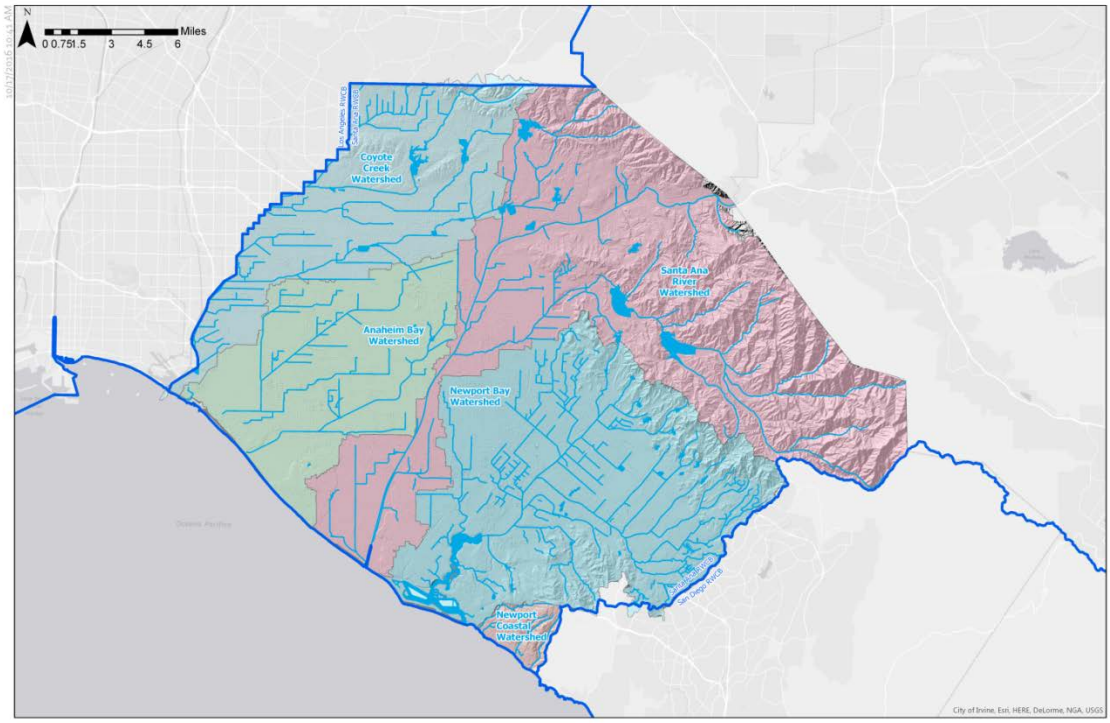
C-11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

C-11.1 Introduction

In response to the monitoring and reporting requirements of the Fourth Term Municipal Stormwater Permit (R8-2009-0030, NPDES CAS618030) from the Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board), the Permittees implemented a water quality monitoring and assessment program that is reported annually in this section of the Unified PEA. 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 2003 and approved by the Executive Officer in August 2005. 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, State Board, USEPA Region 9, Caltrans, and the Southern California Coastal Water Research Project (SCCWRP).

On October 3, 2013, the Permittees submitted the Report of Waste Discharge (ROWD) to the Santa Ana Regional Board, which included a State of the Environment analysis of stormwater quality issues and priorities in north Orange County under the jurisdiction of the Santa Ana Regional Board. Building on the assessment questions and themes developed for the ROWD State of The Environment submittal, this report presents the results of water quality monitoring conducted in the Santa Ana Region of Orange County between July 1, 2015 and June 30, 2016. The Santa Ana Region is mapped as **Figure C-11.1** below.

Figure C-11.1: Santa Ana Regional Board Jurisdiction in North Orange County



The collection of attachments representing analyses of monitoring data collected in 2015-16 are presented below in accordance with the Monitoring and Reporting Program from Order No. R8-2009-0030. The report includes a number of attachments that provide the data and findings for each core monitoring program element, which is organized as follows:

Attachment C-11-I – Monitoring Approaches and Methods of Analysis

Attachment C-11-II – Long Term Mass Emissions Monitoring

Attachment C-11-III – Estuary / Wetlands Monitoring

Attachment C-11-IV – Bacteriological / Pathogen Monitoring

Attachment C-11-V – Urban Stream Bioassessment Monitoring

Attachment C-11-VI – Dry Weather Monitoring Program

Attachment C-11-VII – Quality Assurance / Quality Control

The 2015-16 monitoring year constitutes the seventh year of monitoring under the Fourth Term Permit. Core recommendations and regional trends are presented in the main body of **Section C-11.0. Attachment C-11-I** provides a detailed summary of the program methods used to implement the various monitoring programs, as well as overall procedures for data analysis and reporting in this PEA. Individual monitoring results for the core program elements are included in **Attachments C-11-II** through **Attachment C-11-VI**. The PEA is organized to provide individual attachments that consolidate the associated program monitoring stations, sampling data, results and findings for each program element. **Attachment C-11-VII** summarizes the Quality Assurance / Quality Control (QA/QC) procedures and sampling results for 2015-16.

C-11.2 Program Goals

As outlined in the ROWD, the State Water Resources Control Board has provided the following four assessment questions that provide the context for water quality monitoring across the state:

1. Is our water safe to drink?
2. Is it safe to swim in our waters?
3. Is it safe to eat fish and shellfish from our waters?
4. Are our aquatic ecosystems healthy?

The monitoring programs developed for the Santa Ana Regional Board area as part of the Program focus on Questions 2 and 4 above, whereas Questions 1 and 3 are evaluated through other regulatory mechanisms and programs.

To help answer these questions, the Santa Ana Regional Board Fourth Term Permit establishes a series of monitoring program objectives. **Table C-11.1** below depicts the correlation between each monitoring program element and the associated permit objectives.

Table C-11.1: Monitoring Program Goals and their Relationship to the Program Elements

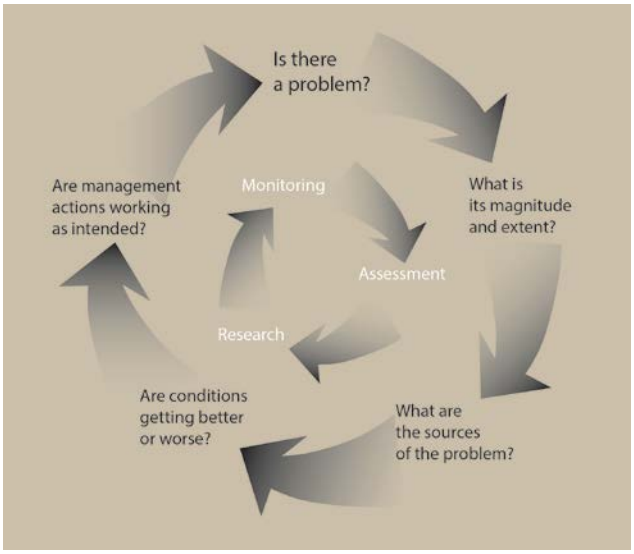
Monitoring Program Objective	Monitoring Program Element				
	Att. C-11-II	Att. C-11-III	Att. C-11-IV	Att. C-11-V	Att. C-11-VI
	Long Term Mass Emissions Station Monitoring	Estuary / Wetlands Monitoring	Bacterio-logical / Pathogen Monitoring	Urban Stream Bio-assessment Monitoring	Dry Weather Monitoring
To develop and support an effective municipal urban runoff pollutant source control program.	X	X	X	X	X
To define water quality status, trends, and pollutants of concern associated with urban runoff and their impact on the beneficial uses of the receiving waters.	X	X	X	X	X
To characterize pollutants associated with urban runoff and to assess the influence of urban land uses on water quality and the beneficial uses of receiving waters.	X	X	X	X	X
To identify significant water quality problems related to urban runoff.	X	X	X	X	X
To identify other sources of pollutants in urban runoff to the maximum extent practicable (e.g., atmospheric deposition, contaminated sediments, other non-point sources, etc.).	X	X			X
To identify and prohibit illicit discharges.					X
To identify those waters, which without additional action to control pollution from urban storm water discharges, cannot reasonably be expected to attain or maintain applicable water quality standards required to sustain the beneficial uses in the Basin Plan (TMDL monitoring).	X	X			
To determine unit loading rates from different urban land use categories.	X				
To determine reference loads and concentrations from un-impacted areas of Orange County including sediment loads from open spaces at the foothills.	X				
To determine runoff concentrations and loads as close as possible to the source (e.g. golf courses, restaurants, etc.).					X
To evaluate the effectiveness of existing urban runoff water quality management programs, including an estimate of pollutant reductions achieved by the structural and nonstructural BMPs implemented by the Permittees. This should include a determination of concentrations and unit loads that are achievable upon BMP implementation.	X	X	X	X	X
To evaluate costs and benefits of proposed municipal storm water quality control programs to the stakeholders, including the public.	X	X	X	X	X

This 2015-16 monitoring assessment presents a summary of results and conclusions for the monitoring year that build upon the ROWD findings and recommendations. As presented in the ROWD State of the Environment report, the Permittees have established the following five assessment questions that drive the implementation and assessment of the environmental monitoring programs as part of the iterative process:

1. Is there a problem?
2. If so, what is the magnitude and extent?
3. What are the sources of the problem?
4. Are conditions getting better or worse?
5. Are management actions working as intended?

The Permittees use these five assessment questions to continuously evaluate their monitoring program framework, design, and priorities for each of the core program elements. Monitoring, assessment, and research programs are implemented and periodically augmented based on the data collected and as new technologies become available. **Figure C-11.2** shows the process graphically.

Figure C-11.2: Monitoring, Assessment, and Research Cycle as Part of the Iterative Process



The ROWD established three key themes to help structure the assessment of environmental conditions in the Santa Ana Region Board jursidiction of Orange County. These assessment themes shown below drive the Permittees assessment strategy as well as the approach for developing new assessment tools, such as the Data Innovation Challenge project discussed in **Section C-11.4**:

- Theme 1: Focus on priority areas and constituents rather than trying to monitor all constituents, potential issues, and locations.
- Theme 2: Increase the integration of data from a wider range of sources in order to leverage the value and impact of the program's efforts to address the five assessment questions.

- Theme 3: Continue evolving from a strictly discharge-specific approach to a risk prioritization approach that can highlight problem areas and support more flexible monitoring designs that include data adaptive triggers.

C-11.3 Summary of Water Quality Results

This was the seventh complete year of monitoring under the Fourth Term Permit. The following summarizes the major outcomes of monitoring efforts during 2015-16 for each core program element:

C-11.3.1 Discussion of **Attachment C-11-I** –Monitoring Approaches and Methods of Analysis

The County implemented its core monitoring programs in 2015-16 as follows:

- Wet weather sampling was carried out during multiple storm events, including an event at the onset of the storm season in October 2015. Additional storm events were monitored in December 2015, early January 2016, late January/early February 2016, and March 2016 at various sampling locations.
- Dry weather sampling was conducted at monitoring intervals specified by the Fourth Term Permit and consistent with prior monitoring years across each program element. Dry weather sampling events for the Long Term Mass Emissions and Estuary/Wetlands elements were conducted quarterly for the Newport Bay watershed and semi-annually for the other North County stations, respectively. The monitoring schedules for the Bacteriological/Pathogen and Urban Stream Bioassessment Programs are conducted in accordance with regional program requirements established for these programs. Dry Weather Reconnaissance monitoring is conducted from May to September each calendar year at both targeted (five times per season) and random sites (three times per season).

C-11.3.2 Discussion of **Attachment C-11-II** – Long Term Mass Emissions Monitoring

Long Term Mass Emissions monitoring was conducted during two semi-annual dry weather monitoring events across the region along with two additional quarterly events in the Newport Bay watershed. Multiple storm events were also monitored during the 2015-16 reporting period. The following findings were noted:

- A total of 120 dissolved metals and total selenium composite samples were collected from Long Term Mass Emissions sites for comparison to the freshwater acute and chronic California Toxics Rule (CTR) criteria (adjusted for water hardness). As indicated in **Attachment C-11-II**, the receiving water dissolved metals exceedances of CTR criteria at Mass Emissions sites included copper, cadmium (one dry weather sample), and zinc (one wet weather sample).
- Dissolved copper in stormwater-influenced samples was the primary metals constituent of concern, with 25% of stormwater-influenced samples exceeding the acute CTR criterion and 54% exceeding the chronic CTR criterion.

- Total selenium exceeded the chronic CTR criterion in multiple samples in dry weather conditions at the four primary monitoring stations in Newport Bay watershed: Peters Canyon Channel (BARSED), San Diego Creek at Harvard (WYLSED), San Diego Creek at Campus (SDMF05), and Santa Ana-Delhi Channel (SADF01). A portion of the stormwater-influenced samples from Newport Bay stations BARSED (4 of 6 samples) and SDMF05 (3 of 7 samples) also showed some exceedances of the chronic CTR criterion.
- Patterns of aquatic toxicity were evaluated in 2015-16 during dry and wet weather conditions. Samples were considered to be toxic if the organism response test results (i.e., survival, reproduction, or growth) were less than (<) 80% effect (e.g., less than 80% survival) compared to the control sample. Toxicity occurred in 4.9% of dry weather samples in comparison to 6.9% of stormwater-influenced samples collected from inland receiving waters.
- Sediment samples were collected quarterly during dry weather conditions as part of the sampling program. Toxicity in the 10 day *Hyallela azteca* survival test occurred in 1 of the 16 samples analyzed at the BARSED station. Overall, the mean response was 98% survival for this sediment toxicity test across the stations sampled during 2015-16.
- Exceedances for organophoshate pesticides in dry weather were infrequent overall, with chlorpyrifos, diazinon, dimethoate, and malathion detected in 0%, 2%, 6%, and 2% of the 46 samples analyzed, respectively.
- Pyrethroid pesticides were generally detected more frequently than organophosphate pesticides in stormwater-influenced samples. Chlorpyrifos, diazinon, and dimethoate were detected in 0%, 4%, and 6%, of stormwater samples collected for organophosphate pesticides, respectively. Malathion was detected in 67% of samples collected, which is the most frequent for this pesticide suite. Amongst the pyrethroid pesticides constituents monitored, Bifenthrin was detected in 93% of samples, followed by Permethrin (84%), Cyfluthrin (76%), Cypermethrin (41%), and Deltamethrin (14%). Other pyrethroid pesticides detected were at frequencies of 14% or less in the 49 total samples analyzed per constituent.

C-11.3.3 Discussion of **Attachment C-11-III –** Estuary/Wetlands Monitoring

The Estuary/Wetlands Program was successfully completed during two dry weather monitoring events in northern Orange County watersheds (semi-annual) and quarterly for the Newport Bay watershed. Sampling was also completed during four storm events in 2015-16; the below average rain year coupled with smaller sized storms limited monitoring opportunities for harbor and estuary sites. The following findings were noted:

- The sediment quality objective (SQO) sampling, which includes a combination of chemical analyses, toxicity analyses, and benthic community analyses, was completed by the Permittees during the summer dry weather semi-annual monitoring events for Newport Bay and Huntington Harbour/North County stations. Of the 13 stations monitored, the overall SQO station assessment scores included 2 unimpacted sites, 5 possibly impacted sites, and 5 likely impacted sites. Overall, SQO assessment of sites

in areas that are minimally influenced by tidal exchange tended toward the Likely Impacted category.

- Sediment toxicity below the <80% effect range was overall infrequent in the 10-day *Eohaustorius* survival test and *Mytilus* fertilization test. In total, four of the 30 *Eohaustorius* survival tests were found to be toxic, and two of the *Mytilus* fertilization tests exhibited toxicity. The 2015-16 sampling results showed some sporadic detections of legacy synthetic pyrethroids, PCB arochlors, and organochlorine pesticide constituents in the sediment chemistry samples collected. The organochlorine compound 4,4′ DDE was the most frequently detected constituent.
- Exceedances of the acute CTR criterion for seawater samples were primarily related to dissolved copper during 2015-16, which was consistent with the 2014-15 reporting period. Exceedance frequencies for the acute CTR for dissolved copper were noted in 22% of dry weather samples collected and 19% of stormwater-influenced samples across the program. Exceedances of the chronic CTR criterion for dissolved copper were found to be 90% for dry weather and 80% for stormwater-influenced seawater samples.
- A total of five of 69 (7%) samples collected during dry and wet weather conditions contained detectable Malathion. These five Malathion exceedances were collected during storm monitoring events.
- Patterns of aquatic toxicity were evaluated in 2015-16 during dry and wet weather conditions at Estuary/Wetlands stations. As with Long Term Mass Emissions and the sediment toxicity samples discussed above, samples were considered to be toxic if the organism response test results (i.e., survival, reproduction, or growth) were <80% effect compared to the control sample. Aquatic toxicity was observed in 6 of the 118 toxicity tests conducted on dry weather samples; by comparison, none of the 96 tests conducted on stormwater-influenced samples collected showed evidence of aquatic toxicity.

C-11.3.4 Discussion of **Attachment C-11-IV** – Bacteriological/Pathogen Program

Bacteriological/Pathogens monitoring was conducted throughout the 2015-16 monitoring year and during the applicable AB411 recreation season period from 2015 (July 1 - October 31, 2015) and 2016 (April 1 to June 30, 2016), with results summarized in **Attachment C-11-IV**. The data presented includes key stations historically monitored by the Permittees as well as regional data from the Unified Beach Water Quality Program for the Santa Ana Region. The following findings were noted:

- Beach water quality during dry weather tends to be very good. Results show that monitoring sites exhibit a low exceedance frequency of 4% across all indicators for all beach samples on an annual basis and during the AB411 period.
- Conditions in regional channels, on the other hand, tend to exhibit more exceedances with an exceedance frequency of 18% for all indicators for the entire monitoring year and AB411 period; *Enterococcus* is the primary contributing factor to those for single sample standard exceedances.

- The exceedance rate trend shows an increase in the bacteriological water quality exceedance frequency at the five Huntington City Beach (HB1 – HB5) stations when compared to the 2014-15 entire year and 2014-15 AB411 periods. For 2015-16, the exceedance frequency was less overall for the entire year than during the AB411 period for these five stations.
- For beach samples at locations where urban runoff flowed to the ocean, exceedance rates for all indicators were 6% during the entire year and 7% during the AB411 period, with *Enterococcus* also being the primary bacteria indicator of concern. By comparison, exceedance rates for locations where urban runoff did not reach the ocean were 2% for both the 2015-16 year and AB411 period.
- Exceedance frequencies for all three indicators (Total Coliform, Fecal Coliform, and *Enterococcus*) were presented for the regional Unified Beach Water Quality Program in the Santa Ana Region. Overall, during the 2015-16 entire year and AB411 period, water quality exceedance frequencies were 9% or less for the 35 beach monitoring stations evaluated, with the majority of these stations below a 5% exceedance frequency.

C-11.3.5 Discussion of **Attachment C-11-V** – Urban Stream Bioassessment Monitoring

The Urban Stream Bioassessment monitoring program has been integrated into a multi-year regional study of southern California watersheds spearheaded by the SMC. The 2015-16 reporting period, with samples collected in April and May 2016, was the second year of the current five year study that began in 2015. The findings of the 2015-16 bioassessment monitoring events are summarized below:

- The 2015-16 monitoring assessment introduces a number of new and/or enhanced data products related to the California Stream Condition Index (CSCI) scoring system and the Southern California Algae Index of Biotic Integrity (SoCA Algal IBI). Examples include calculation of CSCI scores using data going back to 2009, SoCA Algal IBI scores for Spring 2015 monitoring (2016 data is still pending review by the State), and a comparison of CSCI scores versus overall CRAM scores.
- The County conducted sampling in spring 2016 at six stations: Santa Ana-Delhi Channel (801M12641); Esperanza Channel (801M12644); San Diego Creek (801M12649); Silverado Creek (SMC00105); and the two San Gabriel River Regional Monitoring Program (SGRRMP) stations (SGLR10601 and SGLR0011), both on Fullerton Creek. Station SGLR10601 is an upper portion of Fullerton Creek within Craig Regional Park, and SGLR0011 is a trapezoidal concrete section.
- At the five urban sites sampled in 2015-16, CSCI scores ranged from 0.39 to 0.72. The SGLR10601 station within Craig Regional Park, which is an urban environment, scored the highest of the 2015-16 monitoring locations at 0.72, exceeding the more rural Silverado Creek location (SMC00105) with a score of 0.68.
- Along with Ventura County, the Orange County Permittees participated in special studies related to sediment toxicity at three stations as part of the regional SMC program. The sediment toxicity study included testing survival for *Hyalella azteca* at 23 °C and 15 °C, along with survival and growth testing for the midge larvae *Chironomus tentans,* to mirror SWAMP's Stream Pollution Trends (SPoT) Monitoring

Program. No sediment toxicity was observed at the three stations that were sampled for the two organisms, including *Hyalella azteca* at 15 °C. Additionally, a screening for microcystins in sediment at these stations was also conducted. Samples analyzed were found to be non-detect for total microcystins as well as the variants.

The Permittees will continue to participate in this regional SMC program and San Gabriel River Regional Monitoring Program (SGRRMP) in 2016-17. Additional special studies are anticipated by the SMC workgroup in 2017 related to sediment toxicity and chemistry.

C-11.3.6 Discussion of **Attachment C-11-VI –** Dry Weather Monitoring Program

The Permittees successfully completed required monitoring for this program during the months of May through September, 2016.

- The Principal Permittee worked with the Permittees to select a list of 62 monitoring sites in 2016. Of the 62 sites monitored, a total of 46 were targeted and sampled five times. The remaining 16 random sites were sampled three times during the dry season to develop the data set used to calculate statistical tolerance intervals for each constituent. The random sites do not change over time.
- Water quality data collected was compared to statistically-derived tolerance intervals for various constituents with particular focus on bacteria, nutrients, metals, and pesticides. **Attachment C-11-VI** provides a geospatial analysis of targeted and random sites with one or more tolerance interval exceedances of bacteria, nutrients, metals, and pesticide constituents. Additional station level details are included for bacteria, nutrients, and metals along with a summary of organophosphate detections in 2016.
- Organophosphate pesticides were detected at low frequencies in 2016, similar to prior monitoring years. Of the 241 samples collected in 2016, the most frequently detected compound was Malathion at 2.9% (7 out of 241 samples analyzed). The remaining organophosphate pesticide compounds were detected in less than 1% of samples or not detected at all.
- Each of the 2016 targeted and random monitoring stations was analyzed using a water quality index (WQI) for the frequency and magnitude of exceedances of the tolerance intervals. The individual stations were then compared to the average WQI score calculated for the entire 2016 dataset and plotted spatially. The overall average WQI score for 2016 was 86, which is consistent with previous years for this program. By comparing each individual monitoring station to the overall average, the Permittees can assess where the best and worst performing stations are located.
- The Permittees are responsible for providing updates on their Dry Weather Monitoring source investigations as part of their jurisdictional PEAs.

C-11.3.7 Discussion of **Attachment C-11-VII –** Quality Assurance / Quality Control

The monitoring and reporting program is supported by a quality assurance/quality control (QA/QC) assessment program developed and implemented by the Orange County Stormwater Program. Laboratory analyses are independently validated through quality

control check samples in addition to the quality assurance requirements established by USEPA, state certification through the Environmental Laboratory Accreditation Program (ELAP), and Standard Method procedures. The quality assurance program evaluates data for accuracy, precision, and other factors using certified reference materials (for preparing synthetic samples), laboratory control standards for common analyses, duplicate field samples for precision, and equipment/trip blanks. For 2015-16, the QA/QC program provided the following key findings:

- The proportion of quality assurance samples submitted this year was approximately 14% of the total samples submitted to contract laboratories for constituent analyses. In addition to the contract laboratories, QA/QC samples for bacteriological constituents are prepared and submitted to the Orange County Public Health Water Quality Laboratory for analysis.
- The Permittees routinely evaluate their usage of certified reference materials for a variety of constituents in the preparation of synthetic samples. The Permittees have also completed additional servicing of the water purification systems used to prepare blanks and synthetic samples in 2015-16 as part of the QA/QC program.
- The program has developed new tools in 2016 of automated dashboards to track the performance of each of the contract laboratories more easily and efficiently, particularly as it relates to the synthetic samples, duplicates, and blanks. This has resulted in more streamlined QA/QC data evaluations that benefit the entire monitoring and assessment program.

C-11.4 Watershed Evaluation and Prioritization

Several components of the monitoring program were evaluated in combination to provide an overview of patterns across the region for the ROWD. The assessment ranked the following constituents as requiring further evaluation:

1. Indicator bacteria, primarily *Enterococcus*
2. Nutrients, primarily inorganic nitrogen and phosphorus
3. Pesticides and toxicity, primarily synthetic pyrethroids
4. Metals/trace elements and toxicity, primarily selenium and copper

The ROWD State of the Environment Report was organized into three critical areas of concern: bacterial contamination of swimming beaches, effects of nutrient enrichment, and patterns and trends in toxicity in the region's water bodies. These critical areas of concern were prioritized using a water quality index developed by the Canadian Council of Ministers of the Environment (CCME). A variation of this index has been used by the Central Coast Regional Board to assess watershed health within their Region. The index provides a measure, scored from 0 to 100, of the frequency and magnitude of exceedances that can be tracked over time, with lower scores representing worse conditions and higher scores indicative of better conditions. The scoring can help provide a more effective means of communicating results of water quality monitoring. The index accounts for the number of indicators in each category that exceed standards (such as bacteria or metals), the percentage

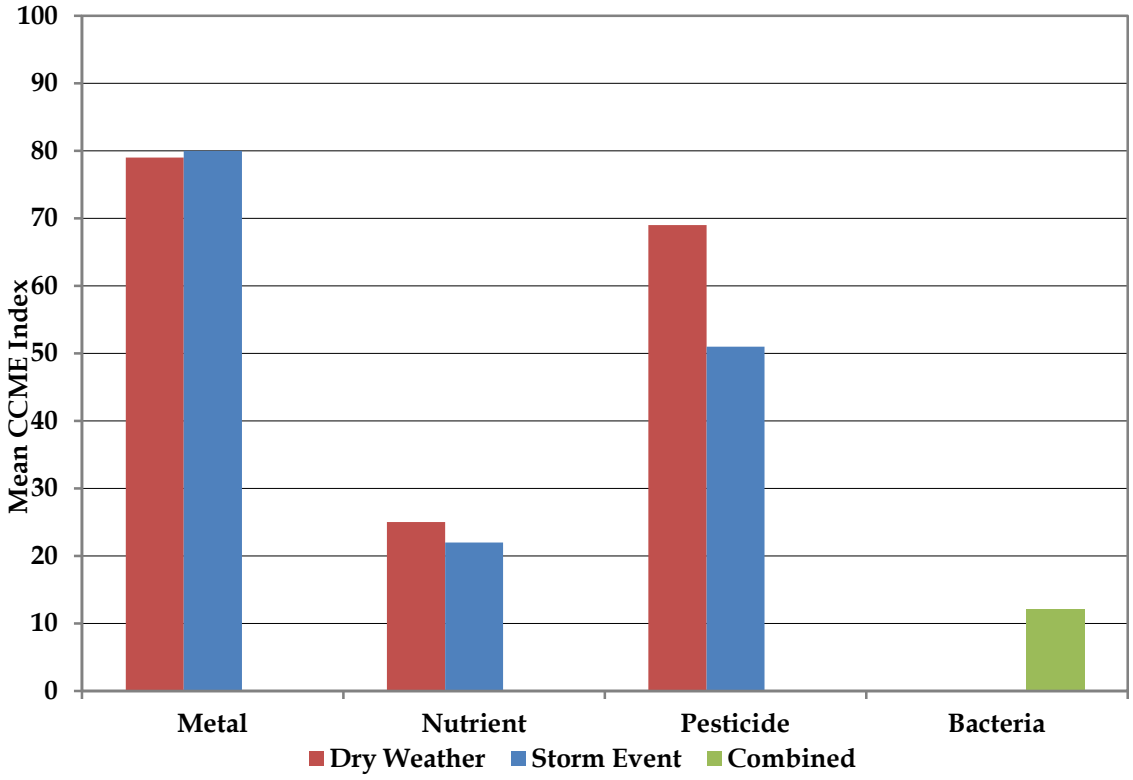
of individual samples that exceed corresponding standards, and the average magnitude of these exceedances.

Table C-11.2 below provides an overall summary of the ROWD prioritization analysis for various constituents in the Santa Ana Regional Board area using a dashboard-style table. Each constituent category is separated into dry and wet conditions. Red colors denote persistent and widespread exceedances of water quality objectives for receiving waters, or other widely used targets. Yellow colors indicate occasional exceedances, and green colors represent minimal or no exceedances. **Table C-11.2** can be compared with **Figure C-11.3** below.

Table C-11.2: Overall Summary of Results for the Prioritization Analysis, Santa Ana Regional Board Area. This summary was compiled from available data sets for each constituent over multiple years dating back to the early to mid-2000s.

	BACTERIA	NUTRIENTS	PESTICIDES	METALS	TOXICITY
CHANNELS					
DRY					
WET					

Figure C-11.3: Overall Water Quality Index for Core Monitoring Constituents in Inland Channels, summarized over the 2003 – 2016 monitoring period. This figure presents the mean CCME index scores in dry weather, wet weather, and/or combined data sets for bacteria, nutrients, metals, and pesticides in the Santa Ana Regional Board area over the 2003-2016 monitoring period.



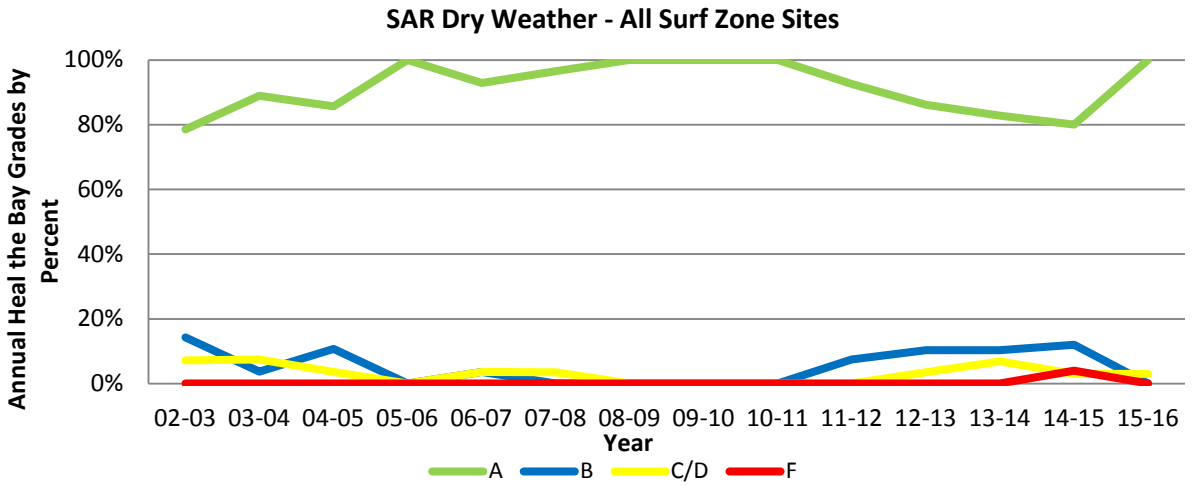
The following sections provide additional analysis and data presentation on a regional scale by constituent.

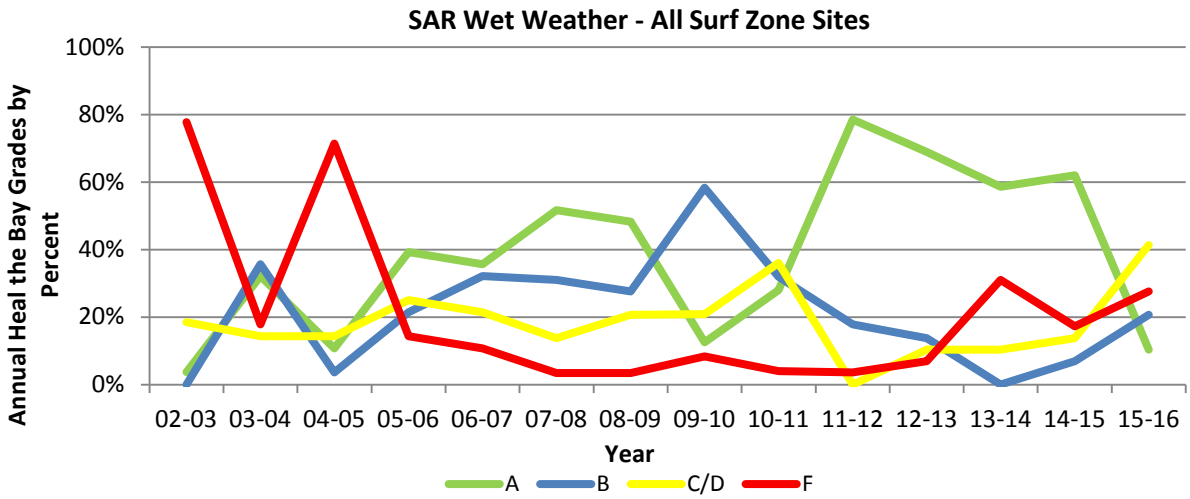
C-11.4.1 Bacteria

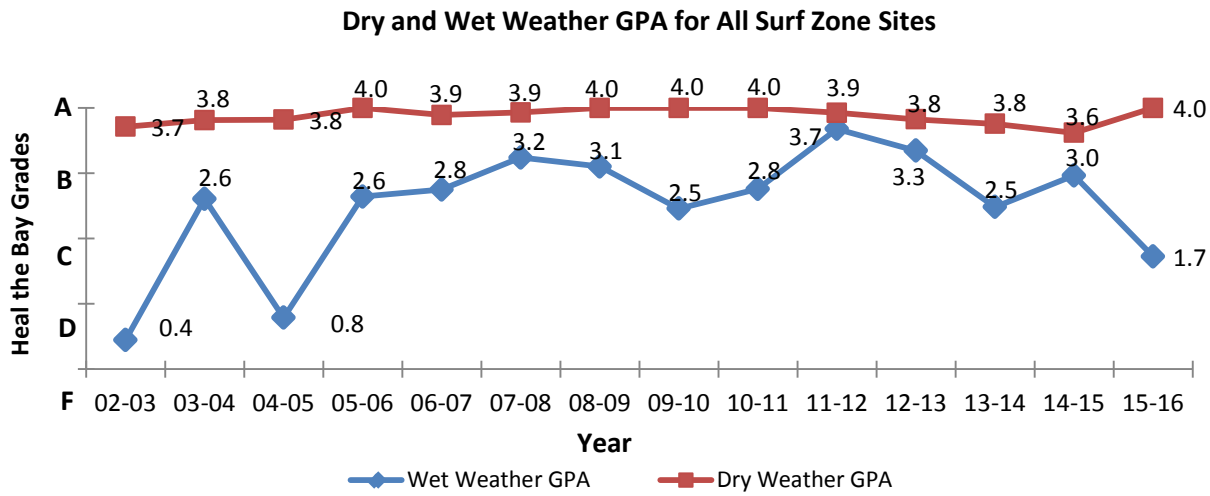
Several years of progress in addressing sources of bacteria through targeted actions implemented by the Permittees has led to a majority of swimming beaches in the Santa Ana Region maintaining an A grade in Heal the Bay's Annual Beach Report Card during dry weather conditions. During wet weather conditions significant challenges remain when stromwater containing elevated levels of bacteria discharge directly to the ocean, and as a result exceedances of standards increase and beach report card grades become more variable.

As indicated in **Figure C-11.4**, a comparison of ocean water quality during dry weather and wet weather conditions can be made by aggregating Heal the Bay's Annual Beach Report Card grades at all 28 surf zone monitoring locations to provide a yearly grade point average (GPA). The results indicate consistently good ocean water quality during dry weather conditions and a trend that reflects an overall improvement in bacteriological water quality during wet weather conditions.

Figure C-11.4: Annual Heal the Bay Report Card Grades for Dry Weather and Wet Weather Conditions. Also included are the cumulative Grade Point Averages (GPA) for Dry and Wet Weather Conditions for all Surf Zone Sites (third chart down).

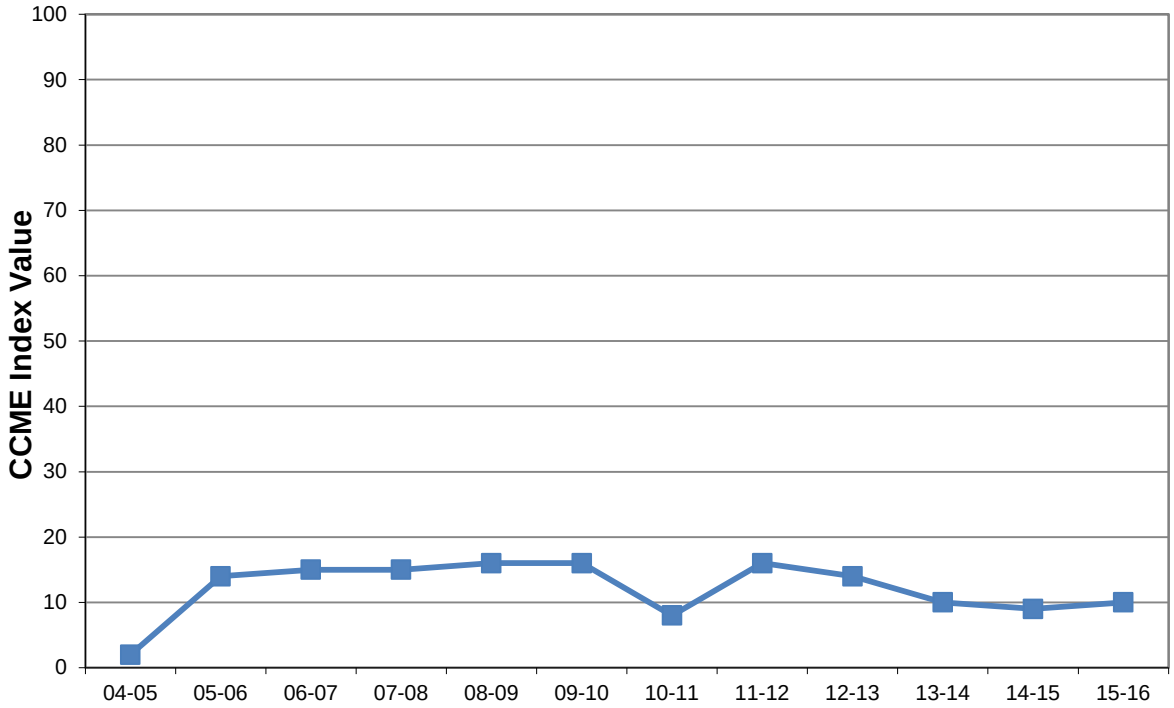






Challenges remain for indicator bacteria in the inland channels during both wet and dry weather. **Figure C-11.5** shows that CCME bacterial indicator index scores for inland channels during both wet and dry weather conditions remain low, meaning poor conditions, since 2005.

Figure C-11.5: Overall Index of the Extent to which Bacteria meet Thresholds in Channels, for both Dry and Wet Weather Conditions.



The following section describes additional information related to the regional shoreline monitoring program for northern Orange County.

Regional Beach Water QualityMonitoring Program

On July 1, 2012, the Permittees entered into a unified regional shoreline monitoring program under the Fourth Term MS4 Permit. Participants in this unified regional program include the Permittees, Orange County Health Care Agency, and Orange County Sanitation District. This unified program has facilitated regional collaboration, created a sustainable monitoring program for public health protection purposes, improved consistency in field and laboratory procedures to improve data comparability and prioritization abilities, and effectively leveraged resources and technical capabilities amongst the agencies involved. Each of these benefits is consistent with the monitoring and assessment approach themes described in **Section C-11.2**. **Attachment C-11-IV** includes 2015-16 regional data for the northern Orange County coastline from Seal Beach to the El Moro station near Crystal Cove State Beach.

The 2015 Annual Ocean, Harbor & Bay Water Quality Report was prepared by Orange County Health Care Agency and recently published in September 2016 (see http://ocbeachinfo.com/downloads/reports/2015oceanreport.pdf). The report provides an updated analysis of bacteriological water quality data for Orange County's recreational

waters countywide and includes data on sewage spills and related ocean, harbor and bay water closures. All surf zone recreational water monitoring locations in the region met compliance with dry weather AB411 bacteriological standards at least 90% of the time during the 10-year period from 2005 to 2015, with 21 of the 29 monitoring stations evaluated having compliance 98% or greater of the time.

Progress in Assessing Epidemiological Risks during Wet Weather

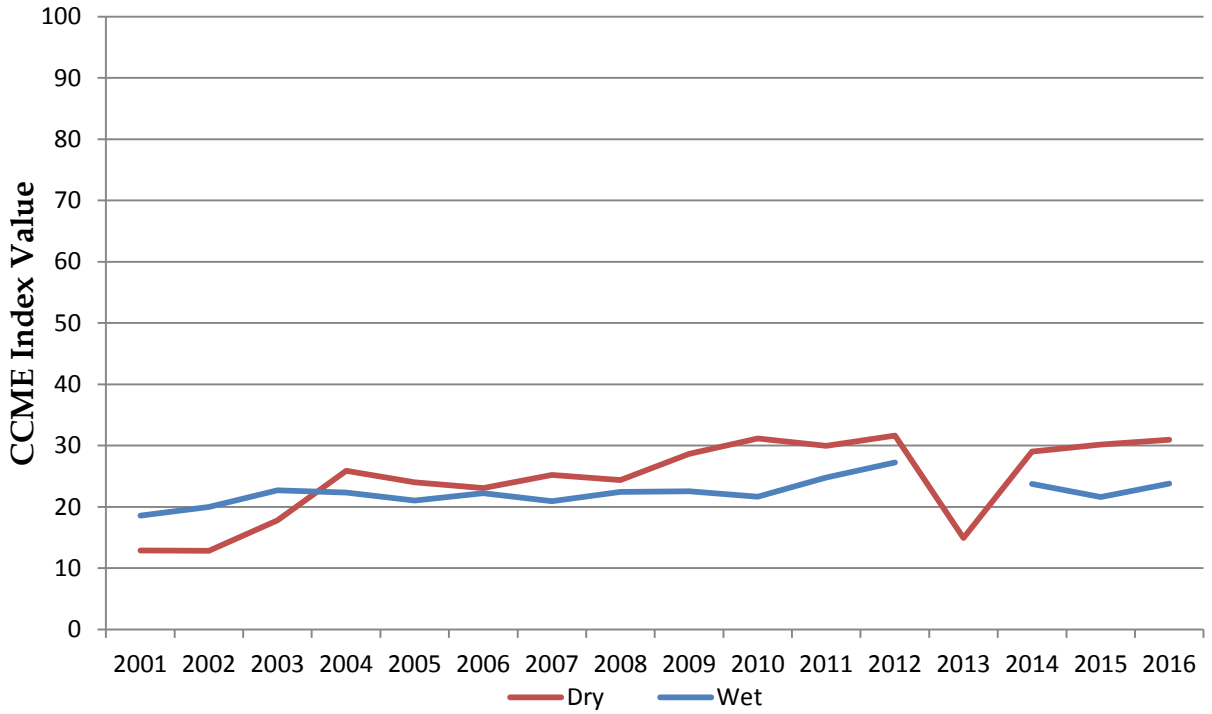
SCCWRP and its partner entities have completed a three-year epidemiological study examining the health impacts to surfers from entering the coastal surf zone during and just after rain events in September 2016. SCCWRP has published a news article and the Surfer Health Study report at the following link: http://sccwrp.org/homepage/news/16-09-12/Surfer_rainfall_study_helps_focus_water-quality_discussion.aspx. Based on an evaluation of two popular surfing locations during the winters of 2013-14 and 2014-15, the rate at which surfers contracted gastrointestinal illness was less than the illness rate predicted by the federal USEPA guidelines issued in 2012. The results of the Surfer Health Study have elicited further discussion on its public policy implications, and the Permittees will continue to track how the science and regulatory initiatives evolve relating to wet weather bacteria and pathogen risks.

C-11.4.2 Nutrients

Elevated nutrient levels are found in both urban and undeveloped areas, making it a complex regional challenge. Visual evidence of nutrient impacts is often manifested by the presence of macroalgae.

Many Permittee BMPs such as water conservation programs, LID, and public education for improved landscape maintenance practices target sources of nutrients. However, nonpoint and diffuse loading of nutrients, such as leaching from upland soils and intrusions from shallow groundwater, have increasingly become more important sources. In addition, the complex internal recycling of nutrients in creeks, streams, and other systems can contribute an additional source of loading. **Figure C-11.6** below demonstrates that water quality index scores for nutrients (total nitrogen and total phosphorus) are consistently low (poor conditions) over time at channel sites.

Figure C-11.6: Overall Index of the Extent to which Nutrients (Total Nitrogen and Total Phosphorus) meet Thresholds in Channels for both Dry and Wet Weather Conditions.



The following sections document additional programs and studies conducted in 2015-16.

Assessing Regional Nutrient Concentrations

Nutrient levels in inland receiving waters have a wide range of concentrations. Inorganic nitrogen and total phosphorus levels are significantly different between sites and between seasons as shown spatially in **Figures C-11.7** (total inorganic nitrogen) and **C-11.8** (total phosphorus), respectively. The statistical breakdown of the nutrient data collected in the receiving water monitoring programs used to create these figures is included at the following links:

- **Table C-11.3** for mean total inorganic nitrogen concentrations (mg/L) in inland surface waters during dry weather and stormwater-influenced conditions (https://ocgov.box.com/s/1atitq2vraglv2lpb02ce1ck0z6txh90); and
- **Table C-11.4** for mean total phosphorus concentrations (mg/L) in inland surface waters during dry weather and stormwater-influenced conditions (https://ocgov.box.com/s/4szpp5ww2gy0xawor08ar8ze67uao6sv).

Figure C-11.7: Mean Total Inorganic Nitrogen (mg/L) in Inland Surface Waters during Dry and Wet Weather Conditions, 2015-16

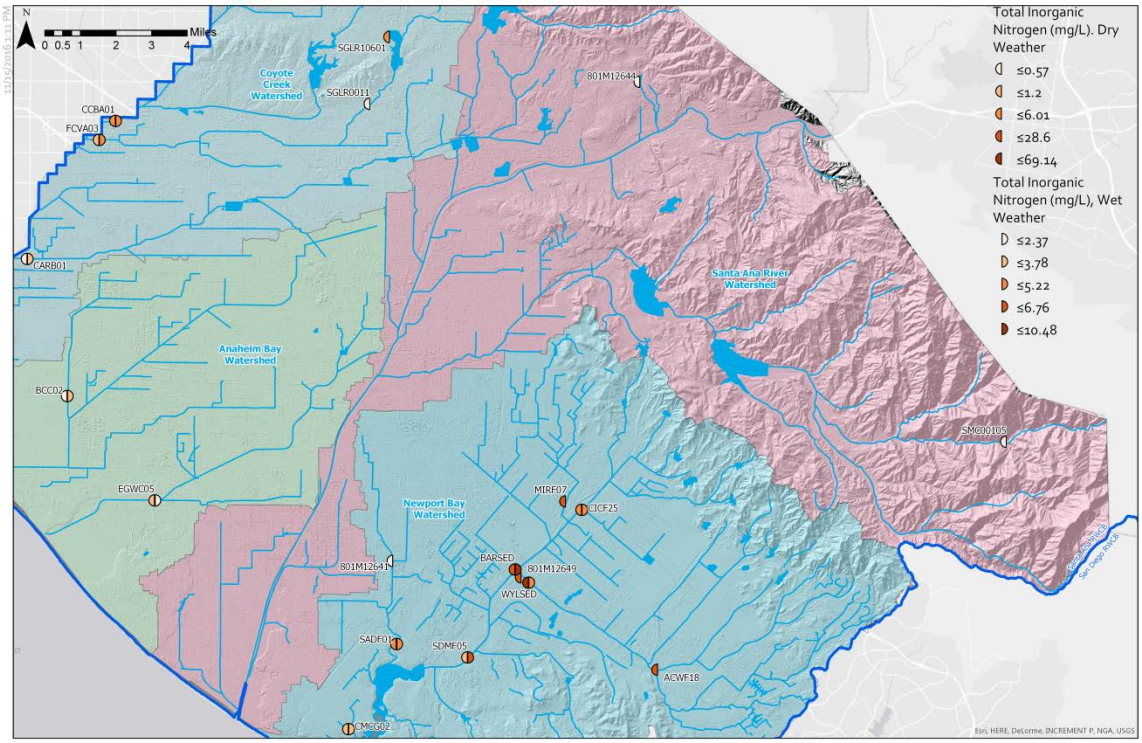
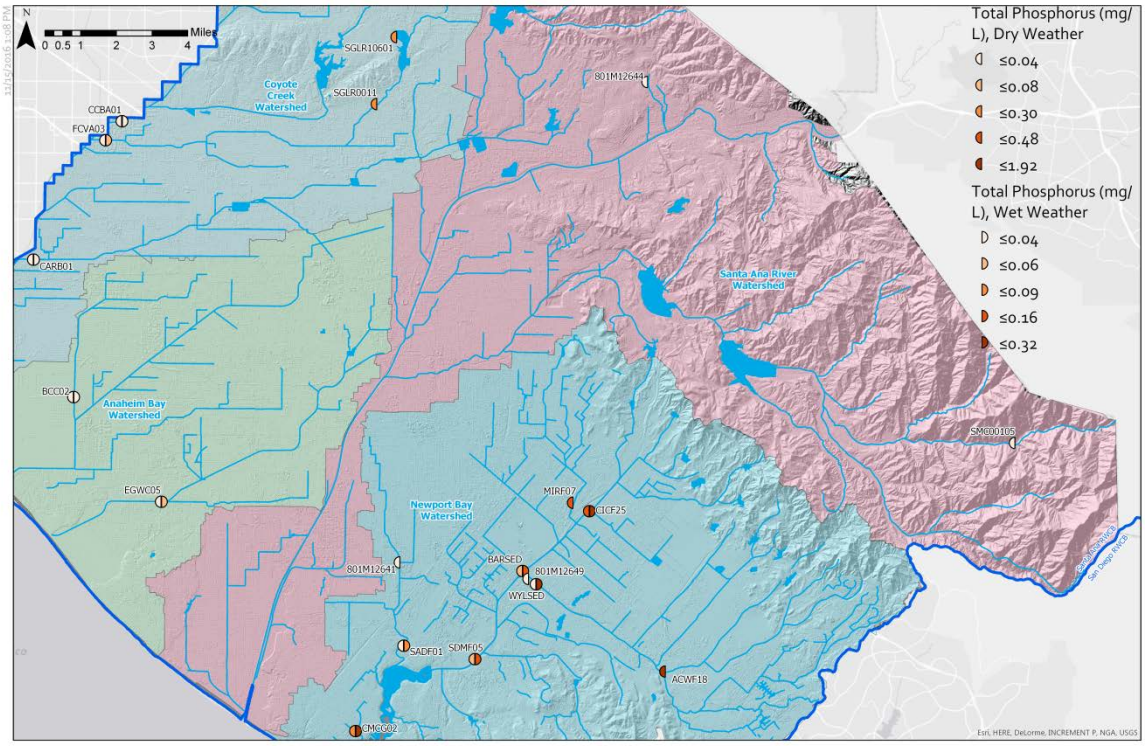


Figure C-11.8: Total Phosphorus Concentrations (mg/L) in Inland Surface Waters during Dry and Wet Weather Conditions, 2015-16.



Inorganic nitrogen levels are highest in the Newport Bay watershed. Inorganic nitrogen concentrations at Peter's Canyon Wash at Barranca Parkway (BARSED) and San Diego Creek at Harvard Avenue (WYLSED) contained the highest mean concentrations of Long Term Mass Emissions sites at 24.82 and 69.14 mg/L during dry weather, respectively. The mean concentrations for stormwater-influenced samples at BARSED and WYLSED were 10.48 and 4.7 mg/L, respectively. These two stations are the only Long Term Mass Emissions sites to see substantial (i.e. greater than 50%) total inorganic nitrogen concentration reductions in storm conditions. The majority of other Long Term Mass Emissions sites have increased mean total inorganic nitrogen concentrations in stormwater-influenced samples compared to dry weather conditions. This suggests that groundwater exfiltration in the area of BARSED and WYLSED represents the predominant source of inorganic nitrogen in the watershed during dry weather. As discussed in the 2014-15 PEA, this portion of central Irvine contains a shallow groundwater basin in the former "Swamp of the Frogs" area with both natural and agricultural inputs of nitrogen in the groundwater table that can impact surface waters.

The mean dry weather total inorganic nitrogen was 2.00 mg/L for San Diego Creek at Campus Drive (SDMF05), which is substantially less than BARSED and WYLSED. The operation of the Natural Treatment System which diverts, treats, and discharges back San Diego Creek water upstream of the SDMF05 station has been demonstrated to reduce nitrate as N concentrations and mean daily flow rates in this area (see **Attachment C-11-II.2**).

Mean total phosphorus concentrations at Long Term Mass Emissions stations ranged from 0.02 to 0.48 mg/L in dry weather and 0.0 to 0.32 mg/L during 2015-16 storm events. The highest mean concentrations detected for both dry and stormwater-influenced conditions were at the Central Irvine Channel and Costa Mesa Channel stations.

C-11.4.3 Toxicity Sources from Pesticides

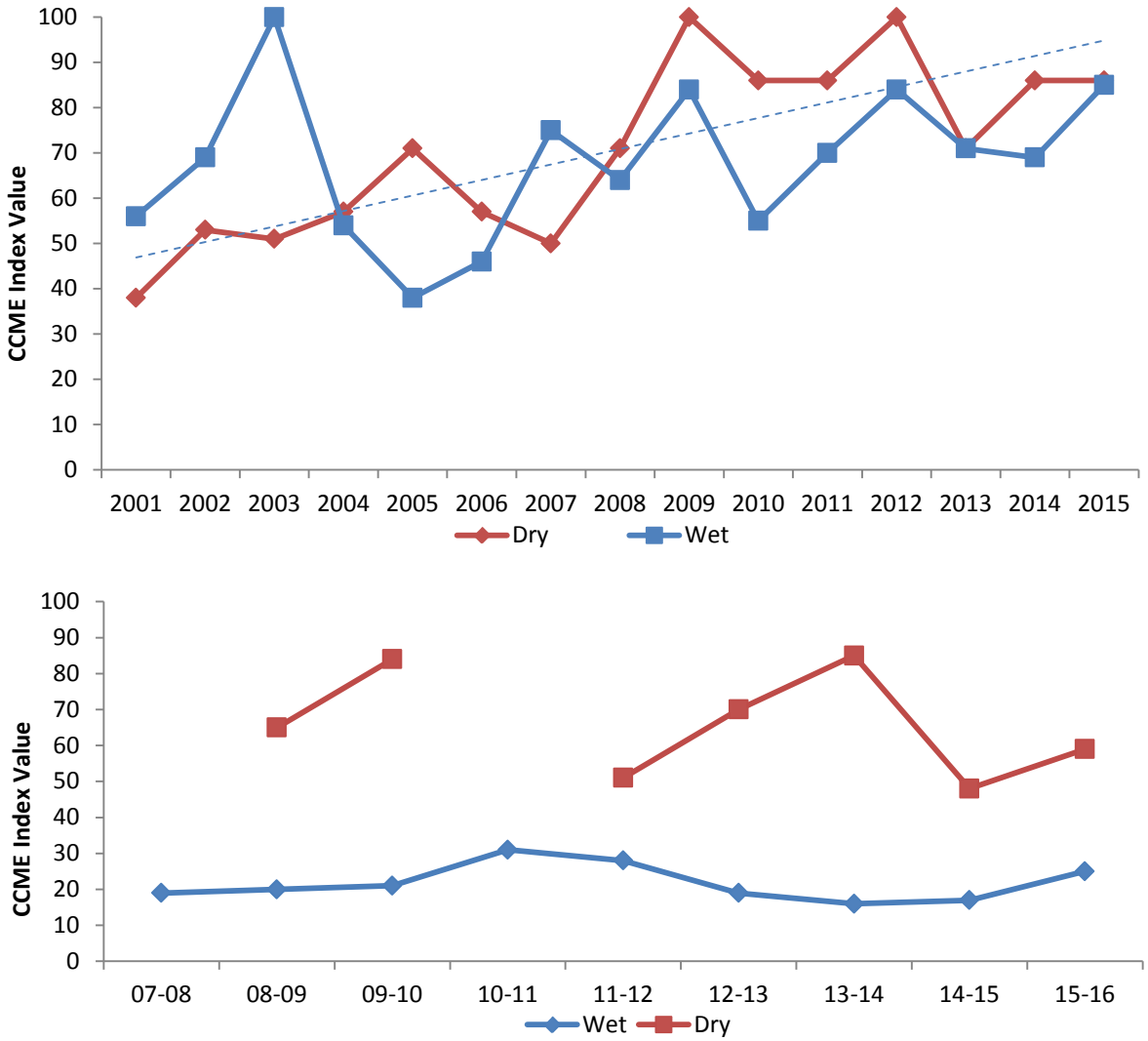
Aquatic and sediment toxicity has been attributed to the use and passive discharge of pesticides into the MS4. Tracking pesticide sources is a challenge as retail pesticide sales and usage is widespread and not fully documented. In addition, classes and amounts of pesticide compounds used in the environment evolve over time. An example would be the observed shift in usage from organophosphate pesticides to pyrethroid pesticides and other emerging pesticide compounds (fipronil and neonicitinoid pesticide classes).

The Permittees have incorporated pesticide monitoring into their core program elements. **Figure C-11.9** below demonstrates trends over time for organophosphate and pyrethroid pesticides in both dry and wet weather. The upper figure shows that water quality index values are improving overall in dry weather.

There are occasional detections of organophosphate pesticides in receiving waters in both dry and wet weather, mostly for Malathion. However, these detections generally occur to a much lower degree than pyrethroid pesticides, hence the lower overall water quality index scores for pyrethroids versus organophosphate pesticides in the two charts associated with **Figure C-11.9**. Pyrethroid pesticide water quality index scores have been variable in recent monitoring years in dry weather, and additional sampling data and statistical analysis is needed to fully understand potential trends. The Permittees have recommended that the Dry Weather Monitoring Program for outfalls transition from sampling organophosphate pesticides to

pyrethroid pesticides to gain additional dry weather data during the upcoming Fifth Term Permit.

Figure C-11.9: Overall Water Quality Index of the Extent to which Organophosphate (Top) and Pyrethroid Pesticides (Bottom) meet Regulatory Standards in Dry and Wet Weather Conditions.



Progress in Identifying Toxicants to Benthic Sediment Species and other Aquatic Organisms

As part of the Estuary/Wetlands monitoring program, sediment samples for various pesticide analyses were collected alongside sediment toxicity samples to evaluate the relationship between the presence of the pyrethroid pesticides and survival rates for *Eohaustorius*. The results from 2015-16 monitoring show an overall low occurrence of sediment toxicity and sporadic detections of pyrethroid compounds (see **Attachment C-11-III.2 –** *Sediment Chemistry and Toxicity Analysis*). To further evaluate this issue, the Permittees have re-assessed their sediment chemistry analytical program in 2016. As a result, the Permittees have changed their laboratory that analyzes pesticides so that lower detection limits can be obtained for

pesticide compounds in water and sediment. The Permittees are hopeful that lower detection limits will provide a better understanding of the complex relationship between toxicity detections and pesticide chemistry.

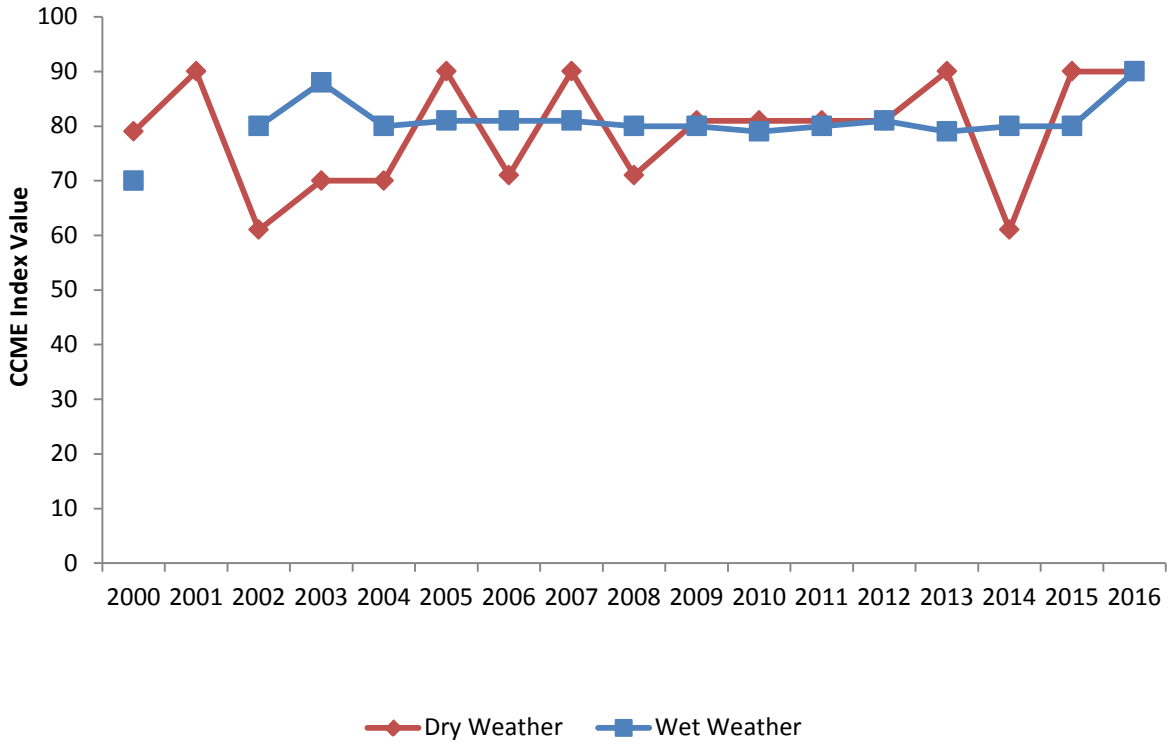
Progress in Evaluating Toxicity Testing Methods and Procedures

The Permittees have participated in the SMC Toxicity Intercalibration Study throughout 2015-16. The SMC commissioned this intercalibration study to quantify toxicity sample testing comparability amongst various participating laboratories. The SMC has performed similar studies for the chemical testing program to address comparability issues. The toxicity intercalibration study aimed to assess variability amongst testing laboratories, identify potential improvements in laboratory methods and procedures, and improve comparability and consistency. The SMC, with project oversight by SCCWRP, conducted exercises to characterize and ultimately minimize inter-laboratory variability for testing marine and freshwater species, and to develop a manual to provide guidelines for testing precision and sensitivity. The SMC prepared a draft Toxicity Testing Laboratory Guidance Document in August 2016, which is presently under review and discussion by the SMC member agencies. In addition, the SMC is considering additional testing based on the results of the initial study. The Permittees, and their contract laboratory for toxicity testing, plan to continue to particpate in these efforts in 2016-17, which is consistent with Theme 2 of the monitoring and assessment approach discussed in **Section C-11.2**

C-11.4.4 Toxicity Sources from Trace Metals

Trace metals are evaluated as potential sources of toxicity. However, studies by the Permittees have indicated that metals, with exception of some instances of elevated dissolved copper, are at relatively low exceedance frequencies and do not appear to contribute to aquatic toxicity in freshwater. **Figure C-11.10** below demonstrates that water quality index scores for metals are relatively high (better conditions) in channels and embayments and have remained steady since 2003. The index includes the number of metals that exceed standards each year, the percentage of individual samples that exceed standards, and the average magnitude of any such exceedances.

Figure C-11.10: Overall Water Quality Index of the Extent to which Metals meet Regulatory Standards in Dry and Wet Weather Conditions.



Progress in Assessing Sources of Dissolved Cooper

Dissolved copper exceedances of applicable acute and chronic CTR criteria in receiving waters (freshwater and seawater) was assessed across the region in wet and dry weather, as shown in **Attachment C-11-II** and **C-II-III**. Dissolved copper remains as the primary metal constituent with CTR exceedances in dry and wet weather. The primary sources of dissolved copper in wet weather runoff from urbanized areas include the following:

- Vehicle brake pads – SB346, passed in 2010, will require new brake pads to contain no more than 5% copper by 2021, with the amount being reduced to near zero by 2025.
- Industrial sites – the new Industrial General Permit (Order 2014-0057-DWQ) includes provisions for addressing metals sources including copper. A more robust dataset from industrial chargers is anticipated as a byproduct of this permit, which may allow for improved source tracking for metals constituents overall.

Copper-based anti-fouling paint commonly used on boat hulls has been identified as the primary source of copper within Newport Bay, and the Santa Ana Regional Board is developing a TMDL would address copper releases from paint on boat hulls. The Permittees will continue to be involved in this TMDL program.

Progress in Evaluating Metals and Selenium Sources

Research into the nature and occurrence of geologically derived contaminants impacting urban creek systems continued during 2015-16 and remains an ongoing research process. The collaborative Nitrogen and Selenium Management Program (NSMP) has completed an extensive set of studies and assessed management alternatives addressing groundwater inputs (www.ocnsmp.com). Research in the Newport Bay watershed has linked selenium inputs from shallow groundwater infiltration into the MS4 and directly into receiving waters as the principal source.

In addition to the NSMP in the Newport Bay watershed, the Permittees continued their efforts researching natural sources of metals and selenium from ambient geology. The Permittees have established a working relationship with a research team lead by the University of Southern California's Department of Earth Sciences, who are implementing advanced isotopic and geochemical evaluations of shallow groundwater contaminant sources in urban creek systems. A key achievement of this research included publishing of the following article in August 2015 to the **Journal of Environmental Science & Technology** (accessed at http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01006): Bardsley, A. I.; Hammond, D. E.; Von Bitner, T.; Buenning, N. B.; Townsend-Small, A. *Shallow Groundwater Conveyance of Geologically Derived Contaminants to Urban Creeks.* Environmental Science & Technology. 2015, 49 (16), pp 9610-9619.

As indicated in the article, the County, along with other entities, provided various forms of support into this research project. Other recent activities completed by the County included field monitoring support in July and August 2016 for researchers Douglas Hammond and Audra Bardsley from the University of Southern California, Department of Earth Sciences. The summer 2016 field studies involved examining groundwater transit times and ground water age dating in San Juan Creek, San Mateo Creek and Dana Point Coastal Streams watersheds, which was necessary to help develop a radium-based groundwater transit time method for the researchers. As part of the County's support, staff provided access and field sampling support to monitor shallow groundwater weep sites along Oso Creek, Salt Creek, San Mateo Creek and Sulfur Creek. The County also began to map known groundwater springs across the County to better understand their impact on the drainage system and receiving waters. Support of this research and the data that is ultimately generated is consistent with Theme 2 of the monitoring and assessment approach (see **Section C-11.2**), which describes the integration of data from a wider range of sources in order to leverage the value and impact of existing program efforts.

Progress in Data Assessment

The California State Water Boards' Office of Information Management and Analysis began their Open Data Initiative at the beginning of 2016 by creating and launching a data portal that integrates several key water databases that are maintained by the state. To celebrate the creation of this portal and promote the value of open data, the State Water Board held a Data Innovation Challenge in April of 2016 – an open competition for software developers and designers to create applications, visualizations, and other tools to enhance availability and integration of important water data.

The County entered the Data Innovation Challenge in partnership with CloudCompli, Inc., a private vendor serving stormwater clients that has experience connecting to widespread data sources. In the spirit of the open data initiative, the team wanted to create an Application Programming Interface (API) for the County's water quality database that would improve the availability of monitoring data. The team also wanted to integrate Orange County stormwater program monitoring data with other sources of data available from the state, in order to develop an increased understanding of the condition of MS4 discharges related to potential pollutant sources.

The County worked with CloudCompli, Inc. (CloudCompli) to conceptualize, build, and test a web application that combined water quality data from two different sources: the Permittee's water quality database and the California Storm Water Multiple Action and Report Tracking System (SMARTS). The application highlighted data points on a map and color coded them based on the concentration of the pollutant (such as metals data), making it easier to visually compare and comprehend patterns in the watersheds. The application only displayed data within a short time span, showing data points that were more likely to be affected by the same environmental influences. Therefore, this web application could be used as a tool in source investigations of degraded water quality.

The County/CloudCompli team submitted the source code for the application, the Water Quality Explorer, and an academic paper to the Data Innovation Challenge. In total, eight projects from public, non-governmental, and private organizations were presented to a panel of judges. The County/CloudCompli project was awarded first place and is highlighted on the Water Boards' website. One of the judges, State Water Board Member Tam Doduc, mentioned that a strong reason why this project was ranked first was "the ingenuity and innovation exhibited" and the application's close connection to the core mission of the State Water Board: to protect water quality. The full list of challenge entries submitted are available at http://www.waterboards.ca.gov/resources/data_databases/data_innov_challenge.shtml.

After winning first place the team compiled ideas about future applications of this concept to continue harnessing the growing number of federated water quality datasets, and further develop the visualization and analysis tools that had been explored through this competition. A presentation about the application that was created ("WQExplorer") was given to Permittees to showcase the concept of a database whose main interface was a map. The inspectors gave valuable feedback about the possibility of the WQExplorer helping with source investigations.

Once the County's water quality data API was created, the County began to investigate different data visualization software, trying to achieve the goals that the Challenge instilled of data availability and data integration. For the 2016 CASQA annual conference, the County developed a mock-up of what the WQExplorer application could be in the future: a tool to help answer all five questions of the monitoring and assessment approach discussed in **Section C-11.2**. During its Data Federation planning meetings, the County has used what it learned from the Challenge to better prepare for future issues.

The team's win at the Data Innovation Challenge was prominent and noted statewide. The achievement closely aligns with the assessment themes discussed in **Section C-11.2** by

focusing on priority areas that highlight water quality issues (Theme 1), and by integrating multiple data sources to better leverage available water quality data (Theme 2).

C-11.5 Recommendations and Changes in the Monitoring and Assessment Program

The ROWD State of the Environment Report and subsequent annual PEA submittals include a number of monitoring and assessment program recommendations. Progress on addressing these changes and/or recommendations in 2015-16 are provided in the bullets below along with identification of the corresponding three assessment themes discussed in **Section C-11.2** which apply:

Themes 1, 2, and 3:

- The ROWD State of the Environment and subsequent 2013-14 and 2014-15 PEAs incorporate the use of a water quality index (based on the CCME index) to assess water quality data and establish priorities in monitoring and program management. The Permittees continued to use and enhance this assessment tool, incorporating it into many of the core monitoring program elements for the 2015-16 PEA, such as for the Dry Weather Monitoring Program. The Permittees continue to work with the SMC on a project to explore development of a standardized water quality index that could be used on a broad scale to interpret large amounts of complex water quality data.
- The State Water Resources Control Board held a Data Innovation Challenge in 2015-16, which was a competition for software developers and designers to create applications, visualizations, and other tools to enhance availability and integration of important water quality data. The County of Orange and its team won this competition in 2016 by creating a web application that spatially mapped water quality data from two different sources: the Permittees water quality database and the California Storm Water Multiple Action and Report Tracking System (SMARTS). The end product was highly innovative, and this achievement demonstrates the Permittees ongoing commitment to continually enhance and improve the monitoring and assessment program through data integration from multiple sources.
- Order No. R8-2009-0030 was anticipated to have been replaced by the Fifth Term MS4 Permit during the 2015-16 reporting period. However, the adoption of the Fifth Term Permit for north Orange County by the Santa Ana Regional Board remains pending. In anticipation of the next Order, the Permittees have taken steps to integrate the MS4 and TMDL monitoring programs into one comprehensive Monitoring and Assessment Program for the region.
- The Permittees have continued to research the applicability of microbial source tracking tools with human and animal genetic markers, particularly on special studies or source investigation activities.

Themes 1 and 2:

- The SMC has developed new protocols for bioassessment monitoring as part of the second 5 year regional study discussed in **Attachment C-II-V**. The Permittees have implemented these new monitoring and assessment protocols in 2015-16, including developing a variety of new data products using CSCI scoring and completing special

studies on sediment toxicity. The Permittees will continue to actively engage in the regional monitoring program in 2016-17.

- Efforts in improving laboratory comparability toxicity sample remain ongoing, and the Permittees will continue to participate in the SMC toxicity intercalibration study in 2016-17.
- Working with the Santa Ana Regional Water Quality Control Board, SCCWRP, and other agencies, the Permittees have voluntarily participated in a causal assessment of a section of San Diego Creek between Jeffrey Road and Culver Drive in the City of Irvine. This process began in 2014-15 and continued in 2015-16. The goal is to develop the capacity to perform causal assessments while attempting to identify the primary stressors resulting in low bioassessment scores historically for monitoring stations within this section of San Diego Creek. The Permittees plan to continue their participation in this causal assessment during 2016-17.

Themes 1 and 3:

- Organophosphate pesticides were detected at low frequencies in 2016 for the Dry Weather Monitoring Program, similar to prior monitoring years. Based on this finding, and unless otherwise needed to support specific source investigation activities, the sampling and analysis of organophosphate pesticides should be eliminated from this program consistent with monitoring and assessment Themes 1 and 3 discussed in **Section C-11.2**.