11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

11.1 Introduction

In response to the First Term Permits, the Permittees developed and implemented a water quality monitoring program (1993 DAMP Appendix K) to aid in the detection and control of illicit connections and illegal discharges to the municipal storm drain systems and to meet other program performance objectives. The monitoring program focused on estimating pollutant loads in urban stormwater runoff, tracked compliance with water quality objectives, searched for sources of pollutants and addressed impacts on areas of special concern.

In response to the Second Term Permits, the Permittees conducted a two-year re-evaluation and revision of the water quality monitoring program in order to re-focus the efforts to determine the role, if any, of urban stormwater discharges to the impairment of beneficial uses and to provide technical information to support an effective urban stormwater management program to reduce the beneficial use impairments determined to be associated with urban stormwater (2000 DAMP Appendix K).

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 will aid 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.

11.2 Program Development

11.2.1 Pre-NPDES Water Quality Monitoring

From 1973 to 1990, the Principal Permittee conducted routine water quality monitoring on drainage facilities which are tributary to water bodies identified as waters of the state by the Regional Boards. The receiving waters were also monitored routinely to assess the chronic effects on established beneficial uses.

When the monitoring program was initiated in 1973, monthly nutrient and trace element sampling was performed at several locations. Sediment samples were collected semiannually to assess the impact of contaminant deposition and adsorption. Additional constituents such as mercury, selenium, DDT, PCBs and radioactivity were also evaluated on a semiannual basis to address public concerns regarding the pollution threat from these constituents.

11.2.2 First Term Permit Water Quality Monitoring

In order to bring the pre-NPDES water quality monitoring program into conformance with the 1990 federal NPDES regulations and the First Term Permit objectives (Section 11.2), field screening to detect gross contamination was added to the program and the number of sampling sites in the channels and receiving waters were increased in order to better assess the amount and type of contamination in the storm drain system.

The First Term Permit water quality monitoring program consisted of field screening (channels only); dry-weather and storm sampling and a receiving water program.

11.2.3 Second Term Permit Water Quality Monitoring

While the First Term Permit monitoring program produced useful information, the Permittees recognized (as has the rest of the nation) the high degree of uncertainty regarding the link between urban stormwater runoff and actual impairment of beneficial uses within the aquatic resources of Orange County.

Therefore, in response to the Second Term Permit objectives, the Permittees conducted a systematic re-evaluation of the water quality monitoring program which led to a re-statement of the monitoring program's primary goals. The primary and parallel goals of the monitoring program were re-stated as:

- To determine the role, if any, of urban stormwater discharges in the impairment of beneficial uses; and
- To provide technical information to support effective urban stormwater management program actions to reduce the beneficial use impairment determined to be associated with urban stormwater.

In order to organize the vast array of monitoring activities needed to carry out the objectives and goals, the Permittees identified three separate key elements within the Final Monitoring Program (May 1999).

These three key elements are:

- 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 (herein referred to as critical aquatic resources or CARs); and
- 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

The Final Monitoring Program includes an underlying rationale for each monitoring element, a discussion of how monitoring data will be used in decision-making, identification of potential links to other relevant monitoring programs being carried out by other agencies, a description of the basic monitoring design, identification of additional study design steps, and a description of anticipated monitoring activities.

These monitoring elements include many locations from the pre-NPDES and First Term Permit water quality monitoring programs that were of value because of the length of their historical record. Each key element of the Final Monitoring Program contains a description of the monitoring activities proposed to accomplish the objectives described above, as well as a description of the process for making decisions about how the monitoring program will respond to incoming data over time. This process can be used at any time throughout the life of the monitoring program to re-evaluate the direction of the program, or to reassess the appropriate allocation of resources within the program.

The Final Monitoring Program and subsequent elements utilize a five-year timeline (1998/99 - 2002/03) for addressing the goals/objectives associated with each task. This timeline is reflective of 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.

The data presented in this section are the result of the water quality monitoring conducted from July 1, 2001 to July 1, 2002. More detailed information specific to data from prior years can be found in each of the prior annual reports and the two prior Reports of Waste Discharge.

11.2.4 Additional Local Water Quality Monitoring

Ten Permittees reported conducting water quality monitoring in addition to that conducted by the Principal Permittee on behalf of the Permittees.

Seven of these Permittees reported conducting analyses for bacteriological components including total coliform, fecal coliform, *Enterococcus* and E. Coli (**Table 11.1).** Newport Beach reported conducting analyses for specific viruses. Huntington Beach reported studies to identify the contaminants in discharges from pump stations. Seal Beach reported conducting analyses of material collected from catchbasins.

11.3 Monitoring Approach

The Final Monitoring Program, described in Section 11.2.3 established three processes for selecting monitoring sites:

- A list of the CARs, including inland streams, bays, harbors, estuaries, and coastal waters, was compiled and ranked according to several criteria including 303(d) listing, community interest, and beneficial uses (**Table 11.2**). A summary of the priority rankings is found in **Table 11.3**. The CARs receiving the highest ranking were prioritized for study during the term of the Final Monitoring Program. The monitoring parameters that were proposed for the CARs investigations arose from mining information from several studies conducted by the Principal Permittee and others. The available information at the time that the program was designed can be found in **Table 11.4. Table 11.5** is a summary of the information found in the sources from **Table 11.4**. The CARs monitoring program is an adaptive process driven by the the on-going analysis of data gathered from this and other programs.

Figure 11.1 is the timeline that was developed for implementation of the studies of specific CARs. It should be noted that the Santa Ana Delhi and Costa Mesa Channels, although not CARs, are included in the timeline because information from these channels is an important component in the assessment of the impacts on the Upper Newport Bay.

The CARs selected for intensive study during this reporting year were the San Diego Creek Watershed, the Upper Newport Bay, the Lower Newport Bay, and Aliso Creek. A baseline monitoring program is being maintained for the other CARs until they are selected for focused studies in the future.

- The NPDES water and sediment quality data from 1991-97 was statistically evaluated to identify areas where the mean concentrations of constituents of concern were above countywide averages. These areas, designated as Warm Spots, were selected if their site mean concentration of a specific pollutant of concern was either (1) greater than two standard deviations above the systemwide mean (including all similar monitoring sites such as channels or harbor locations), or (2) three interquartile ranges above the third quartile. The database of each Warm Spot was further evaluated using power analyses to determine the frequency of annual monitoring that would be needed to detect statistically significant trends in the constituent of concern that led to the Warm Spot designation.

  The Warm Spots include Bonita Creek, Lane Channel, Agua Chinon Wash, Central Irvine Channel, Hicks Canyon Wash, Hines Channel, Sulphur Creek, Prima Deschecha Channel, Segunda Deschecha Channel, the Rhine Channel in the Lower Newport Bay, and Christiana Bay in Huntington Harbour. **Table 11.6** is a list of the Warm Spots and the frequencies of monitoring that were calculated to detect significant trends. **Figure 11.2** is a timeline that was developed for monitoring Warm Spots in order to identify the sources of constituents that resulted in their respective Warm Spot designations.

- The countywide Pollution, Notification, Investigation, and Response (PNIR) database maintained by Principal Permittee water pollution staff was interrogated to identify channels or drainage areas that had high incidences of water pollution activity during the period from 1991 through 1998. From these database evaluations was created a priority list for reconnaissance and source evaluation studies. Areas targeted for study during this reporting year included Construction Circle Drain which flows to Peters Canyon Wash, J01P05 (drainage for El Toro Auto Center) which flows to Aliso Creek, and Collins Channel which drains to the Santa Ana River.

Figure 11.3 is a timeline showing the implementation schedule of all three elements of the Final Monitoring Program.

On January 18, 2002 and February 13, 2002, the Santa Ana and San Diego Regional Water Quality Control Boards respectively, adopted third-term NPDES permits for

Orange County. The San Diego Permit (R9-2002-0001) requires development and implementation of new monitoring program elements during the 2002-03 monitoring year. The Santa Ana Permit (R8-2002-0010) requires implementation of a new monitoring program for that region beginning in July 2003.

The timelines for some of the second-term permit investigations (**Figure 11.2**) for the San Diego Region extend into the 2002-03 monitoring year. Where possible the timelines were adjusted to complete these investigations during this reporting year.

11.3.1 Incorporation of the Nutrient Total Maximum Daily Load (TMDL) Regional Monitoring Program

At the direction of the Santa Ana Regional Board, a Regional Monitoring Program (RMP) for the San Diego Creek Nutrient TMDL was initiated in February of 2000. The chemical monitoring for this program includes many of the same sites in the Newport Bay and watershed as the Final Monitoring Program. Monitoring frequencies for some of the sites were increased as a result of the RMP and orthophosphate was been added to the suite of nutrient analyses. The Final Monitoring Program and the RMP are intended to complement each other. Therefore the chemical data from both programs will be included in this report.

Table 11.7 is compilation of the Warm Spots and CARs from the Final Monitoring Program and the RMP sites that were monitored during this reporting year. **Table 11.8** shows the monitoring frequencies of the Final Monitoring Program with the RMP additions in bold letters. If a monitoring location is within a designated "Water of the State" the beneficial uses for waterbody can be found **Table 11.9**. **Appendix M** contains the location maps of channels that were monitored with automatic samplers and continuously monitoring streamgauges.

11.4 Description of Monitoring Procedures

The following are brief descriptions of the procedures used during this reporting period.

11.4.1 Time-composite Sampling

Time-composite sampling is the primary method of monitoring the concentration and load of constituents in streams, creeks, and drainage channels. This type of sampling is conducted with automatic samplers that consist of programmable pumps (peristaltic) which transport water from the channel to a collection reservoir in the autosampler base. The collection reservoir can be a single large composite bottle or a series of up to 24 bottles. The autosampler program can be modified to vary sample volumes and frequency of collection. In the Final Monitoring Program, 24 discrete sample bottles are used in each autosampler base.

For dry weather discharge evaluations, the automatic samplers are programmed to collect a discrete sample once an hour for a 24-hour period. During storms, sampling is initiated when the water level in the channel rises above a triggering device hardwired to the autosampler. The frequency of collection during the first hour of the storm is set at 1 sample/15 minutes. After the fifth sample is collected at the one-hour mark, the collection frequency is decreased to once every 2 hours. A storm event sampling spans approximately 96 hours to allow comparison of the data to 96-hour guidance criteria for chronic aquatic toxicity from the California Toxics Rule (CTR). Autosampler maintenance is performed periodically to change bottles, icepacks, and power supplies.

The first five samples collected during a storm are composited and represent the first flush. The concentrations of dissolved heavy metals in this sample can be compared to acute toxicity criteria. The remaining bi-hourly storm samples are used to prepare composite samples that are representative of the subsequent parts of the storm. The discrete samples used to prepare each composite sample are selected using the stage hydrograph for the channel or by evaluating the electrical conductivities of the discrete samples. Using the hydrograph from the 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 are composited into a single sample. Storms spanning multiple days may be broken up into two or more composite samples.

In the absence of a streamgauge hydrograph for the sampled channel, the conductivity of each discrete sample (in order of collection) is 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) can also be used in the compositing process. Storm samples tend to be more turbid and contain more fluvial sediment. Using these electroanalytical measurements and visual observations as a guide, composite samples can be prepared to evaluate various parts of a storm.

Composite samples are analyzed for pH, electrical conductivity, turbidity, nitrate, ammonia, total Kjehldahl Nitrogen (TKN), phosphate, total suspended and settleable solids, volatile suspended solids, and total recoverable and dissolved copper, chromium, lead, cadmium, zinc, silver and nickel (see **Appendix N**). The frequency of time composite monitoring is dependent on whether the waterbody is designated as a Water of the State. Waters of the State are monitored monthly and during storms. Other waterbodies are monitored during storms only.

Time composite monitoring is supported by the Principal Permittee's precipitation and streamgaging network which consists of recording and/or transmitting ALERT gages. Mechanical recording raingages are weighing bucket type. Accumulated rainfall is recorded in analog format on drum charts. The ALERT precipitation gages are tipping bucket type with dataloggers. Data are recorded and transmitted in digital format; sensitivity is 1 mm (0.04 inches) of accumulated rainfall.

The Principal Permittee uses several types of streamgauges to monitor changes in water level. The oldest design is the stilling well with water level float; the newer types are manometer gages or pressure transducers. Data (water level versus time) are recorded on stripcharts. The ALERT interface to these gages consists of a connection from the recorder chart drive to an ALERT shaft encoder. ALERT information is recorded on a datalogger and transmitted to the Principal Permittee Katella yard base station in digital format. Sensitivity of the transmitted and recorded ALERT record is user-variable with the greatest sensitivity being a change in water level of 0.01 feet.

11.4.2 Harbor/Bay Monitoring

Harbor/bay monitoring is conducted semiannually and during storms (see **Appendix O**). Monthly sampling in the Upper Newport Bay is also conducted to evaluate nutrient loading from the San Diego Creek. Monthly monitoring of nitrogen and phosphorus in the sediments of the Upper Newport Bay was added in 1999/2000 reporting period to assist with the CARs evaluation. The semiannual monitoring includes sampling for nutrients in the water column, and trace metals and organic contaminants in the sediments (See Section 11.4.3). Storm monitoring consists of surface water sampling for nutrient concentrations and depth-integrated sampling to evaluate the magnitude of heavy metal contamination in the water column.

11.4.3 Semiannual Sediment Sampling

On a semiannual schedule, sediment samples are collected from the channels and several locations in the harbors and bays (see **Table 11.8**) to evaluate concentrations of copper, chromium, cadmium, lead, zinc, silver, nickel, chlorinated hydrocarbon and organophosphate pesticides, herbicides, PCBs, and Polynuclear Aromatic Hydrocarbons (PAHs). The data from these samplings is contained in **Appendix P**.

11.5 Methods of Data Analysis

Acute (CMC-Criteria Maximum Concentration) and chronic (CCC-Criteria Continuous Concentration) aquatic toxicity criteria from the CTR were used as guidance to evaluate dissolved metals data collected from storm channels and harbors. Water quality criteria from the CTR and other sources are presented in **Table 11.10.**

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. A summary of the sediment guidance criteria is found in **Table 11.11.**

11.5.1 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.

On March 2, 2000, the State adopted the United States Environmental Protection Agency's (USEPA) Rules establishing numeric water quality criteria for priority toxic pollutants (commonly referred to as the CTR) for the State of California. The CTR 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. **Table 11.12** presents these guidance criteria for freshwater relative to water hardness.

According to the CTR, 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 WER. For this reporting period the former method was used. The saltwater guidance criteria are found in **Table 11.10**.

In applying the CTR 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.

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. During this monitoring year the low detection limits achieved by the contract laboratory did not make this approach an issue except for a few instances where the calculated criterion for silver was lower than the detection limit of 2 μg/L.

With respect to the saltwater guidance from the CTR, 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 criteria for trivalent chromium (Chromium III) were used.

11.5.2 Mass Load Calculations

Mass loads were calculated using chemical and hydrographic data. **Appendix M** contains watershed maps for all of the channels monitored to date, with automatic samplers. On each map, the watershed boundary upstream of the monitoring site, hydrographic (water level station) and representative precipitation station are shown. 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. Graphs of time vs. water level stage are contained in **Appendix Q**. The total discharge in acre-feet during each sampled period was 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. **Appendix R** contains the mass load data from each monitored storm. **Table 11.13** is an annual summary.

11.5.3 Event Mean Concentrations (EMCs)

Event mean pollutant concentrations were calculated to produce a site mean EMC that could be used in the estimation of the mass loads from unsampled storms. To calculate the 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 EMCs were updated each year (**Appendix S**) with the EMC data from that year. **Table 11.14** contains the calculated EMCs of each monitored storm during the 2000-01 season.

11.5.4 Statistical Methods

Site mean EMCs were used to estimate mass loads from unsampled storms. To estimate these mass loads, the site mean 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 EMC was calculated from the set of calculated EMCs from each sampled storm from the beginning of the NPDES program. Only 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 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[1]. 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}	$(X_n-X_{n-2})/X_n-X_3)$	$(X3-X_1)/X_{n-2}-X_1)$

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

Using Table A.7[2], 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.

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[3]. 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_1 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

[2] Taylor, John Keenan. Statistical Techniques for Data Analysis, 1990. Lewis Publishers, Inc., p168.
[3] Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, p255.

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

The values of H_α and $H_{1-\alpha}$ were found in Table A10 - A13[4]

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

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

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

The true median of a lognormal distribution can be estimated by

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

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

11.5.5 Assessing Anthropogenic Influence in Harbor Sediments

The Southern California Coastal Water Research Project (SCCWRP) database for iron normalization[5] 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.

11.6 Analysis of Data

The Final Monitoring Program included a series of tables and figures outlining expected progress over the five-year term of the permit. These provide a framework for assessing the Program's current status and its progress toward completing the planned activities. The following sections briefly describe Program status with respect to each of the three

[4]Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, pp264-265.
[5] Southern California Coastal Water Research Project. Annual Report,1996. Southern California Coastal Water Research Project Authority, pp68-76.

major Program components, warm spots trend monitoring, critical aquatic resources monitoring and assessment, and reconnaissance and source identification.

Figure 11.4 shows the total annual rainfall at three sites in Orange County during the last six seasons. **Figure 11.5** shows the accumulated rainfall per season measured at the Principal Permittee gauge in Santa Ana. The season total of 3.82 inches measured at the Santa Ana gauge was the lowest in 40 years. Because of this low total, completion of all intended stormwater monitoring from **Table 11.8** was not accomplished.

11.6.1 Warm Spot Monitoring

The Final Monitoring Program is generally on track with the categories of activities and the timelines listed in **Figure 11.3**. Stations were prioritized and sampling frequencies established as part of the monitoring program design. Long-term trends monitoring is ongoing and some source identification studies have been undertaken. Monitoring data are analyzed and evaluated each year, although a full trends analysis will not be repeated until the end of the five-year period. The power analyses indicated that trends would only be apparent after several additional years of monitoring data were available. The following paragraphs provide additional detail on the specifics of trend monitoring and source identification efforts at the Warm Spots. Each site is listed followed by the constituent(s) of concern that caused it be listed as a Warm Spot.

Rattlesnake Canyon Wash – total suspended solids and metals in stormwater

Rattlesnake Canyon Wash was designated as Warm Spot because of high concentrations of total suspended solids and total recoverable lead in stormwater samples. Subsequent to the development of the Final Monitoring Program Rattlesnake Canyon Wash was rerouted to intersect with an underground section of Peters Canyon Channel upstream of the Peters Canyon / Hicks Canyon Wash confluence. The site on Bryan Avenue to which the Warm Spot designation was assigned does not receive runoff from this channel in its present configuration. With its new configuration sampling would be extremely difficult and trend analysis relative to its former configuration would not be meaningful. This Warm Spot is no longer monitored.

Lane Channel – total dissolved solids

Lane Channel was designated as a Warm Spot because of high electrical conductivity measurements (a surrogate measurement of total dissolved solids) in dry-weather discharges. The summary of the initial phase of the investigation for sources of high total dissolved solids in Lane Channel can be found in **Appendix Q** of last year's Annual Status Report.

The results from the initial investigation suggest that the high dissolved solids concentrations found in Lane Channel are from multiple sources. Additional investigation would be required to isolate these sources. These source identifications may be conducted during the next year or be incorporated into the Reconnaissance Program of the next permit term.

Segunda Deschecha Channel – total dissolved solids

Segunda Deschecha Channel has been investigated for elevated levels of total dissolved solids (TDS) in the water at the sampling point. Last year's analysis showed that the high TDS level found at the sampling point was not a function of tide and that on average the peak TDS concentration occurred at approximately 10 PM. For Prima Deschecha Channel it was shown that the TDS concentration was inversely proportional to the flowrate in the channel. This observation suggested that urban runoff diluted the naturally high level of dissolved solids in that channel. To determine if the same relationship existed for Segunda Deschecha a fiberglass flume and portable flowmeter were placed in the channel to monitor dry-weather flowrates from June through September 2002. **Figure 11.6** shows the hourly electrical conductivity in Segunda Deschecha Channel measured on sixteen different days between October 1999 and October 2001. **Figure 11.7** shows the average hourly conductivity and flowrate from these two sources of data. Although not as dramatic as the graphic for Prima Deschecha Channel in last year's report, **Figure 11.7** suggests that urban runoff dilutes the naturally high dissolved solids concentration in the channel.

The source of the ionic solids appears to be the seepage from the hundreds of weepholes in the concrete sidewalls of the channel. These conduits were part of the channel construction to allow for subsurface drainage. This drainage however leaches the salts from soils and carries them into the channel. A reconnaissance of the channel conducted in June 2000 showed seepage from a majority of these weepholes in the early morning. Samples of the seepage from three weepholes had electrical conductivities of 17,270, 16,600 and 10,500 μmhos/cm. A sample of the crystalline residue on the channel walls near the sampling location was analyzed and found to have high concentrations of sodium and soluble sulfate.

Prima Deschecha Channel – total dissolved solids in dry-weather and metals in stormwater runoff

The results presented last year suggested that the high TDS levels in Prima Deschecha Channel were the result of a natural condition. Reconnaissance conducted on March 1, 2002 provided more evidence to corroborate this theory. The electrical conductivity in the channel was measured at several points upstream of the usual monitoring location at Calle Grande Vista. The total dissolved solids concentration was analyzed for selected sites. The results are summarized below.

Reach of Channel	time	Monitoring Point	EC (μmhos)	TDS (mg/L)
At Diamante	13:00	Prima Deschecha Channel (M01)	Dry	
At Calle Nuevo	13:40	M01	5,150	
u/s Avenida Vacquero	14:48	M01 50' u/s weeping seam	5,510	4,880
	14:45	weeping seam	19,870	18,900
	14:42	M01 50' d/s weeping seam	7,510	7,330
	14:50	36" pipe discharging to M01	3,800	
d/s I-5	15:20	M01 in Shorecliff Golf Course	7,550	
u/s Calle Grande Vista	15:37	M01 50' u/s bubbling weepholes	7,750	7,490
	15:34	Bubbling weepholes	14,480	12,800
	15:40	48"pipe discharging to M01, 20' d/s weepholes	5,850	
At Calle Grande Vista	15:30	M01	8,480	

The data appear to indicate that the seepage from the channel seams and weepholes increase the concentrations of dissolved solids in the channel downstream of the seepage.

On June 26, 2002 a soil sample was collected the levee of the channel above the weeping seam upstream of Avenida Vacquero. A sample from the levee of San Juan Creek at La Novia was also collected for comparison purposes. The results of the analyses are presented below.

	Chloride	Soluble Sulfate	Calcium	Magnesium	Potassium	Sodium
Location	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg
Prima Deschecha Channel levee	61.3	0.447	861	275	37.2	582
San Juan Creek levee	13.7	0.048	34.1	11.1	15.4	202

As can be seen by the results of these analyses the soil from the levee of Prima Deschecha is much higher in salts than that of San Juan Creek, where dry-weather electrical conductivity in the range of 1300-1500 μmhos/cm.

To investigate the source of high levels of heavy metals in the stormwater, monitoring was conducted upstream of the golf course during a storm in March 2002. The 12-hour composite sample had high levels of turbidity, suspended solids, and metals. There was however, no corresponding sample from the downstream monitoring site. Since data from this investigation are limited no conclusions can be drawn at this time.

Bonita Canyon Channel – metals in stormwater

Bonita Channel Channel was designated as a Warm Spot because of high levels of total recoverable nickel in its stormwater discharge. No source identification has been carried out, but this site has been added to the sediment TMDL program. A streamgauge has been installed and is currently being maintained by the USGS under contract to the Principal Permittee. The last annual status report graphically showed that, aside from the El Niño season, the concentrations of metals have decreased from the high levels found in previous seasons. No stormwater samples were collected during this monitoring year.

Rhine Channel – copper in sediments

The Rhine Channel in Lower Newport Bay was designated as a Warm Spot because of high concentrations of copper in the bottom sediments. It is believed that these elevated levels of copper are the product of past activities of the boatyards in the immediate area. The boatyards carry out maintenance activities and have related discharge permits, but samples have not been collected to confirm this supposition. The data from LNBRIN is plotted in **Figure 11.8**. The concentration of copper in the sediments during the last four seasons is much lower than during the period from 1992 to 1998.

Agua Chinon and Hicks Canyon Wash – DDT in sediments

Agua Chinon Wash and Hicks Canyon Wash were designated as Warm Spots because of high concentrations of DDT metabolites in the bottom sediments of these creeks. The sources of these high concentrations have not been investigated. It is assumed that these legacy pesticides are in the soils of the agricultural areas in the watershed and enter the drainage system after large storms or development of these agricultural areas. From **Figure 11.9** it appears that the concentrations of these compounds in the sediments of Agua Chinon Wash have decreased since the mid-1990s with only one sample in the last four years having detectable concentrations. In Hicks Canyon Wash (**Figure 11.10**) detectable quantities of both compounds have been found in three of the last four samples. This monitoring location is no longer sampleable as the drain configuration has been converted from an open channel to a subsurface conduit.

Central Irvine and Hines Nursery Channels – nitrates

Central Irvine and Hines Nursery Channels have been investigated for high levels of nitrate in dry-weather samples. Efforts in the Central Irvine Channel are part of the last three intensive nutrient studies in Peters Canyon Wash. The current emphasis has been on intensified monitoring, on a bi-weekly schedule, to better understand the temporal pattern of discharges. This information is intended, in part, to help focus subsequent source identification efforts on periods when discharge levels are highest. The situation is the same for Hines Channel, which is a tributary to Central Irvine Channel. **Figures 11.11** and **11.12** show the nitrate concentrations in Central Irvine and Hines Channels measured throughout the year.

In late May of 2002 a short-term mass load study was attempted on Hines and Central Irvine Channels. Because of a flowmeter malfunction and inconsistent flowrates at the Hines Channel location, the study was repeated in late June of 2002. The June monitoring consisted of 6-hour composite sampling and continuous flowrate measurement. **Figure 11.13** shows the average flowrate during each composite sampling at each location. **Figure 11.14** shows the nitrate concentrations of each composite sample and **Figure 11.15** shows the nitrate nitrogen load from each composite sampling. **Figure 11.16** shows the flowrates, nitrate concentrations, and loads for the sampling conducted in Central Irvine Channel during the May study. As can be seen by comparison to the June study the daily loads in May were generally greater than those in June. Note that **Figure 11.15** presents loads for 6-hr composites. Daily loads can be estimated by the sum of the loads from four consecutive 6-hr composite samples. A May sampling will be attempted again in 2003.

Sulphur Creek downstream of Sulphur Creek Dam – metals in sediment

Sulphur Creek downstream of the Sulphur Creek Reservoir (station SCDAM) was designated as a Warm Spot because of relatively high levels of cadmium and nickel in the sediments downstream of the dam. The data from analyses of these two metals since the beginning of the program are shown in **Figure 11.17**. Source investigation during this monitoring year consisted of collection of sediment samples from Laguna Niguel Lake near the outlet to the lower dam gate and in Sulphur Creek upstream of the lake (station SCBJ03). These data are presented in **Figure 11.18**. **Figure 11.18** shows little difference between the cadmium and nickel levels in the lake and Sulphur Creek downstream of the dam. There does however appear to be differences in copper and zinc concentrations between these two sites with the lake being noticeably higher. The higher levels in the lake and SCDAM relative to other channel locations may be a function of the amount of fine particles in the samples submitted for analyses. The particle size distribution in sediment samples has been analyzed since 1997. The average percentage of clay (<2 micron) particles in all samples collected from channels since those analyses were initiated is 5.2%. The average of all samples collected from SCDAM is 10.4%. As can be seen from **Figure 11.18** the percentage of fine particles in the sample from the lake was more than three times that of the sample from SCDAM.

11.6.2 <u>Critical Aquatic Resources (CARs) Monitoring</u>

The CARs element is generally on track with the categories of activities and timelines listed in **Figure 11.3**. Baseline monitoring has been carried out as specified in **Table 11.8**, with the exception that Huntington Harbor was not sampled during this monitoring period because of the low number of storms.

The Final Monitoring Program envisioned that the CARs would fulfill a broader impact assessment role that would involve filling important data gaps and collecting and integrating data from all sources to develop a more complete picture of impacts on aquatic resources.

The following are summaries of the activities conducted in the CARs (from **Figure 11.1**) during the reporting period.

Upper Newport Bay tributaries

The Upper Newport Bay and its tributaries were assigned the top monitoring priority in the Final Monitoring Program. The monitoring of these areas included routine NPDES and TMDL sampling as described in **Table 11.8.**

Monitoring in the Upper Newport Bay and San Diego Creek also includes separate, but related studies to evaluate the trapping efficiency of the basins in the Upper Bay, assess toxicity in the Upper Bay, and evaluate the efficiency of the Irvine Ranch Water District's nutrient removal ponds.

The mass loads of nutrients and total recoverable metals were calculated for each storm monitored for which there was water quality and flowrate information. In the Upper Newport Bay watershed loads were calculated for sampled stormwater runoff in Santa Ana-Delhi Channel, El Modena Irvine Channel, Lane Channel, Peters Canyon Wash, San Diego Creek at Harvard Avenue, and San Diego Creek at Campus Drive. The mass load information for each sample from every storm is contained in **Appendix R**. The total annual stormwater discharge volumes from Santa Ana-Delhi Channel, Peters Canyon Wash, San Diego Creek at Harvard, and San Diego Creek at Campus Drive were calculated from Principal Permittee's streamgaging records. Using these volumes and the updated site mean EMCs from **Appendix S,** the unsampled stormwater loads from each of these channels was estimated. **Table 11.15** includes a summary of the sampled and unsampled loads from each of the sites from **Appendix S** including those from the Newport Watershed.

The direct impacts on the Upper Newport Bay from its tributaries have not been measured by the Final Monitoring Program. Ideally monitoring would be conducted within the areas defined by the respective channel's stormwater plume during a representative storm (e.g. 2-yr or 5-yr return frequency). This monitoring would consist of aqueous toxicity testing during storms and sediment toxicity testing during dry weather conditions. Since monitoring thus far has only involved sampling of the channels, the impacts on the Bay can only be estimated by comparing the concentration concentrations of known toxicants in the freshwater discharges to saltwater toxicity criteria. Using this approach leads to a large margin of safety as mixing zone considerations are not taken into account. The results of this type of evaluation are only used to prioritize sites for further testing. It was intended that toxicity testing be conducted on the freshwater discharges and the receiving bays during the 2001/2002 storm season. Because of the season's abnormally low rainfall this monitoring was not conducted.

For channels discharging directly to the Newport Bay, dissolved metal concentrations were compared to the guidance criteria for saltwater from the CTR. Out of 37 stormwater samples, all exceeded the acute toxicity guidance criterion for copper and six exceeded the acute toxicity guidance criterion for zinc. Of the six composite storm periods that were evaluated against the chronic toxicity guidance criteria for the protection of saltwater aquatic life, all exceeded the guidance criterion for copper. **Table 11.16** is a summary of exceedances relative to the CTR that were found in the storm channels during this monitoring year.

Santa Ana Delhi Channel

Figure 11.1 shows monitoring and assessment efforts at Santa Ana Delhi Channel extending throughout the permit period. Santa Ana Delhi was added to the sediment TMDL monitoring program, in order to help quantify the amount of sediment impacting Upper Newport Bay. It is also part of the nutrient TMDL program, and is therefore being monitored at levels above those proposed in the Final Monitoring Program.

Costa Mesa Channel

The Costa Mesa Channel was selected as a model urban runoff site because its watershed is approximately one square mile in area and has predominately urban land uses within it. It is sampled weekly for metals, nutrients, and bacteria and monthly for organophosphate pesticides. Monitoring at this site will be determined largely by requirements of the nutrient, pathogen, and toxics TMDLs.

With respect to the monitoring results from this reporting year and recognizing the discussion above, all of the stormwater concentrations and 38 of 40 dry weather concentration of dissolved copper in Costa Mesa Channel would exceed the CTR acute toxicity criteria for saltwater at the interface of the channel and the Upper Newport Bay. Since the average dry-weather discharge rate of the Costa Mesa Channel is very low, the impact on the Bay due to copper is likely to be negligible.

Figure 11.19 is plot of the fecal coliform concentration in Costa Mesa Channel throughout the year. As can be seen from the graph the fecal coliform concentration were extremely variable with a range of <2 to >160,000 MPN / 100 ml and a logmean of approximately 6,674 MPN / 100 ml. These results are similar to the previous two monitoring periods.

Diazinon was found above the detection limit (0.05 μg/l) of the laboratory in nearly every sample collected from Costa Mesa Channel during this monitoring year. Chlorpyrifos was not detected (<0.05 μg/L) in any sample from this reporting period. During the first year of sampling (1999-2000) over one third of the samples had concentrations greater than the LC_{50} for the freshwater toxicity testing organism *Ceriodaphnia dubia*[6]. In the second year only about 10% were greater than the LC_{50} and about 13% were greater than the LC_{50} this year. **Figure 11.20** is a graphical summary of the diazinon sampling conducted during this monitoring year.

San Diego Creek and its tributaries

Sampling for diazinon in dry-weather discharges was also conducted in San Diego Creek at Campus Drive. **Figure 11.21** shows the concentration of diazinon in the samples collected this year. None of the samples had levels above the LC_{50} for *Ceriodaphnia*.

In order to gather more information for the toxics TMDL, samples for analyses of total recoverable selenium were collected from San Diego Creek at Campus Drive. The results of these analyses are shown in **Figure 11.22**.

Newport Bay

Because of the paucity of rainfall, the Newport Bay was not sampled during any storms from the current year. Monitoring in the bay included monthly sampling for nutrients

[6] Lee, G. Fred, Evaluation Monitoring Report for San Diego Creek, 1998, Table 6-3.

and bacteria in the water column, and semiannual sampling of the sediments for metals and organic compounds.

Figure 11.23 shows the dry-weather concentrations of fecal coliform at four Upper Bay stations during the year. As in previous years the concentrations of bacteria are generally greatest near the mouth of San Diego Creek (station UNBJAM).

In February of 2000, the Regional Monitoring Program (RMP) for the Nutrient TMDL was initiated. Chemical sampling for nutrients during storms and dry weather was conducted according to the frequencies outlined in RMP report. The data from the 2001/02 reporting period are contained in **Appendix T.**

Lower Newport Bay

Other than the additional sediment samples collected in the Rhine Channel there have been no efforts to date focused on Lower Newport Bay.

Aliso Creek

Extensive studies are being carried out in Aliso Creek to better characterize patterns of bacterial contamination, identify sources of this contamination, and assess options for source reduction and/or treatment. These studies were initiated as the result of a directive from the San Diego Regional Board. The results of these studies can be found in the six quarterly progress reports submitted to the San Diego Regional Board on July 31, 2001, October 31, 2002, January 31, 2002, April 30, 2002, July 31, 2002, and October 31, 2002, respectively.

Dana Point Harbor

Monitoring of Dana Point Harbor consisted of semiannual sampling for nutrients in the water column and for metals and organic compounds in the sediments. No stormwater sampling was conducted.

San Juan Creek

The Orange County Health Care Agency with assistance from researchers from the University of South Florida is currently conducting a bacterial source tracking study in the San Juan Creek watershed. Antibiotic resistance analysis is being used to characterize the sources of bacteria from several stormdrains discharging to the Creek.

11.6.4 Reconnaissance

The Reconnaissance Program was developed to aid in source identification in areas of known water pollution problems. The Program is proceeding with the categories of activities and timelines listed in **Figure 11.3**. Stations were prioritized as part of the monitoring program design. Site-specific designs have been established and source identification conducted as each site is addressed.

Additional reconnaissance of the automotive repair complex on Orange Avenue in Lake Forest was conducted (Section 10) this year. A preliminary reconnaissance of the Collins Channel watershed in Orange was also conducted.

BMP evaluation was identified as a part of the Reconnaissance Program. The context of BMP evaluation was further defined in a collaborative assessment of research needs conducted with the Southern California Coastal Water Research Project (SCCWRP), Southern California Counties, and three Regional Boards. This group identified BMP effectiveness evaluation as a priority area of study and recommended the development of a regionally consistent, standardized framework for such assessments. The Final Monitoring Program's commitment in this area will therefore focus on supporting and participating in a regional research project. The grant agreement is currently undergoing final approval and it is anticipated that the County would be working with SCCWRP in early 2003 to identify potential candidate BMPs for evaluation.

11.6.5 Semiannual Sediment Sampling

Samples of bottom sediment from several watershed and harbor/bay locations were collected in the fall/winter of 2001 and the spring/summer of 2002. These samples were analyzed for trace metals, iron, chlorinated hydrocarbon pesticides, selected herbicides, and particle size distribution. One monitoring location in Dana Point Harbor was also monitored for polynuclear aromatic hydrocarbons (PAHs).

The database for harbor and bay sediments was evaluated using NOAA's guidance criteria for sediment toxicity. These criteria are used by SCCWRP in assessing toxicity of sediments collected from the Southern California Bight. Concentrations of metals and organic compounds from Newport Bay, Huntington Harbor, and Dana Point Harbor were compared to NOAA's Effects Range Median (ER-M). An ER-M is a predicted concentration at which half the test organisms in a toxicity test would show a toxic effect. Although none of the metals concentrations in the harbors exceeded ER-Ms several samples collected during the fall of 2001 had levels of Chlordane exceeding the ER-M.

SCCWRP's iron normalization procedure was again used to determine the presence of trace metal enrichment in the sediments from the bays and harbors. Using the regression equations and prediction intervals (**Table 11.11**) it was determined that every monitoring site in Newport Bay (Upper and Lower), Huntington Harbour, and Dana Point Harbor were anthropogenically (caused by the actions of man) enriched with zinc. All monitoring locations in Dana Point Harbor showed enrichment with copper and zinc, with the three locations near the outlets of the stormdrains also showing enrichment with lead. Every location in Huntington Harbour and Bolsa Bay showed enrichment with copper, lead, and zinc. In the Lower Newport Bay, the Rhine Channel and the turning basin showed enrichment with copper, lead, and zinc. As in the previous reporting year, the furthest upstream sampling point in the Upper Newport Bay (UNBJAM) showed the least anthropogenic influence of any harbor/bay monitoring location.

11.7 Quality Assurance / Quality Control

The quality of data produced by each of the three contractor laboratories was evaluated by submitting quality control samples with environmental samples. Most of the samples submitted were synthetic, comprised of aliquots of prepared standard solutions in nanopure water matrices. Quality Control sample conductivities were adjusted to levels similar to environmental samples with Ultrex grade sodium chloride. These synthetic samples were used to assess the accuracy of each laboratory. Replicate samples were also submitted to evaluate the precision of the laboratories.

The contractor laboratories conduct internal quality control programs utilizing certified reference materials (CRMs), spiked and replicate samples.

The results of the quality assurance program with the contract laboratory are summarized in **Appendix U.** The allowable range of percent recovery for synthetic and samples is set at 70 - 130 for concentrations above 5 times the detection limit. For replicate samples in which the highest reported value exceeded 5 times the detection limit, the allowable range was set at 75-125 percent. For blank sample analyses the allowable range was the detection limit (dl) to 3(dl).   Those results outside these ranges are boxed in the appendix.

Generally, the analytical performance of each laboratory was acceptable. Three of the 35 analyses for TKN in synthetic samples produced results outside acceptable range of recovery.

Ten replicate samples for nutrient analyses and six replicate samples for trace metals analyses were submitted to the contract laboratories. Two total phosphate results and one nickel result were outside the allowable range or error.

Four samples of Nanopure water were submitted for nutrient analyses and three for trace element analyses. One of the analyses for TKN was outside the allowable range of error.

11.8   Regional Research Monitoring Program

Stormwater runoff in southern California has become one of the largest environmental management issues in the region. While current runoff management has become an immensely successful system for flood control, it has not historically been designed to enhance water quality. Current estimates of pollutant loads from stormwater runoff rival those of traditional point sources for many constituents, and several examples of impacts from storm drains and channels have been observed in receiving waters. Examples include the contribution of bacteria that has resulted in posting of beaches for swimming, contributions of nutrients that have resulted in blooms of macroalgae, and contributions of toxics that has led to aquatic toxicity and degradation of aquatic habitats. This combination of emissions and impacts has led to an increasing regulatory focus on stormwater runoff, but much of the science needed to make effective and efficient management decisions is still lacking.

As a result of the increasing regulatory focus and the lack of scientific knowledge base, both stormwater regulators and municipal stormwater management agencies throughout southern California have developed a collaborative working relationship. The goal of this relationship is to develop the technical information necessary to better understand stormwater mechanisms and impacts, and then develop the tools that will effectively and efficiently improve stormwater decision-making. As individuals and agency representatives, there was early recognition that these issues are oftentimes not localized, but typically cross watershed and jurisdictional boundaries. This relationship culminated in a formal letter of agreement signed by all of the Phase I municipal stormwater NPDES lead permittees and the NPDES regulatory agencies in southern California to create the Stormwater Monitoring Coalition (SMC).

List of member agencies in the Stormwater Monitoring Coalition.

California Regional Water Quality Control Board, Los Angeles Region
California Regional Water Quality Control Board, San Diego Region
California Regional Water Quality Control Board, Santa Ana Region
City of Long Beach
County of Orange, Public Facilities and Resources Dept.
County of San Diego Stormwater Management Program
Los Angeles County Department of Public Works
Riverside County Flood Control and Water Conservation District
San Bernardino County Flood Control District
Southern California Coastal Water Research Project
Ventura County Flood Control District

The SMC member agencies have developed a clear vision of regional cooperation. The vision includes combining resources to cost effectively achieve their goal. The vision includes improved effectiveness of existing monitoring programs by promoting standardization, coordination, and reducing duplication of effort across individual programs. This will lead to improving the basic infrastructure for exchanging, combining, and analyzing data from across the region. The multi-agency collaboration hopes to trade off redundant or ineffective monitoring program elements in order to allocate resources to the research projects necessary for improving stormwater management. The findings from these applied research projects can then be easily and quickly integrated into the existing stormwater management programs.

This document outlines the activities that the SMC has accomplished over the last year. The initial project promoted by the SMC was the creation of a research agenda. The SMC has subsequently embraced three of the proposed projects in the research agenda and have begun work to accomplish the project objectives. The SMC meets on a quarterly basis to discuss these projects and ensure their success. Cumulatively, these activities demonstrate that the SMC is an active organization and is making great strides in achieving its stated goals. The common vision shared in by the initial founding members of the SMC has taken root and is being implemented to the benefit of both regulatory and regulated communities.

11.8.1 Project Status

Creation of a Stormwater Research Agenda (status: complete)

The first project undertaken by the SMC was to develop a research agenda they could jointly undertake. Creation of this research agenda required careful consideration since this document would form the basis of future activities by the SMC. Therefore, the SMC assembled a panel of 16 experts, in a variety of disciplines, for a 3-day facilitated workshop. These experts included hydrologists, civil engineers, water quality scientists, biologists, toxicologists, statisticians, modelers as well as representatives from the regulatory, regulated and environmental community. The goal of the workshop was to create a list of priority project descriptions including background and objectives, general approach, expected products, as well as a timeline and estimated budget. This project was jointly funded by all SMC sponsoring agencies.

The final research agenda was comprised of 15 distinct projects. The 15 projects fell into a three-part framework that included building a monitoring infrastructure, understanding stormwater mechanisms and processes, and understanding receiving water impacts. Building monitoring infrastructure included projects such as developing standardized sampling and analysis protocols, assessing BMP effectiveness, and examining historical monitoring data. Understanding stormwater mechanisms and processes included projects such as developing a systemwide conceptual model, identifying non-point sources that contribute to stormwater, and determining appropriate reference conditions. Understanding receiving water impacts included projects such as developing bioassessment indicators and protocols, developing microbial source tracking techniques, and evaluating indicators of peak flow impacts. The final report entitled "Stormwater Research Needs in Southern California" can be found online at ftp://ftp.sccwrp.org/pub/download/PDFs/358_stormwater_workplan.pdf

Develop standardized sampling and analysis protocols (Status: initiated and ongoing)

This project is an attempt to build a stormwater monitoring infrastructure in order to increase comparability among programs throughout southern California. The SMC developed a four-step approach to accomplish this goal: (1) define the monitoring questions of interest, (2) assess what monitoring programs are currently doing to determine how well they are answering the monitoring questions, (3) create an optimum design for answering the monitoring questions, and (4) conduct QA inter-calibration studies. This study is partially funded by the State Water Resources Control Board (SWRCB) in response to SB 72, whose legislative goal was to standardize sampling, analysis and reporting for stormwater monitoring. It has been made clear that the SMC is only developing a design for the southern California region.

There has been substantial progress thus far. A technical working group has been formed to guide the study and includes the stormwater agencies and regulators on the SMC, the SWRCB, and at least one environmental group. The group has had one meeting and has begun defining the monitoring questions of interest (step 1). The SMC is currently recruiting a facilitator to continue this process. A laboratory intercalibration is in its initial stages will be completed in the upcoming year.

Microbial Source Tracking Method Comparison (status: initiated and ongoing)

There are numerous waterbodies throughout southern California, both marine and freshwater, that suffer contamination of fecal indicator bacteria such as total coliforms, fecal coliforms, and *enterococcus*. There are several Microbial Source Tracking (MST) techniques now being developed for determining sources (i.e. humans, dogs, cats, horses, etc.) of fecal indicator bacteria in receiving waters. However, all of them are in the early stages of development and none have been tested side-by-side for their ability to accurately discriminate or quantify these sources of fecal contamination. This study was designed to evaluate each of these new methods for accuracy and precision, using bacterial sources from southern California, and then make recommendations to the management community on the most effective and efficient method application(s). The SMC is partially funding this study in collaboration with the US Environmental Protection Agency, State Water Resources Control Board, City of Santa Barbara, and the National Water Research Institute.

Twenty-one of the most prominent researchers in the field are testing nine different MST techniques all at the same time on the same split samples. These techniques include techniques such as ribotyping, antibiotic resistance (ARA), pulsed-field gel electrophoresis (PFGE), polymerase chain reaction (PCR), and terminal restriction fragment length polymorphism (TRFLP). Each of the specific sources were collected in October and shipped to the researchers for characterization. Next, each sample was added to sterile freshwater or seawater in varying mixtures and densities, then were delivered blind to each laboratory. Each researcher will be asked three questions regarding the blind samples: 1) are human or non-human sources of indicator bacteria are present? 2) if non-human sources are present, what source are they (i.e., dog, cow, seagull)? and 3) what fraction of the sample is attributable to each source? Sample analysis is currently underway and results are expected by February 2003.

Peak Flow Impacts (status: initiated)

Watershed development increases imperviousness eventually leading to alterations in runoff flow regimes. This alteration in flow regime, particularly increased flows during high frequency events (i.e. 1-2 year storms), can result in downstream impacts such as increased erosion or habitat loss. The goal of this study is to quantify impacts from increased peak flows as a result of watershed development. Ultimately, the objective of this study is to develop indicators of peak flow and resulting peak flow impacts so that regulators and regulated agencies can develop numerical criteria for peak flow. This project is fully funded by the Los Angeles County Department of Public Works (LACDPW), although all of the SMC members are interested in this study.

This project is in its initial stages. A Request for Proposals (RFP) was released, written proposals were submitted, and short-listed bidders have had an oral interview. The SMC selection committee is in the process of selecting the winning bidder.

Table 11.1
Additional Local Water Quality Monitoring

Permittees	Objective	# of Locations	Sampling Frequency	Constituents Sampled	Results & Analysis Summary
Aliso Viejo	Source Identification for Bacteria and Chlorine	14	3	Total coliform, fecal coliform, fecal streptococcus, E-coli, Chlorine	Six locations exceeded the REC 2 fecal coliform limit of 4,000 MPN/100 for single grab sample. Data for chlorine in J01P23, as of July 2002, are within typical range for other storm drains.
Dana Point	To provide design information for a treatment facility near the terminus of Salt Creek to remove contaminants that cause beach closures in that area, ie, Enterococcus Bacteria, Fecal Coliform, and Total Coliforms.	2	Weekly from 10/29/01 to 11/29/01	Total Coliform, fecal coliform, Enterococcus, and E-Coli	
Huntington Beach	Identify pollutants found in stormwater pump stations	8		Total coliform, fecal coliform, Enterococcus, TSS, pH, turbidity, 1,1,2 Trichloroethane, 1,1-Dichloroethane, and others	
La Habra	Stop possible illegal wet sanding	1			No evidence of wet sanding found and still under surveillance.
Laguna Niguel	Followup investigations of localized "Warm Spots" from Aliso Creek; Samplings and monitoring of J03P02 wetlands performance.	25	Weekly	Total Coliform; fecal coliform; E. coli; Enterococcus; Temperature monthly; N,P,Mn,TSS, turbidity, Cl, & oil/grease at 4 sites	Refer to Aliso 13225 Monitoring Quarterly Reports, Laguna Niguel Appendices; and to J03P02 CAO 99-211 Quarterly Reports.
Mission Viejo		4	1 time	Bacteria	
Newport Beach	Sources of bacteria in Upper and Lower Newport Bay, 3 separate monitoring programs in Summer 2002	Multiple	Varies	Fecal Coliform, Total coliform, Enterococcus, F-Specific Coliphage, Enteric Viruses, Adenoviruses.	Results of the City-Regional Board-UCI testing program for Summer 2002 will be available in the next reporting period.
Orange	Ensure quality potable water for residents and businesses	32	Weekly	Sampling sites represent entire city population	City exceeds the federally mandated water quality standards and therefore monitors potable water coming from groundwater.
Seal Beach	Testing of debris in catch basins	12	One	6010B ICP Cam Metals Only; 8015 UPS Total Petroleum Hydrocarbons	All samples proved to be non-hazardous.
County of Orange/OCFCD	Source of bacterial contamination in the Aliso Creek Watershed	41	5 times per 30 day period	Total coliform, fecal coliform, Enterococcus	Seasonal fluctuation of pollutants has been discovered and pipes have been found that are higher in concentration. Permittees are using these locations to focus their efforts.

Table 11.2
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 Harbour	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 Desheca			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 Desheca			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

Scoring of candidate monitoring sites on each of several subjective criteria and Basin Plan beneficial uses that reflect habitat value and human us. Cells with more than one "X" indicate heavier weighting for that site on that criterion.

Table 11.3
Summary of Ranking Critical Aquatic Resources

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 Desheca
6	Trabuco Creek
4	Segunda Desheca
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 11.1. * Dana Point Harbor is included as a first priority site because of the extensive amount of human use and community interest.

Table 11.4
Sources of Information Used for Critical Aquatic Resource Impact Assesment

	Study/Location	Agency	Funded by	Duration	Data
1	UNB Algal Studies	UCLA	IRWD	1996-	Salinity, nutrients, algal biomass
2	Newport Marine Life Reserve W'shed Studies	RiverTech	The Irvine Company		Nutrients
3	Newport Marine Life Reserve Offshore Studies	Dr. Ford, Cal State U. San Diego	The Irvine Company		Growth rate of kelp
4	Santa Ana River, Reach 1	SCCWRP	CSDOC	10/97-10/98	TSS, priority pollutants (organics, etc.)
5	Southern California Bight Pilot Project	SCCWRP	POTWs	1994, 1998	Chemical, biological, and toxicity samples
6	Basin Study, Santa Ana River (Imp. Hwy)	OC Water District & USGS	OCWD & USGS	10/95 - 9/99	Nitrates, organics
7	State Mussel Watch (UNB, DP, Huntington Harbor)	Ca. Dept. of Fish & Game	Reg'l Board	1977-	Toxics (trace metals, synthetic organics)
8	Toxic Substances Monitoring Program	Ca. Dept. of Fish & Game	Reg'l Board	1989	Toxics (trace metals, synthetic organics)
9	TMDL studies	Reg'l Board	Reg'l Board	1997	TMDLs on nutrients
10	TMDL studies	Reg'l Board	Reg'l Board		TMDLs on sediments
11	NB Plant Survey	Dr. Alex Horne, UC Berkeley	IRWD	1996	Plants
12	Coastal bacteria (coast)	County Environmental Health	County	1977-	Bacteria
13	Coastal bacteria (Aliso Creek, Laguna Beach)	Aliso Water Management Agency (AWMA)	AWMA	NPDES permit term	Bacteria
14	Coastal bacteria (San Juan Creek)	Southeast Regional Reclamation Authority (SERRA)	SERRA	NPDES permit term	Bacteria
15	Coastal bacteria (Santa Ana River)	County Sanitation Districts of Orange County (CSDOC)	CSDOC	NPDES permit term	Bacteria
16	Talbert Channel Conservancy	Cal State Long Beach			Polychaete taxonomy
17	Evaluation Monitoring Program (UNB w'shed)	Dr. Fred Lee, Transportation Corridor Agencies (TCA)		1997-2000	Toxicity
18	SD Creek Sediment Monitoring Program	Orange County Environmental Resources Section	County, Cities of Irvine, Tustin, & Newport Beach, Irvine Company	1987-	Transported sediment, channel profiling, bathymetric survey of NB
19	San Diego Creek/NB model	Resource Management Associates	County, City of Newport Beach, Army Corps of Engineers	1997-	Sediment transport model with potential for expansion into water quality model
20	Orange County Municipal NPDES Stormwater Program	Orange County Environmental Resources Section	County, Flood Control District, Cities	1991 -	Water and sediment quality data
21	Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries	NOAA, SWRCB, USEPA, DFG, UCSC, CSUSJ	NOAA, SWRCB, USEPA, DFG	1997	Sediment quality data
22	Maintenance of trash/debris booms in Orange County flood control channels	Orange County PFRD/PW/OPS	County	Ongoing	Debris boom maintenance, debris disposal costs
23	Maintenance of Newport Dunes Aquatic Park	Newport Dunes Aquatic Park	Newport Dunes Aquatic Park	Ongoing	Algae removal costs
24	Debris removal in Huntington Harbour	G.H. Boston Company	City of Huntington Beach	Ongoing	Debris volumes
25	Debris removal in Newport Bay	City of Newport Beach Public Works	City of Newport Beach	Ongoing	Algae and debris volumes
26	Maintenance dredging in County facilites	Contractor administration by County Coastal Facilities	County	Ongoing	Sediment testing results, biological resources
27	Fish trawling in Newport Bay	Orange Coast College	Orange Coast College	Ongoing	Population distribution of fish
28	Army Corps of Engineers Reconnaissance Study - Aliso Creek	Army Corps of Engineers	Army Corps of Engineers, Cities, County, Water Districts	1998 - 2001	Create integrated watershed management plan.

Table 11.5
Critical Aquatic Resources Preliminary Impact Assessment

Resource	Beneficial use(s)	Available Indicators of probable impact	Source of Indicator From Table 10	Constituents of concern	Possible Sources
San Diego Creek, Reach 1 & 2	Aquatic habitat	Elevated toxics in fish tissue	8	Toxaphene, Dacthal, Diazinon, Oxidizon, Total DDT, Group A, Cd, Se, Zn	Urban runoff, agriculture
		Bioaccumulation	7	Chlorpyrifos, Oxidizon, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Cd	Urban runoff, agriculture
	Wildlife habitat	Water quality	17,20	Diazinon, Chlorpyrifos, nutrients	Urban runoff, agriculture
		Sedimentation	18,19,26	Sediment	Channel erosion, construction, agriculture
		Wildlife changes			Urbanization, urban runoff
		Vegetation changes			Urban runoff, channel erosion, flowrate
	Recreation/ aesthetics	Algal blooms	20	Nutrients	Urban runoff, agriculture
		Elevated levels of bacteria	12		Urban runoff, wildlife, sewer overflows / line breaks
San Juan Creek & Lower	Recreation/ aesthetics	Beach closures	12, 14	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
	Groundwater Recharge	Water quality	14,20	Total Dissolved Solids	Urban runoff
Upper Newport Bay	Aquatic habitat	Elevated toxics in fish tissue	8	Cu, Hg, Pb, Total DDT	Urban runoff, recreational boating
		Water quality	17,20	Diazinon, Chlorpyrifos, nutrients	Urban runoff, agriculture, open space
		Sediment contamination	5,20,21,26	Total DDT	Urban runoff, agriculture, boatyards
		Bioaccumulation	7	Chlorpyrifos, Toxaphene, Total Chlordane, Total DDT, Dichlorobenzophenone, Dicofol, Dieldrin, Total PCB, Total PAH, Cu, Hg	Urban runoff, agriculture
	Wildlife habitat	Sedimentation	18,19,26	Sediment	Channel erosion, construction, agriculture
		Loss/change of species diversity	26,27	Toxics, DO, nutrients, sediment, species composition	Urban runoff, agriculture, open space
		Sediment contamination	20,21,26	Total Chlordane, Total DDT, DDE	Urban runoff, agriculture, boatyards
	Recreation/ aesthetics	Algal blooms	11,23,25	Nutrients	Urban runoff, agriculture
		Trash and debris	22	Trash and debris	Urban, natural
		Beach closures	12	Bacteria	Urban runoff, POTW discharge/line breaks
Aliso Creek & Mouth	Aquatic/ riparian habitat	Bank erosion	28	Flowrate	Urban development
		Loss of riparian vegetation	28	Flowrate	Urban development
	Recreation/ aesthetics	Beach closures	12,13,33	Bacteria	Urban runoff, sewer overflows / line breaks
Lower Newport Bay	Aquatic habitat	Bioaccumulation	7	Chlorpyrifos, Dacthal, Heptachlor Epoxide, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Al, As, Cd, Cu, Cr, Hg, Mn, Pb, Se, Zn	Urban runoff, agriculture,boatyards, recreational boating
		Sediment contamination	5,20,21,26	Total Chlordane, Total DDT, Cu, Hg	Urban runoff, agriculture
	Recreation/ aesthetics	Algal blooms	11,25	Nutrients	Urban runoff, agriculture
		Trash and debris	25	Trash and debris	Urban, natural
		Complaints	12,20,25	Trash and debris, nutrients, bacteria	Urban, natural, agriculture, open space
Sunset Aquatic/Anaheim Bay/Huntington Harbour	Aquatic habitat	Bioaccumulation	7	Chlorpyrifos, Dacthal, Heptachlor Epoxide,Oxidizon, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Al, As, Cd, Cu, Cr, Mn, Pb, Se, Zn	Urban runoff, agriculture
		Elevated toxics in fish tissue	8	Total Chlordane, Total DDT, Total PCB, Total PAH	Urban runoff, agriculture
		Sedimentation	26	Sediment	Agricultural runoff
		Loss/change of species diversity	5,26	Sediment, disturbance	Agricultural runoff, dredging
		Sediment contamination	5,20,26	DDE	Urban runoff, agriculture
		Water quality	20	Metals, nutrients	Urban runoff, agriculture
	Recreation/ aesthetics	Trash and debris	22,24	Trash and debris	Urban runoff
		Beach closures	12	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
Dana Point Harbor	Recreation/ aesthetics	Beach closures	12	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
	Aquatic habitat	Bioaccumulation	7	Total Chlordane, Total PCB, Al, Cd, Cu, Zn	Urban runoff, recreational boating
		Sediment contamination	5,20,21,26	Total Chlordane, Cu	Urban runoff, recreational boating

Bioaccumulation - toxics found in filter feeding invertibrates such as mussels
bacteria - pathogenic indicator organisms
Group A chemicals - includes aldrin,dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total), endosulfan, toxaphene

Table 11.6
Warm Spot Constituents of Concern and Trend Monitoring Frequencies

Warm Spot	Location	STORET Code	Constituent(s) of Concern	from Power Analyses: Trend Detectable	Monitoring Frequency samples/yr	term (years)	min. reduction to show signifcant trend
Bonita Creek	u/s F05 conf.	BCF04	Ni Ni(s)	N N	(12) (2)		
Lane Channel	u/s Jamboree	LANF08	EC(d)	Y	10	5,10	28,13
Agua Chinon Wash	@ Irvine Ctr. Dr.	ACWF18	DDE(s), DDT(s)	N	(2)		
Central Irvine Channel	@ East Yale Loop	CICF25	NO_3(d)	?	20	20	78
Rattlesnake Canyon Wash	@ Bryan Ave.	RCWF26	TSS Pb	 Y	 20	 20	 70
Hicks Canyon Wash	@ Culver Dr.	HCWF27	DDE(s)	N	(2)		
Hines Channel	@ Bryan / Jeffrey	HINF28	NO_3(d)	Y	20	10,20	50,35
Sulphur Creek	d/s Sulphur Cr. Reservoir	SCDAM	Cd(s)	N	(2)		
Prima Deshecha Channel	@ Calle Vista Grande	PDCM01	EC(d) Cd Ni	Y Y Y	10 20 20	10,20 10,20 10,20	42,29 50,33 53,37
Segunda Deshecha Channel	@ El Camino Real	SDCM02	EC(d)	?	10	20	75
Lower Newport Bay	@ the Rhine Channel	LNBRIN	Cu(s)	?	5	20	85
Huntington Harbour	@ Christiana Bay	HUNCRB	Pb(s)	?	5	20	68

(s) sediment concentrations; (d) dry weather measurements; all others stormwater concentrations
(#) - frequency not based on power analyses

Table 11.6
Warm Spot Constituents of Concern and Trend Monitoring Frequencies

Warm Spot	Location	STORET Code	Constituent(s) of Concern	from Power Analyses: Trend Detectable	Monitoring Frequency samples/yr	term (years)	min. reduction to show signifcant trend
Bonita Creek	u/s F05 conf.	BCF04	Ni Ni(s)	N N	(12) (2)		
Lane Channel	u/s Jamboree	LANF08	EC(d)	Y	10	5,10	28,13
Agua Chinon Wash	@ Irvine Ctr. Dr.	ACWF18	DDE(s), DDT(s)	N	(2)		
Central Irvine Channel	@ East Yale Loop	CICF25	NO_3(d)	?	20	20	78
Rattlesnake Canyon Wash	@ Bryan Ave.	RCWF26	TSS Pb	 Y	 20	 20	 70
Hicks Canyon Wash	@ Culver Dr.	HCWF27	DDE(s)	N	(2)		
Hines Channel	@ Bryan / Jeffrey	HINF28	NO_3(d)	Y	20	10,20	50,35
Sulphur Creek	d/s Sulphur Cr. Reservoir	SCDAM	Cd(s)	N	(2)		
Prima Deshecha Channel	@ Calle Vista Grande	PDCM01	EC(d) Cd Ni	Y Y Y	10 20 20	10,20 10,20 10,20	42,29 50,33 53,37
Segunda Deshecha Channel	@ El Camino Real	SDCM02	EC(d)	?	10	20	75
Lower Newport Bay	@ the Rhine Channel	LNBRIN	Cu(s)	?	5	20	85
Huntington Harbour	@ Christiana Bay	HUNCRB	Pb(s)	?	5	20	68

(s) sediment concentrations; (d) dry weather measurements; all others stormwater concentrations
(#) - frequency not based on power analyses

Table 11.7
NPDES and Nutrient TMDL Monitoring Locations

	Warm Spot	CAR	TMDL	Waterbody	Location of Site	Station Code
			X	El Modena Irvine Channel	at Michelle Dr.	MIRF07
			X	Lane Channel	at Jamboree Blvd.	LANF08
	X		X	Agua Chinon Wash	at Pacifica	ACWF18
Upper Newport Bay	X			Central Irvine Channel	at I-5 Fwy.	CICF25
Watershed	X			Hines Nursery Channel	at Trabuco / Jefferey	HINF28
				Hicks Canyon Wash	at Culver Dr.	HCWF27
			X	Bonita Canyon Wash	u/s University Ave.	BCF04
		X	X	San Diego Creek	at Campus Dr.	SDMF05
		X	X	San Diego Creek	at Harvard Ave.	WYLSED
			X	Peters Canyon Wash	at Barranca Pkwy.	BARSED
			X	Costa Mesa Channel	at Westcliff Dr.	CMCG02
			X	Santa Ana Delhi Channel	u/s Irvine Ave.	SADF01
		X		San Juan Creek	at Ortega Hwy. In Caspers Park	SJOL01
		X			at La Novia	SJNL01
		X		Aliso Creek	in Laguna / Wood Canyon Wilderness Park	ACJ01
	X			Prima Deschecha Channel	at Calle Vista Grande	PDCM01
	X			Segunda Deschecha Channel	at El Camino Real	SDCM02
	X			Sulphur Creek	d/s Sulphur Creek dam	SCDAM
Upper Newport Bay		X	X		Unit I in-bay basin	UNBJAM
		X	X	Narrows	d/s Unit II In-bay basin	UNBSDC
		X	X	North Star Beach		UNBNSB
		X	X		at PCH bridge	UNBCHB
Lower Newport Bay		X	X	Turning Basin		LNBTUB
	X	X	X	Rhine Channel		LNBRIN
		X	X	Harbor Island Reach		LNBHIR
Sunset Aquatic Park /		X		Sunset Aquatic Park	Near U.S. Navy bouys	HUNSUN
Anaheim Bay /		X		Huntington Harbour	approx. 1/4 mi. d/s Bolsa Chica Ch. Mouth	HUNBCC
Huntington Harbour		X		Huntington Harbour	d/s Warner Ave. near HH Yacht Club dock	HUNWAR
	X	X		Christiana Bay	near outlet of Sunset Channel	HUNCRB
		X		Anaheim Bay	between two breakwaters	HUNHAR
		X		Bolsa Bay	off pier	BBOLR
Dana Point Harbor		X		East Basin	near outlet of 60" RCP	DAPTEB
		X		West Basin	near outlet of 51" RCP	DAPTWB
		X		Launch Ramp	near outlet of 18" RCP	DAPTLB
		X			near boatyard	DAPTLR
		X		Harbor Entrance	between two breakwaters	DAPTHE

Table 11.8
NPDES and Nutrient TMDL Monitoring Frequencies

Station Code	Nutrients (aq)	Nutrients (sed)	Trace (aq)	Trace (sed)	PHP (s)	PAH (s)	Other Interest
MIRF07	**m/st**						
LANF08	**m/st**						EC(m)
ACWF18	**m/st**				semi		
CICF25	biweekly						
HINF28	biweekly						
HCWF27					semi		
BCF04	**m/st**		st(12)	semi			
SDMF05	w/st		st	semi	semi		op pest (m)
WYLSED	**biweekly**/st		st	semi	semi		
BARSED	**biweekly/st**						
CMCG02	w/st		w/st				bacteria (w/st), op pest (m)
SADF01	**biweekly/st**		st				
SJOL01	m/st		st	semi	semi		
SJNL01	m/st		st	semi	semi		
ACJ01	m/st		st	semi	semi		
PDCM01			st(20)				EC(m)
SDCM02							EC(m)
SCDAM				semi			
UNBJAM	m(s,**m,b**)/st	m	st	semi	semi		bacteria (m/st), debris (st)
UNBSDC	m(s,**m,b**)/st	m	st	semi	semi		bacteria (m/st), debris (st)
UNBNSB	m(s,**m,b**)/st	m	st				bacteria (m/st), debris (st)
UNBCHB	m(s,**m,b**)	m	st				bacteria (m/st), debris (st)
LNBTUB	st		st	semi	semi		
LNBRIN	st		st	5	semi		
LNBHIR	**m(s,m,b**)/st		st	semi	semi		
HUNSUN	semi/st		st				
HUNBCC	semi/st		st	semi	semi		
HUNWAR	semi/st		st	semi	semi		
HUNCRB	semi/st		st	5	semi		
HUNHAR	st		st				
BBOLR	semi/st		st	semi	semi		
DAPTEB	semi/st		st	semi	semi	semi	
DAPTWB	semi/st		st	semi	semi		
DAPTLB	semi/st		st	semi	semi		
DAPTLR	st		st	semi	semi		
DAPTHE	st		st				

(s,m,b) surface, middepth, bottom
s(12) storm sampling - 12 total composite samples per year
bold - nutrient TMDL additions including orthophosphate

Table 11.9
Beneficial Uses of Monitored Waterbodies

Bay/Harbor	Station Codes		MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWARM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST
Anaheim Bay - Outer	HUNHAR		+					X		X	X					X	X	X	X	X		
Anaheim Bay - Seal Beach Nat'l Wildlife Refuge	HUNSUN		+							X[1]	X					X	X	X	X	X		X
Sunset Bay - Huntington Harbor	HUNBCC, HUNCRB HUNWAR		+					X		X	X	X					X	X	X	X		
Bolsa Chica Ecological Reserve	BBOLR		+							X	X					X	X	X	X	X		X
Upper Newport Bay	UNBJAM, UNBSDC UNBBCW, UNBNSB UNBNDB, UNBCHB		+							X	X	X				X	X	X	X	X	X	X
Lower Newport Bay	LNBTUB, LNBTRI, LNBRIN, LNBHIR LNBHAR		+					X		X	X	X					X	X	X	X	X	
Dana Point Harbor	DAPTLB, DAPTLR DAPTEB, DAPTWB DAPTHE				X			X		X	X	X					X	X	X	X	X	

Channel	Station Code	Watershed	MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWARM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST
Santa Ana Delhi	SADF01	Upper Newport Bay																				
Bonita Canyon Channel	BCF04	Upper Newport Bay	+				I			I	I		I									
San Diego Creek - Harvard	WYLSED	Upper Newport Bay	+				I			I	I		I				I					
San Diego Creek - Campus	SDMF05	Upper Newport Bay	+							X[2]	X		X				X					
Peters Canyon Wash	BARSED	Upper Newport Bay	+				I			I	I		I									
Sand Canyon Wash	SCCF15	Upper Newport Bay	+				I			I	I		I									
Bee Canyon Channel	BEEF17	Upper Newport Bay	+				I			I	I		I									
Agua Chinon Wash	ACWF18	Upper Newport Bay	+				I			I	I		I									
Serrano Creek	SERF19	Upper Newport Bay	+				I			I	I		I									
Rattlesnake Canyon Wash	RCWF26	Upper Newport Bay	+				I			I	I		I									
Hicks Canyon Wash	HCWF27	Upper Newport Bay	+				I			I	I		I									
E. Costa Mesa Channel	CMCG02	Upper Newport Bay																				
Santa Isabella Channel	SICG03	Upper Newport Bay																				
Big Canyon Wash	BCWG04	Upper Newport Bay																				
Laguna Canyon	LCW102	South County	+	X						O	X		X				X					
Aliso Creek Channel	ACJ01	South County	+	X						O	X		X				X					
Sulphur Creek Channel	SCDAM	South County	+	X						O	X		X				X					
San Juan Creek - La Novia Ave	SJNL01	South County	+	X	X					X	X		X		X		X					
San Juan Creek - Ortega	SJOL01	South County	+	X	X					X	X		X		X		X					
Trabuco Creek	TCOL02	South County	+	X	X					X	X		X		X		X					
Oso Creek	OSOL03	South County	+	X	X					X	X		X		X		X					
Prima Deschecha	PDCM01	South County	+	X						O	X		X				X					
Segunda Deschecha	SDCM02	South County	+	X						O	X		X				X					
Santa Ana River - Imperial	SARIMP	Santa Ana River	+				X			X	X		X				X	X				
Santa Ana River - 5th Street	SARE01	Santa Ana River	+							X[2]	X		I				I					
Santiago Creek	SANE08	Santa Ana River	X				X			X[3]	X		X				X					
Silverado Creek	SILE17	Santa Ana River	X				X			I	I		I				I	I				

X - Present or Potential Beneficial Use
1 - No access per agency with jurisdiction (U.S. Navy)
2 - Access Prohibited in all or part by PFRD
I - Intermittent Beneficial Use
* - Excepted from MUN
o - Potential Beneficial Use
This information was taken from the 1994 update of the beneficial uses & water quality objectives for the San Diego Region and the 1995 Santa Ana River Basin Plan update.

Table 11.10
Applicable Water Quality Guidance for the Protection of Aquatic Life

Water Quality Measurement	**California Toxics Rule (CTR) Freshwater dissolved metals** **H=ln(water hardness in mg/L as $CaCO_3$)**	**CTR Saltwater Dissolved metals**	**Ocean Plan Toxic Mat. Limits Total metals**	**Region 8/9 Basin Plans**
Lead ug/L H=ln Hardness	4 day =[1.462-0.146H][exp(1.273H-4.705)] 1 hour =[1.462-0.146H][exp(1.273H-1.460)]	4day = 8.1 1hr = 210	Daily max = 8 Inst. max = 20	
Cadmium ug/L	4 day = [1.107-0.042H][exp(0.7852H-2.715)] 1 hour = [1.137-0.042H][exp(1.128H-3.6867)]	4day = 9.3 1hr =42	Daily max = 4 Inst. max = 10	
Hexavalent Chromium ug/L		4day = 50 1hr = 1100	Daily max = 8 Inst. max = 20	
Nickel ug/L	4 day = 0.997[exp(0.846H+0.0584)] 1 hour = 0.998[exp(0.846H + 2.255)]	4day = 8.2 1hr = 74	Daily max = 60 Inst. max = 150	
Copper ug/L	4 day = 0.96[exp(0.8545H-1.702)] 1 hour = 0.96[exp(0.9422H-1.70)]	4day = 3.1 1hr = 4.8	Daily max = 12 Inst. max = 30	
Silver ug/L	1 hour = 0.85[exp(1.72H-6.52)]	1hr = 1.9	Daily max = 2.8 Inst. max = 7	
Zinc ug/L	4 day = 0.986[exp(0.8473H+0.884)] 1 hour = 0.978[exp(0.8473H+0.884)]	4 day = 81 1 hr = 90	Daily max = 80 Inst. max = 200	
Turbidity				Natural — Max. increase 0-50 NTU — 20% over natural 50-100 NTU — 10 NTU >100 NTU — 10% over natural
pH				6.5 - 8.5 freshwater 7.0 - 8.5 saltwater
Dissolved Oxygen				>5.0 mg/L MAR & WARM >6.0 mg/L COLD
Unionized Ammonia*				0.025 in receiving waters

$$* \text{ [Unionized Ammonia]} = \frac{[NH3\text{-}N]}{10^{(pka-pH)} + 1}$$

$$\text{where } pka = 0.09018 + \frac{2729.92}{T}$$

NH3-N = Total Ammonia as N
T = water temperature in Kelvin (C + 273.16)
pH = water pH

For example : at 20 C and pH 8.0 divide the ammonia nitrogen value by 26.25 to obtain unionized ammonia.
at 25 C and pH 9.0 divide by 2.76.

Table 11.11
Guidance Criteria for Harbor Sediment Evaluation

NOAA's Screening Concentrations

Metals (ppm)	**ER-L**	**ER-M**
Cadmium	1.2	9.6
Chromium	81	370
Copper	34	270
Lead	46.7	218
Nickel	20.9	51.6
Silver	1.0	3.7
Zinc	150	410
Organics (ppb)		
Acenaphthene	16	500
Acenaphthylene	44	640
Anthracene	85.3	1100
Fluorene	19	540
2-Methyl naphthalene	70	670
Naphthalene	160	2100
Phenanthrene	240	1500
Low molecular weight PAH	552	3160
Benzo(a)anthracene	261	1600
Benzo(a)pyrene	430	1600
Chrysene	384	2800
Dibenzo(a,h)anthracene	63.4	260
Fluoranthene	600	5100
Pyrene	665	2600
High molecular weight PAH	1700	9600
Total PAH	4022	44792
p,p' -DDE	2.2	27
Total DDT	1.58	46.1
Total PCBs	22.7	180

ER-L - Effects Range Low

The ERL represents the concentration corresponding to the 10th percentile in toxicity testing. No effects are likely below the ER-L.

ER-M - Effects Range Median

The ERM represents the concentration corresponding to the 50th percentile or median value. Effects are likely above the ER-M.

SCCWRP Iron Normalization Regression Coefficients

Iron (% dry) versus	Sample Size	r^2	Slope (m)	Intercept (b)	$\pm$ 99% Prediction Interval
Cadmium (µg/dry g)	83	0.734	0.0978	0.0055	0.1274
Chromium (µg/dry g)	88	0.882	16.50	-0.021	11.56
Copper (µg/dry g)	96	0.833	7.40	-2.01	6.50
Lead (µg/dry g)	103	0.738	4.350	0.0836	5.199
Nickel (µg/dry g)	110	0.533	9.850	-0.407	19.596
Silver (µg/dry g)	99	0.581	0.0795	-0.0183	0.1426
Zinc (µg/dry g)	88	0.967	31.50	-1.95	15.45

Table 11.12
California Toxics Rule Criteria for Dissolved Metals in Freshwater

HARDNESS	In	Lead		Cadmium		Chromium III		Nickel		Copper		Silver	Zinc	
mg/L as CaCO3	Hardness	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CMC µg/L	CCC µg/L
10	2.30	4.91	0.19	0.35	0.41	83.25	27.00	67	7	1.54	1.25	0.07	17	17
20	3.00	10.79	0.42	0.74	0.68	146.86	47.64	120	13	2.95	2.26	0.22	30	30
30	3.40	17.04	0.66	1.16	0.92	204.70	66.40	169	19	4.32	3.20	0.43	42	43
40	3.69	23.51	0.92	1.58	1.14	259.09	84.05	216	24	5.67	4.09	0.71	54	54
50	3.91	30.14	1.17	2.01	1.34	311.04	100.90	260	29	6.99	4.95	1.05	65	66
60	4.09	36.88	1.44	2.45	1.53	361.14	117.15	304	34	8.31	5.79	1.43	76	77
70	4.25	43.71	1.70	2.90	1.72	409.73	132.91	346	38	9.60	6.60	1.87	87	87
80	4.38	50.61	1.97	3.35	1.90	457.08	148.27	388	43	10.89	7.40	2.35	97	98
90	4.50	57.57	2.24	3.80	2.07	503.37	163.29	428	48	12.17	8.18	2.88	107	108
100	4.61	64.58	2.52	4.26	2.24	548.74	178.00	468	52	13.44	8.96	3.45	117	118
110	4.70	71.63	2.79	4.73	2.40	593.29	192.46	508	56	14.70	9.72	4.06	127	128
120	4.79	78.72	3.07	5.20	2.56	637.11	206.67	546	61	15.96	10.47	4.72	137	138
130	4.87	85.83	3.34	5.67	2.72	680.28	220.67	585	65	17.21	11.21	5.42	146	148
140	4.94	92.97	3.62	6.14	2.87	722.84	234.48	622	69	18.45	11.94	6.15	156	157
150	5.01	100.13	3.90	6.62	3.02	764.86	248.11	660	73	19.69	12.66	6.93	165	167
160	5.08	107.31	4.18	7.10	3.17	806.38	261.58	697	77	20.93	13.38	7.74	175	176
170	5.14	114.50	4.46	7.58	3.31	847.43	274.90	734	81	22.16	14.09	8.59	184	185
180	5.19	121.70	4.74	8.06	3.45	888.04	288.07	770	86	23.38	14.80	9.48	193	194
190	5.25	128.92	5.02	8.55	3.60	928.25	301.11	806	90	24.60	15.50	10.41	202	204
200	5.30	136.14	5.31	9.03	3.73	968.07	314.03	842	93	25.82	16.19	11.37	211	213
210	5.35	143.37	5.59	9.52	3.87	1007.54	326.84	877	97	27.04	16.88	12.36	220	222
220	5.39	150.61	5.87	10.02	4.01	1046.67	339.53	912	101	28.25	17.57	13.39	229	230
230	5.44	157.85	6.15	10.51	4.14	1085.48	352.12	947	105	29.46	18.25	14.45	237	239
240	5.48	165.10	6.43	11.00	4.27	1123.98	364.61	982	109	30.66	18.92	15.55	246	248
250	5.52	172.34	6.72	11.50	4.40	1162.19	377.00	1017	113	31.86	19.59	16.68	255	257
260	5.56	179.59	7.00	12.00	4.53	1200.13	389.31	1051	117	33.06	20.26	17.85	263	265
270	5.60	186.84	7.28	12.50	4.66	1237.80	401.53	1085	121	34.26	20.93	19.04	272	274
280	5.63	194.09	7.56	13.00	4.78	1275.23	413.67	1119	124	35.46	21.59	20.27	280	283
290	5.67	201.34	7.85	13.50	4.91	1312.41	425.73	1153	128	36.65	22.24	21.53	289	291
300	5.70	208.58	8.13	14.01	5.03	1349.36	437.72	1186	132	37.84	22.90	22.83	297	300
310	5.74	215.83	8.41	14.51	5.16	1386.09	449.63	1219	135	39.02	23.55	24.15	306	308
320	5.77	223.07	8.69	15.02	5.28	1422.60	461.48	1253	139	40.21	24.20	25.51	314	317
330	5.80	230.31	8.97	15.53	5.40	1458.91	473.25	1286	143	41.39	24.84	26.89	322	325
340	5.83	237.54	9.26	16.04	5.52	1495.02	484.97	1319	146	42.57	25.48	28.31	331	333
350	5.86	244.77	9.54	16.55	5.64	1530.94	496.62	1351	150	43.75	26.12	29.76	339	341

Table 11.12
California Toxics Rule Criteria for Dissolved Metals in Freshwater

		Lead		Cadmium		Chromium III		Nickel		Copper		Silver	Zinc	
HARDNESS mg/L as CaCO3	ln Hardness	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CCC µg/L	CMC µg/L	CMC µg/L	CCC µg/L
360	5.89	252.00	9.82	17.06	5.76	1566.67	508.21	1384	154	44.93	26.76	31.24	347	350
370	5.91	259.22	10.10	17.57	5.88	1602.22	519.74	1416	157	46.10	27.39	32.74	355	358
380	5.94	266.43	10.38	18.09	5.99	1637.60	531.22	1449	161	47.28	28.02	34.28	363	366
390	5.97	273.64	10.66	18.60	6.11	1672.81	542.64	1481	164	48.45	28.65	35.85	371	374
400	5.99	280.85	10.94	19.12	6.22	1707.86	554.01	1513	168	49.62	29.28	37.44	379	382
410	6.02	288.04	11.22	19.64	6.34	1742.75	565.33	1545	172	50.79	29.90	39.07	387	390
420	6.04	295.24	11.50	20.15	6.45	1777.49	576.60	1577	175	51.95	30.53	40.72	395	399
430	6.06	302.42	11.78	20.67	6.56	1812.07	587.82	1608	179	53.12	31.15	42.40	403	407
440	6.09	309.60	12.06	21.19	6.67	1846.52	598.99	1640	182	54.28	31.76	44.11	411	415
450	6.11	316.77	12.34	21.71	6.79	1880.82	610.12	1671	186	55.44	32.38	45.85	419	423
460	6.13	323.93	12.62	22.23	6.90	1914.98	621.20	1703	189	56.60	32.99	47.62	427	430
470	6.15	331.09	12.90	22.76	7.01	1949.01	632.24	1734	193	57.76	33.61	49.41	435	438
480	6.17	338.24	13.18	23.28	7.12	1982.90	643.23	1765	196	58.92	34.22	51.23	443	446
490	6.19	345.38	13.46	23.81	7.22	2016.67	654.19	1796	200	60.07	34.82	53.08	450	454
500	6.21	352.51	13.74	24.33	7.33	2050.32	665.10	1827	203	61.23	35.43	54.96	458	462
510	6.23	359.64	14.01	24.86	7.44	2083.84	675.98	1858	206	62.38	36.03	56.86	466	470
520	6.25	366.75	14.29	25.38	7.55	2117.25	686.81	1889	210	63.53	36.64	58.80	474	478
530	6.27	373.86	14.57	25.91	7.65	2150.54	697.61	1920	213	64.68	37.24	60.75	481	485
540	6.29	380.96	14.85	26.44	7.76	2183.71	708.37	1950	217	65.83	37.84	62.74	489	493
550	6.31	388.05	15.12	26.97	7.87	2216.78	719.10	1981	220	66.98	38.44	64.75	497	501
560	6.33	395.14	15.40	27.50	7.97	2249.73	729.79	2011	223	68.13	39.03	66.79	504	509
570	6.35	402.21	15.67	28.03	8.07	2282.58	740.45	2041	227	69.27	39.63	68.85	512	516
580	6.36	409.27	15.95	28.56	8.18	2315.33	751.07	2072	230	70.42	40.22	70.94	520	524
590	6.38	416.33	16.22	29.09	8.28	2347.97	761.66	2102	233	71.56	40.81	73.06	527	532
600	6.40	423.38	16.50	29.63	8.38	2380.52	772.21	2132	237	72.70	41.40	75.20	535	539
610	6.41	430.41	16.77	30.16	8.49	2412.96	782.74	2162	240	73.84	41.99	77.37	542	547
620	6.43	437.44	17.05	30.69	8.59	2445.31	793.23	2192	243	74.98	42.58	79.57	550	554
630	6.45	444.46	17.32	31.23	8.69	2477.56	803.70	2222	247	76.12	43.17	81.79	557	562
640	6.46	451.47	17.59	31.76	8.79	2509.73	814.13	2252	250	77.26	43.75	84.03	565	569
650	6.48	458.47	17.87	32.30	8.89	2541.80	824.53	2281	253	78.40	44.33	86.30	572	577
660	6.49	465.46	18.14	32.84	8.99	2573.78	834.91	2311	257	79.53	44.92	88.60	580	585
670	6.51	472.45	18.41	33.38	9.09	2605.68	845.25	2341	260	80.67	45.50	90.92	587	592
680	6.52	479.42	18.68	33.91	9.19	2637.48	855.57	2370	263	81.80	46.08	93.27	595	599
690	6.54	486.38	18.95	34.45	9.29	2669.21	865.86	2400	267	82.93	46.66	95.64	602	607
700	6.55	493.33	19.22	34.99	9.39	2700.85	876.13	2429	270	84.07	47.23	98.04	609	614
710	6.57	500.28	19.50	35.53	9.49	2732.41	886.37	2458	273	85.20	47.81	100.46	617	622

Table 11.12
California Toxics Rule Criteria for Dissolved Metals in Freshwater

		Lead		Cadmium		Chromium III		Nickel		Copper		Silver	Zinc	
HARDNESS	ln	CMC	CCC	CMC	CCC	CMC	CCC	CMC	CCC	CMC	CCC	CMC	CMC	CCC
mg/L as CaCO3	Hardness	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
720	6.58	507.21	19.77	36.07	9.59	2763.89	896.58	2488	276	86.33	48.38	102.90	624	629
730	6.59	514.13	20.04	36.61	9.68	2795.29	906.76	2517	280	87.46	48.96	105.37	631	637
740	6.61	521.05	20.30	37.15	9.78	2826.61	916.92	2546	283	88.59	49.53	107.87	639	644
750	6.62	527.95	20.57	37.70	9.88	2857.86	927.06	2575	286	89.71	50.10	110.39	646	651
760	6.63	534.85	20.84	38.24	9.97	2889.03	937.17	2604	289	90.84	50.67	112.93	653	659
770	6.65	541.73	21.11	38.78	10.07	2920.12	947.26	2633	292	91.96	51.24	115.50	661	666
780	6.66	548.60	21.38	39.33	10.17	2951.15	957.32	2662	296	93.09	51.81	118.09	668	673
790	6.67	555.47	21.65	39.87	10.26	2982.10	967.36	2691	299	94.21	52.38	120.71	675	681
800	6.68	562.32	21.91	40.42	10.36	3012.98	977.38	2719	302	95.34	52.94	123.35	682	688
810	6.70	569.17	22.18	40.96	10.45	3043.79	987.37	2748	305	96.46	53.51	126.01	690	695
820	6.71	576.00	22.45	41.51	10.55	3074.53	997.35	2777	308	97.58	54.07	128.70	697	703
830	6.72	582.82	22.71	42.05	10.64	3105.20	1007.30	2805	312	98.70	54.63	131.41	704	710
840	6.73	589.64	22.98	42.60	10.74	3135.81	1017.22	2834	315	99.82	55.19	134.15	711	717
850	6.75	596.44	23.24	43.15	10.83	3166.35	1027.13	2863	318	100.94	55.76	136.91	718	724
860	6.76	603.24	23.51	43.70	10.92	3196.83	1037.02	2891	321	102.06	56.32	139.69	726	731
870	6.77	610.02	23.77	44.24	11.02	3227.24	1046.88	2919	324	103.18	56.87	142.49	733	739
880	6.78	616.79	24.04	44.79	11.11	3257.59	1056.73	2948	327	104.29	57.43	145.32	740	746
890	6.79	623.56	24.30	45.34	11.20	3287.88	1066.55	2976	331	105.41	57.99	148.17	747	753
900	6.80	630.31	24.56	45.89	11.29	3318.10	1076.36	3004	334	106.53	58.55	151.05	754	760
910	6.81	637.05	24.83	46.44	11.39	3348.27	1086.14	3033	337	107.64	59.10	153.95	761	767
920	6.82	643.78	25.09	46.99	11.48	3378.37	1095.91	3061	340	108.76	59.66	156.87	768	774
930	6.84	650.51	25.35	47.55	11.57	3408.42	1105.66	3089	343	109.87	60.21	159.81	775	782
940	6.85	657.22	25.61	48.10	11.66	3438.40	1115.38	3117	346	110.98	60.76	162.78	782	789
950	6.86	663.92	25.87	48.65	11.75	3468.33	1125.09	3145	349	112.09	61.32	165.77	789	796
960	6.87	670.61	26.13	49.20	11.84	3498.21	1134.78	3173	352	113.21	61.87	168.78	796	803
970	6.88	677.30	26.39	49.76	11.93	3528.02	1144.45	3201	356	114.32	62.42	171.82	803	810
980	6.89	683.97	26.65	50.31	12.02	3557.78	1154.11	3229	359	115.43	62.97	174.88	810	817
990	6.90	690.63	26.91	50.86	12.11	3587.49	1163.74	3257	362	116.54	63.51	177.96	817	824
1000	6.91	697.28	27.17	51.42	12.20	3617.14	1173.36	3284	365	117.64	64.06	181.06	824	831

CMC : Contaminant Maximum Concentration - Highest concentration that aquatic life can be exposed to without deleterious effects.
CCC : Contaminant Continuous Concentration - Highest concentration that aquatic life can be exposed to for an extended period (4 days) without deleterious effects.
For Hardness greater than 400 mg/L multiply CMC or CCC by Water Effects Ratio (WER). Alternatively use criterion at for hardness=400 and WER=1.

Table 11.13
Mass Loads from Sampled Storms : 2001-2002

		Volume			Nitrate	Tot. Phosphate						Total Recoverable Metals							
		Sampled	Total Storm	Percent	as NO_3	as PO_4	NH_3/N	TKN	TSS	VSS	OPO_4	Cd	Cr	Cu	Pb	Ni	Ag	Zn	Hardness
Location		ac-ft	ac-ft	Sampled	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
BARSED	Nov 24-29, 2001	164.19	148.71	110.4	12,481.8	1,261.1	151.2	1,414.2	101,679	16,763	155	0.68	4.94	16.94	5.37	4.60	0.45	68.31	194,677
											Dissolved	0.22	1.78	4.70	0.45	1.53	0.45	6.45	
	Nov 29-Dec 3, 2001	98.57	64.90	151.9	7,511.1	332.5	61.3	402.0	17,358	3,865	81.1	0.10	0.84	2.99	0.64	0.79	0.21	10.07	98,072.6
											Dissolved	0.31	0.84	2.27	0.21	0.70	0.21	3.49	
	Dec 14-18, 2001	87.37	47.69	183.2	9,175.5	536.3	44.1	443.5	24,162	3,846	108.8	0.24	1.49	2.51	0.76	2.09	0.23	13.7	116,673
											Dissolved	0.12	0.95	1.76	0.24	0.71	0.24	3.42	
	Jan 27-31, 2002	303.16	300.80	100.8	21,875.6	2,074.3	350.2	2,807.5	92,386	13,062	406.6	0.41	3.30	15.74	3.34	6.93	0.82	38.1	213,770
											Dissolved	0.41	3.30	8.88	0.82	4.27	0.82	12.93	
	Feb 17-19, 2002	76.62	71.21	107.6	8,530.9	630.6	114.1	665.9	20,315	3,046	124.8	0.28	1.10	4.89	0.94	2.30	0.21	14.0	67,898
											Dissolved	0.10	0.83	2.28	0.21	1.00	0.21	5.29	
	Mar 7-10, 2002	78.37	57.67	135.9	8,163.2	399.3	54.3	448.8	12,781	2,984	90.1	0.11	0.99	4.97	0.77	0.93	0.21	10.9	100,831
											Dissolved	0.11	0.85	3.67	0.27	0.61	0.21	4.68	
SADF01	Nov 29-Dec 3, 2001	210.71	228.62	92.2	1,614.3	285.5	175.4	1,177.8	17,952	4,765	52.8	0.29	2.29	13.32	3.71	4.32	0.57	33.6	
											Dissolved	0.29	2.29	7.72	0.97	1.15	0.57	12.93	
	Dec 14-18, 2001	73.67	31.06	237.2	888.2	129.8	40.5	427.3	4,790	1,134	17.2	0.11	0.80	3.82	0.89	1.55	0.20	11.6	31,334
											Dissolved	0.10	0.80	2.92	0.24	0.44	0.20	5.17	
	Jan 27-31, 2002	224.10	208.76	107.3	2,121.7	434.4	114.5	1,124.8	37,077	9,178	63.5	0.30	2.44	16.35	6.21	4.18	0.61	50.2	53,904
											Dissolved	0.30	2.44	7.62	0.62	1.24	0.61	17.66	
	Feb 17-21, 2002	138.50	66.63	207.9	1,022.8	114.4	23.7	405.5	1,882	1,882	23.0	0.20	1.55	4.65	0.59	1.17	0.38	9.6	43,200
											Dissolved	0.19	1.51	3.80	0.38	0.80	0.38	4.75	
	Mar 7-11, 2002	66.46	47.36	140.3	1,315.9	110.4	11.2	259.3	2,529	1,039	20.7	0.09	0.72	4.85	0.57	0.97	0.18	9.6	55,956
											Dissolved	0.09	0.72	3.88	0.19	0.76	0.18	6.76	
SDMF05	Nov 29-Dec 2, 2001	153.75	157.02	97.9	6,031.3	475.5	81.8	927.9	25,680	5,245	103.4	0.21	1.67	7.12	1.58	2.05	0.42	21.0	198,703
											Dissolved	0.05	0.17	0.36	0.04	0.25	0.04	1.20	
	Feb 17-21, 2002	289.64	236.74	122.3	24,722.1	1,161.3	295.8	1,555.6	34,862	3,935	277.8	0.4	3.1	17.4	1.7	7.1	0.8	22.5	303,464
											Dissolved	0.39	3.15	12.40	0.79	7.05	0.79	9.75	
	Mar 7-11, 2002	256.49	230.65	111.2	15,345.5	735.1	208.1	1,548.7	22,075	3,485	165.1	0.35	2.79	19.22	1.44	3.18	0.70	25.5	240,858
											Dissolved	0.35	2.79	13.45	0.70	1.93	0.70	14.38	
WYLSED	Nov 12-16, 2001	280.89	277.11	101.4	23,651.3	3,165.8	103.7	3,721.6	758,050	103,194	232.8	3.62	31.00	59.87	16.95	31.70	0.76	236.1	197,875
											Dissolved	0.38	3.05	5.68	0.76	1.54	0.76	9.29	
	Nov 24-28, 2001	297.23	291.38	102.0	18,766.1	1,510.4	250.0	2,376.3	169,857	27,209	232.1	0.40	3.20	22.57	4.33	7.58	0.80	59.5	317,431
											Dissolved	0.40	3.20	9.45	0.80	3.88	0.80	7.99	
	Nov 29-Dec 2, 2001	161.04	154.53	104.2	16,230.7	422.2	90.9	713.4	27,319	5,519	95.9	0.4	1.8	7.1	1.2	2.9	0.4	23.0	157,852
											Dissolved	0.22	1.75	4.71	0.44	1.29	0.44	8.14	
	Dec 14-17, 2001	64.18	66.00	97.2	6,562.0	283.6	70.7	381.1	20,777	3,099	57.5	0.09	0.70	3.14	0.67	1.26	0.17	11.4	52,960
											Dissolved	0.09	0.70	1.60	0.17	0.39	0.17	2.00	
	Feb 17-21, 2002	72.77	66.10	110.1	7,016.9	295.1	66.2	439.0	20,399	3,183	64.3	0.10	0.79	4.02	0.50	1.94	0.20	8.6	56,849
											Dissolved	0.10	0.79	2.62	0.20	1.49	0.20	2.88	
	Mar 7-11, 2002	26.18	22.78	114.9	2,035.3	62.9	1.8	133.7	4,943	894	9.6	0.04	0.28	1.56	0.14	0.35	0.07	2.6	23,161
											Dissolved	0.04	0.28	1.03	0.07	0.32	0.07	0.76	

Table 11.14
Event Mean Concentrations of Sampled Storms : 2001-2002

Location		Sampled ac-ft	Total Storm ac-ft	Percent Sampled	Nitrate as NO_3 mg/L	Tot. Phosphate as PO_4 mg/L	NH_3/N mg/L	TKN mg/L	TSS mg/L	VSS mg/L	OPO_4 mg/L	Total Reoverable Metals Cd µg/L	Cr µg/L	Cu µg/L	Pb µg/L	Ni µg/L	Ag µg/L	Zn µg/L	Hardness mg/L
BARSED	Nov 24-29, 2001	164.19	148.71	110.4	28.0	2.83	0.34	3.17	228	37.6	0.35	1.5	11.1	38.0	12.0	10.3	1.0	153	436
											Dissolved	0.5	4.0	10.5	1.0	3.4	1.0	14.5	
	Nov 29-Dec 3, 2001	98.57	64.90	151.9	28.0	1.24	0.23	1.50	65	14.4	0.30	0.4	3.1	11.2	2.4	2.9	0.8	38	366
											Dissolved	1.1	3.1	8.5	0.8	2.6	0.8	13.0	
	Dec 14-18, 2001	87.37	47.69	183.2	38.7	2.26	0.19	1.87	102	16.2	0.46	1.0	6.3	10.6	3.2	8.8	1.0	58	491
											Dissolved	0.5	4.0	7.4	1.0	3.0	1.0	14.4	
	Jan 27-31, 2002	303.16	300.80	100.8	26.6	2.52	0.43	3.41	112	15.9	0.49	0.5	4.0	19.1	4.0	8.4	1.0	46	260
											Dissolved	0.5	4.0	10.8	1.0	5.2	1.0	15.7	
	Feb 17-19, 2002	76.62	71.21	107.6	41.0	3.03	0.55	3.20	98	14.6	0.60	1.3	5.3	23.5	4.5	11.0	1.0	67	326
											Dissolved	0.5	4.0	10.9	1.0	4.8	1.0	25.4	
	Mar 7-10, 2002	78.37	57.67	135.9	38.3	1.87	0.26	2.11	60	14.0	0.42	0.5	4.6	23.3	3.6	4.3	1.0	51	473
											Dissolved	0.5	4.0	17.2	1.2	2.9	1.0	22.0	
SADF01	Nov 29-Dec 3, 2001	210.71	228.62	92.2	2.8	0.50	0.31	2.06	31	8.3	0.09	0.5	4.0	23.3	6.5	7.5	1.0	59	
											Dissolved	0.5	4.0	13.5	1.7	2.0	1.0	22.6	
	Dec 14-18, 2001	73.67	31.06	237.2	4.4	0.65	0.20	2.13	24	5.7	0.09	0.5	4.0	19.1	4.4	7.7	1.0	58	157
											Dissolved	0.5	4.0	14.6	1.2	2.2	1.0	25.8	
	Jan 27-31, 2002	224.10	208.76	107.3	3.5	0.71	0.19	1.85	61	15.1	0.10	0.5	4.0	26.9	10.2	6.9	1.0	82	89
											Dissolved	0.5	4.0	12.5	1.0	2.0	1.0	29.0	
	Feb 17-21, 2002	138.50	66.63	207.9	2.7	0.30	0.06	1.08	5	5.0	0.06	0.5	4.1	12.4	1.6	3.1	1.0	25	115
											Dissolved	0.5	4.0	10.1	1.0	2.1	1.0	12.6	
	Mar 7-11, 2002	66.46	47.36	140.3	7.3	0.61	0.06	1.44	14	5.8	0.11	0.5	4.0	26.9	3.2	5.4	1.0	53	310
											Dissolved	0.5	4.0	21.5	1.1	4.2	1.0	37.5	
SDMF05	Nov 29-Dec 2, 2001	153.75	157.02	97.9	14.4	1.14	0.20	2.22	61	12.6	0.25	0.5	4.0	17.0	3.8	4.9	1.0	50	476
											Dissolved	0.1	0.4	0.9	0.1	0.6	0.1	2.9	
	Feb 17-21, 2002	289.64	236.74	122.3	31.4	1.48	0.38	1.98	44	5.0	0.35	0.5	4.0	22.1	2.1	9.0	1.0	29	386
											Dissolved	0.5	4.0	15.8	1.0	9.0	1.0	12.4	
	Mar 7-11, 2002	256.49	230.65	111.2	22.0	1.05	0.30	2.22	32	5.0	0.24	0.5	4.0	27.6	2.1	4.6	1.0	37	346
											Dissolved	0.5	4.0	19.3	1.0	2.8	1.0	20.6	
WYLSED	Nov 12-16, 2001	280.89	277.11	101.4	31.0	4.15	0.14	4.88	993	135.2	0.31	4.7	40.6	78.4	22.2	41.5	1.0	309	259
											Dissolved	0.5	4.0	7.4	1.0	2.0	1.0	12.2	
	Nov 24-28, 2001	297.23	291.38	102.0	23.2	1.87	0.31	2.94	210	33.7	0.29	0.5	4.0	27.9	5.4	9.4	1.0	74	393
											Dissolved	0.5	4.0	11.7	1.0	4.8	1.0	9.9	
	Nov 29-Dec 2, 2001	161.04	154.53	104.2	37.1	0.96	0.21	1.63	62	12.6	0.22	0.9	4.0	16.3	2.7	6.6	1.0	53	361
											Dissolved	0.5	4.0	10.8	1.0	3.0	1.0	18.6	
	Dec 14-17, 2001	64.18	66.00	97.2	37.6	1.63	0.41	2.19	119	17.8	0.33	0.5	4.0	18.0	3.8	7.2	1.0	65	304
											Dissolved	0.5	4.0	9.2	1.0	2.2	1.0	11.5	
	Feb 17-21, 2002	72.77	66.10	110.1	35.5	1.49	0.33	2.22	103	16.1	0.33	0.5	4.0	20.3	2.6	9.8	1.0	44	287
											Dissolved	0.5	4.0	13.2	1.0	7.5	1.0	14.6	
	Mar 7-11, 2002	26.18	22.78	114.9	28.6	0.88	0.03	1.88	69	12.6	0.14	0.5	4.0	22.0	2.0	5.0	1.0	37	326
											Dissolved	0.5	4.0	14.4	1.0	4.5	1.0	10.7	

Table 11.15
Total Stormwater Loads

	Total Storm Volume ac-ft	Volume Sampled ac-ft	Nitrate as NO_3 tons	Total Phosphate as PO_4 tons	TSS tons	Cu lbs	Pb lbs	Zn lbs
Peters Canyon Wash at Barranca Parkway								
Nov 24-29, 2001	148.71	164.19	6.24	0.63	50.84	16.94	5.37	68.31
Nov 29-Dec 3, 2001	64.90	98.57	3.76	0.17	8.68	2.99	0.64	10.07
Dec 14-18, 2001	47.69	87.37	4.59	0.27	12.08	2.51	0.76	13.7
Jan 27-31, 2002	300.80	303.16	10.94	1.04	46.19	15.74	3.34	38.1
Feb 17-19, 2002	71.21	76.62	4.27	0.32	10.16	4.89	0.94	14.0
Mar 7-10, 2002	57.67	78.37	4.08	0.20	6.39	4.97	0.77	10.9
Total Sampled Load		808	33.87	2.62	134.34	48.0	11.8	155.0
Annual Stormwater Volume	1,630	**Site Mean EMC**	**29.8**	**2.9**	**597.0**	**44.4**	**18.9**	**155.8**
Calc. Unsampled Load	822		33.2	3.3	666.5	99	42	348
Sampled+Unsampled Load			67.1	5.9	800.9	147	54	503
Santa Ana Delhi Channel at Irvine Avenue								
Nov 29-Dec 3, 2001	228.62	210.71	0.81	0.14	8.98	13.32	3.71	33.6
Dec 14-18, 2001	31.06	73.67	0.44	0.06	2.40	3.82	0.89	11.6
Jan 27-31, 2002	208.76	224.10	1.06	0.22	18.54	16.35	6.21	50.2
Feb 17-21, 2002	66.63	138.50	0.51	0.06	0.94	4.65	0.59	9.6
Mar 7-11, 2002	47.36	66.46	0.66	0.06	1.26	4.85	0.57	9.6
Total Sampled Load		713	3.48	0.54	32.12	43.0	12.0	114.5
Annual Stormwater Volume	1,289	**Site Mean EMC**	**7.5**	**2.1**	**220.2**	**41.4**	**33.2**	**185.1**
Calc. Unsampled Load	576		5.9	1.7	172.4	65	52	290
Sampled+Unsampled Load			9.3	2.2	204.5	108	64	404
San Diego Creek at Campus Drive								
Nov 29-Dec 2, 2001	157.02	153.75	3.02	0.24	12.84	7.12	1.58	21.0
Feb 17-21, 2002	236.74	289.64	12.36	0.58	17.43	17.4	1.7	22.5
Mar 7-11, 2002	230.65	256.49	7.67	0.37	11.04	19.22	1.44	25.5
Total Sampled Load		700	23.05	1.19	41.31	43.8	4.7	69.0
Annual Stormwater Volume	4,533	**Site Mean EMC**	**17.6**	**4.0**	**1,008.5**	**39.0**	**26.6**	**142.6**
Calc. Unsampled Load	3,833		91.7	21.0	5,253.4	406	277	1485
Sampled+Unsampled Load			114.7	22.2	5,294.7	450	282	1,554
San Diego Creek at Harvard Avenue								
Nov 12-16, 2001	277.11	280.89	11.83	1.58	379.02	59.87	16.95	236.1
Nov 24-28, 2001	291.38	297.23	9.38	0.76	84.93	22.57	4.33	59.5
Nov 29-Dec 2, 2001	154.53	161.04	8.12	0.21	13.66	7.1	1.2	23.0
Dec 14-17, 2001	66.00	64.18	3.28	0.14	10.39	3.14	0.67	11.4
Feb 17-21, 2002	66.10	72.77	3.51	0.15	10.20	4.02	0.50	8.6
Mar 7-11, 2002	22.78	26.18	1.02	0.03	2.47	1.56	0.14	2.6
Total Sampled Load		902	37.13	2.87	500.67	98.3	23.8	341.3
Annual Stormwater Volume	1,776	**Site Mean EMC**	**18.8**	**5.2**	**1,289.8**	**44.5**	**18.8**	**187.4**
Calc. Unsampled Load	873		22.3	6.1	1,531.0	106	45	445
Sampled+Unsampled Load			59.4	9.0	2,031.7	204	69	786
Anaheim Barber City Channel at Rancho Road								
		Site Mean EMC	**6.7**	**1.3**	**74.7**	**41.0**	**18.9**	**179.1**
Annual Stormwater Volume	1,296		11.8	2.3	131.7	144	66	631
Bolsa Chica Channel at Westminster Avenue								
		Site Mean EMC	**8.6**	**2.1**	**247.7**	**33.4**	**25.0**	**171.7**
Annual Stormwater Volume	1,209		14.2	3.4	407.1	110	82	564
Westminster Channel at Beach Boulevard								
		Site Mean EMC	**7.1**	**1.6**	**176.7**	**47.9**	**28.3**	**170.0**
Annual Stormwater Volume	302		2.9	0.7	72.6	39	23	140
Oso Creek at Crown Valley Parkway								
		Site Mean EMC	**4.7**	**2.8**	**450.0**	**23.7**	**6.9**	**87.6**
Annual Stormwater Volume	1,751		11.1	6.8	1,070.8	113	33	417

Table 11.16
Evaluation of Dissolved Metal Concentrations in Channels Relative to the CTR

			Freshwater									Discharges to Saltwater							San Diego Creek
			n		> Criteria							> Criteria							> Criteria*
			Acute	Chronic	Acute			Chronic				Acute			Chronic				Acute or Chronic
Station Code	**Channel**		**(CMC)**	**(CCC)**	**Cd**	**Cu**	**Zn**	**Cd**	**Ni**	**Cu**		**Cu**	**Ni**	**Zn**	**Cd**	**Cu**	**Ni**	**Zn**	
ACJ01	Aliso Creek	**S**	19	5								17				5	5		
BARSED	Peters Canyon Wash	**S**	17	2		2													None
CMCG02	Costa Mesa	**S**	15	2		9	5			2		15		5		2			
	Costa Mesa	**D**	40			3						38		1					
LANF08	Lane	**S**	14	2		1													1 Cu CMC
PDCM01	Prima Deschecha	**S**	14	3	3			3	1			14	10		3	3		1	
SADF01	Santa Ana Delhi	**S**	16	3		5						16		1		3			
SDMF05	San Diego Creek @ Campus	**S**	6	1								6				1			
	San Diego Creek @ Campus	**D**	25									13							
SJNL01	San Juan Creek @ La Novia	**S**	16	5															
WYLSED	San Diego Creek @ Harvard	**S**	14	3															
	Totals	**S**	**156**	**26**	**3**	**17**	**5**	**3**	**1**	**2**		**68**	**10**	**6**	**3**	**14**	**5**	**1**	**1**
		D	**65**	**0**	**0**	**3**	**0**					**51**	**0**	**1**					

Not Applicable

n = Number of observations

CMC = Criteria Maximum Concentration

CCC = Criteria Continuous Concentration

S = Stormwater sampling

D = Dry weather sampling

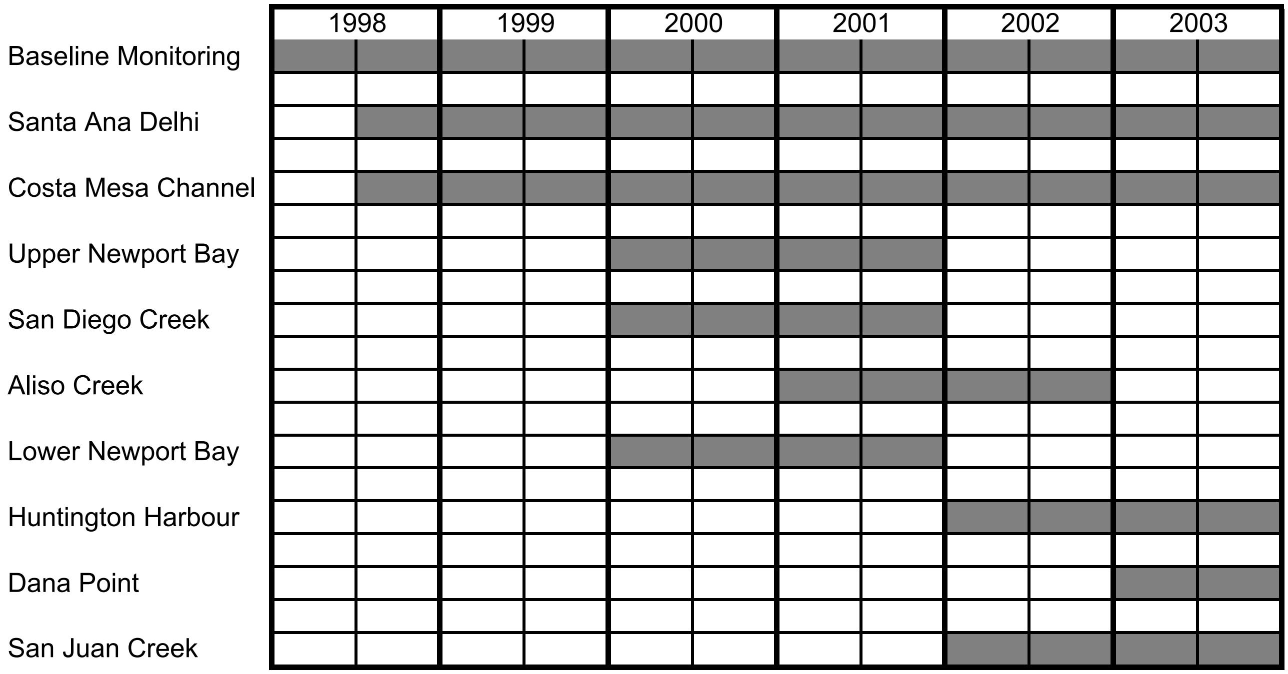
Freshwater evaluation included comparison to CTR criteria for Cd, Cu, Cr **III**, Pb, Ni, Ag, Zn

Evaluation of discharges to saltwater included comparison to CTR criteria for Cd, Cu, Pb, Ni, Ag, Zn

*Using freshwater criteria and average hardness of 400 mg/L for San Diego Creek

Figure 11.1

Critical Aquatic Resources Monitoring Timeline



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

Figure 11.2
Warm Spot Monitoring Timeline

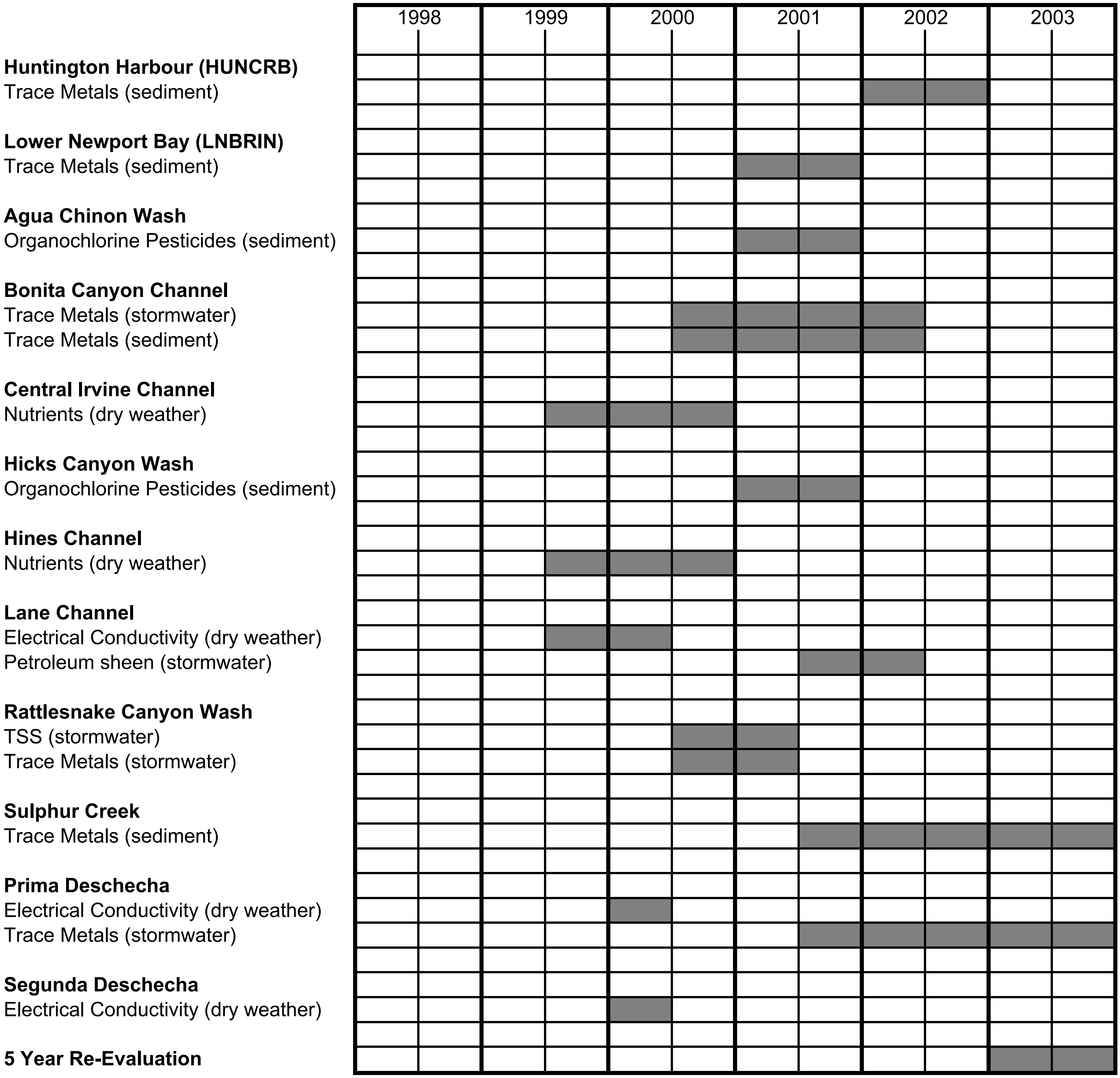


Figure 11.3
Water Quality Monitoring Program Timeline

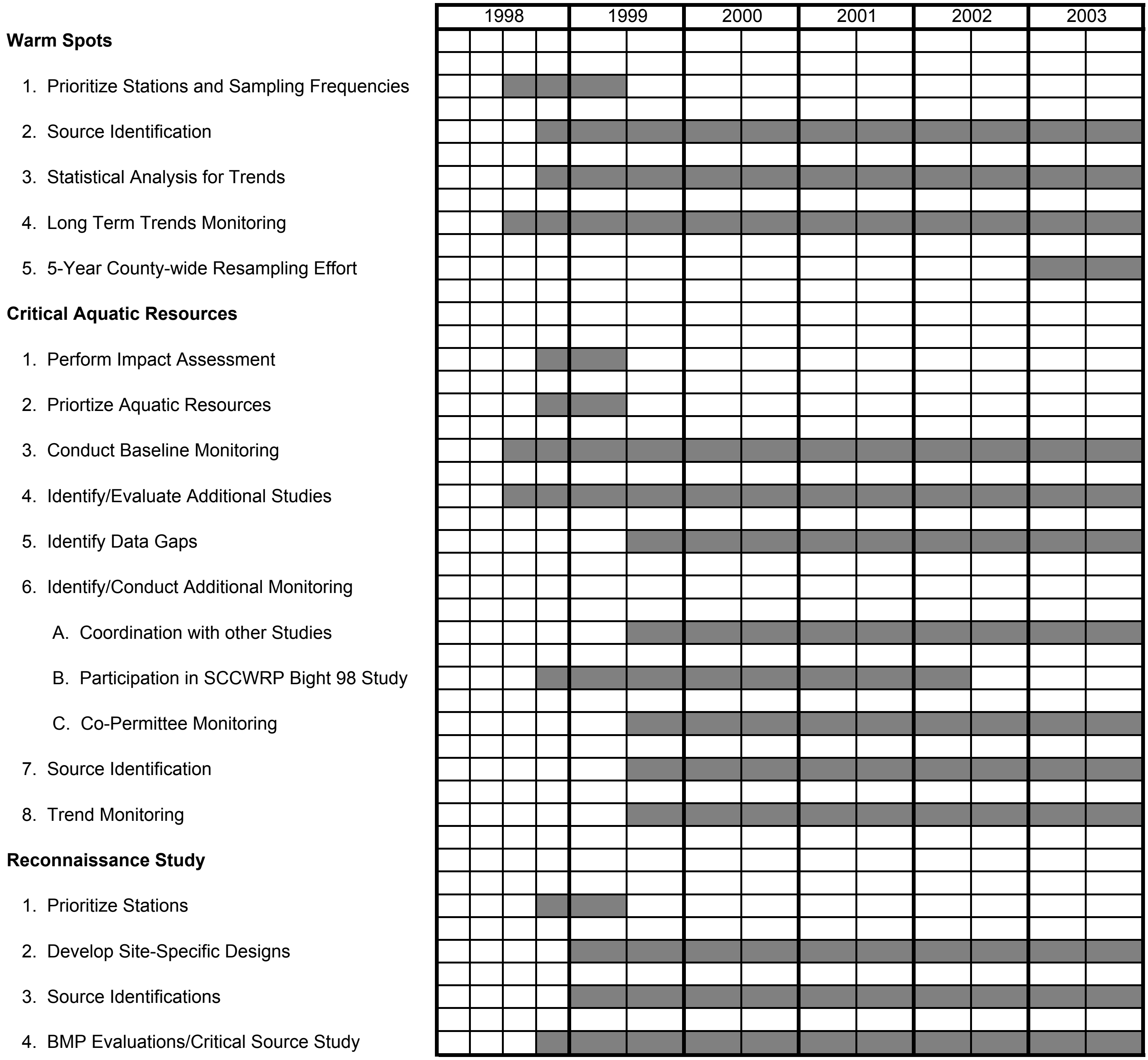
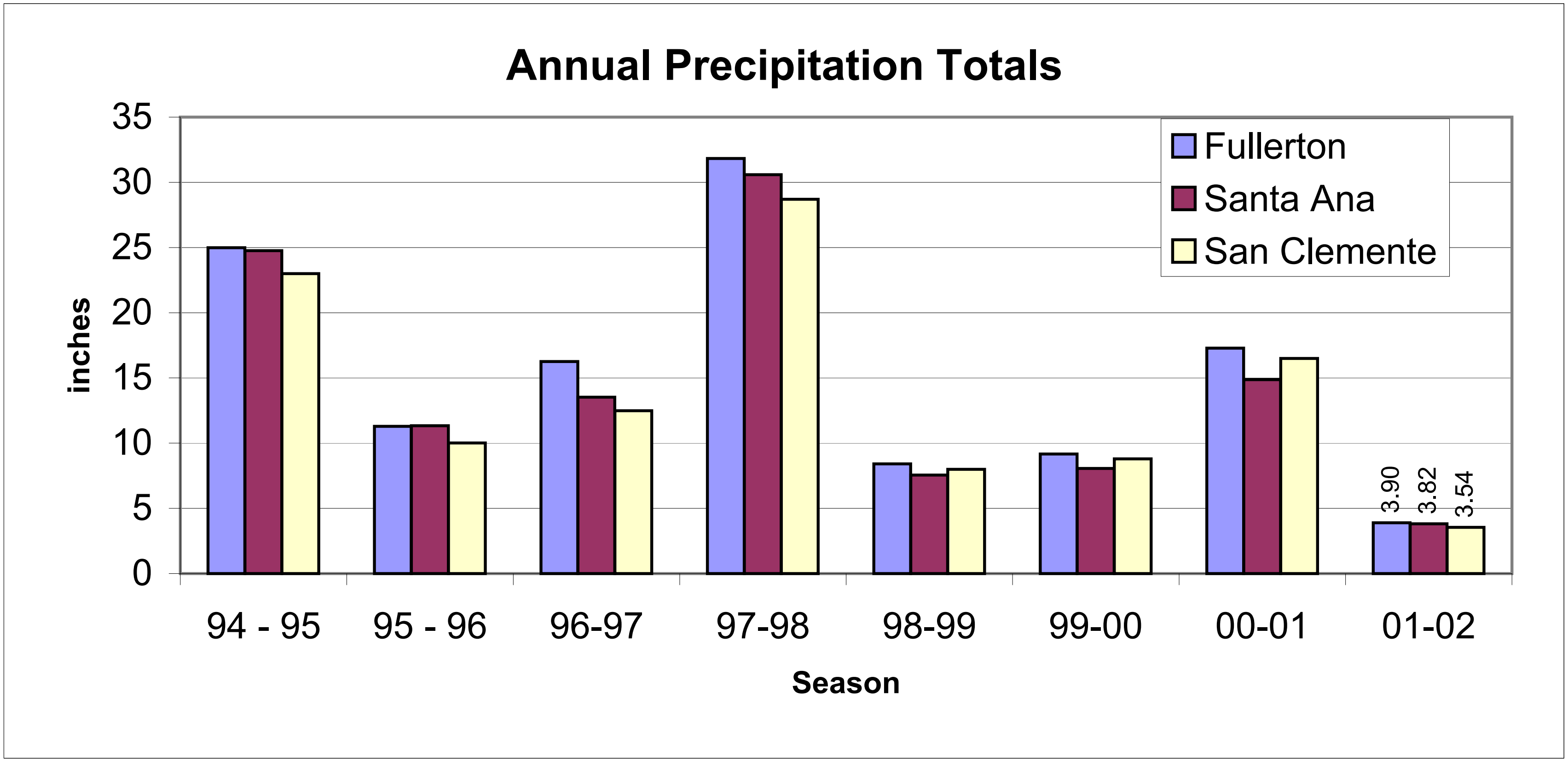
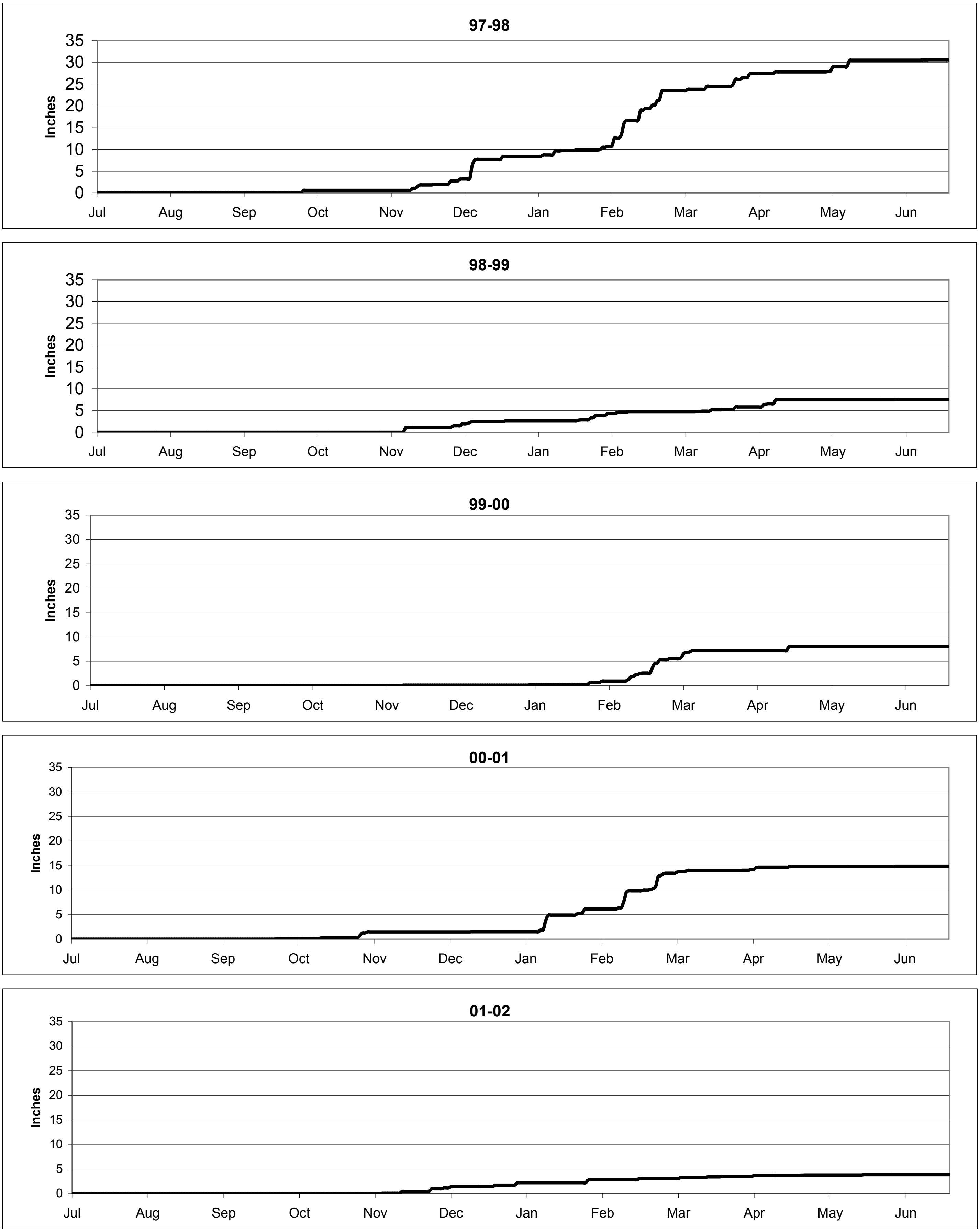


Figure 11.4



Season = July 1 - June 30

Figure 11.5
Annual Accumulated Rainfall at Santa Ana



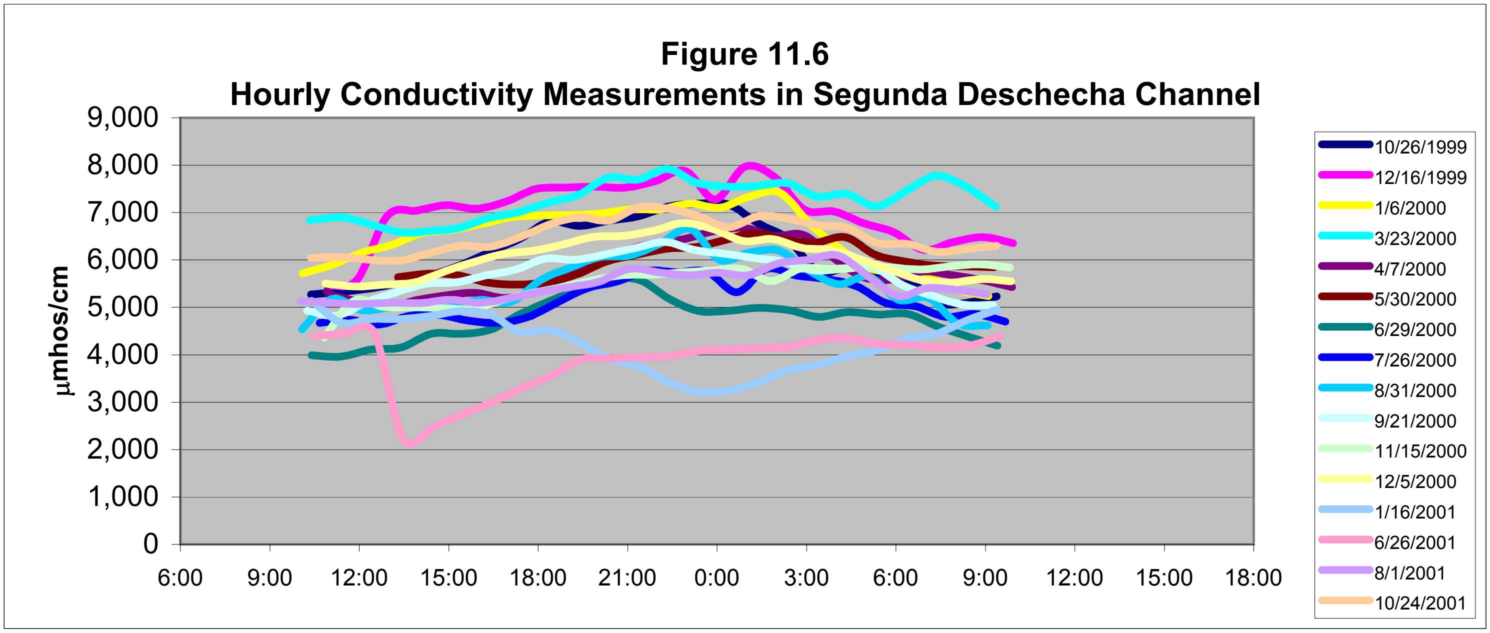


Figure 11.6
Hourly Conductivity Measurements in Segunda Deschecha Channel
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
µmhos/cm
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
10/26/1999
12/16/1999
1/6/2000
3/23/2000
4/7/2000
5/30/2000
6/29/2000
7/26/2000
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6/26/2001
8/1/2001
10/24/2001

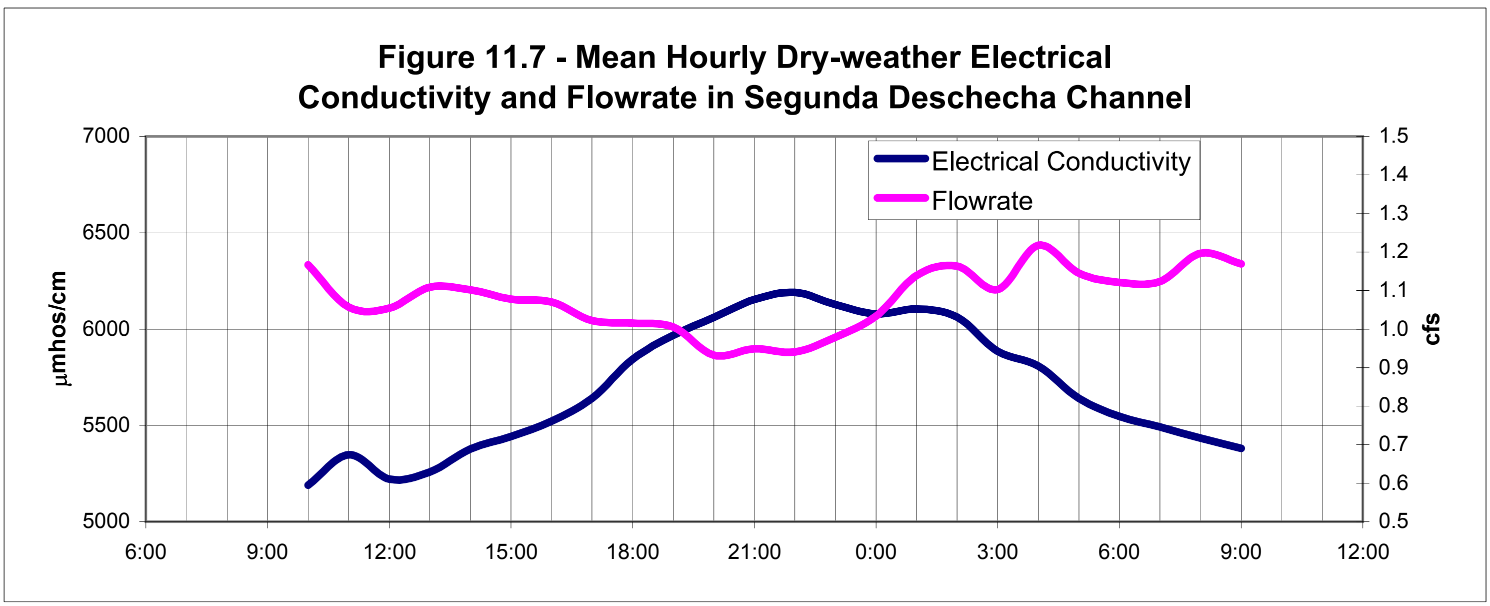


Figure 11.7 - Mean Hourly Dry-weather Electrical
Conductivity and Flowrate in Segunda Deschecha Channel
7000
6500
6000
5500
5000
µmhos/cm
Electrical Conductivity
Flowrate
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
cfs
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
9:00
12:00

Figure 11.8
Copper in Rhine Channel Sediments

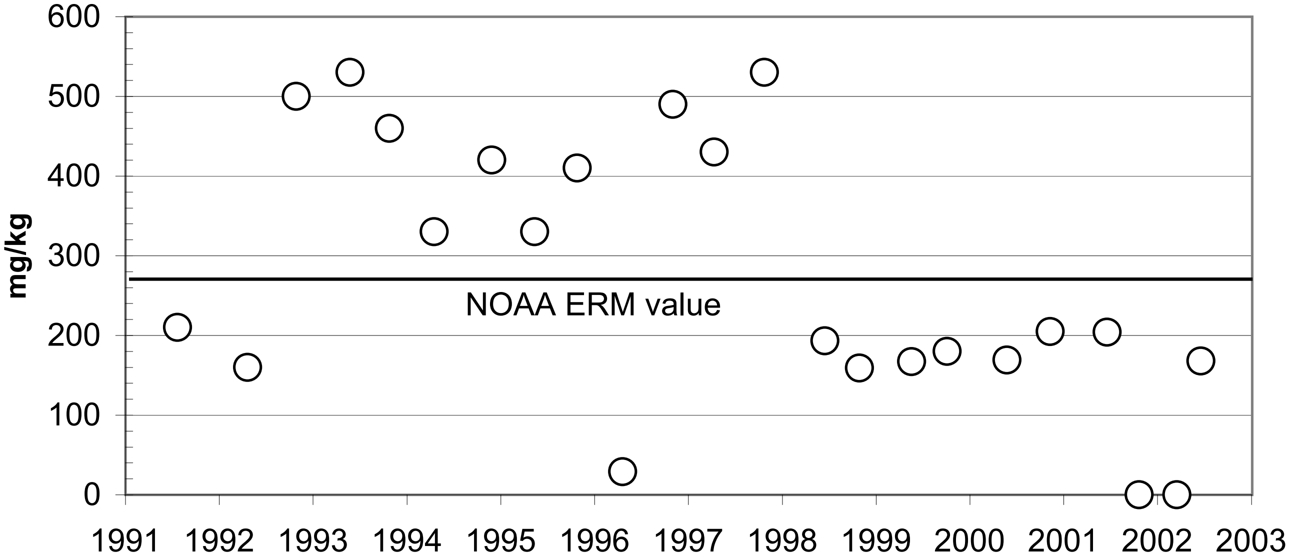


Figure 11.9
DDT and DDE in Agua Chinon Wash Sediments

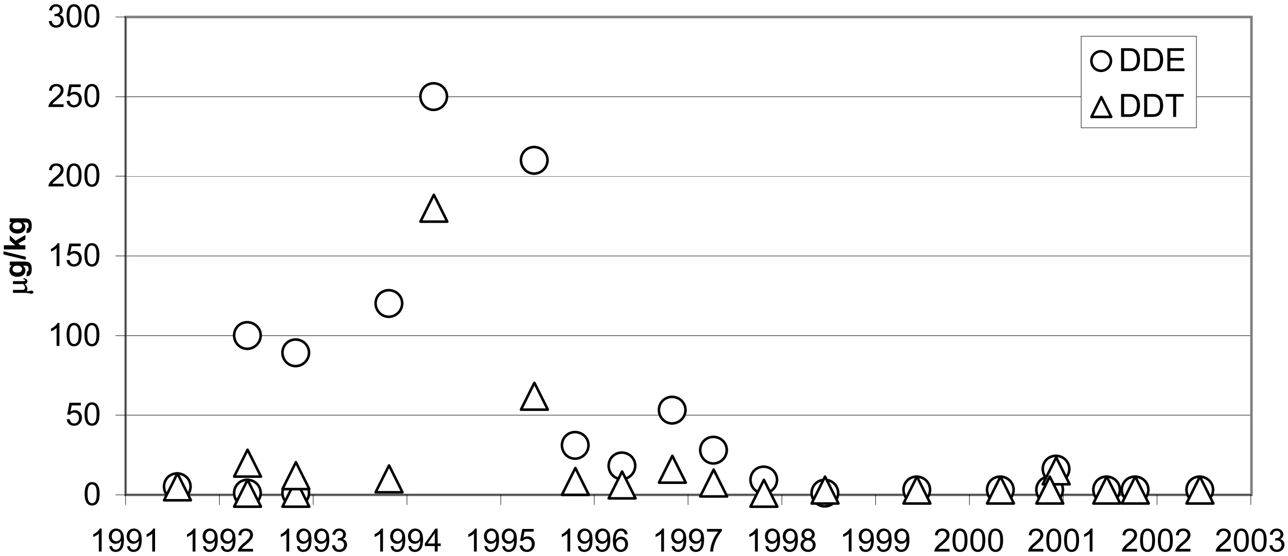
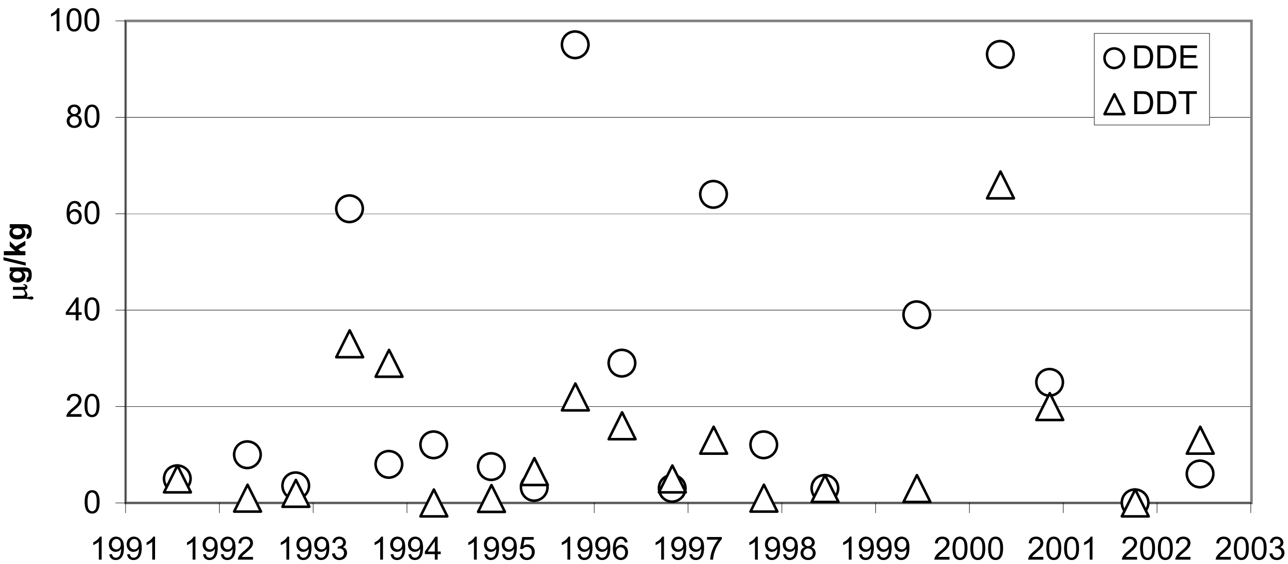


Figure 11.10
DDT and DDE in Hicks Canyon Wash Sediments



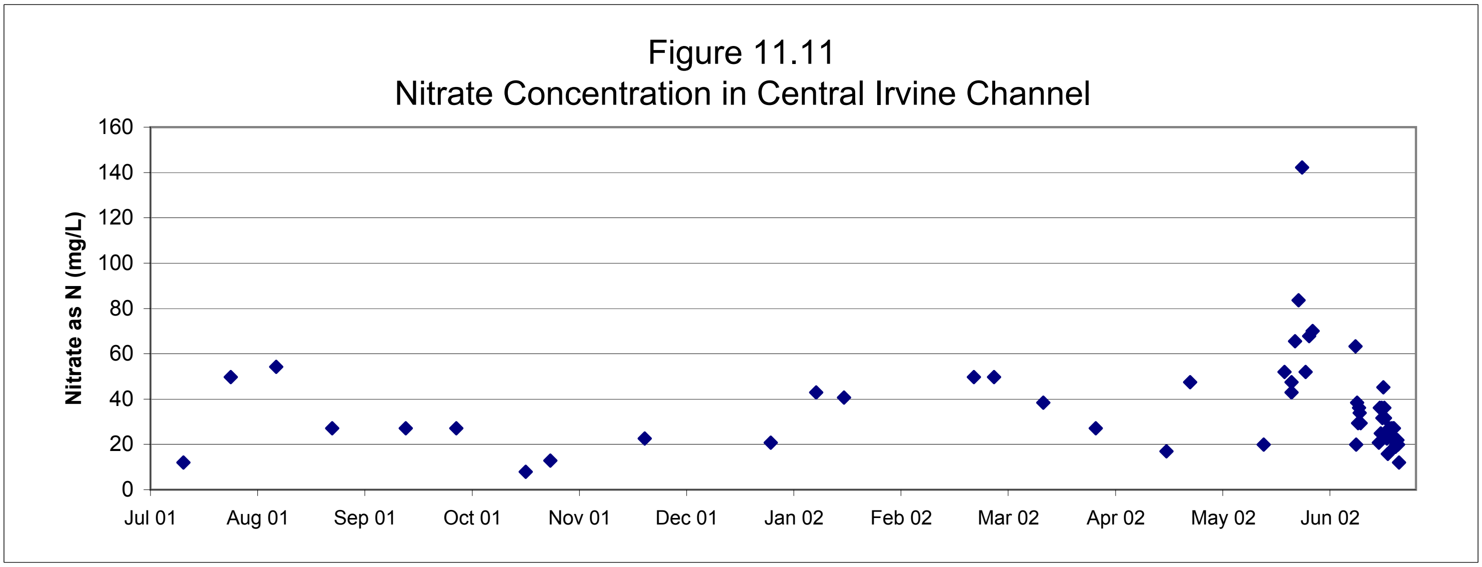


Figure 11.11
Nitrate Concentration in Central Irvine Channel
Nitrate as N (mg/L)
0
20
40
60
80
100
120
140
160
Jul 01
Aug 01
Sep 01
Oct 01
Nov 01
Dec 01
Jan 02
Feb 02
Mar 02
Apr 02
May 02
Jun 02

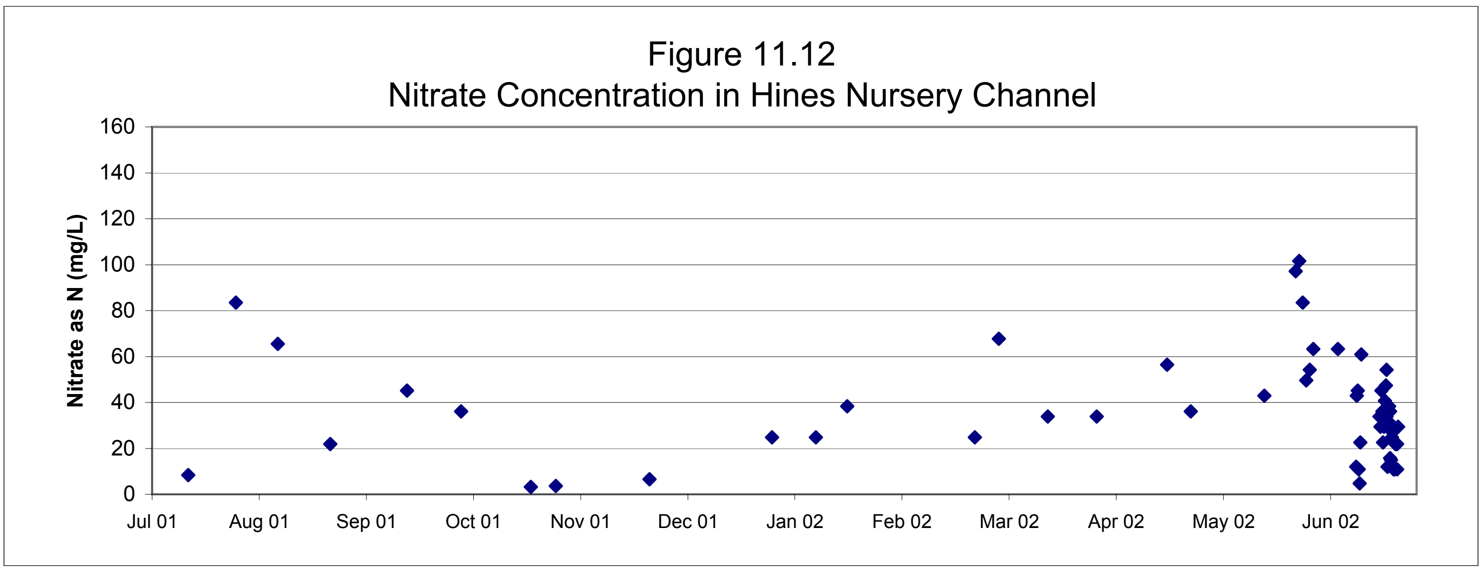


Figure 11.12
Nitrate Concentration in Hines Nursery Channel
Nitrate as N (mg/L)
0
20
40
60
80
100
120
140
160
Jul 01
Aug 01
Sep 01
Oct 01
Nov 01
Dec 01
Jan 02
Feb 02
Mar 02
Apr 02
May 02
Jun 02

Figure 11.13
Average Flowrate in Hines and Central Irvine Channels

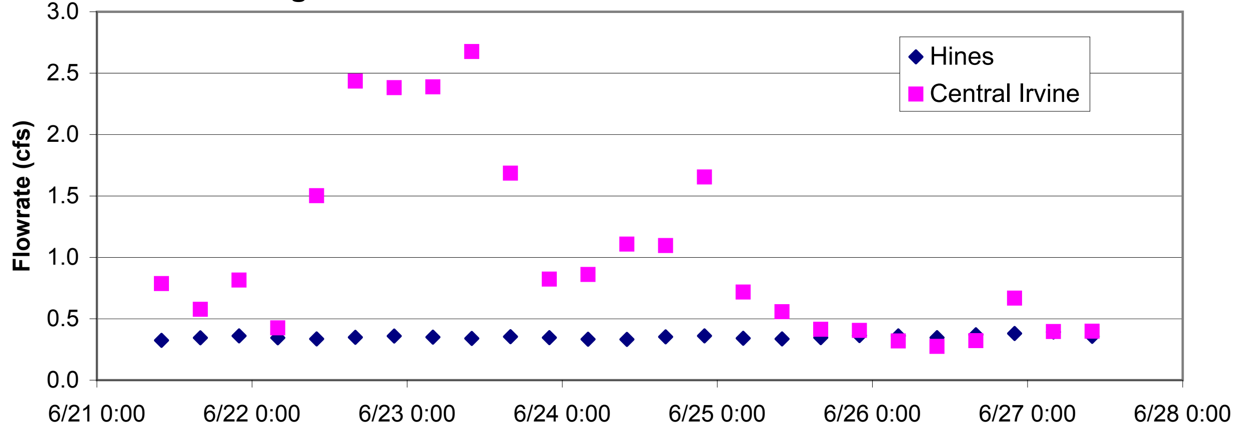
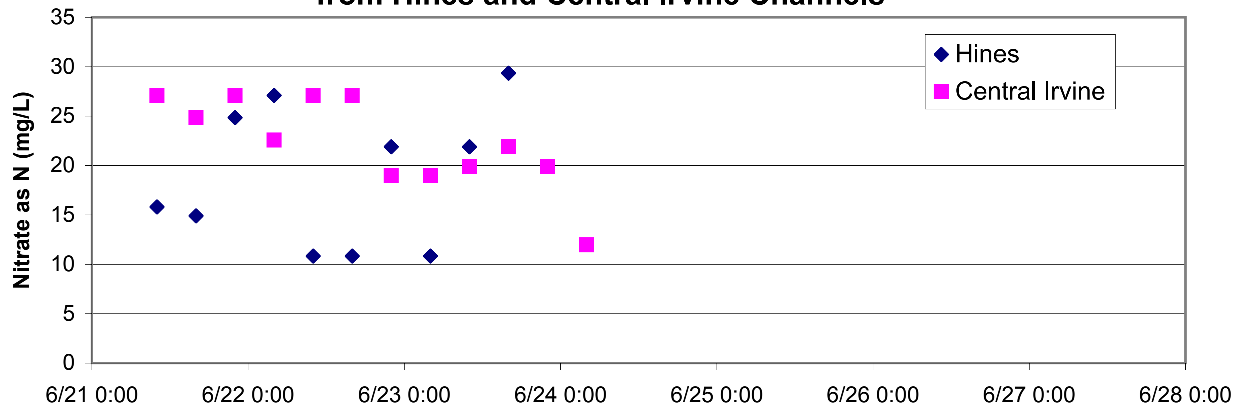


Figure 11.14
Nitrate Concentrations in 6-hr Composite Samples from Hines and Central Irvine Channels



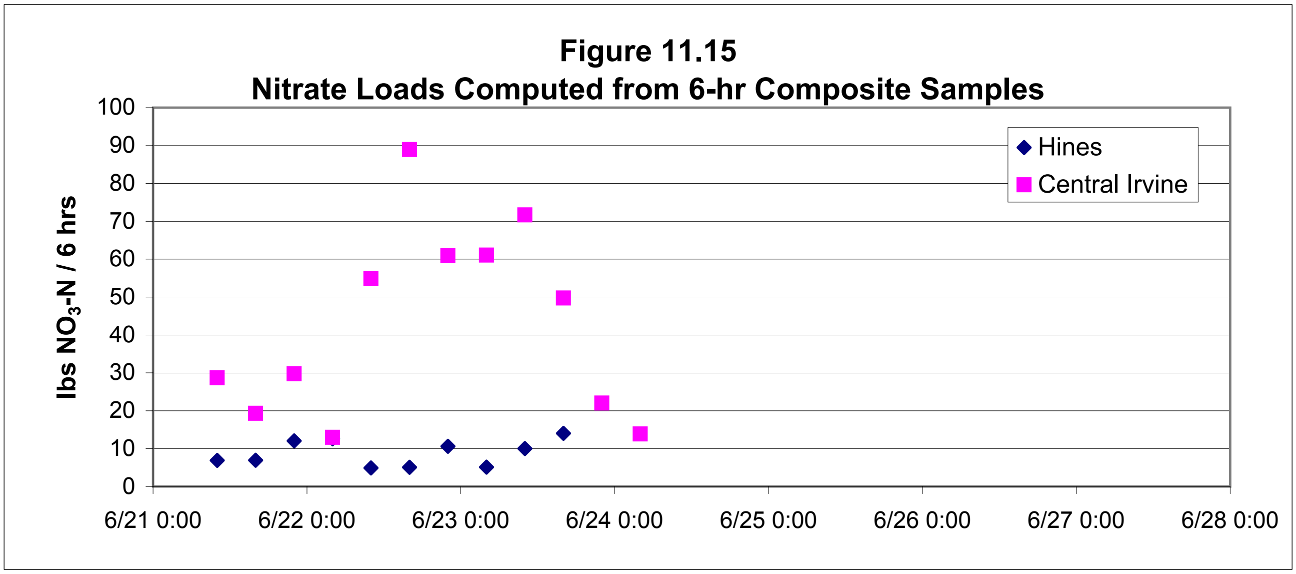
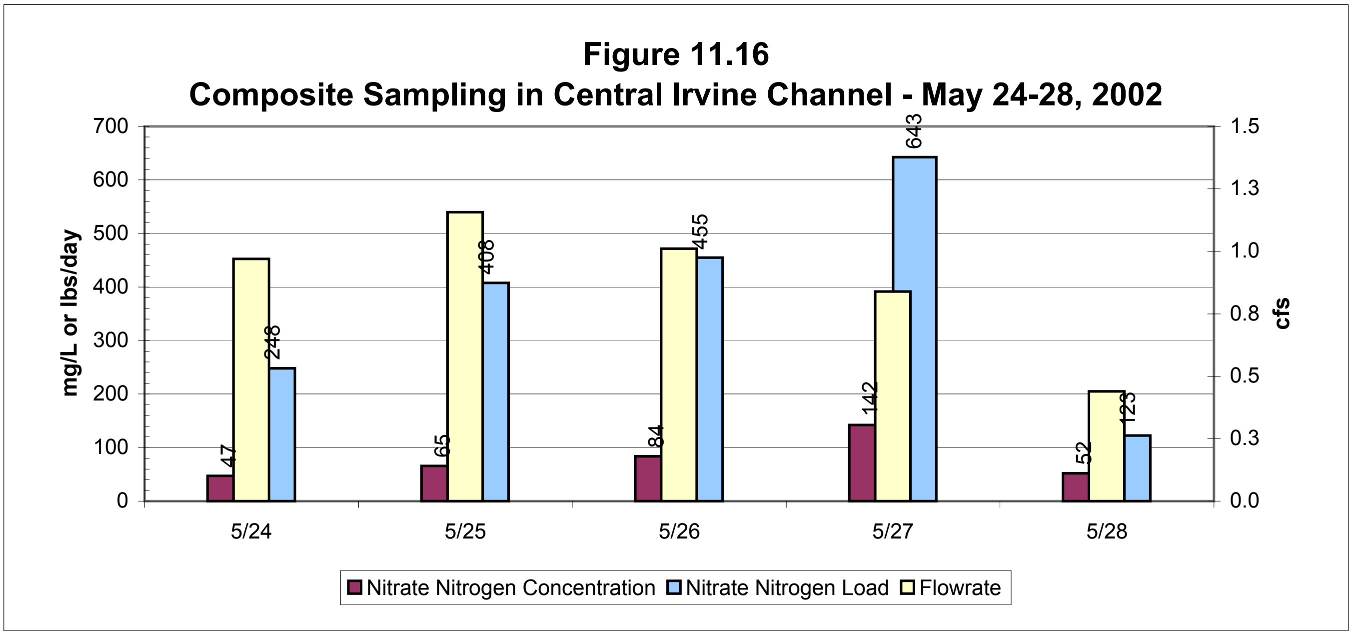


Figure 11.15
Nitrate Loads Computed from 6-hr Composite Samples
lbs NO_3-N / 6 hrs
0
10
20
30
40
50
60
70
80
90
100
6/21 0:00
6/22 0:00
6/23 0:00
6/24 0:00
6/25 0:00
6/26 0:00
6/27 0:00
6/28 0:00
Hines
Central Irvine



24-hr Composite Samples from 10 AM - 9 AM

Figure 11.17
Concentrations of Nickel and Cadmium at SCDAM

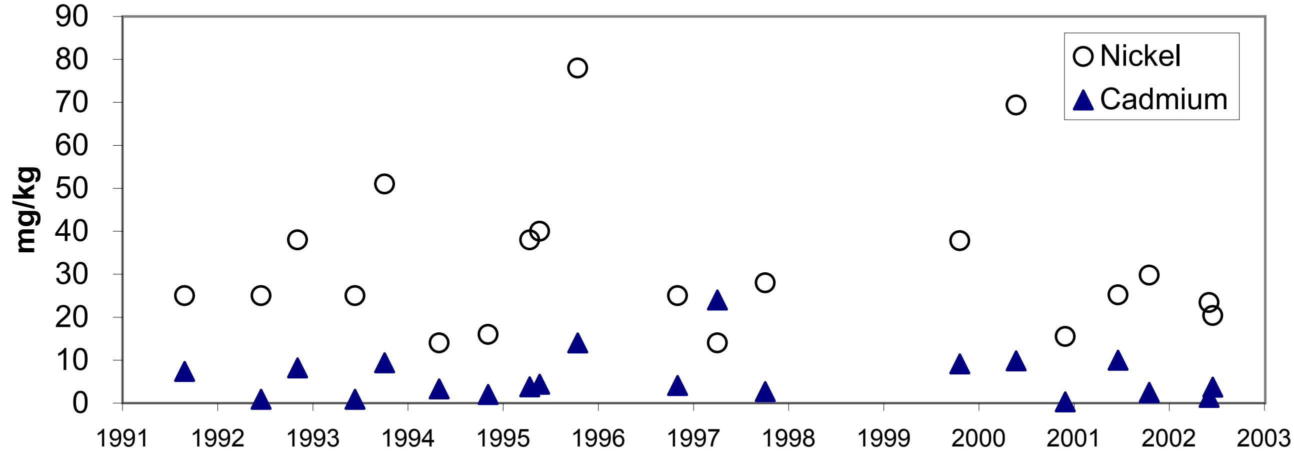


Figure 11.18 - Concentrations of Metals in Sediments in Sulphur Creek and Laguna Niguel Lake - June 26, 2002

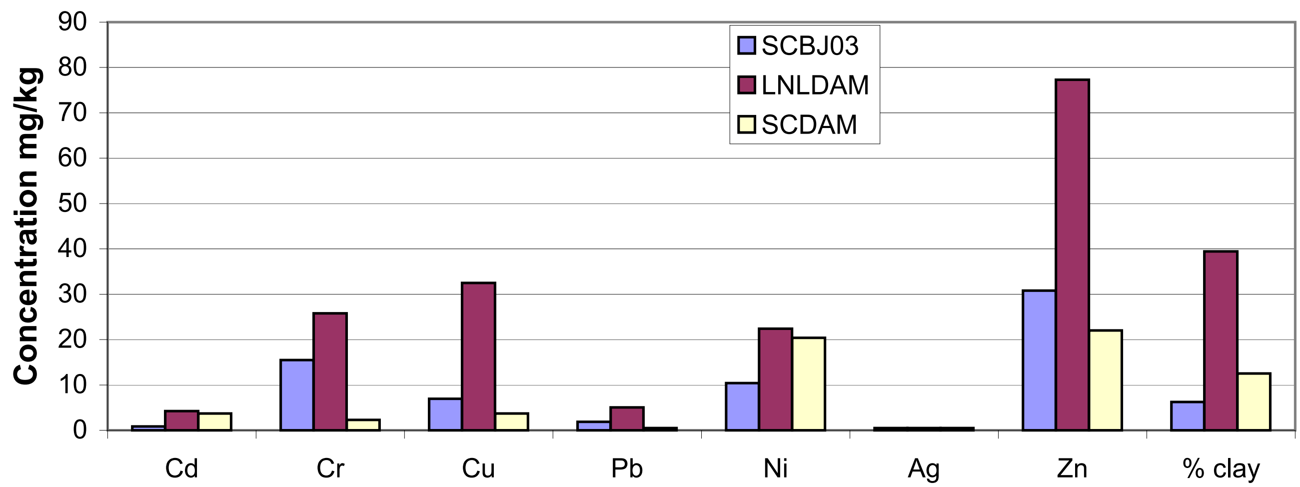
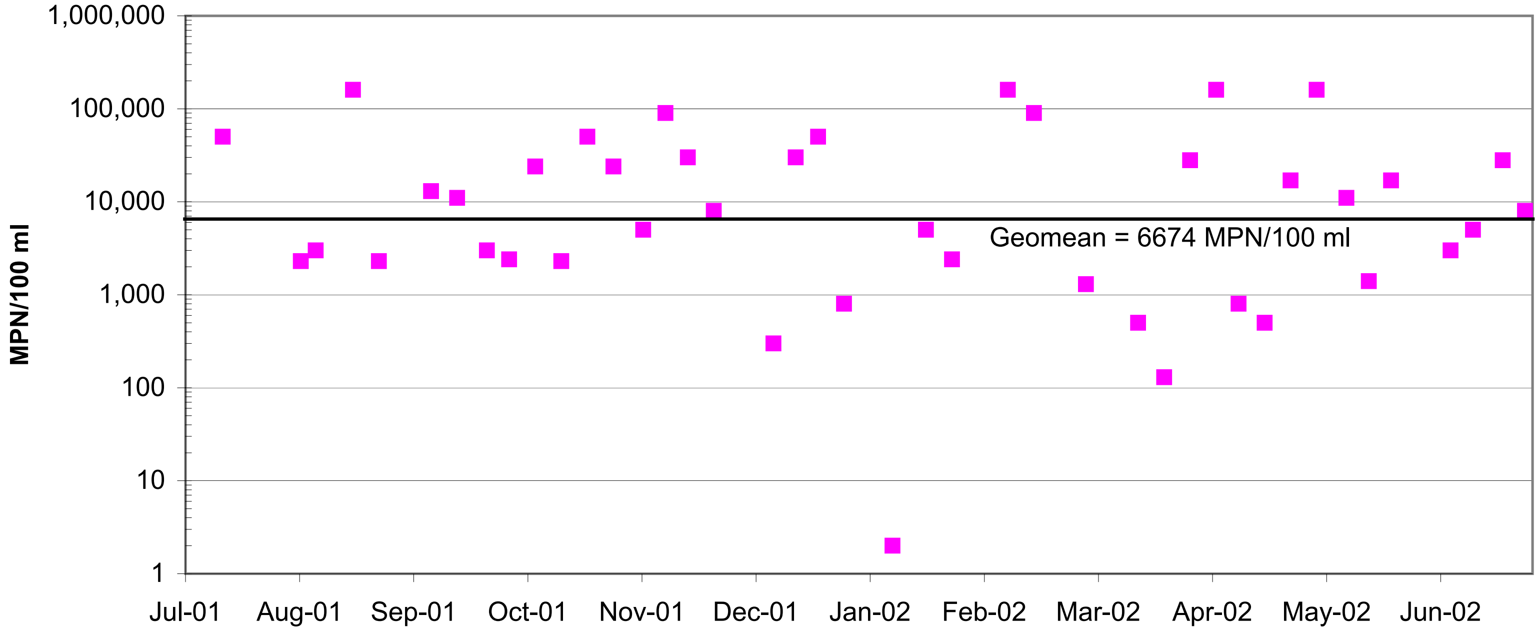


Figure 11.19
Dry-weather Fecal Coliform Concentration in Costa Mesa Channel



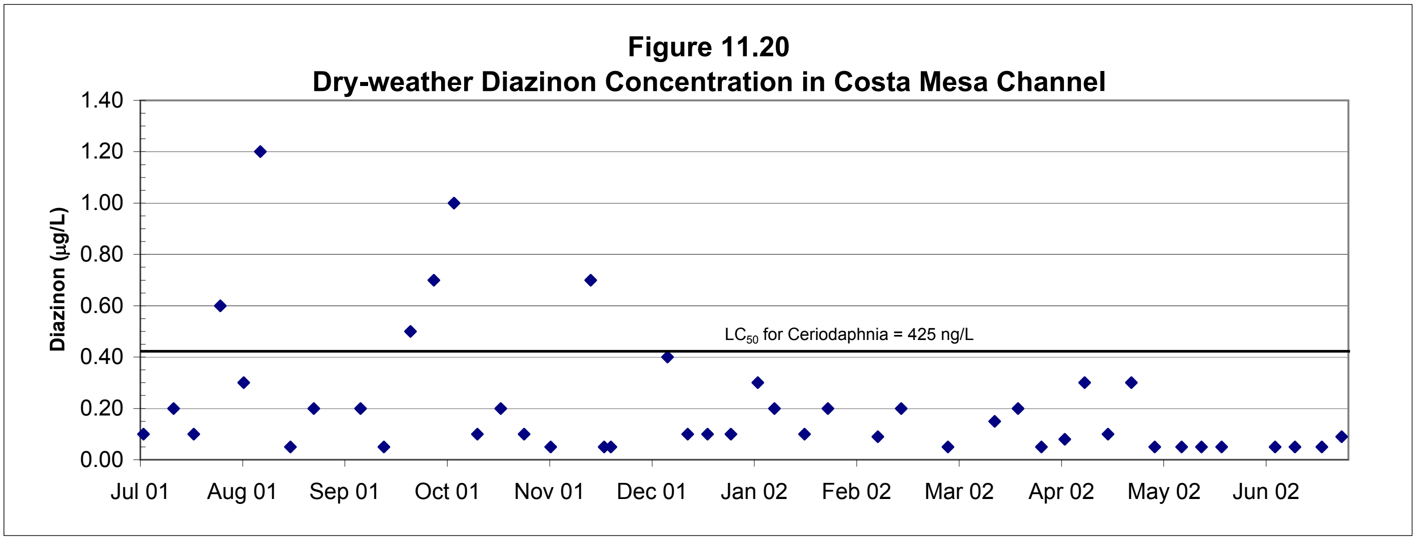


Figure 11.20
Dry-weather Diazinon Concentration in Costa Mesa Channel
Diazinon (µg/L)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
LC50 for Ceriodaphnia = 425 ng/L
Jul 01
Aug 01
Sep 01
Oct 01
Nov 01
Dec 01
Jan 02
Feb 02
Mar 02
Apr 02
May 02
Jun 02

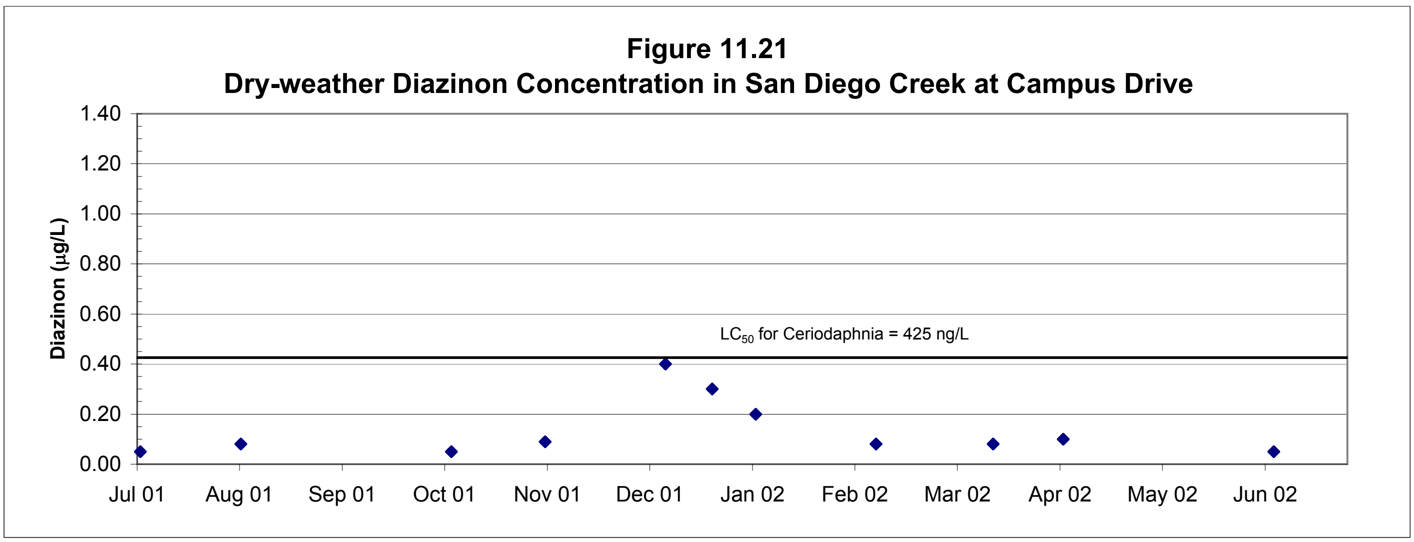


Figure 11.21
Dry-weather Diazinon Concentration in San Diego Creek at Campus Drive
Diazinon (µg/L)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
LC50 for Ceriodaphnia = 425 ng/L
Jul 01
Aug 01
Sep 01
Oct 01
Nov 01
Dec 01
Jan 02
Feb 02
Mar 02
Apr 02
May 02
Jun 02

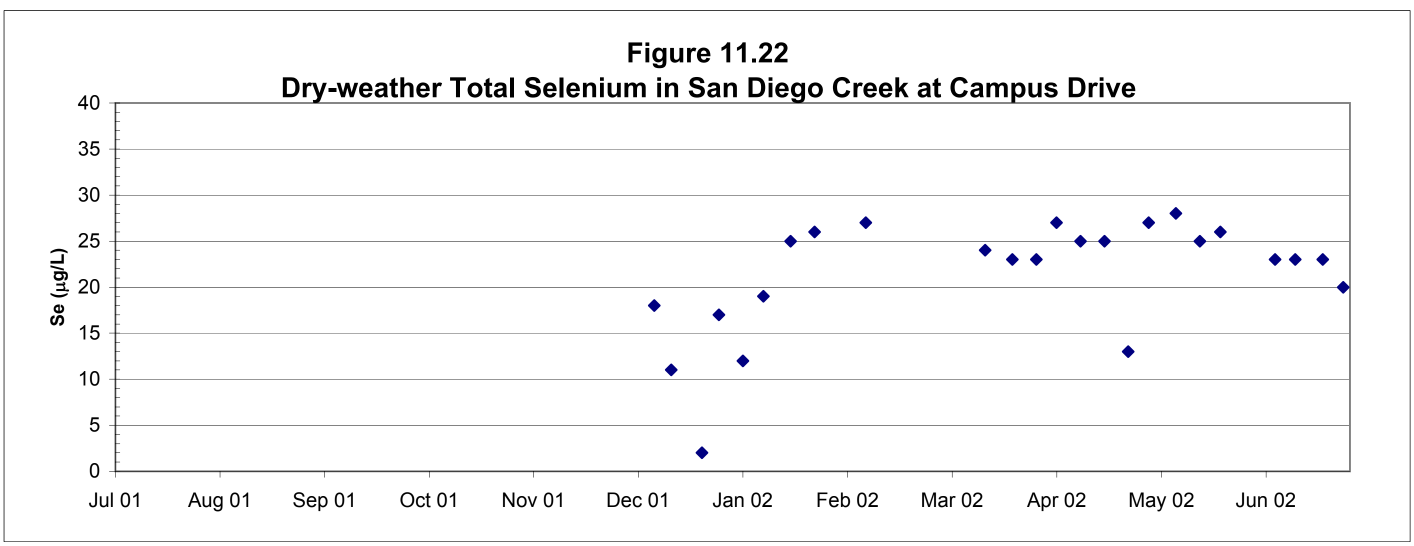


Figure 11.22
Dry-weather Total Selenium in San Diego Creek at Campus Drive
Se (µg/L)
40
35
30
25
20
15
10
5
0
Jul 01
Aug 01
Sep 01
Oct 01
Nov 01
Dec 01
Jan 02
Feb 02
Mar 02
Apr 02
May 02
Jun 02

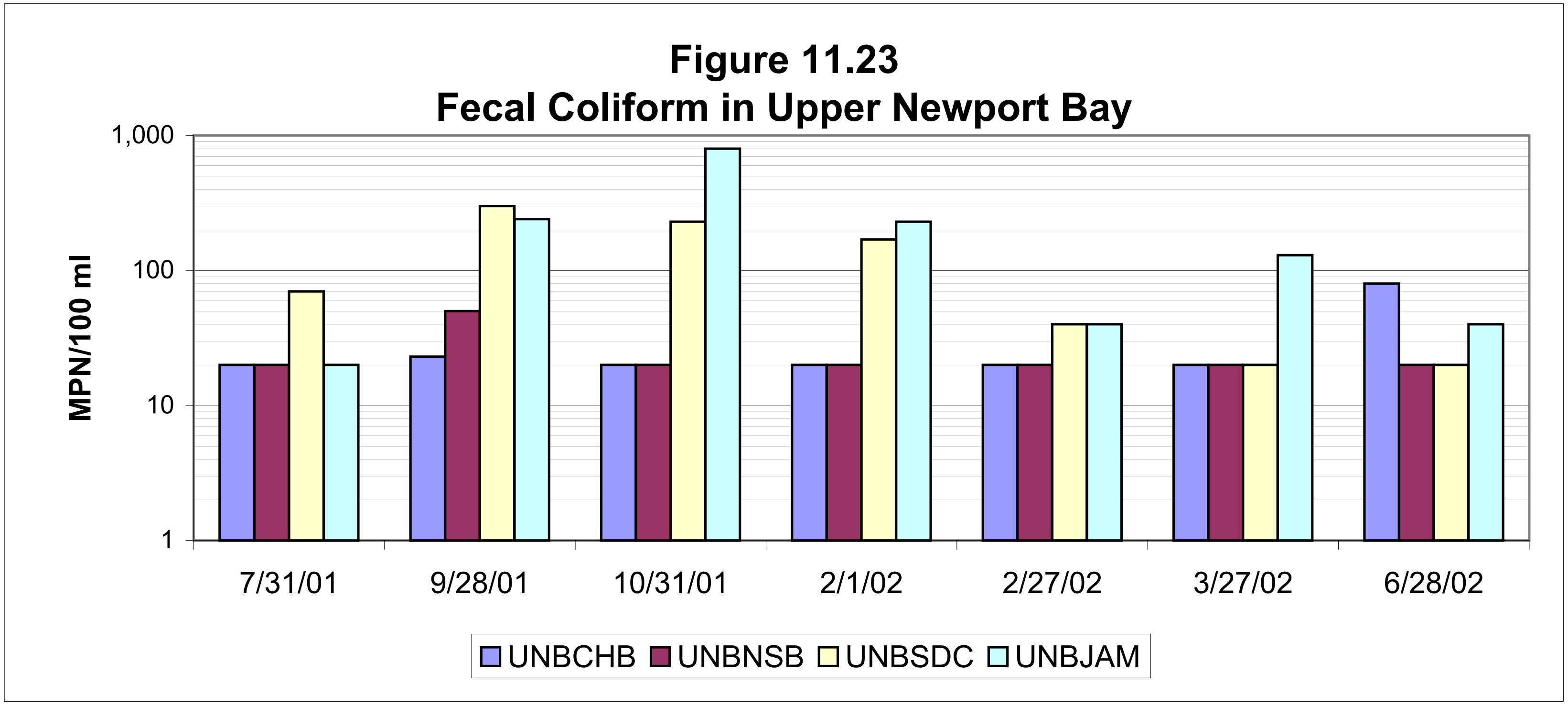


Figure 11.23
Fecal Coliform in Upper Newport Bay
MPN/100 ml
1,000
100
10
1
7/31/01
9/28/01
10/31/01
2/1/02
2/27/02
3/27/02
6/28/02
UNBCHB
UNBNSB
UNBSDC
UNBJAM