C-11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

C-11.1 Introduction

In response to the First Term Municipal Stormwater Permits from the Santa Ana and San Diego Regional Boards, 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).

Under the Third Term Permits the Permittees incorporated several new monitoring components including toxicity testing and bioassessment to better assess the conditions in the drainage system and its receiving waters.

The Permittees also initiated several water quality planning efforts, conducted additional water quality evaluations in response to technical requests from the Regional Board 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.

This report presents the results of water quality monitoring, conducted between July 1, 2008 and June 30, 2009, in the portion of Orange County under the jurisdiction of the Santa Ana Regional Board.

C-11.2 Background

C-11.2.1 Program Development

C-11.2.1.1 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.

C-11.2.1.2 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 stormdrain system.

The First Term Permit water quality monitoring program consisted of field screening for illegal discharges and illicit connections (channels only); dry-weather and stormwater runoff monitoring and a receiving water program.

C-11.2.1.3 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 (CARs); and
- A county-wide 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 monitoring program included 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 second term monitoring program contained 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 would respond to incoming data over time. This process was intended 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 second term monitoring program and subsequent elements utilize a five-year timeline (1998/99 - 2002/03) for addressing the goals/objectives associated with each task.

C-11.2.1.4 Third Term Permit Water Quality Monitoring Under Order R8-2002-0010

In the fall of 2005 the Program implemented the Third Term Permit monitoring programs for wet and dry weather, respectively. This program extends stormwater monitoring to a broader range of locations and to a wider array of methods for measuring impacts. For example, the Third Term monitoring plan more completely examined storm drains that discharge directly to the coast and pose a potential health risk to swimmers and bathers. Inland, the Third Term monitoring plan includes bioassessment studies of creeks, along with the more consistent use of toxicity testing. Combined with the existing measurement of chemical parameters, this "triad" approach is intended to describe impacts more fully; more accurately identify their sources, and target follow-up studies and BMPs more effectively.

The overall monitoring approach and methods are summarized in the following sections.

C-11.2.1.5 Additional Local Water Quality Monitoring

Any additional water quality monitoring conducted by the Permittees is described and summarized within the Performance Evaluation Assessment (PEA) of the respective Permittee.

C-11.2.2 Monitoring Approach

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

1. Develop and support an effective municipal urban runoff and non-point source control program
2. Define water quality status, trends, and pollutants of concern associated with urban storm water and non-storm water discharges and their impact on the beneficial uses of the receiving waters
3. Characterize pollutants associated with urban storm water and non-storm water discharges and to assess the influence of urban land uses on water quality and the beneficial uses of receiving waters
4. Identify significant water quality problems related to urban storm water and non-stormwater discharges
5. Identify other sources of pollutants in storm water and non-storm water runoff to the maximum extent possible (e.g., atmospheric deposition, contaminated sediments, other non-point sources, etc.)
6. Identify and prohibit illicit discharges
7. Identify those waters, which without additional action to control pollution from urban stormwater discharges, cannot reasonably be expected to attain or maintain applicable water quality standards required to sustain the beneficial uses in the Basin Plan (TMDL monitoring)
8. Evaluate the effectiveness of existing municipal storm water quality management programs, including an estimate of pollutant reductions achieved by the structural and non-structural BMPs implemented by the permittees
9. Evaluate costs and benefits of proposed municipal storm water quality control programs to the stakeholders, including the public.

The monitoring program described in the following section meets these objectives (with the proviso that evaluating the overall effectiveness and cost-benefit relationships of municipal stormwater programs, including specific BMPs, requires further effort beyond the scope of the water quality monitoring program outlined in the Permit and detailed in the following section). Each of the eight monitoring program elements directly addresses specific permit objectives.

The Monitoring Program continues and expands the previous monitoring program's emphasis on assessing impacts on aquatic resources, documenting long-term trends in water quality, targeting problematic discharge sites for more focused investigations, and adding additional monitoring elements. The following objectives for each program element include descriptions of management goals, monitoring strategies, reference conditions, and temporal and spatial extent, as appropriate:

Mass emissions monitoring:	Using measurements of a range of urban contaminants, loads, as well as exceedances of relevant standards, evaluate trends over time.
Estuary / wetlands monitoring:	Using measurements of key pollutants, loads, and biological community parameters, describe impacts on estuarine and wetlands ecosystems and the relationship of any impacts to runoff, based on theoretical and empirical expectations about the structure and function of healthy communities.
Bacteriological / pathogen monitoring:	Using measurements of a suite of bacterial indicators, identify spatial and temporal patterns of elevated level in order to prioritize problem areas.
Bioassessment:	Using a "triad" of indicators (bioassessment, chemistry, toxicity), describe impacts on stream communities and the relationship of any impacts to runoff, based on comparisons with reference locations and a regional IBI on a year-to-year timeframe.
Reconnaissance:	Using measurements of key pollutants, identify potential illegal discharges and illicit connections, based on comparison with historical data and available estimates of background levels.
Land use correlations:	Using an experimental, "before-after," design, identify changes in runoff associated with the urbanization of previously agricultural land.
TMDL/303(d) listed water body monitoring – nutrient TMDL:	Using measurements of nutrients, track progress of nutrient control measures over time, based on comparison with TMDL targets.
TMDL/303(d) listed water body monitoring - toxics TMDL	Using measurements of key pollutants, identify potential sources and pathways of toxic compounds and track progress of control measures over time, based on comparison with TMDL targets.

The Monitoring Program will reflect the Management Program's continued evolution toward watershed management and toward addressing a more complex set of questions that integrate multiple Program elements. For example, the inclusion of an adaptive toxicity testing component in the mass emissions program element provides the ability to more fully characterize toxicity and then track its upstream source(s) on a watershed scale. As another example, the reconnaissance program (focused on identifying illegal discharges and illicit connections) will make use of the growing databases of commercial and industrial facilities resulting from the cities' ongoing inventories of such facilities. Further, the inclusion of bioassessment and estuary/wetlands program elements enables the Monitoring Program to investigate the relationship of important biological endpoints to chemical contamination and physical changes in habitat. Overall, the monitoring program described in the following sections has expanded its focus on identifying the sources of problems, while continuing important historical data collection on trends at key sites.

Finally, the receiving water quality monitoring program responds explicitly to Section 3.3.1, Item 2, of the DAMP, which states that water quality problems will be identified through a Countywide monitoring program and other assessments.

C-11.2.3 Description of Monitoring Procedures

C-11.2.3.1 Mass Emissions Monitoring

The Permittees use time-composite sampling and continuously recording streamgauges as the primary method of monitoring the concentrations and loads of constituents at their Mass Emissions sites. The sampling is conducted with automatic samplers that consist of programmable pumps (peristaltic) that transport water from the channel to a collection reservoir in the auto-sampler base. The collection reservoir can be a single large composite bottle or a series of up to 24 bottles. The auto-sampler program can be modified to vary sample volumes and frequency of collection. Two automatic samplers were used at each Mass Emissions site. One auto-sampler was used for monitoring water chemistry and the other was used for monitoring aqueous toxicity.

To collect samples for the analysis of water chemistry, 8, 1.8-liter glass bottles are used in the auto-sampler base. The water chemistry auto-sampler is programmed to collect three discrete samples per 1.8-liter bottle. To collect samples for toxicity testing, a single 5-gallon glass bottle is used in the second auto-sampler base. The two samplers are programmed to collect at the same frequency to maintain the consistency between the composite samples produced by each.

The program attempted to monitor three storms at each Mass Emissions site during the year. For each storm the water chemistry was monitored with a series of 3 to 5 composite samples collectively spanning approximately 96-hours. The sampling for toxicity testing was coincident with just one of these composite samples. The Permittees chose the following temporal segments of storms that would be monitored for toxicity.

- Storm 1 – first flush (first hour of storm);
- Storms 2 and 3 – 24-hour period beginning three hours after the initiation of the first flush sampling by the water chemistry auto-sampler.

For dry weather discharge evaluations, the automatic samplers are programmed to collect a discrete sample once an hour for a 24-hour period. During each storm the automatic sampling programs are initiated when the water level in the channel rise above a triggering device (level actuator or flow meter) hardwired to the respective auto-sampler. When possible, a single triggering device is used to trigger both samplers simultaneously. For the water chemistry sampler (and the toxicity sampler during the first storm) the frequency of collection during the first hour of a storm is set at 1 sample per 12 minutes. After the sixth sample is collected at the one-hour mark, the collection frequency is decreased to once every 2 hours. Sampling of water chemistry spans approximately 96 hours to allow comparison of the data to 4-day (96-hour) guidance criteria for chronic aquatic toxicity from the California Toxics Rule (CTR). The concentrations of dissolved heavy metals in each of the composite samples collected during a storm can be compared to acute toxicity criteria from the CTR. The concentrations of organophosphate pesticides can be compared to literature values of LC_{50}s for toxicity testing organisms used in the Program.

Autosampler maintenance is performed periodically throughout a storm to change sample bottles, icepacks, and power supplies.

The first six samples collected during the first hour each storm are composited and represent the “first flush”. The remaining bi-hourly storm samples are used to prepare composite samples that are representative of the subsequent parts of the storm. Unless a 24-hour composite sample is prepared for comparison to toxicity testing results, the samples beyond the first flush were composited using the water level hydrograph for the channel, or by evaluating the specific conductance of the samples in each bottle. Using water level hydrographs from the Principal Permittee’s Automated Local Evaluation in Real Time (ALERT) system as a guide, samples collected beyond the first flush and representing the storm peak and recession are composited into a single sample. Storms spanning multiple days are broken up into two or more composite samples.

Water chemistry samples are analyzed for pH, specific conductance, turbidity, nitrate + nitrite, ammonia, total Kjehldahl Nitrogen (TKN), total phosphate, orthophosphate, dissolved and total organic carbon, total suspended and settleable solids, volatile suspended solids, chloride, sulfate, and total recoverable and dissolved cadmium, copper, chromium, lead, nickel, selenium, silver, and zinc. Priority pollutant scans are performed on the first flush of the first monitored storm of the year at each site. Grab samples are collected at the time of auto-sampler servicing and submitted for bacteriological analyses.

An aliquot of each sample collected for total recoverable metals analyses are filtered with a 0.45 micron groundwater filtering capsule. The filtered and the unfiltered fractions are then acidified with ultra-pure grade nitric acid and submitted to the contract laboratory for analysis.

Toxicity of stormwater runoff samples are evaluated using three toxicity tests with marine organisms. Aliquots from each stormwater sample are salinity-adjusted by the laboratory to proper range for the respective testing organism. The toxicity due to pesticides is measured using the mysid (*Mysidopsis bahia* a.k.a. *Americamysis bahia*) survival/growth test. The toxicity due to dissolved metals is measured using the sea urchin (*Stronglyocentrotus purpuratus*) fertilization and embryo development tests. In the Newport Bay watershed stormwater toxicity tests also include testing with freshwater organisms. These tests included fathead minnow (*Pimephales promelas*) survival /growth and *Ceriodaphnia dubia* survival / reproduction. During dry-weather monitoring the toxicity tests are conducted only with freshwater organisms. The tests include *Ceriodaphnia* survival / reproduction, *Selenastrum* growth, and *Hyallela azteca* survival. In the Newport Watershed fathead minnow survival /growth is also evaluated.

Time composite monitoring is supported by the Principal Permittee's precipitation and streamgaging network which consists of recording and/or transmitting ALERT gages. The ALERT precipitation gages are tipping bucket type with data loggers. Data are recorded and transmitted in digital format. The sensitivity of the ALERT transmitting gauges is 1 mm (0.04 inches) of accumulated rainfall. The recording non-transmitting gauges have a sensitivity of 0.01 inch of 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 in analog form on strip charts and/or in digital form on dataloggers. 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 data logger and transmitted to the Principal Permittee's Orange 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.

C-11.2.3.2 Estuary / Wetlands Monitoring

Estuary / Wetlands monitoring focuses on three receiving waters and their major tributaries. These receiving waters are the Newport Bay, Huntington Harbor / Bolsa Bay, and the Talbert Marsh. Monitoring is conducted at 12 locations in these receiving waters during dry-weather and storm runoff conditions. Because there are significant equipment and manpower demands for monitoring of a receiving water and its tributaries for the same dry-weather or stormwater event, each receiving water system is monitored separately. Dry-weather monitoring consists of 24-hour composite sampling of the tributaries and monitoring the respective receiving waters on the subsequent day. Stormwater monitoring of the tributaries is conducted according to the Mass Emissions monitoring protocol. Sampling of the receiving waters during a storm is conducted over a 4-day period with three samplings, with each sampling separated from the prior sampling by two days.

All the tributary channel sites, with the exception of Talbert Channel, are also mass emissions sites. The availability of mass emissions data for these channels will assist in identifying potential relationships between patterns and trends in the estuaries/wetlands and the inputs of key pollutants.

Some sites in receiving waters are situated near the mouths of channels that represent major inputs of runoff, and there is a minimum of one site in each estuary that is free of direct runoff influences from the channels, including UNBCHB, LNBHIR, LNBTUB, and BBOLR. Comparisons between these two types of sites may help identify differences between the impacts from localized effects (e.g. marina operation) and urban runoff. During an average rainfall year an attempt is made to sample the estuary / wetland sites in Huntington Harbour, Bolsa Bay, and Talbert Marsh during two storm events per year and twice during the dry season. With the below average level of precipitation this year, the storm monitoring goals for all of the bays, estuaries, and marshes was not achieved. The Newport Bay was sampled during two storms but the Huntington Harbour, Bolsa Bay, and Talbert Marsh areas were not sampled during any storm. Dry-weather monitoring at every site was conducted once prior to the beginning of the storm season (October) and once after the end (May). Dry-weather monitoring was also conducted quarterly at the sites that are part of the Toxics TMDL. Sites in Upper Newport Bay have a somewhat different sampling regime because they are also part of the nutrient TMDL Regional Monitoring Program (RMP) which has a separate set of monitoring requirements. These four sites were monitored monthly throughout the year.

The constituents measured in the tributary input channels are the same as those sampled in the mass emissions element. The constituents measured in the estuaries / wetlands themselves depend on the season, on whether the sample is an aqueous or a sediment sample, and on the location of the monitoring site.

During stormwater events, the monitoring in the receiving waters includes chemical analyses for nutrients, total and dissolved metals, dissolved organic carbon, and organophosphosphate pesticides. In-situ measurements are made in the water column from the surface to the bottom at 1-meter increments. These measurements included specific conductance, pH, temperature, and dissolved oxygen. Samples were evaluated for aqueous toxicity using the sea urchin fertilization test, sea urchin embryo development test and the mysid survival / growth test. The nutrients samples were collected at the surface to evaluate impacts on plant growth in the photic zone. The other samples are collected using a depth-integrating, composite technique to determine the average condition in the water column.

Quarterly dry-weather monitoring in the receiving waters includes the aqueous analyses described above and a benthic sediment component to evaluate sediment chemistry and sediment toxicity. The sediment chemistry analytes include total organic carbon, particle size distribution, metals, organochlorine pesticides, PCBs, organophosphate pesticides, and pyrethroid pesticides. Sediment toxicity is evaluated using the 10-day amphipod (*Eohaustorius estuarius)* survival test.

Once a year, usually during the summer, the benthic sediment sampling also includes monitoring of the benthic invertebrate community for taxonomy.

The Nutrient TMDL program includes monthly dry-weather sampling of the Newport Bay to evaluate the effects from nutrients in the discharge from the San Diego Creek. Samples are collected from the surface, mid-depth, and bottom at four locations in the Upper Bay and one location in the Lower Bay. Monthly monitoring of total nitrogen and phosphorus in the sediments of the Upper Newport Bay was added in 1999/2000 reporting period to assist with the CARs evaluation.

C-11.2.3.3 Bacteriological / Pathogen Monitoring

The Permittees selected nine coastal stormdrains to monitor the effects of urban runoff on the coastal zone. The following selection criteria were used:

- The stormdrain has an equivalent circular diameter greater than 39-inches and/or a daily dry-weather discharge volume exceeding 100,000 gallons;
- Outlet of the stormdrain is posted with a warning sign by the Orange County Health Care Agency;
- The flow from the stormdrain reaches the surfzone at least seasonally; and
- The stormdrain and the surfzone are accessible by monitoring staff.

Monitoring is conducted on both the discharge from the stormdrain and the surfzone 25 yards up-coast and 25 yards down-coast of the stormdrain-ocean interface. Grab samples are collected weekly for the analysis of total coliform, fecal coliform, and *Enterococcus* bacteria. At the time of sample collection an estimate of the flow rate from the stormdrain is made and the temperatures of the stormdrain discharge and the surfzone down-coast are measured.

In addition to these nine coastal stormdrains, seven inland channels and/or creeks that are currently impaired for pathogens are also monitored.

The following criteria were established for monitoring:

- Samples are not collected on the day of rainfall;
- Samples are not collected from a stormdrain during the period when its discharge is diverted to a sanitation district; and
- During stormdrain diversion only a sample from the surfzone (down-coast of the stormdrain-ocean interface) is collected.

A detailed description of the sampling methods used in the Pathogen monitoring program element is contained in **Attachment C-11-V**.

C-11.2.3.4 Bioassessment

The Permittees with assistance of Regional Board staff have selected nine channels and three reference sites to conduct urban stream bioassessments using California Stream Bioassessment Procedure (CSBP) established by the California Department of Fish and Game (DF&G). A contract laboratory conducts the bioassessment sampling and taxonomic analyses on behalf of the Permittees. A description of the CSBP can be found at http://www.dfg.ca.gov/cabw/Field/csbpwforms.html.

During the course of the fall 2007 and spring 2008 surveys, one or two reference sites were sampled according to the new SWAMP (2007) protocols which were recently authorized for State wide use by SWAMP. These protocols can be found at: http://www.waterboards.ca.gov/water_issues/programs/swamp/

In order to conduct the triad analysis, at the time of bioassessment sampling the Permittees collect grab samples for water chemistry and aqueous toxicity analysis. The suite of chemical constituents is the same as analyzed in the Mass Emissions Program. The aqueous toxicity is evaluated using three freshwater organisms, *Ceriodaphnia dubia*, *Selanastrum capricornutum*, and *Hyallela azteca*. In the Newport Bay watershed toxicity testing organisms also include *Pimephales promelas* (fathead minnow).

C-11.2.3.5 Dry Weather Reconnaissance

The Reconnaissance Program was developed to aid in source identification in areas of known water pollution problems. 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. In prior years reconnaissance activities in the Santa Ana Region focused on the Construction Circle drain in Irvine and Collins Channel in Orange.

The monitoring program for the Third Term Permit includes a reconnaissance element that focuses on approximately 40 "targeted" stormdrains in the Santa Ana Region. These drains were identified by the Permittees as potential conduits for illegal discharges and illicit connections. Monitoring involves five separate visits to each site during the dry season (May 1 – September 30). Each site visit consisted of a visual reconnaissance, in-situ measurements of physical characteristics (flow rate, specific conductance, pH, temperature, turbidity and dissolved oxygen), and field analysis of nitrate + nitrite, ammonia, reactive phosphorus, total chlorine, phenols, surfactants, dissolved copper and hexavalent chromium, and water hardness. Samples are collected and submitted for laboratory analysis of total suspended solids, dissolved metals, oil and grease, indicator bacteria and organophosphate pesticides.

Unusual observations or measurements in the field are reported immediately to the respective Permittee representative. The field and laboratory results are entered into a statistical database, which is used to determine if those results warrant additional reconnaissance by the respective Permittee. The "average" condition is determined from analysis of results from randomly selected stormdrains in the region. There are two triggers for upstream watershed reconnaissance. The first is exceedance of the tolerance interval bound based on the average condition established by the random sites. The second is exceedance of the site-specific control chart bound, which has been tentatively established as 3.9 standard deviations above the average (mean) value for any monitored parameter. If two consecutive measurements exceed either trigger level, reconnaissance will be initiated by the Permittee.

C-11.2.3.6 Land Use Correlations

Seven sites were established to monitor the effects of changes in land use on the quality of receiving waters, in particular, the impacts of increasing development and the conversion of agricultural land on the pollutant loading to the Upper Newport Bay. This Program element is based on an experimental design that uses a series of comparisons to help isolate the impacts of specific kinds of land use changes.

The monitoring design includes three experimental conditions and one reference site, all in the City of Irvine:

- Grassland to residential conversion (SJQF14u and SJQF14d)
- Agriculture to residential conversion (HINF25u and HINF25d)
- Military Installation (Marine Corps Air Station – Tustin) to commercial conversion (TABF09u and TABF09d)
- Military Installation (Marine Corps Air Station – Tustin) to residential conversion (SASF10u and SASF10d)
- Reference (BORF20).

Monitoring is conducted monthly for the same suite of water quality parameters as is monitored in the mass emissions element of the Program. In addition, an attempt is made to sample two storms per year. As development was completed some monitoring locations became inaccessible. During this reporting year only the Barranca Channel (TABF09u and TABF09d) and Santa Ana Santa Fe Channel (SASF10u and SASF10d) were monitored.

C-11.2.3.7 TMDL / 303(d) Listed Waterbody Monitoring (Nutrient TMDL)

Dry Weather Monitoring

At each site, composite samples are collected using the methods described in the Mass Emissions section.

Stormwater Runoff Monitoring

Unless the monitoring location is part of the NPDES mass emissions program, composite surface water samples are collected at two (2) hour intervals for a 96-hour period using automatic samplers with Tygon or Teflon-lined strainer tubing. This protocol is different from the mass emissions program in that no "first flush" sample is collected.

Discharge Rate Data

The discharge rate or flow data used to calculate nutrient loadings are collected year round from nine streamgauges in the Newport Bay watershed. Of these nine gauges, seven are operated by the County of Orange and two are operated by the United States Geological Survey (USGS). The locations of these gauges are listed below:

- San Diego Creek at Campus Drive (OC)
- Santa Ana-Delhi upstream of Irvine Avenue (OC)
- Peters Canyon Wash at Barranca Parkway (OC)
- San Diego Creek at Culver Drive (OC)
- El Modena-Irvine at Michelle Drive (OC)
- Lane Channel at McCabe Way (OC)*
- Costa Mesa Channel at Westcliff Drive(OC)*
- Bonita Canyon Creek at MacArthur Boulevard (USGS)
- Agua Chinon Channel at Irvine Boulevard (USGS).

**station not equipped with real-time reporting capabilities*
OC – County of Orange

Five of the seven County of Orange operated streamgauges stations are equipped with a continuous water-stage recorder, precipitation gauge and ALERT transmitter/data logger which provide the ability for the County to monitor rainfall and channel water level in real-time. The USGS stations are equipped with continuous water-stage recorders and a satellite telemetry system that can be viewed (with minimal time delay) on the USGS internet home page.

C-11.2.4 Methods of Data Analysis

C-11.2.4.1 Comparison to Water Quality Criteria

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). 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 California Toxics Rule or 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 collected in each program element are compared to the applicable acute (instantaneous maximum concentration) or chronic (4-day average concentration) criteria.

Acute (CMC-Criteria Maximum Concentration) and chronic (CCC-Criteria Continuous Concentration) aquatic toxicity criteria from the CTR are 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 C- 11.1** and for sediment from other sources in **Table C- 11.2**.

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 program element the former method is used.

In applying the CTR as guidance in evaluating freshwater monitoring program elements, if the time period to which the criteria 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 acute criterion 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 criterion.

When computing the time-weighted mean concentration for 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 laboratory 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 criterion as it reduces the likelihood that the exceedance was caused by an erroneous estimation of a non-detected value.

In applying the CTR as guidance in evaluating the saltwater monitoring program elements, 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 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.

C-11.2.4.2 Toxicity Testing Data

Toxicity tests span varying time periods depending on the type of organism function (survival, growth, reproduction, etc.) being evaluated. Endpoint data are used to compute statistics that can be compared against regulatory criteria. These statistics include Acute Toxicity Units (TUa) and Chronic Toxicity Units (TUc).

Each sample is analyzed by monitoring organism responses in a series of sample dilutions (e.g. 100, 50, 25, 12.5, and 6.25% sample concentration). The responses measured in each dilution are validated by a number of replicates. Responses are also monitored in laboratory control water.

The concentration that causes 50% mortality of the organisms (the median lethal concentration, or LC_{50}) is determined using a statistical calculation with the endpoint data from an acute toxicity test. The acute toxicity test spans 48 hours for *Ceriodaphnia, Americamyis*, and fathead minnow, and 96 hours for *Hyalella azteca*. The LC_{50} values are expressed as "percent sample;" the lower the LC_{50} percentage the more toxic the sample. For acute regulatory standards, the LC_{50} acute value is used.

For chronic regulatory standards, the chronic effects are estimated using the No Observable Effects Concentration (NOEC), for both survival and reproduction. For the *Ceriodaphnia* reproduction, *Americamysis* growth, and fathead minnow growth tests the endpoint is at seven days. For the *Selenastrum* growth test the endpoint is at 96 hours. The NOEC is the highest concentration tested in which there is no statistically significant difference in the organism response relative to the control sample response. The lower the NOEC, the more toxic the sample.

For purposes of assessment between sites or between samplings, the endpoints described above are transformed into toxic units (TU). Toxic units are further divided into toxic units acute (TUa) and toxic units chronic (TUc) for acute and chronic endpoints, respectively. As toxicity increases, the toxic units increase.

TUa and TUc values are calculated very differently and are not interchangeable or related. The TUa equals 100/acute LC_{50}. If the LC_{50} is greater than 100% (i.e. more than 50% survival in the undiluted sample), then the TUa is calculated by the following formula:

$$TUa = \log(100-S)/1.7$$

Where S = percentage of survival in 100% sample. If S > 99%, the TUa is reported as zero, which is the lowest TUa value possible. The percent survival in the 100% concentration used in this formula is expressed as a percentage of the control survival. The TUc equals 100/NOEC. The lowest TUc possible, which indicates no toxicity, is 1. TUc values were calculated separately for survival and reproduction endpoints.

For some tests, if the test data meet acceptability criteria, inhibition concentrations, an IC_{25} and an IC_{50}, are calculated. These are the concentrations that cause a 25 percent or 50 percent inhibition of an organism's function such as growth, or cell density, in the *Selanastrum* growth test.

A reference toxicant test is also run to establish whether the test organisms used fall within the normal range of sensitivity. The reference toxicant test is conducted with known concentrations of a given toxicant (e.g., copper chloride is used for *Ceriodaphnia*). The effect on the survival and reproduction of the animals is compared to historical laboratory data for the test species and reference toxicant. If the values are within two standard deviations of the historical average, the test organisms are considered to fall within the normal range of sensitivity.

A description of the methods used in each toxicity test can be found by consulting the references cited in **Attachment C-11-I**.

For toxicity tests available LC_{50} and EC_{50} data on key contaminants can be used to compare the observed toxicity (measured as toxic units) to the expected toxicity. The toxicity testing organisms used in this Program tend to be more sensitive to some categories of toxicants than others. For example, the mysid (*mysidopsis bahia*) survival/growth (MSG) test tends to be very sensitive to OP pesticides and unionized ammonia but less sensitive to metals. The Sea Urchin Fertilization (SUF) test is sensitive to dissolved metals and unionized ammonia but not very sensitive to OP pesticides.

LC_{50} data from the *Mysidopsis bahia* (a.k.a. *Americamysis bahia*) survival tests with ammonia, Chlorpyrifos, Diazinon, Dimethoate and Malathion were obtained from the PAN Exotoxicity database http://www.pesticideinfo.org/Search_Ecotoxicity.jsp which contains the results of over 220,000 toxicity tests. Results can be sorted by species, chemical or effect. Additional data are available from SCCWRP research studies. EC_{50} data for the sea urchin 40 minute fertilization test for unionized ammonia, copper, and zinc can be obtained from the same sources. The observed concentration of each chemical constituent (from the aquatic chemistry samples collected at the same time) can be divided by the appropriate LC_{50} or EC_{50} value to produce an estimated TU_a from each constituent. These estimated TU_as are then summed and compared to the observed TU_a from the toxicity test, as in the following equations:

$$\frac{\text{Concentration of toxicant}}{\text{Average literature value of } LC_{50} \text{ or } IC_{50} \text{ of toxicant}}$$

The total predicted toxicity from n toxicants is $\sum_{i}^{n} \frac{[toxicant_i]}{[LC_{50} or IC_{50}]_i}$

The calculated TUa from the toxicity test can be compared to this predicted toxicity.

This approach to comparing observed and predicted toxicity has potential shortcomings, including:

- The lack of availability of relevant LC_{50} and EC_{50} data for the full range of chemical constituents of concern,
- Lack of available data for the same life stages (e.g. larval vs. juvenile, or adult) of the organisms evaluated in our program,

- Lack of available data for the same test evaluation periods used in our program (e.g. 48-hr LC_{50} for mysids and *Ceriodaphnia* and 96-hr LC_{50}s for *Hyalella azteca*),
- Ranges of responses from multiple studies in the literature,
- The implicit assumption of simple additivity of toxic effects. While probably not true, there is no clear guidance on how to accurately represent synergistic effects, which could very well vary from site to site and over time.
- The fact that the predicted toxicity in several instances is larger than the observed toxicity, which serves to weaken confidence in the reliability of the LC_{50} and EC_{50} data.

Despite these shortcomings, this approach is useful for:

- Assessing the overall accuracy or reliability of the toxicity results,
- Identifying specific chemicals that appear to contribute most to toxicity and that are therefore targets for further study and/or source identification and reduction efforts, and
- Identifying monitoring locations that may have consistently high levels of unexplained toxicity. In these cases, more sophisticated studies may be called for.

C-11.2.4.3 Mass Load Calculations

Mass loads are calculated using chemical and hydrographic data. Water level records from permanent streamgaging stations at or near the sampling site are processed using Hydstra software. Water levels from the station's continuous strip chart recorder are digitized and converted to discharge rates using stage-discharge relationships (channel ratings). At sites which had ISCO water level recorders, the data loggers are downloaded periodically and the information was stored in Hydstra. Using the respective rating tables for each site, the water level data are converted to flow rates files. The total discharge volume (in acre-feet) during each sampled period is 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 is calculated. For data reported as ND (non-detected), one-half of reported laboratory detection limits are used in the calculations.

An EMC is the flow-weighted average concentration during a storm. It is calculated from composite sample concentrations and measured stormwater volumes represented by those composite samples. The annual mean EMC represents the flow-weighted mean of all storms sampled at a site during the monitoring year.

$$MeanEMC = \frac{\sum_{i=1}^{n} V_i EMC_i}{\sum_{i=1}^{n} V_i}$$

where n storms are monitored and V_i is the stormwater volume of the *i*th storm. The EMC for a storm *i* is defined as

$$EMC_i = \frac{\sum_{j=1}^{m} SWL_j}{k\sum_{j=1}^{m} SWV_j}$$

where SWL*j* is the stormwater load from composite sample *j* , SWV*j* is the stormwater volume used to calculate SWL*j*, *m* is the total number of composite samples collected during storm *i* and k is a conversion factor to produce the appropriate concentration units.

Annual site-mean EMCs are used to estimate mass loads from un-sampled storms during the monitoring year for two purposes:

- To estimate total annual loads on a site-by-site basis and
- To estimate the loads on a watershed basis.

To estimate these un-sampled loads in pounds, the site mean EMC (in mg/L) for each stormwater contaminant is multiplied by the total annual volume of water (in acre-ft) discharged during un-sampled storms, and the unit conversion factors [2.718 liter • lbs/mg • ac-ft]. If the units of the EMC are ug/L the conversion factor is 2.718 X 10^{-3}. The watershed load is calculated by simply summing the total estimated annual loads from each monitoring site in the watershed. Only EMCs in which 75-120% of the total runoff volume of a storm was sampled are used to calculate the annual site EMCs.

C-11.2.4.4 Evaluation of Bacteriological / Pathogen Data

Coastal stormdrain data include water temperature and concentrations of bacterial indicators in the discharge and in the surfzone upcoast (north) and downcoast (south) of these stormdrains. Data analysis consisted of:

1. Comparing indicator levels at each drain to the state's AB411 single sample standards for ocean water sports contact

2. Ranking drains in terms of the proportion of total possible exceedances of the AB411 standards. The actual number of microbiological analyses or tests conducted on receiving water samples collected at each drain throughout the year is summed. This does not always equal 312 (i.e., 52 weeks x 3 indicators per sample x 2 locations) because it was not always possible to collect the full suite of samples at each site throughout the entire year. The total number of AB411 exceedances is then divided by the total number of sample tests, resulting in a proportion for each drain between

0 and 1.0. The exceedance proportion for each site is then indicated on a map of the sampling sites, according to the following color scheme:

- Green: 0 - < 0.14
- Blue: 0.14 - < 0.40
- Yellow: 0.40 - < 0.75
- Red: 0.75 – 1.0

It should be noted that this color scheme was developed to provide a relative ranking of the surfzone water quality at the outfalls of south Orange County stormdrains. The Heal the Bay Report card scoring methodology uses a different evaluation process which also includes analyses of total to fecal coliform ratios and 30-day geometric mean concentrations of all three indicators.

3. Plotting indicator levels in the receiving water vs. those in the drain. The surfzone concentrations for each indicator are plotted vs. the indicator concentrations in the drain during the same sampling event, with receiving water values on the y-axis and drain values on the x-axis. Separate plots are presented for each indicator at each drain, with upcoast and downcoast data displayed with distinct symbols. The plots are divided into sectors suggesting the conclusions and possible management actions that would be appropriate when a preponderance of the data points fall into one sector or another.

4. Ranking drains in terms of the slope of the linear regression of receiving water indicator levels vs. those in the drain. The concentration data are log transformed and then a standard least squares linear regression calculated for relationship between receiving water indicator concentrations and stormdrain concentrations. A separate regression is calculated for each indicator / drain combination. Sites are then ranked in terms of the "p" value for the regression for each indicator. The "p" value reflects the strength of the drain – receiving water relationship. In combination with the other analyses, this can be used to help assess each drain's likely effect on receiving water conditions.

5. Plotting percentages of sampled days in which at least one indicator bacteria concentration exceeded the AB411 concentration in the surfzone. Each day of surfzone sampling is evaluated with respect to the AB411 standards for the three indicators. For each drain, the percentage of sampled days in which at least one standard was exceeded in the surfzone (upcoast or downcoast) is calculated. These percentages are calculated for the entire year and the AB411 season. The results are plotted, with the drains grouped by City jurisdiction on the x-axis. This method of analysis provides a better assessment of the health risk (compared to analysis #2) associated with water contact in the surfzone near the discharges from the drains.

These analyses are performed for the entire year and for the AB411 season alone. Analyses also focus on only those instances where field notes indicate that the outflow of a drain is flowing to the surfzone.

Analysis results are then evaluated to identify consistent spatial and temporal patterns. Drains with exceedance and/or regression ranks are evaluated more carefully to identify potential explanatory factors in their drainage areas.

Data analysis for the inland channels proceeded somewhat differently because sampling consists simply of grab samples in the channel, rather than samples from a coastal stormdrain discharge and from surfzone stations up- and downcoast. Although the AB411 standards apply to ocean water sports contact, the concentrations of the indicators in each channel sample are compared to AB411 standards for discussion purposes only. As with the surfzone data the proportion of exceedances were calculated, for both the entire year and the AB411 season. The sites are then ranked in terms of their exceedance proportions. Exceedance proportions are mapped as described above.

C-11.2.4.5 Bioassessment and Index of Biotic Integrity (IBI)

Each site is evaluated in terms of a series of metrics (**Table C-11.3**), which are then scored (**Table C-11.4**) to provide a basis for determining the overall IBI score for each site. These scoring ranges are based on data from the southern California region, from southern Monterey County to the Mexican border. This southern California IBI is more representative of reference conditions throughout the whole of the southern California area than was the original IBI, which was based only on data from streams in the San Diego region. The use of the more broadly applicable IBI follows the California Department of Fish and Game protocol. In addition, the Stormwater Monitoring Coalition is planning a number of efforts to improve the IBI's ability to monitor conditions in the urbanized coastal zone. These include developing an IBI for low-gradient urban streams, a perennial stream succession survey, and developing a regional bioassessment monitoring program for southern California. The Permittees participated in the regional monitoring program during the spring of 2009,

C-11.2.4.6 Evaluation of triad data

Evaluation of triad data (i.e., bioassessment, water chemistry, toxicity) is based on the framework developed by the Stormwater Monitoring Coalition's Model Stormwater Monitoring committee. This approach, which is described in detail in the SMC's report to the State Water Resources Control Board ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/419_smc_mm.pdf is based on a weight of evidence approach that compares each of the three legs of the triad against each other. **Table C-11.5**, drawn from the SMC's report, summarizes the types of conclusions that can be drawn from various combinations of triad results. Thus, there is no routine or standard method for evaluating triad data. However, the triad data from the bioassessment stations for the most part has resulted in relatively clear interpretations of causal factors for observed conditions.

Three additional analyses are included in this year's report to more thoroughly examine the relationships among the three legs of the triad. In actuality, there are four legs if the physical habitat data collected as part of the bioassessment protocol are considered separately from the biological community data.

1. Thresholds were established for each of the four data types (IBI, physical habitat, aquatic chemistry, and toxicity) in order to divide the range of values for each data type into four categories representing conditions from excellent to poor. IBI categories were based on the Fish and Game interpretation framework for these data types. The following thresholds for total physical habitat scores were used as the color scheme for the PHAB symbols on the maps showing the triad evaluation:

Color	CSBP (0-200)	SWAMP (0-60)
• Green:	160-200	48-60
• Blue:	120-159	36-47
• Yellow:	80-119	24-36
• Red:	<80	<24

   Aquatic chemistry thresholds focus on dissolved metals. At each station, the total number of CTR exceedances at each sampling time is divided by the total number of constituents (Cd, Cr, Cu, Pb, Ni, Ag, Zn) with relevant CTR acute criteria, resulting in a proportion for each station between 0 and 1.0. The exceedance proportion for each station is then indicated on a map of the sampling sites, according to the following color scheme:

   - Green: 0 - < 0.14
   - Blue: 0.14 - < 0.40
   - Yellow: 0.40 - < 0.75
   - Red: 0.75 – 1.0

   Toxicity categories are based on the number of toxicity tests that showed toxicity above 25% mortality in the undiluted sample of a multiple dilution test with invertebrates or fish (*Ceriodaphnia* or Fathead minnow chronic survival or *Hyalella azteca* acute survival) or, if the value for TUc was greater than 1 in the *Selenastrum* growth test. For each site, icons on a map of the monitoring sites representing the four data types are then colored green, blue, yellow, or red to summarize the overall range of conditions at each site.

2. All data from the bioassessment sampling program were analyzed for spatial and temporal patterns in the benthic invertebrate community. Two methods were used to describe spatial and temporal patterns in the benthic invertebrate community: cluster analysis and two-way coincidence tables.

   a. Cluster analysis defines groups of stations with similar community composition. The results are displayed in a hierarchical tree-like structure called a dendrogram. On the dendrogram, two groups are first defined, and within these groups subgroups are defined. Subsequently, subgroups within the subgroups are defined. This process is continued until all stations are a separate subgroup. The hierarchical nature of the dendrogram allows the analyst to choose groups of stations that represent a scale of community differences relevant to the present project. Cluster analysis is also used to define groups of species that tend to have similar distributional patterns among the stations.

b. A two-way coincidence table is the station-species abundance data matrix displayed as a table of symbols indicating the relative abundances of the species at the stations. The rows and columns of the table are arranged to correspond to the order of stations and species along the respective station and species dendrograms. Since similar entities (stations or species) will tend to be closer together along a dendrogram, the row and column orders will efficiently show the pattern of species over the stations and station groups.

   Since the rows and columns of the two-way coincidence table are ordered according to the dendrograms, the two-way coincidence table is also used to help delimit the station and species groups defined by the cluster analyses. At each potential separation of subgroups defined by the dendrogram, the two way coincidence table is examined to see the corresponding group differences in terms of species presences and abundances. This allows the analyst to choose groups with a level of community differences consistent with the goals of the project.

The specific steps are as follows:

- Preliminary biotic data transformation, using a square root transformation and standardization by species mean of values >0 (Smith, 1976; Smith et al., 1988) [1]
- Calculation of a Dissimilarity Index for cluster analysis of stations, using the Bray-Curtis Index, step-across procedure for dissimilarity >0.8 (Bradfield and Kenkel, 1987; Clifford and Stephenson, 1975; Smith, 1984; Williamson, 1978)[2]

[1] Smith, R.W. 1976. Numerical Analysis of Ecological Survey Data. PhD thesis, Univ. of S. Calif., Los Angeles. 401 pp.
Smith, R.W., B.B. Bernstein, and R.L. Cimberg. 1988. Community-Environmental Relationships in the Benthos: Applications of Multivariate Analytical Techniques. Chapter 11 In: Marine Organisms as Indicators. Springer-Verlag. New York: 247-326.

[2] Bradfield, G.E. and N.C. Kenkel. 1987. Nonlinear ordination using shortest path adjustment of ecological distances. Ecology 68(3): 750-753.
Clifford, H.T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York: 229 pp.
Smith, R.W. 1984. The re-estimation of ecological distance values using the step-across procedure. EAP Technical Report No. 2.
Williamson, M.H. 1978. The ordination of incidence data. J. Ecol. 66: 911-920.

- Calculation of similarities for cluster analysis of species, using flexible clustering (β=-0.25) (Clifford and Stephenson, 1975; Lance and Williams, 1967; Smith, 1982)[3]
- Creation of the two-way coincidence table (Kiddawa, 1968; Smith, 1976)[4].

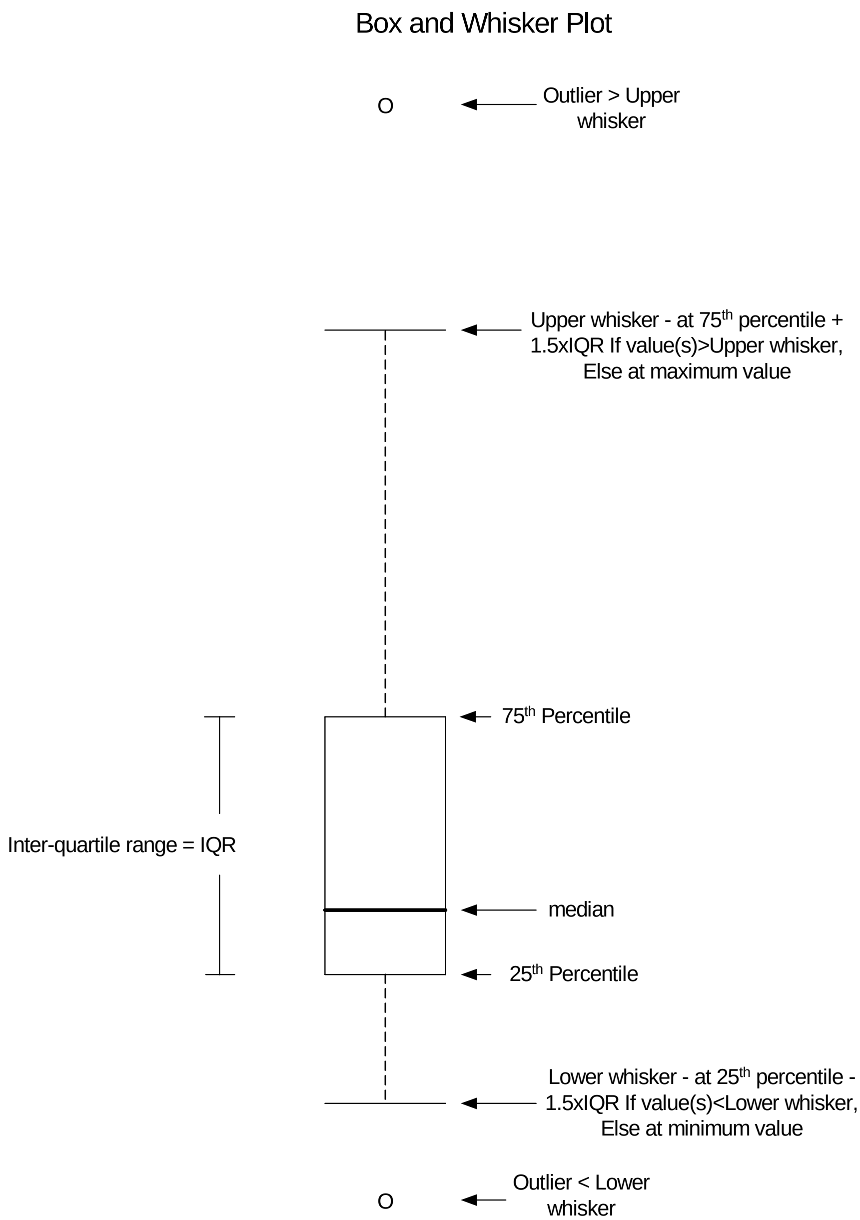
3. These patterns were then compared to potential explanatory variables (physical habitat, aquatic chemistry, toxicity) to identify potentially causative relationships among the different data types.Potential explanatory relationships between IBI scores and physical habitat, aquatic chemistry, and aquatic toxicity data were examined in more depth with the use of scatterplots, the development of a RIVPACs model, and correlations of the components of the physical habitat score with both IBI and the RIVPACs scores.

The distribution of the external parameters measured at each station/survey is described with box and whisker Plots (Tukey, 1977)[5], as illustrated in the example below:

[3] Clifford, H.T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York: 229 pp.
Lance, G.N., and W.T. Williams. 1967. A general theory of classificatory sorting strategies. I. Hierarchical systems. Computer J. 9: 373-380.
Smith, R.W. 1982. Analysis of ecological survey data with SAS and EAP. Proc. 7th Annual SAS Users' Group International (SUGI). SAS Institute Inc. P.O. Box 8000, Cary NC 27511: 610-615.

[4] Kikkawa J. 1968. Ecological association of bird species and habitats in Eastern Australia; similarity analysis. J. Anim. Ecol. 37: 143-165.
Smith, R.W. 1976. Numerical Analysis of Ecological Survey Data. PhD thesis, Univ. of S. Calif., Los Angeles. 401 pp.

[5] Tukey, J.W. 1977. Exploratory Data Analysis. Addison-Wesley, Menlo Park, CA. 506 pp.



C-11.2.4.7 Prioritization of Reconnaissance Sites for Source Identification

Concentrations of monitored constituents at dry weather reconnaissance sites are compared to the upper bounds (lower bound for dissolved oxygen) of tolerance intervals around the 90th percentile calculated from the set of random urban background sites. The concentrations are also compared to the limits from the site-specific control charts. These control charts are time series plots of each measurement at a site. The upper control limit for each measurement is set at 3.9 standard deviations above the mean of all measurements at the site. Instances in which data values for a specific contaminant exceeds either of these two qualifiers for two consecutive monitoring events are flagged for further source identification efforts to identify upstream sources of pollution.

C-11.2.4.8 Identification of Parameter Trends Associated With Land Use Change

Evaluation of monitoring data from the land use transition sites is based on an examination of trends described by graphical analysis. For each site, the data for specific groundwater and urban runoff markers are plotted against time. Where available, data from monitoring points upstream of the development are plotted on the same graph.

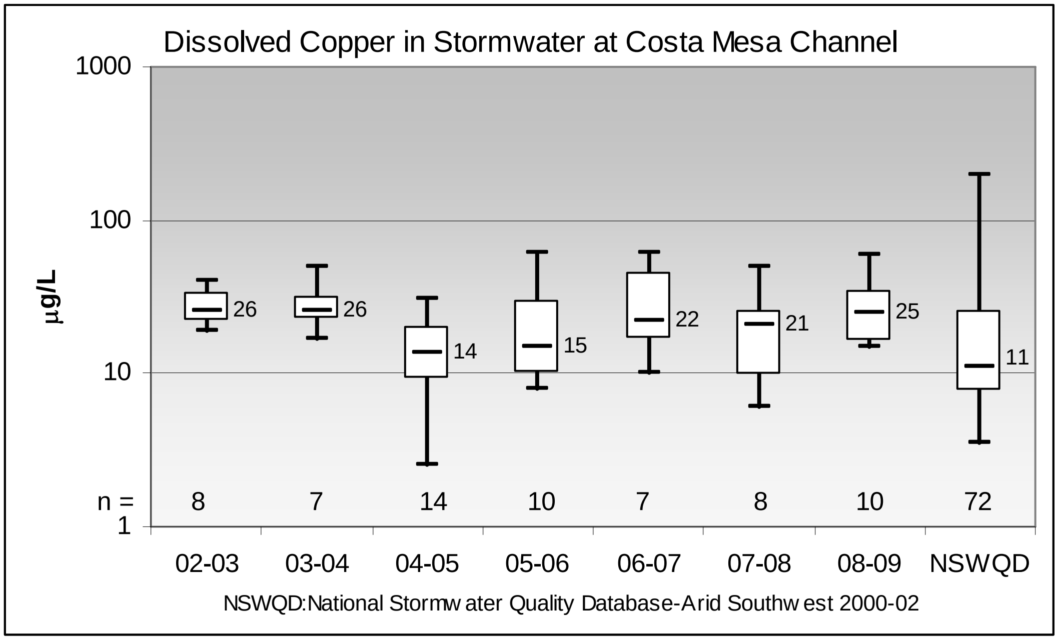
C-11.3 Analysis of Data

The following sections present data summaries and interpretations for each of the major monitoring program components.

C-11.3.1 Long Term Mass Loading

Mass loading monitoring is conducted for a wide range of constituents at the stations shown in **Figure C-11.1**. The intent is to monitor each station during three periods of stormwater runoff and during at least three dry weather periods. As can be seen by the annual rainfall summary in **Figure C-11.2**, this year's total, as the previous three years was less than the long-term average of 13.8 inches. The low rainfall total coupled with fact that nearly all the rainfall occurred prior to mid-February limited the opportunities for completing all of the intended stormwater runoff monitoring.

Water chemistry data from mass emissions stations are used to calculate loads and to assess water quality with respect to applicable acute and chronic toxicity criteria from the CTR. **Table C-11.6** contains the measured stormwater mass loads of nutrients and dissolved metals and **Table C-11.7** the corresponding flow-weighted event mean concentrations (EMC) of these constituents. The concentrations of dissolved metals in each composite sample collected in the Mass Emissions program element are compared to the acute toxicity criteria from the CTR. The time-weighted mean concentrations for periods spanning 3.5 days or more are compared to the chronic criteria. Both freshwater and saltwater criteria are used, depending on whether the monitoring station discharged directly to the ocean or an estuarine environment, and on whether there was another station further downstream. **Attachment C-11.II** presents all of these data and **Table C-11.8** summarizes the comparisons to the CTR criteria. Of the 82 samples collected during dry weather only 2 show an exceedance of the acute freshwater criteria for dissolved copper. Of the 93 stormwater samples collected, 19 show an exceedance of the acute freshwater criteria for dissolved copper and 4 show an exceedance of the acute freshwater criteria for dissolved zinc. Many of these exceedances are from samples collected in Costa Mesa Channel (7 of 12 samples for copper, and 4 of 12 for zinc). Since the CTR saltwater criterion for copper is very low (4.8 μg/L) compared to the typical hardness-adjusted freshwater criterion, exceedances of the saltwater criterion are relatively more frequent. This season, 21 of the 39 dry-weather samples and 39 of 43 stormwater samples exceed the CTR criterion for copper. The following graphic shows the annual statistics of dissolved copper in stormwater at Costa Mesa Channel. For reference, the statistics from Rain Region 6 (Arid Southwest – Arizona, southern and central California) of the National Stormwater Quality Database (NSWQD) are included. Only NSWQD data from 2000 and beyond were included in the analysis. As can be seen by the graphic, the annual median concentrations of dissolved copper in Costa Mesa Channel were greater than the regional median from the NSWQD.



The toxicity testing results for the mass emissions program element are contained in **Table C-11.9.** As was expected, the samples showing the greatest toxicity were collected during the first storm of the season on November 4, 2008. Grab samples were collected at eleven sites in the region and all show significant toxicity in the sea urchin fertilization tests with two yielding values for chronic toxicity units (TUc) equal to 16 and five sites showing values of TUc greater than 16. The mysid survival tests showed no to moderate toxicity with values for acute toxicity units (TUa) ranging from 0 to 1.02 units and values of TUc ranging from 1 to 8. The water chemistry analyses of these samples (**Attachments C-11.II** and **C-11-IX**) show levels of synthetic pyrethroid pesticides, dissolved copper, and zinc which may have contributed to the toxic responses. The following is a summary of the toxicity results and the possible contributory toxicants.

	Urchin	Mysid Survival			Diss Metals		Synthetic Pyrethroid Pesticides			
	Fert	Control Adjusted%			Cu	Zn	Bifen	Cyflu	Cyper	Perm
Site	TUc	48hr	7d	TUc	µg/L		ng/L			
BARSED	4	85	25	4	11	32	< 50	85	81	210
BCC02	> 16	100	76	2	13	42	< 10	< 10	< 10	< 10
CARB01	> 16	100	92	1	17	79	< 50	< 50	< 50	< 50
CCBA01	> 16	95	29	4	9.3	45	< 50	< 50	< 50	< 50
CICF25	> 16	49	3	8	15	66	< 50	< 50	< 50	< 50
CMCG02	16	90	45	2	35	87	< 10	< 10	< 10	< 10
EGWC05	> 16	100	76	2	10	36	< 50	< 50	< 50	< 50
FULA03	16	97	92	1	2.7	13	< 50	< 50	< 50	< 50
SADF01	4	74	53	2	22	81	< 50	100	110	< 50
SDMF05	4	97	97	1	1.4	2.7	< 50	100	100	240
WYLSED	4	100	100	1	14	77	< 50	84	88	210

Bifen=Bifenthrin; Cyflu=Cyfluthrin; Cyper=Cypermethrin; Perm=Permethrin

The dissolved zinc and copper levels most likely contributed to the observed effects in the sea urchin tests except for the samples collected at Fullerton Creek (FULA03) and San Diego Creek at Campus Drive (SDMF05). The toxicity testing with mysids show a significant amount of acute toxicity (<80% survival @ 48hr in the undiluted sample) in the samples from Central Irvine Channel (CICF25) and Santa Ana Delhi Channel (SADF01). Chronic toxicity is seen in the testing results from Peters Canyon Wash (BARSED), Coyote Creek (CCBA01), Central Irvine Channel, Costa Mesa Channel, East Garden Grove Wintersburg Channel (EGWC05) and Santa Ana Delhi. The observed toxicity to mysids can not be explained by the measured organophosphate pesticide concentrations. Of all of the OP pesticides analyzed, only Malathion was found above the laboratory's reporting limit, and at only one site (Peters Canyon Wash-50 ng/L). This level of Malathion is well below the literature value for LC_{50} (2200 ng/L, static/renewal, 96hr) in the mysid survival test. Significant amounts of synthetic pyrethroid pesticides can be seen in the water chemistry results from four sites in the Upper Newport Bay watershed. Interestingly, the site showing the greatest toxicity to mysids, Central Irvine Channel, does not show detectable amounts of either organophosphate or pyrethroid pesticides. The observed toxicity may be attributable to surfactants, an unmeasured pesticide or another organic compound.

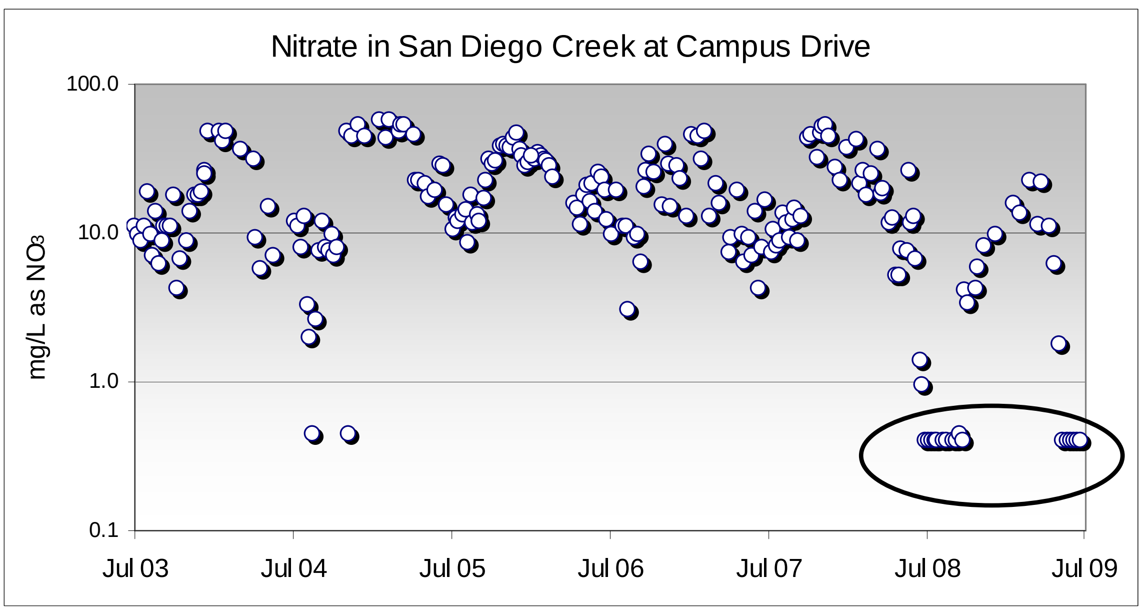
A summary of the chronic toxicity testing data from stormwater samples of mass loading sites during the last four seasons are presented in the table below. It appears that the greatest toxicity with respect to urchin fertilization was observed in samples collected during the 2006-07 season. The results for the *Ceriodaphnia* tests show no toxicity during the 2004-05 monitoring year but significant toxicity in the next two years. During the 2008-09 monitoring year, no toxicity was observed in the *Ceriodaphnia* survival tests but about a third of the samples showed a measureable effect in the reproduction tests. The mysid survival tests show similar percentages of toxic responses during the four years.

Year	Organism	Sea Urchin		Mysid		Ceriodaphnia		Fathead Minnow	
	Test type	Fert	Dev	Surv	Gwth	Surv	Repro	Surv	Gwth
05-06	samples	27	16	27	27	11	11	6	6
	TUc>1	17	6	10	5	0	0	1	2
	TUc>16	2	0	1	2	0	0	0	0
06-07	samples	21	21	20	20	21	21	6	6
	TUc>1	17	16	7	4	6	8	2	2
	TUc>16	10	3	0	0	0	0	0	0
07-08	samples	22	16	21	22	21	21	6	6
	TUc>1	10	2	5	5	4	6	1	0
	TUc>16	4	0	0	0	0	0	0	0
08-09	samples	27	27	27	27	17	17	0	0
	TUc>1	11	5	11	6	0	6	0	0
	TUc>16	5	0	0	0	0	0	0	0

The results of toxicity tests conducted on samples collected from mass emissions sites during dry weather conditions in the 2008-09 monitoring year are summarized in the table below. The results suggest that there was no consistent presence of substances at any site causing toxicity. Inspection of the data from the individual samplings in **Table C-11.9** revealed that toxic responses were generally not uniform among all of the test organisms for a given sampling. The sites that showed significant toxicity to two different organisms during a single sampling include BARSED (9/16/08), CICF25 (12/10/08), CMCG02 (9/16/08), SDMF05 (9/16/08), and WYLSED (12/10/08).

Site	Hyalella Surv%				Selenast		Ceriodaphnia				Fathead Minnow			
	Sed		Water			Gr		Surv		Rep		Surv		Gr
						TUc		48hr	7d	TUc		48hr	7d	TUc
	n	<80	n	<80	n	>1	n	<80	<80	>1	n	<80	<80	>1
BARSED	4	1	4	1	4	2	4	1	1	1	3	0	0	1
BCC02			2	0	2	1	2	0	0	0				
CARB01			2	0	2	0	2	0	2	0				
CCBA01			2	0	2	0	2	0	1	2				
CICF25			3	2	3	0	3	1	1	1	3	0	0	0
CMCG02			3	2	3	0	3	0	1	0	3	0	0	0
EGWC05			2	1	2	0	2	0	1	0				
FULA03			2	0	2	0	2	0	2	0				
SADF01	4	1	4	1	4	0	4	0	0	1	3	0	0	0
SDMF05	4	1	4	1	4	1	4	0	2	2	3	0	0	0
WYLSED	4	1	4	1	4	1	3	0	0	1	2	0	1	1

Dry weather monitoring for nutrients is conducted at the mass emissions sites in the San Diego Creek watershed as part of the Nutrient TMDL program. For this reporting year, the concentrations of nitrate in San Diego Creek at Campus Drive are the lowest ever measured with several values during the summer of 2008 and late spring of 2009 reported as below the detection limits of the laboratory. This dramatic reduction can be attributed to the seasonal operation of the IRWD treatment wetlands just upstream of Campus Drive. The following graphic shows the dry-weather nitrate concentrations at Campus Drive over the last 6 years.



C-11.3.2 Estuary / Wetlands Monitoring

The evaluation of estuary / wetlands monitoring data includes three distinct elements that will be reported separately. The first is a benthic sediment triad monitoring effort that took place in the fall of 2008. The analysis included a search for related patterns among the three data types (sediment chemistry, sediment toxicity, benthic infauna) sampled at the same time.

Benthic triad analysis, Fall 2008

Sediment monitoring at the estuary and wetlands stations (**Figures C-11.3a-b**) is based on the Triad approach, and includes benthic infaunal, sediment chemistry and toxicity analyses. **Attachment C-11.III** shows the sediment chemistry results and **Table C-11.10** the sediment toxicity testing results.

The Benthic Response Index measures the condition of a benthic assemblage with defined thresholds for levels of environmental disturbance (Smith et al. 2001, Ranasinghe et al. 2003, SCCWRP 2008). The pollution tolerance of each species is assigned based upon its distribution of abundance along a pre-established environmental gradient developed using hundreds of benthic samples collected from bays and harbors from the Mexican border to Pt. Conception. To give index values an ecological context and facilitate their interpretation, four thresholds of biological response to pollution are identified. These thresholds are based on changes in biodiversity along a pollution gradient. The reference threshold, below which natural benthic assemblages normally occur, are identified at an index value of <39.96; the point on the pollution vector where pollution effects first result in a net loss of species. **Table C-11.11** presents the benthic infauna community analysis for the Fall 2008 survey. **Table C-11.12** describes the BRI scoring ranges in terms of amount of deviation from reference conditions.

Attachment C-11.III shows that the concentrations of copper and mercury at the Rhine Channel sampling location (LNBRIN) in the Lower Newport Bay exceed the NOAA Effects Range Median (ERM) concentrations . Many sites in the Newport Bay, the Christiana Bay site in Huntington Harbour (HUNCRB), and the Bolsa Bay site near the tidegates of the East Garden Grove Wintersburg Channel (TGDC05) show concentrations of the DDT metabolite 4,4'-DDE above the ERM. Using SCCWRP's assessment method for marine sediments nearly every site except the Talbert Marsh (TBTMAR) and the Huntington Harbour location near Warner Avenue (HUNWAR) can be characterized as anthropogenically enriched with cadmium, copper and zinc.

The greatest amount of sediment toxicity (30.2% survival) from samples in the fall 2008 survey is seen in the results from Huntington Harbour near the mouth of the Bolsa Chica Channel (HUNBCC). This sample was by far the most toxic of any of the 32 collected throughout the reporting year in the region's harbors, bays, or marshes. All other samples show amphipod survival rates greater than 80%. The chemical analyses of the sediment from HUNBCC does not show any evidence of toxicants that could have contributed to the low survival rate. The State Water Quality Control Board's current effort to develop sediment quality objectives (SQO) for bays and estuaries has shown, using a large dataset from across the state, that the relationship between sediment chemistry and toxicity is very noisy at best. This is due to the fact that the bioavailability of contaminants in the sediment is highly variable and is affected by a number of poorly understood factors, making it extremely difficult to draw firm conclusions about the relationship between sediment chemistry and toxicity on a site-specific basis. The pending SQOs (Part 1 release date – 8/25/09) will provide a rigorous assessment framework for combining sediment chemistry, sediment toxicity, and benthic infauna data for site and water body assessment.

Figure C-11.4 and **Table C-11.13** provide a larger regional context for assessing toxicity results from the estuary / wetlands stations. They show that sediment toxicity in Newport Bay and Huntington Harbour / Talbert Marsh has been declining relative to toxicity found in the regional Southern California Bight surveys of harbors and marinas conducted in 1998 and 2003. The broader pattern of sediment toxicity, along with its potential sources, are discussed in the following section which addresses the entire set of sediment chemistry and toxicity results for the monitoring year.

The benthic infaunal analysis of sediment samples collected in the fall of 2008 (**Table C-11.11)** shows that the BRI scores at the two monitoring locations in the Bolsa Bay (BBOLR and TGDC05) fall within response level 4 indicating the benthic communities at these are sites were highly disturbed at the time of sampling. Three sites (LNBHIR, LNBTUB, and UNBCHB) score in the range of low disturbance and all of the other sites score in the range of moderate disturbance. The taxonomic data from each of the last four samplings were processed using SCCWRP's BRI assessment protocol and averaged to produce **Figures C-11.5a and C-11.5b**. As expected, the average scores from the two sites in the uppermost reaches of the Upper Bay (UNBJAM and UNBSDC) and the Rhine Channel (LNBRIN) are in the range of response level 4 – highly disturbed. The site in Bolsa Bay near the East Garden Grove Wintersburg tidegates (TGDC05) also shows an average BRI in the range of response level 4 as well.

Figure C-11.6 shows that there was no consistent relationship between BRI scores and sediment toxicity. The upper plot in **Figure C-11.6** shows that the regression for all the 2006-08 data from both locations is slightly positive, but not statistically significant. ($p > 0.05$). Regression lines calculated for each location separately (lower plot) are also non-significant. This suggests that effects on the benthic infaunal community may not be driven by sediment toxicity, but by other factors such as physical disturbance. It also suggests that simple sediment chemistry values do not reliably predict potential toxicity, except perhaps at the extremes. These relationships are currently under investigation as part of the State Water Resources Control Board's Sediment Quality Objectives project. The findings and guidance from that effort will be applied by the Program as they become available.

Additional sediment chemistry and toxicity analysis

As stated above, concentrations above the ERM value for the DDT metabolite 4,4' DDE were found in many samples from the harbors and bays. The data from the last four years at selected locations are presented graphically in **Attachment C-11.III**. Since September 2006, five of the six samples collected from Christiana Bay in Huntington Harbour, 12 of 13 samples from the Turning Basin in the Lower Newport Bay, and 8 of the 13 samples from Harbor Island Reach show concentrations of 4,4' DDE above the

NOAA ERM. In the Upper Newport Bay, the last two samplings at Unit Basin II (UNBSDC) and North Star Beach (UNBNSB) show concentrations of 4,4' DDE greater than the ERM.

Concentrations of metals and pesticides in benthic sediments are a function of the amount of fine particles in those sediments. The particle size distribution in sediment changes markedly near the mouths of flood control channels with increases in sands and coarser particles after large storms. The percentage of sand at these sites decreases with the deposition of predominately fine particulates during extended dry periods. **Attachment C-11.III** also contains a graphic that shows the relationship between particle size distribution and the concentration of copper in the sediments at the sampling sites in the Unit I Basin near the mouth of San Diego Creek (UNBJAM) and the Unit II Basin near the mouth of the Santa Ana Delhi Channel (UNBSDC).

This reporting year's summary of aqueous and sediment toxicity testing in the harbors, estuaries, and the Talbert Marsh are contained in **Table C-11.10**. The observed sediment toxicity at a sampling location can vary between monitoring years and during the same monitoring year . For example, the toxicity at Harbor Island Reach (LNBHIR) has shown a large reduction of toxicity since the first sample was collected in August 2005. The five samples collected between August 2005 and September 2006 all yielded *Eohaustorius* survival rates of 13% or less. The last seven samples collected between September 2007 and June 2009 however, show survival rates of 90% or higher. The Bight Program also documented some differences in sediment toxicity between the 1998 and 2003 surveys. **Figure C-11.7a and C-11.7b** show the results of two Bight Studies and this year's NPDES sampling in the Newport Bay and Huntington Harbour/Bolsa Bay/Talbert Marsh, respectively. **Figure C-11.7c** shows the trends in sediment toxicity at each of the NPDES sites over the last four years.

The patterns of sediment toxicity were compared to those for sediment chemistry over the course of the year to assess whether potential sources of elevated toxicity could be identified. From August 2006 to April 2008 ten sediment samples were collected from UNBJAM. All showed extremely high sediment toxicity (<14% survival) in the 10-day *Eohaustorius* survival test. This observed toxicity was consistent with the Bight '03 results from the same area.

The five samples collected between June 2008 and June 2009 however, all showed survival rates greater than 90%. Synthetic pyrethroid pesticides (specifically Bifenthrin) were the suspected toxicants in previous samplings. Samples collected from Newport Bay in May and June of 2009 were analyzed for synthetic pyrethroid pesticides and many of the samples had detectable levels of Bifenthrin and or Permethrin. The sample collected UNBSDC on May 5, 2009 contained 139 µg/kg of Bifenthrin and 99 µg/kg of Permethrin. The sediment toxicity measured for that date however was very low (96% control-adjusted survival).

The absence of toxicity in the last five samples from UNBJAM may have been related to the dredging that was conducted in the Unit I Basin between May 13 and June 20, 2008.

The dredging included the area where UNBJAM is located and the toxicants that were responsible for the observed toxicity in the prior samplings may have removed with the dredged sediments.

One station in the Lower Newport Bay has consistently shown values of sediment toxicity in stark contrast with Bight '03 data from the same general area. The Rhine Channel (LNBRIN) has produced results that would be characterized (Bight '03 criteria) as non-toxic to moderately toxic, but has exhibited the highest levels of copper, zinc, and mercury in the sediments of any Harbor monitoring location in Orange County. By contrast, the Bight'03 toxicity results for nearby areas in the Rhine Channel show high levels of toxicity. The results from the Bight '08 Regional Survey should provide valuable feedback with respect to the temporal differences in the toxicity of sediments in the Upper Bay and spatial inconsistencies in the Rhine Channel.

As noted above, this overall lack of consistency between sediment chemistry and toxicity is not surprising. The Bight Program, in both its 1998 and 2003 surveys, demonstrated that the Lower Newport Bay has the highest sediment toxicity of any embayment along the southern California coast. The Bight Program concluded that this toxicity was not due to usual sources such as metals, DDT/DDE, or PCBs, but to some unknown toxicant.

Aquatic chemistry and toxicity analysis

The estuary / wetlands program component also included both aquatic toxicity testing (with marine test organisms) and aquatic chemistry sampling. **Attachment C-11.IV** presents the overall aqueous chemistry results and **Table C-11.14** a summary of the numbers of acute CTR exceedances at each sampling station. **Table C-11.10** presents the aqueous toxicity testing results using marine test organisms.

Table C-11.14 shows that only 3 of the 36 samples collected during dry weather contained a dissolved metal which exceeded a CTR acute saltwater criterion. None of the 36 samples collected during the two storm samplings of Newport Bay contained metals exceeding CTR criteria.

Aquatic toxicity testing was performed on samples collected during two of the dry weather evaluations of Newport Bay the two evaluations of Huntington Harbour/Bolsa Bay/Talbert Marsh. In September 2008, minor effects were seen in the sea urchin fertilization tests on samples from the Upper Bay. Significant toxicity was seen in the chronic mysid survival tests on the samples from the Upper Bay. At UNBJAM, the sample was both acutely and chronically toxic to mysid survival. In December 2008, a significant but smaller amount of toxicity was observed in the chronic survival test for mysids for dry weather sample from UNBJAM. In the October 2008 testing, no toxicity was seen in any of the samples collected from Huntington Harbour, Bolsa Bay, or Talbert Marsh. In June 2009, however, significant toxicity was observed in both the acute and chronic mysid survival tests on samples collected from these areas.

The storm sampling of the Upper Newport Bay on December 15, 2008 showed significant toxicity in the sea fertilization, mysid survival, and mysid growth tests. The samples from the Lower Bay during this storm also showed significant toxicity in the mysid survival test. The samples collected from Newport Bay on February 6, 2009 showed negligible toxicity except for the sample from LNBTUB which showed significant toxicity in the mysid growth test.

The aqueous chemistry data collected on the days of toxicity testing were reviewed to assess the possible causes of toxicity. Nothing in the chemistry could account for the observed toxic responses. It appears that the toxic responses observed in the mysid tests were not the result of organophosphate pesticides or dissolved trace metals, but some unmeasured toxicant, perhaps a surfactant.

Graphical presentations of the aquatic toxicity testing data from the Harbor – Estuary – Marsh program element can be seen in **Figures C-11.7d - C-11.7h**.

C-11.3.3 Bacteriological / Pathogen Monitoring

Coastal and channel stormdrain monitoring took place at the sites shown on **Figure C-11.8**. The results of the bacteriological / pathogen monitoring are presented in **Attachment C-11-V** with exceedances of the AB411 standards in the surfzone highlighted in bold. The data do display substantial differences between stations in their relative frequency of exceedances of the AB411 single-sample standards, which are:

- Total coliforms: 10,000 cfu / 100 ml
- Fecal coliforms: 400 cfu / 100 ml
- *Enterococcus*: 104 cfu / 100 ml.

Table C-11.15 shows the proportion of all results exceeding AB411 standards in the receiving water upstream and downstream of coastal drains, and in inland channels, both for the entire year and for the AB411 season (April 1 through October 30). The proportion for each monitoring location is calculated as:

$$\frac{\text{Number of exceedances of a single sample standard}}{\text{Number of samples X number of analyses per sample}}$$

For a typical sampling there would be two samples (upcoast and downcoast) and three analyses (total coliform, fecal coliform, and *Enterococcus*) per sample. It should be noted that comparison of the water quality in the inland channels to the AB411 standards was only done for comparison purposes as the AB411 standards are for ocean water contact.

The results show that the proportion of exceedances was relatively low (0 - 4.4%) for the entire year along the coast with the greatest percentage observed in the surfzone near the outlet of Buck Gully Creek. It should be noted that despite showing minor exceedances of the Ocean Water Contact Standards in the surfzone near the Huntington Beach stormdrains (HB1-HB5), no discharges from these drains were observed commingling with the surfzone at the times of sampling. This would suggest that sources of bacteria in the surfzone were external and not related to urban runoff.

There does not appear to be any major differences in the proportion of exceedances between the entire year and the AB411 season. At some sites the percentages of exceedances are slightly higher in the AB411 season and at other sites the percentages are slightly lower. This information is presented visually in **Figure C-11.9** and **Figure C-11.10**, which show that spatial distribution of exceedance proportions. Coastal sites are consistently rated much cleaner than the inland channels. **Table C-11.16** shows that exceedances of AB411 standards are predominately for *Enterococci* in the surfzone and more equally distributed among the three indicators in the regional channels.

Each receiving water site is also evaluated by determining the proportion of sampled days on which at least one single sample standard was exceeded in the surfzone. The results are shown graphically in **Figure C-11.10a**. This method of ranking provides a better assessment of the health risks from water contact recreation in the surfzone near the outlets of each drain.

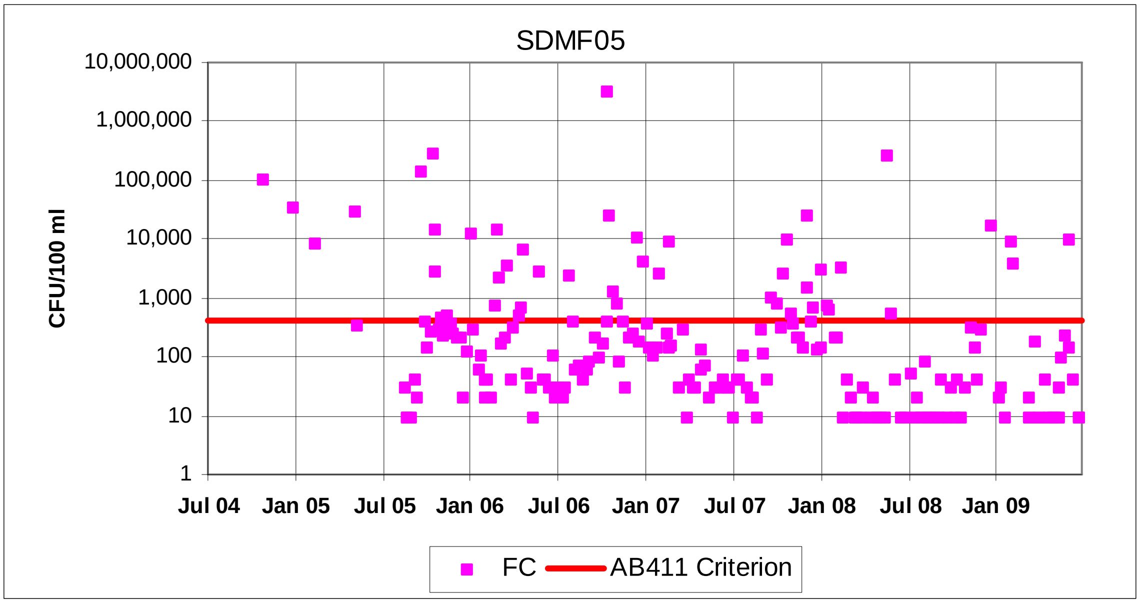
Table C-11.17 provides the average discharge rate, over the entire year, for each coastal stormdrain. The relationship between the proportion of exceedances (**Table C-11.15)** and the discharge rates is not strong except for the Buck Gully Drain which had the greatest average discharge and the highest exceedance proportion when considering the data from the entire year. The discharge rates from the monitored coastal stormdrains in the Santa Ana Region are lower relative to some of the larger monitored coastal channels (e.g. Aliso Creek, Salt Creek, and San Juan Creek) in southern Orange County. The coastal stormdrains at Huntington Beach (HB1 – HB5) discharge at the inland edge of the beach and these discharge points are separated by the width of the beach (about 100 yards) from the surfzone. Thus, except during large storms, the discharge is absorbed by the sand and does not reach the surfzone. The other coastal monitoring locations in the Santa Ana Region are coastal creeks that drain into Crystal Cove State Park. These creeks all flow over the edge of the bluff on the Newport Coast, into ponded areas on the beach which eventually drain to the surfzone.

Exceedances in the surfzone are sometimes, but not always, associated with elevated levels in the stormdrain itself. **Figures C-11.11** and **C-11.12** (prepared with data from the San Diego Region Coastal Stormdrain Outfall Program) illustrate analysis approaches used to systematically investigate the relationship between indicator concentrations in the stormdrain itself and in the receiving water, for both the entire year and for the AB411 season. **Figure C-11.11** is divided into segments that represent different likely conclusions about the extent to which the stormdrain discharge is causing elevated indicator levels in the receiving water. **Figure C-11.12** illustrates how linear regressions of the receiving water indicator values against those from the drains provide additional insight into the relationship between the drains and the nearby receiving water. (A complete set of these figures for all sites, indicators, and conditions can be found in **Attachment C-11.VI**.) **Table C-11.18a-b** ranks the drains in terms of the strength of this relationship, as measured by the significance, or "p" value, of the regression slope for the entire year and for the AB411 season. It is important to remember that a statistically significant regression is not, by itself, indicative of a potentially problem drain. A statistically significant regression must be combined with a relatively high proportion of exceedances, particularly in the AB411 season and a relatively high rate of discharge that reaches the surfzone.

Taken together, these analyses identified several overall patterns, including:

- Relatively low exceedance rates along the coast and high exceedance rates in inland channels;
- Similar exceedance rates for the entire year and for the AB411 season, for both the coastal drains and the inland channels;
- Exceedance rates for *Enterococci* tended to be greater than for the other two indicators; and

Data from **Tables C-11.15 - C.11.18a-b** and **Figure C-11.10a** indicate that during the 2008-09 reporting year, the discharges from the monitored coastal drains in this program have little impact on the surfzone. On the other hand, channel sites were uniformly contaminated, with very high exceedance rates. However, water contact recreation is either prohibited by the Orange County Flood Control District or extremely rare in these inland flood control channels. Despite the high exceedance rates in the regional channels, there has been an overall declining trend in fecal coliform bacteria at each location. Time series plots of fecal coliform concentration are included in **Attachment C-11-V**. The most dramatic reduction can be seen in the data from San Diego Creek at Campus as can be seen in the graphic below. Several values from early 2008 onward were reported as below the detection limit (<9 CFU/100 ml) of the laboratory.



C-11.3.4 Bioassessment

IBI Scores

Figure C-11.13 displays the bioassessment monitoring sites, which are sampled twice each year, in fall and spring. Spring sampling for bioassessment was conducted at four randomly selected sites as part of the Stormwater Monitoring Coalitions (SMC) Southern California Regional Monitoring Program. The target sites previously sampled for this watershed were eliminated. **Figures C-11.14** and **C-11.15** present the IBI scores for each bioassessment monitoring site (**Table C-11.19**). In the fall, scores range between Poor and Very Poor at all sites, including reference sites. Only station REF-SVC scores in the good range. Three of the sites sampled for the SMC were located in Silverado Canyon (SMC01155 and SMC26288) and on one of its upper tributaries (SMC00105). Site SGLR00670 is located in a concrete lined channel in the City of Fullerton.

IBI scores for each site from 2005 to 2008 were averaged and showed that all sites in the lower watershed scored in the Very Poor range, while each of the reference sites scored from Poor to Fair with Station REF-MC having the greatest average IBI score during the four-year period (**Figure C-11.15b**).

Spatial pattern analysis

In addition to describing patterns and trends in benthic invertebrate, a further purpose of the bioassessment program element is to determine whether physical habitat, aquatic chemistry, and/or toxicity are correlated with IBI scores. If strong correlations exist, then this would suggest a causal relationship. Last years report for the San Diego Region, which analyzed data from 2002 through spring of 2008, showed that there were no apparent correlations between IBI scores and either toxicity or aquatic chemistry. In contrast, there was a broad relationship between higher physical habitat scores and higher IBI scores. In addition, the pattern of several components of the physical habitat score mimicked patterns in the biological community across the region. An analogous approach was used for the Santa Region using data from 2005 to 2008 to search for such correlations among biological patterns on the one hand and aquatic chemistry, toxicity, and physical habitat on the other. The analysis consisted of three elements:

1. Spatial Distribution

   Broad patterns for each of the four types of indicator (i.e., IBI, physical habitat, aquatic chemistry, toxicity) were mapped. **Figures C-11.16a and C-11.16b** show the consistently low IBI scores across the urbanized portion of the County. The physical habitat scores (total of the scores from the 10 metrics) for these sites were in the fair to good range. As expected, the reference sites show much better IBI scores with physical habitat scores in the good range.

2. Relationship to Aquatic Toxicity and Chemistry

   Detailed monitoring data for bioassessment, aquatic chemistry, and toxicity were examined to determine whether there are any clear relationships among these at a finer level of detail. Toxicity data (**Table C-11.20**), from the fall 2008 sampling, show that there was significant toxicity (0-5% survival in undiluted samples) in the acute survival tests for *Hyalella azteca* at four sites (Bonita Canyon Wash-BCF04, Big Canyon Wash-BCWG04, San Diego Creek at Laguna Canyon Road-LCRF05, and Serrano Creek-UBPF19). Big Canyon Wash also showed significant toxicity (35% survival in undiluted sample) to *Hyalella* last year. The water chemistry data for the Bioassessment Program element can be found in **Table C-11.21**. The sample from BCWG04 contained Diazinon at a concentration of 68 ng/L. This level however, is well below the literature value (~4500 ng/L) for the LC_{50} in the 4–day survival test for *Hyalella azteca*. In the Spring 2008 survey at Serrano Creek, the organophosphate pesticide Dimethoate was present at a concentration of 1046 ng/L. This site also had a high concentration (1947 ng/L) of the same pesticide in the fall sampling in 2006. Although Dimethoate or other pesticides were not detected at UBPF19 during the Fall 2008 survey it is not unlikely that some type of unmeasured pesticide was present. The source of these pesticides is most likely a commercial nursery located upstream in the city of Lake Forest. The Dry Weather Reconnaissance Program has a monitoring site (LFF19S02@PB) just downstream of this nursery.

3. Biological Cluster Analysis

   A more powerful set of analyses was used to discern relationships between the biological patterns in the benthic community and patterns in potential explanatory variables in the toxicity, aquatic chemistry, and physical habitat data.

   As a first step, the species data from all surveys was clustered to identify groupings of sites that were similar in terms of their community composition. **Figure C-11.17** shows the cluster analysis of all sites during surveys conducted from the fall 2005 to spring 2009 and **Figure C-11.18** the two-way coincidence table of the relative distribution of species in each site at each sampling time. Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and sites, respectively. (Sites are identified by their site number, year of sampling and IBI score. Relative species abundances are shown as symbols. The abundance of each species was standardized in terms of its maximum at each site over all surveys. Smaller symbols represent a lower proportion of maximum abundance and larger symbols a larger proportion.)

   These two figures clearly show several dominant patterns. First, reference sites are concentrated at the upper end of the dendrogram, which is equivalent to station groups 1 and 2, located on the left side of the two-way coincidence table. Second, two lower watershed sites (BGH01 and BCWG04) grouped with the reference sites during the fall and spring surveys. Also, three of the four SMC stations sampled during 2009 (SMC00105, SMC01155 and SMC26288) grouped with the reference sites. These groupings indicate that the species composition and abundances at these sites were more similar to reference conditions than to sites in the lower watershed. This observation was in contrast to the IBI scores at BGH01, BCWG04 and SMC26288, which were much lower compared to the reference sites in the same cluster. Third, species with broader distributions across sites and times are concentrated in the lower half of the two-way coincidence table. Species with such broad distributions tend to be more pollution and/or disturbance tolerant. In contrast, species in the upper half of the two-way coincidence table have much more restricted distributions and in fact are found primarily at the reference sites. A closer examination of the species groups shown in the two-way table shows that species group A (concentrated in reference sites and upper watershed sites with relatively high IBI scores) is a diverse assemblage of several very sensitive types of organisms. Species group D (at the bottom of the two-way table) include moderately to very tolerant species characteristic of disturbed sites.

Correlation with physical habitat parameters

Variables measured during the surveys conducted from 2005-09 were then grouped into biological parameters (e.g., numbers of taxa, magnitude of toxicity), physical habitat parameters (e.g. elevation, bank stability), water quality parameters (e.g. pH, dissolved oxygen), and potential pollutant parameters (e.g. dissolved copper, Diazinon). The values of each parameter were then plotted for each cluster site group for the fall and spring surveys combined (**Figures C-11.19**), using box and whisker plots. "Group" on the x-axis of the box and whisker plots refers to the site groups from the dendrograms and two-way tables. The fall and spring survey data were combined for this assessment after review from previous years showed that seasonal trends were similar for each of the parameters.

The box and whisker plots (**Figures C-11.19a-d**) document that a subset of variables show consistent differences among the site groups and are therefore possible causes, or at least strong correlates, of the differences in community composition and IBI scores. The IBI score is strongly correlated with number of taxa. The two-way table (**Figures C-11.18**) shows that the reference sites near the left side of the tables have larger numbers of species. This is because they generally contain populations of both tolerant (widely distributed) and intolerant (narrowly distributed) species. However, toxicity did not differ in any consistent way across the site groups, in either spring or fall.

The pattern of physical parameters across site groups (**Figure C-11.19b**) varies depending on the parameter. A subset of physical habitat parameters differs markedly across the site groups. In general, physical habitat scores for channel alteration, embeddedness, instream cover, riffle frequency, riparian vegetation zone, sediment deposition and vegetative protection were better at reference sites and worse at the lower watershed, urban effected sites (**Figure C-11.19b**). This is expected because diverse biological communities, such as those found at the upper watershed reference sites, require undisturbed and relatively complex stream habitat, coupled with good vegetative cover on the banks. Of note is the strong relationship between watershed position and channel alteration. The reference sites (groups 1 and 2) had the least amount of alteration, the lower watershed sites, in cluster group 3, were moderately altered and group 4 was composed of sites where the channel had been completely changed from the original configuration. For this reason channel alteration was inversely related to bank stability since groups 4 and 5 sites were nearly all concrete lined channels and, therefore, completely stable.

Values for water quality parameters such as nitrate-nitrite, orthophosphate, specific conductance, TKN, total phosphorus and temperature were all somewhat greater at sites in the lower watershed cluster groups (3 and 4; **Figure C-11.19c**). Increased temperature is the result of the loss of vegetative canopy cover over the highly altered concrete channels found in the lower watershed. In addition, arsenic, copper and, to a lesser extent, selenium and zinc concentrations were elevated at the lower watershed stations compared to the reference sites (**Figure C-11.19d**). Increased metals and nutrients in the lower watershed are presumably the result of their accumulation from urban and agricultural runoff from the surrounding watershed. There was no clear trend in concentrations of the orthophosphate compounds measured.

The evaluation of four years of monitoring data in the Santa Ana Region shows that there is an apparent relationship between the biological community patterns and physical habitat parameters (e.g., channel alteration, riparian vegetation zone). This relationship has been observed in a number of other bioassessment programs, including the County's bioassessment monitoring in the San Diego Region and the San Gabriel River Watershed (LASGRWC 2008). On the other hand, strong relationships between the biological pattern and water chemistry have not been typically observed in other programs. The relationships observed here may be causal, or it may simply be due to the fact that chemical contamination and physical habitat alteration are highly correlated in urbanized environments. This issue will be investigated more thoroughly as more data become available.

C-11.3.5 Reconnaissance

The dry weather reconnaissance stations are shown in **Figure C-11.21**. The dry weather period (May 1 – September 30) does not precisely match the Program's reporting period (July 1 – June 30). The data from the entire 2009 monitoring year however will be presented as an Attachment to this report.

Approval of the Santa Ana Region monitoring programs by the Santa Ana Regional Water Quality Control Board in July of 2005 meant that during the reporting period, dry weather monitoring commenced in this portion of Orange County for the first time under the Third Term Permits in May of 2006. In the Santa Ana Region, there are 41 targeted sites and 10 random sites. The tolerance interval statistics from the San Diego Region are used for evaluating data from the Santa Ana program. A comparison of the stats from each region will be made before the next monitoring year begins. It appears from preliminary observations that there are differences between regions in the statistics for bacteria, nickel, and cadmium.

For reference, the dry weather program monitoring results from both regions for the reporting period are presented in **Attachment C-11-VII**.

C-11.3.6 Land Use Correlations

Table C-11.22 is a list of the monitoring locations and the type of landuses that are found in their respective watersheds. **Figure C-11.22** shows the locations of the monitoring sites. At one of the sites, the original monitoring location (e.g. HINF25d) is no longer sampleable because the earthen flood channel has been reconfigured to an underground drain. **Attachment C-11.VIII** presents the monitoring data collect during the current reporting year.

The primary purpose of this program element is to determine whether several different types of land use conversions are correlated with detectable changes in water quality downstream of the conversion.

During the past reporting year monitoring was focused primarily at the sites around the former MCAS Air Station in Tustin. The time-series plots of the dry weather concentrations of groundwater and urban runoff markers that were created for the 2006-07 report were updated.

The plots (**Figure C-11.23a-b**) show interesting patterns in the data, some of which can be explained as a function of seepage of groundwater into the stormdrain system and others as products of the development in the watershed or modification of the drainage system. Nitrate and selenium are used as markers of groundwater seepage into the stormdrain system. The concentrations of these two markers tended to show the same temporal pattern if groundwater seepage was present. Nitrate was also used as an indicator of activity in the watershed. It along with total phosphate, TSS, copper and zinc were used to track trends in urban runoff.

Figure C-11.23a presents the data from the Santa Ana-Santa Fe Channel which flows along the northern border of the former Tustin Marine Corp Air Station (MCAS-Tustin). The nitrate and total selenium plots show the persistent influence of groundwater seepage downstream of the former base (SASF10d) relative to upstream of the former base (SASF10u). The trace element data (copper, zinc, and selenium) show that this groundwater contribution is substantial. Note that the concentration of copper and zinc (urban runoff markers) are higher in upstream samples than in the downstream (SASF10d) samples. As in the previous year the selenium (groundwater marker) concentrations during the 2008-09 reporting year were generally more than an order of magnitude higher in the downstream samples.

Figure C-11.23b presents the data from the Barranca Channel which flows along the southern border of MCAS-Tustin. The nitrate and selenium concentrations at the location upstream of the project (TABF09u) were greater during the period from July 2007 to March 2008 relative to the previous six-month period. These high concentrations of selenium during this July 2007 to March 2008 period suggest that a dewatering discharge was occurring upstream of the study area. In the summer and fall of 2008 the upstream concentrations of nitrate and selenium were generally much lower than the downstream location suggesting that the dewatering discharge had ceased.

C-11.3.7 Additional Comparisons to CTR

Aquatic chemistry samples from several components of the water quality monitoring program (mass emissions, estuary / wetlands, bioassessment) are evaluated in comparison to thresholds established in the CTR. While such CTR thresholds are available for only a portion of the constituents measured in the program's samples, the combination of CTR exceedances from all available program components provides an overview of the patterns of potential impacts across the region.

Table C-11.23 summarizes exceedances of acute CTR criteria for all water quality monitoring stations in the Santa Ana region. For purposes of this assessment, all program components (mass emissions, estuary / wetlands, bioassessment) are combined into one dataset, in order to better represent the spatial pattern of exceedances across the region.

Exceedances overall are predominantly due to copper, with a much smaller percentage due to zinc. Exceedances of the CTR acute criteria for cadmium, lead, and silver were not found and thus not included in **Table C-11.23**. The greatest percentage of the exceedances of the freshwater CTR criteria during the 2008-09 monitoring year occurred at Costa Mesa Channel (CMCG02), with exceedances much more prevalent during wet weather. **Figures C-11.26** and **C-11.27** visually summarize these regional patterns, using the data presented in **Table C-11.23**.

C-11.3.8 Priority Pollutants and Other Analyses

The standard suite of analyses was expanded for grab samples that were collected from eleven the mass emissions sites during the first storm of the year. The additional analyses included priority pollutant metals, acid extractable organic compounds, base/neutral extractable organic compounds, polycyclic aromatic hydrocarbons (PAHs), and synthetic pyrethroid pesticides. Stormwater samples collected from mass emissions sites in December 2008, January 2009 and February 2009 were analyzed for synthetic pyrethroid pesticides in addition to nutrients and trace elements. The contract laboratory had difficulties with the matrices of the samples collected in November 2008 and as a result their reporting limits for semi-volatile organic compounds (SVOCs) were many orders of magnitude greater than in previous reports. Consequently SVOCs were all reported as not detected. **Attachment C-11.IX** contains the results of the analyses for trace elements, organochlorine pesticides, PCB Arochlors, and synthetic pyrethroid pesticides**.** Significant amounts of synthetic pyrethroids were found in some of the samples. There did not appear to be any persistent concentrations at any of the sites. The two samples from East Garden Grove Wintersburg Channel (EGWC05) collected on consecutive days (January 23-24, 2009) both showed significant amounts with the greater concentrations occurring near the onset of the storm.

In previous reports **Figure C-11.28** presented time-series plots of organo-phosphate pesticide concentrations in samples collected at Mass Emissions sites during dry-weather and stormwater runoff conditions. During this monitoring year a new contract laboratory performed the analyses and their reporting limits varied from 10 to 50 ng/L throughout the year. During the previous three years the values for the reporting limits were less than 5 ng/L. As a result, values below the reporting limits from the current year would appear as spikes in concentration on the long term time-series plots**.** Consequently **Figure C-11.28** will not be presented in this year's report. The following table is a summary of the sampling at the mass emissions sites

	n	Diazinon	Chlorpyrifos	Dimethoate	Malathion
Dry	77				
Storms	93				
Values >RL		3	6	0	56
Max detected		28	530		3200
Location		SICG03	CMCG02		CMCG02
Date		8/6/08	4/13 – 4/14/09		2/6 - 2/8/09
Type		Dry	Dry		Storm

Closer examination of the data yielded the following observations:

- The two highest concentrations of Chlorpyrifos were detected in dry weather samples from Central Irvine Channel (220 ng/L on 10/27 – 10/28/08) and Costa Mesa Channel (530 ng/L on 4/13 – 4/14/09);
- Malathion is the OP pesticide that most commonly detected at each site; Nearly all of the detectable amounts (55 of 56) were found in stormwater samples.

C-11.3.10 TMDL/303(d) Listed Waterbody Monitoring – Nutrient TMDL

The Nutrient TMDL's reporting process is now quarterly. Electronic copies of the reports from the last four quarters can be found on the Watershed and Coastal Resources website.

C-11.4 Summary

This was the fourth year of monitoring conducted for the Third Term Permit. This was also the fourth consecutive season with below-average rainfall. Consequently, opportunities to conduct stormwater runoff monitoring were limited. Despite the low rainfall total most of the intended stormwater monitoring was completed. The only major element that was not completed was the stormwater runoff monitoring in the Huntington Harbour, Bolsa Bay, and Talbert Marsh.

Although criteria from the California Toxics Rule (CTR) do not apply to stormwater comparisons to these criteria were made to provide insight into the results of toxicity testing of stormwater runoff samples. With respect to the **Long-Term Mass Loadings** program, the watercourses in which concentrations of dissolved metals in stormwater exceeded CTR acute criteria most often were the Costa Mesa and Santa Ana Delhi channels. In Costa Mesa Channel the criteria for copper in freshwater was exceeded in 7 of 10 stormwater samples.

Toxicity testing at mass emissions sites included both dry weather and stormwater runoff evaluations. Of the 223 tests that were conducted on samples collected under dry-weather conditions, 41 exceeded the threshold for significant toxicity (<80% survival relative to control or chronic toxicity units [TUc]>1). Note that the chronic survival tests for mysids, *Ceriodaphnia* and Fathead Minnow are just extensions of the acute tests but they were counted as two separate tests for each organism.

The toxicity testing of stormwater at mass emissions sites produced variable results depending on the time of year and site of the sampling. The first storm of the year expectedly produced the most toxic responses. Samples from 7 of the 11 sites during that November 4, 2008 event showed chronic toxicity units (TUc) greater than or equal to 16 in the sea urchin fertilization tests and 4 of the sites showed less than 50% survival (undiluted samples) in the chronic mysid survival tests.

The analyses for organophosphorus pesticides at the mass emissions sites continue to show that Malathion is the most commonly used OP pesticide. It was rarely found in dry weather samples (1 of 77) but frequently detected in stormwater samples (55 of 93). Supplemental analyses conducted on stormwater samples from Mass Emissions sites showed detectable levels of synthetic pyrethroid pesticides which are generally much more toxic than OP pesticides.

This year, the concentrations of nitrate in San Diego Creek at Campus Drive were the lowest ever measured with several values during the summer of 2008 and late spring of 2009 reported as below the detection limits of the laboratory. This dramatic reduction can be attributed to the seasonal operation of the IRWD treatment wetlands just upstream of Campus Drive.

The **Harbor Estuary / Wetlands** program component included both sediment and water quality analyses. None of the stormwater samples collected from the Newport Bay during two storms contained dissolved metals exceeding CTR criteria for acute toxicity. Three dry weather samples contained a dissolved metal (copper or zinc) that exceeded a CTR acute criterion.

The toxicity testing of dry weather samples from Newport Bay showed nominal toxicity in the sea urchin survival tests and significant toxicity in the mysid chronic survival tests for samples collected from the Upper Bay. As expected the greatest toxicity was seen in the samples collected from the uppermost station, UNBJAM in Unit Basin I. The dry-weather samples collected in Huntington Harbour, Bolsa Bay, and Talbert Marsh produced perplexing results. The samples from October 9, 2008 produced negligible toxic responses in the both the sea urchin and mysid tests. The samples from June 25, 2009 however, showed very high toxicity in the acute and chronic mysid survival tests. The results from the latter sampling are very unusual considering there was antecedent rainfall and the sites are not hydrologically connected. The water chemistry data could not explain these results either.

The stormwater samples from Newport Bay on December 15, 2008 showed significant toxic responses in both the urchin and mysid tests. The greatest toxicity was found in samples from the Upper Newport Bay. The stormwater samples from Newport Bay on February 6, 2009 showed only one significant toxic response, a value of greater than 16 chronic toxicity units in the mysid growth test for the sample collected in the Turning Basin of the Lower Bay.

Samples of sediment from the Rhine Channel in the Lower Newport Bay had concentrations above the Effects Range Median (ERM) values for copper, mercury, and the DDT metabolite 4,4′-DDE. Several other sites in the Upper and Lower Newport Bay and one location in Huntington Harbour (Christiana Bay – HUNCRB) also had concentrations of the same DDT metabolite above the ERM. Analyses of sediment toxicity during the last two years have shown only a few instances of highly toxic sediment (<50% survival in the 10-day amphipod survival test). During the current reporting year only one site (Huntington Harbour near the mouth of Bolsa Chica Channel – HUNBCC) produced a result that would be considered as highly toxic. One site (Upper Newport Bay at North Star Beach – UNBNSB) produced a result on the threshold of being considered moderately toxic. Samples from all other sites produced results in the non-toxic range. The sediment toxicity testing results from the last two years are in stark contrast with the results from prior years. One of the findings of the 2003 Southern California Regional Bight Survey was that Newport Bay contained the highest percentage of toxic sediment of any southern California marina.

The benthic infaunal analysis for 2008 showed that the Benthic Response Index (BRI) scores at the two monitoring locations in the Bolsa Bay (BBOLR and TGDC05) fell within response level 4 indicating the benthic communities at these are sites were highly disturbed at the time of sampling. Three sites (LNBHIR, LNBTUB, and UNBCHB) scored in the range of low disturbance and all of the other sites scored in the range of moderate disturbance. As was expected, the average scores from the last four years for the two sites in the uppermost reaches of the Upper Bay (UNBJAM and UNBSDC) and the Rhine Channel (LNBRIN) were in the range of response level 4 – highly disturbed. The site in Bolsa Bay near the East Garden Grove Wintersburg tidegates (TGDC05) also showed an average BRI in the range of response level 4.

Regression analysis of the BRI scores and toxicity testing data from the last four years shows that there was no consistent relationship between BRI scores and sediment toxicity. This suggests that effects on the benthic infaunal community may not be driven by sediment toxicity, but by other factors such as physical disturbance. It also suggests that simple sediment chemistry values do not reliably predict potential toxicity, except perhaps at the extremes. These relationships are currently under investigation as part of the State Water Resources Control Board's Sediment Quality Objectives project. The findings and guidance from that effort will be applied by the Program as they become available.

The **Bacteriological / Pathogen Monitoring** effort included sites both along the coastline and in inland channels. In the coastal receiving waters the exceedance rates of the AB411 Ocean Water Sports Contact Standards were similar for all three pathogen indicators. Along the coast, where the sampling design made it possible to assess the strength of the relationship between drain discharges and the receiving water, only the relationships for total coliform in the stormdrain discharge and the surfzone proved to be statistically significant. Two of the drains in the Crystal Cove area, Buck Gully Creek and Pelican Point Creek appear to impart the greatest effect on the surfzone. While the concentrations of indicator bacteria in the inland channels are very high relative to the coastal receiving waters, these sites are not commonly used for body contact recreation. Despite the high exceedance rates in the regional channels there has been an overall declining trend in fecal coliform bacteria at each location. The most dramatic reduction can be seen in the data from San Diego Creek at Campus Drive. Several values from early 2008 onward were reported as below the detection limit (<9 CFU/100 ml) of the laboratory.

The **Urban Stream Bioassessment** monitoring effort, in its fourth year, has continued to document the fact that biological communities are clearly impacted in the urbanized portions of the region. A simple graphical correlation analysis provided preliminary suggestions about potential causal mechanisms for these impacts. Several physical habitat parameters displayed the same pattern as the biological community, as did a few aquatic chemistry constituents such as copper. However, degradation of physical habitat and chemical contamination are highly correlated in this region and further analyses will be needed to tease apart the relative influence of chemical contamination and physical habitat. It is useful to note, however, that findings in several other bioassessment programs have identified the key role played by modifications to physical habitat in determining the pattern of IBI scores.

This was the fourth year of **Dry Weather Reconnaissance Program** and the data from some stormdrains in the monitoring network have identified persistent problems. The cities are kept up to date with immediate notification of obvious problems identified during the time of sampling and with monthly updates of the data from the entire program.

The data from the **Land Use Correlation Monitoring** is suggestive of development impacts, as indicated by trends observed in the urban runoff and groundwater markers. Some of the sites originally monitored are no longer accessible because the drainage system has been modified because of the development.

The data from the Santa Ana-Santa Fe Channel on the northeast side of the former MCAS-Tustin Air Station continue to show how the seepage of groundwater into the channel dramatically changes the water chemistry. The data from the upstream site (SASF10u) show low levels of nitrogen and selenium (the two groundwater markers) and levels of copper and zinc that are typical of dry-weather urban runoff. At the monitoring site downstream of the development, the nitrate and selenium concentrations were consistently higher but the copper and zinc concentrations were consistently lower than those from the upstream location.

C-11.5 Quality Assurance / Quality Control

During the middle of the reporting period the Principal Permittee relocated to a new facility in Orange, California. With that move was the construction of a larger and more modern laboratory. The additional space will allow more efficient sample processing and analysis as well as better quality assurance of Program data.

Overall the proportion of quality assurance samples grew from last year's 13%of sample submittals to 18% this year. The Annual QA/ QC Summary which describes the quality assurance (QA) sample type and percent breakdown are presented in **Attachment C-11-X**.

The Monitoring programs QA officer oversaw preparation and submittals of quality assurance (QA) samples to evaluate the quality of data produced by each of the three contractor laboratories and the Public Health Laboratory. The preparation included synthetic samples for accuracy which are comprised of aliquots of prepared standard solutions in ultra-pure (Nanopure) water matrices where the level of total dissolved solids (TDS) was adjusted with Ultrex grade sodium chloride to simulate comparable levels of TDS in environmental samples. Additionally, replicates of the environmental samples were also submitted to evaluate analytical precision.

Along with the previously described QA regime, the Dry-weather Reconnaissance monitoring staff routinely analyzed synthetically prepared standards to assess the quality of mobile laboratory measurements. Moreover, contractor laboratories supplied QA data relating to their respective internal quality control programs utilizing certified reference materials (CRMs), spiked and replicate samples analyzed along with county environmental sample batches.

The results of the quality assurance program are summarized in tabular and graphic form in **Attachment C-11-X**. Control charts were created to show the performance of the laboratories over the course of the monitoring year. The upper (UCL) and lower (UCL) control limits are shown on each of the control charts.

The results of the QA program show that:

- The precision of analyses for pathogen indicator bacteria were generally within the bounds of the control limits.
- The analyses for nutrients and trace metals in freshwater were generally good for precision.
- The precision of some analyses of samples with salt water matrices collected during storms was outside of the control limits especially lead, thallium,zincammonia, TSS and turbidity.
- Many of the recoveries in the analyses of Oil and Grease were consistently outside control limits. The Program will work with the lab to resolve this issue.
- Although the precision of organophosphate pesticides analyses was goodthe accuracy of analyses was inconsistent toward the end of the reporting year (June). This dip in performance coincided with a change in analytical services providers. The Program will work with the new contract laboratory to improve the quality of these analyses. If acceptable quality cannot be achieved an alternative vendor which can meet the requirements will be used.
- Some trip blank and equipment blank results showed slight contamination with trace metals possibly due to the use of de-inionized water rather than nanopure water when the Principal Permittee's ultrapure water system failed.

The accuracy of field chemical analyses in the Dry-weather reconnaissance programs was generally acceptable with the exception of the analyses for total chlorine and surfactants (MBAS). For San Diego region, the percent recovery for total chlorine analyses was consistently low (mid 60%) and there were 5 of 7 samples for which the recoveries for MBAS were below 75%. For MBAS, the Santa Ana region also had 6 of 8 samples below acceptable ranges.