Annual Water Quality Monitoring and Research Report

Fiscal Year

2016

City of Santa Barbara
Creeks Division
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Clean Creeks
HEALTHY BEACHES
CITY OF SANTA BARBARA

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Contents

Introduction

The following report describes sampling and results that were based on the Fiscal Year 2016 Research and Monitoring Plan (Research Plan; Appendix A). The Research Plan is organized around program elements and research questions that have been reviewed by the Creeks Advisory Committee (CAC). The Research and Monitoring Program is adaptive, and as questions are answered or modified, sampling strategies change as well. The program elements and research questions are provided below. Where possible, the report is organized around the research questions. ***The primary purpose of this report is to serve as an internal record of data collection and analysis. Please see the Creeks Division 2001-2006 report for a discussion of methods, information on water quality criteria, and a glossary of monitoring terms.***

Program Goals

The goals of the monitoring program are to:

1. Quantify the levels (concentration, flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.
6. Meet monitoring requirements for grants.
7. Meet General Permit monitoring requirements.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

FY 16 Research and Monitoring Plan

In support of the program goals, the Research Plan consists of eight key elements and associated research questions (see Research Plan in Appendix A for questions):

1. Grant Project Requirements
2. General Permit Requirements
3. Watershed Assessment
4. Storm Monitoring
5. Restoration and Water Quality Project Assessment
6. Source Tracking
7. Creeks Walks

8. Bioassessment

The Research Plan changed substantially in FY14 due to new regulatory requirements in the new Phase II Small MS4 General Permit (Permit) and an increase in the number of water quality and restoration projects requiring sampling. Minor changes were made for FY 15. For FY 16, changes include the addition of two new projects and removal of two projects due to completion:

1. Remove Verification Monitoring project due to completion (update provided below).
2. Remove grant-required sampling and reporting for the LID Parking Lots Project because it has been completed (update below).
3. Add Neonicotinoid Pesticides in Santa Barbara Project (update below).
4. Add Leadbetter Beach and East Beach at Sycamore Creek Microbial Source Tracking Project, to be completed by UCSB (update below).

Grant Project Requirements

Questions/tasks, followed by status:

LID Streets, Sidewalks, and Alleys

1. Calculate the load of pollutants infiltrated during 2015-16 rain events at 4 sites, based on Event Mean Concentration results from FY 2015 results. *The load calculation results are presented below, for each inch of rainfall.*
2. Maintain HOBO data loggers and graph results. *Tim Burgess maintains the HOBO loggers and plots. Some are included in the material below.*
3. Provide information for grant reporting. *Results and calculations have been provided for grant reporting.*
4. Monitor and report according to approved Monitoring Plan/Quality Assurance Project Plan (MP/QAPP). *Monitoring and reporting was carried out according to the approved MP/QAPP.*

The following section is copied from the Final Report for the LID Streets, Sidewalks, and Alleyways Project:

Monitoring and Reporting

The City measured the Project's benefits by monitoring the storm water runoff for pollutants and toxicity at each site before construction in order to calculate the pollutant loads associated with each site and establish a baseline condition. Monitoring was completed according to the approved LID Streets, Sidewalks and Alleys Project Monitoring Plan/QAPP. A sampling location was identified for each site where storm water runoff could be collected. Sampling took place at each of the four sites during three different storms. Composite samples were collected when possible (two of three storms). Samples were tested for fecal indicator bacteria, metals, pesticides, nutrients, hydrocarbons, surfactants, total suspended sediment, and toxicity and results were compared to Basin Plan water quality objectives where possible. All sample results were averaged to obtain event mean concentrations (EMC). The EMCs were compared among sites, and there were no significant differences among sites. Therefore, a project-wide EMC for each pollutant was used in calculating load reduction. Load reductions were calculated per inch of rainfall and for the time period between project completion and January 25, 2017.

TABLE 1. CONSTITUENTS INCLUDED IN LOAD REDUCTION MONITORING.

Parameter Group	Highest Reporting Limit	Central Coast Water Board Basin Plan Objective
Fecal Indicator Bacteria	100 MPN/100 ml	From AB 411, rather than Basin Plan: Total Coliform: 1000 MPN/100 ml E. coli: 400 MPN/100 ml Enterococcus: 104 MPN/100 ml
Organic Carbon (Dissolved)	0.5 mg/L	
Nutrients		
Nitrate (as N)	0.11 mg/L	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.
TKN	0.5 mg/L	
Total Nitrogen	0.05 mg/L	
Total Phosphorus	0.05 mg/L	
Total Petroleum Hydrocarbons - Diesel	0.5 mg/L	Waters shall not contain oils, greases, waxes, or other similar materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses
Total Suspended solids	20 mg/L	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Total Metals 1		
Arsenic	0.01 mg/L	
Cadmium	0.005 mg/L	0.03 mg/L
Calcium	0.1 mg/L	
Chromium	0.005 mg/L	0.05 mg/L
Copper	0.01 mg/L	0.03 mg/L
Iron	0.04 mg/L	
Lead	0.005 mg/L	0.03 mg/L
Magnesium	0.02 mg/L	
Manganese	0.02 mg/L	
Mercury	0.0008 mg/L	0.0002 mg/L
Nickel	0.01 mg/L	0.4 mg/L
Potassium	0.5 mg/L	
Silver	0.01 mg/L	
Sodium	0.5 mg/L	
Zinc	0.02 mg/L	0.2 mg/L
Surfactants	0.1 mg/L	0.2 mg/L
Pesticides		
Neonicotinoids	5-10 ng/L	None in Basin Plan.
Pyrethroids	2-100 ng/L	None in Basin Plan
Toxicity		All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Current 303(d) evaluations use the criteria of test results being significantly different than the control.

[1] Reporting limits in some samples were high due to dilutions performed for sample analysis.

Monitoring Locations

The following figures show the sampling location at each project site. One to four sampling sites were selected at each location in the Project area. Each site(s), shown by the red stars below, was selected to provide runoff that is inclusive of or representative of runoff from the project before construction, while excluding runoff that will not be infiltrated by the Project. Sampling sites were observed during dry weather, and in some cases prepared for sampling by digging out areas to place sample vessels for runoff collection. In some cases, alternative locations were identified during storm sampling events.

To confirm the amount of rainfall infiltrated by the project, monitoring ports were installed below the permeable pavers. These ports allow access from the surface of the pavers to the sub-grade soil, so the depth of water stored beneath the pavers in the sub-grade can be measured. Measurements are made using water level loggers that record water depth every five minutes. Data from these loggers reveal the changing depth of the stored water during a rainstorm as it fills and infiltrates into the ground below. Locations of these monitoring ports are shown as yellow triangles in the maps below. Coordinates are provided in **Error! Reference source not found.**.

TABLE 2. SAMPLING LOCATIONS. NAD 83 DATUM USED FOR GPS COORDINATES

Site Name	Sample Site Code	Sample Site Specific Location	Comments	Latitude	Longitude
Plaza de Vera Cruz Alley Project Site			GPS Location of each end of project site	34.4193 34.4185	-119.6950 -119.6938
Plaza de Vera Cruz Alley Monitoring Port				34.4187	-119.6941
Plaza de Vera Cruz Alley Runoff Sample Site	LIDVeraCru	Where runoff flows off of alley.		34.4186	-119.6940
Alice Keck Park Memorial Gardens Sidewalk Project Site			GPS Location of each corner of project site	34.4302 34.4293 34.4284 34.4292	-119.7062 -119.7050 -119.7060 -119.7072
Alice Keck Park Memorial Gardens Sidewalk Monitoring Ports				34.4297 34.4287	-119.7055 -119.7057
Alice Keck Park Memorial Gardens Sidewalk Sample Sites	LIDAliceKe	Where runoff discharges off of sidewalk into gutter, and where runoff discharges off of a concrete sidewalk in adjacent Alameda Park		34.4290 34.4275	-119.7054 -119.7047
700 block of N. Quarantina St. Project Site			GPS Location of each end of project site	34.4270 34.4259	-119.6913 -119.6898
700 block of N. Quarantina St. Monitoring Port				34.4265	-119.6907
700 block of N. Quarantina St. Runoff Sample Site	LIDQuarS	Runoff collected from sidewalk runoff and street runoff into gutter.		34.4264	-119.6904
800 block of N. Quarantina St. Project Site			GPS Location of each end of project site	34.4279 34.4270	-119.6926 -119.6915
800 block of N. Quarantina St. Monitoring Port				34.4273	-119.6919
800 block of N. Quarantina St. Runoff Sample Site	LIDQuarN	Runoff collected from sidewalk runoff and street runoff into gutter.		34.4263	-119.6904

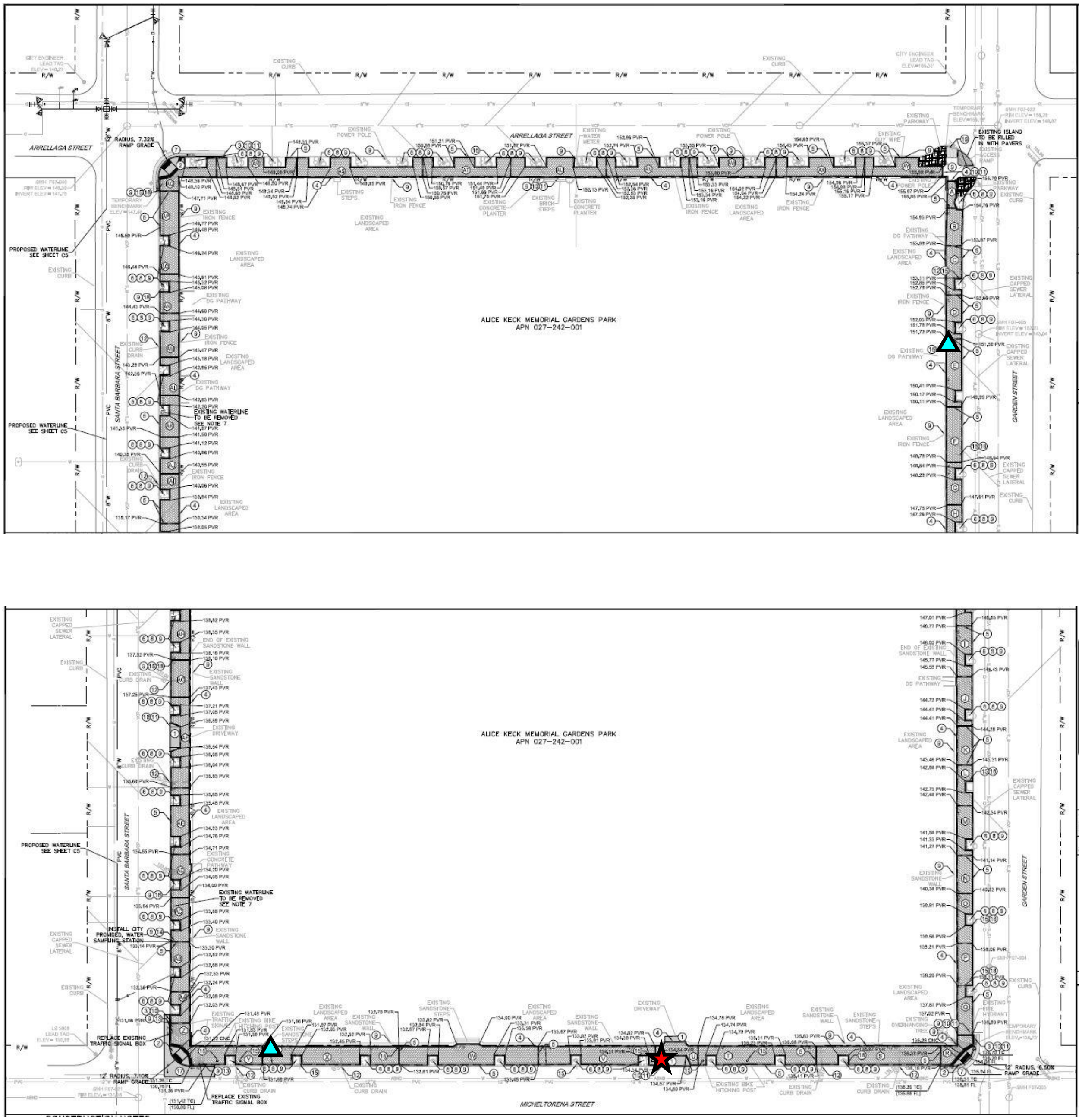


FIGURE 1. ALICE KECK PARK MEMORIAL GARDENS SIDEWALKS SITE WITH MONITORING PORTS (BLUE TRIANGLES) AND PRE-PROJECT STORMWATER SAMPLING LOCATIONS (RED STAR).

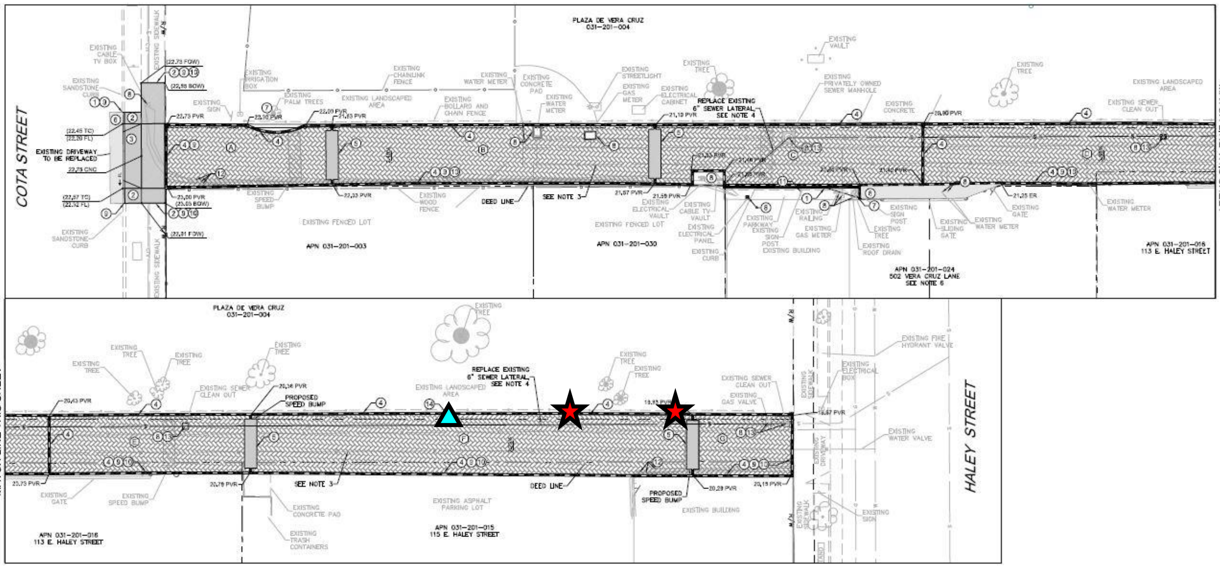


FIGURE 2. VERA CRUZ WITH MONITORING PORT (BLUE TRIANGLE) AND PRE-PROJECT STORMWATER SAMPLING LOCATION (RED STARS).

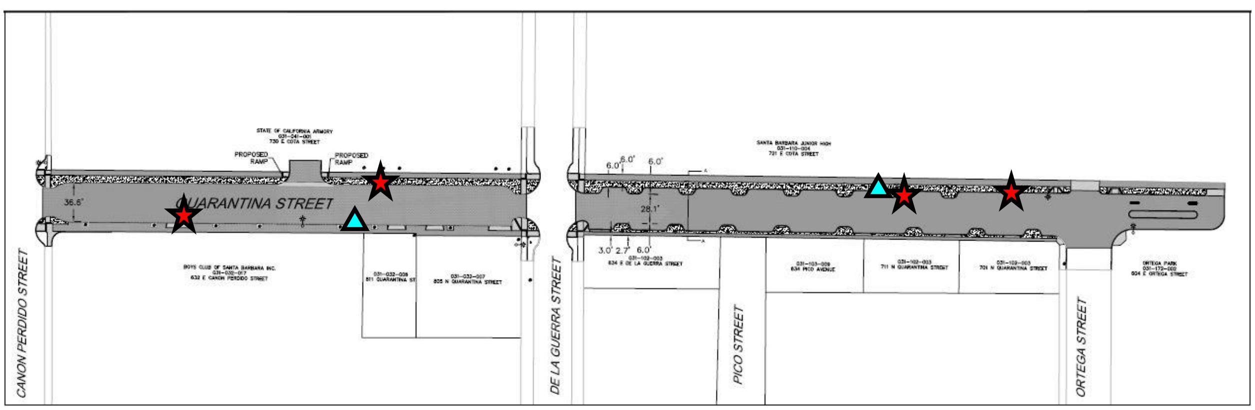


FIGURE 3. 800 AND 700 BLOCKS OF N. QUARANTINA STREET WITH SAMPLING PORTS (BLUE TRIANGLES) AND PRE-PROJECT STORMWATER SAMPLING LOCATIONS (RED STARS).

Storm Sampling

Despite below-average rainfall, samples were collected and tested during three storms (**Error! Reference source not found.**). Rainfall patterns show that the storms were representative of rainfall throughout the year (**Error! Reference source not found.**). Due to rapidly changing forecasts, staff limitations, and small storms during most of the year, the goal of composite samples covering three time points for each storm was not achieved. Two samples were composited with two time points per location, and the third storm was sampled as a grab sample (although multiple sampling sites were used, as mapped above, at most locations).

TABLE 3. SUMMARY OF SAMPLED STORMS

Storm Number	Date	Time Period	Grab or Composite	Total Rainfall during storm
1	12/2/2014	7:20 am – 1:00 pm	Composite (2 time points)	2.1”
2	2/7/2015	12:00 pm – 2:00 pm	Composite (2 time points)	0.6”
3	4/7/2015	12:30-1:30 pm	Grab	0.28”

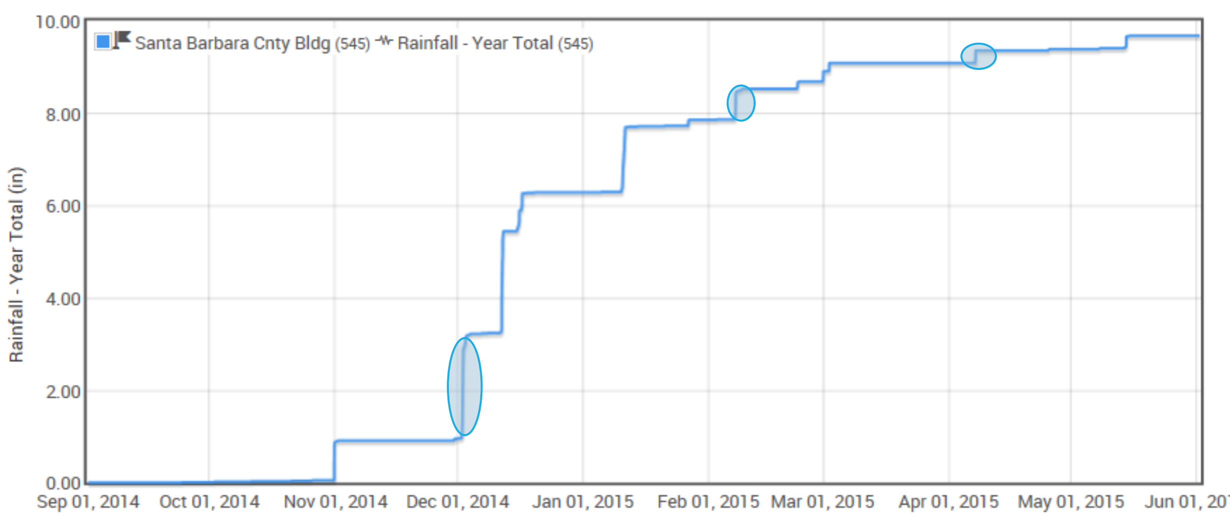


FIGURE 4. TOTAL RAIN ACCUMULATION IN WATER YEAR 2014-2015. BLUE OVALS INDICATE SAMPLED EVENTS.

The following figures show the precipitation patterns and sampling windows for each of the three storms.

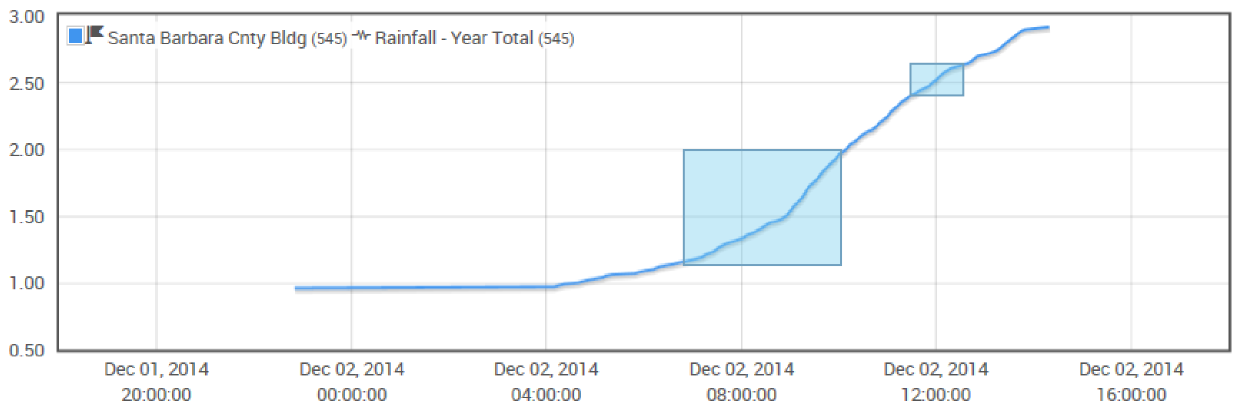


FIGURE 5. TOTAL RAINFALL AND SAMPLE COLLECTION TIMES DURING STORM 1.

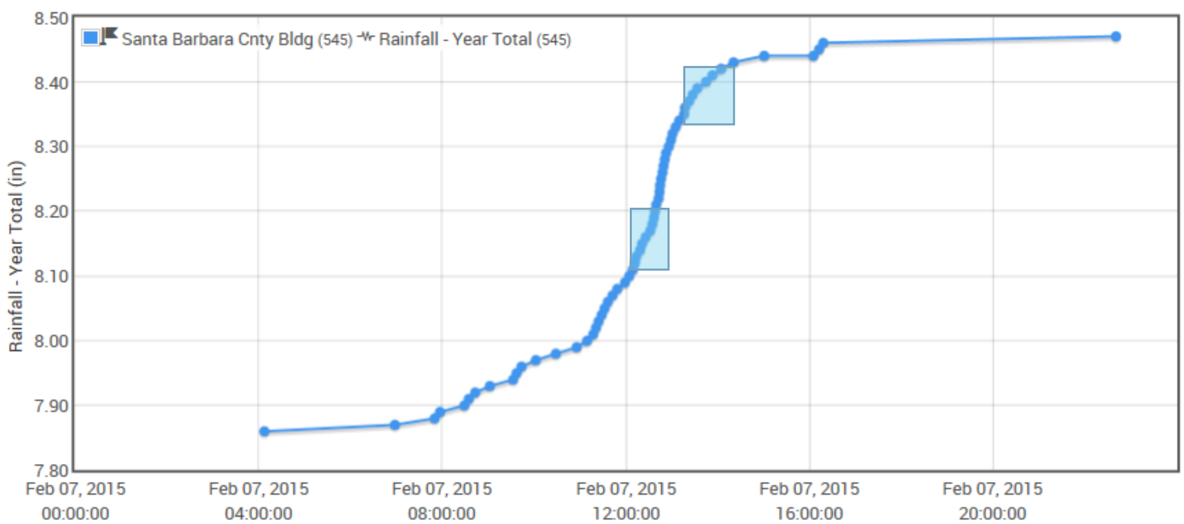


FIGURE 6. TOTAL RAINFALL AND SAMPLING TIMES DURING STORM 2.

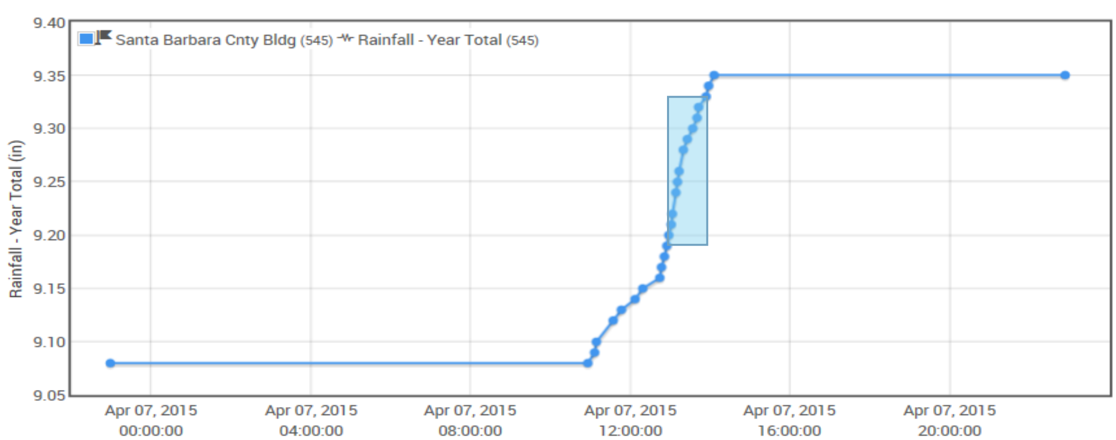


FIGURE 7. TOTAL RAINFALL AND SAMPLING TIMES DURING STORM 3.

Sample Results

In the following figures, all parameters are graphed by site (horizontal axis) and coded by storm (color). Box plots are not used due to limited sample sizes for each parameter/site combination (n=2-4). Censored data, e.g. results above or below method detection limits (DL), and/or data between the DL and reporting limit (RL) re marked using partially filled symbols (see legends). Non-detects (ND) are plotted at DL for the sample analysis; however the true value could lie anywhere between zero and the DL. The highest DL for each parameter is plotted as a dashed line. Data above method detection limits (only relevant for fecal indicator bacteria) are plotted at the upper detection limit; the true value could lie anywhere above the limit. Data between the DL and RL are plotted at the laboratory-provided result but are known to have less precision than data above the RL. Water quality objectives are shown by red dashed lines where available.

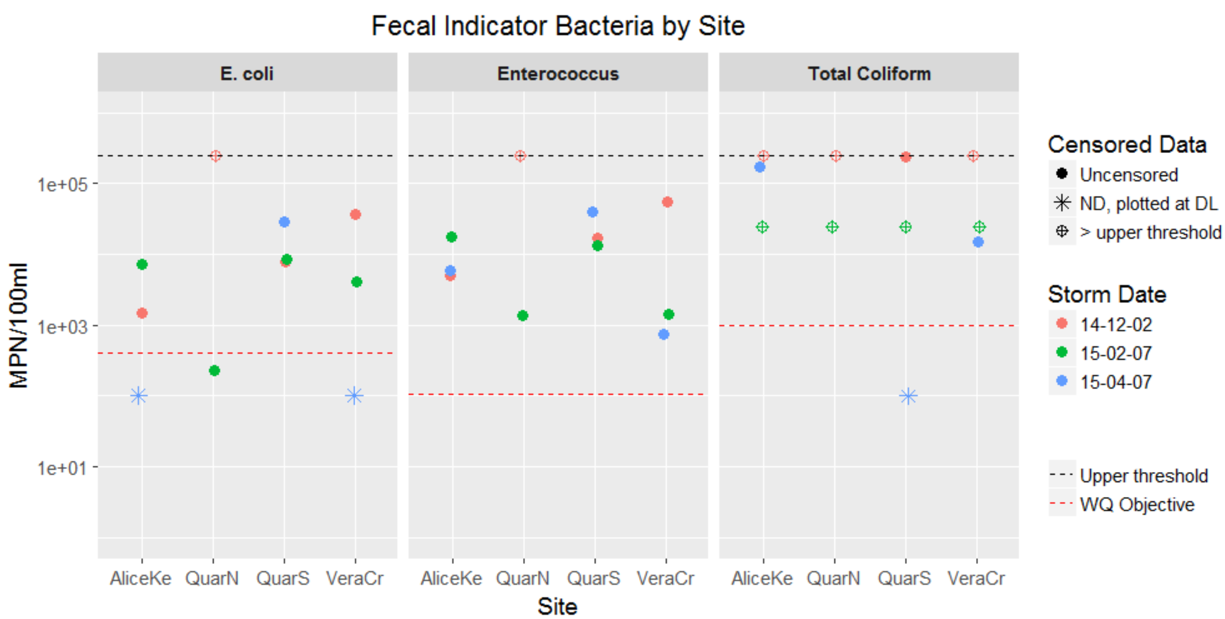


FIGURE 8. FECAL INDICATOR BACTERIA RESULTS FOR STORMS 1-3. BLACK LINES SHOW UPPER METHOD LIMIT. RED LINES SHOW AB411 WATER QUALITY OBJECTIVES FOR EACH BACTERIAL GROUP.

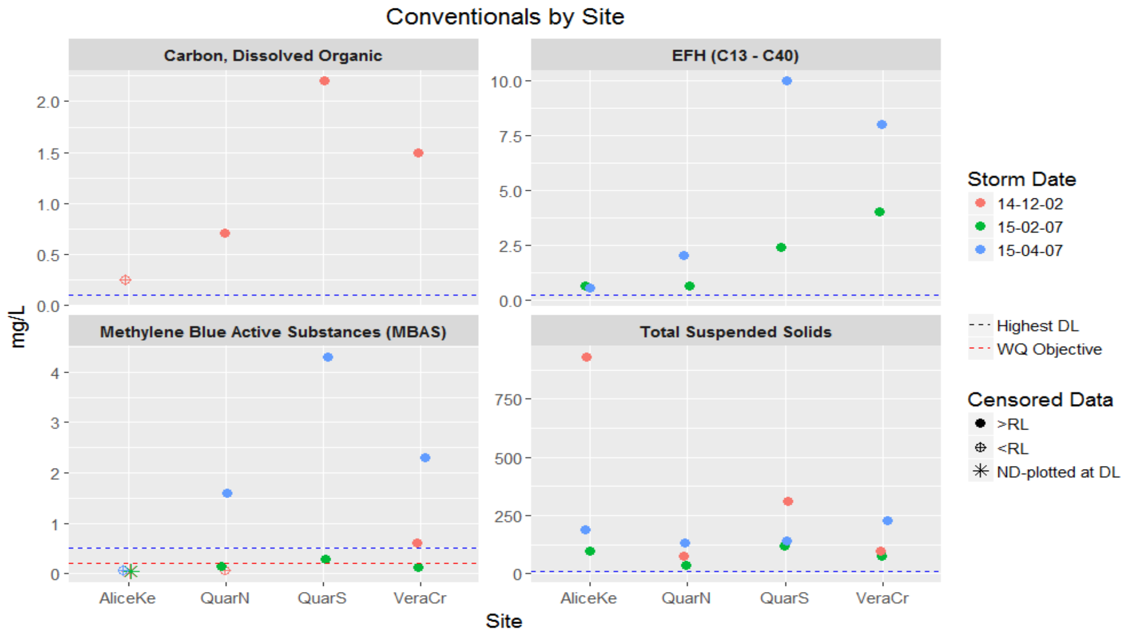


FIGURE 9. CONVENTIONAL PARAMETERS, INCLUDING DISSOLVED ORGANIC CARBON, HYDROCARBONS, SURFACTANTS, AND SEDIMENT, FOR STORMS 1-3.

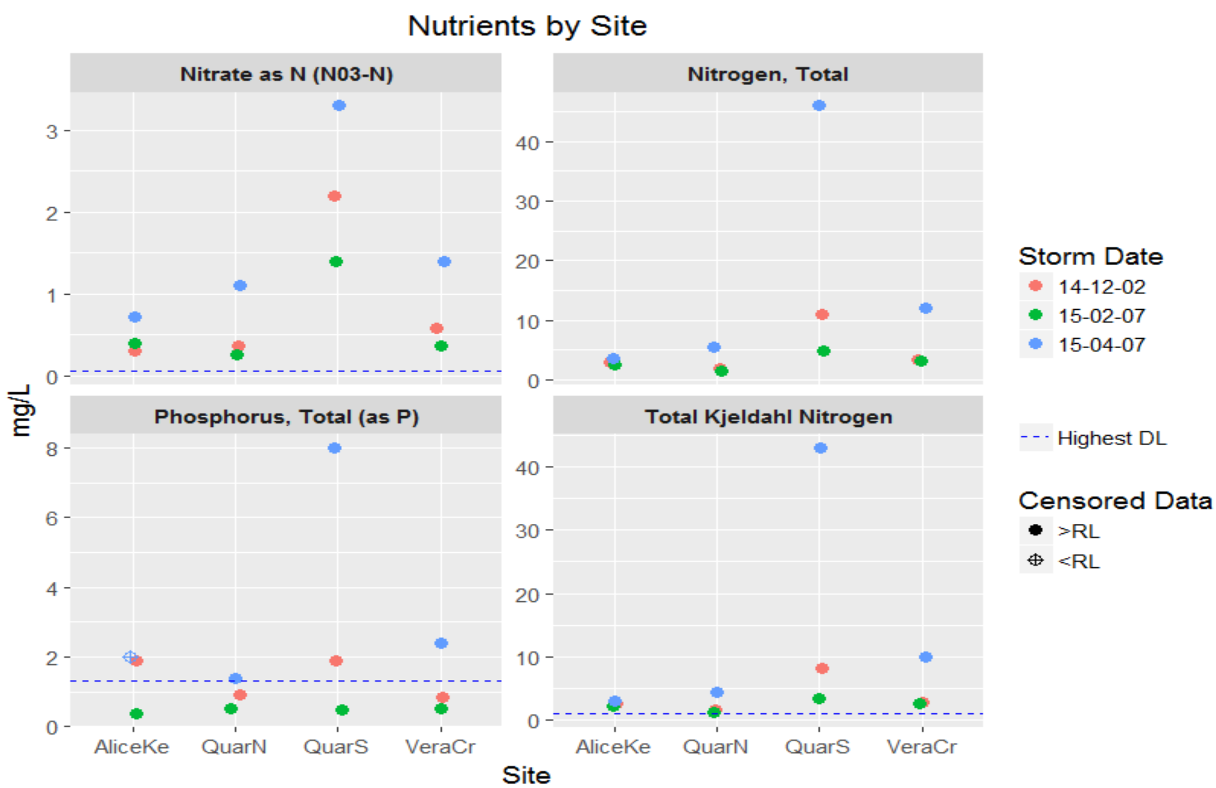


FIGURE 10. NUTRIENT RESULTS FOR STORMS 1-3.

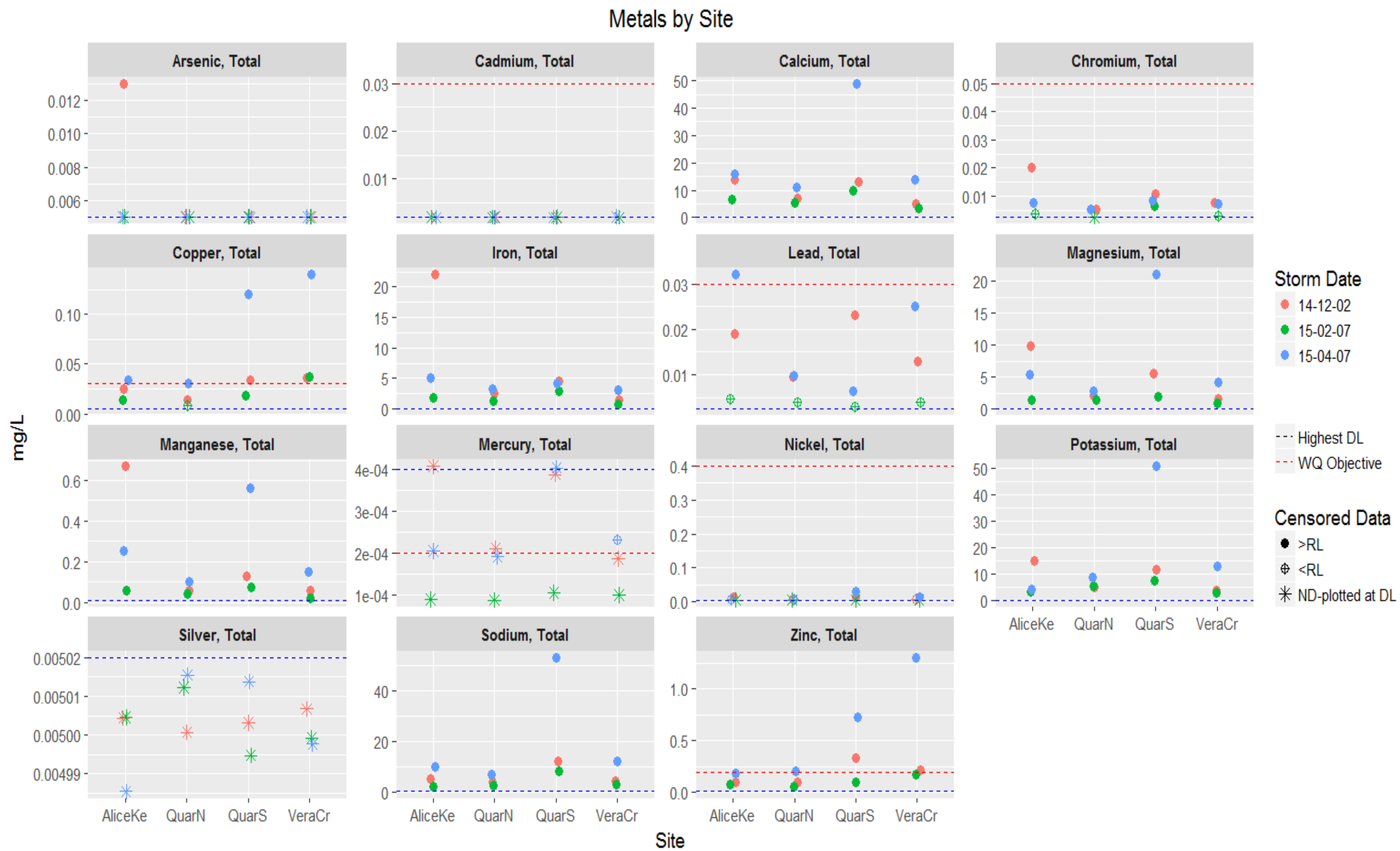


Figure 11. Total metals results for Storms 1-3. Red lines show Basin Plan objectives where available. Mercury has a quality objectives below the highest detection limits (blue lines), so exeedances cannot be determined for all samples.

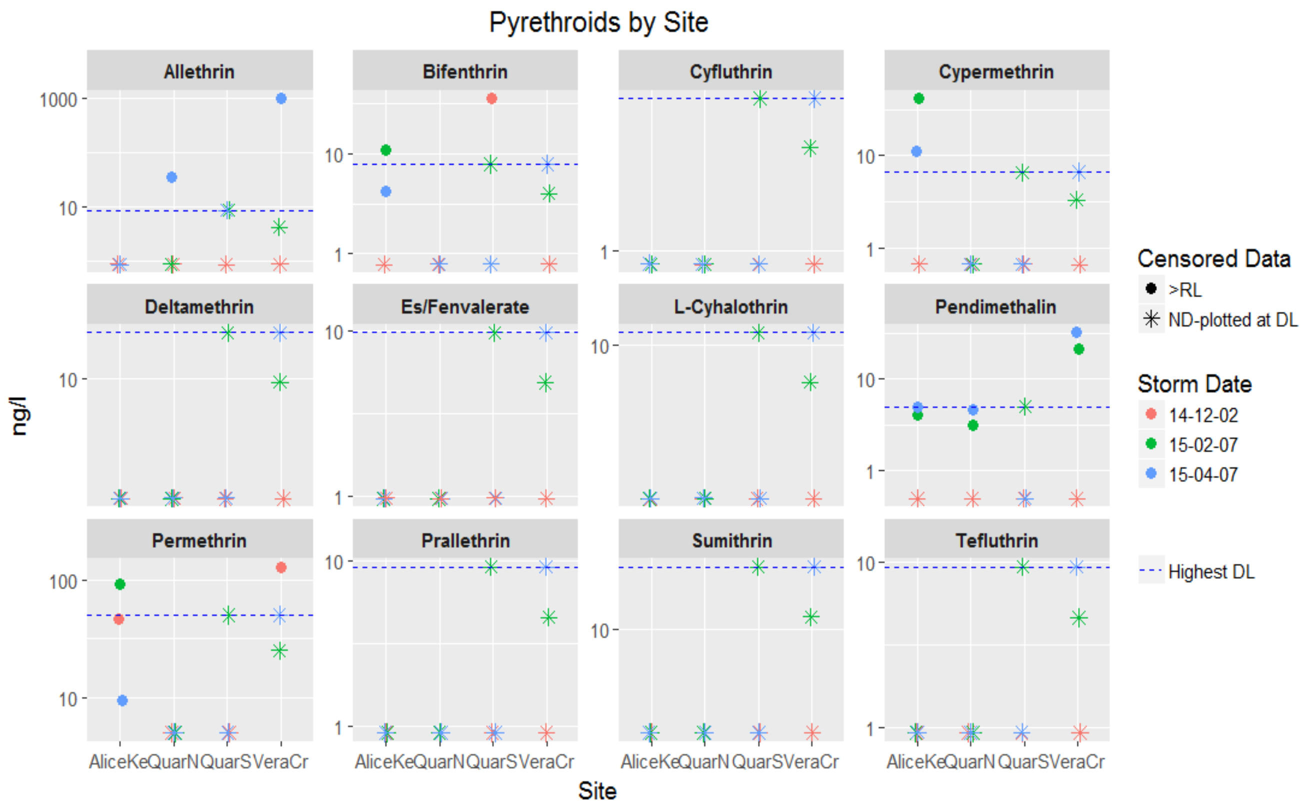


FIGURE 12. PYRETHROID PESTICIDE RESULTS FOR STORMS 1-3.THERE ARE NO WATER QUALITY OBJECTIVES AVAILABLE FOR COMPARISON.

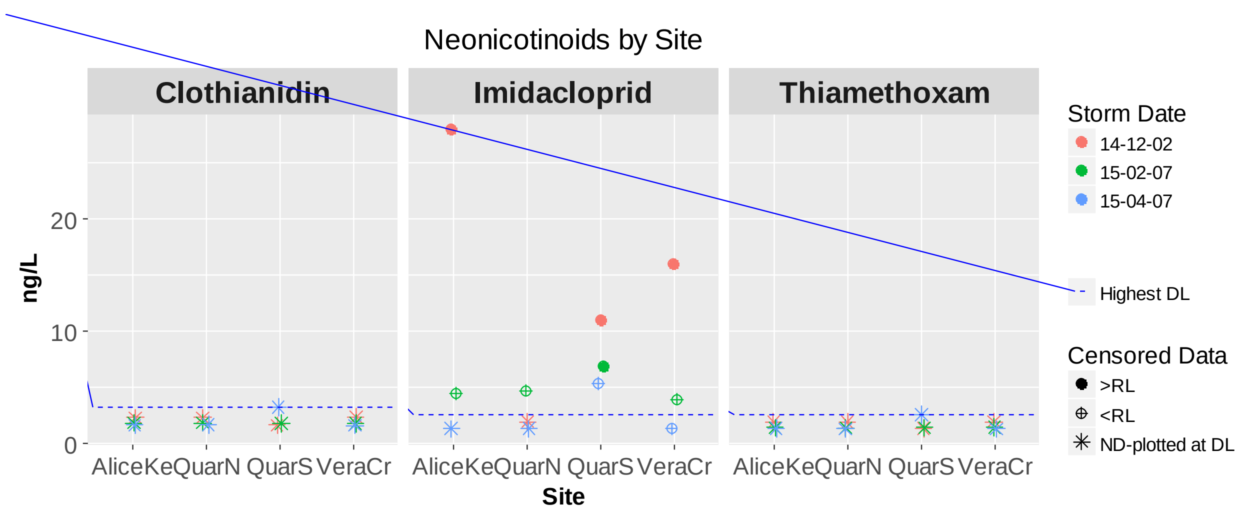


FIGURE 13. NEONICOTINOID PESTICIDE RESULTS FOR STORMS 1-3.THERE ARE NO WATER QUALITY OBJECTIVES AVAILABLE FOR COMPARISON.

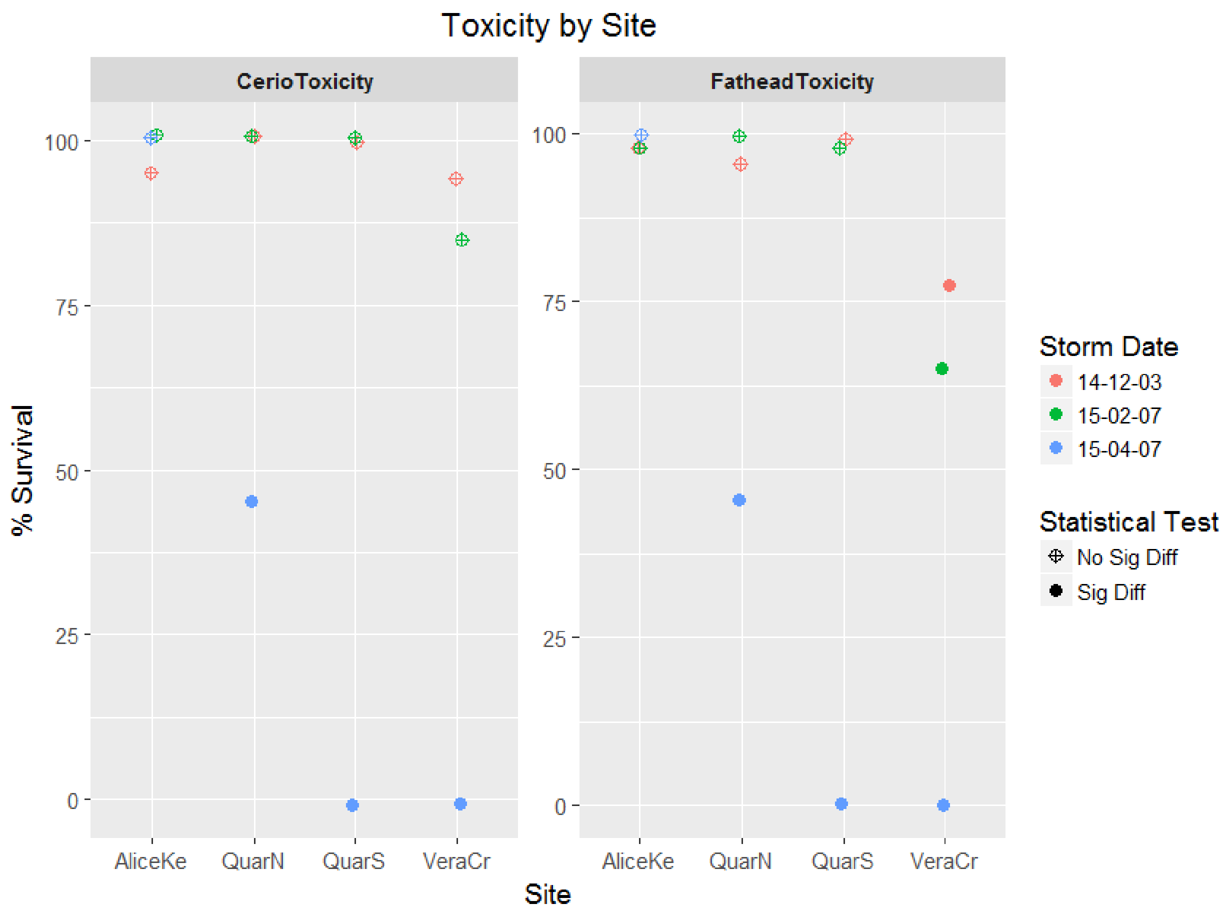


Figure 14. Toxicity results for storm 1-3. Left panel shows *Ceriodaphnia* 96-hr survival rates and right panel shows Fathead Minnow96-hr rates. All test results are scaled to the control. Filled symbols denote samples with a statistically significant difference from the control sample, as reported the out-sourced laboratory.

Post-Project Rainfall

Post project rainfall data are used in the interpretation of monitoring-well logger data and in load reduction calculations.

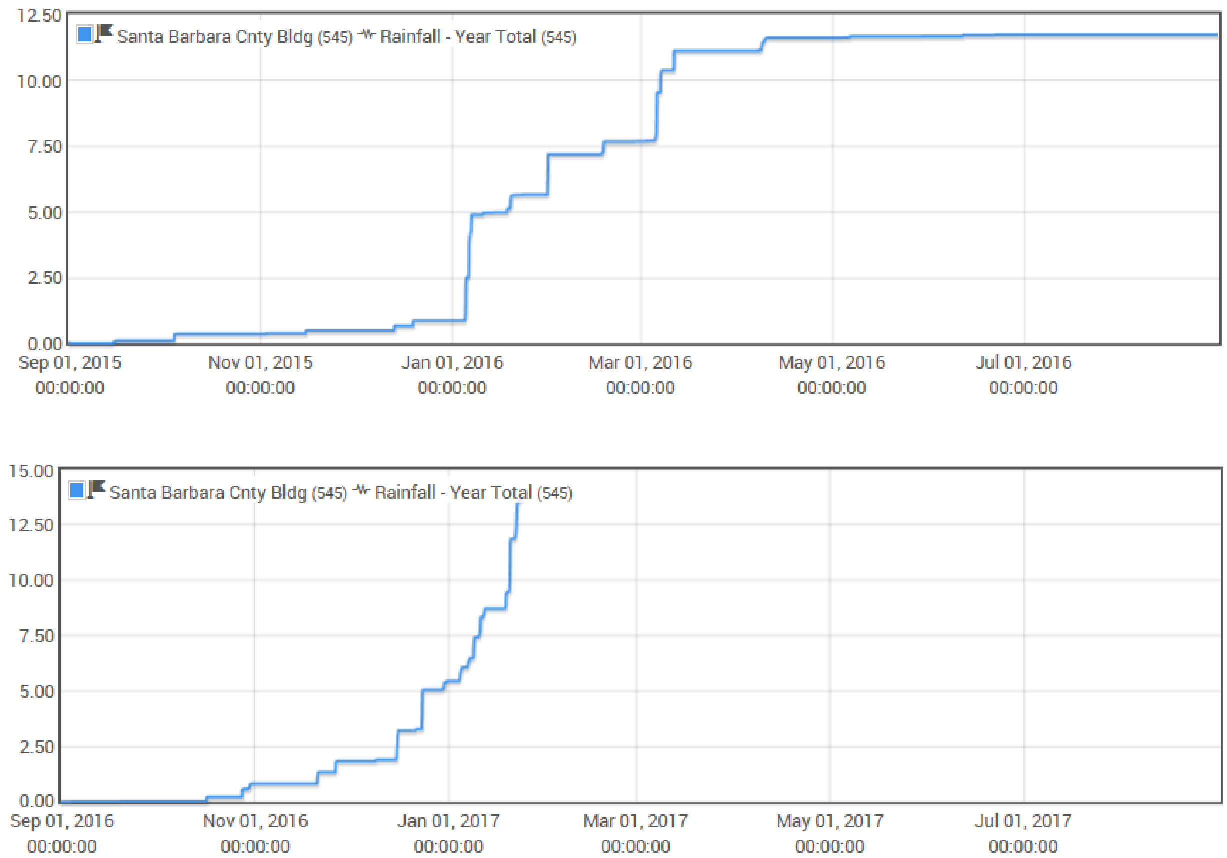


FIGURE 15. RAINFALL DURING THE 2015-2016 RAIN YEAR (UPPER PANEL) AND THE 2016-2017 RAIN THROUGH JANUARY 25, 2017.

Data from Water Level Loggers

Water level loggers were placed in the monitoring ports during storm events in order to measure the depth of the water as it rose from heavy rainfall and fell from infiltration into the subgrade soil below. This data confirmed that all of the water was infiltrated and did not overflow from the basins. The minimum depth of the basins is 18 inches and the graphs show that the water level never reached that level. The rise and fall of the water is plotted against rainfall accumulation and shown in the graphs below (**Figure** 16, **Figure** 17, **Figure** 18, **Figure** 19, and Figure 20).

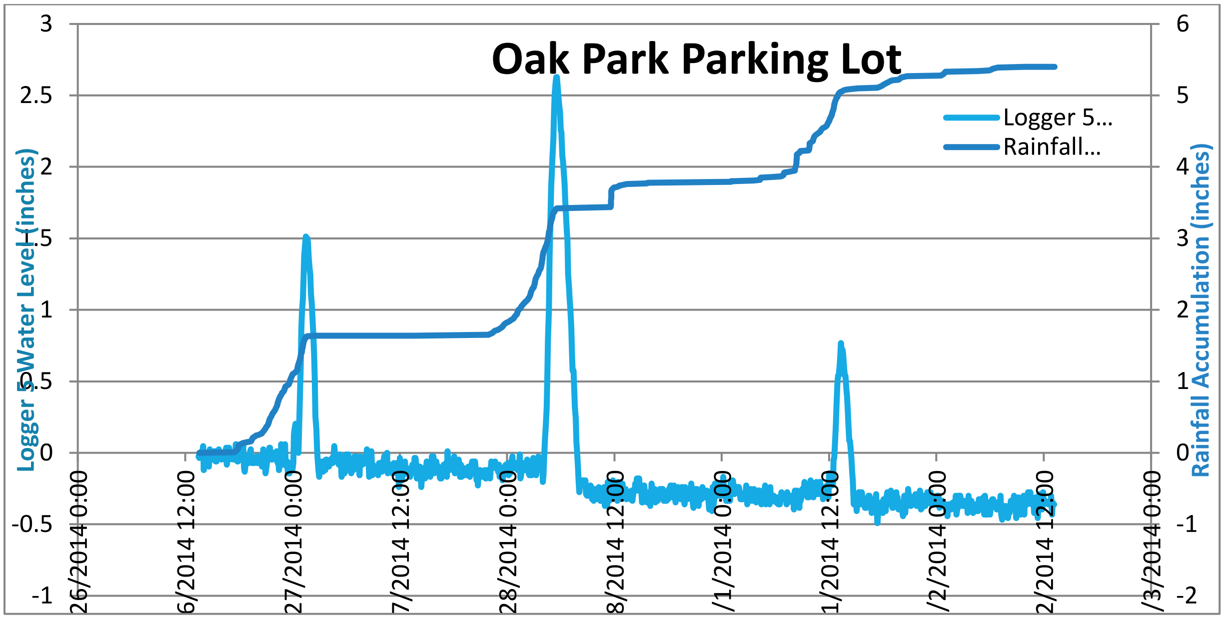


Figure 16. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). The total rainfall accumulation was 5.40 inches. The water level is shown in blue and rainfall accumulation is shown in red.

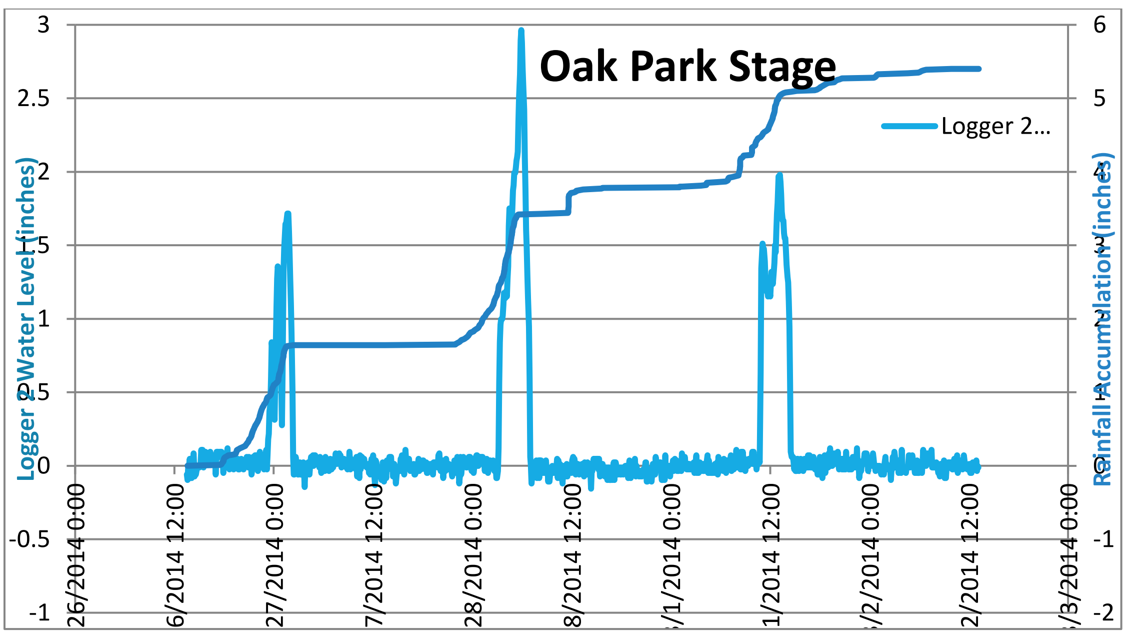


Figure 17. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). The total rainfall accumulation was 5.40 inches. The water level is shown in blue and rainfall accumulation is shown in red.

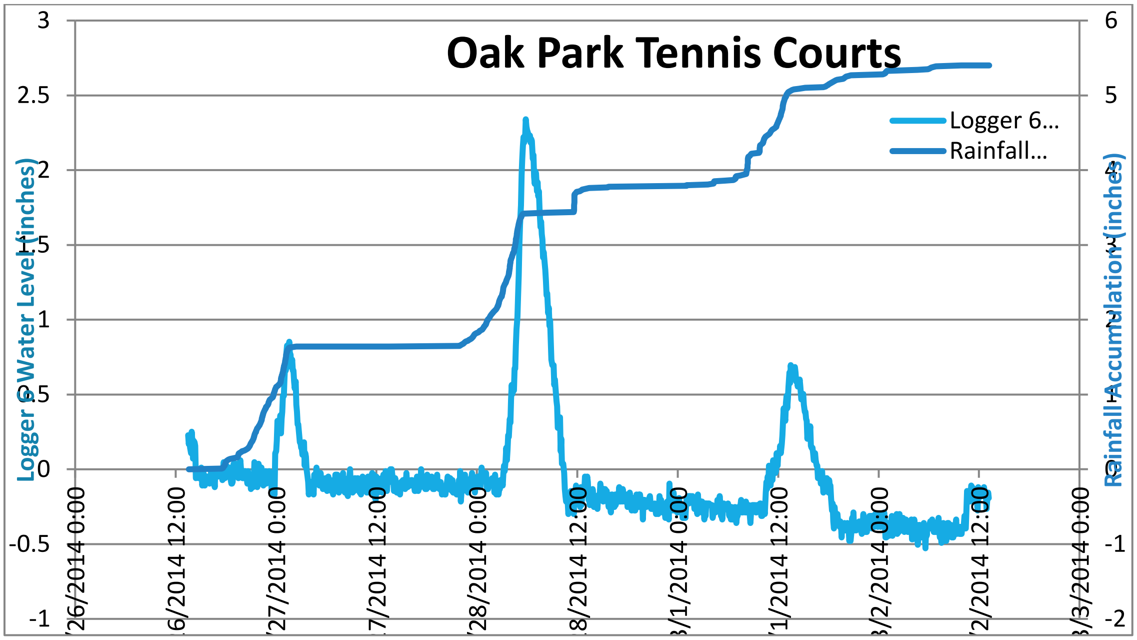


FIGURE 18. GRAPH SHOWING WATER LEVEL IN BASIN DURING THREE CONSECUTIVE PERIODS OF RAINFALL OVER AN APPROXIMATE FOUR DAY PERIOD (MARCH 26 – APRIL 2, 2014). THE TOTAL RAINFALL ACCUMULATION WAS 5.40 INCHES. THE WATER LEVEL IS SHOWN IN BLUE AND RAINFALL ACCUMULATION IS SHOWN IN RED.

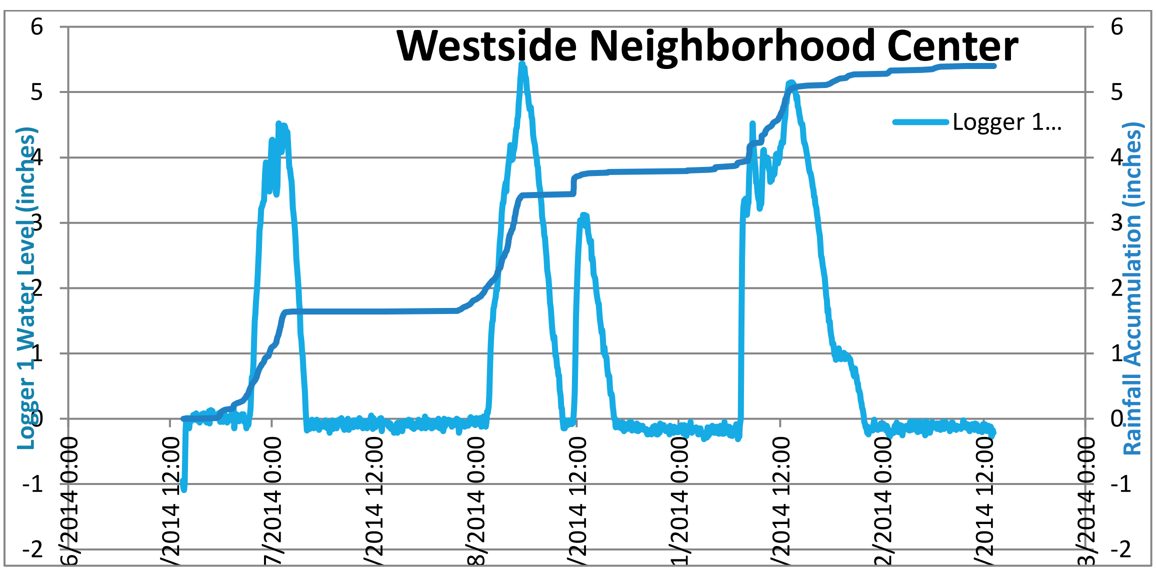


FIGURE 19. GRAPH SHOWING WATER LEVEL IN BASIN DURING THREE CONSECUTIVE PERIODS OF RAINFALL OVER AN APPROXIMATE FOUR DAY PERIOD (MARCH 26 – APRIL 2, 2014). THE TOTAL RAINFALL ACCUMULATION WAS 5.40 INCHES. THE WATER LEVEL IS SHOWN IN BLUE AND RAINFALL ACCUMULATION IS SHOWN IN RED.

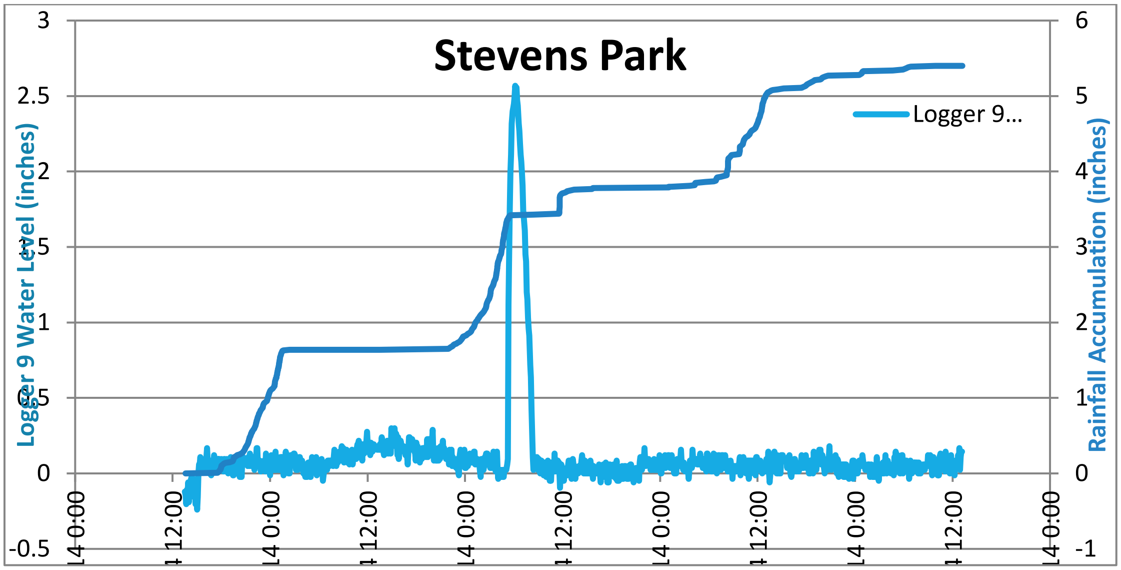


FIGURE 20. GRAPH SHOWING WATER LEVEL IN BASIN DURING THREE CONSECUTIVE PERIODS OF RAINFALL OVER AN APPROXIMATE FOUR DAY PERIOD (MARCH 26 – APRIL 2, 2014). THE TOTAL RAINFALL ACCUMULATION WAS 5.40 INCHES. THE WATER LEVEL IS SHOWN IN BLUE AND RAINFALL ACCUMULATION IS SHOWN IN RED.

Data Evaluation/Pollutant Load Reduction

Data Evaluation

Runoff from the parking lots sites contained fecal indicator bacteria, dissolved organic carbon, nutrients, petroleum hydrocarbons, sediment, metals, surfactants, and pesticides.

All but four of 34 fecal indicator bacteria samples were above the California Ocean Plan's AB411 fecal indicator bacteria criteria. Results showed that metals exceeded Basin Plan water quality in some cases for lead, copper, and zinc. For mercury, the highest detection limit was above the water quality objective for some samples, preventing the assessment of water quality impacts. One third of the samples exceeded the Basin Plan for surfactants (MBAS). Pesticide analysis showed detections of imidacloprid and several pyrethroids, especially in runoff from Alice Keck.

Toxicity was very high in several samples. There was 0% survival of both test species in two samples. Toxicity was significantly different from the control in 8 of 24 tests. Toxicity was highest in the samples from the third storm at Quar N, Quar S, and Vera Cruz, and this is likely due to the limited runoff and the need to sample from puddles in some cases, i.e. the sample was composed of "first flush" contaminants.

Pollutant Load Reduction

Using pollutant data collected before the project was built, and infiltration volumes calculated in the period after the project was built, load reductions were calculated for all parameters with detections (toxicity data is not included). Visual comparison showed no consistent difference among sites or storms; therefore, a City-wide, year-long event mean concentration (EMC) was calculated for each parameter (**Error! Reference source not found.**). A total area for all of the project sites was calculated (20,781 m^2).

Assuming complete infiltration, which was confirmed using level loggers in monitoring wells, the load reduction is equal to the EMC multiplied times the volume of rainfall after the project. First, a load reduction per inch of rainfall was calculated:

$$Load\ Reduction\ (M/L) = EMC\ (M/L^3)*Area\ (L^2)$$

where M=Mass and L=Length

This is the equation used to calculate load in kg:

$$Load\ Reduction\ (kg/in)=EMC(g/m^3)*Total\ Area\ (m^2)*0.0254(m/in)$$

This value can be used in future estimates of load reduction. For the post-project period, the yearly rainfall of 9/1/15-9/1/16 plus 9/1/16-1/25/17 (25.34") was used for Alice Keck and Vera Cruz calculations. For Quarantina North and South, only the second year was used (13.64").

Total load reduction was calculated as the amount using EMC * Total Area * Rainfall Depth,

$$Total\ Load\ Reduction\ (M/T) = EMC\ (M/L^3)*Area\ (L^2)*Rainfall\ Depth/Year\ (L/T)$$

where M=Mass, L=Length and T=Time.

This is the equation used to calculate the Post Project Load Reduction in kg:

$$Load\ Reduction\ (kg/yr)=EMC(g/m)^3*Total\ Area\ (m^2)*0.0254(m/in)*8.0\ in/yr.$$

TABLE 4. LOAD REDUCTION FROM COMBINED LID PARKING LOT SITES.

Parameter	Event Mean Concentration, mg/L unless noted[1]	Load Reduction per Inch of Rain Infiltrated by Project, kg[2]	Total Load Reduction, By Project Through 1/25/2017, kg[3]
Fecal Indicator Bacteria			
E. coli	7300 MPN/100 ml	1.1×10^8 MPN	1.7×10^9 MPN
Enterococcus	1.3×10^4 MPN/100 ml	2.2×10^8 MPN	3.5×10^9 MPN
Total coliform	>2.4×10^4 MPN/100 ml[4]	>4.5×10^9 MPN	>7.4×10^{10} MPN
Organic Carbon (Dissolved)	1.1	0.58	9.5
Nutrients			
Nitrate (as N)	1.0	0.53	8.6
TKN	7.0	3.7	60
Total Nitrogen	8.2	4.3	71
Total Phosphorus	1.8	0.95	16
Hydrocarbons - EFH	3.5	1.8	30
Total Suspended solids	202	110	1700
Total Metals [1]			
Arsenic	<0.005[5]	<0.003	<0.04
Calcium	13	6.9	110
Chromium	0.0070	0.0037	0.060
Copper	0.043	0.023	0.37
Iron	4.4	2.3	38
Lead	0.013	0.0069	0.11
Magnesium	4.8	2.5	41
Manganese	1.8	0.95	16
Nickel	0.0079	0.0042	0.068
Potassium	6.5	3.4	56
Sodium	6.0	3.2	52
Zinc	0.18	0.095	1.6
Surfactants	0.22	0.12	1.9
Pesticides			
Neonicotioids			
Imidacloprid	4.6 ng/L	9.8×10^{-5}	0.0016
Pyrethroids			
Allethrin	<0.85 ng/L	<3.6×10^{-5}	<5.8×10^{-4}
Bifenthrin	<2.4 ng/	<1.5×10^{-4}	<0.025
Cypermethrin	<0.66 ng/L	1.2×10^{-4}	<9.0×10^{-4}
Pendimethalin	3.6 ng/L	8.3×10^{-4}	0.0061
Permethrin	<17.1 ng/L	<0.0021	<0.037

[1] Medians were used for all fecal indicator bacteria and parameters that had any non-detect results.

[2] Uses total area of 20781.45 m^2.

[3] Uses total rainfall of 13.64 in. for Quarantina North and South, and 25.34 in. for Alice keck and Vera Cruz. Project areas for individual sites were used in calculations.

[4] For total coliform bacteria, the median was greater than the maximum quantification limit.

[5] For all parameters marked with <, the median was less than the highest detection limit, making it impossible to calculate an appropriate EMC. However, because there was at least one result with a detection, the EMCs and load reductions are somewhere between zero and the value listed. Parameters with all non-detect results were not included in the table.

Neonicotinoid Pesticides

Storm monitoring in FY16 included testing for neonicotinoid pesticides in order to assist with planning for the neonicotinoid grant project. Imidacloprid was found in Laguna Creek at low concentrations at multiple time points throughout several storms, suggesting that aquatic insects receive chronic exposure to the pesticide for days at a time in urban settings. The following abstract is for a presentation at the October 2015 CASQA meeting.

Neonicotinoid Pesticides: Not Just a Bee Problem

PURPOSE: The purpose of this presentation is to inform the stormwater community that neonicotinoid pesticides are widespread in urban runoff and potentially causing chronic, cumulative toxicity in receiving waters.

MAIN IDEAS: After years of testing for pesticides in urban runoff, and having spot detections of various compounds here and there, the City of Santa Barbara Creeks Division is now seeing neonicotinoids in nearly every sample we collect. At the same time, there is more research coming out almost weekly about their potential impact on ecosystems, leading some scientists to say they are the “new DDT” (without the human-harm component).

The neonicotinoids have rapidly become the most widely used pesticides globally, and are used for agriculture, structural pest control, pet care, and home garden care. Systemic poisons, the neonicotinoids have been implicated for harming pollinators throughout the world. The United State Environmental Protection Agency (US EPA) and the California Department of Pesticide Regulation (CA DPR) are both reevaluating the registration of neonicotinoid pesticides with a focus on pollinator impacts. However, there is new and compelling evidence that the neonicotinoids are widespread in surface waters, are toxic at levels far below existing toxicity thresholds, and are likely harming aquatic and riparian ecosystems worldwide through food web effects. With most research conducted on inland agricultural areas, there are scant data on impacts to urban or coastal streams, coastal estuaries, and the marine environment. Imidacloprid, the most widely used neonicotinoid in California, was detected repeatedly in a pilot test of urban stormwater runoff in Santa Barbara, CA, at levels suggested to cause ecotoxicity. Physical characteristics such as long half lives in soil and high solubility (rapid leaching) in storm events, combined with the widespread impact on nontarget organisms combine to make this class of pesticides harmful to urban receiving waters. Given the neonicotinoids’ widespread use, documented ecotoxicity, and demonstrated presence in surface waters, it is urgent that the CA DPR and US EPA address storm water impacts. Municipalities with pesticide and/or toxicity TMDLs or monitoring requirements should consider neonicotinoid pesticide sampling and targeted outreac.

AUDIENCE ENGAGEMENT: The talk will include a question-and-answer callout where the audience is asked how to create the best and worst pesticide from stormwater perspective – and neonicotinoids will exemplify the worst (broad application, long half life in soil and plant material, rapid leaching and high solubility, and toxicity that is difficult to quantify using standard toxicity tests). In addition, a short segment of an outreach video that the City produced will be shown.

CONFERENCE THEME: This talk fits into the conference theme because it demonstrates how we have to stay on top of emerging contaminants to continue achieving water quality improvements. Complacency will lead to new poisons reaching our waterways, as one class of pesticides is replaced by another.

General Permit Requirements

Outfall Monitoring

From the Annual Report:

2015 Outfall Monitoring

Per Phase II Permit Provision E.9.c., the City conducted Dry Weather Monitoring during spring 2015 at flowing outfalls (previously identified in the summer of 2014). Several outfalls flowing in 2014 were no longer flowing due to the drought. Samples were tested for all parameters listed in Table 1 of Phase II Permit Provision E.9. Project action limits for all indicator parameters were the same as in Table 2 of Phase II Permit Provision E. 9, as presented below in **Table C-1**.

TABLE 5. ACTION LEVEL CONCENTRATIONS FOR INDICATOR PARAMETERS (PHASE II PERMIT PROVISION E. 9.C.)

Parameter	Action Level Concentration
Ammonia	≥ 50 mg/L
Color	≥ 500 units
Conductivity	≥ 2,000 µS/cm
Hardness	≤ 10 mg/L as $CaCO_3$ or ≥ 2,000 mg/L as $CaCO_3$
pH	≤ 5 or ≥ 9
Potassium	≥ 20 mg/L
Turbidity	≥ 1,000 NTU

Only nine outfalls were flowing during the sampling effort.

Flowing outfalls were identified in summer 2014 and outfall monitoring was conducted in spring 2015. Several outfalls flowing in 2014 were no longer flowing in 2015 due to the drought. Nine outfalls were flowing during the sampling effort. Samples were tested for all parameters listed in Table C-1.

Three outfalls exceeded the Project Action Limit for conductivity, and one of these (N-J05-12) also exceeded for potassium. The laboratory's upper threshold for color was greater than the Project Action Limit for color for seven of the outfalls, so it not possible to determine if they exceeded the Projection Action Limit for color.

Due to the results on the color tests, an investigation was carried out according to written procedures following Permit section E.9.d for all flowing outfalls. For eight of nine outfalls, no illicit discharges were detected. Two high conductivity outfalls (N-J05-12 and N-C07-19) were determined to be comprised of groundwater flowing through old marine deposits and then entering drainage pipes. The conductivity of these outfalls is in line with creek water conductivity in Santa Barbara. One outfall (N-E05-03) continues to be investigated due to anomalously high conductivity. Closed circuit televising will be used as a next step.

Outfall monitoring data is presented in **Table C-2** and will be uploaded to SMARTS with the 2015 Annual Report.

Table 6. 2015 Outfall Monitoring Data

StationID	SampleDate	SampleTime	ParameterCode	Qualifier	Result	Units
N-C07-19	5/7/2015	11:42 AM	Ammonia	<	2	mg/L
N-C08-11	5/7/2015	12:22 PM	Ammonia	<	2	mg/L
N-C08-15	5/7/2015	12:13 PM	Ammonia	<	2	mg/L
N-C08-16	5/7/2015	12:06 PM	Ammonia	<	2	mg/L
N-C08-21	5/7/2015	12:31 PM	Ammonia	<	2	mg/L
N-C09-05	5/7/2015	12:45 PM	Ammonia	<	2	mg/L
N-C09-12	5/7/2015	12:38 PM	Ammonia	<	2	mg/L
N-E05-03	3/24/2015	12:53 PM	Ammonia	<	2	mg/L
N-J05-12	6/25/2015	10:38 AM	Ammonia	<	2	mg/L
N-C07-19	5/7/2015	11:42 AM	Color	>	50	unit
N-C08-11	5/7/2015	12:22 PM	Color	>	50	unit
N-C08-15	5/7/2015	12:13 PM	Color	>	50	unit
N-C08-16	5/7/2015	12:06 PM	Color	N	7	unit
N-C08-21	5/7/2015	12:31 PM	Color	>	50	unit
N-C09-05	5/7/2015	12:45 PM	Color	>	50	unit
N-C09-12	5/7/2015	12:38 PM	Color	N	15	unit
N-E05-03	3/24/2015	12:53 PM	Color	N	n/a	unit
N-J05-12	6/25/2015	10:38 AM	Color		17	unit
N-C07-19	5/7/2015	11:42 AM	Conductivity	N	2099	µS/cm
N-C08-11	5/7/2015	12:22 PM	Conductivity	N	1174	µS/cm
N-C08-15	5/7/2015	12:13 PM	Conductivity	N	1902	µS/cm
N-C08-16	5/7/2015	12:06 PM	Conductivity	N	1492	µS/cm
N-C08-21	5/7/2015	12:31 PM	Conductivity	N	1929	µS/cm
N-C09-05	5/7/2015	12:45 PM	Conductivity	N	1453	µS/cm

StationID	SampleDate	SampleTime	ParameterCode	Qualifier	Result	Units
N-C09-12	5/7/2015	12:38 PM	Conductivity	N	1580	µS/cm
N-E05-03	3/24/2015	12:53 PM	Conductivity	N	7750	µS/cm
N-J05-12	6/25/2015	10:38 AM	Conductivity	N	4380	µS/cm
N-C07-19	5/7/2015	11:42 AM	Fluoride	N	0.85	mg/L
N-C08-11	5/7/2015	12:22 PM	Fluoride	N	0.24	mg/L
N-C08-15	5/7/2015	12:13 PM	Fluoride	N	0.59	mg/L
N-C08-16	5/7/2015	12:06 PM	Fluoride	N	0.42	mg/L
N-C08-21	5/7/2015	12:31 PM	Fluoride	N	0.18	mg/L
N-C09-05	5/7/2015	12:45 PM	Fluoride	N	0.19	mg/L
N-C09-12	5/7/2015	12:38 PM	Fluoride	N	0.32	mg/L
N-E05-03	3/24/2015	12:53 PM	Fluoride	N	0.44	mg/L
N-J05-12	6/25/2015	10:38 AM	Fluoride	N	n/a	mg/L
N-C07-19	5/7/2015	11:42 AM	Hardness	N	684	mg/L
N-C08-11	5/7/2015	12:22 PM	Hardness	N	341	mg/L
N-C08-15	5/7/2015	12:13 PM	Hardness	N	580	mg/L
N-C08-16	5/7/2015	12:06 PM	Hardness	N	425	mg/L
N-C08-21	5/7/2015	12:31 PM	Hardness	N	674	mg/L
N-C09-05	5/7/2015	12:45 PM	Hardness	N	474	mg/L
N-C09-12	5/7/2015	12:38 PM	Hardness	N	257	mg/L
N-E05-03	3/24/2015	12:53 PM	Hardness	N	541	mg/L
N-J05-12	6/25/2015	10:38 AM	Hardness	N	n/a	mg/L
N-C07-19	5/7/2015	11:42 AM	pH	N	8.4	
N-C08-11	5/7/2015	12:22 PM	pH	N	8.4	
N-C08-15	5/7/2015	12:13 PM	pH	N	7.6	
N-C08-16	5/7/2015	12:06 PM	pH	N	8.6	
N-C08-21	5/7/2015	12:31 PM	pH	N	7.8	
N-C09-05	5/7/2015	12:45 PM	pH	N	7.6	
N-C09-12	5/7/2015	12:38 PM	pH	N	8.4	
N-E05-03	3/24/2015	12:53 PM	pH	N	8.3	
N-J05-12	6/25/2015	10:38 AM	pH	N	8.5	
N-C07-19	5/7/2015	11:42 AM	Potassium	N	5.24	mg/L
N-C08-11	5/7/2015	12:22 PM	Potassium	N	2.64	mg/L
N-C08-15	5/7/2015	12:13 PM	Potassium	N	8.36	mg/L
N-C08-16	5/7/2015	12:06 PM	Potassium	N	6.12	mg/L
N-C08-21	5/7/2015	12:31 PM	Potassium	N	2.66	mg/L
N-C09-05	5/7/2015	12:45 PM	Potassium	N	3.26	mg/L
N-C09-12	5/7/2015	12:38 PM	Potassium	N	5.06	mg/L
N-E05-03	3/24/2015	12:53 PM	Potassium	N	12.6	mg/L
N-J05-12	6/25/2015	10:38 AM	Potassium	N	28.1	mg/L
N-C07-19	5/7/2015	11:42 AM	Surfactants (MBAS)	N	0.25	PPM

StationID	SampleDate	SampleTime	ParameterCode	Qualifier	Result	Units
N-C08-11	5/7/2015	12:22 PM	Surfactants (MBAS)	N	0.125	PPM
N-C08-15	5/7/2015	12:13 PM	Surfactants (MBAS)	N	0.2	PPM
N-C08-16	5/7/2015	12:06 PM	Surfactants (MBAS)	N	0.125	PPM
N-C08-21	5/7/2015	12:31 PM	Surfactants (MBAS)	N	0.1	PPM
N-C09-05	5/7/2015	12:45 PM	Surfactants (MBAS)	N	0.1	PPM
N-C09-12	5/7/2015	12:38 PM	Surfactants (MBAS)	N	0.2	PPM
N-E05-03	3/24/2015	12:53 PM	Surfactants (MBAS)	N	2	PPM
N-J05-12	6/25/2015	10:38 AM	Surfactants (MBAS)	N	0.25	PPM
N-C07-19	5/7/2015	11:42 AM	Turbidity	N	20.4	NTU
N-C08-11	5/7/2015	12:22 PM	Turbidity	N	2.16	NTU
N-C08-15	5/7/2015	12:13 PM	Turbidity	N	37.6	NTU
N-C08-16	5/7/2015	12:06 PM	Turbidity	N	0.566	NTU
N-C08-21	5/7/2015	12:31 PM	Turbidity	N	28.8	NTU
N-C09-05	5/7/2015	12:45 PM	Turbidity	N	37.3	NTU
N-C09-12	5/7/2015	12:38 PM	Turbidity	N	1.11	NTU
N-E05-03	3/24/2015	12:53 PM	Turbidity	N	1.99	NTU
N-J05-12	6/25/2015	10:38 AM	Turbidity	N	0.554	NTU

From the 2016 Annual Report to the Water Board:

Flowing outfalls in priority areas were sampled in summer 2016. Several outfalls flowing in 2014 and 2015 were no longer flowing due to the ongoing drought. One outfall was sampled that had not been seen flowing in previous years. Seven outfalls were flowing and sampled during the sampling effort. Samples were tested for all parameters listed in Table 1 of section E.9. Action limits for select constituents were taken from Table 2 of section E. 9. Two outfalls exceeded the Project Action Limit for conductivity, and one of the two exceeded for potassium. All other results were within the tolerable range for each parameter.

Results from outfall monitoring showed one outfall, N-E05-03, indicated an illicit discharge. Both conductivity and potassium were well above the action limits, which suggested that water softener brine may be reaching the drain. This outfall was identified in 2015 as having signs of an illicit discharge, but no source was identified. In 2106, extensive field investigations, including closed circuit televising, additional sampling, and interviews with property owners revealed the source of contamination. A basement sump at a residential facility received water softener brine and mop water; when the sump was full it was pumped directly to the storm drain. Immediately upon discovery of the problem the water softener was plumbed to sanitary sewer drains and the mop washing station was moved to an area with a drain to sanitary sewer. The outfall has remained dry since the problem was rectified.

Results from the other six outfalls did not indicate an illicit discharge. Outfall N-C09-12 exceeded the conductivity Project Action Limit by 3.5%, but a review of historical field records, photographs, and water quality data suggests that the flow is natural groundwater seepage. No other parameters exceeded Project Action Limits.

Special Studies and 303(d) Monitoring

During Permit Year 3, the City carried out monitoring for Special Studies and 303(d) Monitoring under Regional-Board Approved Monitoring Plan/QAPPs. The City also carried out extensive monitoring and research under the Creeks Advisory Committee-approved Water Quality Research and Monitoring Plan (not included here).

Special Studies Monitoring

Special Studies Monitoring was carried out according to the approved Monitoring Plan/QAPP with the following exceptions: the Hope Drain was only sampled in one quarter and Haley Drain was not sampled due to lack of flow in the storm drains. The Westside Summer Urban Runoff Facility was not sampled due to lack of operation. As discussed as a possibility in the Monitoring Plan/QAPP, the City moved forward with a second LID project, the Streets, Sidewalks and Alleys Project. The Waterboard-approved Monitoring Plan/QAPP is attached here (Appendix A).

The City will complete and have available a report (50 page maximum) that includes a comparison of data collection to baseline data, and discussion of monitoring program results, to be included with or attached to the fifth year Annual Report.

303(d) Monitoring

303(d) Monitoring was carried out according to the approved Monitoring Plan/QAPP with the following exceptions:

Sycamore Creek was not sampled on 19 sample dates due to non-existent flow in the creek. Mission Creek was not sampled on 3 samples dates, and Arroyo Burro was not sampled on 2 sample dates due to holiday closure of City offices and staff illness. Fecal indicator bacteria results are shown in Figure 1. Project Action Limits are shown for visual comparison; however additional calculations are required to demonstrate exeedances. Table 1 shows the samples which exceed Project Action Limits; note, however, that the water quality objectives underlying the Project Action Limits were developed mostly for beach environments and are not typically applied to freshwater. For comparison purposes, beach water quality exceedances are summarized in Table 2 (these data were acquired from the County of Santa Barbara and were not sampled by the City). Interestingly, higher exceedances rates in creeks during summer months did not carry through to the beach results, whereas higher winter exceedances rates at the beaches due to rain and flowing lagoons occurred during times of low exeedances for creek bacteria. During a rare summer rain storm on the morning of July 20, 2015, the sampling found the highest creek fecal indicator levels ever recorded by the City. It is hypothesized that environmental bacteria growing in warm storm drains, creek pools, and sediment due to high air temperature were flushed through the creek that morning. Also, it appears that the event may have persisted, with very high levels of *E. coli* found in Mission Creek for three months thereafter. Toxicity testing was not completed during wet weather due to difficulty with storm monitoring during the drought, including limited storms, limited staff resources during particular storms, and insufficient time between forecasted storm arrival and rain for the contract laboratory to prepare for samples during the drought. During annual winter dry weather testing, *Chironomus* chronic toxicity showed 100% survival. *Hylallela azteca* was not tested due to a miscommunication Full toxicity testing will take place in Permit Year 4, pending sufficient rain events. There is no separate or specific report required by the Permit for this Project. Data generated under this will be entered into the California Environmental Data Exchange Network (CEDEN).

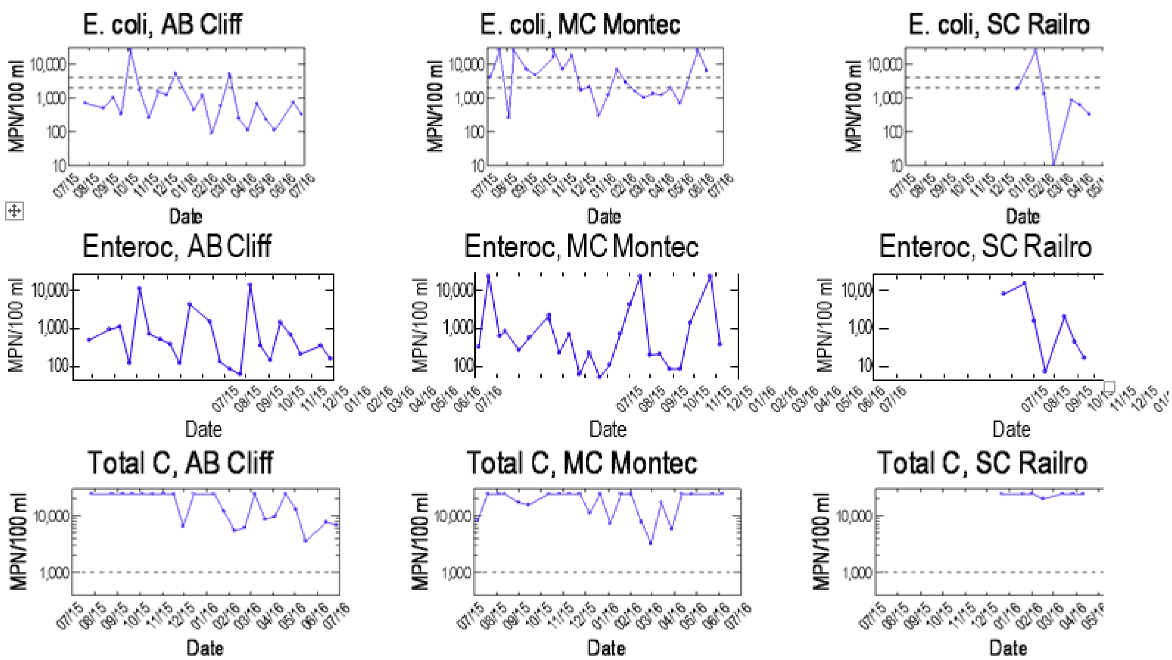


FIGURE 21. FECAL INDICATOR BACTERIA RESULTS DURING PERMIT YEAR 3. MISSING DATA POINTS REPRESENT DATES WHEN CREEK WAS NOT FLOWING DUE TO DROUGHT. HORIZONTAL LINES REPRESENT OR PARTIALLY REPRESENT PROJECT ACTION LIMITS AS FOLLOWS: FECAL COLIFORM/*E. COLI*, 10% OF SAMPLES SHOULD NOT EXCEED 4,000 MPN/100 ML (UPPER LINE) DURING ANY 30 DAY PERIOD AND 5-SAMPLE/30 DAY GEOMEAN SHOULD NOT EXCEED 2,000 MPN/100 ML (LOWER LINE); NOTE THAT DUE TO ONLY TWO SAMPLES COLLECTED PER 30-DAY PERIOD, THE UPPER LIMIT FUNCTIONS AS A SINGLE SAMPLE MAXIMUM FOR THESE SAMPLES AND NOTE THAT GEOMEANS WERE NOT CALCULATED DUE TO SAMPLING FREQUENCY < 5 SAMPLES/30 DAYS. ENTEROCOCCUS: NO PROJECT ACTION LIMIT. TOTAL COLIFORM: SAMPLES SHOULD NOT EXCEED 1,000 MPN/100 ML WHEN THE RATIO OF FECAL COLIFORM/TOTAL COLIFORM>0.1.

TABLE 7. 303(D) FECAL INDICATOR BACTERIA MONITORING RESULTS, PERMIT YEAR 3. SHADING REPRESENTS EXCEEDANCES.

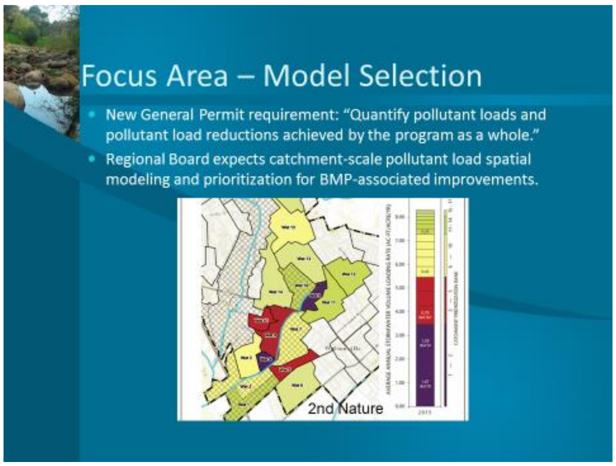
StationID	Date		E. coli		Enterooccus		Total Coliform	Ratio of Fecal:Total Coliform
AB Cliff	27-Jul-15		676		487	>	24192	n/a
AB Cliff	24-Aug-15		495		959	>	24192	n/a
AB Cliff	8-Sep-15		988		1126	>	24192	n/a
AB Cliff	21-Sep-15		324		121	>	24192	n/a
AB Cliff	5-Oct-15	>	24192		11199	>	24192	n/a
AB Cliff	19-Oct-15		1723		711	>	24192	n/a
AB Cliff	3-Nov-15		249		512	>	24192	n/a
AB Cliff	17-Nov-15		1553		384	>	24192	n/a
AB Cliff	30-Nov-15		1187		121		6488	0.18
AB Cliff	14-Dec-15		5172		4352	>	24192	n/a
AB Cliff	11-Jan-16		426		1515		24192	0.02
AB Cliff	25-Jan-16		1153		132		12033	0.10
AB Cliff	8-Feb-16		86		84		5475	0.02
AB Cliff	22-Feb-16		563		62		6131	0.09
AB Cliff	7-Mar-16		4884		14136	>	24192	n/a
AB Cliff	21-Mar-16		238		350		8664	0.03
AB Cliff	4-Apr-16		108		145		9804	0.01
AB Cliff	18-Apr-16		663		1455	>	24192	0.03
AB Cliff	2-May-16		228		683		12997	0.02
AB Cliff	16-May-16		108		213		3578	0.03
AB Cliff	13-Jun-16		712		354		7701	0.09
AB Cliff	27-Jun-16		313		161		6867	0.05
AB Cliff	11-Jul-16		345		246		17329	0.02
AB Cliff	8-Aug-16		496		213		10462	0.05
AB Cliff	22-Aug-16		246		369		15531	0.02
MC Monteci	6-Jul-15		3873		332		8164	0.47
MC Monteci	20-Jul-15	>	24192	>	24192	>	24192	n/a
MC Monteci	4-Aug-15		256		624	>	24192	n/a
MC Monteci	12-Aug-15	>	24192		857	>	24192	n/a
MC Monteci	31-Aug-15		6867		272		17329	0.40
MC Monteci	14-Sep-15		4611		563		15531	0.30
MC Monteci	12-Oct-15	>	24192		1723	>	24192	n/a
MC Monteci	26-Oct-15		6867		231	>	24192	n/a
MC Monteci	9-Nov-15		17329		708	>	24192	n/a
MC Monteci	23-Nov-15		1658		62		24192	0.07
MC Monteci	7-Dec-15		2143		230		11199	0.19
MC Monteci	21-Dec-15		292		52	>	24192	n/a
MC Monteci	4-Jan-16		1187		110		7270	0.16
MC Monteci	19-Jan-16		6867		727	>	24192	n/a
MC Monteci	1-Feb-16		2755		4352	>	24192	n/a
MC Monteci	16-Feb-16		1497	>	24192		7701	n/a
MC Monteci	29-Feb-16		1014		201		3255	0.31
MC Monteci	14-Mar-16		1313		213		17329	0.08
MC Monteci	28-Mar-16		1198		85		5794	0.21
MC Monteci	11-Apr-16		1918		85	>	24192	n/a
MC Monteci	25-Apr-16		657		1401	>	24192	0.03
MC Monteci	23-May-16		24192	>	24192	>	24192	n/a
MC Monteci	6-Jun-16		6131		373	>	24192	n/a
MC Monteci	1-Aug-16		7270		576		19863	0.37
MC Monteci	15-Aug-16		8664		95	>	24192	n/a
MC Monteci	12-Sep-16	>	24192		1565		6910	n/a
SC Railroa	21-Dec-15		1860		8164	>	24192	n/a
SC Railroa	19-Jan-16	>	24192		15531	>	24192	n/a
SC Railroa	1-Feb-16		1313		1565	>	24192	n/a
SC Railroa	16-Feb-16	<	10		73		19863	<0.01
SC Railroa	14-Mar-16		839		2046	>	24192	n/a
SC Railroa	28-Mar-16		591		441	>	24192	n/a
SC Railroa	11-Apr-16		323		168	>	24192	n/a
Exceedances			17				10	

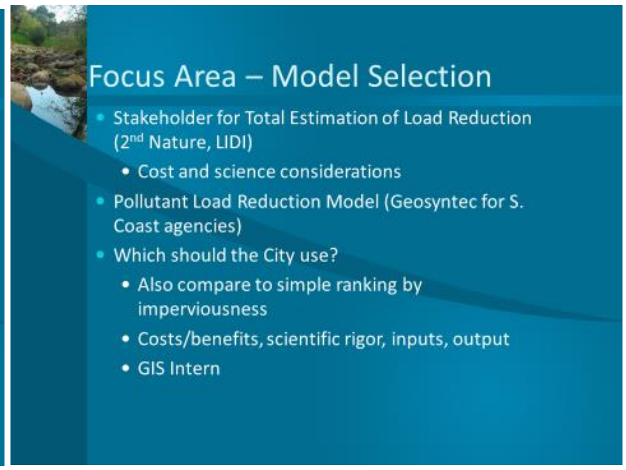
Table 8. Santa Barbara County Beach Water Quality Results during Calendar Year 3 for Beaches Impacted by 303(d) impaired water sampled here. Warning means one or more of the AB 411 criteria were exceeded, and n.s. represents no sample was collected, typically on days where resamples were collected for some beaches but not others.

Date	Arroyo Burro	Mission Creek	Sycamore Creek at E
7/6/2015			
7/14/2015			
8/3/2015			
8/17/2015			
8/24/2015			
8/31/2015			Warning
9/14/2015			
9/21/2015			
9/28/2015			
10/5/2015		Warning	Warning
10/12/2015	Warning	Warning	
10/14/2015			
10/19/2015		Warning	
10/21/2015	n.s.		n.s.
10/26/2015	Warning	Warning	
10/28/2015			
11/2/2015			
11/9/2015			
11/16/2015			
11/23/2015			
11/30/2015			
12/7/2015			
12/14/2015		Warning	
12/16/2015	n.s.		n.s.
1/11/2016		Warning	
1/13/2016	n.s.		n.s.
1/19/2016			
1/25/2016			
2/1/2016	Warning	Warning	Warning
2/3/2016			
2/8/2016			
2/22/2016			
2/16/2016			
2/29/2016			
3/7/2016	Warning	Warning	Warning
3/9/2016		Warning	
3/14/2016		Warning	
3/21/2016			
03/28/16	n.s.	n.s.	n.s.
04/04/16	n.s.	n.s.	n.s.
04/11/16	n.s.	n.s.	n.s.
04/18/16	n.s.	n.s.	n.s.
04/26/16			
05/02/16			
05/09/16			
05/16/16			
4/26/2016			
5/24/2016			
5/31/2016			
6/6/2016			
6/13/2016			
6/20/2016	Warning		
6/22/2016		n.s.	n.s.
6/27/2016			
Exceedances	**5**	**10**	**4**

Pollutant Load Modeling

The City participated in the Total Estimation of Pollutant Load modeling as an active stakeholder during Fiscal Year 2016. The City is trying to determine which model, among TELR, PLRM (Geosyntec), and simple in-house model would be the most cost-beneficial.





Watershed Assessment

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time? *Data collected, but not analyzed for this report.*
2. Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and reclaimed water main breaks? *On hold until reclaimed water system is upgraded.*
3. Is contaminated groundwater at cleanup sites reaching creeks?
4. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro? *Not studied this fiscal year.*
5. Are new or emerging contaminants detected in dry weather conditions? *Neonics not detected in dry weather.*
6. Is DO below Basin Plan standards in upper watershed, in pre-dawn, summer conditions? *Loggers purchased but not yet installed.*
7. Are high levels of sodium and chloride in Sycamore Creek from natural sources? *No additional sampling this fiscal year.*
8. Is toxicity listing for Mission Creek justified? *This question continues to be studied.*

Storm Monitoring

Restoration and Water Quality Improvement Project Assessment

Catch Basin Screens

Summary

Previous analysis has suggested a reduction in fecal indicator bacteria in some locations after catch basin debris screens were installed 2008-09; this analysis has been confounded by the persistence of drought in the post-project period. One explanation for the impact of the screens is that a reduction in leaf litter reaching catch basins, storm drains, and creeks could limit nutrient levels required for the growth of fecal indicator bacteria in the environment. However, the screens were installed to reduce trash, and it was not known if they reduced leaf litter in storm drains as well. Shannon Mueller and Jane Westfall, Watershed Stewards with the Creeks Division, conducted a retrospective image analysis of catch basin photographs collected for the purpose of documenting trash reduction. Using a digital grid overlay similar to quadrats used in tide-pool analysis, plus a simple scoring system, leaf litter in the photographs was quantified. There was a strong and significant reduction in the amount of leaf litter in catch basins after screens were installed. Comparing fecal indicator bacteria levels from the same location and time period suggests that water quality improvements may have been achieved with the catch basin screens. However, the analysis is compromised by the single year of pre-project data. The limited data illustrates the need for the Creeks Division to collect as much pre-project data as possible for the upcoming Regional Board Trash Capture requirements.

Methods

Photographs were taken every year inside the manhole or other opening of 12 catch basins. The photos were analyzed by placing a digital grid over each photo in Powerpoint (Figure 22). The grid was stretched to fit the photograph so that 100 grid spaces filled the photograph. Leaf litter in each grid space was ranked according to the following metric:

0 No leaf litter
1 <50% covered by leaf litter
2 >50% covered by leaf litter
3 100% cover
Evidence for multiple layers at
4 100% coverage

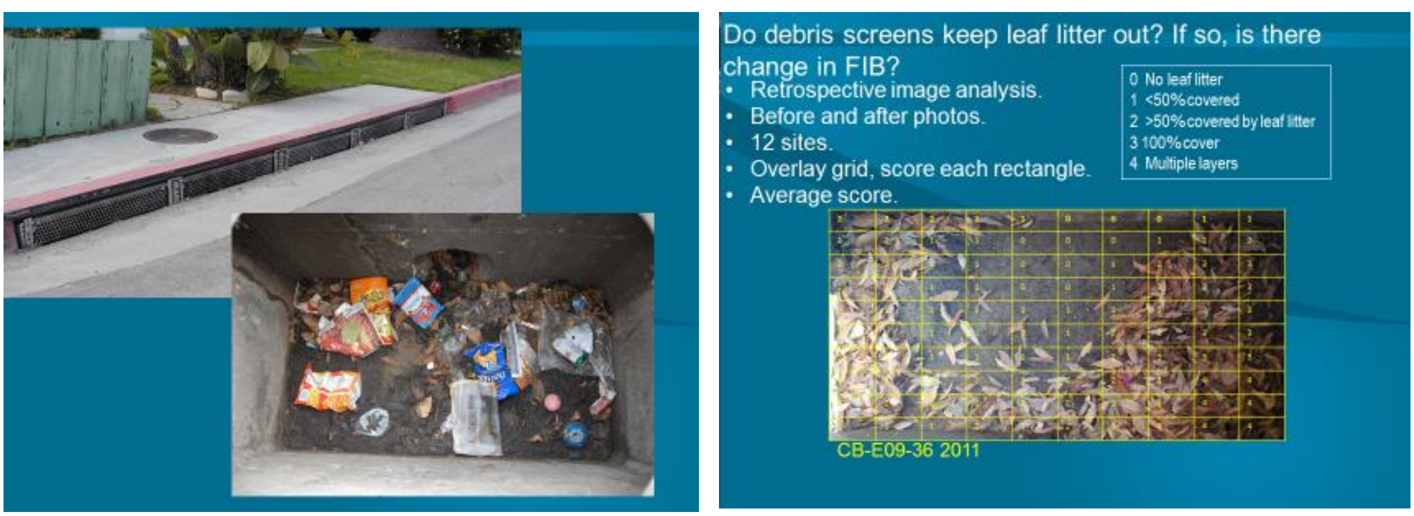


FIGURE 22. METHODS FOR CATCH BASIN LITTER SCORING

Results - Leaf Litter Analysis

Results show a dramatic and significant reduction in the leaf litter score, from a median of 2.2 pre-project to a median of 1.2 post project (Figure 23). This corresponds roughly to a decrease from 50-100% coverage of the catch basin floor to <50% coverage. Detailed results are presented in . Statiscal support is as follows:

▼ Nonparametric : Wilcoxon signed rank test – shows significant difference (p=0.004)

Wilcoxon Signed Ranks Test Results

Counts of Differences (row variable greater than column)

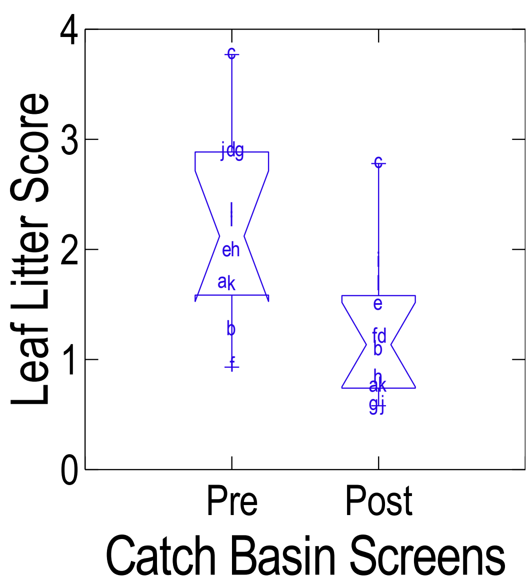
	PREAVG	POSTAVG
PREAVG	0.000	11.000
POSTAVG	1.000	0.000

Z = (Sum of signed ranks)/Square root(sum of squared ranks)

	PREAVG	POSTAVG
PREAVG	0.000	
POSTAVG	-2.903	0.000

Two-sided Probabilities using Normal Approximation

	PREAVG	POSTAVG
PREAVG	1.000	
POSTAVG	0.004	1.000



Leaf Litter Scoring – Scores are based on overlaying each catch basin photograph with a 10 x 10 grid, scoring each box, and averaging the scores across the catch basin. Letters represent individual catch basins. Pre is based on one year of data. Post is an average of three years of data.	
0	No leaf litter
1	<50% covered by leaf litter
2	>50% covered by leaf litter
3	100% cover
4	Evidence for multiple layers at 100% coverage

FIGURE 23. REDUCTION IN LEAF LITTER SCORES AFTER SCREENS INSTALLED IN WESTSIDE CATCH BASINS. NOTCHES DO NOT OVERLAP, SO THEY ARE SIGNIFICANTLY DIFFERENT. LETTERS REPRESENT INDIVIDUAL CATCH BASINS.

However, the caveat is that we only have one year of pre project data. It is possible to see that for the post project data (2009-2011), there are not significant differences among years, supporting the pre-post comparison (Figure 24). The year 2010 did appear higher than 2009 and 2011 for almost all catch basins. *Therefore, the only remaining question is: was 2008 unusually high in leaf litter, biasing the comparison? Unfortunately, we will never know….*

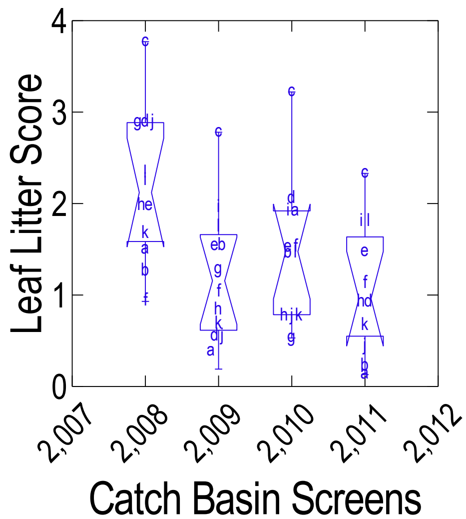


FIGURE 24. LEAF LITTER SCORES FOR POST-PROJECT YEAR. LETTERS MARK INDIVIDUAL CATCH BASIN.

Indicator Bacteria

What about the effect on indicator bacteria at OMC W Anap?

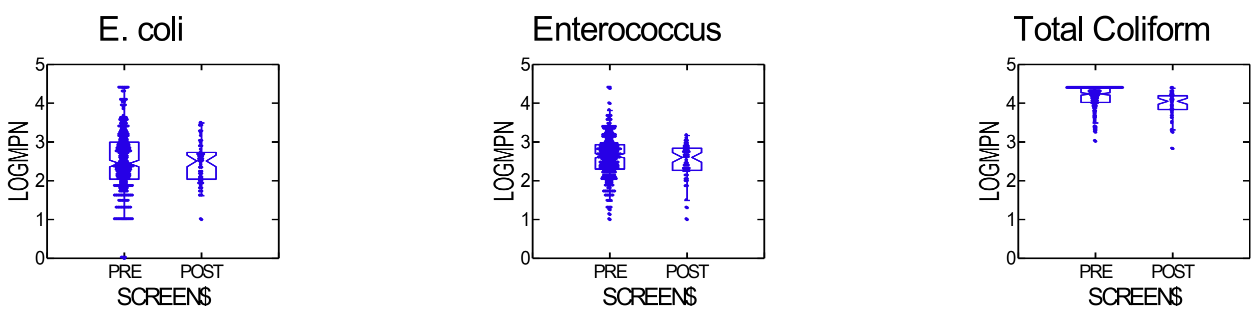


FIGURE 25. FECAL INDICATOR BACTERIA CONCENTRATIONS AT OMC W. ANAPAMU BEFORE AND AFTER THE CATCH BASIN SCREENS WERE INSTALLED. TOTAL COLIFORM, WHICH ARE KNOWN TO GROW IN THE ENVIRONMENT, APPEAR LOWER AFTER THE SCREENS WERE INSTALLED.

Total coliform did appear to decrease after the catch basins were installed, whereas E. coli and enterococcus were not changed (Figure 25). A closer examination of total coliform shows the change is robust, whether multiple years of pre-project data are used, or just a single year (Figure 26). The analysis also held strong when the SURF disinfection was controlled for, by including data only when the SURF project was not in operation.

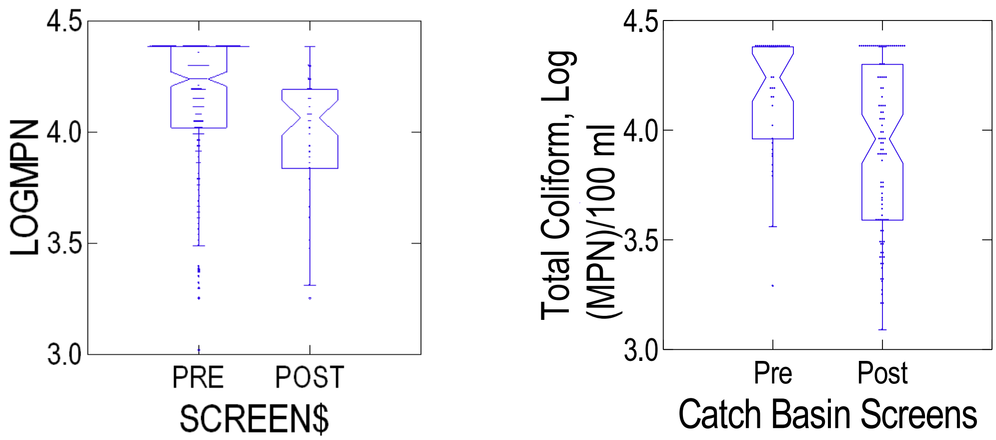


Figure 26. Total coliform results. Left panel: Pre includes all years of data collection. Right panel: pre includes on the year before the screens were installed in the drainage. Sample point is SURF IN, so it only includes data for when the SURF project is in operations. Both comparisons show significantly different results.

Source Tracking

Verification Monitoring

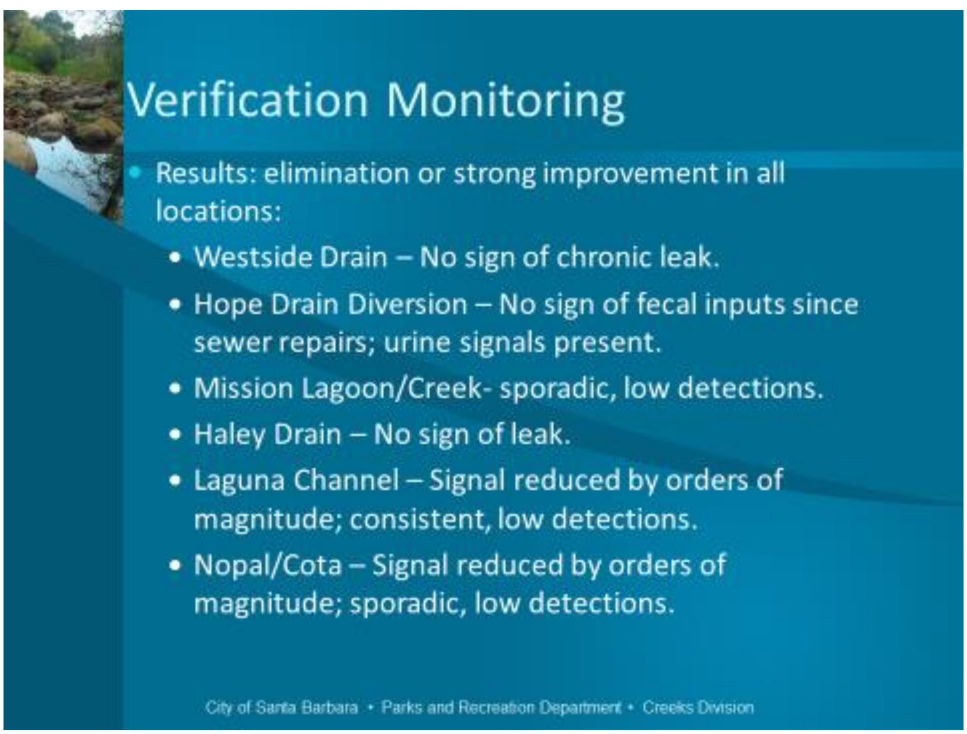


TABLE 9. SUMMARY OF RESULTS FROM VERIFICATION MONITORING PROJECT (HOLDEN, UCSB)

Each site is a different color, shading goes from oldest (lightest) to newest (darkest).

	Caffeine, ppb MDL=0.175	Cotinine, ppb MDL=0.05	HF183 Taqman, copies/100 ml	HumM2, copies/100 ml	NH_3–N mg/L	Notes
Westside Drain-2005-2010 (N=1-4)	ND	ND	ND, ND, ND, ND		.005	
Westside Drain-2014 (N=3)	ND, ND,ND	ND, ND, ND	DNQ, ND, ND	DNQ, ND, ND	.005	No sign of detectable chronic leak.
Hope Drain Diversion-2005-2010 (N=1-8)	124	2.4	(HF183SYBR) 2 ND, 6 samples **10^3 -10^6**			At the time, undetected SS-SD leak at State/Plaza.
Hope Drain Diversion-Post Repair 2010 (N=1)	7	1 sample, 0.3	ND		2	
Hope Drain Diversion – 2014 (N=3)	**0.8-62**	**0.3-1.6**	ND,ND,ND	ND,ND,ND	**0.6--5**	No sign of human fecal inputs, but urine is present (or possibly dumped coffee and littered butts). Holden and conventional wisdom say it is urine.
Mission Lagoon-2005 (N=3)			ND,ND,ND			ND, even when LC and Carrillo leaks were ongoing.
Mission Lagoon-2014 (N=3)	ND,ND,ND	ND,ND,ND	DNQ, DNQ, ND	ND, ND, ND	.005	Possible input but not confirmed byHumM2; too low and infrequent to track upstream.
MC Montecito 2005 (N=4)			(HF183SYBR) ND,ND,ND, 744			
MC Montecito (upstream) 2014 (N=3)	ND,ND,ND	ND,ND,ND	ND, 1868, DNQ	ND,ND,ND	.005	Some hits, but not confirmed by HumM2. Homeless likely involved.
MC Haley 2005 (N=6)			(HF183SYBR) ND, ND, ND 16,483;41,458; 35,287			
MC Haley 2014 (N=3)	ND,ND,ND	ND,ND,ND	ND, ND,ND	DNQ, ND, ND	.005-.00 7	FIB decreased significantly as well. The drain was not flowing while we sampled, so this data is not sufficient to shut off diversion.
LC under 101, 2008 (N=7)			7,234-8,937	DNQ, DNQ, DNQ, 73-1,190		
LC under 101, 2014 (N=5)	ND, ND, ND,ND,ND	ND, ND, ND, ND, ND	DNQ, DNQ, DNQ, 337, 966	ND, ND, DNQ, DNQ, 124	0.1-0.2	Some chronic, low level input may be occurring. Larger flow volume than Nopal/Cota, so larger load also. Confirmed by HumM2. Could possibly be tracked upstream.
Nopal at Cota 2009, before leak found (N=3)	31-56	0.4 - 2	**10^4-10^7**	**10^3- 10^6**		Highest levels recorded in the City.
Nopal at Cota, 2009, after repair (N=3)	ND, ND, ND	ND, ND, ND	ND, ND, DNQ	ND, ND, ND		Leak appears to be fixed.
Nopal at Cota, 2014 (N=5)	ND, ND, ND,0.4, 0.3	ND, ND, ND, ND, ND	ND, ND, ND, DNQ, 70	ND, ND, ND, ND, ND	.05-.06	May be chronic leak, may be sporadic direct input. Concentrations too low to track.

Bioassessment

The 2015 Southern Coastal Santa Barbara Streams and Estuaries Bioassessment Program Report (available at sbcreeks.com), produced by Ecology Consultants for the Creeks Division and Santa Barbara County Project Clean Water, documents the devastating impacts of drought to stream health. The Program involves annual collection and analyses of benthic macroinvertebrate samples and other data at study streams and estuaries. The Index of Biological Integrity (IBI) is used to score the health of creek and estuary sites throughout the South Coast. In most years, reference sites (those considered to be nearly undisturbed by development) have much higher IBI scores than disturbed, urban stream sites. During this past year of drought, scores for reference sites were indistinguishable from disturbed sites due to low flows, separated pools, and very low dissolved oxygen. The bioassessment report contains additional details.

Appendix 1. FY16 Research and Monitoring Plan

The goals of the monitoring program are to:

1. Quantify the levels (concentration, flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.
6. Meet monitoring requirements for grants.
7. Meet General Permit monitoring requirements.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

<u>Program Elements with Associated REQUIREMENTSand/or Research QUESTIONS</u>

A. Grant Project Monitoring Requirements

1. **LID Streets, Sidewalks, and Alleys**
    a. Calculate the load of pollutants infiltrated during 2015-16 rain events at 4 sites, based on Event Mean Concentration results from FY 2015 results.
    b. Maintain HOBO data loggers and graph results.
    c. Provide information for grant reporting.
    d. Monitor and report according to approved Monitoring Plan/Quality Assurance Project Plan
2. **Neonicotinoid Pesticides in Santa Barbara**
    e. Partnering with UCSB and USGS to study neonicotinoid pesticides in SB.

B. NPDES Permit Requirements: Phase II Small MS4 General Permit.

3. **Illicit discharge, detection and elimination.**

E.9.a. Outfall Mapping

(i) **Task Description –** Within the second year of the effective date of the permit, the Permittee shall create and maintain an up-to-date and accurate outfall map[15]. The map may be in hard copy and/or electronic form or within a geographic information system (GIS) the development of the outfall map shall include a visual outfall inventory involving a site visit to each outfall. Renewal Permittees that have an existing up-to-date outfall map that includes the minimum requirements specified in Section E.9.a.(ii)(a-e) are not required to re-create the outfall map. This does not exempt Renewal Permittees with an existing outfall map from conducting the field sampling specified in Section E.9.c.

(ii) **Implementation Level** - The outfall map shall at a minimum show:

(a) The location of all outfalls[16] that are operated by the Permittee within the urbanized area, drainage areas, and land use(s) contributing to those outfalls that are operated by the Permittee, and that discharge within the Permittee's jurisdiction to a receiving water. Each mapped outfall shall be located using coordinates obtained from a global positioning system (GPS) and given an individual alphanumeric identifier, which shall be noted on the map. Photographs or an electronic database shall be utilized to provide baseline information and track operation and maintenance needs over time.

(b) The location (and name, where known to the Permittee) of all water bodies receiving direct discharges from those outfall pipes.

(c) Priority areas, including, but not limited to the following:

1) Areas with older infrastructure that are more likely to have illegal connections and a history of sewer overflows or cross-connections
2) Industrial, commercial, or mixed use areas;
3) Areas with a history of past illicit discharges;
4) Areas with a history of illegal dumping;
5) Areas with onsite sewage disposal systems;
6) Areas upstream of sensitive water bodies;
7) Areas that drain to outfalls greater than 36 inches that directly discharge to the ocean; and
8) Other areas that are likely to have illicit discharges

The priority area list shall be updated annually.

(d) Field sampling stations

(e) The permit boundary

Submerged outfalls or other outfalls that may pose a threat to public safety and/or that are inaccessible are not required to be inventoried.

E.9.c. Field Sampling to Detect Illicit Discharges

(i) **Task Description –** Within the second year of the effective date of the permit (e.g. while conducting the outfall inventory under Section E.9.a.), the Permittee shall sample any outfalls that are flowing or ponding more than 72 hours after the last rain event. The Permittee shall also conduct dry weather sampling (more than 72 hours since the last rain event) of outfalls annually identified as priority areas.

(ii) **Implementation Level** – The Permittee shall:

(a) Conduct monitoring[17] for the following indicator parameters identified in Table 1 to help determine the source of the discharge. Alternatively, the Permittee may select parameters based on local knowledge of pollutants of concern in lieu of sampling for the parameters listed in Table 1. Modifications and associated justifications shall be identified within SMARTS prior to conducting field sampling as specified in Section E.9.c.(i).

Table 1. Indicator Parameters

Indicator Parameters Used to Detect Illicit Discharges					
Parameter	Discharge Types It Can Detect				
	Sewage	Washwater	Tap Water	Industrial or Commercial Liquid Wastes	Laboratory/Analytical Challenges
Ammonia	●	⦿	○	⦿	Can change into other nitrogen forms as the flow travels to the outfall
Color	⦿	⦿	○	⦿	
Conductivity	⦿	⦿	○	⦿	Ineffective in saline waters
Detergents – Surfactants	●	●	○	⦿	Reagent is a hazardous waste
Fluoride*	○	○	●	⦿	Reagent is a hazardous waste Exception for communities that do not fluoridate their tap water
Hardness	⦿	⦿	⦿	⦿	
pH	○	⦿	○	⦿	
Potassium	⦿	○	○	●	May need to use two separate analytical techniques, depending on the concentration
Turbidity	⦿	⦿	○	⦿	

● Can almost always (>80% of samples) distinguish this discharge from clean flow types (e.g., tap water or natural water). For tap water, can distinguish from natural water.
⦿ Can sometimes (>50% of samples) distinguish this discharge from clean flow types depending on regional characteristics, or can be helpful in combination with another parameter
○ Poor indicator. Cannot reliably detect illicit discharges, or cannot detect tap water
N/A: Data are not available to assess the utility of this parameter for this purpose.
Data sources: Pitt (
*Fluoride is a poor indicator when used as a single parameter, but when combined with additional parameters (such as detergents, ammonia and potassium), it can almost always distinguish between sewage and wash water.

(b) Verify that indicator parameters, as specified in Table 2. Action Level Concentrations for Indicator Parameters are not exceeded. Alternatively, the Permittee may tailor Table 2 to align with parameters based on local knowledge of pollutants of concern. Modifications and associated justifications shall be identified within SMARTS prior to conducting field sampling as specified in Section E.9.c.(i).

Table 2. Action Level Concentrations for Indicator Parameters

Indicator Parameter	Action Level Concentration
Ammonia	>= 50 mg/L
Color	>= 500 units
Conductivity	>= 2,000 µS/cm
Hardness	<= 10 mg/L as CaCO3 or >= 2,000 mg/L as CaCO3
pH	<= 5 or >=9
Potassium	>= 20 mg/L
Turbidity	>= 1,000 NTU

(c) Conduct follow up investigations per Section E.9.d. if the action level concentrations are exceeded.

[14] The Permittee shall use the Center for Watershed Protection's guide on Illicit Discharge Detection and Elimination (IDDE): A Guidance Manual for Program Development and Technical Assistance (available at www.cwp.org) or equivalent when developing an IDDE program. Guidance can also be found at: http://cfpub.epa.gov/npdes/stormwater/idde.cfm.
[15] The Permittee may utilize existing forms such as the CWP Outfall Reconnaissance Inventory/Sample Collection Field Sheet while conducting the mapping inventory and Field Sampling as specified below, in Section E.9.c.(http://cfpub.epa.gov/npdes/stormwater/idde.cfm).
[16] Submerged outfalls or other outfalls that may pose a threat to public safety and/or that are inaccessible are not required to be inventoried.

[17] A description of indicator parameter sampling equipment is described in Chapter 12: Indicator Monitoring in the CWP IDDE: Guidance Manual found at: http://www.epa.gov/npdes/pubs/idde_manualwithappendices.pdf. Sampling may be conducted using field test kits.

4. General Permit Monitoring.

a. Special Studies.

E.13.d. Receiving Water Monitoring and Special Studies

Traditional Small MS4 Permittees with a population greater than 50,000 listed in Attachment A that are not already conducting ASBS, TMDL or 303(d) monitoring efforts shall participate in one of the following monitoring programs, subject to Regional Water Board Executive Officer approval:

- E.13.d.1. Receiving Water Monitoring
- E.13.d.2. Special Studies

Conduct monitoring according to Special Studies Plan. Plan includes load reduction monitoring for FIB reduction projects, including:

- Hope Diviersion
- Haley Diversion
- SURF Project
- Parking Lot LID
- Streets, Alley, and Sidewalks LID

Quality Assurance Project Plan (approved by Regional Board)

Where applicable, the Permittee shall prepare, maintain, and implement a Quality Assurance Project Plan (QAPP) in accordance with the Surface Water Ambient Monitoring Program. All monitoring samples shall be collected and analyzed according to the Program QAPP developed for the purpose of compliance with this Order. SWAMP Quality Assurance Program Plan (2008) is available at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/qaprp082209.pdf

A formatted Microsoft Word document that includes guidelines and boilerplate language for developing the permit QAPP is available at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa

Water quality data shall be uploaded to SMARTS and must conform to California Environmental Data Exchange Network (CEDEN) Minimum Data Templates format. CEDEN Minimum Data Templates are also available at: http://ceden.org/

- **Reporting**

(iii) **Reporting** – By the second year Annual Report, the Permittee shall complete and have available a report (50 page maximum) that includes a summary of baseline data collections and discussion of monitoring program results;

By the fifth year Annual Report, the Permittee shall complete and have available a report (50 page maximum) that includes a comparison of data collection to baseline data, and discussion of monitoring program results.

At a minimum, the second and fifth year Annual Reports shall include the following information:

(a) The purpose of the monitoring, brief contextual background and a brief description of the study design and rationale.
(b) Sampling site(s) locations, including latitude and longitude coordinates, water body name and water body segment if applicable. Sampling design, including sampling protocol, time of year, sampling frequency and length of sampling.
(c) Methods used for sample collection: list methods used for sample collection, sample or data collection identification, collection date, and media if applicable.
(d) Results of data collection, including concentration detected, measurement units, and detection limits if applicable.
(e) Quantifiable assessment, analysis and interpretation of data for each monitoring parameter.
(f) Comparison to reference sites (if applicable), guidelines or targets
(g) Discussion of whether data collected addresses the objective(s) or question(s) of study design
(h) Quantifiable discussion of program/study pollutant reduction effectiveness.

- Water quality data submittal.

Water quality data shall be uploaded to SMARTS and must conform to California Environmental Data Exchange Network (CEDEN) Minimum Data Templates format. CEDEN Minimum Data Templates are also available at: http://ceden.org/

- For the Special Studies Plan, the Regional Board agreed that submittal to CEDEN is not necessary.

b. 303(d) Monitoring.

E.13.c. 303(d) Monitoring

All Permittees that discharge to waterbodies listed as impaired on the 303(d)[28] list where urban runoff is listed as the source, shall consult with the Regional Water Board within one year of the effective date of the permit to assess whether monitoring is necessary and if so, determine the monitoring study design and a monitoring implementation schedule. Permittees shall implement monitoring of 303(d) impaired water bodies as specified by the Regional Water Board Executive Officer.

2010 303(d) listings with Urban Runoff as a Source

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	POTENTIAL SOURCES
Arroyo Burro Creek	Escherichia coli (E. coli)	Pathogens	Urban Runoff/Storm Sewers
Arroyo Burro Creek	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Escherichia coli (E. coli)	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Unknown Toxicity	Toxicity	Urban Runoff/Storm Sewers
Pacific Ocean at East Beach – Mission Ck.	Total Coliform	Pathogens	Urban Runoff/Storm Sewers
Sycamore Creek	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers

Conduct FIB and toxicity monitoring, once Monitoring Plan has been submitted and approved (verbal approval of weekly FIB sampling at integrator sites has already been obtained). The Regional Board will not require Receiving Water Monitoring.

c. Program Evaluation, Assessment, and Identification Plan. According to the Regional Board, the following text from section E.14 dictates modeling and monitoring to assess pollutant load reductions. The City will consult with the Regional Board in order to submit a draft PEAIP by October 2015. The following excerpts from section E.14 provide direction. The Draft PEAPIP is due October 14, 2015.

> 6) Quantification of pollutant loads and pollutant load reductions achieved by the program as a whole

> (d) The Program Effectiveness Assessment and Improvement Plan shall identify assessment methods the Permittee will use to quantitatively assess BMP performance at reducing pollutant loads wherever feasible, using the following or equivalent methods:
> 1) Direct quantitative measurement of pollutant load removal for BMPs that lend themselves to such measurement (e.g., measuring sediment collected through street-sweeping activities);
> 2) Science-based estimates of pollutant load removal for BMPs where direct measurement of pollutant removal is overly challenging (e.g., removal of heavy metals through a bioswale);
> 3) Direct quantitative measurement of behaviors that serve as proxies of pollutant removal or reduction (e.g., the percentage of construction sites demonstrated by inspection to be in compliance with permit conditions); or
> 4) Visual comparison (e.g., using photographs to compare the amount of trash in a creek between one year and the next).

C. Watershed Assessment

Research questions:

9. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
10. Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and reclaimed water main breaks? *On hold until reclaimed water system is upgraded.*
11. Is contaminated groundwater at cleanup sites reaching creeks?
12. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro?
13. Are new or emerging contaminants detected in dry weather conditions?
14. Is DO below Basin Plan standards in upper watershed, in pre-dawn, summer conditions?
15. Are high levels of sodium and chloride in Sycamore Creek from natural sources?
16. Is toxicity listing for Mission Creek justified?

D. Storm Monitoring

Research Questions:

1. Is there toxicity in Mission Creek during storm events?
2. New and Emerging Contaminants: Neonicotinoid Pesticides
3. Is runoff from coal tar sealed parking lots and slurry sealed roads more toxic than untreated surfaces?
4. How to Water Quality Improvement Projects function during rain events?
    a. Upper Las Positas (Golf Course)
    b. MacKenzie LID
    c. Parking Lot Storm Water Treatment Demonstration Project.
    d. Streets, Sidewalks and Alleys LID
    e. Fish Passage Projects
    f. Permit PAEIP – Private BMPs
    g. Are human waste markers present in creek flow during wet weather?

E. Restoration and Water Quality Project Assessment

Overall Research Questions:

1. What is the baseline water quality at future restoration, LID, and/or treatment sites, particularly as they relate to project design and assessment of project performance?
2. Do Creeks Division treatment projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
3. Do Low Impact Development (LID)/infiltration projects result in pre-development runoff patterns? What are the loads of pollutants prevented from entering surface water from LID projects?
4. What are the mechanisms of project success?
5. Are installed projects continuing to function correctly?

Projects and Specific Questions

1. **Westside SURF and Old Mission Creek Restoration**
   a. Is the UV disinfection equipment functioning?
   b. What percentage of flow in Westside Storm Drain is the facility treating?
   c. Have habitat scores and index of biological integrity (IBI) scores in Bohnett Park improved?
2. **Arroyo Burro Restoration, including Mesa Creek Daylighting**
   a. How does Arroyo Burro Estuary biological integrity compare to other estuaries in the area?
3. **Hope and Haley Diversions**
   a. Are human waste markers still found in Hope and Haley Storm Drains?
   b. What are the loads of fecal indicator bacteria (FIB) that are diverted to the sanitary sewer by these projects?
4. **Upper Las Positas Creek Project Performance (Storm) and Operation (Dry weather)**
   a. Do treatment elements (Adams bioswale, East Basin, West Basin) reduce pollutant concentrations during storms?
   b. What is the quality of water discharged during spillover conditions (East Basin, West Basin)?
   c. What are the temporal and spatial patterns of pH, temperature, DO, and conductivity in the East Basin during dry weather?
   d. What is the quality of water released prior to storm events from the East Basin and West Basin (field parameters, FIB, nutrients, metals, hydrocarbons, pesticides, and toxicity)? What are the conditions downstream during releases?
5. **McKenzie Park Storm Water Treatment Retrofit (Storm)**
   a. Are basins functioning correctly?
   b. Is the design storm fully infiltrated?
   c. What are rainfall, storage, and draw down patterns?
6. **Debris Screens (Creek Walks)**
   a. Has the installation of catch basin screens lead to decreased trash observed in creeks?
7. **Mission Creek Fish Passage (Dissolved Oxygen)**
   a. What are the conditions in creek segments where fish spend time waiting for passage conditions (above or below passages)?
8. **Laguna Channel Disinfection**
   a. Are there human markers in scavenger.
9. **Storm Water Infiltration Retrofit Projects (Prop 84). See Section A.** Calculate the load of pollutants infiltrated during 2014-15 rain events at six parking lot sites, based on Event Mean Concentration results from FY 2013 results.
   f. Maintain HOBO data loggers and graph results.
10. **Andre Clark Bird Refuge**
    a. What is the cause of stink events?
    b. How is the pilot project performing? Does bioaugmentation help?
    c. What are the sources of nutrients during dry and wet weather?
11. **Las Positas Creek Restoration Project**
    a. What are the flow patterns in dry and wet weather?
12. **Upper Arroyo Burro Restoration**
    a. Is water being pumped from creek or adjacent groundwater?
    b. What is the historical water quality?
    c. Identify any data gaps.

F. Source Tracking/Illicit Discharge Detection

Research questions:

1. Conduct IDDE investigation per General Permit (Section B).
2. What are the causes of persistent beach warnings that occur?
3. How do FIB, host-specific markers and pathogens decay in lagoons?
4. Is RV dumping a consistent problem in Santa Barbara?
5. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?
6. Are human waste markers present and associated with beach warnings at Leadbetter Beach and E. Beach at Sycamore?
7. Are human waste markers present in creek flows during wet weather?
8. Historical FIB Data Analysis

G. Creeks Walks/Clean ups

Research Questions:

1. Outfall screening, per guidance in Section B.
2. Can we see anything unusual in lower Arroyo Burro, regarding flow patterns?
3. Is the amount of trash in creeks decreasing over time?
4. Has the installation of catch basin screens lead to decreased trash observed in creeks?
5. Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?

H. Bioassessment

Research Questions:

1. How does the biological integrity in our creeks change over time, in response to environmental variation?
2. How does the biological integrity respond to water quality and restoration projects?
3. What is the biological integrity of estuaries in Santa Barbara?
4. What is the biological integrity of Laguna Channel? (In support of Mission Lagoon Restoration Project)

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
A. Grant Project Monitoring Requirements			
1. Streets, Alleys, and Sidewalks LID Project	a. Calculate the load of pollutants infiltrated during 2014-15 rain events at 4 sites, based on Event Mean Concentration results from FY 2015 results. b. Maintain HOBO data loggers and graph results. c. Provide information for grant reporting. d. Report according to approved Monitoring Plan/Quality Assurance Project Plan. e. Provide calculations for PW grant (two sites).	No sampling required for FY 16, only data analysis and calculations.	○ Draft Final Report due January 2017
2. Neonicotinoid Pesticides in Santa Barbara	a. Partnering with UCSB and USGS to study neonicotinoid pesticides in SB. Preproposal to CA SeaGrant selected for final proposal submission.	TBD, pending grant funding.	○ Grant deadline June 30, 2015. ○ Funding announcement September 2015. Sampling to start in February 2016.
B. General Permit Requirements			
1. IDDE	Conduct outfall mapping and outfall sampling for chemical indicators at any flowing drain.	**Sites:** Following year, all flowing outfalls in priority areas. Priority areas TBD. **Parameters:** Ammonia, color, conductivity, surfactants, fluoride, hardness, pH, potassium, and turbidity. Add FIB. **Frequency:** Annually	○ Mapping complete; may be updated per Regional Board recommendations. ○ Watershed Stewards to conduct sampling.
2. Monitoring-Special Studies	Conduct monitoring according to Special Studies Plan, once revisions are approved by Regional Board. Plan includes load	See project sections below.	○ Special studies. ○ Calculate load reductions for Year 2 Report (10/15/15).

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
	reduction monitoring for FIB reduction projects, including: a. Hope Diviersion b. Haley Diversion c. SURF Project d. Parking Lot LID e. Streets, Alley, and Sidewalks LID		
3. Monitoring-303(d)	RB has indicated it will approve of biweekly FIB sampling as in C.1 and toxicity sampling as in C.8 and D.1.	See blow.	○ Monitoring Plan due to RB in Year 2. ○ Draft Plan reviewed by Regional Board, requiring minor changes. ○ Submit changes by June 30, 2015.
4. Performance Evaluation, Assessment, and Identification Plan	General Permit requires quantification of pollutant load reduction by entire stormwater permit. Specific plan to meet this requirement has yet to be finalized. Creeks Division is on Technical Advisory Committee for Total Evaluation of Load Reduction model (TELR).	TBD.	○ Draft PEAIP due 10/1/15. ○ Consider intern assistance with mapping and modeling.
C. Watershed Assessment			
1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?	Long term sampling of integrator sites.	**Sites:** Integrator Sites (3), Honda and Lighthouse **Parameters:** FIB, field parameters, flow. **Frequency:** Biweekly for integrators, quarterly for Honda and Lighthouse.	○ Inform El Estero of sampling schedule for FY 16.
2. Are pharmaceutical and personal care products (PPCPs) reaching creeks?		On hold for FY15 and FY 16 due to system shut down and rebuild.	
3. Is contaminated groundwater at cleanup sites reaching creeks?	Follow up on groundwater work by Josh Bader.	**Sites:** 3 creek sites, TBD. **Parameters:** VOCs **Frequency:** One time, dry weather.	
4. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro, including San Roque Creek.	HOBO level loggers, creek walks, no sampling required.	None.	

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
5. Are new and emerging contaminants detected in dry weather?	Integrator sites tested one time for pyrethroids and neonics, all ND. However, sumithrin and dichloran not included. Focus now on neonics in irrigation runoff.	**Sites:** Dry weather outfall sampling where we know irrigation runoff to occur (TBD). **Parameters:** pyrethroids, including sumithrin and dichloran. Neonicotinoids, including imadochlorpid. **Frequency:** one time, dry weather.	○ See SCCWRP list
6. Is DO below Basin Plan standards in upper watershed, in pre-dawn, summer conditions?	Use data loggers to record DO levels in Rattlesnake and lower Mission.	**Sites:** Rattlesnake, Mission Canyon **Parameters:** DO, temperature, **Frequency:** Two week installations, log every 5 minutes.	
7. Are high levels of sodium and chloride in Sycamore Creek from natural sources?	Communicated with Regional Board about additional evidence required to de-list SC; waiting to learn next step.	None as of now.	
8. Is toxicity listing for Mission Creek justified?	Twice yearly dry weather sampling per 303(d) Monitoring Plan to be approved by Regional Board. Two storms (see below).	Semiannual, at Montecito Street. Species still TBD.	
D. Storm Monitoring			
1. Is there toxicity in Mission Creek during storm events?	Two storms, per 303(d) Monitoring Plan to be approved by Regional Board.	**Sites:** Mission Creek at Montecito. **Parameters:** Selenastrum toxicity, other spp. **Frequency:** Two storms, may be first flush.	
2. New and Emerging Contaminants: Neonicotinoid Pesticides	What are the concentrations of neonicotinoid pesticides in runoff during storm events?	**Sites:** Mission Creek at Cabrillo **Parameters:** Neonicotinoids **Frequency:** 3 storms, 12 time points per storm.	Contract with USGS in Sacramento.
3. Is runoff from coal tar sealed parking lots and slurry sealed roads more toxic than untreated surfaces?	Very high toxicity for Daphnia in Corp Yard runoff.	**Sites:** 3 pairs of sites (6 total), TBD. **Parameters:** Invertebrate toxicity **Frequency:** One storm.	Inquire with UCSB (Means) about partnership.
4. Upper Las Positas (Golf Course)	Treatment effect when water is spilling: FIB, TSS, nutrients.	**Sites:** GC PondUp, Spillway **Parameters:** FIB, nutrients, TSS **Frequency:** 3 time points, same storm or different storm.	
5. MacKenzie LID	Infiltration using HOBO loggers	None.	○ Tim Burgess

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
6. Parking Lot Storm Water Treatment Demonstration Project.	7. Calculate the load of pollutants infiltrated during 2014-15 rain events at six parking lot sites, based on Event Mean Concentration results from FY 2014 results. a. Maintain HOBO data loggers and graph results.	No sampling required for FY 16, only data analysis and calculations.	○ Include data analysis in FY 15 WQ Report.
8. Streets, Sidewalks and Alleys LID	See A.2.		○ Tim Burgess
9. Fish Passage Projects	Flow measurements		○ George Johnson
10. Permit PAEIP – Private BMPs	See B. 4	**Sites:** 5 private BMPs (TBD), upstream & downstream, 10 total. **Parameters:** Hydrocarbons, trash, nutrients, bacteria,TSS, pesticides, herbicides **Frequency:** 3 time points (same or different storms).	
11. Are human waste markers present in creek flow during wet weather?	See Source Tracking below.	None.	
E. **Restoration and Water Quality Project Assessment-**What is the baseline water quality at future restoration, LID, and/or treatment sites, particularly as they relate to project design and assessment of project performance?			
1. Westside SURF and Old Mission Creek Restoration (see annual report for details)		**Sites:** SURF up, SURF down, Westside Drain, OMC at W. Anapamu, **Parameters:** FIB, field. **Frequency:** Weekly for SURF operation, biweekly for downstream impacts when SURF in operation.	
2. Arroyo Burro Restoration, including Mesa Creek daylighting (Suspension of quarterly testing until results from biweekly testing warrant a change).		**Sites:** AB at Cliff, Mesa upper, Mesa lower, AB Estuary upper, AB Estuary Mouth **Parameters:** FIB, field.	○ Include results in FY16 WQ Report.

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
		Frequency: biweekly.	
3. Hope and Haley Diversions	See B.2.	**Sites:** Hope Diversions, Haley Pump **Parameters:** FIB, field **Frequency:** Quarterly	
4. Laguna Channel Disinfection/Mission Lagoon Restoration	Collect data to inform two possible new design elements, a wetland below the scavenger pump and restoration of" turtle park."	**Sites:** Water discharged from scavenger pump during low flow, turtle park. **Parameters:** FIB, nutrients, field. Toxicity for turtle park. Human waste markers. **Frequency:** quarterly	○ George Thompson to assist with sampling at turtle park. ○ Congtract with UCSB for human markers.
5. Upper Las Positas Restoration	See storm monitoring. Install HOBO logger in East and West Basins to monitor infiltration and discharge. Calculate loads infiltrated during storms based on previous measurements.		○ Manage two HOBO in basins. Service quarterly. With assistance from George Thompson
6. Parking Lot LID (Storm)	See storm monitoring		
7. Streets, Alleys, and Sidewalks LID	See storm monitoring		
8. Debris Screens (Creek Walks)	See creek walks.		
9. MacKenzie LID	See storm monitoring		
10. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)	Dissolved Oxygen, pH, temperature, conductivity (nutrients as part of above study)	MC Lagoon, MC upper reaches	○ Analyze for summer months, collect data continuously.
11. Bird Refuge	a. Continue monitoring aeration pilot project and annual cycles. b. Follow up on sediment pyrethroid results, storm water pyretroid and neonicotinoid results. c. Conduct sampling for potential project analysis as needed.	**Sites:** Aeration and open sites. **Parameters:** field **Frequency:** Weekly. **Sites:** 3 sites, TBD. **Parameters:** pyrethroids, neonicotinoids. **Frequency:** Once. TBD	
12. Las Positas Creek Restoration Project. What are the flow patterns in dry weather?	Measure flow in channel and test for temperature increases along concrete channel.	**Sites:** Every 25' along concrete reach **Parameters:** Temperature **Frequency:** Quarterly	○ Manage HOBO logger in lower end of concrete reach

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
13. Upper Arroyo Burro Restoration (Barger) a. Is water being pumped from creek or adjacent groundwater? b. What is the historical water quality? c. Identify any data gaps.		**Sites:** Upper and lower end of project. **Parameter:** FIB, nutrients, field. **Frequency:** Quarterly	○ Purchase and install HOBO in lower end of concrete reach
F. Source Tracking			
1. Conduct IDDE investigation per General Permit (Section B).	See above.		
2. What are the causes of persistent beach warnings that occur?	Conduct additional surveillance and sampling (indicator bacteria and/or DNA techniques) up creek and within estuaries when persistent warnings occur.	TBD	As needed (none in FY 14)
3. Are there pathogens present in Santa Barbara creeks? Are SB beaches suitable for Quantitative Microbial Risk Assessment (QMRA)?	Hold for FY 17.		
4. How do FIB, host-specific markers and pathogens decay in lagoons?	No sampling required for Creeks.	Arroyo Burro Lagoon.	UCSB Project.
5. Is RV dumping a consistent problem in Santa Barbara?	Observation.	Situational.	
6. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?	Use new epidemiology studies in Southern California to conduct simple model of illness rates at Santa Barbara beaches. No sampling required.		Include in FY 16 Annual Report.
7. Are human waste markers present and associated with beach warnings at Leadbetter Beach and E. Beach at Sycamore?	Clean Beaches Initiative Grant to fund microbial source tracking at Leadbetter and E. Beach at Sycamore.		UCSB and Geosyntec.
8. Are human waste markers present in creek flows during wet weather?	Grant in F.8 includes wet weather sampling.		UCSB sampling as part of MST project.
9. Historical FIB Data Analysis	Update previous historical analysis conducted in 2009 and submit to peer reviewed journal.		Partnership with UCSB.

PROGRAM ELEMENT and QUESTIONS	APPROACH/METHODS	SAMPLING SITES, PARAMETERS, FREQUENCY	RESPONSIBLE PARTY IF NOT CREEKS/DEADLINES
G. Creeks Walks/Clean ups			
1. Outfall screening, per guidance in Section B.	See above.		
2. Can we see anything unusual in lower Arroyo Burro and San Roque Creek, regarding flow patterns?	Observation.		
3. Is the amount of trash in creeks decreasing over time?	Weight of trash removed each year.		
4. Has the installation of catch basin screens lead to decreased trash observed in creeks?	Continue measuring and marking GPS coordinates of trash in Old Mission Creek and Lower Mission Creek (Oak Park to beach).		
5. Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?	Creek walks.		
H. Bioassessment	See Bioassessment Proposal and Reports. Larger data analysis from FY 14. Submit for publication in peer reviewed journal.		Ecology Consultants.Scott Cooper (retired, UCSB)