C-11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

C-11.1 Introduction

In response to the monitoring and reporting requirements of the Fourth Term Municipal Stormwater Permit (R9-2009-0002, NPDES CAS0108740) from the San Diego Regional Board, the Permittees developed and implemented a water quality monitoring program. This monitoring and reporting program is an extension of the Third Term Permit program developed and submitted by the Permittees to the Regional Board in September 2011. The program is based on "The Model Monitoring Program for Municipal Separate Storm Sewer Systems (MS4) in Southern California" developed by the Stormwater Monitoring Coalition (SMC). The SMC is an organization of municipal stormwater agencies, Regional Boards, US Environmental Protection Agency (EPA) Region 9, NGOs, and the Southern California Coastal Water Research Project (SCCWRP).

This report presents the results of water quality monitoring, conducted between October 1, 2011 and September 30, 2012, in the portion of Orange County under the jurisdiction of the San Diego Regional Board. The report includes a number of attachments that provide supporting and supplemental information, as follows:

Attachment C-11-I – Includes maps of monitoring sites.

Attachment C-11-II – Includes monitoring data from the major monitoring program components.

Attachment C-11-III – Includes a history of the monitoring program and descriptions of monitoring and data analysis methods used to evaluate the water, sediment, and benthic infaunal taxonomy data collected in this monitoring program.

Attachment C-11-IV – Includes a summary of the quality assurance program for 2011-12.

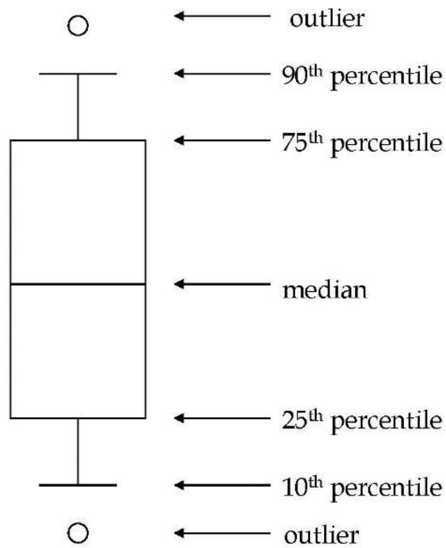
C-11.2 Analysis of 2011-12 Data

The following sections present data summaries and interpretations for each of the major monitoring program components. The approach for evaluating water quality monitoring data includes comparisons to benchmarks, as described in the Monitoring and Reporting Program and **Attachment C-11-III**, including as appropriate:

- Basin Plan Objectives for Inland Waters and Enclosed Bays
- CTR criteria for toxics and priority pollutants
- Shoreline recreational water contact objectives established by Assembly Bill 411 (AB411)
- Water Quality Control Policy thresholds for aquatic and sediment toxicity
- US EPA aquatic life benchmarks
- Southern California IBI for freshwater streams
- Reference stream thresholds from the SMC's Regional Watershed Monitoring Program

Data in this report are commonly presented using the box and whisker diagram to convey the distribution of data with respect to the specific analysis presented. An explanation of the various components of the box and whisker plot is provided in the following diagram.

Explanation of the Box and Whisker diagram



The analyses of monitoring data collected in 2011-12 are presented in the following in accordance with the Monitoring and Reporting Program from Attachment E of Order No. R9-2009-0002.

C-11.2.1 Long Term Mass Emissions Monitoring

C-11.2.1.1 Core Monitoring Program

Mass emissions monitoring is conducted primarily to estimate the total annual masses of a wide range of constituents which are transported by flood control drainage channels to receiving waters during both dry-weather and stormwater runoff conditions. Water chemistry and channel discharge rates are measured to compute loads for specific dry weather and wet weather events each year. Ideally, the total annual load of a selected constituent from a channel would be determined from a continuous monitoring of the water chemistry and discharge rate throughout the year. The cost for analytical services and monitoring labor requirements however, make the continuous analysis of aquatic chemistry cost prohibitive. Consequently, monitoring of aquatic chemistry is conducted during representative runoff conditions (dry-weather or stormwater runoff) and the information gathered is used to estimate the conditions throughout the year. The monitoring locations are shown in **Attachment C-11-I – Map 1.** The intent is to monitor each site during two periods influenced by stormwater runoff and two representative dry weather periods. The annual rainfall summary for Santa Ana, shown in **Figure C-11.1,** shows that this year's total of 8.27 inches was the fifth lowest total in the last 15 years.

Water quality data from mass emissions stations were used to assess stormwater mass loads, toxicity effects associated with runoff, and compliance with respect to acute and chronic criteria from the California Toxics Rule (CTR). **Attachment C-11-II - Table 1** and **Table 2** contains the measured flow-weighted event mean concentrations (EMC) of these constituents and stormwater mass loads of nutrients and trace elements, respectively. **Attachment C-11-II – Table 3** presents all of the data.

The concentrations of dissolved metals and total recoverable selenium 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. Freshwater criteria are used to evaluate channel discharges and **Attachment C-11-II – Table 6** summarizes the comparisons to the CTR criteria. Regional patterns of CTR exceedances during dry weather and wet weather conditions are presented in **Attachment C-11-1 - Table 2** and **Attachment C-11-1 - Table 3.**

Of the 38 composite samples collected during in 2011-12, exceedances of CTR criteria were limited to selenium, copper, and zinc.

Selenium

10 composite samples were collected during dry weather, 6 (60%) of which showed an exceedance of the chronic CTR criterion for total recoverable selenium. All of the dry weather samples showing exceedances of the selenium criterion were collected from Aliso Creek (ACJ01: 2 of 2 samples), Salt Creek (SC-MB: 2 of 2 samples), San Juan Creek at Highway 74 (SJC-74: 2 of 2 samples), Prima Deschecha Creek (PDCM01: 2 of 2 samples), and Segunda Deschecha Creek (SDCM02: 2 of 2 samples). The chronic CTR criterion for total recoverable selenium was exceeded in 6 out of 28 stormwater samples.

Copper and Zinc

0 of the 10 (0%) dry weather samples collected across the region showed an exceedance of the acute freshwater criteria (adjusted for water hardness) for dissolved copper.

Of the 28 stormwater-influenced composite samples collected, 1 (3.6%) showed an exceedance of the acute freshwater criteria for dissolved copper and 1 (3.6%) showed an exceedance of the acute freshwater criteria for dissolved zinc. On an annual basis during 2011-12, exceedances of the copper criteria were found in samples collected from Laguna Canyon Wash (LCWI02: 1 of 6 samples). On an annual basis during 2011-12, exceedances of the zinc criteria were found in samples collected from Aliso Creek (LCWI02: 1 of 7 samples).

Toxicity

Toxicity testing is also conducted on selected samples of dry weather and stormwater runoff and streambed sediments at mass emissions monitoring sites. **Attachment C-11-II – Table 4** presents all of the data.

Toxicity testing provides a cumulative perspective of pollutant effects on receiving water aquatic species. Results indicate that toxicity effects in receiving waters across the region were different between dry weather and storm events as shown in **Attachment C-11-I – Map 4** and **Attachment C-11-I – Map 5**. Samples were considered to be toxic if the organism response test results (i.e. survival, reproduction, or growth) were less than 80% effect. Toxicity was found occur in only 3 of 54 tests (6%) of dry weather samples in comparison to 9 of 54 tests (17 %) of stormwater samples collected from inland receiving waters. Sediment toxicity was not found in any samples collected during dry weather conditions.

The tests on the dry weather and stormwater runoff samples are conducted with freshwater and marine organisms. The tests involve a statistical comparison of the mean organism responses (e.g. survival, growth, reproduction, or fertilization rates) in a series of sample dilutions to the mean value of responses in laboratory control samples. The toxicity tests results for all samples analyzed during 2011-12 are contained in **Attachment C-11-II – Table 4.**

A summary of toxicity test result statistics for samples collected during dry weather is provided in the table below.

Dry Weather Tests Statistics	Mean	Min	Max
Ceriodaphnia dubia Reproduction	115%	85%	148%
Ceriodaphnia dubia Survival	102%	100%	111%
Ceriodaphnia dubia Survival 48 Hour	103%	100%	111%
Pimephales promelas Growth	117%	108%	126%
Pimephales promelas Survival	104%	100%	107%
Hyallela azteca Growth 7-day	>100%	39%	>100%
Hyallela azteca Survival 7-day	78%	13%	129%
Hyallela azteca Survival 96 Hour	101%	100%	105%
Selenastrum capricornutum Cell Density	104%	86%	136%

Receiving water samples collected during dry weather conditions, in general, did not show the presence of toxicity to most of the testing species. Organisms' response rates exceeded 80% for nearly all of the test species with the exception of *Hyallela azteca*. Dry weather samples collected on May 23, 2012 showed 7-day *Hyallela azteca* survival rates of 63% at Prima Deschecha Creek (PDCM01) and 13% at Segunda Deschecha Creek (SDCM02). The 7-day *Hyallela Azteca* growth rate was 39% at Segunda Deschecha Creek.

The toxicity test results for stormwater samples collected during 2011-12 were, as noted, slightly different from the dry weather samples statistics and are summarized in the table below.

Stormwater Tests Statistics	Mean	Min	Max
Ceriodaphnia dubia Reproduction	84%	6%	127%
Ceriodaphnia dubia Survival	91%	60%	100%
Ceriodaphnia dubia Survival 48 Hour	100%	100%	100%
Americamysis bahia Growth	82%	0%	109%

Stormwater Tests Statistics	Mean	Min	Max
Americamysis bahia Survival	74%	0%	103%
*Strongylocentrotus purpuratu*s Fertilization	99%	93%	102%

One hour composite stormwater toxicity samples were collected and tested from six sites on October 4, 2011 in the first flush of the first storm at Aliso Creek, Laguna Canyon Wash, Prima Deschecha Channel, San Juan Creek, Segunda Deschecha Channel, and Trabuco Creek. Toxicity testing was also conducted at the same six sites during the February 15, 2012 storm. Grab samples for toxicity testing with the marine organisms *Americamysis bahia* and *Strongylocentrotus purpuratu*s were collected from the surfzone at Prima Deschecha Channel and Segunda Deschecha Channel within 24 hours of the start of the rainfall. The results of the surfzone toxicity testing grab samples collected in 2011-12 are provided in the table below.

Feb. 15, 2012 Stormwater Tests Responses	PDCM01	SDCM02
Americamysis bahia Growth	74%	67%
Americamysis bahia Survival	80%	83%
Americamysis bahia Survival 48 Hour	95%	100%
*Strongylocentrotus purpuratu*s Fertilization	101%	101%

The results show that the most toxic responses were seen in the chronic *Americamysis bahia* survival and growth tests, the *Ceriodaphnia dubia* survival and reproduction tests, and the *Hyallela Azteca* survival and growth tests. None of the samples collected for the acute 48 hour tests were toxic and none of the samples for the *Strongylocentrotus purpuratus* fertilization were toxic. Of the 12 out of 108 tests conducted in 2011-12, toxicity was observed in 5 samples collected from Prima Deschecha Channel and in 4 samples from Segunda Deschecha Channel.

C-11.2.1.2 Regional Monitoring

No regional monitoring for the Long Term Mass Emissions Monitoring Program was conducted during 2011-12.

C-11.2.1.3 Special Studies

The standard suite of analyses was expanded to include additional organic compounds in some stormwater samples from the mass emissions sites. Stormwater samples collected from first flush and the first 24 hour intervals were analyzed for synthetic Pyrethroid pesticides. **Attachment C-11.II – Table 6** contains the results of the analyses for these compounds. The synthetic Pyrethroid pesticides were collected in combination with organophosphorus pesticides in order to evaluate the frequency of detection and range of concentrations.

Pesticide monitoring results from 2011-12 show that detection patterns continue to shift towards the use of pyrethroid pesticides as summarized in **Table C-11.1**. Overall, organophosphorus pesticides were detected in only 10% of all samples collected and showed significant seasonal differences. Chlorpyrifos and Diazinon were detected in only 1of 37 (2.7%) samples collected. Malathion continues to dominate the rate of detection for organophosphorus pesticides with nearly 35% of all samples collected during the 2011-12 monitoring year and was detected in 48% of samples from storm events.

The synthetic pyrethroid pesticide group was detected nearly three times more often that the organophosphorus pesticides during storm events. Amongst the pyrethroid pesticides constituents monitored, Bifenthrin was detected in 90% of samples, a ratio of nearly two to one over Malathion. The detection frequencies of the other pyrethroid pesticides ranged from 5.0% to 90% with Permethrin representing the second most frequent pesticide detected at a frequency of 60%. Concentrations in Bifenthrin ranged from <2 to 85 ng/L (parts per trillion) with an mean of 20 ng/L.

C-11.2.2 Urban Stream Bioassessment Monitoring

This section reviews results and findings from the 2011-12 reporting period of Urban Stream Bioassessment monitoring and continues the initiatives begun in the 2002-03 reporting period that assessed habitat quality in streams using multiple lines of evidence (e.g. chemistry, benthic macro-invertebrate assemblage, toxicity, and physical habitat analysis). While some data from prior years are presented in the discussion of trends more detailed information specific to past monitoring years can be found in each of the prior annual reports.

Bioassessment monitoring is a means of assessing the quality of aquatic habitat by evaluating the assemblage of benthic macro-invertebrates (BMIs). The State of California’s Surface Water Ambient Monitoring Program (SWAMP), in conjunction with the California Department of Fish and Wildlife developed the California Stream Bioassessment Procedure (SWAMP 2007) for the collection of BMIs and assessment of riparian physical habitat. Each site is rated with an Index of Biotic Integrity (IBI) score which is based on a statistical analysis of the distribution of organisms at a site. The scoring range is 0-100 with higher scores indicating a higher distribution of pollution-intolerant BMIs. Bioassessment is one of the multiple lines of evidence performed at each site. Water samples are also collected at each site and analyzed for aquatic chemistry (nutrients, metals, pesticides) and toxicity. The aquatic toxicity testing is performed with multiple organisms to evaluate the impacts of the chemistry on various life functions such as survival, growth, and reproduction rates. Each aqueous toxicity test is conducted with multiple dilutions (2 or more) of the sample to estimate the amount of toxicity present.

This year, monitoring included an assessment of the algae conditions using the EPA’s 1999 Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers[1] and SWAMP’s Incorporating Bioassessment using Freshwater Algae into California’s SWAMP.[2] This algae assessment includes a taxonomic analysis and calculation of biomass.

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[1] EPA, 1999. *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers*. EPA-841-B-99-002.

[2]Fetscher, E. A., and K. McLaughlin. 2008. Incorporating bioassessment using freshwater algae into California's Surface Water Ambient Monitoring Program (SWAMP). Southern California Coastal Water Research Project. Costa Mesa, CA

Four of the bioassessment sites in urban channels and one reference site were selected to evaluate sediment chemistry and toxicity. Sediment chemistry includes analyses of metals, particulate bound pesticides, pH, total organic carbon, total sulfide, ammonia, and particle size distribution. Acute and chronic toxicity testing of sediments is evaluated with *Hyalella azteca* as the test organism.

C-11.2.2.1 Core Monitoring

The core monitoring locations include seven targeted urban sites and three reference sites from the Third Term Permit. Monitoring is conducted once annually in the late spring after the rainy season to coordinate the urban site monitoring with the SMC Regional Watershed Monitoring Program (SMC Program). Collection of benthic macroinvertebrates (BMIs) is conducted according to SWAMP protocols.[3] Calculation of the IBI for each bioassessment is performed using guidance from "A Qualitative Tool for Assessing the Integrity of Southern Coastal California Streams" by Ode, et al. 2005.

Table C-11.2 lists the core bioassessment monitoring sites that were sampled in the spring of 2012. Both REF-BC (Bell Canyon Creek) and CC-CR (Christianitos Creek) were dry in 2012 and could not be sampled.

Four target sites were moved in 2011 from their historic locations to sites that were considered to more fully representative of the conditions of their respective watersheds. These locations were moved based on a number of major factors including 1) non-wadeable stream reaches, 2) physical constraints preventing a full 150-meter stream reach assessment, and 3) optimization of physical habitat conditions in order to assess urban runoff influence on benthic macroinvertebrate infaunal assemblages. The sites that were moved were located in Laguna Canyon Creek (LC-133 new), Aliso Creek (ACJ01 new), Salt Creek (SC-MB new), and Segunda Deschecha Creek (SD-AP new).

Figure C-11.2 presents the IBI scores for each bioassessment monitoring site during the spring of 2012. The IBI ratings of all of the urbanized lower watershed sites scored in the "very poor" range, similar to previous surveys. Regardless of whether these sites were cement lined or unlined, they are surrounded by urban development with roads and buildings near their banks. The four sites that were moved to new, upstream locations still scored in the "very poor" range, indicating that biotic conditions were still impacted.

Of the reference sites, Bell Creek in the Starr Ranch Audubon Sanctuary (REF-BC), Fremont Canyon Creek (REF-FC), and Trabuco Creek at Alder Springs (REF-TCAS), only REF-TCAS and REF-FC had flowing water in 2012. The IBI score at REF-TCAS of 61 was above the impairment threshold (39) in the "good" range (61). This site is located higher in the watershed in open space with little impervious surface. Site REF-FC, Fremont Canyon Creek, is located near Irvine Lake and drains an undeveloped canyon with open space land. In 2012,

[3] Ode, P.R.. 2007. Standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

this site had an IBI score in the "fair" range (56). This was an improvement over previous years when scores were below the impairment threshold (2011 IBI equal to 37). Even though the site had little channel alteration and good vegetative canopy cover, the poor score was attributed to the fact that the streambed had lower than ideal amount of good epifaunal substrate cover due to elevated sediment deposition and relatively high specific conductance (>2000 uS/cm) for an upper watershed site. The reasons for the improved biotic condition in 2012 at this site are not known, since each of the watershed condition and physical habitat factors above have remained relatively constant as shown in **Figure C-11.X**.

The physical habitats condition at sites monitored in 2012 are shown in **Figure C-11.X.** Results from the spring 2012 survey indicate that physical habitat conditions were similar between urban and reference streams. Physical habitat scores in urban streams sampled, in increasing order, were 10 in Trabuco Creek at Del Obispo Avenue (TC-DO), 18 in Salt Creek at Niguel Road (SC-MB new), 31 in San Juan Creek at Highway 74 (SJC-74), 32 in Segunda Deschecha Creek (SD-AP new), 39 in Aliso Creek (ACJ01 new), and 46 in Laguna Canyon Creek (LC-133 new). Reference streams physical habitat scores were 37 in Fremont Canyon Creek (REF-FC) and 44 in Trabuco Creek at Alder Springs (REF-TCAS).

Trabuco Creek at Alder Springs is considered an alternate reference stream during survey periods when the preferred reference streams of Christianitos Creek (CC-CR) or Bell Canyon Creek (REF-BC) are dry. Open space in Orange County is limited and therefore an attraction for people seeking outdoor activities. This level of attraction in concert with the limited amount of open space streams makes finding a quality reference stream site for monitoring a challenge. At least two of the historically monitored reference streams, San Juan Creek at Cold Springs (REF-CS) and Trabuco Creek at Alder Springs (REF-TCAS) have shown the presence of considerable human activities during early season site reconnaissance and follow up visits.

The net effect of annual rainfall totals on benthic macroinvertebrates assemblages is unclear as suggested in **Figure C-11.X**. Reference streams, which typically lack significant anthropogenic influences, show considerable variations in IBI scores that appear to be coincident with annual rainfall totals. Reference sites have shown increases in IBI scores following an above average rain year while also showing decreases in IBI scores during below average rain years. It is very difficult to specifically determine if these changes are associated with stream flow rates or whether confounding factors are influencing the scores. The influence of the 2007 wild fires may have had a significant effect on the local reference streams. Many of the high quality local streams used for assessing reference thresholds are also subject to human activities.

C-11.2.2.2 Regional Monitoring

The Permittees, with assistance of Regional Board staff, began participation in a Regional Monitoring Program sponsored by the SMC (SMC Program) and managed by SCCWRP in 2009. This program was designed to assess stream health using the resident stream benthic macroinvertebrates to determine the water quality conditions within a stream reach. The SMC Program is based on a probabilistic sampling design that will allow for the ambient condition of streams in the southern California to be assessed for the first time allowing comparisons among stream systems, watersheds and by land use. The goal of this multi-agency, five year study is to 1) determine the status of macroinvertebrate conditions across southern California streams, 2) identify key stressors that affect stream macroinvertebrate conditions, and 3) monitor receiving water stressors over time. Stream monitoring sites are stratified by urban, open space, and agricultural land uses to provide a better assessment across stressor gradients from chemical, biological, and physical influences.

During the 2011-12 year, the Permittees continued to participate in the SMC Program. The 2012 sampling effort was the fourth year of the five year study to assess stream macroinvertebrate conditions across southern California. The details of the SMC Program and results of the 2009 sampling effort can be found in:

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/639_SMC_StreamsYear1.pdf

All bioassessment and physical habitat sampling was conducted according to SWAMP protocols which can be found at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/phab_sopr6.pdf

In addition to the SWAMP in-stream physical habitat condition measurements, the SMC Program also specifies that the California Rapid Assessment Method (CRAM) be conducted at each site. This protocol provides an assessment of not only the instream habitat condition, but also of the buffer zone surrounding the site as well as the condition of the hydrology and biotic structure of the riparian zone. Details of the CRAM assessments can be found at:

http://www.cramwetlands.org/

In order to conduct a 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. Aqueous toxicity is evaluated using the freshwater organism, *Ceriodaphnia dubia*,

Each site is evaluated in terms of a series of metrics (**Attachment C-11-III)**, which are then scored 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 representative of reference conditions throughout the whole of the southern California area. Data were analyzed as follows:

- 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.
- 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 River Invertebrate Prediction and Classification System (RIVPACS) model, and correlations of the components of the physical habitat score with both IBI and the RIVPACs scores.

IBI and Physical Habitat Scores

Attachment C-11-I – Table 11 and **Table C-11.5** provide the bioassessment monitoring sites sampled during the May to July 2012 index period. Samples collected in 2012 represented the fourth year of this survey for the Permittees. A total of two sites were visited in 2012, one of which was sampled twice as part of the QA/QC program for the SMC. A contract laboratory conducts the bioassessment sampling and taxonomic analyses on behalf of the Permittees.

Monitoring results from the 2012 regional bioassessment program survey are presented in **Table C-11.3** and **Figure C-11.2** which provide the IBI scores, physical habitat and CRAM conditions. Scores were in the "Poor" range at both sites, with the duplicate sample at Aliso Creek in the "Very Poor" range. This shows the large sampling variability that can be present in these samples. These sites were located in the urbanized lower watershed of their streams, where scores of this magnitude are common. The stream macroinvertebrate conditions of receiving waters as determined by IBI scores during the 2012 monitoring period are provided in **Table C-11-3.** IBI scores for urban sites sampled ranged from 7.15 to 21.45 and the scores are consistent with urban sites sampled during the prior years of the SMC Program.

The physical habitat conditions for each of the SMC Program sites were assessed using three attribute scores (sediment deposition, epifaunal substrate, channel alteration) that, together are summed to a total score ranging from zero (poorest condition) to 60 (best condition). None of the sites scored above 25 on this scale indicating relatively poor habitat conditions. Even the best site (SMC03438 described above) still had poor habitat conditions. CRAM scores for each site also showed poor habitat quality with scores for each site less than 50 on a scale of 100. Of note is that site SMC03438 in Carbon Canyon had the highest CRAM score. CRAM assessment is important in determining stream health since it evaluates not only the condition of the stream bed habitat, but also the condition of the buffer zones surrounding the riparian zone out to 250 meters on either side of the stream. The biotic condition at the site in Carbon Canyon was most likely the result of the open space available in the nearby buffer zone.

Spatial pattern analysis

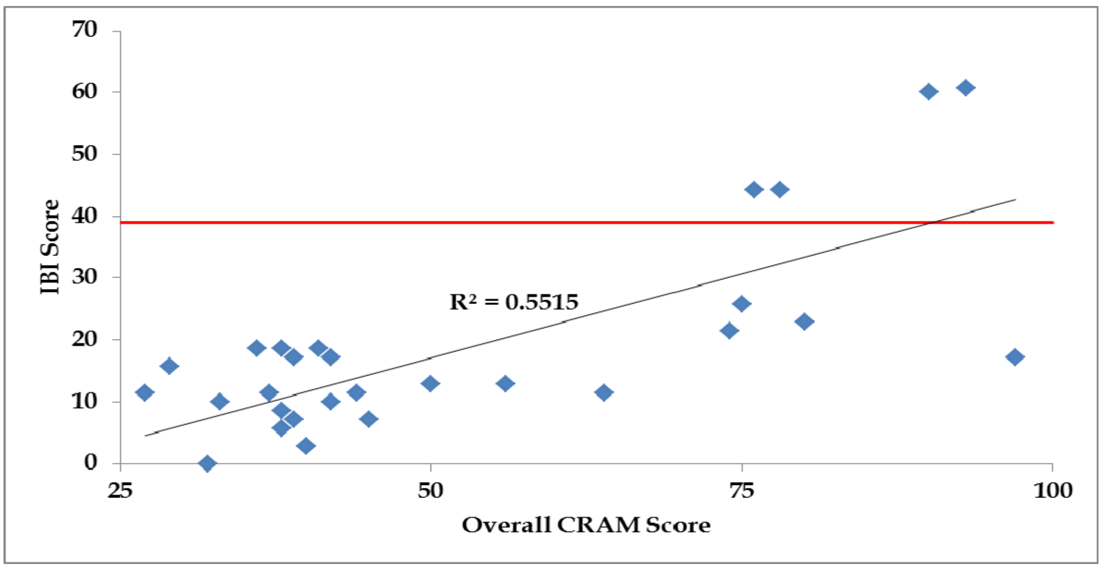
In addition to describing patterns and trends in benthic invertebrates, a further purpose of the SMC Program is to evaluate the monitoring triad to determine whether physical habitat, aquatic chemistry, and/or toxicity are correlated with IBI scores. The spatial patterns of conditions in the 2012 are provided in **Attachment C-11.II - Table 12.** If strong correlations exist, then this would suggest the presence of a causal relationship between the various stressors and biological integrity.

The spatial pattern 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. **Figure C-11.X** shows consistently low IBI scores across the urbanized portion of the County (IBI ≤ 39). Sites in the upper watershed, east of Irvine Lake, had IBI scores that were ≥ 40 indicating the biological communities found there were similar to those found at reference sites in the southern California region.

   The CRAM scores for these same sites showed a very similar pattern, with the poorest habitat scores associated with sites in the highly urbanized lower watershed and highest scores associated with sites in the upper watershed, especially east of Irvine Lake (**Figure C-11.X**). There was a strong association between IBI and CRAM scores ($R^2 = 0.55$) in these watersheds as shown in the figure below.



   Of note were a few sites that bordered the upper watershed where the CRAM scores indicated relatively good habitat conditions, but the IBI scores were slightly elevated and still below the threshold of 39 (SMC03438, SMC1822, SMC2422). This was especially true at site SMC26288, on a tributary to Irvine Lake, where the CRAM score indicated good habitat conditions, but the IBI score was in the "Very Poor" 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.

   Past reports adopting this method of analysis 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.

Additionally, the patterns of several components of the physical habitat score mimicked patterns in the biological community across the region.

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 were clustered to identify groupings of sites that were similar in terms of their community composition. **Figure C-11.3** shows the cluster analysis of all sites during surveys conducted from 2009 to 2012 and **Figure C-11.4** shows 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 and year of sampling. The average IBI score for the station group is provided. 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, sites that are at or near reference conditions based on the southern California IBI are concentrated at the lower end of the dendrogram, which is equivalent to station Group 4, located on the left side of the two-way coincidence table. These sites are almost exclusively located in the upper watershed above Irvine Lake (**Figure C-11.X**). An exception to this was station SMC03438 which was also located in the upper watershed, but in Carbon Canyon. This site had relatively good habitat conditions based on CRAM, but an IBI below 40. Inclusion of this site with Group 4 indicates that while impacted, the basic composition of species at this site is similar to reference sites.

Second, three sites located on the Santa Ana River (SMC05230, SMC24222 and SMC21822) fell into Group 3 which had species composition that was more similar to the upper watershed Group 4 sites than sites in the lower watershed (Groups 1 and 2). Each of these sites is located where the Santa Ana River is a low gradient, natural bottom wash. The IBI scores at each of these sites are slightly better than other lower watershed sites, but still below the impairment threshold. The riparian zones on either side of these reaches are surrounded by residential and industrial land use and, as a result, the habitat quality is not optimal for benthic macroinvertebrate communities.
Third, there is no clear clustering of sites based on sample year. This indicates that annual variability in weather conditions is not driving the composition and abundances of taxa in the watersheds.

Finally, species with broader distributions across sites and times are concentrated in the upper three species groups (Groups A, B and C) on the two-way coincidence table. Species with such broad distributions tend to be more pollution and/or disturbance tolerant. In contrast, species in the lower two species groups (Groups D and E), half of the two-way coincidence table have much more restricted distributions and in fact are found primarily at the upper watershed and Santa Ana River sites. A closer examination of the species groups shown in the two-way table shows that species Groups D and E contain a diverse assemblage of several sensitive types of organisms. Species Groups A, B and C (at the top of the two-way table) include moderately to very tolerant species characteristic of disturbed sites.

Correlation with parameters

Variables measured during the surveys conducted from 2009 to 2012 were then grouped into biotic condition (e.g. IBI scores), physical habitat parameters (e.g. channel alteration), water quality parameters (e.g. pH, dissolved oxygen), nutrients, potential pollutant parameters (e.g. dissolved metals) and ions (e.g. chloride). The median values of each parameter were then plotted for each cluster site group using box and whisker plots. "Cluster Group" on the x-axis of the box and whisker plots refers to the site groups from the dendrograms and two-way tables.

The box and whisker plots show the biological condition of each cluster group as determined by the median IBI score (**Figures C-11.5** to **C-11.6**). Median IBI scores were above the threshold of 39 for Group 4 which were the sites located in the upper watershed east of Irvine Lake. Median IBI scores were below the 39 threshold in Groups 1, 2 and 3. These groups included all stations located in the lower watershed. IBI scores were somewhat better in Groups 2 and 3 than Group 1.

Physical habitat parameters differed markedly across the site groups. In general, physical habitat scores for channel alteration, in stream cover, and sediment deposition were better at reference sites and worse at the lower watershed, urban sites (**Figure C-11.X**). 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 sites with the greatest median IBI scores (Group 4) had the least amount of alteration, the lower watershed sites, in Group 3 (Santa Ana River), were moderately altered and Groups 1 and 2 were composed of sites where the channel had been completely changed from the original configuration.

Dissolved metal concentrations for arsenic, copper, zinc and, chromium concentrations were elevated at the lower watershed stations compared to the reference sites (**Figure C-11.X**). Increased metals and nutrients in the lower watershed are presumably the result of urban and agricultural runoff from the surrounding watershed. Nutrients were somewhat elevated in the lower watershed (Groups 1 and 2) compared to the upper watershed sites (**Figure C-11.X**). This was especially true for cluster Group 3 which was greater in ammonia, TKN, orthophosphate, and total phosphorus.

Values for physical chemistry parameters such as water temperature, dissolved oxygen and pH were slightly elevated at the lower watershed site groups which is most likely associated with the reduction in canopy cover in highly urbanized areas. Several parameters were similar across sites and Groups including hardness, conductivity (EC) and total suspended solids (TSS) except at site Group 3 in the Santa River where TSS was much greater than all other groups.

The evaluation of four years of SMC Program 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 and instream cover). 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 2010). On the other hand, strong relationships between biological patterns 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 concentrations and physical habitat alteration are highly correlated in urbanized environments. This issue will be investigated further as more data become available.

C-11.2.2.3 Special Studies

A special study initiated during 2011-12 focused on evaluating synthetic Pyrethroid pesticides in sediments to better understand the linkages between potential toxicity effects and changes in the biological communities of streams. The special study results have been transferred to SCCWRP and will be included as part of the overall data analysis and future reporting from SMC Program.

A second special study implemented during 2011-12 focused on evaluating sediment toxicity during dry weather using the 10 day *Hyallela azteca* survival in sediment test. Sediment toxicity samples were more than 100% survival in samples collected from four urban sites that were Aliso Creek (ACJ01), San Juan Creek at Highway 74 (SJC-74), Salt Creek (SC-MB), and Segunda Deschecha Channel (SDCM02). Sediment toxicity samples collected were also collected from one reference site in Fremont Canyon (REF-FC) that did not show the presence of toxicity.

C-11.2.3 Ambient Coastal Receiving Waters Program

C-11.2.3.1 Core Monitoring Program

Ambient Coastal Receiving Water (ACRW) monitoring is conducted to assess the impact of dry weather and wet weather discharges into the surfzone from stormdrains that may affect coastal ecological habitats along the south Orange County coastline. **Figure C-11.X i**s a map showing the locations of the monitoring sites. Monitoring includes both toxicity testing (with marine test organisms) and analyses of water chemistry. ACRW monitoring during the 2011-12 reporting period was conducted in coordination with watershed monitoring through either the Long Term Mass Emissions or Urban Stream Bioassessment programs, to the extent feasible. Additionally, core monitoring for the ACRW program was conducted exclusively at each discharge point (creek or stormdrain) that had a hydrologic connection to the surfzone. A reconnaissance effort was conducted before each dry weather monitoring event to confirm if a hydrologic connection existed or whether storm drain discharges were diverted to the local sanitation district. **Table C-11.10** presents the standard aqueous chemistry results from sites samples during the 2011-12 monitoring year. The aqueous chemistry results include additional analyses for synthetic Pyrethroid pesticides during stormwater runoff events. **Table C-11.11** presents the results of toxicity testing results for samples collected during dry weather and wet weather conditions.

There were no exceedances of CTR saltwater criteria for dissolved metals in the surfzone receiving waters during dry weather or stormwater runoff conditions. Receiving waters did not contain any detectable amounts of the organophosphate pesticides. Bifenthrin was the only synthetic Pyrethroid pesticide detected and was measured in only one surfzone sample during the November 12, 2011 storm event at a concentration of 2.5 ng/L (parts per trillion).

Aquatic toxicity was evaluated on dry weather and stormwater runoff influenced samples with four toxicity tests with marine organisms: the purple sea urchin (*Stronglyocentrotus purpuratus*) fertilization test, the mysid shrimp (*Americamysis bahia*) 48 hour and 7 day survival and growth tests. Testing results were considered to be toxic if the organism response result (i.e. survival, reproduction, or growth) was less than 80% effect.

A summary of toxicity test result statistics for samples collected during dry weather is provided in the table below.

Dry Weather Toxicity Test Statistics	Mean	Min	Max
Americamysis bahia Growth test	94%	85%	100%
Americamysis bahia Survival test	97%	95%	100%
Americamysis bahia Survival, 48 Hour test	100%	97%	102%
*Strongylocentrotus purpuratu*s Fertilization test	97%	94%	102%

Stormwater runoff-influenced samples were collected on November 12, 2011 and on February 15, 2012. A summary of the toxicity organism responses statistics during wet weather is summarized in the tables below.

Stormwater Toxicity Test Statistics	Mean	Min	Max
Americamysis bahia Growth test	89%	67%	143%
Americamysis bahia Survival test	87%	74%	103%
Americamysis bahia Survival 48 Hour test	98%	90%	112%
*Strongylocentrotus purpuratu*s Fertilization test	97%	79%	101%

18 samples were collected resulting in a maximum of 63 tests conducted using the four different tests organism responses. The integrated results of toxicity during dry weather are shown in **Attachment C-11-I – Map 4** and during wet weather are shown in **Attachment C-11.I – Map 5.** Overall, aquatic toxicity (<80% effect) occurred in 0 of 24 (0%) tests conducted with dry weather conditions and occur during conditions affected by stormwater toxicity in 6 of 39 (15%) tests. The toxicity testing results were delineated by testing organism and by site as follows:

Toxicity Results by Organism	Dry Weather	Storm Event
Americamysis bahia Growth	0 of 5	4 of 10
Americamysis bahia Survival	0 of 5	1 of 10
Americamysis bahia Survival 48 Hour	0 of 5	0 of 9
*Strongylocentrotus purpuratu*s Fertilization	0 of 9	1 of 10

Toxicity Results by Site	Dry Weather	Storm Event
Aliso Creek (ACM1)*	0 of 4	1 of 8
Laguna Canyon Wash (LB2)*	0 of 4	NS
Laguna Avenue (LB3)**	0 of 0	1 of 8
Salt Creek	0 of 8	4 of 8
San Juan Creek**	0 of 0	0 of 8
Prima Deschecha Channel	0 of 2	1 of 4
Segunda Deschecha Channel*	0 of 1	1 of 4

*No dry weather flows observed during 1 of 2 sampling events
**No dry weather flows observed
NS = site not accessible

The toxicity testing results from ACRW samples during 2011-12 were consistent with samples collected from Long Term Mass Emission monitoring sites. The test organisms that produced the most consistent toxic responses were the *Americamysis bahia* survival and growth tests. It is unclear as to whether the patterns in test responses were coincidental or may have originated from similar or chemically related constituents. A discussion of lessons learned from chemistry and toxicity monitoring efforts during 2011-12 is provided in **Sections C-11.4.**

C-11.2.3.2 Regional Monitoring Program

Regional monitoring conducted during 2011-12 focused on continued implementation of the Dana Point Regional Harbor Monitoring Program (RHMP). The RHMP was developed by the Port of San Diego, the City of San Diego, the City of Oceanside, and the County of Orange in response to a July 24, 2003 request by the San Diego Regional Board under §13225 of the California Water Code. The RHMP is a comprehensive effort to survey the general water quality and condition of aquatic life in the harbors and to determine whether beneficial uses are being met in Dana Point Harbor, Oceanside Harbor, Mission Bay, and San Diego Bay. The program is comprised of a core monitoring program supplemented by focused special studies. The core program was designed to answer questions regarding (1) the spatial distribution of pollutants and their impacts, (2) the safety of the waters for human contact, (3) the safety of fish for human consumption, (4) the abilities of the waters and sediments to sustain healthy biota, and (5) the long-term trends in harbor conditions. The core monitoring was conducted in combination with Southern California Bight Regional Monitoring Program in 2008 (Bight'08). The major findings include: 1) human input, especially boat paints, is the main source of copper in the RHMP harbors; 2) RHMP harbor waters are safe for human contact; and 3) RHMP harbors generally support health biota. In general the water quality of RHMP harbors is improving over time. In 2013, RHMP regional survey will again be conducted as part of the Bight'13.

In addition to the above core monitoring program, RHMP has conducted special focused studies to 1) assess the extent of copper contamination within marinas and the potential for adverse effects, 2) identify causes of toxicity through toxicity identification evaluations (TIEs) in sediment and overlying water tests, and 3) determine whether marina sediments with elevated copper levels serve as sources or sinks for dissolved copper. Of the above, The TIE study was not carried out due to lack of toxicity throughout the RHMP harbors. The other two special studies have been completed. A summary synthesis report is being prepared to summarize the findings of both the core monitoring program as well as special studies. The report is anticipated to be available in the spring of 2013.

C-11.2.3.3 Special Studies

Special studies conducted during 2011-12 at ACRW sites focused on assessing toxicity in the Salt Creek watershed in an effort to better understand the sources and causes of toxicity effects. The Salt Creek watershed toxicity study is being used a model approach in an effort to identify sources of toxicity in other watersheds. The results of the special study effort are summarized and discussed in Section C-11.4.

C-11.2.4 Coastal Storm Drain Outfall Program

C-11.2.4.1 Core Monitoring Program

The concentrations of fecal indicator bacteria are monitored weekly during dry-weather conditions at twenty-eight coastal stormdrains and their respective surfzone receiving waters. The monitoring locations are shown on **Attachment C-11-I – Map X**. The results of the monitoring are presented in **Attachment C-11-II – Table 12.** Details on the methods of data analysis are provided in **Attachment C-11.III**.

The data display differences between stations in the 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-11.4 is a summary of the monitoring conducted in 2011-12, the number of samples collected throughout the year, the number of samples collected during the AB411 season, and the number of AB411 single sample criteria exceeded, by indicator. Each receiving water site was also evaluated to determine the proportion of sampled days on which at least one single sample standard was exceeded in the surfzone. The results for each site are provided in **Table C-11.6.**

This approach provides a mechanism for ranking sites and establishing priorities for each drainage. The proportion of exceedances for each monitoring site is calculated as:

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

Attachment C-11-I – Map 9 and **C-11-I – Map 10** show the spatial distribution of monitoring stations exceeding AB411 standards in the surfzone receiving water upcoast (north) and downcoast (south) of coastal drains, and in the channels, both for the entire year and for the AB411 season (April 1 through October 31). For a typical sampling there are two receiving water samples (upcoast and downcoast) and three laboratory analyses (total coliform, fecal coliform, and *Enterococcus*) included in the analysis.

In general, indicator bacteria conditions in receiving waters experienced moderate to low exceedance frequencies of the three indicator bacteria as listed in **Table C-11.4**. Consistent with previous years, beach water quality exceedances were largely due to *Enterococcus* which continues to represent the primary fecal indicator bacteria of concern during the entire year and the AB411 period (April 1 to October 30). *Enterococcus* levels exceeded AB411 single sample standards 27% and 29% during the entire year and AB411 season, respectively. Fecal Coliform and Total Coliform levels on an annual basis were found to exceed recreational contact standards at beach sites up to a maximum rate of 1.9% and 2.1%, respectively. There were not significant differences in the proportion of exceedances between the entire year and the AB411 season.

The condition of receiving waters did change depending on whether storm drains were flowing to the ocean. Of the 841 samples collected during the AB411 period, 174 (21%) were collected at sites that flowed to the ocean. Of the 174 samples from sites that flowed to the ocean, 113 samples (65%) were collected from Poche Beach (POCHE) and Salt Creek County Beach (SCM1).

The results provided in **Table C-11.5** show that the proportion of exceedances at each surfzone site was moderate to very low ranging from 26% to 0%, respectively, for the entire year with the greatest percentages of exceedances observed in the surfzone at Poche Beach (POCHE), Doheny Beach at North Creek (DSB5), and Doheny Beach at San Juan Creek (SJC1);

- On 39 of the 43 days that Poche Beach and its surfzone receiving waters were sampled, the discharge from the Creek reached the surfzone at the time of sampling. AB411 standards were exceeded in 26% of samples collected.
- On 0 of the 43 days that Doheny Beach at North Creek and its surfzone receiving waters were sampled, the discharge from North Creek reached the surfzone at the time of sampling. AB411 standards were exceeded in 23% of samples collected.
- On 6 of the 43 days that Doheny Beach at San Juan Creek and its surfzone receiving waters were sampled, the discharge from San Juan Creek reached the surfzone at the time of sampling. AB411 standards were exceeded in 14% of samples collected.

The significance of the relationships between discharges from a creek or storm drain and the surfzone were further evaluated using linear regression analyses. The slope of the best fit line and p-values were calculated and are summarized in **Attachment C-11-II – Table 13.** The purpose of this analysis was to identify those outfalls that had the most consistent relationship, both for the entire reporting period and during the AB411 season, between the outfall discharge and the receiving water. The assumption underlying this analysis is that the strength of the regression reflects the strength of each drain's influence on its nearby receiving water. **Attachment C-11-II – Table 13** for the 2011-12 reporting period ranks the drains in terms of the strength of this relationship, as measured by the statistical significance, or "p" value, of the regression slope. It is important to note that a highly 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 of ocean water contact standards, particularly in the AB411 season and when the drain is flowing to the ocean.

Fecal indicator bacteria issues at Doheny Beach and Poche continue to represent a significantly challenging issue to solve. The Permittees conducted multiple efforts during the 2011-12 year to address beach water quality at these beaches as discussed in Special Studies **Section C-11.2.4.3.**

C-11.2.4.2 Regional Monitoring

Water quality monitoring efforts for the Coastal Storm Drain Outfall Monitoring Program focused on the core monitoring component during 2011-12 and no regional monitoring has been conducted during the 2011-12 reporting period. Monitoring efforts during 2012-13 are expected to change as the Permittees participate in the Regional Shoreline Monitoring Program. A discussion of the Regional Shoreline Monitoring Program is provided in **Section C-11.4.2**. Regional monitoring efforts during the 2012-13 may also include the Permittees participation in the 2013 Southern California Bight Regional Monitoring Program microbiology study.

C-11.2.4.3 Special Studies

The Permittees have invested in source investigation studies and made long term investments in additional control measures to reduce runoff impacts on beach water quality at Doheny Beach and Poche Beach. Special studies conducted during the 2011-12 year focused efforts on identifying and mitigating the sources affecting water quality including:

- Completing the Prima Deschecha watershed study to identify sources and develop plans for additional BMPs to mitigate indicator bacteria levels at Poche Beach.
- Continuing operation of the Poche Beach ultraviolet treatment system to reduce indicator bacteria levels in watershed runoff.
- Conducting a pilot scale falconry project to discourage gulls from congregating at Poche Beach.
- Providing support for the scientific development of new microbial source tracking host-specific fecal source markers through contributions of in-kind services to the Source Identification Pilot Protocol Project at Doheny Beach.
- Providing support of scientific advancements to identify beaches affected by potential human sources through contributions of in-kind services to the Southern California Bight Regional Monitoring Program Shoreline Microbiology Study.

The goal of the source investigations at Poche Beach and Doheny Beach are intended to develop a prioritization effort to identify and ultimately reduce the most important sources that represent a potential health risk for beach visitors. The effort is currently still in-progress and will continue through the 2012-13 monitoring year.

C-11.2.5 Stormwater Action Levels Program

The quality of stormwater discharges from the MS4 in south Orange County is assessed in the Stormwater Action Levels (SALs) monitoring program. Twelve stormdrains were randomly selected as shown in **Attachment C-11-I Map X** to be representative of the urbanized portions of hydrologic subareas in south Orange County.

During this reporting year each site was monitored at least twice with a automatic sampler during a stormwater runoff period. The results of monitoring are presented in **Attachment C-11-II Table 14.** In general, the monitoring data indicate that exceedances of the SALs were very infrequent during the 2011-12 reporting period. Similar results were measured during the 2010-11 reporting period. The results from the previous two monitoring years were combined in order to provide perspective on the quality of stormwater discharges from the Permittees MS4 as shown in the table below.

	Units	**Action Level**	**90th Percentile**	**Mean**	**Min**	**Max**
Copper	µg/L	127	90	37	16	160
Turbidity	mg/L	126	81	31	4	190
Cadmium	µg/L	3	1.7	0.5	0.5	3.3
Nitrate+Nitrite as N	mg/L	2.6	2.0	1.0	0.3	3.0
Total P	mg/L	1.46	0.81	0.49	0.18	3.27
Lead	µg/L	250	5.4	2.1	0.5	10
Nickel	µg/L	54	12	5.2	1.3	28
Zinc	µg/L	976	122	55	16	280

Beginning on December 16, 2012 the Permittees will be required to comply with the action level requirement for MS4 wet weather runoff based on a running 20% exceedance frequency standard. The results of the cumulative program are presented to document the current condition of wet weather discharges from the Permittees MS4 as well as to highlight lessons learned from the past two storm seasons. The combined monitoring results from the 2010-11 and 2011-12 reporting periods in relation to the stormwater action levels are shown in **Figure C-11.12.** A summary of the cumulative wet weather monitoring data is provided in **Attachment C-11-II – Table 14.**

In general, the results show several important issues:

- MS4 wet weather discharges 90th percentiles concentrations are, on average, below the action levels and in some instances remarkably below the action levels,
- Copper and Turbidity produced the highest maximum concentrations over the action levels, and
- The 90th percentiles concentrations for lead, zinc, and nickel were significantly lower than the action levels by a factor of 46, 8, and 4.5, respectively.

The exceedance frequency summary shows that across the monitoring sites individual constituent concentrations only exceed action levels up to a maximum rate of 5.1%. Copper and Turbidity represented the most frequently exceeding constituents at 5.1% each followed secondly by Cadmium and Nitrate + Nitrite as N at a rate of 3.4% each and lastly by Total Phosphorus as P at a rate of 1.7%, the remaining constituents Lead, Nickel, and Zinc did not exceed any of the action levels over the two monitoring seasons.

Additionally, monitoring data were normalized to the action levels and ranked according to median values in decreasing order as shown in **Figure C-11.X**. The magnitude ranking shows that, in contrast to Copper and Turbidity considered as a priority on an exceedance frequency basis, the magnitude ranking analysis indicates that Nitrate + Nitrite as N and Total Phosphorus as P are the top two constituents followed secondly by Copper and Turbidity and next by Cadmium. The magnitude ranking analysis also shows that median Nickel, Zinc, and Lead concentrations in MS4 wet weather discharges were 10 to 100 lower than action levels.

C-11.2.6 Non-Stormwater Action Levels Program

The Non-stormwater Action Levels (NALs) monitoring program assesses the quality of dry weather discharges from the MS4, relative to criteria from the CTR, and water quality objectives from the Water Quality Control Plan for the San Diego Region (Basin Plan objectives). The results of the 2011-12 monitoring program are presented to document the current condition of dry weather discharges from the Permittees MS4 as well as to highlight lessons learned from this year. The 2011-12 monitoring data is provided in **Attachment C-11-II – Table 15. Attachment C-11-I – Map 9** shows the locations of monitoring sites sampled during 2011-12.

MS4 non-stormwater discharges were evaluated by comparing monitoring data with the action levels and other assessment benchmarks provided in Section 2.0. The top five constituents groups from this analysis were nutrients, indicator bacteria, dissolved solids, metals, and pyrethroid pesticides. The top ten constituents from the prioritization analyses, in decreasing order of importance, were 1)Total Dissolved Solids, 2) *Enterococcus*, 3) Total Nitrogen, 4) Total Phosphorus, 5) Sulfate, 6) Chloride, 7) Selenium, 8) Fecal Coliforms, 9) Cadmium, and 10) Bifenthrin. The prioritization analysis had some additional surprising results such as the low exceedances frequencies for Copper, Malathion, and Permethrin.

Additionally, monitoring data were normalized to the action levels and assessment benchmarks and ranked according to median values in decreasing order as shown in **Figure C-11.X.** The magnitude ranking shows that in contrast to exceedance frequencies, the magnitude of the discharge does not always agree with the frequency of exceedance. The differences are particularly highlighted in the rankings of Total Dissolved Solids using the two different assessment approaches. The ranking of dry weather discharges indicates that the constituents in decreasing order of importance were 1) *Enterococcus*, 2) Total Nitrogen, 3) Total Phosphorus, 4) Total Dissolved Solids, 5) Sulfate, 6) Selenium, and 7) Fecal Coliforms. The median concentrations for the three remaining constituents 8) Copper, 9) Ammonia, and 10) Turbidity were 4.7, 5.5, and 6.8 times lower, respectively, than action levels and assessment benchmarks.

C-11.3 Additional Monitoring Efforts

Multiple efforts to remove trash and gain a better understanding of the sources and pathways are currently in progress by the Permittees (see especially **Section C-5.0**). Targeted studies aimed at understanding problematic locations have been initiated in collaboration with California State University Fullerton and regional surveys are being conducted by the Permittees in concert focused on addressing these specific types of problems. These efforts are additionally supported by two studies were are the Trash and Litter Investigation special study as well as the Southern California Regional Watershed Trash Assessment Project.

The goal of the Southern California Regional Watershed Trash Assessment Project conducted in 2011 and 2012 was to improve the understanding and ability to manage trash in the environment at both regional and local scales. The regional trash assessment effort collected stream trash data at sites in open space, agricultural areas, and urban streams following the SWAMP Rapid Trash Assessment protocol using a probabilistic monitoring design. The focus of the project was to generate an assessment of regional conditions and provide the SMC member agencies with an opportunity to examine common pathways and sources over a larger geographic scale across a range of stream conditions.

The goal of the Trash and Litter Investigation special study is to improve the understanding of temporal changes in trash in urban watershed and increase our ability to manage trash in the environment. The Trash and Litter Investigation focuses on the Orange County creeks and streams within the urban stratum from the Southern California Regional Watershed Trash Assessment Project. The focus of the special study is to generate an assessment about the extent and magnitude of trash conditions during dry weather conditions and after storm event over a multiple year period.

Starting in 2012-13 the County will initiate a grant-funded project focusing on trash in receiving waters. The intent of the project is to develop the technical tools and guidance documents that allow watershed scale trash management plans to be developed in a cost effective and efficient manner. This project, in coordination with the SMC, is also intended to develop the framework for an iterative approach that will allow long term monitoring assessments to provide feedback into ongoing management efforts.

In addition to the trash assessment projects, during the 2011-12 monitoring year the Permittees contributed to the 2008 Southern California Bight Regional Monitoring Program Water Quality Study (2008 Bight Study). Additional monitoring data was collected in 2009-10 through in-kind services and these efforts contributed to the 2008 Bight Study. One of the goals of the Bight Study was to characterize riverine nutrient loads discharged to the coastal ocean based on an empirical and model based approach. The goal of this study was to establish a better understanding about the contributions that riverine discharges can have on supporting harmful algae blooms in the coastal ocean.

C-11.4 Evaluation of 2011-12 Water Quality Conditions

This was the third complete year of monitoring under the Fourth Term Permit. The Program underwent some modifications to incorporate the SMC Program and added additional analyses in inland surface waters and ambient coastal receiving waters to enable enhanced assessments of conditions.

C-11.4.1 Receiving Water Conditions from Mass Emissions, Urban Stream Bioassessment, SMC Program, and Ambient Coastal Receiving Waters Monitoring

Water quality samples from several components of the monitoring programs (mass emissions, bioassessment) were evaluated in combination to provide an overview of patterns across the region. For purposes of this assessment, all program components are combined into one dataset, in order to better represent the spatial and temporal patterns across the region.

The results of the assessment and a ranking of receiving water priorities based simply on frequency of benchmark exceedances in the 2011-12 monitoring data are provided in **Table C-11.X** and shown in **Figure C-11-X**.

The analysis shows that 88% of samples in the nutrient category exceeded the assessment benchmarks followed by indicator bacteria at 82%. The lowest categories were the metals with 35% of samples exceeding and pesticides with 22% samples exceeding benchmarks. It should be noted that this analysis does not assess the severity of impact from benchmark exceedances, just the number of exceedances.

The assessment results show the following constituents exceeded the benchmarks most:

- Nutrients - nitrogen (90%) and phosphorus (85%) and
- Indicator bacteria - *Enterococcus* (88%) and fecal coliform (76%)
- Metals - selenium (30%), copper (3%) and zinc (3%), 0% for cadmium, nickel, and lead.
- Pesticides - pyrethroid pesticides (40%), organophosphorus pesticides (10%), and carbamate pesticides (0%).

C-11.4.1.1 Nutrients

Nutrient levels in receiving waters have a wide range of concentrations. Differences in nitrogen and phosphorus levels are significant between sites and between seasonal conditions as shown in **Table C-11.7** and **Table C-11.8** respectively. Mean nitrogen concentrations in dry weather range from 0.35 to 4.5 mg/L while storm events tend to be higher and have a smaller range varying from 1.9 to 5.6 mg/L. Similarly, mean phosphorus concentrations in dry weather range from 0.02 to 0.59 mg/L while storm events typically show higher concentrations and have a smaller concentration range from 0.23 to 0.54 mg/L.

The nutrient concentrations also have several interesting patterns in the nitrogen and phosphorus levels. For example, dry weather nitrogen concentrations at the two sites in Aliso Creek, which are only a few miles apart, are dramatically different. Total nitrogen concentrations as the Long Term Mass Emission station (ACJ01) were 2.1 ± 0.1 mg/L while the SMC Program site (SMC01934) was 0.09 mg/L. Dry weather phosphorus levels at these same sites in Aliso Creek were 0.19 ± 0.02 mg/L and 0.02 mg/L are quite different. The contributing reason for these differences is not well understood at the present time, but warrants additional study. The differences may be associated with channel morphology, riparian habitat canopy cover, riparian habitat density, surrounding land uses, adjacent landscaping practices, or other variables not yet well understood. Nutrient conditions in receiving waters and the characterization of the MS4 contributions, including the BMPs that will reduce nutrient discharges should warrant a higher level of consideration.

C-11.4.1.2 Dissolved Solids

Dissolved solids in receiving waters have a wide range of concentrations and can dramatically vary between sites and between seasons. Elevated dissolved solids is a dry weather issue for receiving waters as shown by the results in **Table C-11.9.** Concentrations of chloride and sulfate in receiving waters range 250 to 1150 mg/L and 300 to 3260 mg/L, respectively, in contrast to storm event concentration ranging from 85 to 440 mg/L and 90 to 1270 mg/L. The receiving waters with the highest dissolved solids concentration were, in decreasing concentration order, Prima Deschecha Creek, Segunda Deschecha Creek, Salt Creek, and Aliso Creek.

The primary contributing source to elevated dissolved solids in receiving waters is associated with the watershed geology. The watersheds of Prima Deschecha Creek, Segunda Deschecha Creek, Salt Creek, Aliso Creek, and smaller areas of the San Juan Creek and Trabuco Creek watersheds are characterized by highly saline tertiary marine sedimentary soils. The Laguna Canyon Wash watershed, above the monitoring site, is derived primarily of non-marine sedimentary and igneous bedrock type of geologic formations. These fundamental differences in geology are manifested in the dissolved solids averages that receiving waters.

C-11.4.1.3 Progress in Characterizing Dissolved Solids Issues in Receiving Waters

Monitoring efforts during the 2011-12 year included finalizing a special study conducted on behalf of the Permittees to characterize dissolved solids in the Oso Creek Watershed. The study was conducted to support management efforts focused on addressing the Section 303(d) listings for Total Dissolved Solids, Chloride, and Sulfate and to additionally support the Permittees' Comprehensive Load Reduction Plan development. The Oso Creek dissolved solids study focused on:

- Characterizing the range of concentrations and loadings of Oso Creek,
- Characterizing the range of concentrations and loadings of geologically similar undisturbed or minimally disturbed reference streams having elevated dissolved solids,
- Evaluating potential barriers that could impede corrective actions, and
- Evaluating trends over time.

The key findings from the Oso Creek dissolved solids characterization study were:

- Dissolved solid concentrations across the watershed are similar and changes only occur in concert with changes in the geologic formation.
- Dissolved solid concentrations in Oso Creek were not significantly different than reference streams, but loadings were, on average, four times higher than the reference streams.

- Preliminary analysis of changes over time indicates that past events may have contributed to incremental increases in the dissolved solids but the ratio of potable water to groundwater appears to be decreasing over the past three decades.

In addition to the technical information provided for the Comprehensive Load Reduction Plan development, the Oso Creek dissolved solid special study serves as an initial starting point for understanding dissolved solids issues in receiving waters on a regional scale. This study provides the initial technical framework for the Permittees to begin assessing the baseline dissolved solids with respect to the ambient geology on a watershed-by-watershed basis. This monitoring effort will continue as the watershed workplans evolve and the issue of dissolved solids reaches priority status for the respective Permittee to address dissolved solids issue in receiving waters.

C-11.4.1.4 Metals

Metals issues in receiving waters during the 2011-12 monitoring year were very limited in terms of the number of constituents that exceeded assessment benchmarks as shown in **Figure C-11.X**. The receiving water metals issues, in decreasing order of importance, were limited to Selenium, Copper, and Zinc.

Total recoverable metal concentrations in receiving waters were considerably different between dry weather and storm events as shown in **Table C-11.10**. Selenium average concentrations in dry weather ranged from 1.0 to 26 µg/L in contrast to storm event runoff concentrations ranging from 0.54 to 10 µg/L. In contrast, total recoverable Copper and Zinc levels in dry weather did not exceed assessment benchmarks and only exceeded assessment benchmarks in 3% of samples collected during storm event conditions. Similarly, Copper and Zinc concentrations tended to be low during dry weather and only increased in response to storm event runoff.

C-11.4.1.5 Progress in Assessing Sources of Selenium

Past monitoring research conducted by the Permittees has shown that the primary contributing source to elevated Selenium in receiving waters is associated with the watershed geology. The watersheds of Prima Deschecha Creek, Segunda Deschecha Creek, Salt Creek, and smaller areas of the Aliso Creek, San Juan Creek, and Trabuco Creek watersheds are characterized by highly saline tertiary marine sedimentary soils. The Laguna Canyon Wash watershed, above the monitoring site, is derived primarily of non-marine sedimentary and igneous bedrock type of geologic formations. These fundamental differences in geology are manifested in the Selenium concentration averages that receiving waters experience.

Efforts during the 2011-12 reporting period, efforts focused on sampling new monitoring parameters that provide a better approach at developing the types of assessments needed to separate the natural watershed geology contributions from anthropogenic, or human based, activities. This work focused on collecting samples from natural streams, groundwater springs, domestic water sources, and urban channels to compare and contrast differences between the various water body types. This approach is based on the use of stable isotopes of water and published methods of mixing model analyses. The 2011-12 effort has provided an important additional contribution that will allow for a more robust approach to assessing Selenium concentrations against natural thresholds as well as determine loading contributions from natural and anthropogenic inputs.

The purpose of this effort is to ultimately help define a model management approach to address the presence of naturally derived pollutants in urban watersheds. As part of this effort, this work has led to new opportunities to connect with subject experts and share these findings with other stormwater agencies outside of Orange County that are challenged by similar water quality issues.

C-11.4.1.6 Pesticides and Other Toxicants

Evaluating the linkages between monitored constituents and biological conditions helps us understand the extent and magnitude of receiving water problems. The 2011-12 toxicity testing results show nearly consistent patterns between dry weather and storm event conditions across testing organisms as shown in **Figure C-11.12**.

Progress in identifying toxicants to aquatic species

An important assessment for the monitoring program is to understand which pollutants have toxic effects (toxicants) or negative effects on aquatic species. The toxicity testing organisms utilized for the monitoring program have a broad spectrum of sensitivities to toxicants at varying levels of concentration thresholds.

It has been noted in previous years that, despite having high concentrations of dissolved copper and zinc, many storm event samples do not show toxicity to the purple sea urchin (*Strongylocentrotus purpuratus)*. In addition to having high concentrations of dissolved metals those first flush samples also contained high concentrations of dissolved organic carbon. Organic carbon in stormwater can also include organic ligands that complex with the dissolved metals and decrease the bioavailability of those metals.

The 2011-12 toxicity test results have several distinct patterns suggesting that potentially only a few key pollutants may be causing toxicity in receiving waters. The toxicity testing results indicate that monitored constituents such as metals like copper create negligible toxic effects on *Strongylocentrotus purpuratus,* which is a species sensitive to metals.

The toxicity testing organisms with the greatest response differences to environmental sample exposure are *Americamysis bahia,Ceriodaphnia dubia,* and *Hyallela Azteca.* It is generally understood that these organisms share similar sensitivities to pesticides and insecticides at low concentrations. However, connecting pesticides concentrations with the toxicity testing responses remains a challenge. Confounding factors work to add difficulty in assessing the linkage between pesticides and impacts on biological species.

To highlight this difficulty, the correlation between *Americamysis bahia* and Bifenthrin (the most frequently detected pyrethroid pesticide and second most toxic compound monitored) shows a poor relationship and correlation as shown in **Figure C-11.13**. Despite the fact that Bifenthrin concentrations were present at substantially toxic levels, the lack of a significant relationship suggests that there is not a direct association between the measured pesticide concentration and subsequent effects on the aquatic species.

In order to manageably assess the relationship between pesticides and receiving water issues, a technical workgroup of the watershed stakeholders including the County of Orange, the cities of Dana Point and Laguna Niguel, the University of California Cooperative Extension, in coordination with staff from the Department of Pesticides Regulations, started a collaborative effort in the Salt Creek watershed to address receiving water toxicity issues. This source investigation effort will become relevant for understanding toxicity issues on a larger scale and findings from this feasibility study may support management efforts countywide.

The watershed investigation places a strong emphasis on evaluating pyrethroid pesticides but is also evaluating fipronil pesticides as a potential contributor to toxicity in receiving waters. Past watershed monitoring data collected by the Department of Pesticide Regulation indicates that fipronil pesticides are frequently detected in receiving waters throughout the Salt Creek Watershed in addition to the pyrethroid pesticides.

Preliminary findings from the watershed investigation suggests that both pyrethroid and fipronil pesticides are correlated with toxicity effects. The results suggest that the matrix type analyzed, for example the dissolved fraction in preference to total recoverable, is important for assessment purposes. The data analysis will continue during the 2012-13 year and the findings from this effort will summarized in a technical report.

C-11.4.2 Recreational Conditions from Bacteriological / Pathogen Monitoring

The structure of the beach water quality monitoring and assessment program is expected to change during 2012-13. As part of a coordinated effort to develop a collaborative, integrated, and efficient shoreline monitoring program, OC Public Works, on behalf of the Permittees, participated in technical workgroup meetings with representatives from the Santa Ana and San Diego Regional Boards, Orange County Health Care Agency, South Orange County Wastewater Authority, and Orange County Sanitation District.

The goal of the workgroup was to establish a sustainable shoreline monitoring program that would ensure the future protection of beach water quality for residents and visitors. This workgroup formed as a result of 2008 state budget shortfalls and the moratorium on funding for the AB411 program.

Representatives from each agency initially joined together in 2008 to develop a unified program that would ensure monitoring coverage at beaches in the absence of state funding. Through support of the State Water Resources Control Board Beach Water Quality Workgroup, representatives from non-governmental organizations were provided the opportunity to review the proposed monitoring program to ensure that a broad spectrum of interests were met with the finalization of the collaborative monitoring program. Additionally, a workgroup convened in 2012 to finalize the development of the San Diego Regional Board jurisdiction shoreline program, which included representative listed above and also included participation of Surfrider and Sierra Club representatives.

It is anticipated that in 2013, the Permittees will enter into the new collaborative regional shoreline monitoring program. The regional shoreline monitoring program supports multiple objectives including:

- A first time opportunity for the partners to share knowledge about conditions and site histories while working together to monitor beach water quality.
- Development of a monitoring program that helps the Regional Boards achieve their goal of developing a sustainable beach water quality monitoring program that will ensure protection of the public.
- Combining monitoring programs so that sites are evaluated on an even comparison which provides a better contextual understanding of issues and ensures that priority sites receive the collective attention firsthand.
- A first time opportunity for the partners to leverage existing resources coupled with a greatly expanded set of technical capabilities that will allow the workgroup to collectively address water quality issues as needed.

Stakeholders in this regional program for the Fourth Term Municipal Stormwater Permit (R9-2009-0002, NPDES CAS0108740) will include the Permittees, the Santa Ana and San Diego Regional Boards, Orange County Health Care Agency, South Orange County Wastewater Authority and representatives from Surfrider and Sierra Club.

C-11.4.3 Urban Stream Bioassessment Monitoring

The Urban Stream Bioassessment monitoring effort has become integrated into a multi-year regional study of southern California watersheds. Each year, a new group of randomly selected creeks and channels are monitored in addition to the Core Monitoring Program sites (see **Section C-11.2.2**) using consistent protocols developed by the State Water Resources Control Board's SWAMP. Although a comprehensive report of the results of this regional study will not be released until all of the sampling is completed, preliminary results of the monitoring conducted in Orange County are available. All eight urban sites monitored in Orange County during the 2011-12 year yielded IBI scores in the "Poor" to "Very Poor" range as shown in **Figure C-11.5**.

During the 2011-12 year, the Permittees continued to participate in the SMC Program. The 2012 survey was the fourth year of the five year study to assess stream macroinvertebrate conditions across southern California. The goal of this multi-agency and multiple region study is to 1) determine the status of macroinvertebrate conditions across southern California streams, 2) identify key stressors that affect stream macroinvertebrate conditions, and 3) monitor receiving water stressors over time. Stream monitoring sites are stratified by urban, open space, and agricultural land uses to provide a better assessment across stressor gradients from chemical, biological, and physical influences.

Additionally, the Permittees participation in the SMC Program is contributing data to the State Waters Resources Control Board's development of biological objectives that will take into account conditions specific to the semi-arid coastal watersheds of southern California. Nearly one-third of all the data that the State Waters Resources Control Board will use to develop the biological objectives comes from the SMC Program and the efforts of the Permittees.

C-11.4.4 MS4 Outfall Discharges

The Non-stormwater Action Levels (NALs) monitoring program assesses the quality of dry weather discharges from the MS4, relative to criteria from the CTR, and water quality objectives from the Water Quality Control Plan for the San Diego Region (Basin Plan objectives). The results of the 2011-12 NALs monitoring program are presented to document the current condition of dry weather discharges from the Permittees MS4 as well as to highlight lessons learned from this year. The 2011-12 monitoring data is provided in **Attachment C-11-II – Table 15. Attachment C-11-I – Map X** shows the locations of monitoring sites sampled during 2011-12.

MS4 non-stormwater discharges were evaluated by comparing monitoring data with the action levels and other assessment benchmarks provided in Section 2.0. The top five constituents groups from this analysis were nutrients, indicator bacteria, dissolved solids, metals, and pyrethroid pesticides. The top ten constituents from the prioritization analyses, in decreasing order of importance, were 1) Total Dissolved Solids, 2) *Enterococcus*, 3) Total Nitrogen, 4) Total Phosphorus, 5) Sulfate, 6) Chloride, 7) Selenium, 8) Fecal Coliforms, 9) Cadmium, and 10) Bifenthrin.

C-11.4.4.1 Indicator Bacteria: Identifying Host Sources

Many different sources contribute indicator bacteria in urban watersheds, however not all sources represent the same level of health risk. Past monitoring conducted by the Permittees has shown that the indicator bacteria sources include decaying vegetation in waterways, landscape runoff, wild and domesticated animals, and occasionally human sources.

As a subset effort to the MS4 dry weather monitoring programs that routinely evaluates the quality of indicator bacteria levels in discharges, the Permittees have invested an additionally effort to better understand the controllable sources that influence receiving water quality and may also represent a potential health risk.

Recent advances in quantitative polymerase chain reaction (qPCR) technologies in the analysis of pollution markers derived from host specific bacteriodes cells has provided a significant improvement for public agencies. These DNA markers, which were independently validated an international group of scientists in collaboration with the SCCWRP, has provided a new opportunity for the Permittees to monitor and identify potential human sources in runoff. The scientific improvement to the monitoring program was developed, in part, through the Permittees' in-kind contributions for microbial source tracking study conducted as part of the Source Identification Pilot Protocol Project at Doheny Beach.

The source identification project is being transitioned into a special study to support the Permittees efforts and the monitoring project will continue during 2012-13 year.

C-11.4.4.2 Nutrients

Nutrient issues in MS4 discharges represents an area of uncertainty for the monitoring program with respect to making a connection between source identification and understanding the loading from various sources within a watershed. Having a more informed understanding of these relationships provides better context as to how to develop appropriate control measures to address these issues and adapt management plans to address these sources. Lessons learned from the 2011-12 monitoring year have helped to improve the understanding of nutrient issues by providing a greater level of detail about the relative proportions of the nutrient chemical forms in MS4 discharges, as shown in **Figure C-11.18**.

The Permittees have started several additional efforts to address nutrient discharges by:

- Developing a sample database library to create "fingerprint" patterns of various nutrient sources in an effort to improve the Permittees' ability to track and locate sources within a MS4 drainage area.
- Completing several source investigations of high nitrate concentration discharges to better understand transport process as well as concentrations of groundwater infiltrating into the MS4.
- Developing BMPs performance assessment study plans as part of the Comprehensive Load Reduction Plan that may additionally include characterization of changes in nutrient concentrations and loads.

C-11.4.4.3 Dissolved Solids

Monitoring efforts during the 2011-12 year included finalizing a special study conducted on behalf of the Permittees to characterize dissolved solids in the Oso Creek Watershed. The study was conducted to support management efforts focused on addressing the Section 303(d) listings for Total Dissolved Solids, Chloride, and Sulfate and to additionally support the Permittees' Comprehensive Load Reduction Plan development. Additionally, the Permittees have started several efforts including to manage dissolved solids discharges by:

- Developing a sample database library to create "fingerprint" patterns of various nutrient sources in an effort to improve the Permittees' ability to track and locate sources within a MS4 drainage area.
- Creating a sample database library of dissolved solids in high salinity reference streams and artesian springs.
- Maintaining a documentation of runoff sources to assess the extent of ground seepage from non-MS4 outfalls.

C-11.4.4.4 Copper in wet weather discharges

Sources of coppers in MS4 discharge during storm events can include atmospheric deposition, industrial and commercial area runoff, and the release of copper based algaecides. Architectural copper represents a source of copper in wet weather discharges that the Permittees have not previously assessed.

In response to persistent elevated levels of total recoverable copper in stormwater runoff, a source investigation of architectural copper was conducted in a residential community MS4 drainage area. The monitoring design evaluated the wet weather runoff over multiple storm events of different sizes and at multiple locations within the drainage area. The monitoring design was intended to evaluate runoff within the upper and lower MS4 and included runoff monitoring from the adjacent highway.

Copper levels in the MS4 samples showed concentrations from 38 µg/L to 285 µg/L. In contrast, runoff samples collected from homes with architectural copper were found to have total copper concentrations ranging from 510 to 9800 µg/L. Highway runoff samples were much lower with concentrations ranging from 29 to 69 µg/L while atmospheric deposition concentrations of copper ranged from 8.9 to 120 µg/L. The results of the drainage area source investigation show that architectural copper was likely the largest source of copper in stormwater in this watershed.

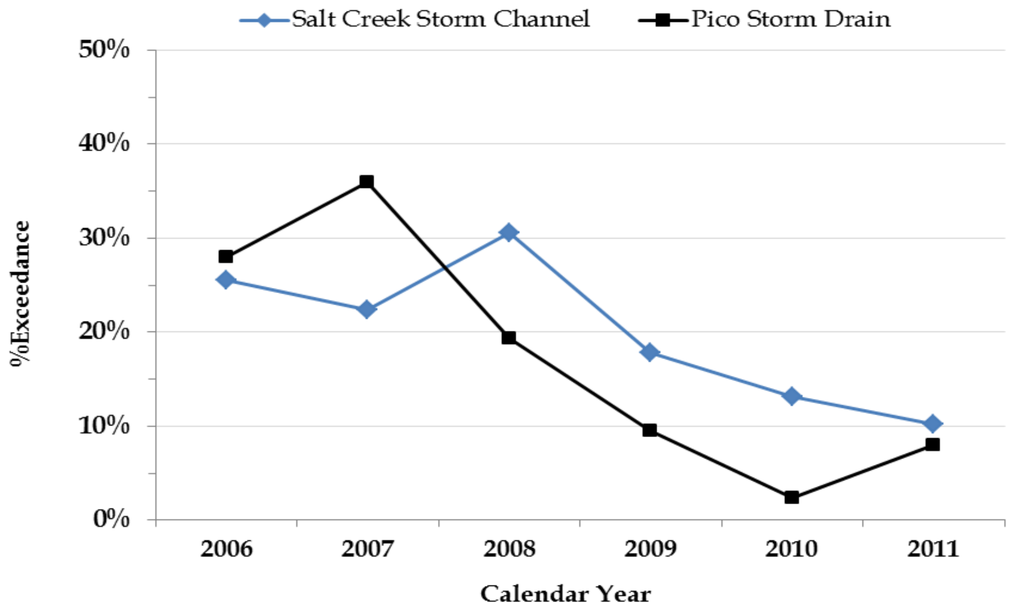
C-11.5 Long Term Trends in Water Quality Conditions

C-11.5.1 Beach Water Quality

Changes in receiving water indicator bacteria levels have seen some positive improvements over the past few years. In general, the number of beach monitoring sites affected by *Enterococcus* levels over the single sample standard is showing a decreasing trend in the number of sites affected. Following the beach categorization criteria established by the Regional Shoreline Monitoring Program, the percent of beach sites that continue to have water quality issues of concern has decreased from 59% in 2007 down to 32% in 2011 as shown in the figure below**.** These changes are attributed to the cumulative effects of 1) increasing attention on water conservation, 2) continued education of the public on the pollution prevention, and 3) implementation of structural BMPs at problematic sites.

Data from 2011-12 show concentrations of fecal indicator bacteria at problematic sites in 2011-12 represented only 32% of all beach sites monitored by the Permittees along the south Orange County coastline as shown in **Figure C-11.19**. The top two problematic sites with the most exceedances were Poche Beach and Doheny Beach. Salt Creek County Beach near the Salt Creek storm channel and North Beach at the Avenida Pico storm drain were the next two highest average exceedance frequency sites. The percent of beach sites that continue to have water quality issues of concern has decreased from 59% in 2007 down to 32% in 2011**.** These changes are attributed to the cumulative effects of 1) increasing attention on water conservation, 2) continued education of the public on the pollution prevention, and 3) implementation of structural BMPs at problematic sites.

The implementation of structural BMPs at two high priority sites has reduced the number of beach sites experiencing water quality issues. The implementation of structural BMPs at Salt Creek County Beach in Dana Point and North Beach in San Clemente has resulted in a significant down trend in Enterococcus exceedances of the single sample standard over a multiple year period as shown in the figure below. The construction of the Salt Creek Ozone Treatment System and installation of the Avenida Pico Storm Drain dry weather diversion has resulted in a reduction of the *Enterococcus* single sample exceedance rates from over 30% down to 10% or less in 2011.



C-11.5.2 Indicator Bacteria in Inland Receiving Waters

Inland receiving water indicator bacteria levels are showing a reaffirming decrease in concentrations at key long term trend monitoring sites. The summer period Fecal Coliform geomeans in Aliso Creek trend monitoring site, as shown in **Figure C-11.20,** indicates that geomean Fecal Coliforms concentrations in receiving waters are less than 100 CFU/100mL. The decreasing trend in Fecal Coliform concentrations is appearing to follow the changes in average flow rates measured in receiving water. The continued reductions appear to be coincident with implementation of increase water conservation efforts by the public water retail agencies and may also be associated with increasing attention by the public on the effects of urban runoff on the environment. Additional factors such riparian benefits associated with the stream restoration efforts on Sulphur Creek and Narco Channel may be significantly contributing to this decreasing trend in Fecal Coliform concentrations, however, these influences are not fully understood and have not been characterized to a greater level of detail.

C-11.5.3 MS4 Discharges

C-11.5.3.1 Non-Stormwater (Dry Weather) Discharges

Changes in the content of MS4 dry weather discharges show a similar trend over time in comparison to receiving waters. Geomean concentrations of Fecal Coliforms and *Enterococcus* in dry weather MS4 discharges have decreased by a factor of 26 and 8, respectively, over the period of 2003 to 2012 as shown in **Figure C-11.21.**

Trends in indicator bacteria concentrations and dry weather flow rates from MS4 discharges are, on average, decreasing. Median Fecal Coliform levels across the MS4 during dry weather have decreased by a factor of 26 over a seven year period from 22300 CFU/100mL in 2005 to 840 CFU/100mL in 2012. Median *Enterococcus* concentrations have decreased 8 fold from 12,210 CFU/100mL to 1,620 CFU/100mL. These changes of indicator bacteria levels during dry weather conditions follow changes in the average flow rate of MS4 discharges.

The average flow rate for MS4 dry weather discharges over the period of 2005 to 2012 indicates the runoff volumes have continued to decrease over the multi-year period as shown in **Figure C-11.22**. Discharge estimates recorded at the same MS4 dry weather discharge monitoring sites (n =20), sampled during the periods of the third term (R9-2002-0001) and fourth term (R9-2009-0002) NPDES permits, indicates that average flow dry weather flow rates have continued to decrease. Average flow over the nine year period has decreased from 0.20 cfs in 2005 down to 0.05 cfs in 2012. The results indicate the cumulative efforts over a long term period are having a positive effect at reducing non-stormwater discharges from the MS4.

C-11.6 Quality Assurance / Quality Control

The monitoring and reporting program is supported by an independent quality assurance (QA) assessment program developed and implemented by the Orange County Stormwater Program. Laboratory analyses are independently validated through quality control (QC) check samples in addition to the quality assurance requirements established by USEPA and Standard Method procedures. The QA program evaluates data for accuracy, precision, and contamination using certified reference materials, laboratory control standards for common analyses, and duplicate field samples along with equipment and trip blanks.

The proportion of QA samples submitted this year was 12.5% of the total samples submitted to the contractor laboratories for analyses. The Annual QA/ QC Summary which describes the QA sample type and percent breakdown are presented in **Attachment C-11-IV**.

The Monitoring Programs QA officer oversaw preparation and submittals of 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 laboratory prepared standards to assess the quality of mobile laboratory field 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 QA program are summarized in tabular and graphic form in **Attachment C-11-IV**. 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.

Analyses from the QA/QC program results indicate that:

- The majority of pathogen indicator bacteria accuracies were within bounds of the control limits with total coliform accuracies having less scatter than fecal coliform bacteria. Pathogen indicator bacteria precisions were generally within bounds of the control limits with the highest range of scatter occurring for *Enterococcus*.

- The recoveries for duplicate analyses for nutrients were generally acceptable with most of the results remaining within control bounds. The majority of out of bounds results occurred for total suspended solids (TSS) and turbidity. Total kjeldahl nitrogen (TKN) precision recoveries had a few outliers for saltwater matrices.

- Accuracy results for oil and grease analyses trended low throughout the year. Recoveries from two contract labs returned similar results prompting an ongoing investigatory QA/QC study.

- Trace metal precision and accuracy results were generally within bounds with the majority of outliers occurring for antimony, beryllium and thallium in a saltwater matrix. Trace metals tended to have the best overall performance in terms of having the least amount and range of scatter associated with the analytical results.

- Organphosphorous Pesticides (OPP) returned accuracies which tended to have large and varied scatter. An investigation was established in order to determine the cause of the scatter. Findings showed the standard had expired in October 2011. Although the expired standard can account for the results after October the investigation did not yield any findings into the results prior to the expiration date.

- Trip blanks as well as equipment blanks for nutrients and trace metals were generally within bounds of the non-detect limit. The majority of outliers for trace metals occurred for saltwater matrices using a Suprapur and Nanopure synthetic solution. The majority of these detects were for zinc, iron, copper and lead. The majority of detects for nutrients occurred for total organic carbon (TOC). The contract lab tasked with the TOC analyses was switched mid-year and produced better results.

The accuracy of field chemical analyses in the Dry-Weather reconnaissance programs was generally acceptable and within control limits. Results of blind samples analyses were within acceptable error limits of ± 25% of the target value for more than 95% of the overall samples analyzed.

In 2012-13 it is expected that an intercalibration program will be initiated with the SMC to evaluate laboratory toxicity testing performance.

C-11.7 Changes in Monitoring Program

The expected changes to the monitoring program in 2012-13 are:

- Participation in Bight 2013 to support the Marine Debris study, and potentially the Shoreline Microbiology study. Pursuant to Monitoring and Reporting Program No. R9-2009-0002, Attachment E Section II.A.5, a request may be submitted to the Executive Officer to allow further changes in the approved monitoring program for 2013-14 in lieu of participation in Bight 2013.
- In 2012-13 the County will initiate a grant-funded project focusing on trash in receiving waters.
- Efforts during the 2012-13 monitoring year will continue working towards establishing a better approach for assessing the relationship between pesticide concentrations and aquatic toxicity.
- Participation in the regional shoreline monitoring program, in collaboration with the, Orange County Health Care Agency, South Orange County Wastewater Authority, and Orange County Sanitation District.

C-11.8 Summary

The 2012 Annual Water Quality Monitoring and Assessment Progress Report follows the question-driven monitoring approach established in 2002 by the SMC. The analyses and findings presented in this progress report reflect an attempt to answer those questions through an effort that encompasses multiple assessments to evaluate conditions and trends over time in both the receiving waters and the MS4. The framework of this approach focuses on answering questions on a regional basis and highlights site specific issues that remain challenging to solve. Monitoring data collected across programs or across water bodies are integrated (to the extent possible) to a) provide an overview of the priority issues, b) identify major receiving water problems to address, c) assess contributions of MS4 discharges, d) determine if/how have management actions over time have affected the trends and e) create measurable, tangible and actionable results for managers to use as a reference point from which program effectiveness can be evaluated.

Analysis of monitoring data resulted in the following observations during the reporting year:

1) Nutrient and indicator bacteria contribute the greatest number of benchmark exceedances in receiving waters across the region. However, monitoring data suggests that indicator bacteria levels are exhibiting significant decreasing trends over time.

2) Beach water quality during dry weather tends to be in moderate to very good condition. Results show that monitoring sites exhibit exceedance frequencies ranging from 0% to 28% on an annual basis. Conditions at Doheny and Poche Beach, on the other hand, tend to exhibit more exceedances; *Enterococcus* is the primary contributing factor to those exceedances.

3) Trends over time indicate that levels of indicator bacteria and reactive phosphorus in MS4 discharges, on average, are decreasing. Median Fecal Coliform levels across the MS4 during dry weather were 340 CFU/100mL while *Enterococcus* remains more challenging, with a median concentration of 390 CFU/100mL. While progress to date is encouraging, *Enterococcus* levels at some sites are still elevated suggesting that additional source tracking efforts are needed.

4) In general, toxicity testing organisms showed little to no negative response to environmental sample exposure during dry weather conditions. The notable exception to this patter was the decreased survival of *Hyallela azteca*. During wet weather, the test organisms with the greatest response are the *Americamysis bahia* and *Ceriodaphnia dubia* which implicates pesticides as the source of the toxicity, although no clear correlation between pyrethroid concentration and biological impact was established.

5) Biotic Integrity scores from urban streams were considered to be "Poor" to "Very Poor" and ranged from 7.1 to 21.4 which were consistent with urban sites sampled during the prior years. Physical habitat conditions at urban sites in the San Diego Region were similar to reference streams suggesting that the decreased IBI scores resulted from an apparent relationship between the biological community patterns and additional parameters not fully characterized at this time. This relationship has been observed in a number of other bioassessment programs, including the County's bioassessment monitoring in the SMC Regional Watershed Monitoring Program and the San Gabriel River Watershed Monitoring Program (LASGRWC 2010).