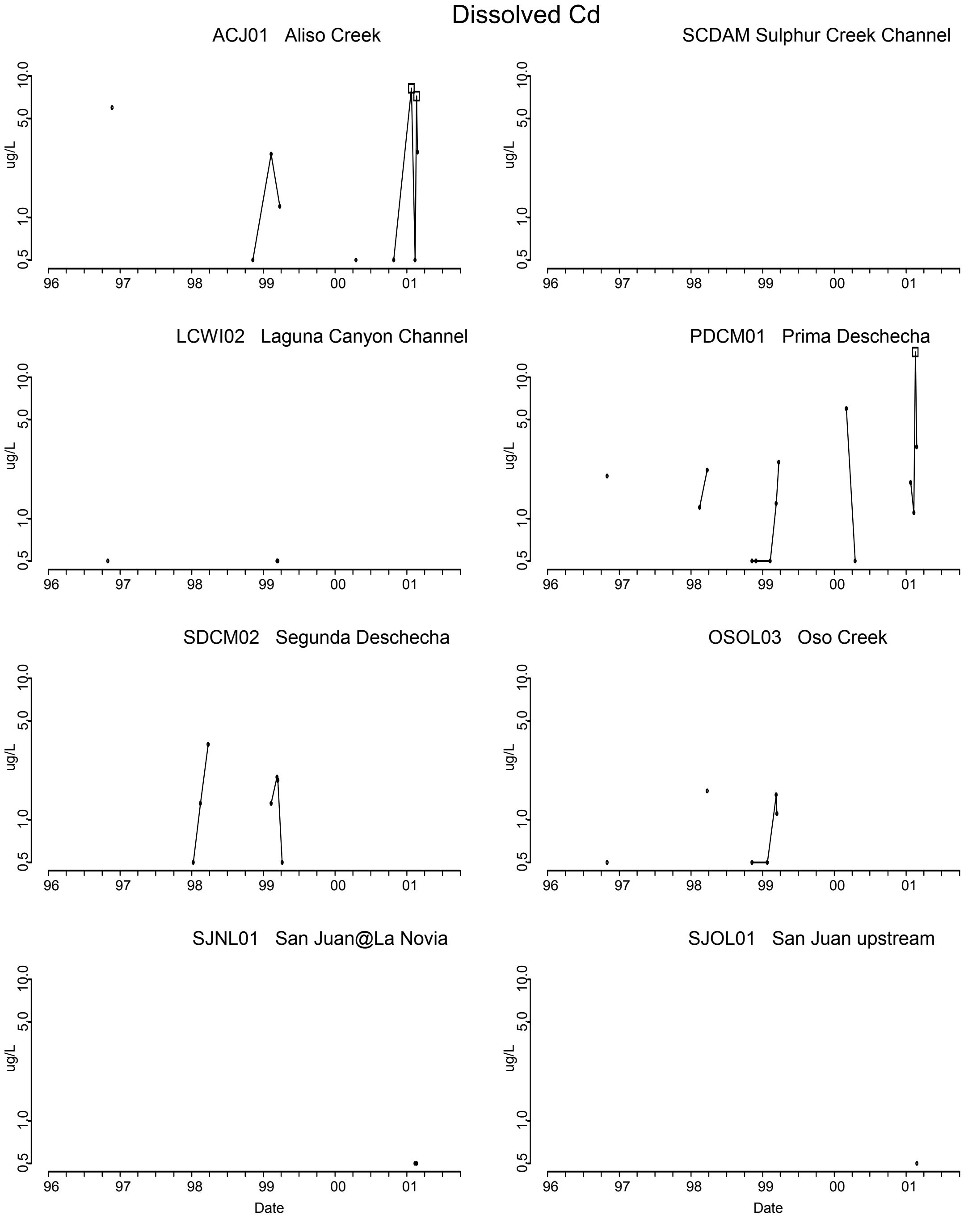
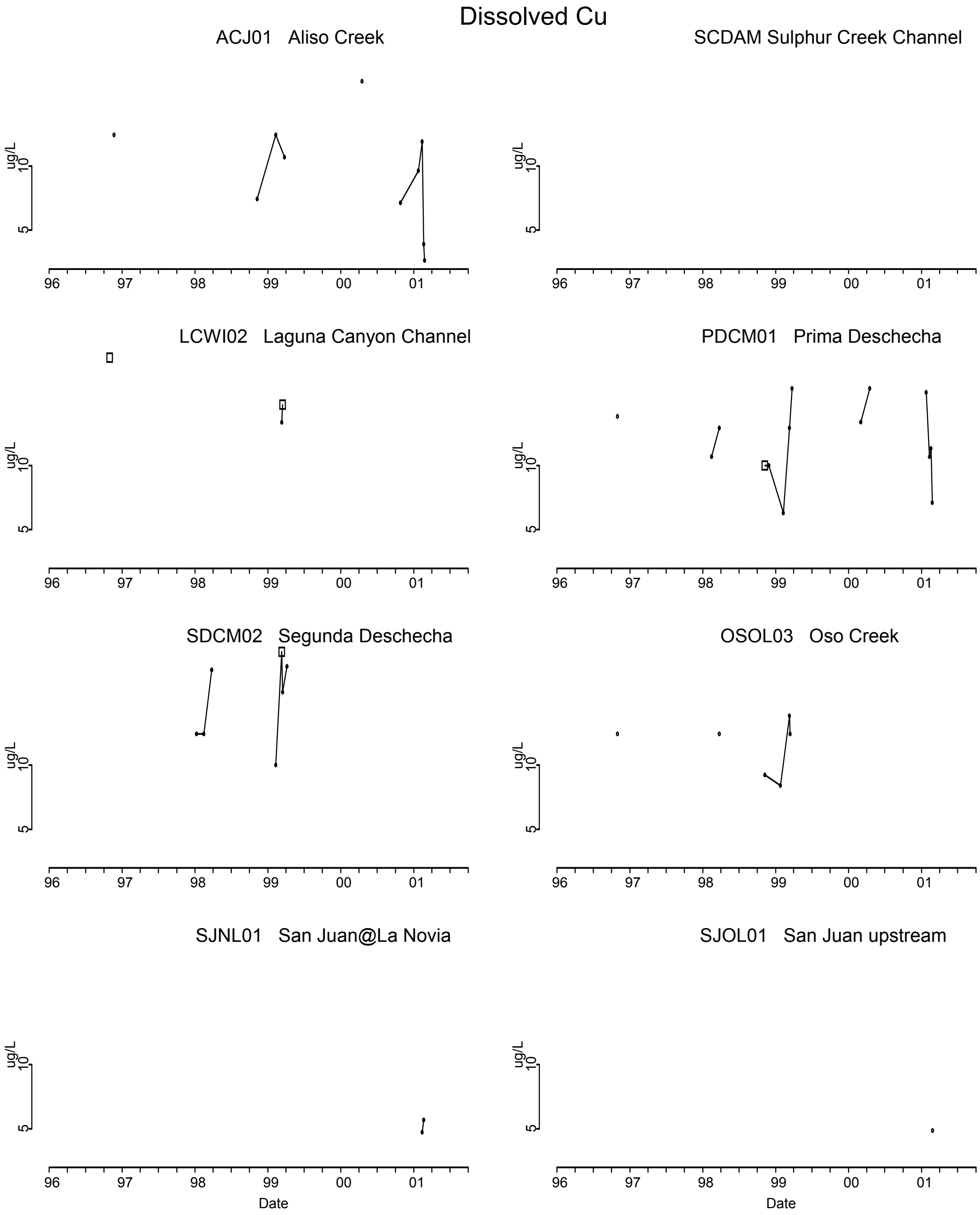


Figure 2-17 Trends of Dissolved Cadmium in "First Flush" Samples from Channel Stations, 1995 – 2001



Small squares on the plot indicate an exceedance of the California Toxics Rule guideline, adjusted for water hardness.

Figure 2-18 Trends of Dissolved Copper in "First Flush" Samples from Channel Stations, 1995 – 2001



Small squares on the plot indicate an exceedance of the California Toxics Rule guideline, adjusted for water hardness.

Figure 2-19 Trends of Dissolved Nickel in "First Flush" Samples from Channel Stations, 1995 – 2001

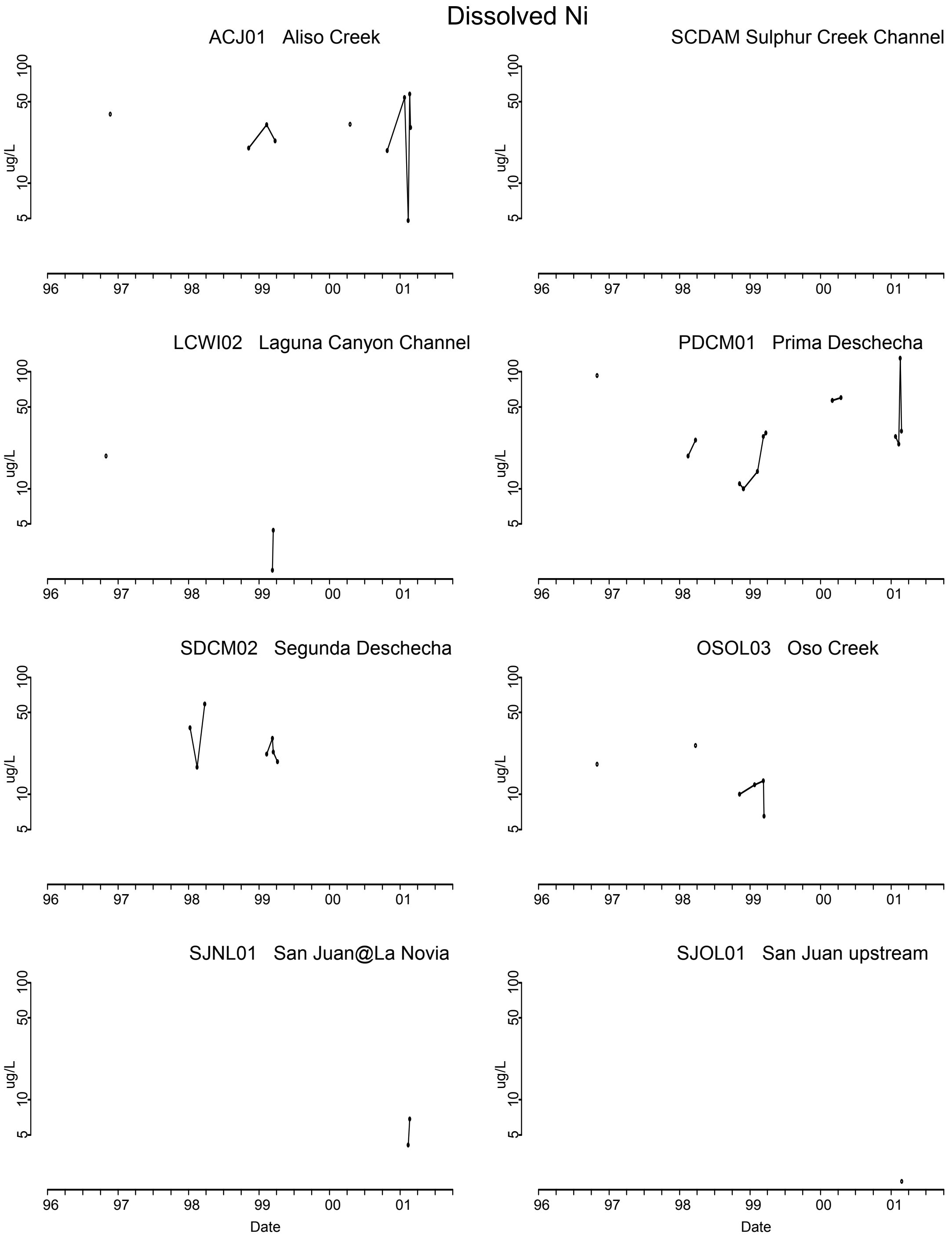


Figure 2-20 Trends of Dissolved Lead in “First Flush” Samples from Channel Stations, 1995 – 2001

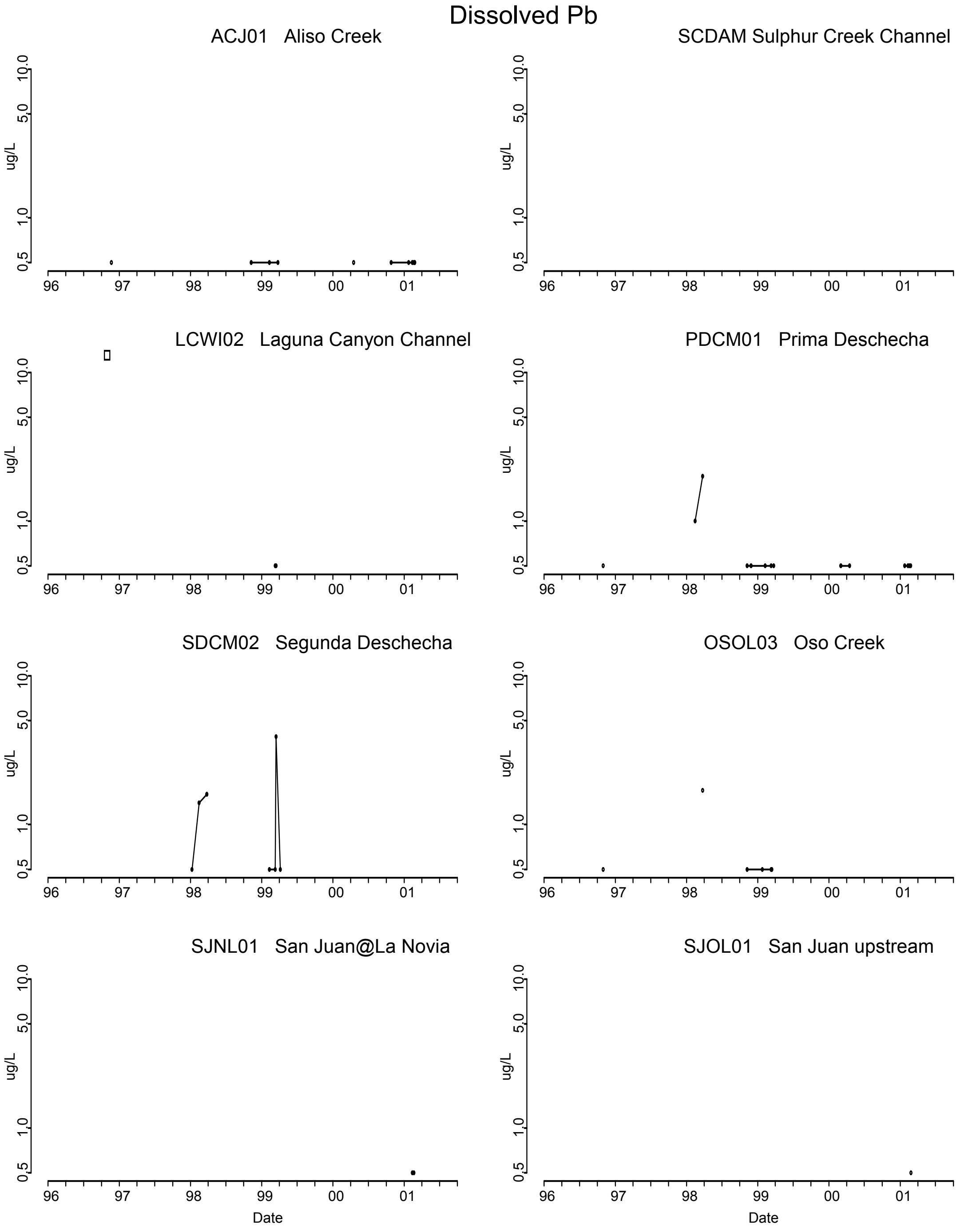


Figure 2-21 Trends of Dissolved Zinc in “First Flush” Samples from Channel Stations, 1995 – 2001

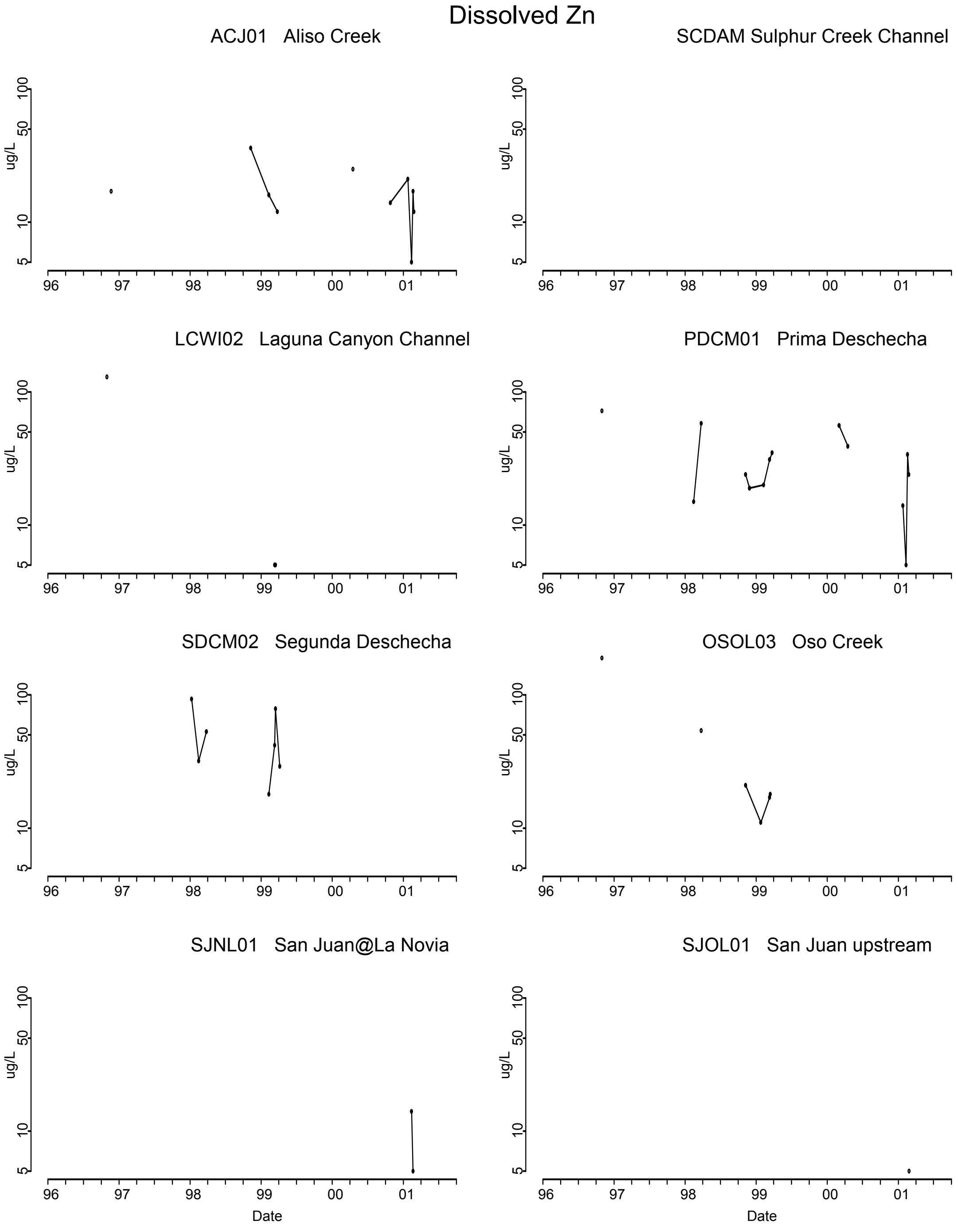
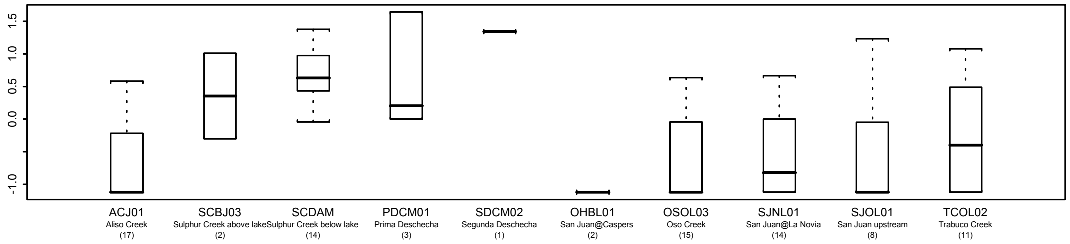
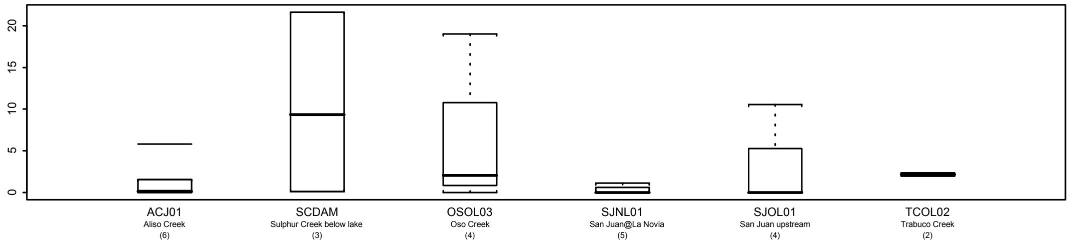


Figure 2-22a Overall Values of Constituents in Sediment Samples from Channels, 1991 – 2000

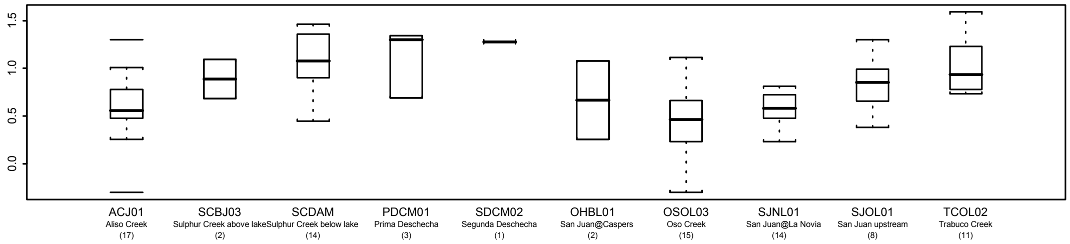
Log(Cd mg/kg)



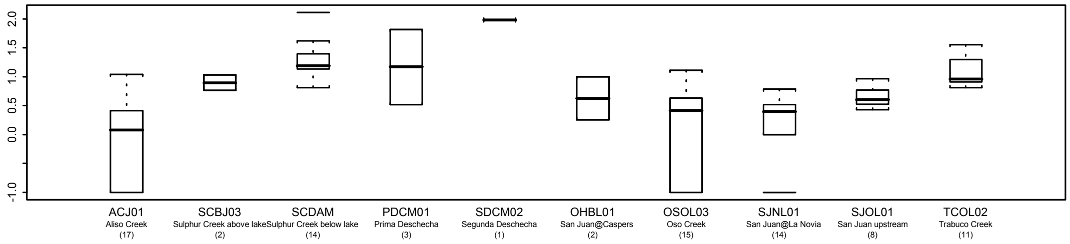
Clay %



Log(Cr mg/kg)



Log(Cu mg/kg)



Log(Fe mg/kg)

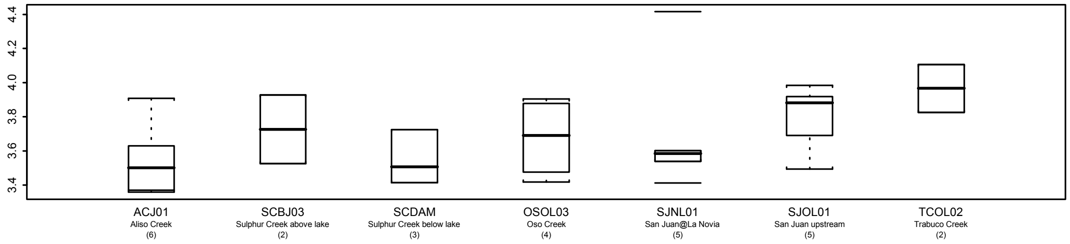


Figure 2-22b Overall Values of Constituents in Sediment Samples from Channels, 1991 – 2000

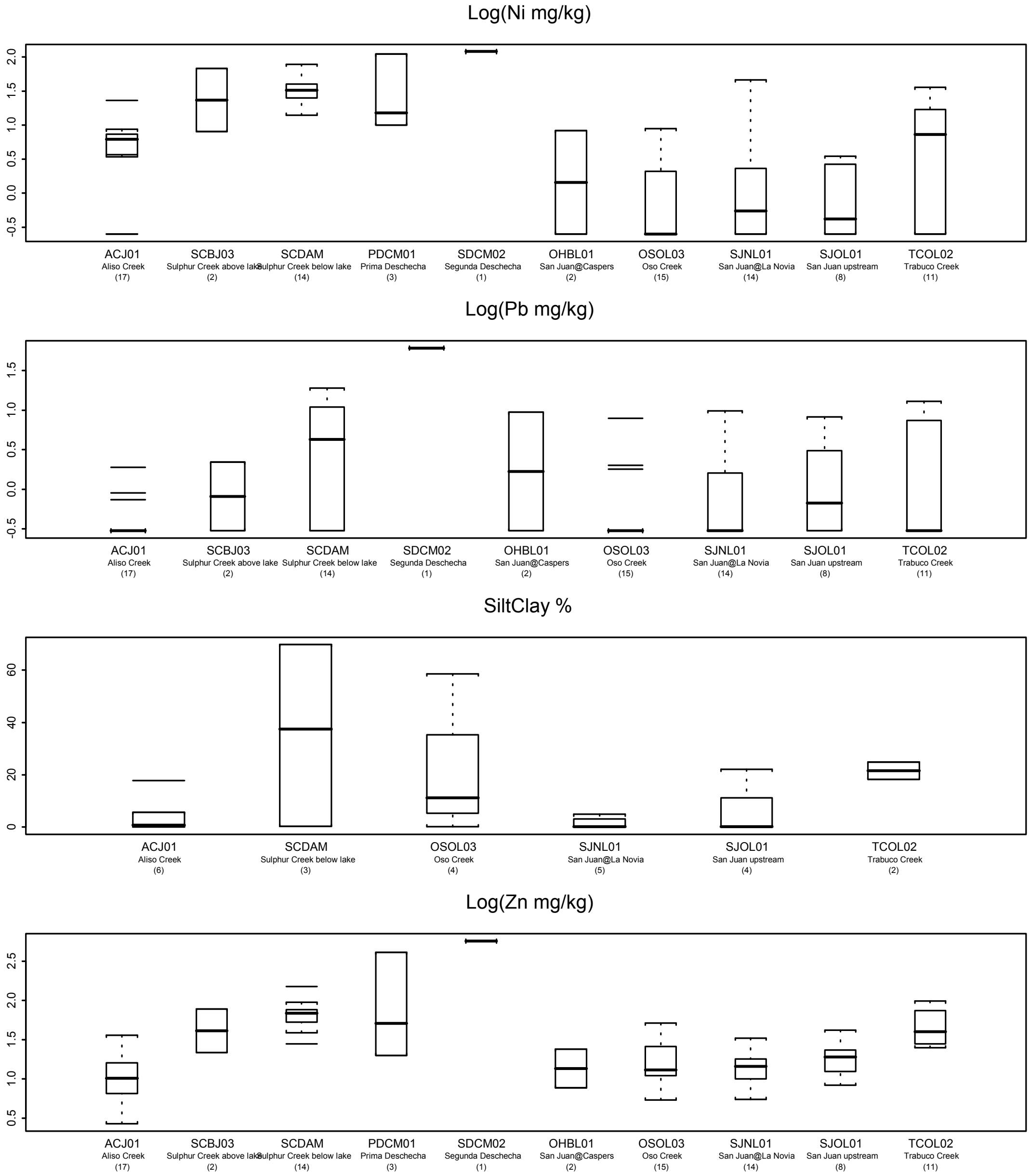
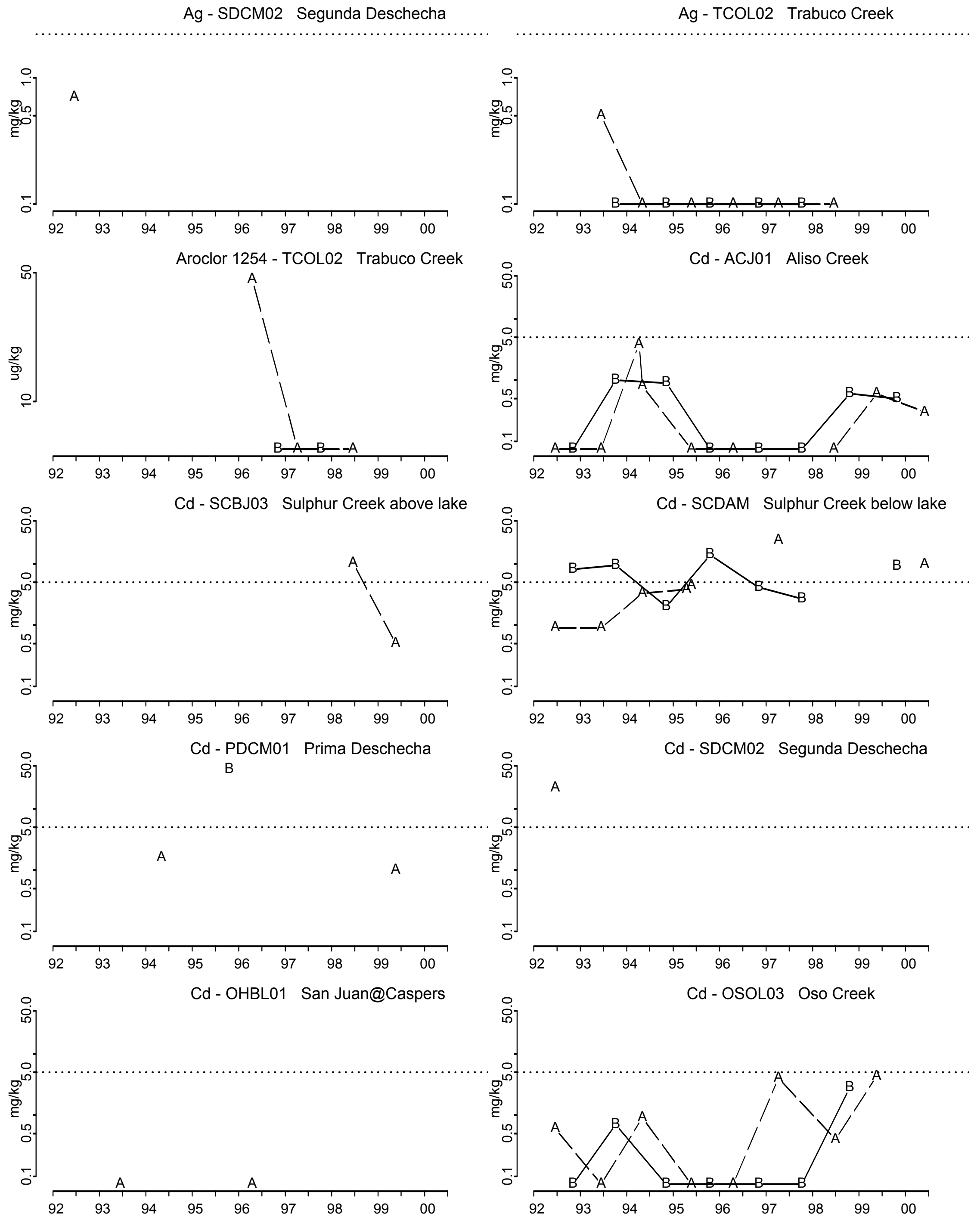
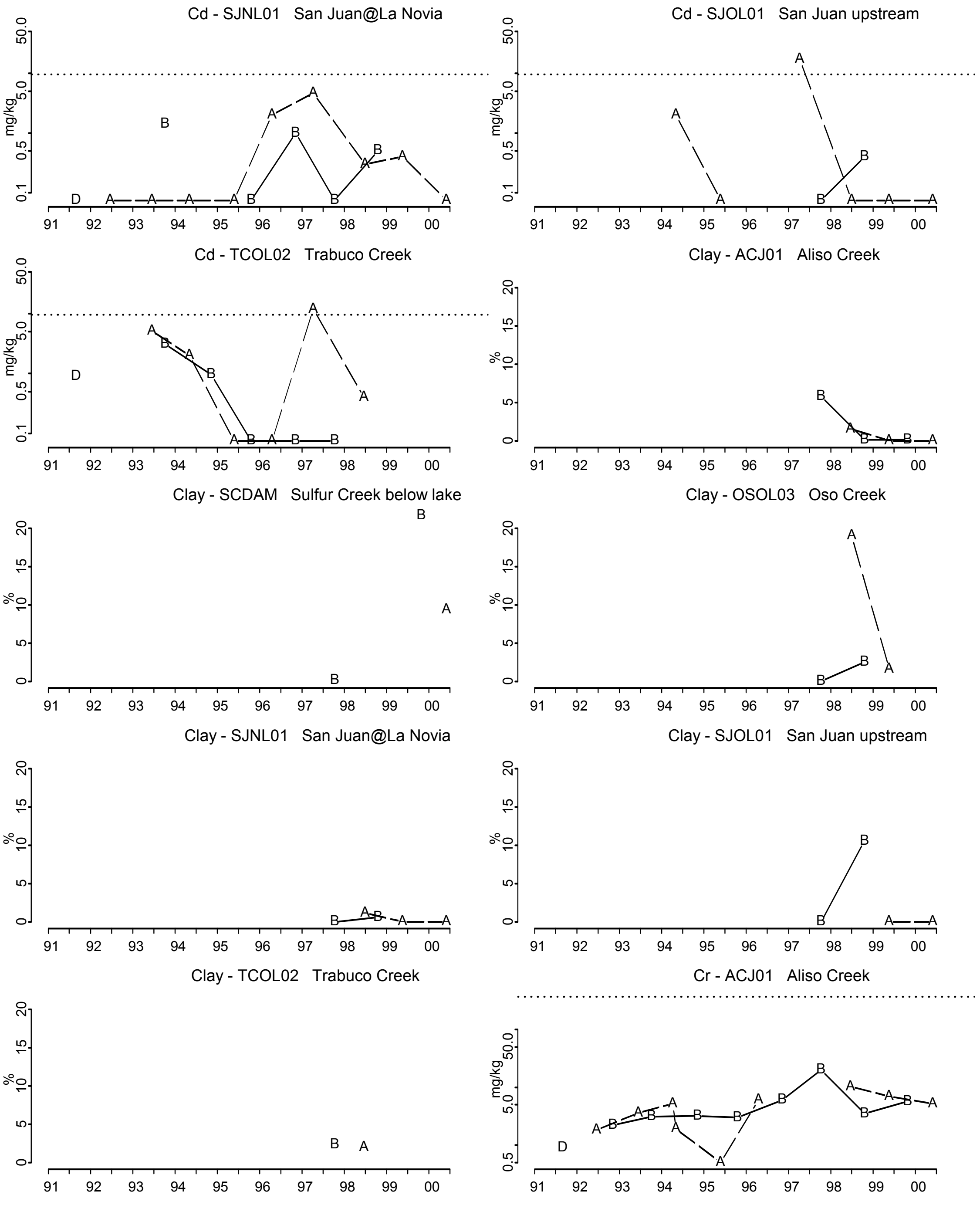


Figure 2-23 Trends of Silver, Aroclor 1254, and Cadmium in Sediment Samples from Channel Stations, 1991 – 2000



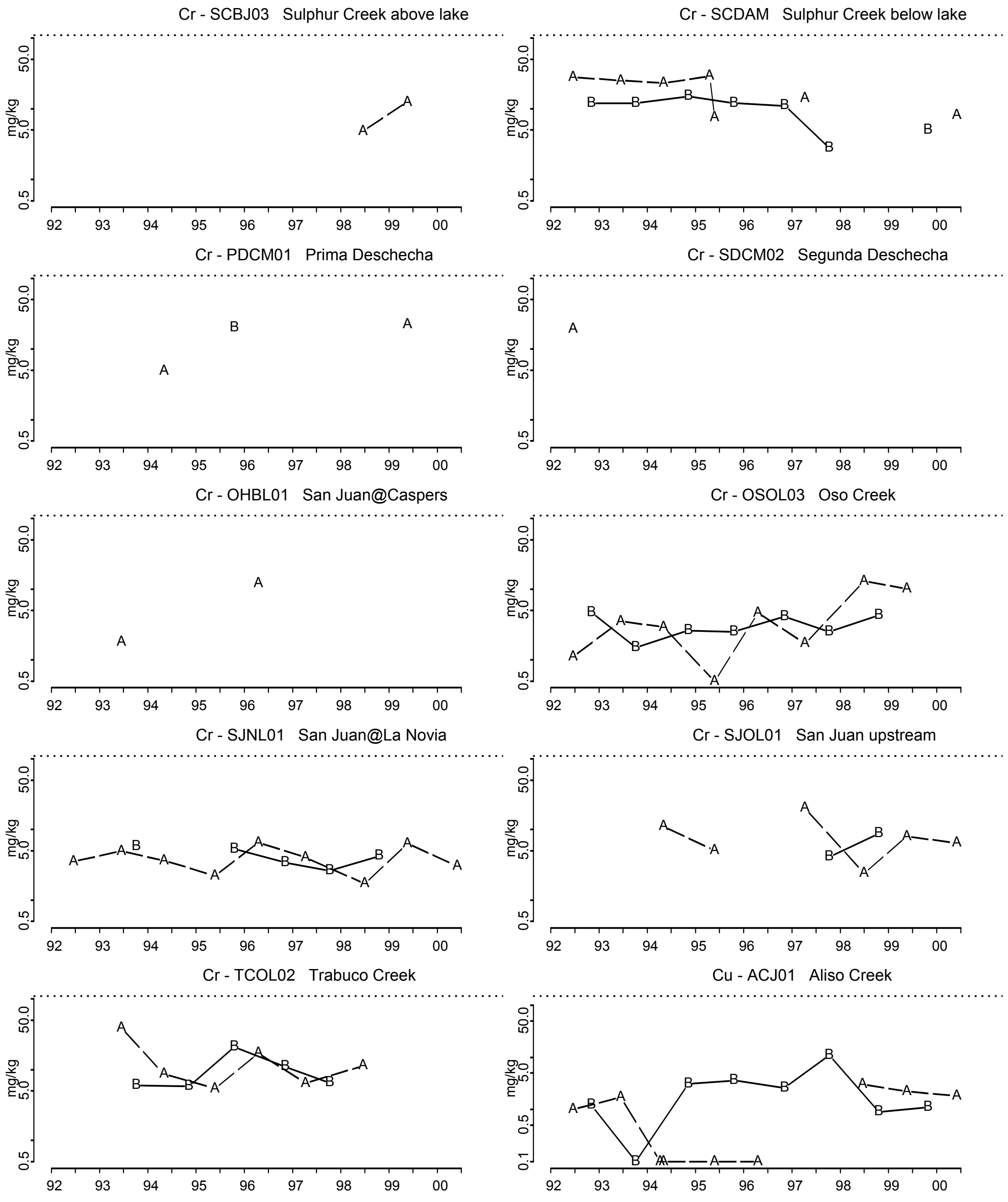
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-24 Trends of Cadmium, Clay, and Chromium in Sediment Samples from Channel Stations, 1991 – 2000



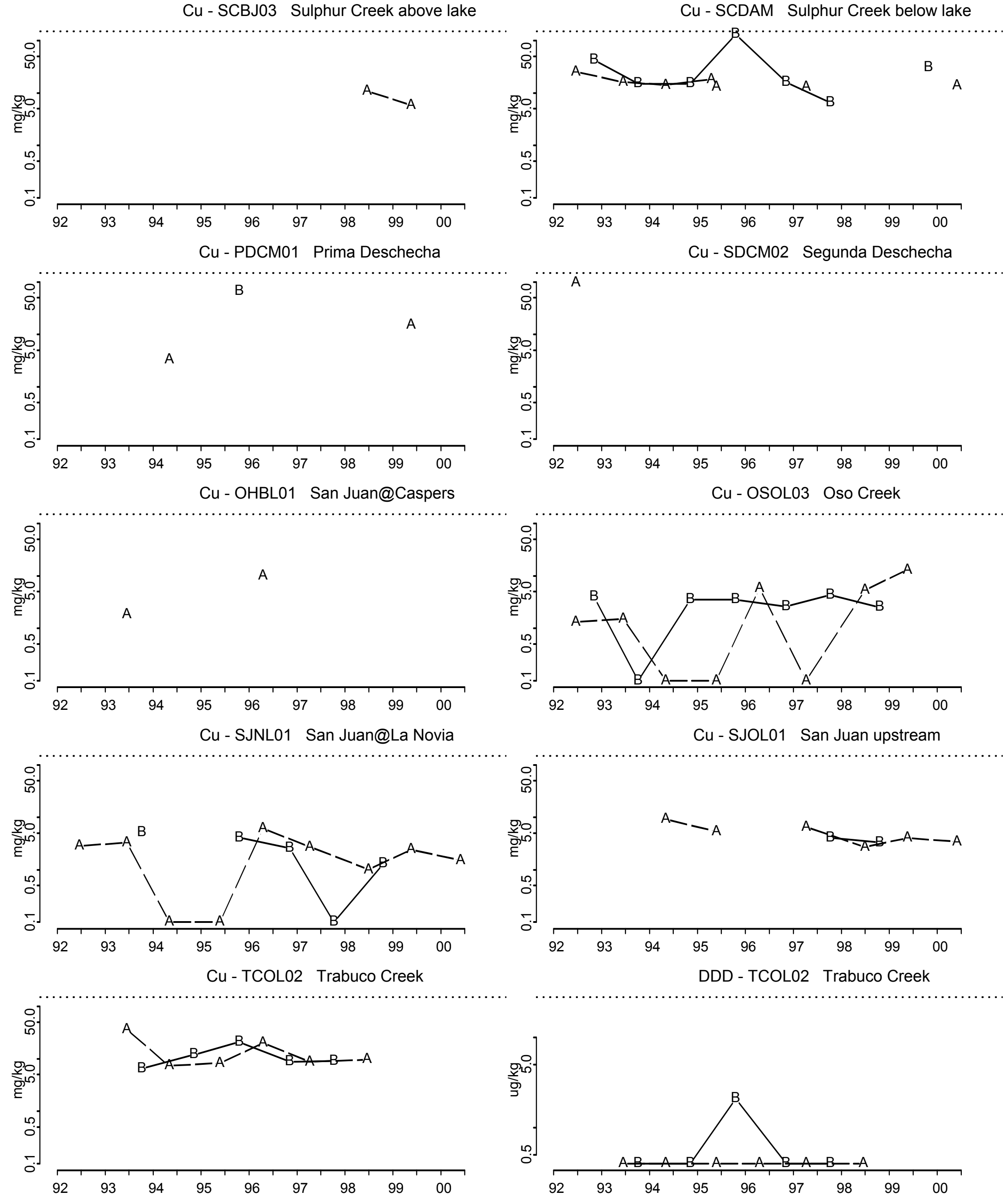
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-25 Trends of Chromium and Copper in Sediment Samples from Channel Stations, 1991 – 2000



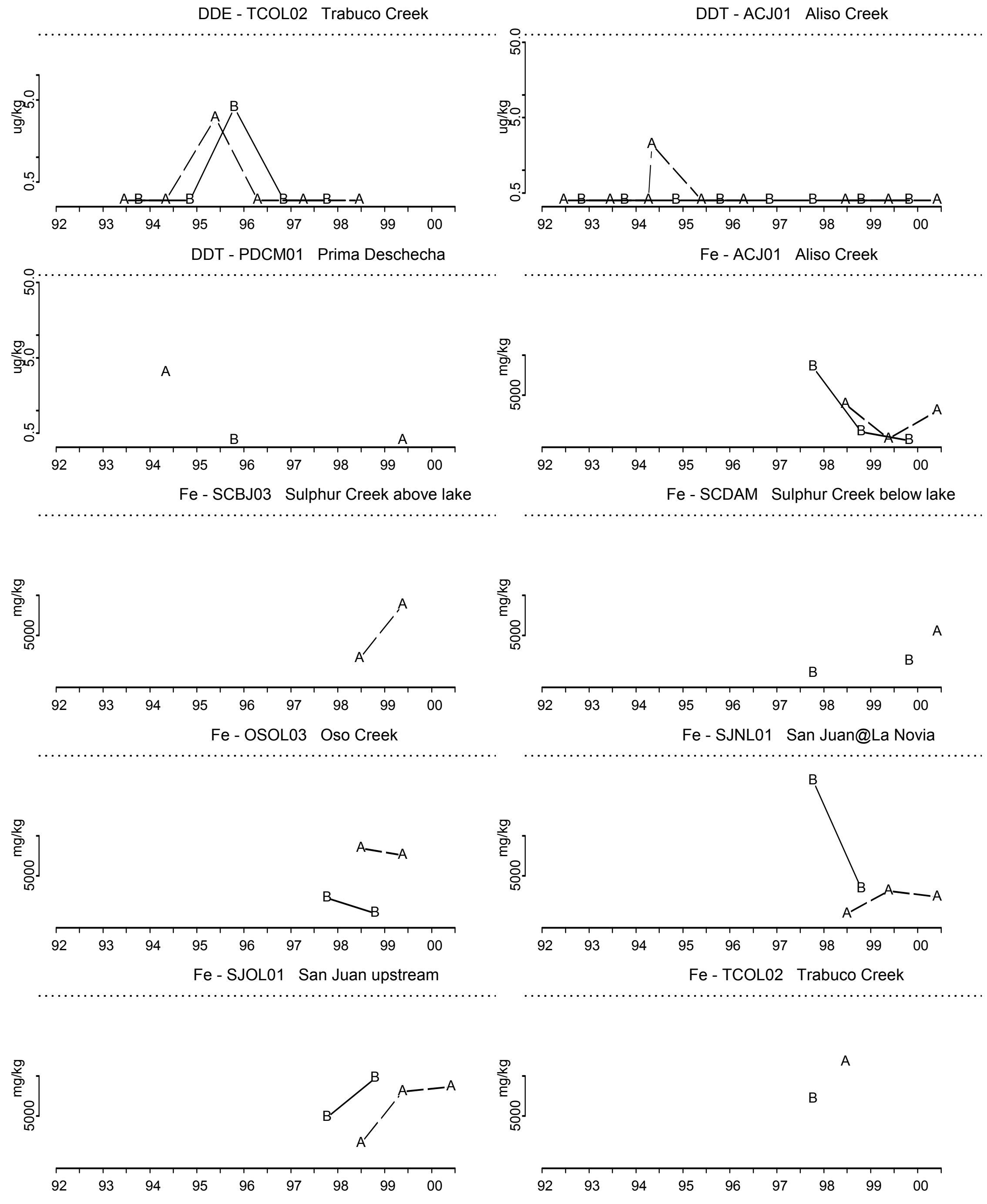
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-26 Trends of Copper and DDD in Sediment Samples from Channel Stations, 1991 – 2000



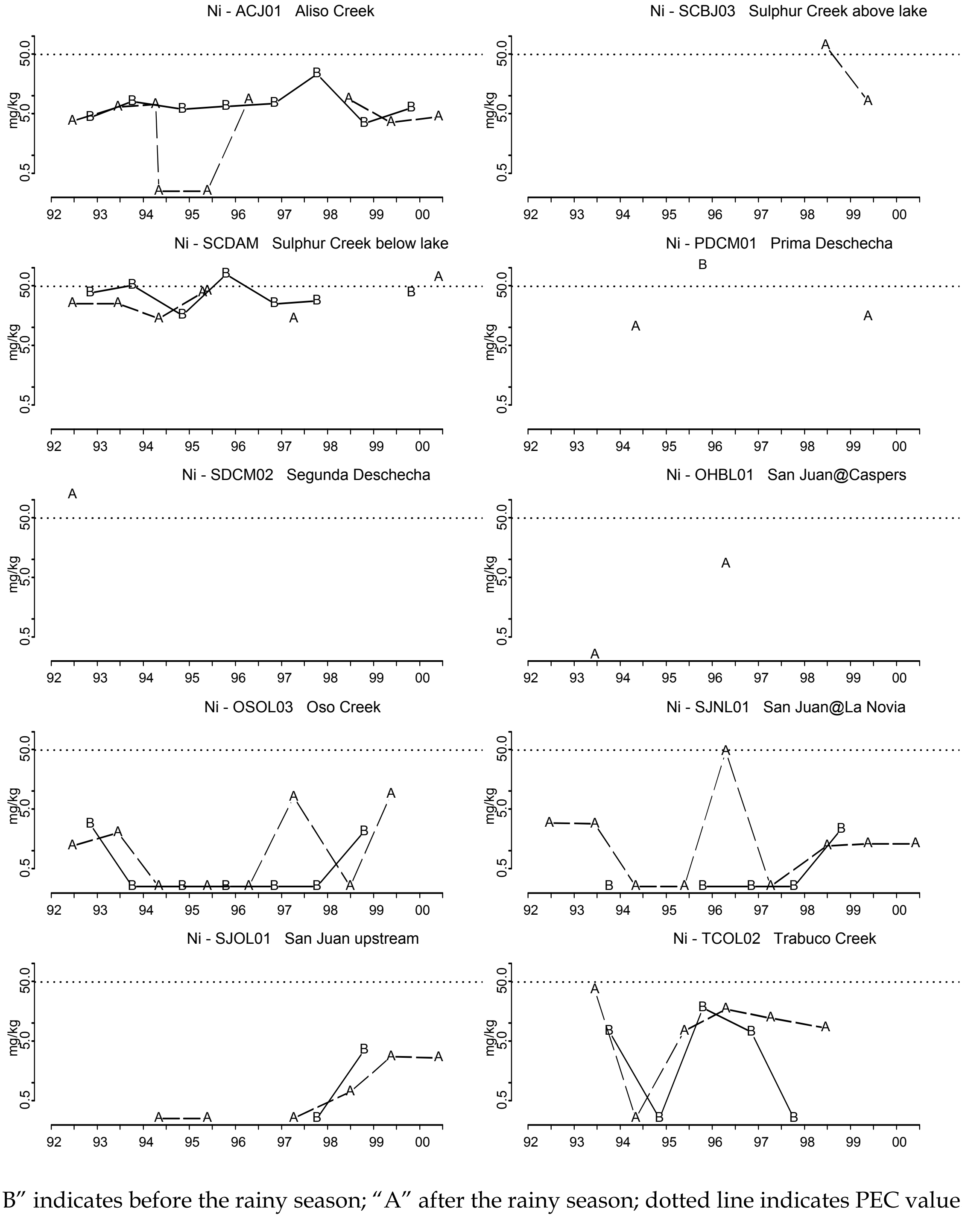
"B" indicates before the rainy season; "A" after the rainy season; otted line indicates PEC value.

Figure 2-27 Trends of DDE, DDT, and Iron in Sediment Samples from Channel Stations, 1991 – 2000



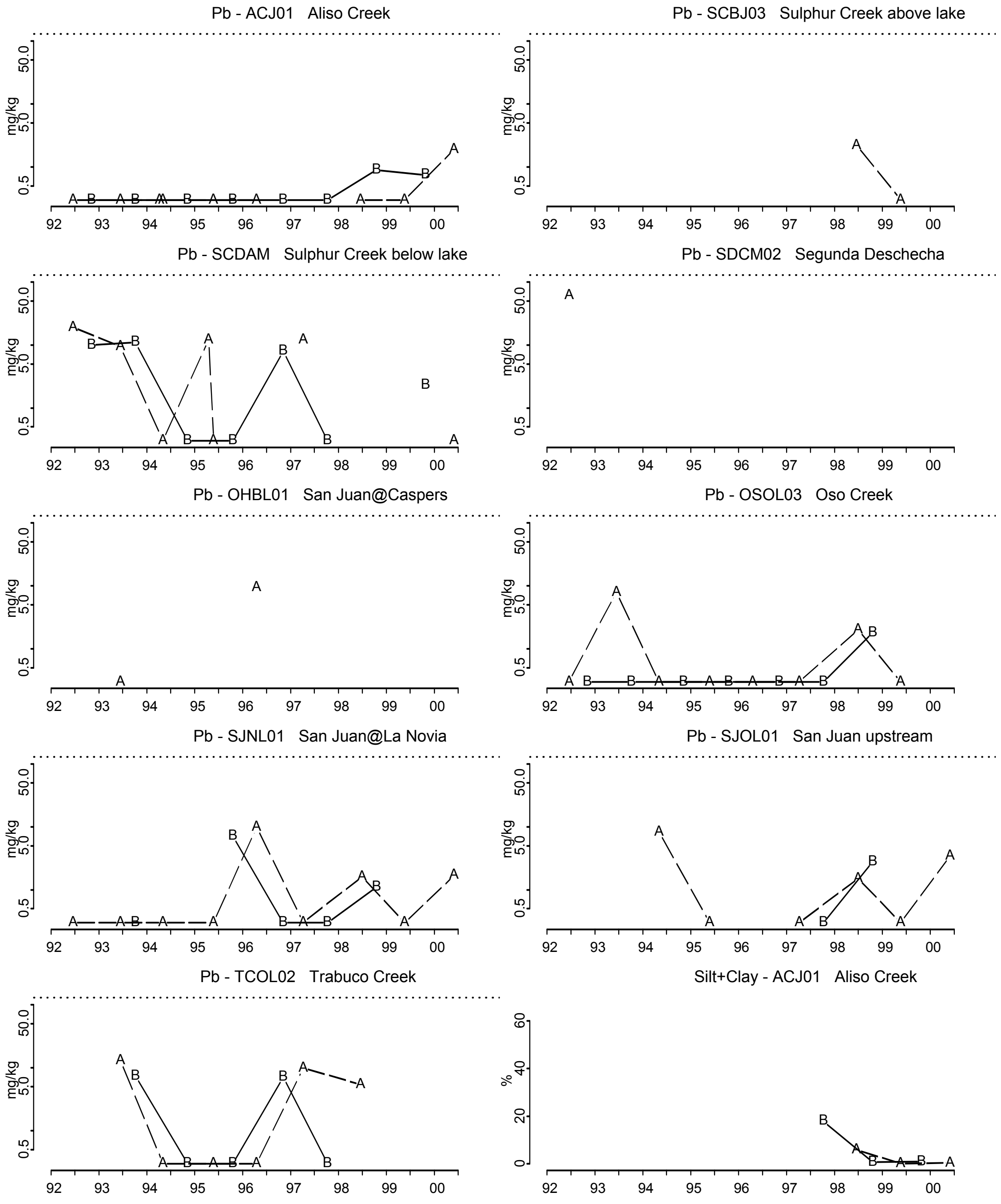
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-28 Trends of Nickel in Sediment Samples from Channel Stations, 1991 – 2000



"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-29 Trends of Lead and Silt / Clay in Sediment Samples from Channel Stations, 1991 – 2000



Pb - ACJ01 Aliso Creek

Pb - SCBJ03 Sulphur Creek above lake

Pb - SCDAM Sulphur Creek below lake

Pb - SDCM02 Segunda Deschecha

Pb - OHBL01 San Juan@Caspers

Pb - OSOL03 Oso Creek

Pb - SJNL01 San Juan@La Novia

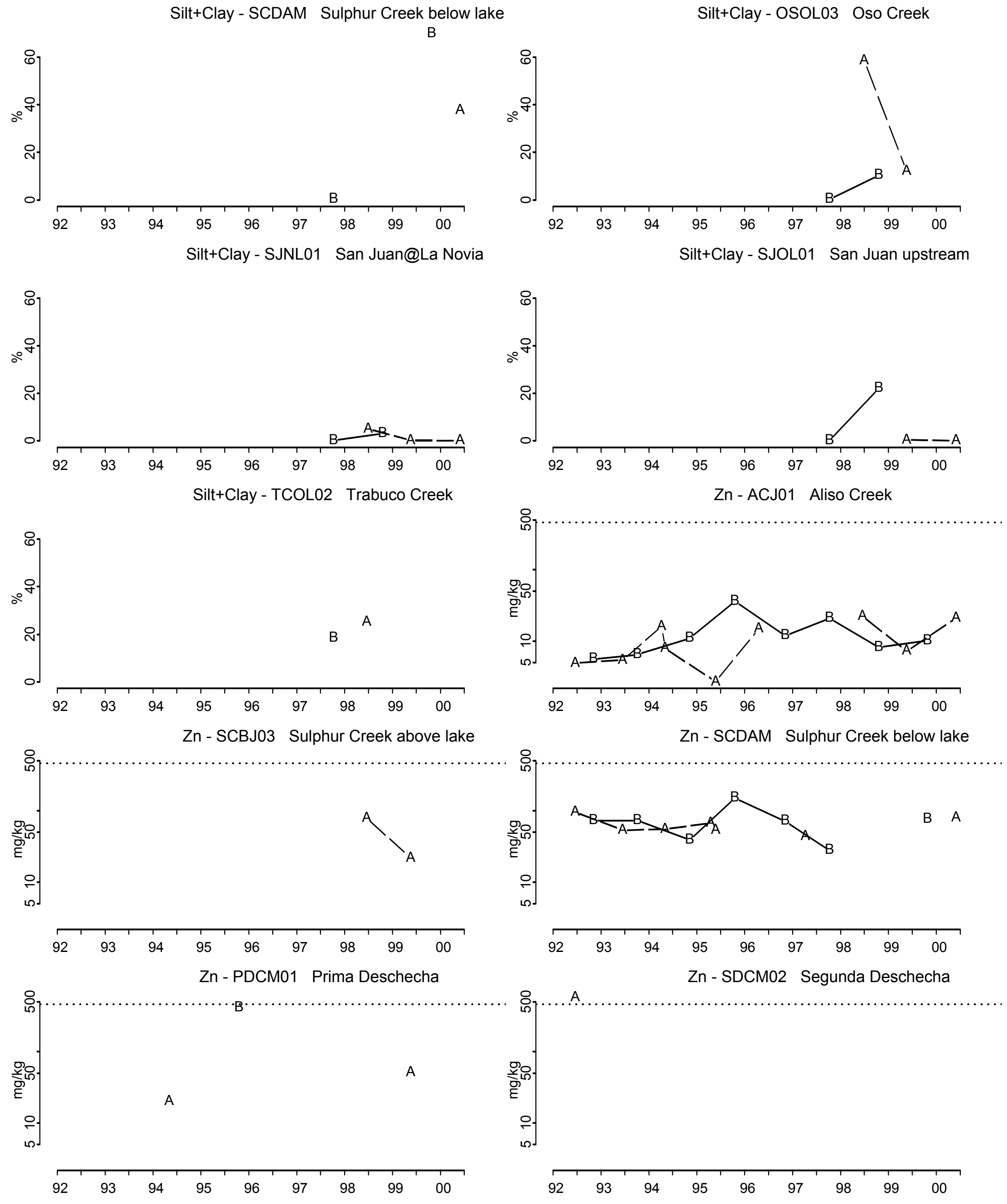
Pb - SJOL01 San Juan upstream

Pb - TCOL02 Trabuco Creek

Silt+Clay - ACJ01 Aliso Creek

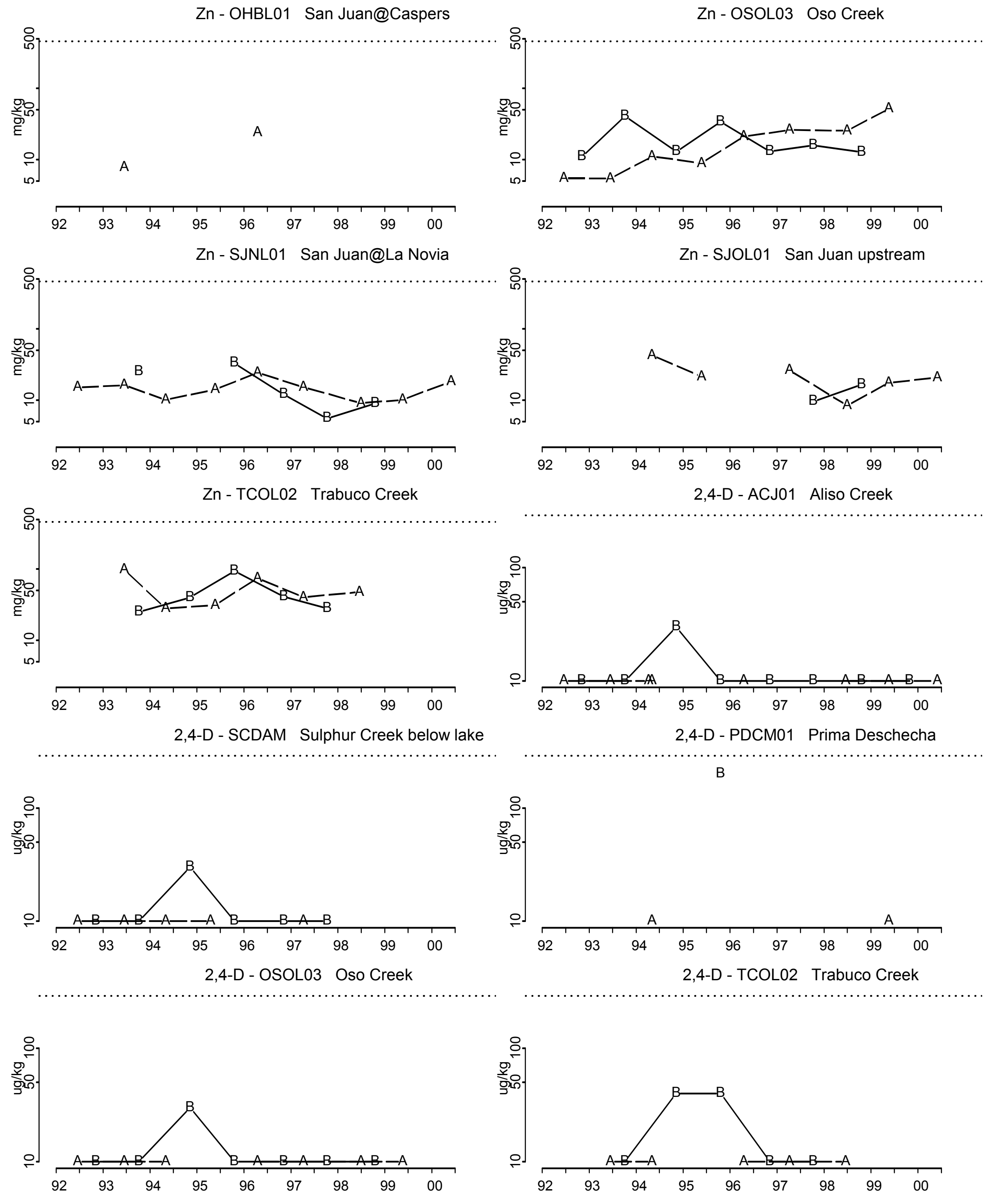
“B” indicates before the rainy season; “A” after the rainy season; dotted line indicates PEC value.

Figure 2-30 Trends of Silt / Clay and Zinc in Sediment Samples from Channel Stations, 1991 – 2000



"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-31 Trends of Zinc and 2-4-D in Sediment Samples from Channel Stations, 1991 – 2000



"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-32 Overall Values of Constituents in First-Day Storm Samples from Dana Point Harbor, 1993 – 2000

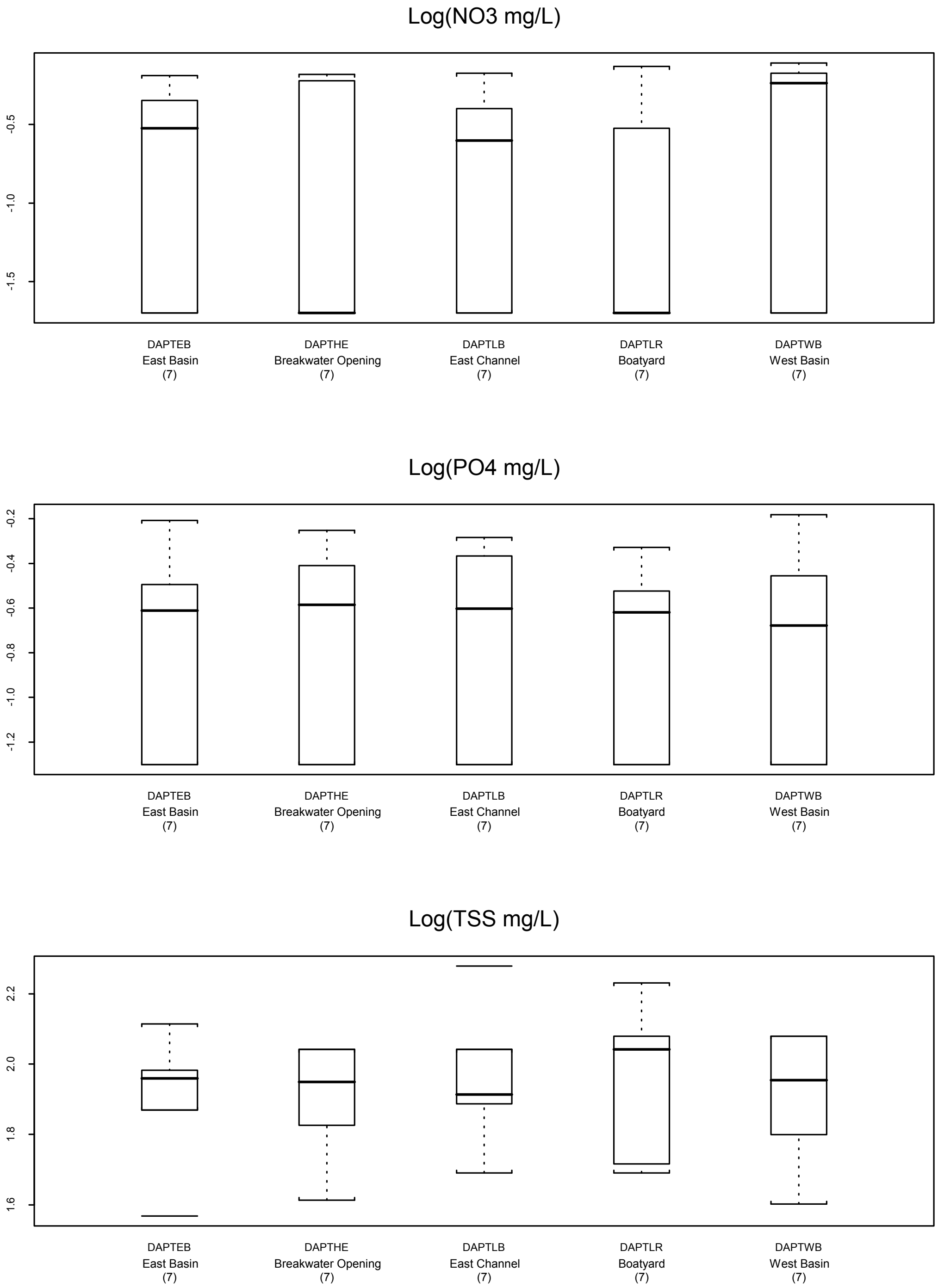


Figure 2-33 Trends of Nitrate in Storm Samples from Dana Point Harbor, 1993 – 2000

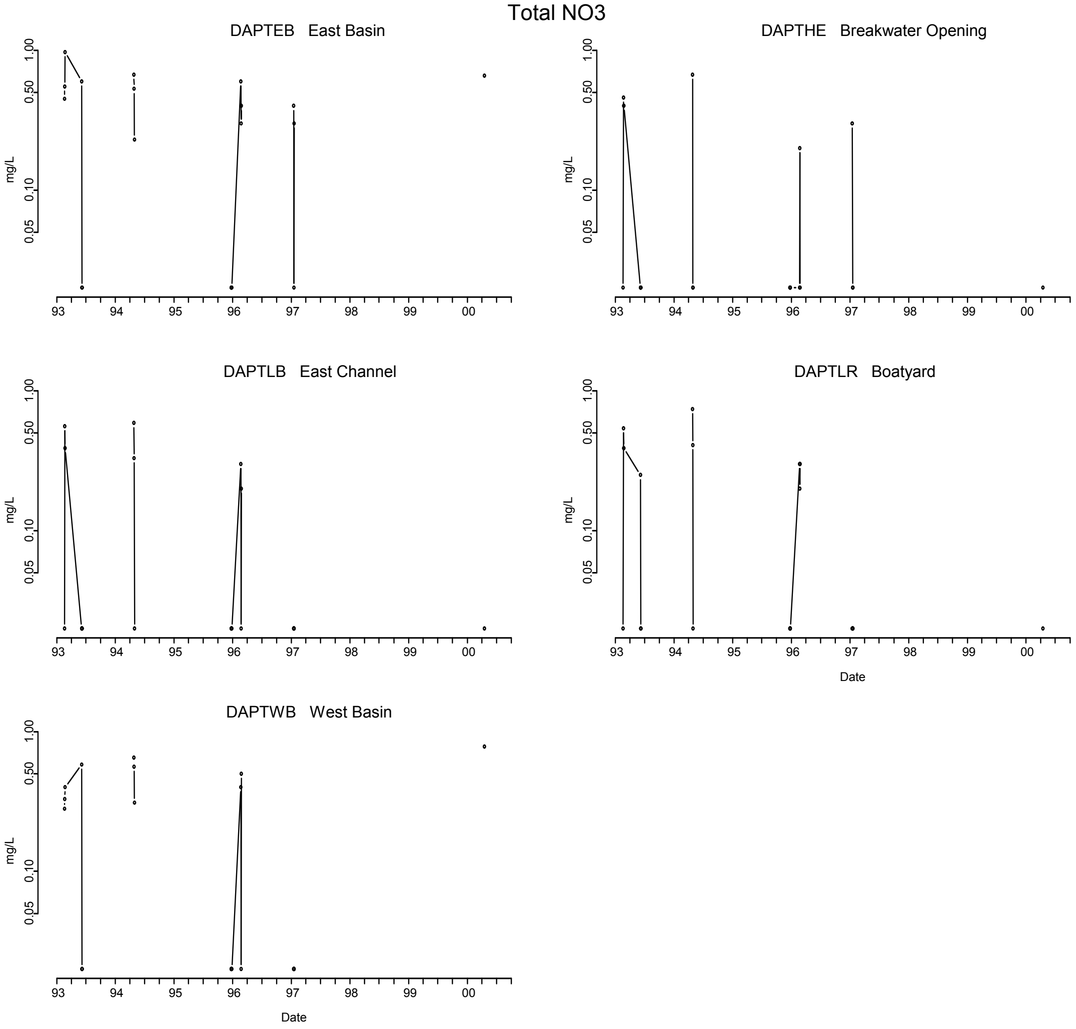


Figure 2-34 Trends of Phosphate in Storm Samples from Dana Point Harbor, 1993 – 2000

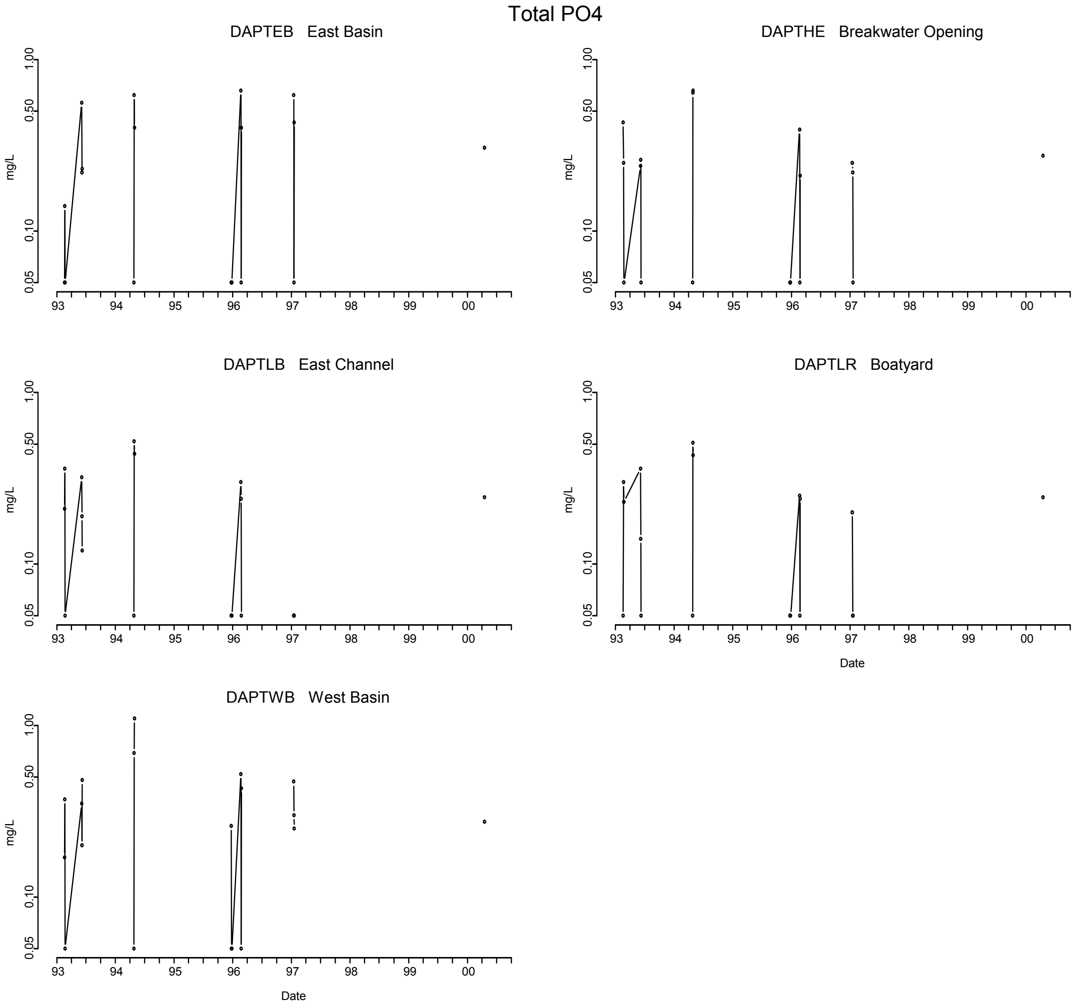


Figure 2-35 Trends of Total Suspended Solids in Storm Samples from Dana Point Harbor, 1993 – 2000

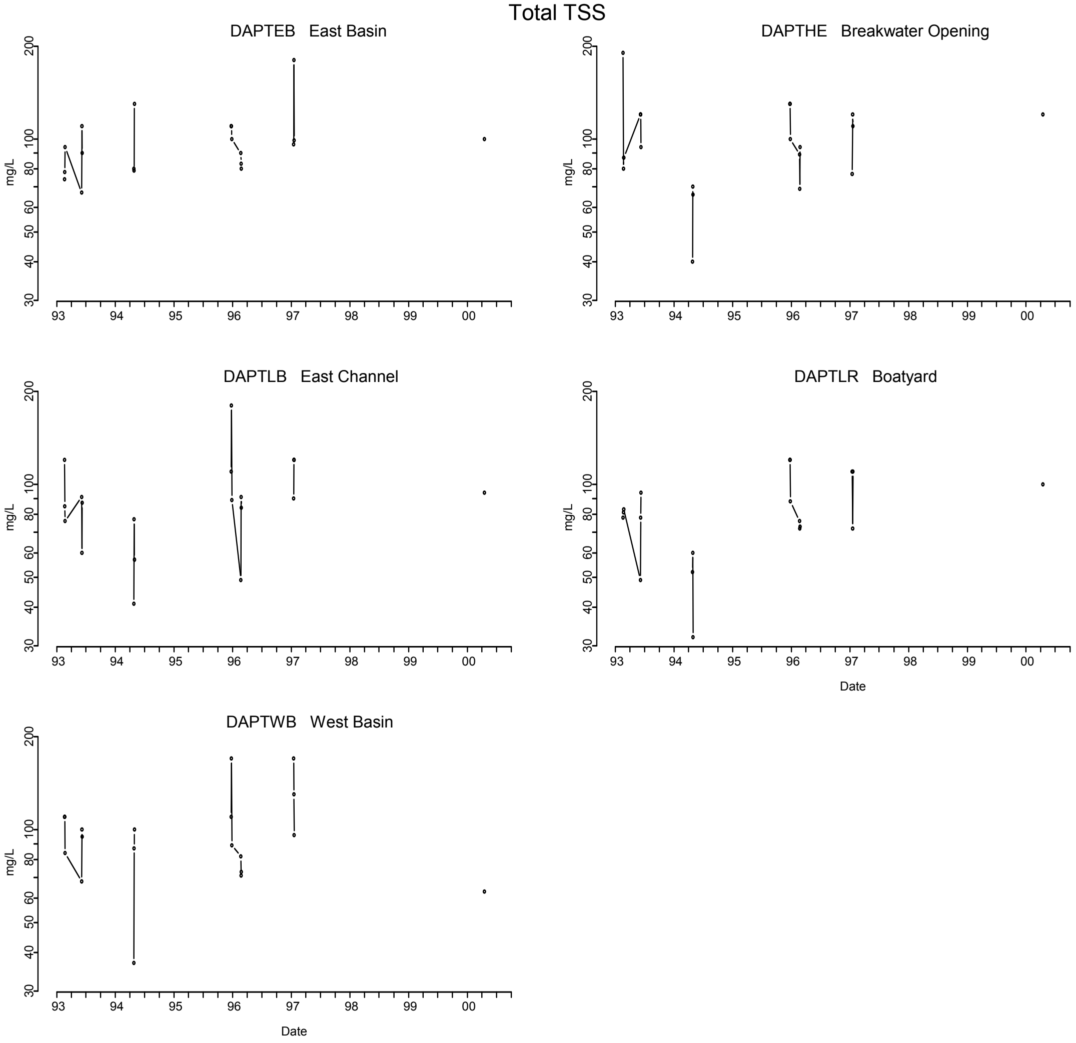


Figure 2-36 Overall Values of Constituents in Sediment Samples from Dana Point Harbor, 1991 – 2000

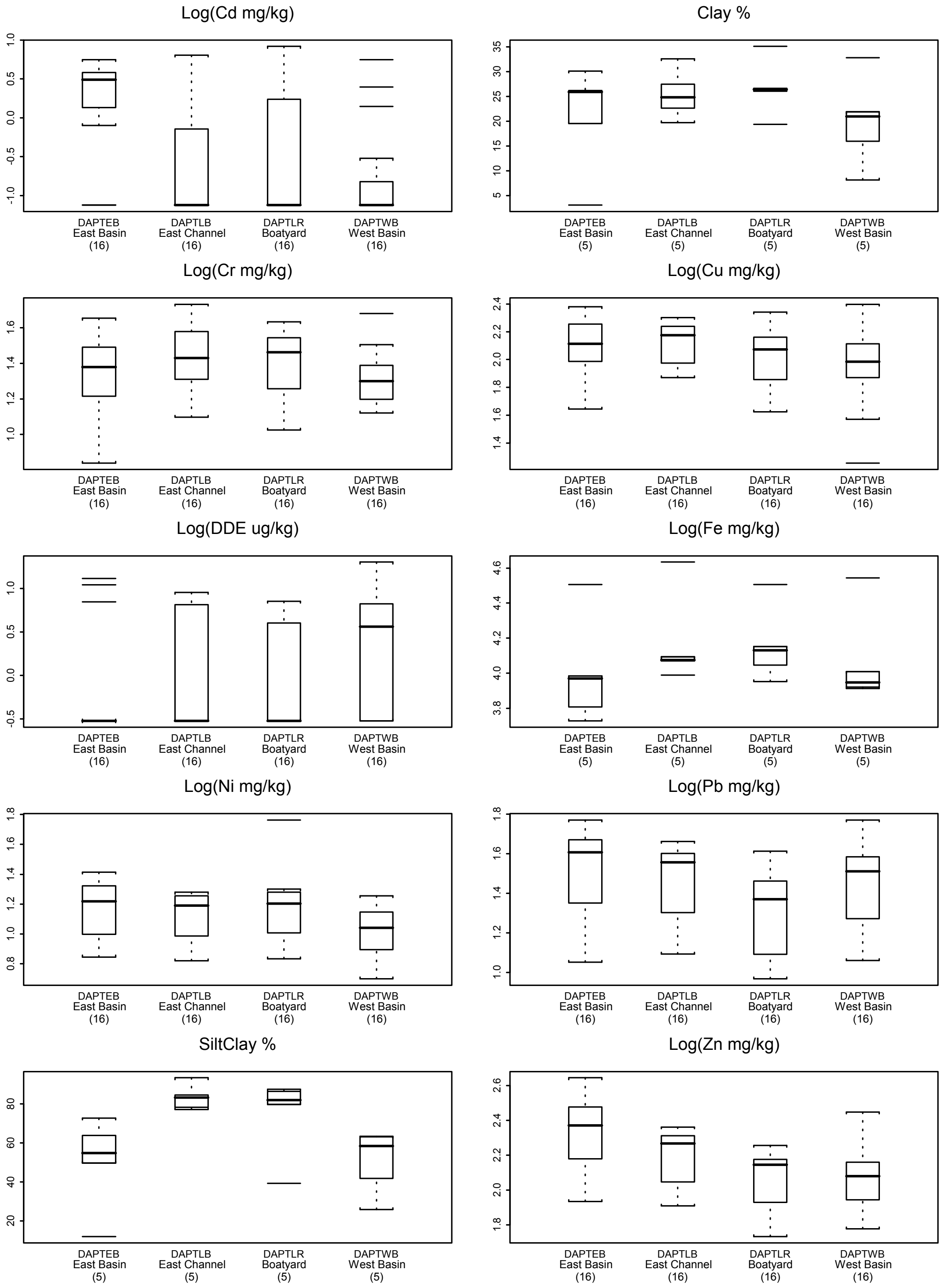
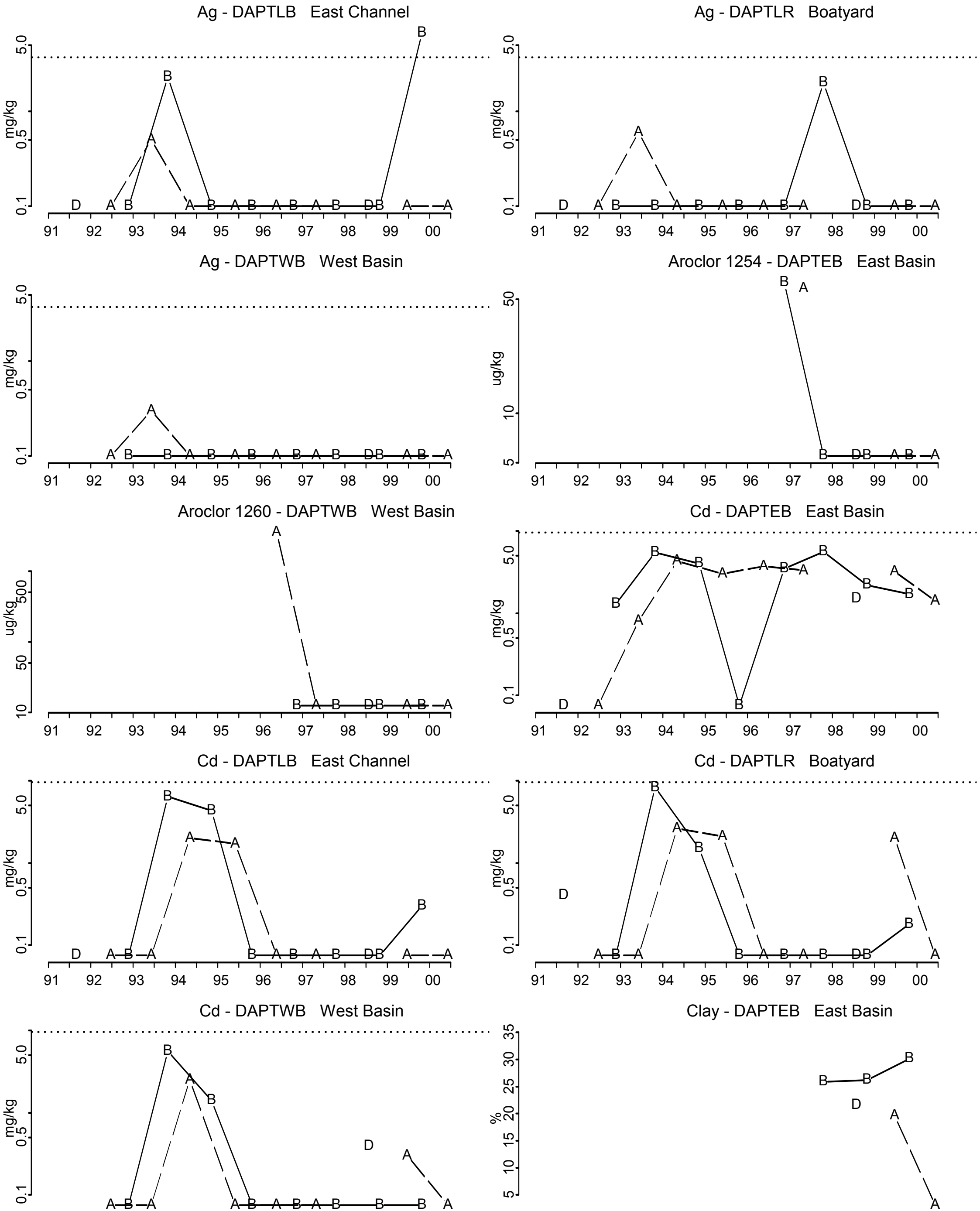
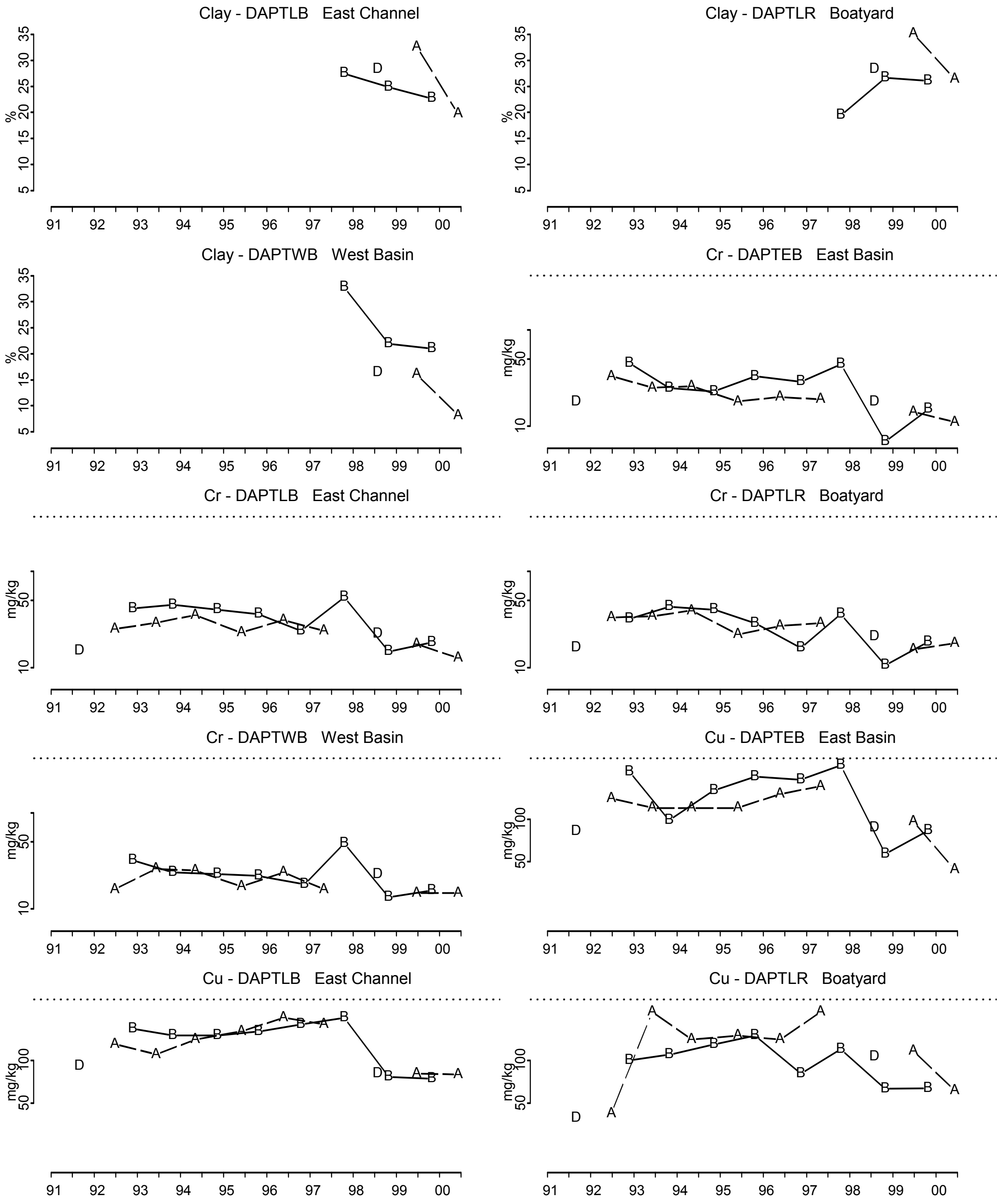


Figure 2-37 Trends of Silver, Aroclor 1260, Cadmium, and Clay in Sediment Samples from Dana Point Harbor, 1991 – 2000


Ag - DAPTLB East Channel
Ag - DAPTLR Boatyard
Ag - DAPTWB West Basin
Aroclor 1254 - DAPTEB East Basin
Aroclor 1260 - DAPTWB West Basin
Cd - DAPTEB East Basin
Cd - DAPTLB East Channel
Cd - DAPTLR Boatyard
Cd - DAPTWB West Basin
Clay - DAPTEB East Basin

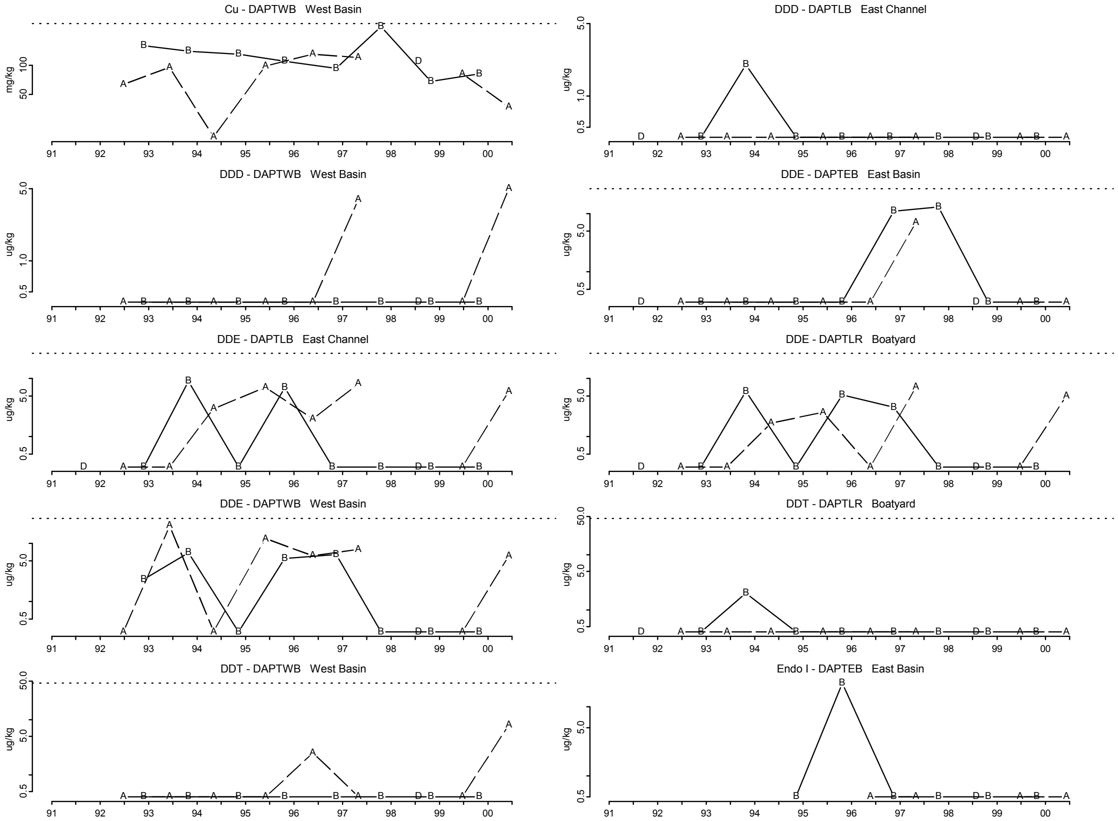
“B” indicates before the rainy season; “A” after the rainy season; dotted line indicates PEC value.

Figure 2-38 Trends of Clay, Chromium, and Copper in Sediment Samples from Dana Point Harbor, 1991 – 2000



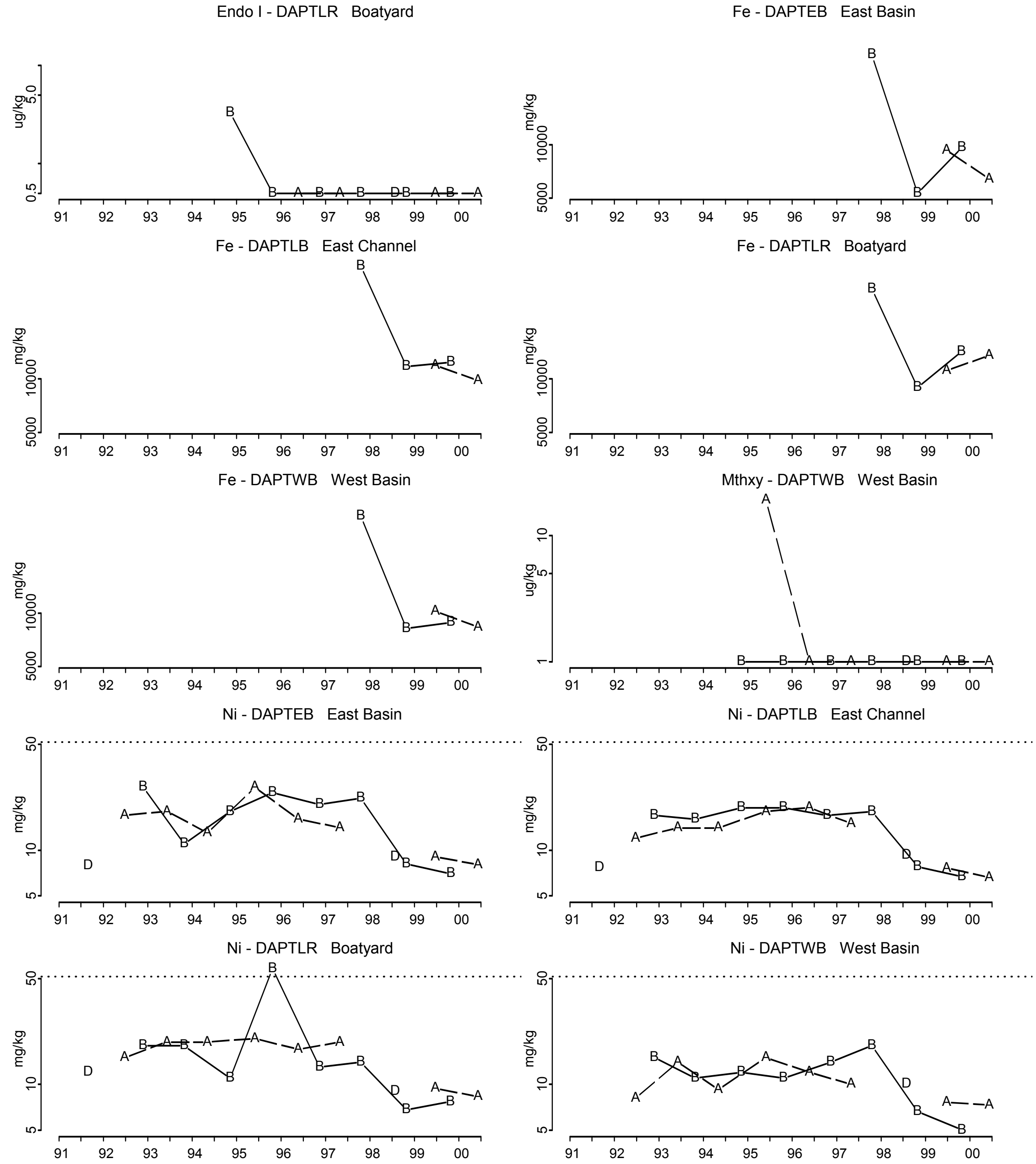
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-39 Trends of Copper, DDD, DDE, DDT, and Endo 1 in Sediment Samples from Dana Point Harbor, 1991 – 2000



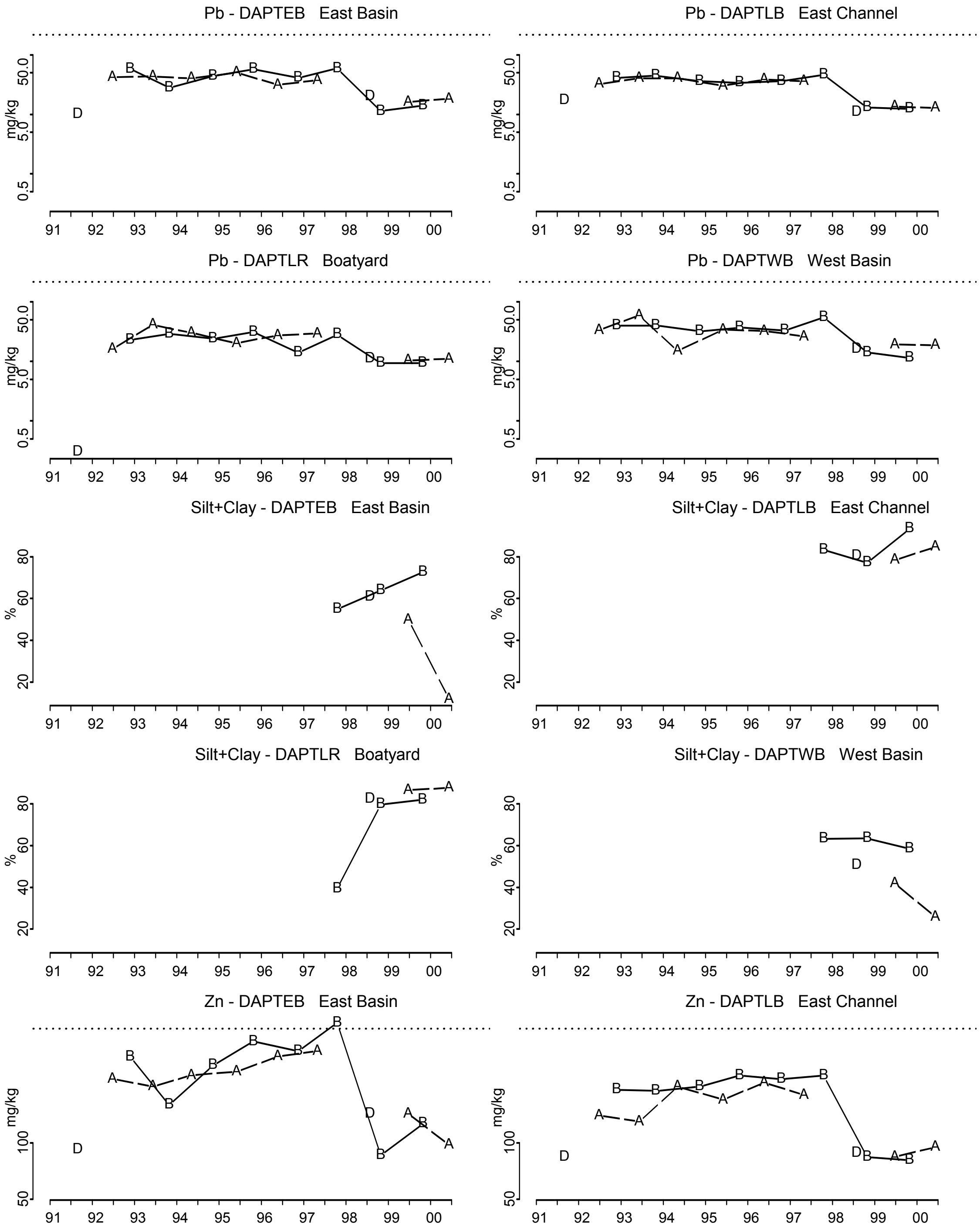
“B” indicates before the rainy season; “A” after the rainy season; dotted line indicates PEC value.

Figure 2-40 Trends of Endo 1, Iron, Mthxy, and Nickel in Sediment Samples from Dana Point Harbor, 1991 – 2000



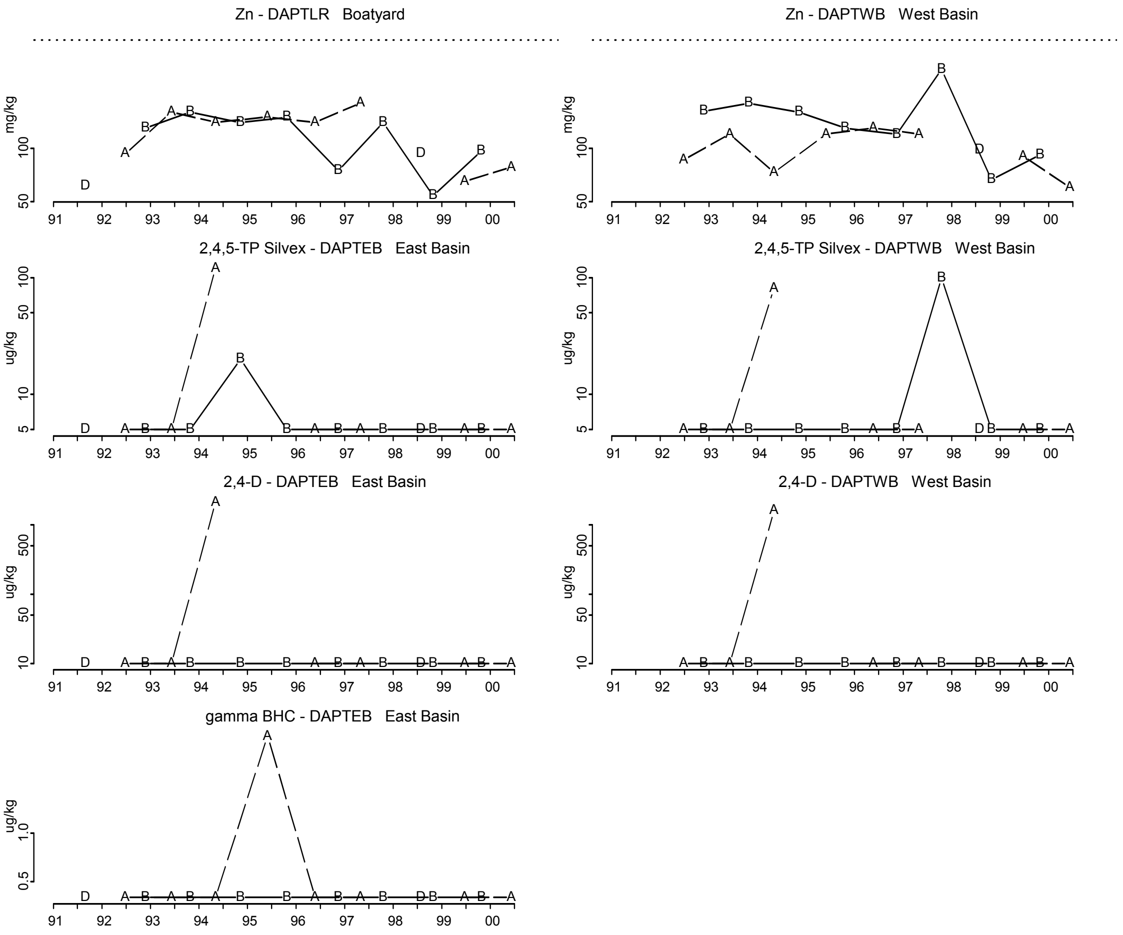
"B" indicates before the rainy season; "A" after the rainy season; dotted line indicates PEC value.

Figure 2-41 Trends of Lead, Silt / Clay, and Zinc in Sediment Samples from Dana Point Harbor, 1991 – 2000



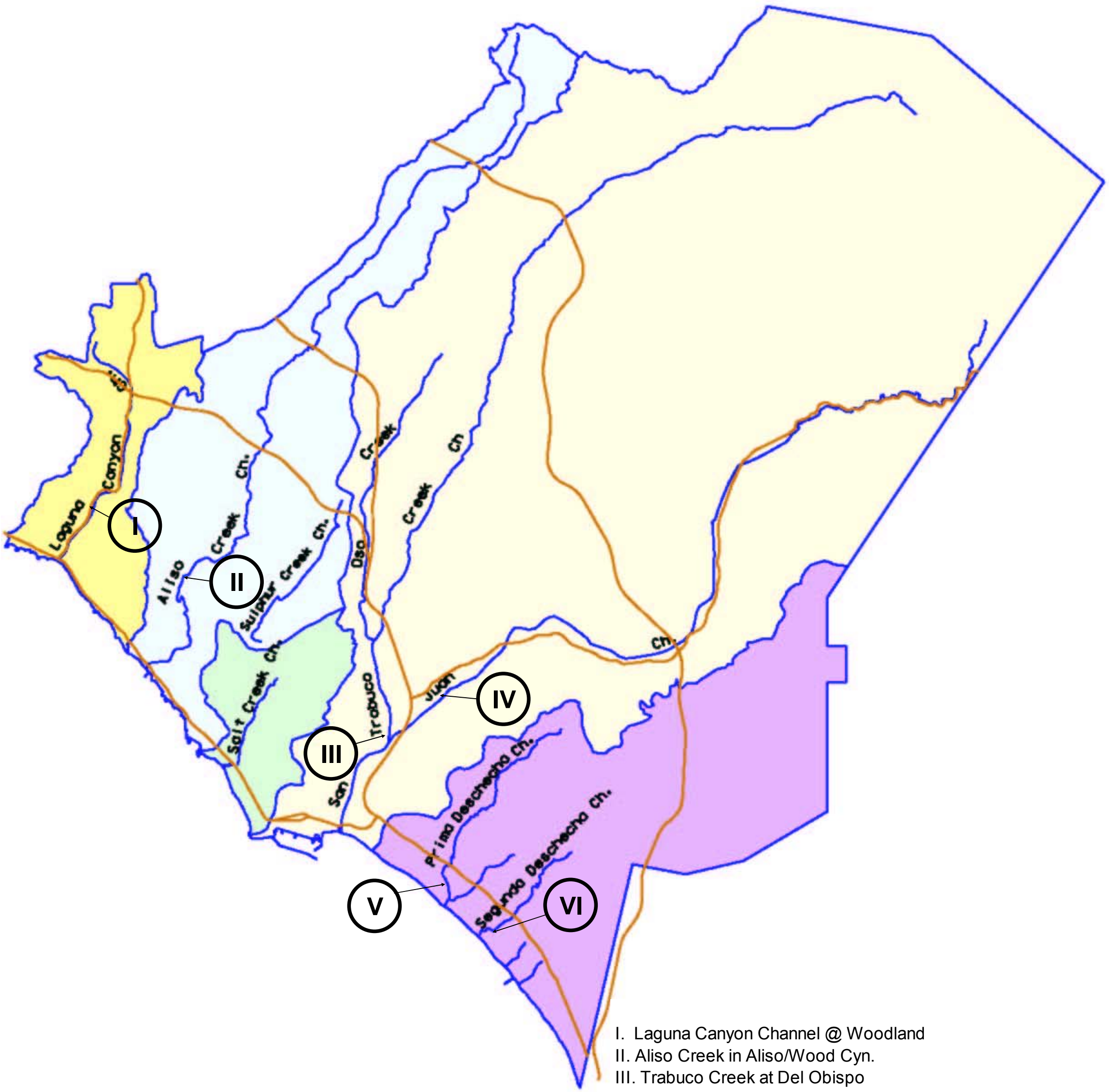
“B” indicates before the rainy season; “A” after the rainy season; dotted line indicates PEC value.

Figure 2-42 Trends of Silver, Aroclor 1260, Cadmium, and Clay in Sediment Samples from Dana Point Harbor, 1991 – 2000



“B” indicates before the rainy season; “A” after the rainy season; dotted line indicates PEC value.

Figure 3-3
Locations of Mass Loading Stations



I. Laguna Canyon Channel @ Woodland
II. Aliso Creek in Aliso/Wood Cyn.
III. Trabuco Creek at Del Obispo
IV. San Juan Creek @ La Novia
V. Prima Deschecha Channel at Calle Vista Grande
VI. Segunda Deschecha at El Camino Real

Figure 3-4 Coastal Storm Drain Site Selection Process

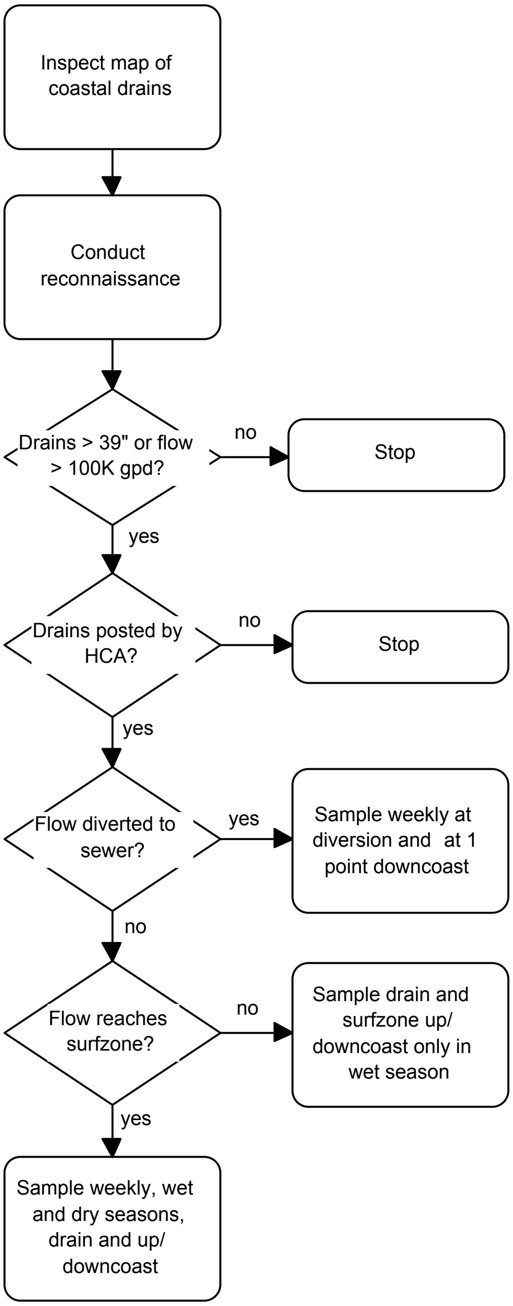
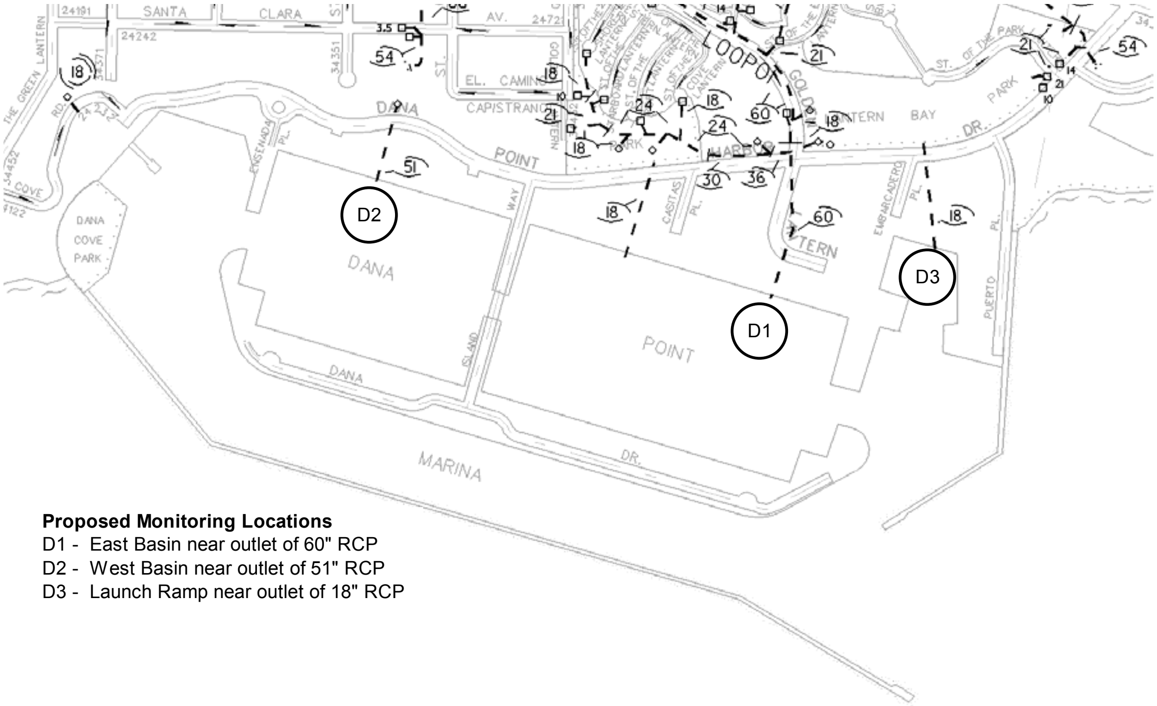
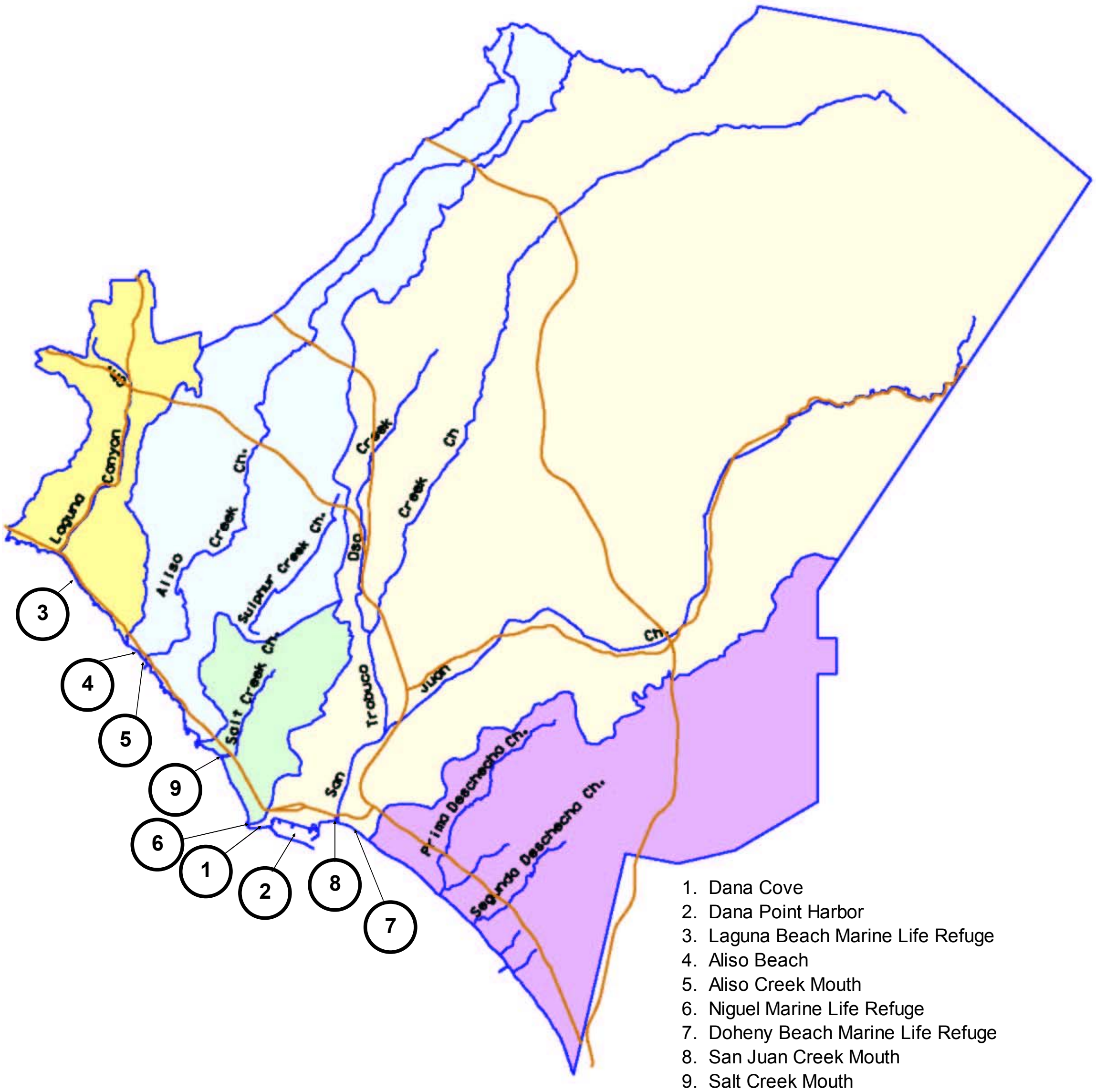


Figure 3-5
Location of Proposed Dana Point Harbor Monitoring Sites



Proposed Monitoring Locations
D1 - East Basin near outlet of 60" RCP
D2 - West Basin near outlet of 51" RCP
D3 - Launch Ramp near outlet of 18" RCP

Figure 3-7
Ambient Coastal Receiving Waters Monitoring Areas



1. Dana Cove
2. Dana Point Harbor
3. Laguna Beach Marine Life Refuge
4. Aliso Beach
5. Aliso Creek Mouth
6. Niguel Marine Life Refuge
7. Doheny Beach Marine Life Refuge
8. San Juan Creek Mouth
9. Salt Creek Mouth