Water Quality Research and Monitoring Program

Clean Creeks
HEALTHY BEACHES
CITY OF SANTA BARBARA

Fiscal Year 2009
Annual Report

SEAL OF THE CITY OF SANTA BARBARA CALIFORNIA

City of Santa Barbara
Creeks Division
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The Creeks Division wishes to thank the volunteers, interns, Creeks Advisory Committee, and staff who assisted with sampling design, storm monitoring, creek walks, laboratory work, and data analysis. Cover invertebrate photo from California Department of Fish and Game (http://www.dfg.ca.gov/cabw/cabwhome.html).

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I. INTRODUCTION

The primary goals of the Creeks Division Research and Monitoring Program are to:

- Quantify the levels (concentration and flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
- Evaluate the effectiveness of the City's restoration and water quality treatment projects in reducing contaminant and pollutant levels.

The secondary goals of the program are to:

- Determine the water quality for aquatic organisms, including fish, invertebrates, amphibians, and plants, in watersheds throughout the city.
- Evaluate the effectiveness of the City's restoration and water quality treatment projects in improving water quality for aquatic organisms.

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

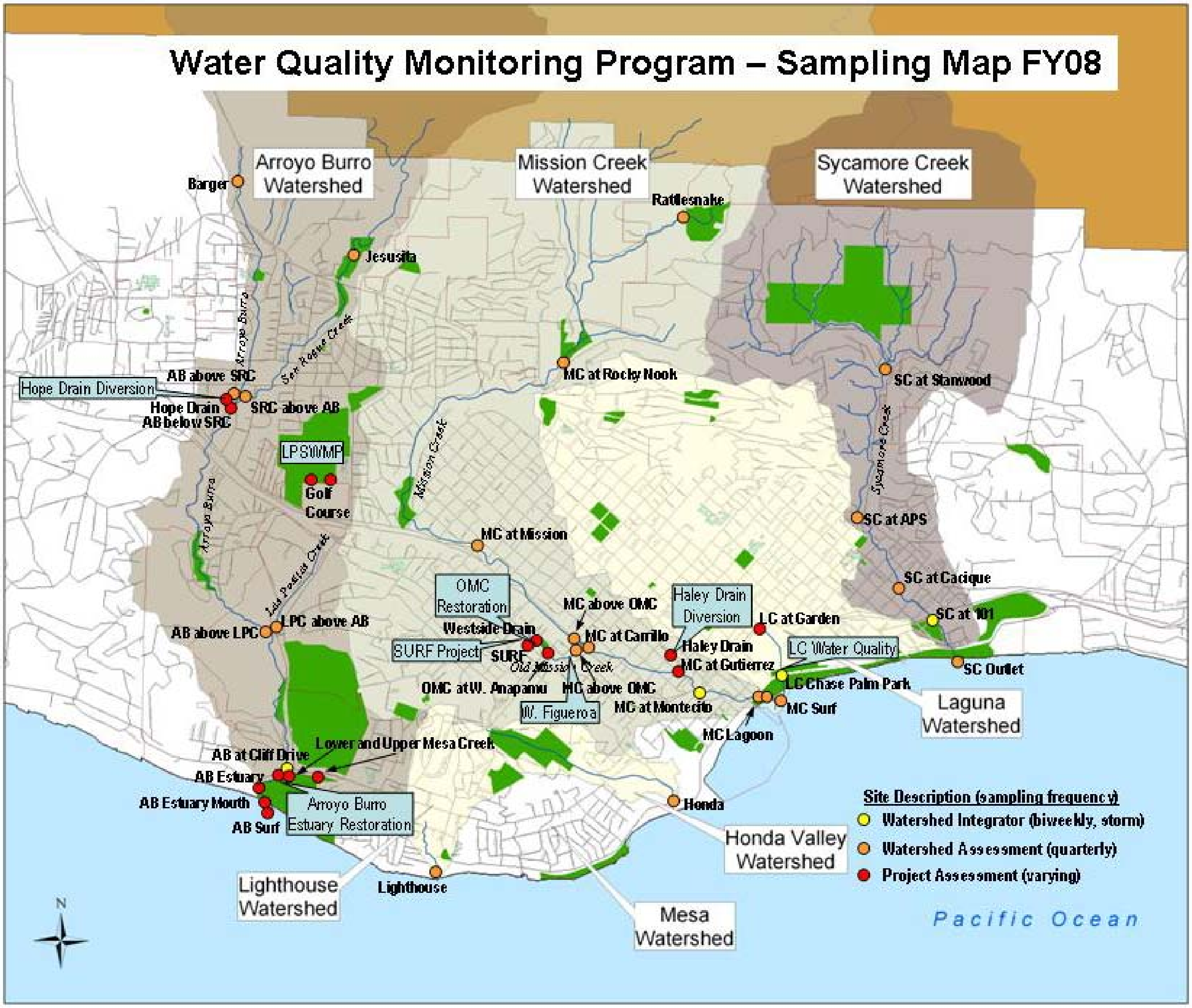
- Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
- Communicate effectively with the public about water quality.

The following report described sampling and results that were based on the Fiscal Year 2009 Research and Monitoring Plan (Appendix A). The Research Plan is organized research questions that have been reviewed by the Creeks Advisory Committee. Where possible, the report is organized around the research questions. Additional sections include Emerging Issues and Literature Updates, Reporting, and the Recommendations for Fiscal Year 2010. The Fiscal Year 2010 Research Plan can be found in Appendix B. *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.***

The monitoring program consists of six key elements:

1. Routine watershed assessment
2. Storm monitoring
3. Restoration and Water Quality Project Assessment
4. Microbial Source Tracking
5. Creek Walks
6. Bioassessment

Samples are collected from sites throughout the City (see map below).



Routine Watershed Assessment

Routine watershed assessment focuses on microbial pollution (as defined by indicator bacteria) and water quality for aquatic organisms (physicochemical properties such as pH, temperature, dissolved oxygen, turbidity, conductivity). During Fiscal Year 2009, Routine Watershed Assessment also focused on quantifying loads of chemical pollutants in creeks during dry weather, assessing toxicity of creek water in dry weather, and assessing pollutants in sediment.

Research questions:

1. Is overall water quality getting better over time?
2. Are new hot spots emerging?
3. Which subwatersheds contribute the greatest loads of pollutants to creeks in Santa Barbara?
4. Do creeks in Santa Barbara have problems with toxicity, particularly in relation to dissolved copper, in dry weather?
5. How contaminated and/or toxic is sediment at creek outfall sites?
6. How does creek water quality relate to beach warnings at Santa Barbara beaches?

Highlights:

- Based on Federal and State regulations, the County uses fecal indicator bacteria levels are to determine beach warnings at Santa Barbara beaches. An analysis of annual beach grades (from Heal the Bay), based on the County's results, suggests that water quality has improved at Santa Barbara

beaches since grading began in 1999, particularly for wet weather. Additional data collection and analysis will be conducted to investigate whether the improvement is due primarily to the impacts of weather and rainfall. There are many limitations with using indicator bacteria to assess water quality, including the lack of consistent correlation with the presence of human pathogens and the ability of indicator bacteria to grow in the environment. Because of the limitations, the US EPA is currently seeking a better indicator of beach water quality.
- Despite enormous variability in fecal indicator bacteria levels in creek samples, Enterococcus levels appear to have decreased in lower Mission Creek in the past five years.
- A combined analysis of quarterly load results showed that the majority of contaminants entering creeks during dry weather occur in the lower reaches. Using flow measurements and contaminant concentrations, the combined analysis showed that the bulk of pollutants in Arroyo Burro during dry weather enter the creek between the confluence with San Roque Creek and the confluence with Las Positas Creek. In Mission Creek, during low-flow conditions, approximately half of the pollutants arrive from Old Mission Creek and half arrive between the confluence of Old Mission Creek and Mission Creek at Montecito Street.
- Vertebrate toxicity testing, which includes exposing fathead minnows to creek water for five days, showed that the Santa Barbra creeks do not have a problem with toxicity in dry weather. Of twenty four samples collected from Mission Creek, Arroyo Burro, Laguna Channel, and Sycamore Creek during dry weather, only one showed less than 95% survival, with a value of 90%.
- Using the latest US EPA-approved method for assessing copper toxicity, which involves calculating site-specific criteria based on several water quality parameters, sampling showed that none of the sites tested exceeded dissolved copper criteria in dry weather. In addition, dissolved copper values were lower than those reported to cause temporary neurological impairment in steelhead.
- After two years of sediment testing in the lagoons at each integrator site, sediment showed no toxicity using the test organism *Euhaustoriaus* (92 - 100% survival at each site). Using California's new Final Sediment Quality Objectives for Enclosed Bays and Estuaries to integrate chemical and toxicity data, Arroyo Burro Estuary, Mission Lagoon, Sycamore Lagoon, and the Andre Clark Bird Refuge were determined to have "minimal potential" for a chemically mediated effect on the benthic community. Laguna Channel sediments were scored as having a "low potential" for chemically mediated effects on the benthic community, primarily due to chlordane, and also cadmium, lead, and zinc. The pyrethroid bifenthrin was found at the Bird Refuge was somewhat close to a sediment quality guideline.

Storm Monitoring

Trace metals, pesticides/herbicides, and additional organic pollutants can have deleterious effects on aquatic organisms and human health. The purpose of storm monitoring is to identify chemical constituents of concern and to identify pollution hot spots. The monitoring program over the past several years has strived to sample the "first flush", thereby testing the worst-case scenario in order to identify pollutants of concern.

Research Questions:
1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms?
2. What are the loads of pollutants discharged from Santa Barbara creeks during storms?
3. How do concentrations and loads vary during storms?
4. What are the sources and routes of pollutants during storms?
5. Do creeks in Santa Barbara have problems with toxicity, particularly in relation to dissolved copper, during storm events?
6. How do restoration/treatment projects impact water quality during storm events?

Highlights:
- Six storms were sampled in Fiscal Year 2009.
- Seasonal first flush sampling, which captures early runoff from the first storm of the season and generally produces the highest levels of pollutants seen in the creeks, was conducted in October and November 2008. These results were the second set to include toxicity measurements during storm runoff. Similar to last year, survival of fathead minnows in the toxicity test was 100% for Mission Creek and 95% for Arroyo Burro. However, only 25% survival was found in the sample from the Laguna

Channel, which was collected very early during the first rainfall. No pesticides or herbicides were detected in creek samples. The only chemical constituent found to exceed current water quality criteria was MBAS, a class of surfactants most often found in detergents.

- Wildfire impacts to water quality were tested after the Tea Fire. Results showed that there were higher levels of suspended sediment and several metals in the burned site (Sycamore watershed) versus the unburned site (Mission Canyon). The levels of metals were well below standards known to cause toxicity in aquatic organisms. All PAHs and the metals lead, cadmium, chromium, selenium, and silver were not detected at either site. Samples from a downstream Sycamore Creek site, collected after more rain had fallen, did not show high levels of any metals or PAHs compared to storm sampling in previous years.
- Baseline samples were collected for the West Figueroa area (two storms), the Upper Las Positas Creek Project, and the Low Impact Development Demonstration Project.

Restoration and Water Quality Project Assessment

The Creeks Division has completed several restoration and water quality improvement capital projects. Project assessment is used to determine the success of these projects in lowering microbial and chemical pollution levels and improving water quality for aquatic organisms. In some cases project monitoring is grant-required, and the remaining project monitoring is for internal review of project effectiveness.

Research Questions:

1. Do Creeks Division projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
2. What is the baseline water quality at future restoration/treatment sites?
3. What are the mechanisms of project success?

Highlights

- The second season of operation of the Westside SURF project was evaluated. The project has been highly successful in eliminating indicator bacteria in runoff from the Westside Drain. Indicator bacteria results return to background levels relatively quickly downstream. Ongoing research is looking into the mechanism behind the increase in levels.
- Additional baseline values were collected for proposed water quality projects at the Santa Barbara Golf Course (storm sample) and West Figueroa on Mission Creek (dry weather). In addition, the Andre Clark Bird Refuge was monitored, but data is still being analyzed. Ongoing post-project data was collected for Mesa Creek daylighting.

Creek Walks

Creek walks from the ocean to upper watersheds are used to identify problem areas and track changes due to natural processes and human activity. Problem areas may include sources of polluted input to the creeks, sites of habitat degradation, or failing bank structures. Problem areas that are typically not seen from roads can be identified, cleaned up, and monitored.

Research Questions:

1. How have the number and location of water pollution sources changed over time?
2. Are there new problems in creeks that need to be addressed?
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?

Highlights

- The second year of baseline data was collected for assessing the impact of catch basin screens in the Westside Neighborhood on trash in Old Mission Creek

Microbial Source Tracking

Microbial source tracking is used to develop better tools for tracking fecal pollution in creeks and to identify sources of indicator bacteria. The Creeks Division has gathered extensive data on the presence of indicator bacteria throughout its watersheds, however, the specific sources of pollution and the degree to which the recreational waters are harmful to human health are not known.

Research Questions

1. Which locations in creeks and drains have consistent presence of human waste?
2. Where does such waste enter drainage systems?
3. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?
4. How does presence of human waste relate to beach warnings?

Highlights

- The Laguna Watershed Study, which involved dry weather hydrology and microbial source tracking, was completed in Fiscal Year 2009.
- Results from the Laguna Watershed Study were used to form a recommendation for installing ultraviolet disinfection at the discharge of Laguna Channel.
- Ongoing source tracking in the Laguna Channel storm drain network has identified locations with relatively high concentrations of fecal contamination. These sites are under ongoing investigation to determine locations of inputs.
- Sampling for the Source Tracking Protocol Development Project began in August 2009. Additional sampling will take place through October 2010.
- A preproposal to the Water Environment Research Federation, for to test canine scent tracking as a source tracking tool, was selected for full proposal submission in October 2009.

Bioassessment

The biological assessment element is used to assess and monitor the biological integrity of local creeks as they respond through time to natural and human influences.

Research Questions:

1. What is the baseline of biological integrity for benthic macroinvertebrates in creeks?
2. Are there differences between upper watershed and lower watershed sites?
3. Are there differences among watersheds?
4. How does the biological integrity in our creeks change over time?
5. How does the biological integrity respond to habitat restoration projects?

Highlights

- As reported by the consultant to the Creeks Division, Ecology Consultants, the Index of Biological Integrity (IBI) scores at most of the study reaches were similar in 2008 to those in 2007, which together were lower than those found in 2005 and 2006. For lower reaches of creeks, especially, a lack of heavy rainfall and scouring discharges are thought to be the cause of this trend.
- Sufficient data has been collected to test hypotheses and patterns statistically. In the 2009 bioassessment effort, the data amassed thus far will be used to calculate a new Index of Biological Integrity and examine causes of impairments.

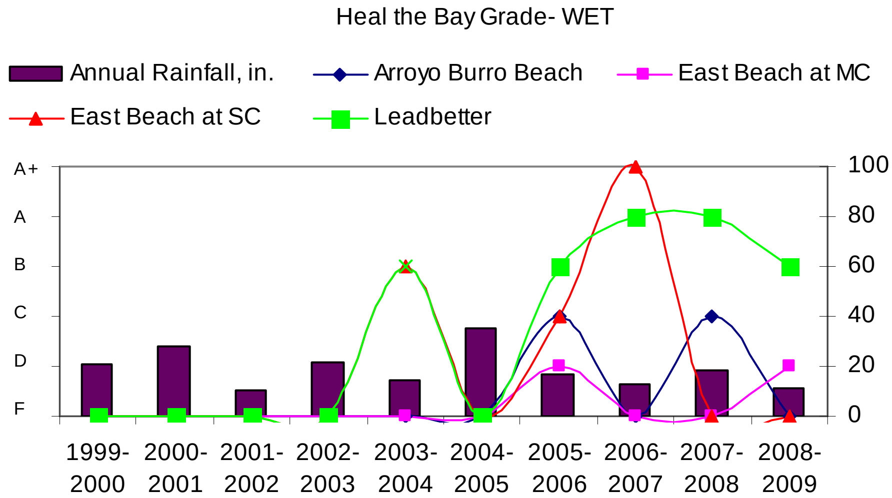
Due to staff resource limitations during FY09, additional data analysis for FY09 will be included in the FY10 quarterly reports.

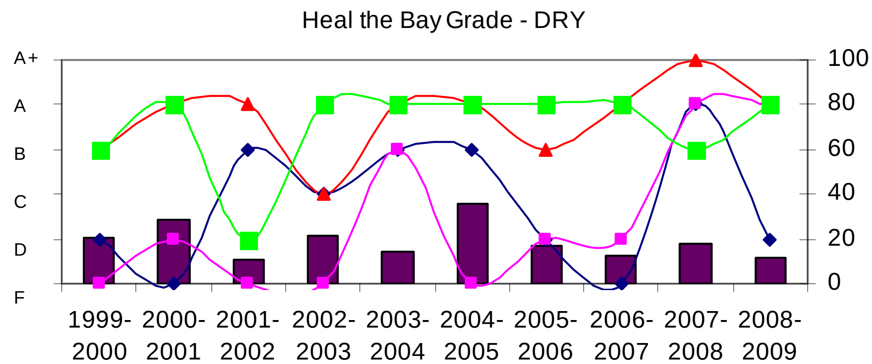
II. ROUTINE WATERSHED ASSESSMENT

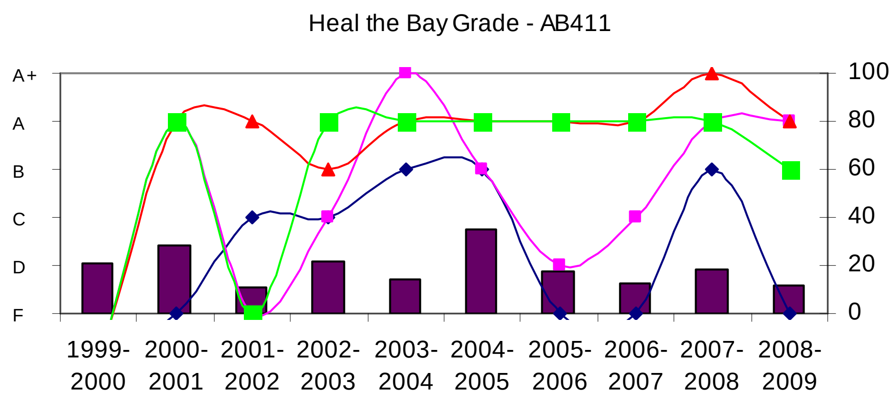
IS WATER QUALITY IMPROVING?

Water quality data is extremely variable over time and from location to location. Previous reports (City of Santa Barbara 2006) have shown that indicator bacteria values in creek locations are highly scattered (City of Santa Barbara).

Presented below are plots of beach water quality over time, using data from Heal the Bay (www.healthebay.org).







Yearly Heal the Bay Report Card grades for beaches in the City of Santa Barbara (www.healthebay.org). Grades are calculated based on levels of three indicator bacteria groups in relation the geomean and single maximum criteria. Grades are calculated for three combinations of sample dates: WET (April 1- March 31, only days impacted by rain), DRY (April 1 - March 31, only days not impacted by rain), and AB411 (dry and wet, from April 1 – October 31). Please see http://www.healthebay.org/brcv2/default.aspx?tabid=4#grades for more details about how grades are calculated.

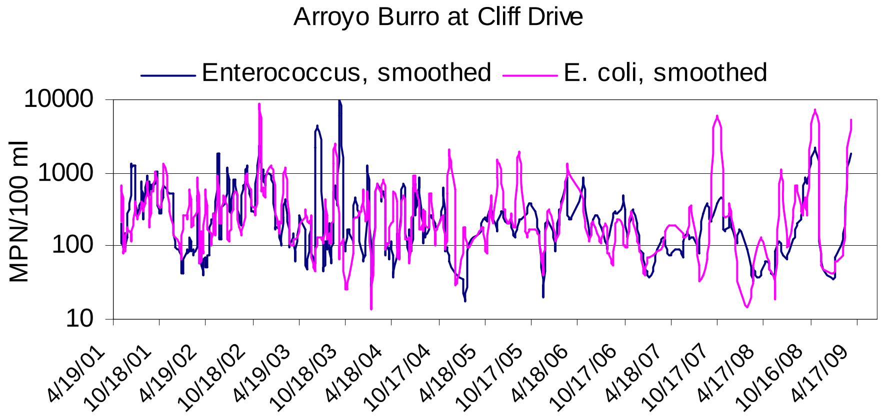
As can be seen in the plots above, wet weather grades may be improving over time. Dry weather and AB411 grades are either too high or too sporadic to see improvement. A brief statistical analysis was conducted that compared wet weather grades from 1999-2003 to grades from 2004-2009. Points were assigned to each grade level (F through A+ corresponding to 1 through 7, as in the plots above), and averages were calculated for each time period. A one-tailed Student's t test was performed for site and category (WET, DRY, AB411). The following table presents the results of the analysis:

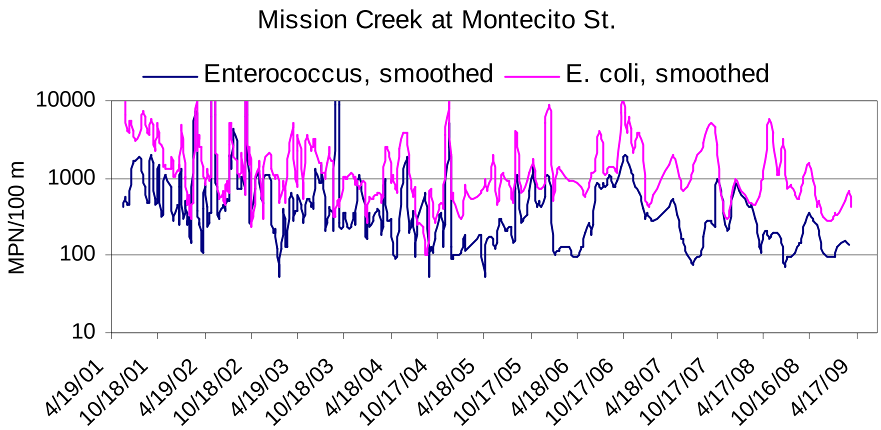
Results of Student's test on beach grades from 1999-2004 compared to 2004-2009. Dark green shading marks sites/conditions which have improved, with p<0.1, light green represents improvements with p>0.1, yellow represents no change, and red represents declining water quality.

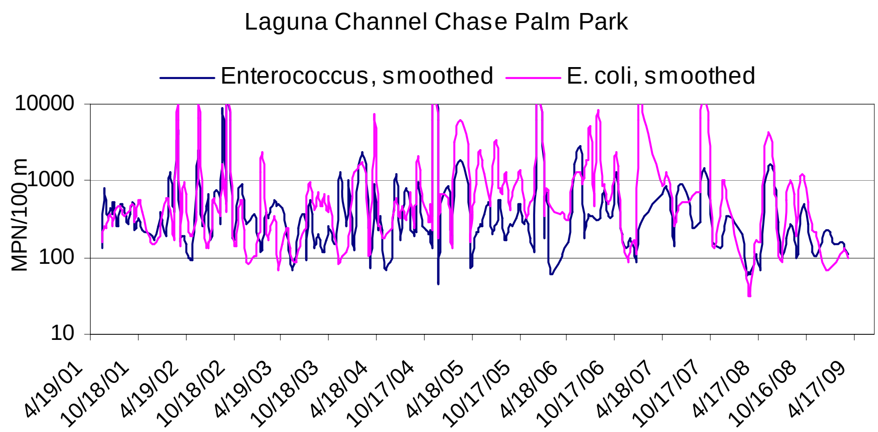
	Arroyo Burro Beach			MC East Beach			E. Beach at SC			Leadbetter		
	Dry	Wet	AB411	Dry	Wet	AB411	Dry	Wet	AB411	Dry	Wet	AB411
1999-2004 average	C	F	C	D	F	B	B	D	A	B	D	A
2004-2009 average	C	D	D	C	D	B	A	D	A	A	B	A
p	0.5	0.07	0.3	0.14	0.07	0.48	0.14	0.26	0.1	0.18	0.02	0.2

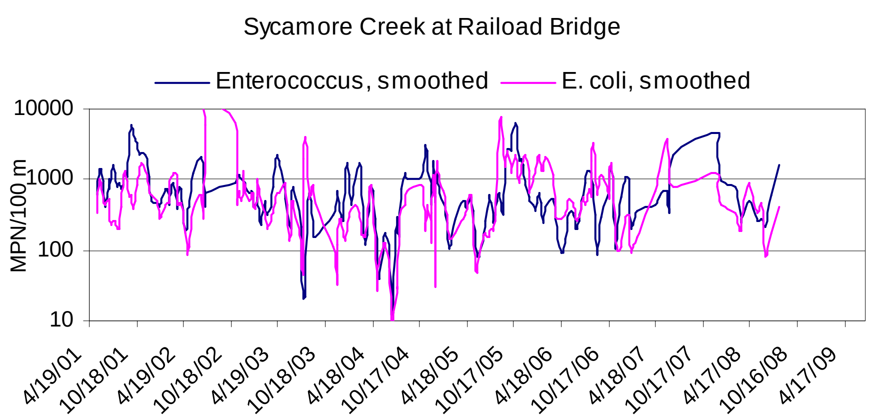
Despite the limitations in using a grading system to compare water quality from year to year, there is a strong suggestion that beach water quality is getting better. Of twelve combinations of location and condition, three showed statistically significant improvement (p<0.1), three showed improvement that was not statistically significant (p>0.1), five showed no change, and one showed decreasing water quality that was not statistically significant. This brief analysis will be expanded in the coming year, using actual indicator bacteria values rather than annual grades.

As can be seen in the plots and table above, grades are worse for Arroyo Burro Beach and East Beach at Mission Creek than for Leadbetter and East Beach at Sycamore Creek. Both Arroyo Burro Beach and Easy Beach at Mission Creek receive runoff from creeks year round. Leadbetter and Sycamore do receive runoff, but the creeks typically dry up during summer months and infrequently discharge to the ocean. Below are plotted indicator bacteria results for integrator sites Arroyo Burro at Cliff Dr., Mission Creek at Montecito St., and Laguna Channel at Chase Palm Park (which discharges to Mission Creek at East Beach).





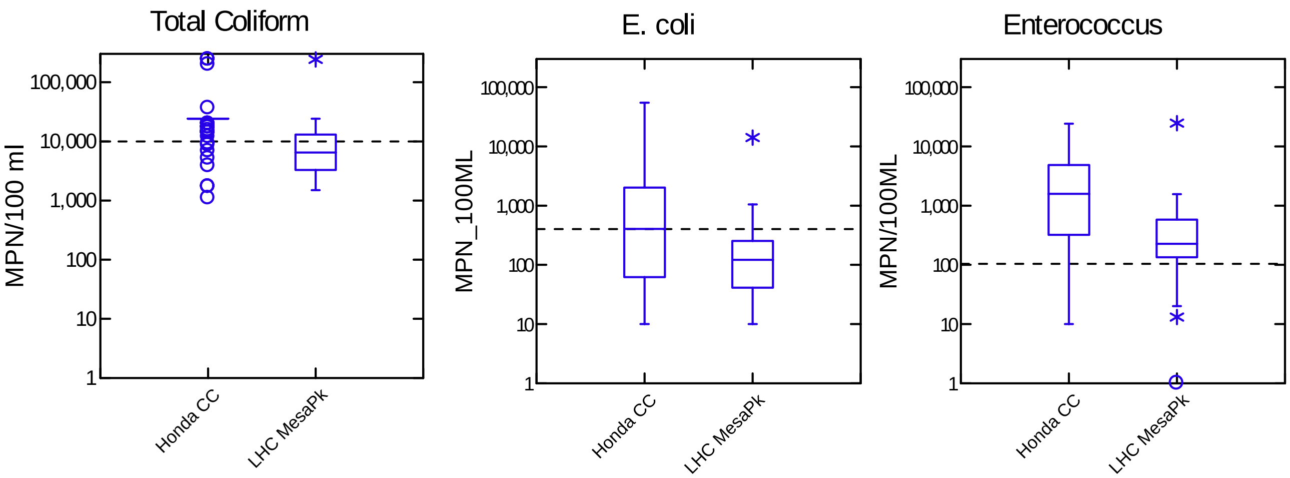




Indicator bacteria results from weekly/biweekly testing at integrator sites. Because values are extremely variable, even on a logarithmic plot, data were smoothed using SYSTAT prior to plotting. In addition, values of "< 10" and > 24,192" were plotted as 10 and 24192, respectively.

As can be seen in the plots above, Enterococcus and E. coli values are highly variable, even when viewed after the data have been smoothed. The plots above suggest that in general, creek indicator bacteria levels have not improved. However, Enteroccus levels at Mission Creek at Montecito St. do appear to be declining. This hypothesis, among others generated from this analysis, e.g. that Enterococcus and E. coli are closely correlated within a site, will be tested in the coming year.

While not directly presenting long term trends, the following boxplots display data collected for Honda and Lighthouse Creeks. These data have not been presented in previous reports. The dashed line represents the beach water quality standards.


Total Coliform
E. coli
Enterococcus
MPN/100 ml
MPN_100ML
MPN/100ML
100,000
10,000
1,000
100
10
1
Honda CC
LHC MesaPk

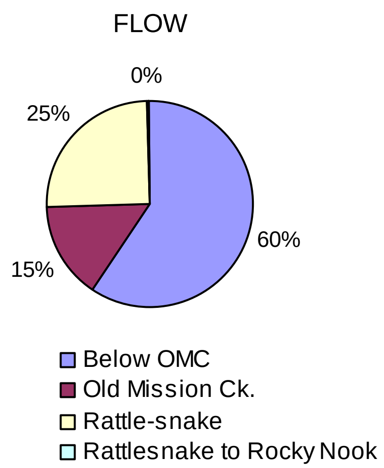
ARE NEW HOT SPOTS EMERGING?

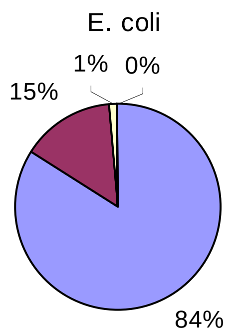
Hot spots that have been identified in the past year include the Serena Drain, which enters Mission Creek, and the Annex Yard drain, which enters Laguna Channel. Serena Drain was been observed to occasionally discharge large amounts of foamy, fecal-indicator bacteria laden water. Extensive upstream investigation has not turned up the source of this discharge. Unfortunately, there are large gaps between manholes, making the tracking more difficult. The Annex Yard drain was identified as problematic in the Laguna Watershed Study. Corrective action is underway.

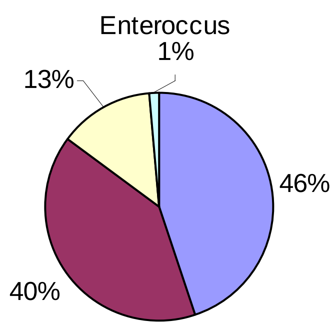
WHICH SUBWATERSHEDS CONTRIBUTE THE MOST POLLUTION?

The Creeks Division conducted quarterly sampling and flow measurements for subwatershed load partitioning on five occasions. The methods and quarterly results have been presented in previous quarterly reports. The following graphs represent an averaging of the five quarters that were tested.

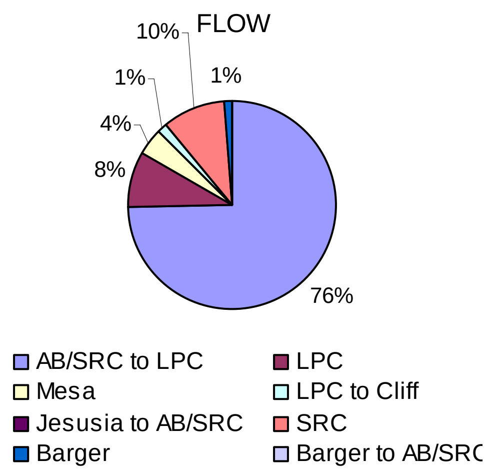
MISSION CREEK

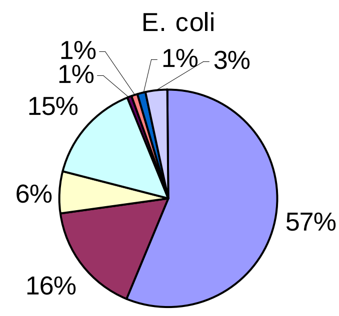


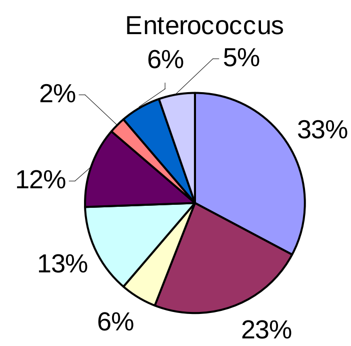


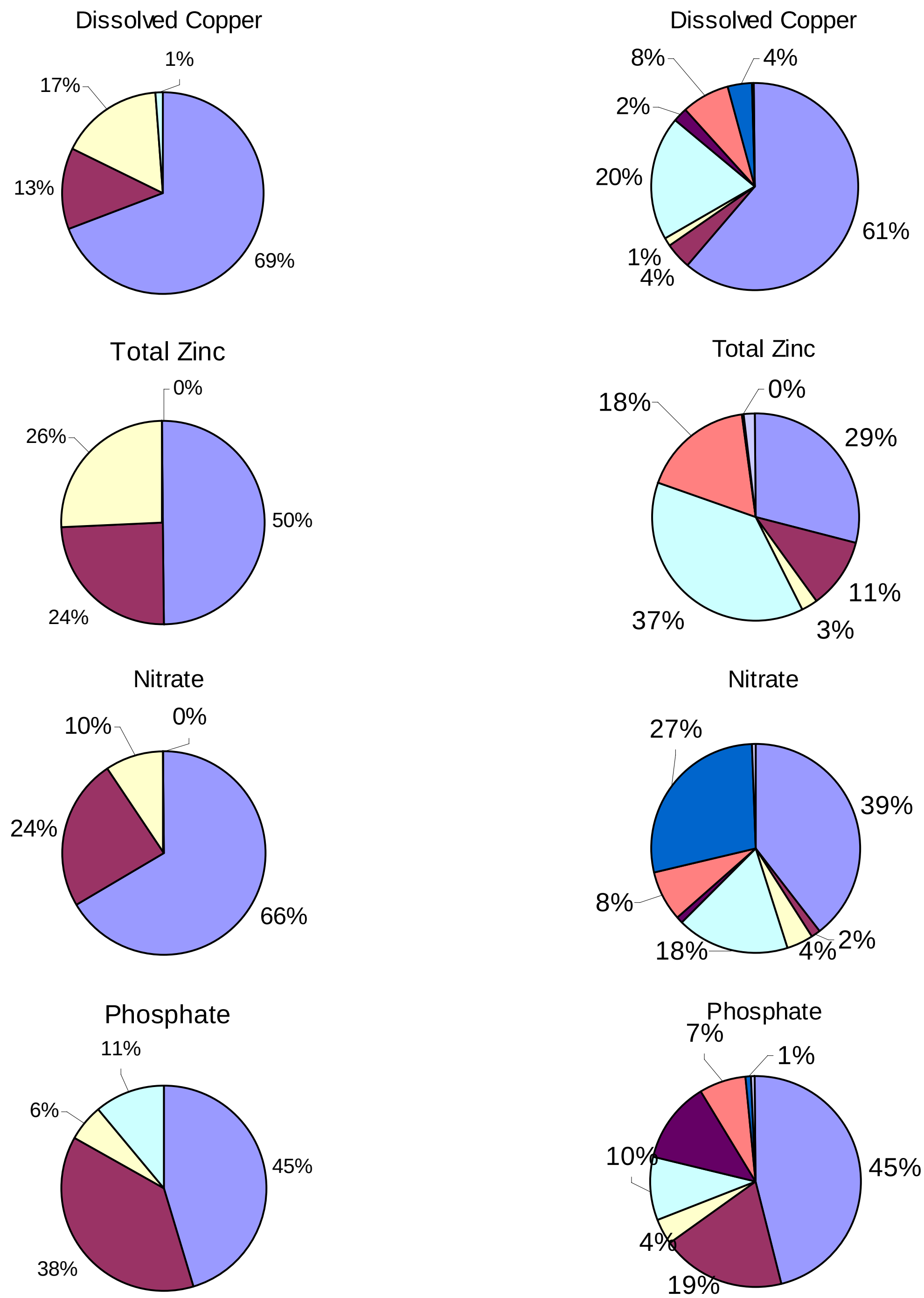


ARROYO BURRO









For Mission Creek:

- Approx. half of flow and contaminants enter in lower Mission Cr. (below OMC, Carrillo)
- High Enterococcus from OMC, 13% from Rattlesnake
- Highest *E. coli* from Lower MC
- Phosphate enters in all reaches

For Arroyo Burro:

- Approx. half of contaminants enter between AB-SRC Confluence (State St.) and AB-LPC Confluence (Veronica Sp.)
  - Approx. 10% from Las Positas Cr.
  - 15% from Las Positas Cr. to Cliff Dr.
- High phosphate from Las Positas Cr.

- Load of *E. coli* 10x lower than in Mission Cr.

IS THERE A PROBLEM WITH DISSOLVED COPPER AND/OR TOXICITY DURING DRY WEATHER?

During the second quarter of FY09, toxicity was tested at the integrator sites during storm sampling, with the exception of Sycamore, which was dry. The tables below summarizes all of the results obtained to date, shown as both percent survival (%) and toxicity score (TU(a)) for water samples. See sediment section for sediment toxicity results. Exceedances were determined using the following criteria, which are also used by the Regional Board in 303(d) listings: Significant reduction of survival of test organism relative to the control (alpha < 0.05) and test organism survival is 20% less than the control survival (SWAMP 2004). Of thirty samples tested throughout Santa Barbara creeks in wet and dry weather, the toxicity was almost always greater than 90% in all but one sample. Incidentally, the testing laboratory has 90% as the cutoff for control samples. The sample that exceeded, at 25% survival and >1 TU(a) was Laguna Channel at Chase Palm Park during the first several minutes of runoff during the seasonal first flush in 2008.

Based on these results it is recommended that dry weather toxicity testing be discontinued. Following the lead of State Board in assessing impairments, but applying their method to the four waterbodies combined, it is concluded that Santa Barbara creeks are not generally impaired for toxicity during dry weather. First flush testing will continue, with a focus on early runoff and storm drain samples.

All results presented as % survival over control and toxicity units.	**Mission Creek at Montecito St.**	**Arroyo Burro at Cliff Dr.**	**Laguna at Chase Palm Park**	**Sycamore at Railroad Br.**
First Flush Fall 07	100%, 0 TU(a)	95%, .41 TU(a)	100%, 0 TU(a)	not sampled- dry
FY08 Quarter 1	90%, .59 TU(a)	100%, 0 TU(a)	not sampled	100%, 0 TU(a)*
FY08 Quarter 2	95%, .41 TU(a)	95%, .41 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)
FY08 Quarter 3	95%, .41 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)
FY08 Quarter 4	95%, .41 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)
FY09 Quarter 1	100%, 0 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)	not sampled - dry
First Flush Fall 08	100%, 0 TU(a)	95%, .41 TU(a)	25%, > 1 TU(a)	not sampled – lab error

* Sycamore's integrator site (railroad bridge) was dry, therefore toxicity sample was taken at first available flowing site (APS).

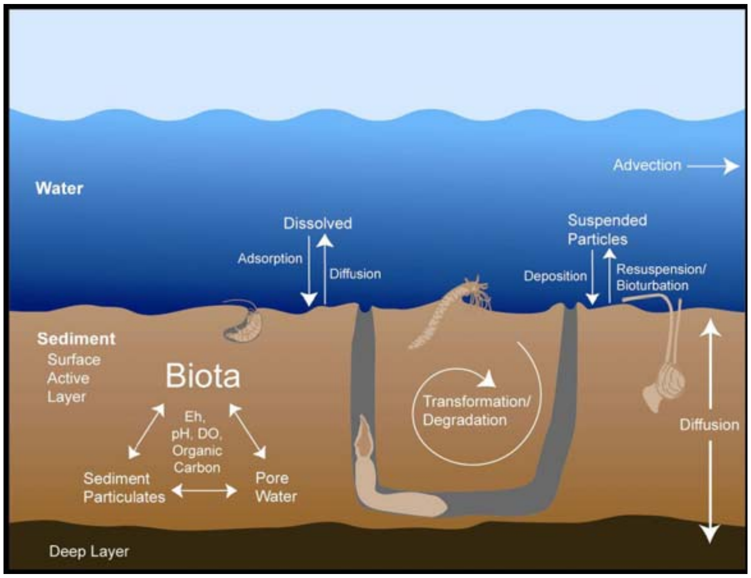
Additional testing in May 2007 was conducted to be used with Bioassessment.

StationID	Sample Date	Result	Units
Rattlesnake	02/May/2007	95	% survival
SRC us AB	02/May/2007	100	% survival
Mesa lower	02/May/2007	100	% survival
OMC W Anap	02/May/2007	95	% survival
MC Cota	02/May/2007	100	% survival
SC APS	02/May/2007	100	% survival

Two drains have been sampled during rain events: Haley with 55% survival and Hope with 0% survival.

HOW CONTAMINATED AND/OR TOXIC IS SEDIMENT AT CREEK OUTFALL SITES?

Many pollutants are known to adhere to sediments and persist for a much longer time than they do in the water column, causing harm to sediment biota. However, assessing the impact of pollutants in sediments is more difficult compared to the water column, because the bioavailability of pollutants in sediments depends on many factors, as shown in the following figure.



Sediment processes affecting the distribution and form of contaminants (in: SWRCB, Draft Staff Report for Water Quality in Enclosed Bays and Estuaries, 2008).

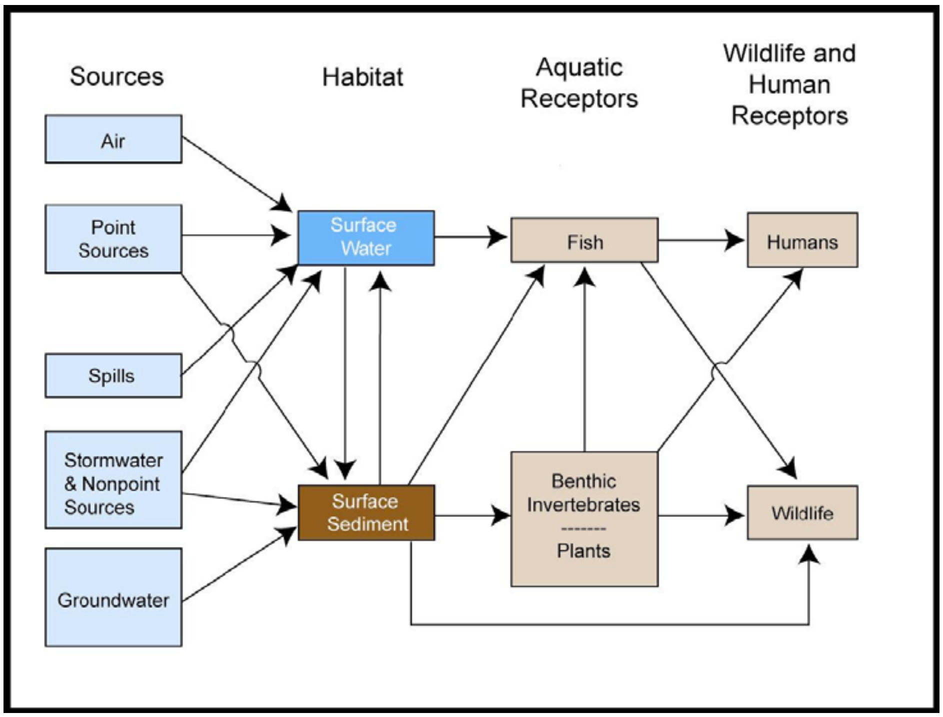
Based on recommendations from the Creeks Advisory Committee, the Creeks Division FY08 Research Plan called for quarterly sediment sampling to assess the condition of sediment downstream the integrator stations, i.e. in the estuarine portion of Mission Creek, Arroyo Burro, and Sycamore, and the lower section in Laguna Channel. However, due to the unexpected high cost of processing these samples, the decision was made to sample sediment annually. Three years of sediment data have been collected, comprised of sampling in November 2007, September 2008, and August 2009. The Andre Clark Bird Refuge (ACBR) was sampled in 2008. Based on the results from the Bird Refuge, limited testing was also conducted 2009. The following section uses the data from 2007 and 2008 to analyze the condition of sediment in Arroyo Burro Estuary, Mission Lagoon, Laguna Channel, and Sycamore Lagoon.

Until recently, there were very few objectives or standards available to use when interpreting sediment chemistry data. The Creeks Division used the California State Water Resources Control Board (State Water Board) draft Sediment Quality Objectives (SQOs) in order to guide the sediment assessment. The SQOs were signed into law in September 2009, and will apply to enclosed bays, estuaries, and coastal lagoons throughout California. Arroyo Burro Estuary, Mission Lagoon, and Sycamore Lagoon fit the definition of coastal lagoons and estuaries. Lower Laguna Channel, which does not receive saline water, does not fit within the definition of a coastal lagoon. In recent years, the outfall of Laguna Channel has merged with Mission Lagoon prior to discharge to the ocean, preventing a separate sampling effort for Laguna Lagoon. In addition, Santa Barbara Harbor fits the definition of an enclosed bay; however, the Creeks Division does not sample harbor sediments.

The SQOs integrate chemical and biological measures to determine if sediment-dependent biota are protected or degraded as a result of exposure to toxic pollutants. The SQOs are also used to determine the risk to human health from consumption of sediment-associated seafood. The approach includes the following narrative objectives and associated beneficial uses:

Beneficial Uses	Target Receptors	Narrative Objective
Estuarine Habitat Marine Habitat	Benthic Community	Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California.
Commercial and Sport Fishing Aquaculture Shellfish Harvesting	Human Health	Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health.

The Sediment Quality Objective Control Plan includes a program of implementation, using multiple lines of evidence (MLOE), including chemistry, toxicity, and bioassessment, to determine if the narrative objective for benthic community protection is met. The human health objective will be addressed in future years. The following figure illustrates the relationship among pollutant sources, habitats, and receptors.



Principal sources, fates, and effects of sediment contaminants in enclosed bays and estuaries. Adapted from Brides et al. 2005 (in: SWRCB, Draft Staff Report for Water Quality in Enclosed Bays and Estuaries, 2008).

Methodology- Where possible, the Draft SQO Implementation Plan was used to determine the sampling, chemistry, and toxicity methods. The ecological component, using bioassessment, has not been implemented explicitly by the Creeks Division.

Staff used a short section of wide PVC pipe, along with a flat shovel, for collecting lagoon sediment samples. The PVC pipe was pushed down into the sediment, approximately 5 cm deep. The flat shovel was slid underneath the pipe to hold the sediment inside the pipe as it was pulled toward the surface. The sediment from this first "scoop" was emptied into a bucket. A total of two scoops were collected at four different areas in each lagoon, ranging from lower to upper lagoon (for a total of 8 scoops). Once all the samples were in the bucket, the sediment was mixed thoroughly and poured into sample bottles provided by the laboratory. In 2008, sediment was collected from the Bird Refuge by Richarde Forde, from several locations throughout the lake. Sediment samples were outsourced to Calscience laboratory for sediment chemistry, ABC Labs for toxicity, and CRG for pyrethroids.

The following table shows the chemical tests required by the Draft SQO to conduct chemistry assessment. All of the chemicals were measured, with the exception of trans nonachlor. The analysis was carried out assuming that it was not detected in any samples. In addition, a second type of analysis that was presented in a recent SCCWRP report (taken from Macdonald et al., 2000) is presented below.

Chemical tests required to conduct the Draft SQO Sediment Chemistry Assessment

Pollutant of Concern	Detection Limit, Units
Cadmium	n/a, mg/kg
Copper	52.8 mg/kg
Lead	26.4 mg/kg
Mercury	0.09 mg/kg
Zinc	112 mg/kg
Chlordane, alpha	µg/kg
Chlordane, gamma	µg/kg
DDDs	µg/kg
DDEs	µg/kg
DDTs	µg/kg
Dieldrin	µg/kg
p,p' DDT (4,4, DDT)	µg/kg
PAHs, high molecular weight	µg/kg
PAHs, low molecular weight	µg/kg
PCBs	µg/kg
trans nonachlor	µg/kg

Results and Analysis

Chemistry - The data (including some that is not shown), were used to follow the steps outlined in the Draft SQOs to determine the sediment condition based on chemistry and toxicity. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals. For each constituent, exposure categories are described in the following table:

Exposure Level	Score	Predicted Effect on Biota
Minimal	1	Sediment-associated contamination may be present, but exposure is unlikely to result in effects.
Low	2	Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.
Moderate	3	Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.
High	4	Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

The following table summarizes the results of the sediment sampling in 2007 and 2008, including constituents that were not used in the analysis. Highlighted values denote constituents that were above thresholds for “minimal disturbance” in the analysis. PEC refers to the concentration above which probable toxic effects would be predicted (Macdonald, et al., 2006)

Constituent	Units	Arroyo Burro	Mission	Laguna	Sycamore	Bird Refuge	PEC	Disturbance Category (highest between CSI and CA LRM)*
Metals								
Cadmium	mg/kg	0.513 0.405	0.179 0.173	0.998 0.629	0.349 0.708	0.446	4.98	minimal, except moderate for LC minimal, except low for LC and SC
Copper	mg/kg	13.5 8.58	7.98 8	19.5 21	13.2 15.6	57.9	149	minimal, except low for ACBR minimal
Lead	mg/kg	4.39 7.15	5.41 13.9	37.1 26.4	4.96 6.84	18	128	minimal, except low for LC minimal
Mercury	mg/kg	ND ND	ND 0.0317	0.0387 0.0329	ND 0.0215	0.0291	1.06	minimal minimal
Zinc	mg/kg	39 35.1	29.7 31.4	109 81.3	21.8 57	33.7	459	minimal, except low for LC minimal, except low for LC
Arsenic	mg/kg	2.42 3.45	2.03 2.59	3.82 3.9	2.66 4.44	2.51	33	n/a
Chromium	mg/kg	16 20.2	14.9 11.8	13.4 11.5	10.5 29.2	9.15	111	n/a
Nickel	mg/kg	24 21.4	13.1 11.4	13.7 10.8	12.7 32.5	12.2	48.6	n/a
Selenium	mg/kg	ND 1.9	ND 1.58	ND 2.85	ND 3.95	ND	n/a	n/a
Silver	mg/kg	ND ND	ND ND	0.229 0.33	ND ND	ND	n/a	n/a
PAHs								
Total LMW PAHs	µg/kg	ND 171	ND 223	909 384	ND 129	77	n/a	Minimal, except moderate for LC Low, except moderate for LC
Naphthalene	µg/kg	ND 130	ND 80	20 160	ND 96	ND	561	n/a
Acenaphthylene	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
Acenaphthene	µg/kg	ND ND	ND ND	140 ND	ND ND	ND	n/a	n/a
Fluorene	µg/kg	ND ND	ND ND	ND ND	ND 11	ND	536	n/a
Phenanthrene	µg/kg	ND ND	ND 23	39 32	ND ND	ND	1170	n/a
Anthracene	µg/kg	ND ND	ND ND	50 ND	ND ND	ND	845	n/a
Fluoranthene	µg/kg	ND ND	ND 67	410 72	ND ND	33	2230	n/a
Pyrene	µg/kg	ND 41	ND 53	250 120	ND 22	44	1520	n/a
Total HMW PAHs	µg/kg	ND 71	ND 169	328 1165	ND 404	ND	n/a	Minimal, except low for LC Minimal, except low for LC and SC
Benzo (a) Anthracene	µg/kg	ND 18	ND 29	54 40	ND ND	ND	1050	n/a
Chrysene	µg/kg	ND 27	ND 49	72 78	ND 14	ND	1290	n/a
Benzo (b) Fluoranthene	µg/kg	ND ND	ND ND	54 ND	ND ND	ND	n/a	n/a
Benzo (k) Fluoranthene	µg/kg	ND 60	ND 16	40 1000	ND 390	ND	n/a	n/a
Benzo (a) Pyrene	µg/kg	ND ND	ND 27	41 ND	ND ND	ND	1450	n/a
Dibenz (a,h) Anthracene	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
Benzo (g,h,i) Perylene	µg/kg	ND 11	ND 17	35 ND	ND ND	ND	n/a	n/a
Indeno (1,2,3-c,d) Pyrene	µg/kg	ND ND	ND 31	32 47	ND ND	ND	n/a	n/a
1-Methylnapthalene	µg/kg	ND	ND	ND	ND	ND	n/a	n/a
2-Methylnapthalene	µg/kg	ND	ND	ND	ND	ND	n/a	n/a
Total PAHs	µg/kg	ND 242	ND 392	1237 1549	ND 533	77	22800	n/a

Chlorinated Pesticides	Units	Arroyo Burro	Mission	Laguna	Sycamore	Bird Refuge	PEC	Disturbance Category*
Chlordane, alpha	µg/kg	ND ND	ND ND	ND ND	ND ND	ND ND	17.6	Minimal Minimal
Chlordane, gamma	µg/kg	ND ND	ND ND	12 9.7*	ND ND	ND ND	17.6	Minimal, except moderate for LC Minimal, except moderate for LC
DDDs, total	µg/kg	ND ND	ND ND	3.39 ND	0.37 ND	0.33	28	Minimal, except moderate for LC Minimal
DDEs, total	µg/kg	ND ND	ND ND	2.6 1.2	0.55 ND	0.98	31.3	Minimal, AB and MC; Low, LC, SC, ACBR Minimal, except low for LC
DDTs, total	µg/kg	ND ND	ND ND	0.73 ND	ND ND	ND	62.9	Minimal, except low for LC Minimal
Total DDT	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	572	n/a
Dieldrin	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	61.8	n/a
Endrin	µg/kg	ND ND	ND ND	0.25 ND	ND ND	ND	207	n/a
Heptoclor epoxide	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	16	n/a
Lindane	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	4.99	n/a
All other EPA 8081A (Chlorinated Pesticides)	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
Pyrethroids (EPA 8270CmNCI)	**Units**	**Arroyo Burro**	**Mission**	**Laguna**	**Sycamore**	**Bird Refuge**	**SCCWRP LC 50**	**Disturbance Category***
Bifenthin	µg/kg dry	ND ND	ND ND	ND ND	ND ND	3	4.5	n/a
Cyfluthrin	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	13.7	n/a
Deltamethrin	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	9.9	n/a
Esfenvalerate	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	24	n/a
Lambda-cyhalothrin	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	5.6	n/a
Permethrin	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	90	n/a
All other EPA 8270	µg/kg dry	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
Other Pesticides and Herbicides								
EPA 8141A (Organophosphorus Pesticides)	mg/kg	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
EPA 8151A (Chlorinated Herbicides)	µg/kg	ND ND	ND ND	ND ND	ND ND	ND	n/a	n/a
PCBs	µg/kg	ND ND	ND ND	1260: 36 ND	ND ND	ND	676	Minimal, except moderate for LC Minimal

PEC from Macdonald 2000.
SCCWRP LC50 are described below and taken from the Habitat Value of Urban Streams (SCCWRP, 2008).

-Highest Disturbance Category scores taken from SWRCB Draft Sediment Quality Plan CA LRM Regression Analysis and Chemical Score Index.
-"n/a" means that the compound was not included in the analysis and that no guidelines have been identified.
-Chlorinated pesticides: Alpha-BHC; Gamma-BHC; Beta-BHC; Heptachlor; Delta-BHC; Aldrin; Heptachlor Epoxide; Endosulfan I; Dieldrin; 4,4'-DDE; Endrin; Endrin Aldehyde; 4,4'-DDD; Endosulfan II; 4,4'DDT; Endosulfan Sulfate; Methoxychlor; Chlordane; Toxaphene; Endrin Ketone

-Pyrethroids (8270): Allethrin, Bifenthrin, Cyfluthrin, Cypermethrin, Danitol, Deltamethrin, Esfenvalerate, Fenvalerate, Fluvalinate, L-Cyhalothrin, Permethrin, Prallethrin, Resmethrin
Organophosphorus pesticides: Azinphos Methyl; Bolstar; Chlorpyrifos; Coumaphos; Demeton-o; Demeton-s; Diazinon; Dichlorvos; Disulfoton; Ethoprop; Fensulfothion; Fenthion; Malathion; Merphos; Methyl Parathion; Mevinphos; Naled; Phorate; Ronnel; Stirophos; Tokuthion; Trichloronate
-Chlorinated herbicides: Dalapon; Dicamba; MCPP; MCPA; Dichlorprop; 2,4-D; 2,4,5-TP; 2,4,5-T; 2,4-DB; Dinoseb

The results show that Laguna Channel has the highest number and degree of pollutants of concern, including cadmium, lead, zinc, PAHs, chlordane, DDTs, DDEs, DDDs, and Endrin. Chlordane is of highest concern due to the identification of the "moderate exposure" category. Chlordane, DDT, DDD, and DDE are "legacy pollutants," and while no longer used in the United States, they are very persistent in the environment. DDT was banned from use in the United States in 1972 and Chlordane was banned in 1988. DDE and DDD are breakdown products of DDT. In addition, all sites were identified as problematic for low molecular weight PAHs, which are generally petrogenic (from fuel sources). High molecular weight PAHs are related to combustion.

The following analysis derives an overall Draft SQO score for each site. Following this section is the SCCWRP analysis.

Draft SQO Analysis

1. The Chemical Score Index, which predicts the degree of benthic community disturbance, was computed for each site and constituent. Average scores for 2007 and 2008 were used. In future analyses, it may be better to average the concentrations first. Scores above 1 indicate constituents of concern. The average score for each site is calculated, and then used to determine the overall disturbance category.

Chemical Score Index

	AB	**MC**	**LC**	**SC**	**ACBR**
Copper	1	1	1	1	2
Lead	1	1	1.5	1	1
Mercury	1	1	1	1	1
Zinc	1	1	1	1	1
PAHs low	1.5	1.5	3	1.5	1.5
PAHs high	1	1	2	1.5	1
Chlrodane, alpha	1	1	1	1	1
Chlordane, gamma	1	1	3	1	1
DDDs	1	1	2	1	1
DDEs	1	1	2	1.5	2
DDTs	1	1	1.5	1	1
PCBs	1	1	1.5	1	1
Average	1.018	1.01	1.89	1.048	1.23
Category Assigned	Reference	Reference	Low	Reference	Reference
Score Assigned	1	1	2	1	1

2. The California Logistic Regression Model was used to predict the probability of sediment toxicity based on concentrations of each constituent. Then the maximum probability for each site is identified, and used to identify a category of response. In addition, trans nonachlor was not included in the analysis because it was not tested.

CA Logistic Regression Model

Constituent	AB	Bird Refuge	LC	MC	SC
Cadmium	0.31	0.30	0.50	0.11	0.36
Copper	0.05	0.26	0.10	0.04	0.07
Lead	0.07	0.24	0.39	0.13	0.07
Mercury	0.00	0.02	0.02	0.01	0.00
Zinc	0.21	0.19	0.42	0.18	0.22
PAHs, high	0.01	0.00	0.08	0.01	0.03
PAHs, low	0.07	0.04	0.18	0.05	0.03
chlordane, alpha	0.00	0.00	0.00	0.00	0.00
Dieldrin	0.00	0.00	0.00	0.00	0.00
PCBs	0.00	0.00	0.07	0.00	0.00
p,p' DDT	0.00	0.00	0.01	0.00	0.00
Maximum P	0.31	0.30	0.81	0.18	0.36
Category Assigned	Minimal	Minimal	Moderate-High	Minimal	Low
Score	1	1	3 - 4	1	2

3. An integration of sediment chemistry categories is conducted by averaging the score using the two methods, and rounding up to the nearest integer.

Integration of Sediment Chemistry

Site	Chemical Score Index	California Logistic Regression Model	Average, Rounded to Nearest Integer	Integration of Sediment Chemistry Guidelines, Disturbance Category
Arroyo Burro	1	1	1	Minimal
Mission Creek	1	1	1	Minimal
Laguna Channel	2	3	3	Moderate
Sycamore Creek	1	2	2	Low
Bird Refuge	1	1	1	Minimal

Toxicity-A ten-day survival test was conducted using *Euhaustoriaus*. The percent survival was scaled to the control, and the Draft SQO was used to identify the toxicity category.

Sediment Toxicity Data

% survival	Arroyo Burro	Mission	Laguna	Sycamore	Andre Clark Bird Refuge	Toxicity Category
2008	90	92	95	95	93	Nontoxic
2007	98	98	100	99		Nontoxic

At all sites in both years, percent survival was considered high enough for the sediment to be considered nontoxic. Therefore, it is possible that chemicals contained in the sediments are not bioavailable. Next year a sublethal toxicity test should be conducted to complete the analysis.

Potential for Chemically Mediated Effects - The Draft SQO was used to combine the chemistry and toxicity data to determine the potential for chemically mediated effects at each site.

Potential for Chemically Mediated Effects, Determined by Chemistry and Toxicity

Site	Potential for Chemically Mediated Effects
Arroyo Burro	Minimal Potential
Mission Creek	Minimal Potential
Laguna Channel	Low Potential
Sycamore Creek	Minimal Potential
Bird Refuge	Minimal Potential

<u>SCCWRP Analysis</u>

As shown in the results table above, no sites exceeded single or grouped constituent Probable Effect Concentrations(PECs) or LC50s. An integration of chemistry data, per SCCWRP, was also conducted. First, PEC quotients were calculated by dividing the result by the PEC. PEC quotients are considered problematic when they are greater than 1, i.e. when the result exceeds the PEC. The average PEC quotient is calculated for As, Cd, Cr, Cu, Pb, Ni, Zn, total PAHs, PCBs, and sum of DDEs. Samples with a mean PEC quotient >0.5 are considered toxic. For pyrethroids, the LC50 quotients are calculated for the constituents that have LC50s, and the mean pyrethroid LC50 quotient is calculated. There is no guideline for predicting toxicity. The mean PEC quotients and LC50 quotients for each site and sampling year are in the following table. There were no identified toxicity problems using this method. It is important to note that this is an analysis designed for freshwater sites.

Mean PEC Quotients and LC50 Quotients

	Year	Arroyo Burro	Mission	Laguna	Sycamore	Andre Clark Bird Refuge	Mean PEC quotient to predict toxicity
Mean PEC quotient	2007	0.10	0.07	0.16	0.07	0.11	0.5
	2008	0.10	0.07	0.12	0.15		
Mean Pyrethroid LC50 quotient	2007	0	0	0	0	0.067	n/a
	2008	0	0	0	0		

Conclusion - According to the Draft SQO analysis conducted here, which was missing trans nonachor data and sublethal toxicity tests, Arroyo Burro Estuary, Mission Lagoon, Sycamore Lagoon, and the Andre Clark Bird Refuge have “minimal potential” for a chemically mediated effect on the benthic community. Laguna Channel sediments have “low potential” for chemically mediated effects on the benthic community, primarily due to chlordane, and also cadmium, lead, and zinc. No sites were identified as problematic using the SCCWRP method, although the pyrethroid found at the Bird Refuge was somewhat close to the threshold. The third line of evidence, bioassessment, would have to be conducted to determine if there are biological impacts to the sites. If the sites besides Laguna were found to be impacted, this would likely be due to non-chemical stressors, such as oxygen and habitat disturbance. If Laguna Channel were found to contain a disturbed community, this would likely be due in part to the chemical contamination.

References:

SWRCB Draft SQOs:
http://www.swrcb.ca.gov/water_issues/programs/bptcp/docs/sediment/071808appendixa_draftpart%201.pdf

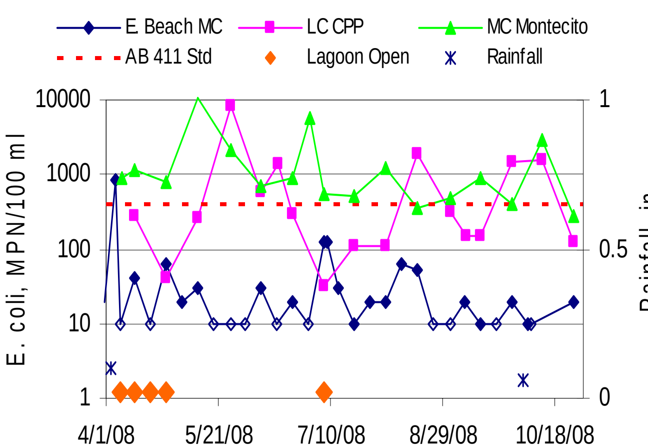
Example Problem:
http://www.swrcb.ca.gov/water_issues/programs/bptcp/docs/sediment/07188appendixc_exampleproblem.pdf

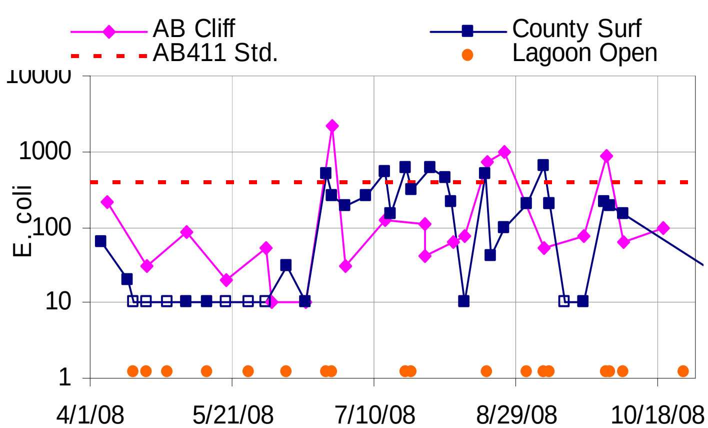
SCCWRP Analysis:
HABITAT VALUE AND TREATMENT EFFECTIVENESS OF FRESHWATER URBAN WETLANDS, 2008
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/559_HabValFreshwaterUrban.pdf

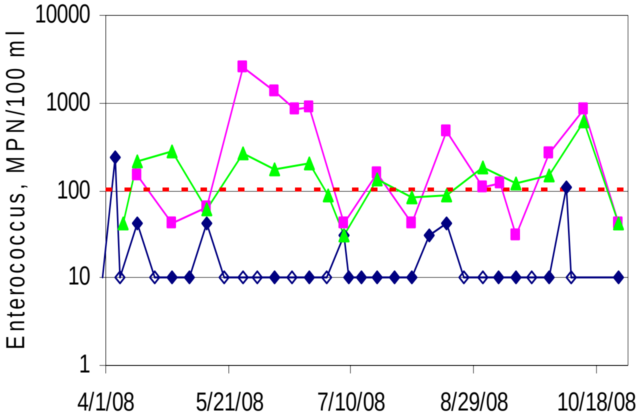
Macdonald, D.D., Ingersoll, C.G., and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31.

HOW DOES CREEK WATER QUALITY RELATE TO BEACH WARNINGS?

The Creeks Division closely monitors the results of the County's beach water quality testing each week. When warnings are found at beaches within the City, the results are compared to nearby creek results for that same day or week to look for a possible correlation. If three out of four tests reveal warnings at a beach within the City, and those warnings appear to correlate with high bacteria levels in a nearby creek, Creeks Division staff is prepared to conduct a rapid response investigation into possible contamination sources in the creek. Below is a table of warnings found during each quarter. The following plots are used for a visual examination of fecal indicator bacteria results at beaches and creek outlets. Open symbols represent data less than 10 MPN/100 ml or greater than 24,192 MPN/100 ml.






Enterococcus, MPN/100 ml
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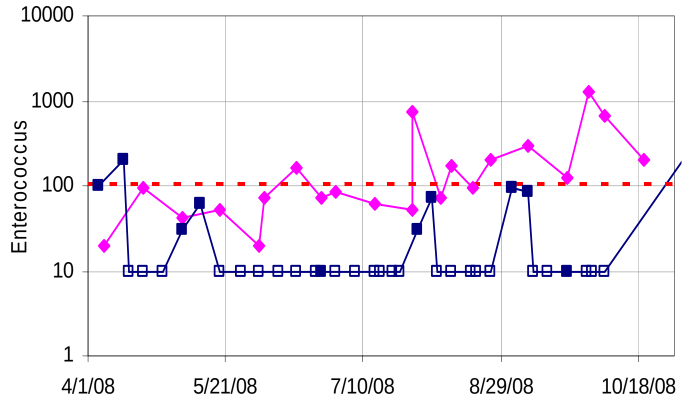
8/29/08
10/18/08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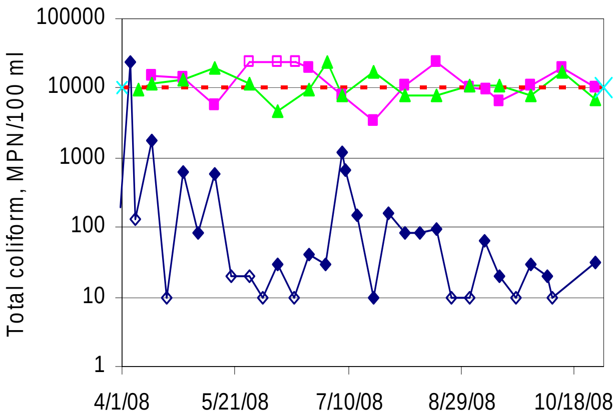
7/10/08
8/29/08
10/18/08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1000
100
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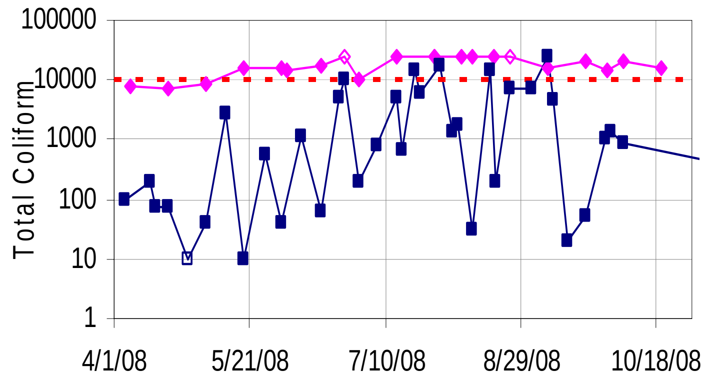
4/1/08
5/21/08
7/10/08
8/29/08
10/18/08


Total Coliform
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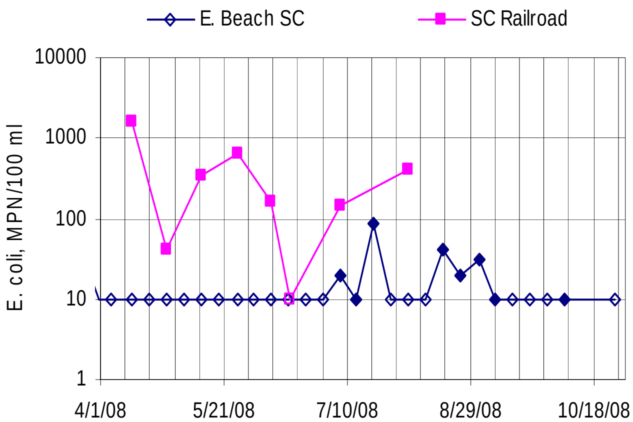
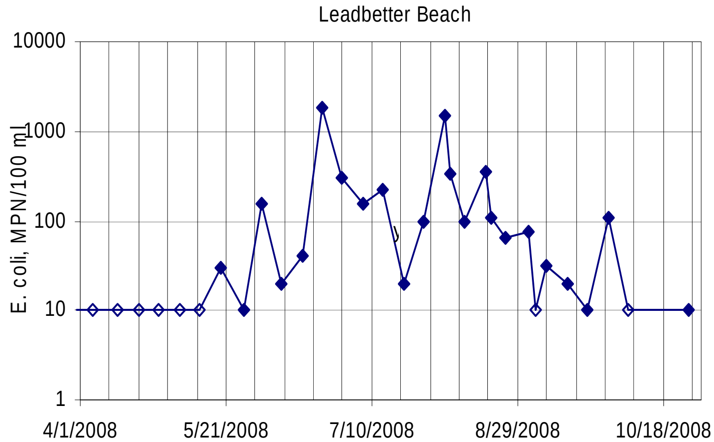
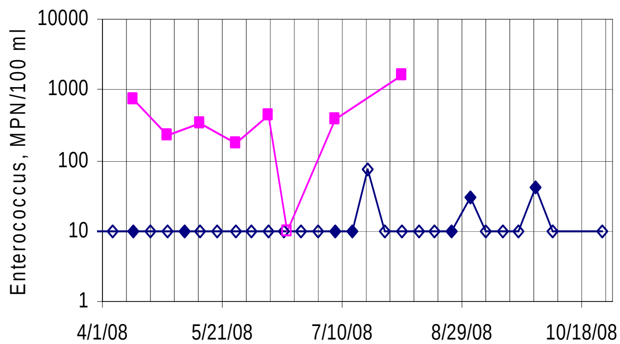
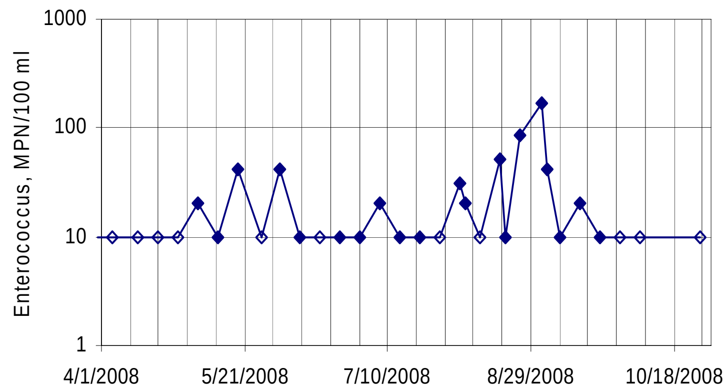
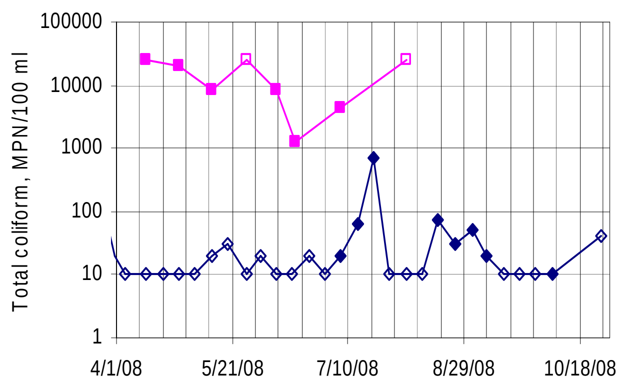
10000
1000
100
10
1
4/1/08
5/21/08
7/10/08
8/29/08
10/18/08

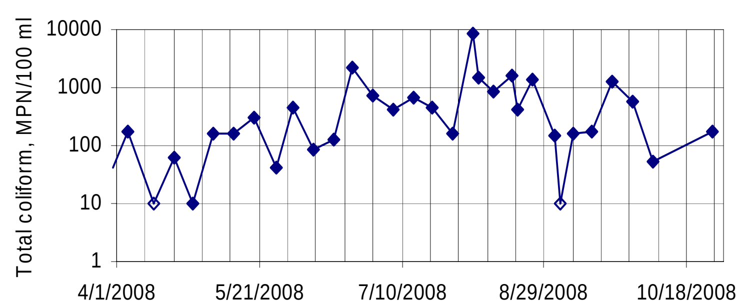












AB411 Beach Water Quality Criteria

Total Coliform (TC)	Fecal coliform (FC)	Enterococcus (ENT)	TC:FC, when TC>1000
10,000 MPN/100 ml	400 MPN/100 ml	104 MPN/100 ml	0.1

Santa Barbara Beach Sampling Results

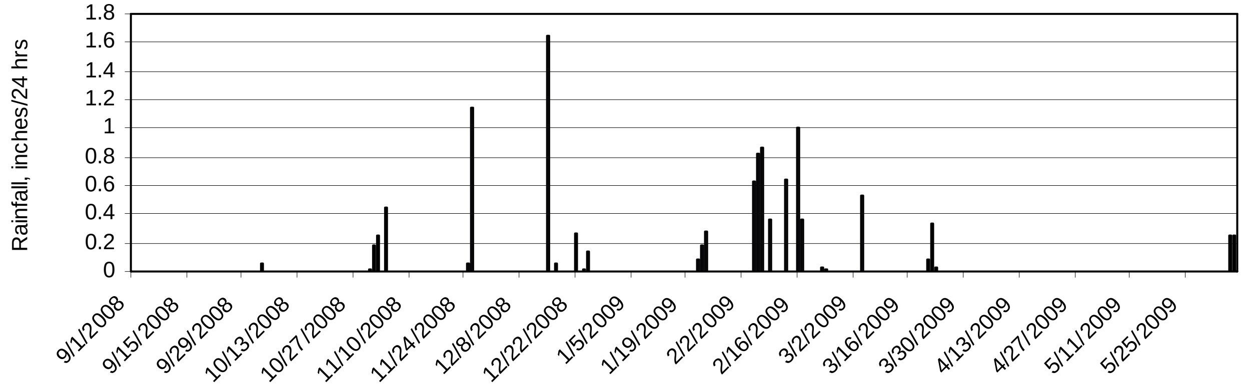
Date	Arroyo Burro Beach	East Beach-Mission Creek	East Beach-Sycamore Creek	Leadbetter Beach	Comments
04/05/08		Warning (TC>24192, FC=836, Ent=240)			
04/07/08					
04/14/08	Warning (Ent=203)				
04/16/08					
04/21/08					

Date	Arroyo Burro Beach	East Beach-Mission Creek	East Beach-Sycamore Creek	Leadbetter Beach	Comments
04/28/08					
05/05/08					
05/12/08					
05/19/08					
05/27/08					
06/02/08					
06/09/08					
06/16/08					
06/23/08	Warning (FC=496)			Warning (FC=1860, FC:TC)	VERY hi temps over weekend
06/25/08	Warning (TC=10462)				
06/30/08					
07/07/08		Warning (FC:TC)			fires past week/hi temps over weekend
07/09/08	ns		ns	ns	
07/14/08	Warning (FC=537, FC:TC)				
07/16/08		ns	ns	ns	
07/21/08	Warning (TC=14136, FC=620)				
07/23/08		ns	ns	ns	
07/28/08	Warning (TC=17329, FC=591)				
08/04/08	Warning (FC=512, FC:TC)			Warning (FC=1455, FC:TC)	
08/06/08	Warning (FC:TC)	ns	ns	Warning (FC:TC)	
08/11/08					
08/18/08	Warning (TC=14136,FC=512)			Warning (FC:TC)	
08/20/08		ns	ns		
08/25/08					
09/02/08				Warning (ENT=171)	
09/04/08	ns	ns	ns		
09/08/08	Warning (TC=24192)				
09/10/08		ns	ns	ns	
09/15/08					All results very low (see below).
09/22/08					
09/29/08	Warning (FC:TC)				
10/01/08	Warning (FC:TC)	ns	ns	ns	
10/06/08		Warning (ENT=106)			Light rain 10/4
10/08/08	ns		ns	ns	
10/20/08		ns	ns	ns	
10/27/08					
11/03/08	Warning (ENT=300)				Rain 10/31/-11/4
11/10/08		Warning (ENT=228,FC:TC)			
11/12/08	ns	ns	ns	Warning (ENT=109)	
11/17/08					
11/24/08					
12/01/08					Rain 11/26
12/08/08	Warning (FC=609)				
12/10/08		ns	ns	ns	
12/15/08	Warning (TC>24192, FC=1918, ENT=5794)	Warning (FC=857, ENT=1223)	Warning (TC>24192)	Warning (ENT=265)	1.64” Rain 12/15
12/17/08	Warning (TC=14136, ENT=377)	Warning (ENT=107)			Light Rain 12/17

Date	Arroyo Burro Beach	East Beach-Mission Creek	East Beach-Sycamore Creek	Leadbetter Beach	Comments
01/05/09					
01/12/09					
01/20/09					
01/26/09					0.5” Rain 1/22-1/24
02/02/09					
02/09/09	Warning (TC>24192, FC=669, ENT=1529)	Warning (ENT=231)	Warning (TC=17329m FC=598, ENT=1198)		2.8” Rain 2/5-2/9
02/11/09				ns	
02/17/09	Warning (ENT=1050)	Warning (ENT=480)	Warning (TC>24192, FC=504, ENT=1439)		2” rain 2/13-2/17
02/19/09	ns			ns	
02/23/09		Warning (FC:TC = 0.2)			Light rain 2/22-2/23
02/25/09	ns		ns	ns	
03/02/09					
03/09/09	Warning (ENT=384)				0.5” rain 3/5
03/11/09		ns	ns	ns	
03/16/09					
03/23/09					0.5” rain 3/22-3/23
03/30/09				Warning (ENT=161)	
04/06/09					
04/13/09					
04/20/09					
04/27/09					
05/04/09					
05/11/09					
05/18/09			Warning (ENT=403)		
05/26/09				Warning (ENT=221)	
05/28/09	ns	ns	ns		
06/01/09					
06/08/09					0.5” Rain 6/5,6/6
06/15/09					
06/22/09	Warning (TC=11199, ENT=882)				Arroyo Burro flowing for first time in a while, smells like hydrogen sulfide
6/24/09	Warning (TC=12033, ENT=323)	ns	ns	ns	
06/29/09			ns		

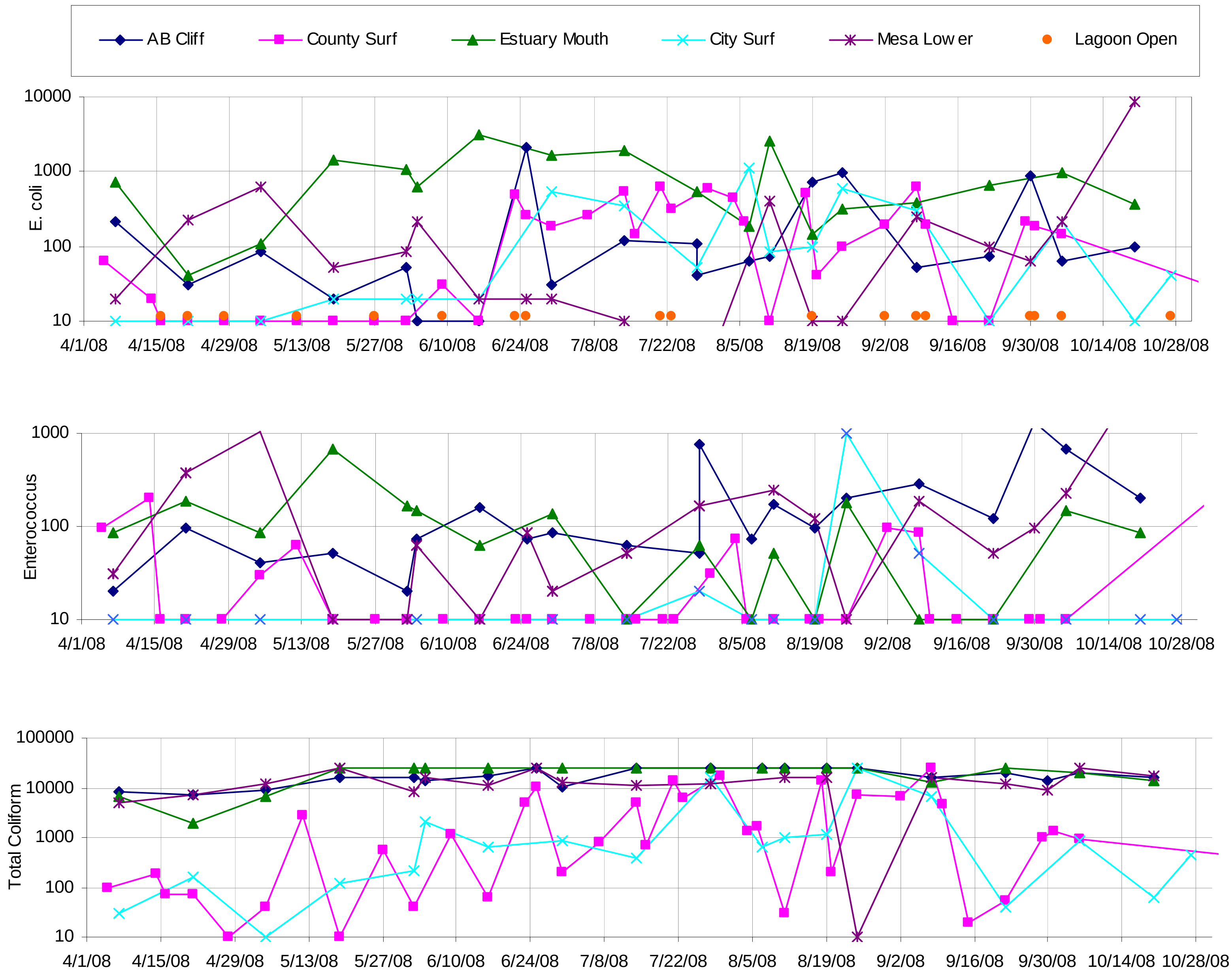
ns = not sampled. Beaches are sampled on Monday, and only those that have a Warning posted are re-sampled on Wednesday. This data set may be missing some resample results.

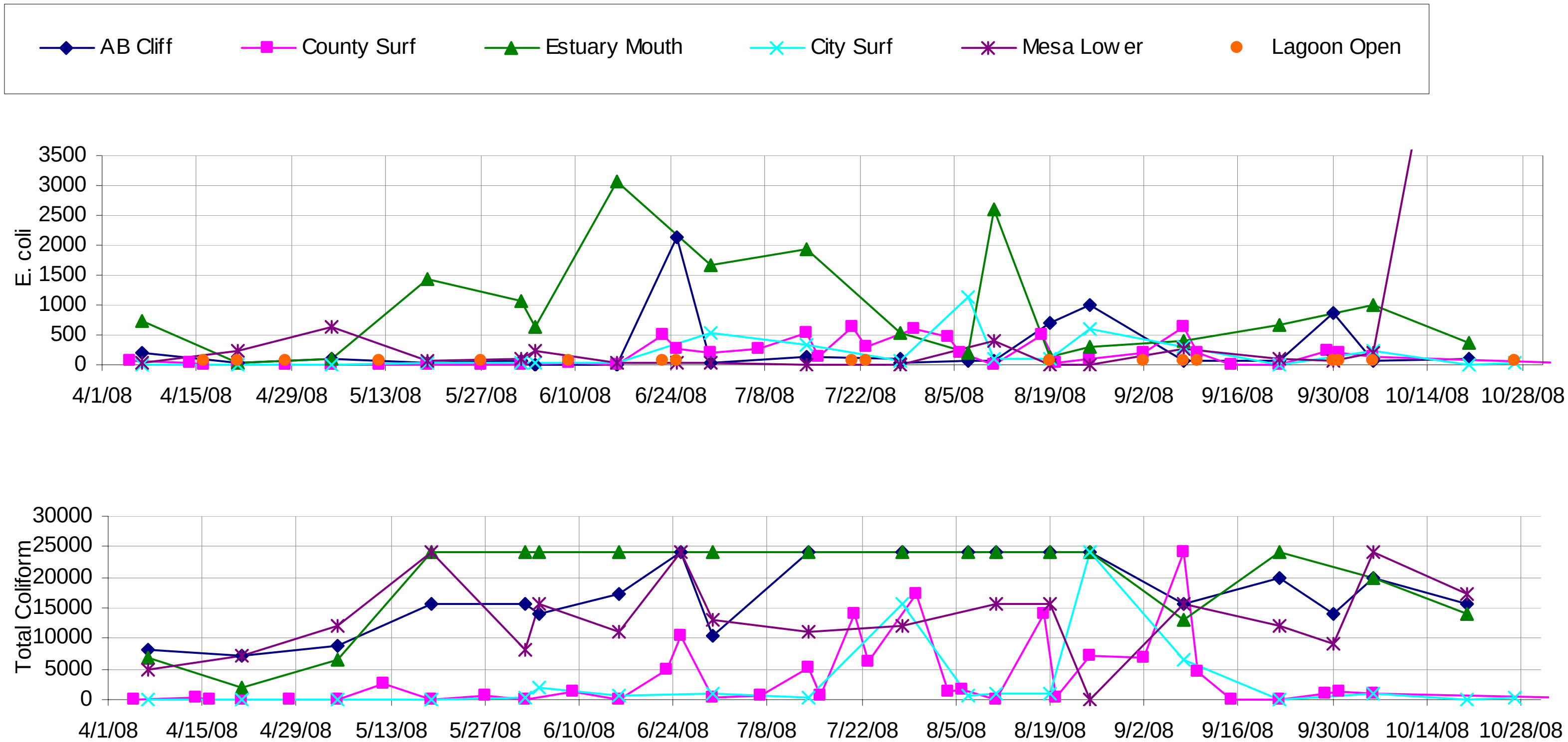
As shown in the comments in the table above, rain events caused a large number of the exceedances during the winter months. The following graph shows the rainfall patterns during the 2008-2009 water year.



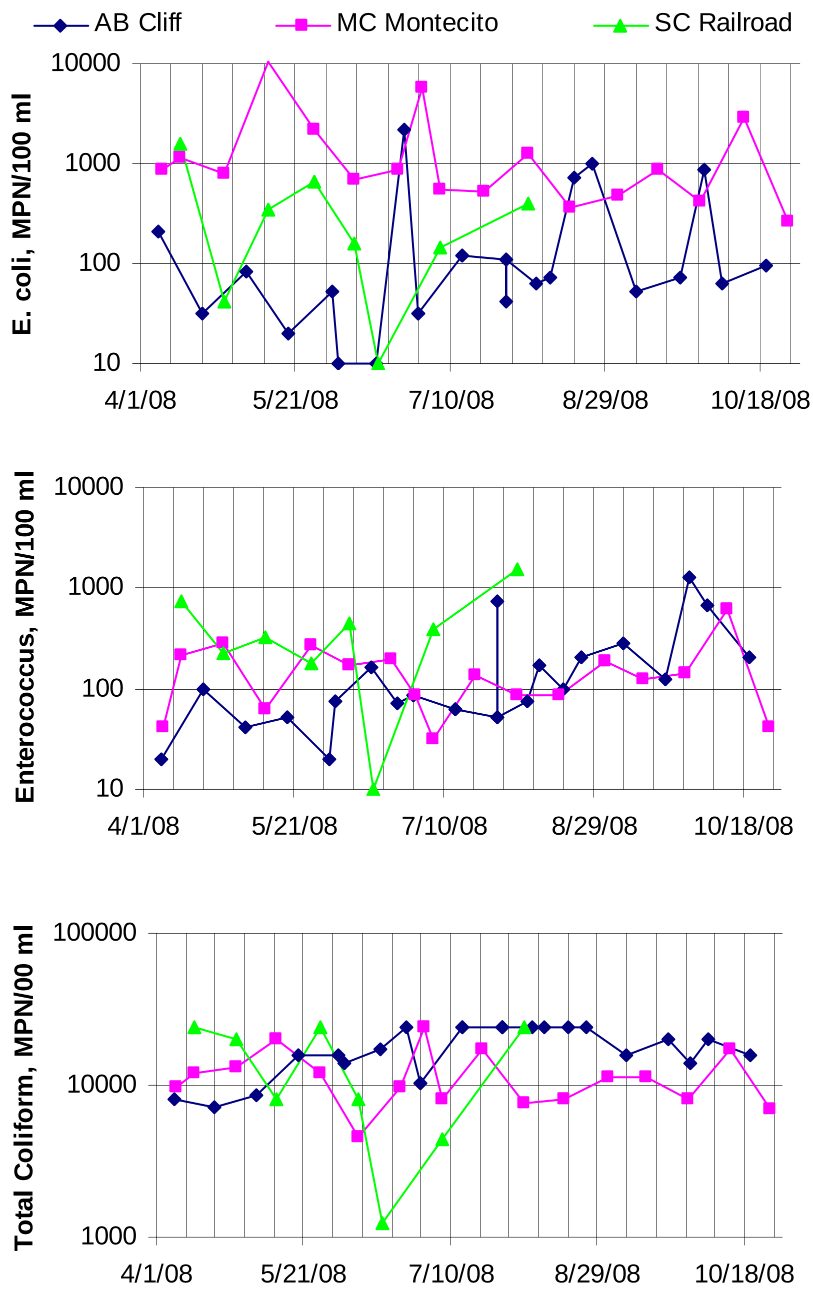
Understanding dry weather exceedances patterns is more challenging. Most of the warnings in summer 2008 were due to fecal coliform (*E. coli*), total coliform, or a combination of the two (ratio). The following descriptive plots show that in summer 2008, at Arroyo Burro during July there was a sharp increase in *E. coli* and a gradual increase in total coliform in surf samples that appears to correspond with a closed lagoon. During this period, *E. coli* levels were higher in surf samples than in creek samples, which is very uncommon. Enterococcus levels were low in the surf samples. In addition, the estuary mouth was higher than AB at Cliff for all indicators, especially *E. coli* and total coliform. These plots were updated to end of the 411 season (4/1 – 10/31).

Arroyo Burro Beach, 2008 AB411 Dates

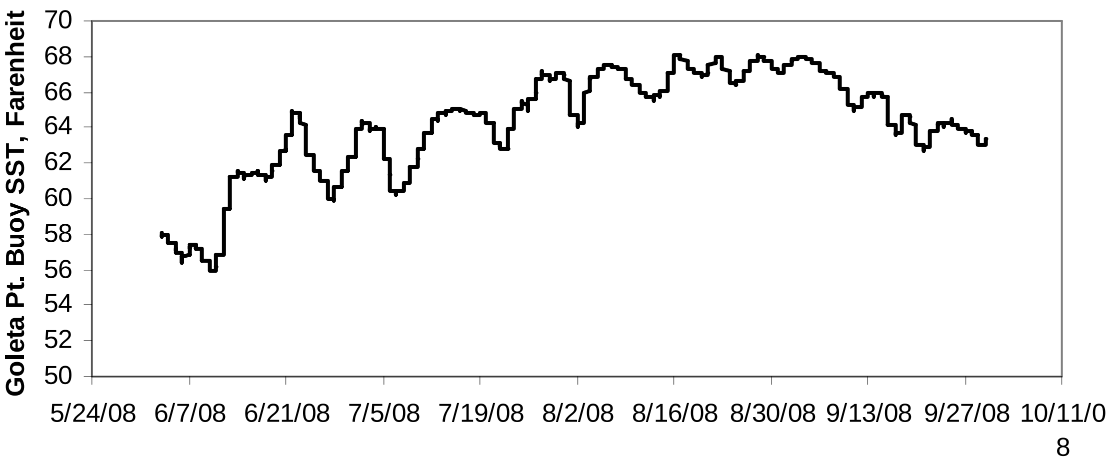



AB Cliff
County Surf
Estuary Mouth
City Surf
Mesa Lower
Lagoon Open
E. coli
3500
3000
2500
2000
1500
1000
500
0
4/1/08
4/15/08
4/29/08
5/13/08
5/27/08
6/10/08
6/24/08
7/8/08
7/22/08
8/5/08
8/19/08
9/2/08
9/16/08
9/30/08
10/14/08
10/28/08
Total Coliform
30000
25000
20000
15000
10000
5000
0
4/1/08
4/15/08
4/29/08
5/13/08
5/27/08
6/10/08
6/24/08
7/8/08
7/22/08
8/5/08
8/19/08
9/2/08
9/16/08
9/30/08
10/14/08
10/28/08

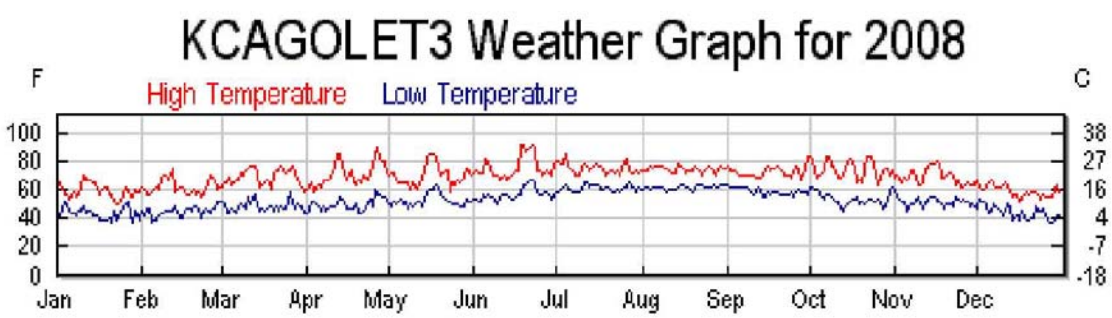
The following plots emphasize that high creek levels of *E. coli* were not responsible for the patterns at Arroyo Burro in summer 2008. Arroyo Burro at Cliff has lower concentrations than Mission Creek and Sycamore Creek (which was dry during the second half of the season). Total coliform is higher in Arroyo Burro and enterococcus is fairly similar among integrator stations.



In addition, there may be air and sea surface temperature effects on the indicator bacteria concentrations. Sea surface temperature at the Goleta Point buoy increased in mid-June and decreased in mid September, when stations in Ventura and Santa Barbara County had very low indicator bacteria results (data will be presented in the Annual Report). Additional hypotheses are that beach visitation over the weekend leads to higher results on Mondays and lower results on Wednesdays. A Monte Carlo simulation show that this is likely not the case (data will be presented in the Annual Report). Data from Santa Cruz County Environmental Health shows that indicator bacteria grow rapidly on kelp (data will be shown in Annual Report). Additional literature search and Creeks sampling suggests that indicator bacteria may grow profusely in stagnant areas of storm drains.



The following graph shows air temperature in Goleta, with a spike in late June. Air temperature patterns were fairly stable from July to September.



III. PROJECT SITE ASSESSMENT

SURF WATER QUALITY IMPROVEMENT PROJECT

Water Quality Monitoring

. The goals of the monitoring plan for the SURF Project were to:

- Quantify the loads of indicator bacteria that are prevented from entering Old Mission Creek, Mission Creek, and East Beach at Mission Creek as a result of installing the

Project. This has not been done for the second season, but the data to do so exist and the calculation is straight forward if needed.

- Quantify the effect of the Project in reducing loads of indicator bacteria entering Old Mission Creek, i.e. quantify the fraction of dry-season runoff in the Westside Storm Drain that is diverted for treatment.
- Test the effectiveness of Project components, i.e. the effect of the media filters and the UV equipment on lowering indicator bacteria levels.
- Test for the effect of the Project reducing concentrations of indicator bacteria in downstream creek reaches.
- Test for the effect of the Project on reducing beach postings. Data on beach postings will be obtained from the Santa Barbara County. This has not been done for the second season, because it has become clear that the system does not lead to lower indicator bacteria values in the creek.
- Conduct one detailed study of the distribution of indicator bacteria immediately downstream of the treatment facility, i.e., test whether and where bacterial regrowth or additional input occurs.

Summary of Monitoring Design (April 1- October 31)

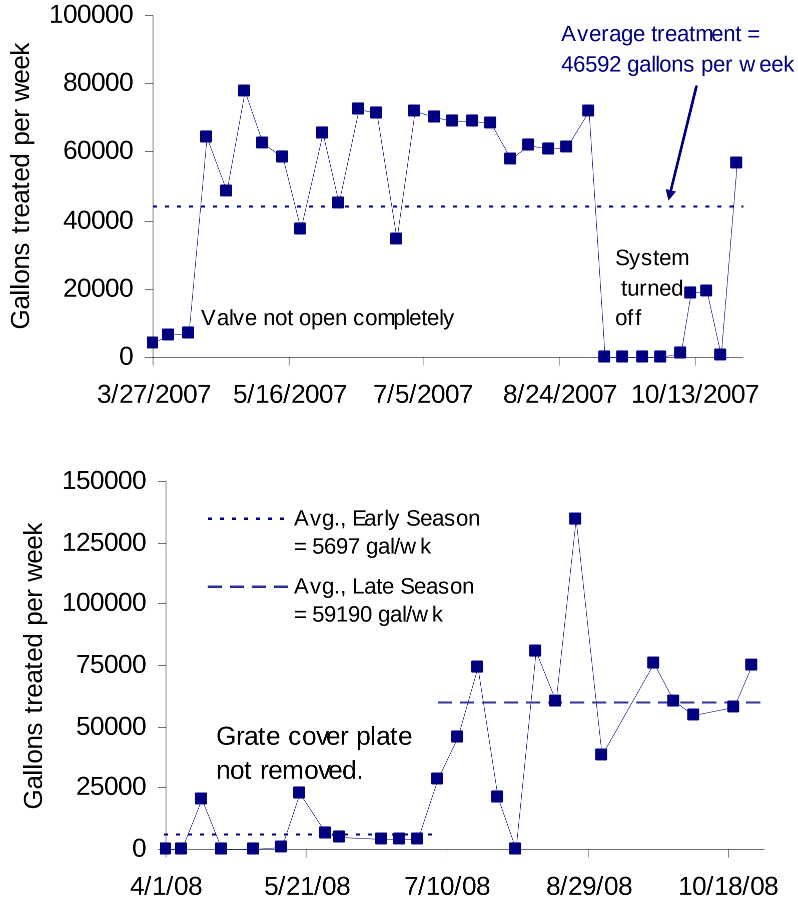
Monitoring Goal (see above)	Indicator Bacteria Concentration	Flow
1) Load Treated	Weekly (Monday), Laboratory	Weekly flow volume, Instrument
2) Percent of Load Treated	Upon observation of untreated flow, Laboratory	Upon observation of untreated flow, Field
3) Effect of Project components	Monthly, Laboratory	-
4) Downstream Concentration – Creek Sites	Bi-Weekly (Monday), Laboratory	-
5) Downstream Concentration - Beach	Weekly (Monday), Laboratory (County)	-
6) Potential Regrowth/Input Downstream	Once per AB411 season, Laboratory	Once per AB411 season, Instrument and Field

Sampling was carried out according to the approved QAPP and Monitoring Plan.

Map of sampling locations for Monitoring Plan. Yellow represents biweekly samples and green represents weekly samples.

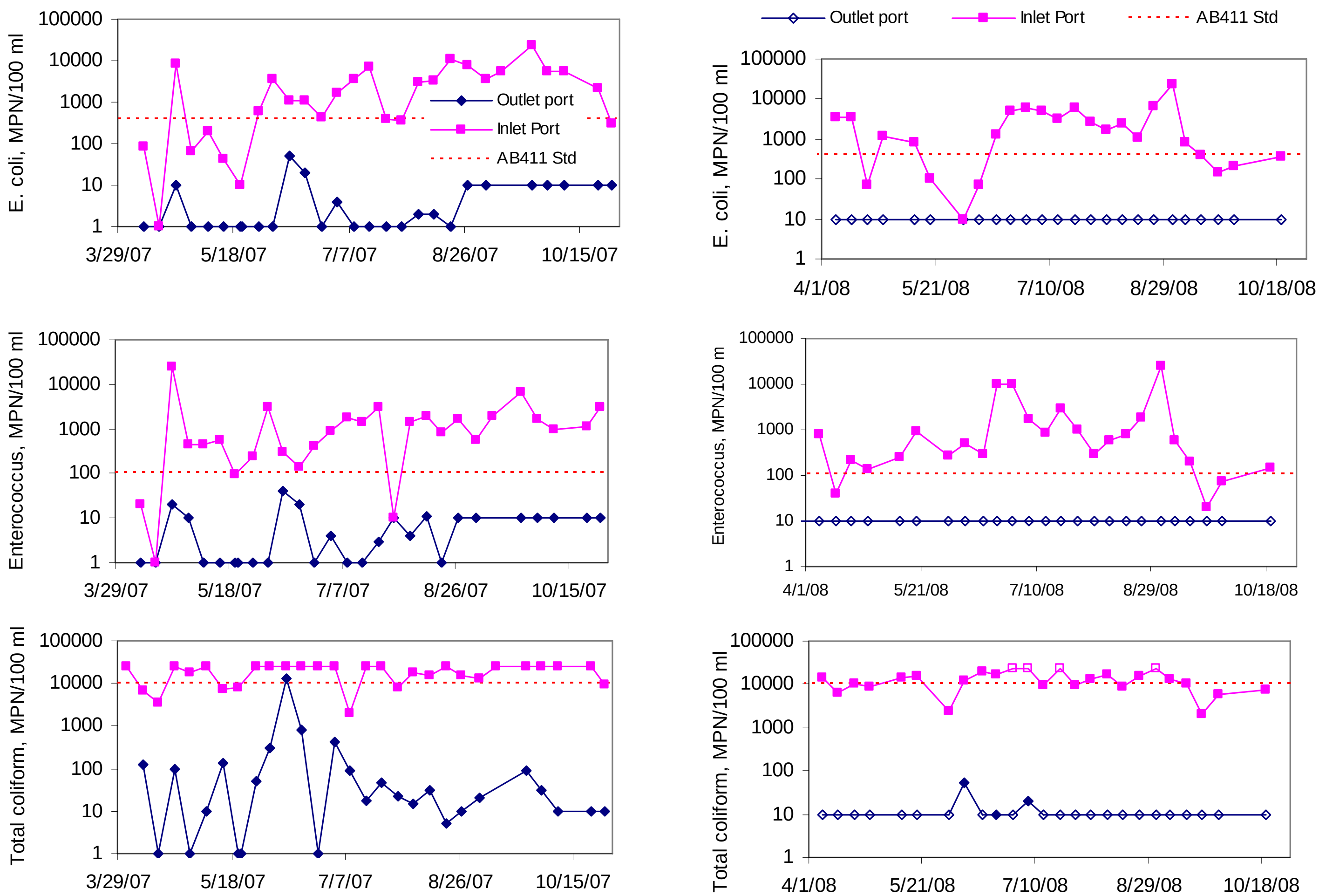
Effectiveness of Project components

The Westside SURF Project began treating water from the Westside storm drain on March 27, 2007. The figures below show the operation of the SURF facility during its first and second season of operation. The first season of monitoring was required by the grant that funded the project, as described in the Monitoring Plan. The second season was completed in order to continue assessing the project performance. In reviewing the data, it became clear that most of the monitoring should continue as long as the facility is in operation, in order to determine if it is functioning properly.



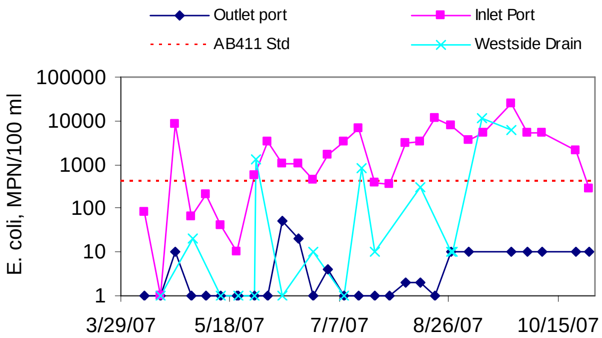
Gallons treated per week at the Westside SURF Project.

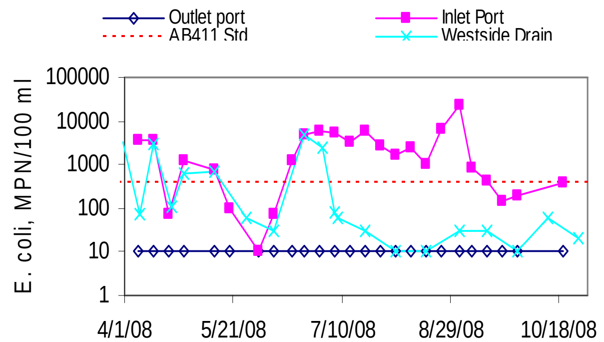
A comparison of indicator bacteria data, collected weekly, shows the dramatic reduction in concentrations between the inlet port of the SURF Project (downstream of pump station, upstream of media filters), and the outlet port (just downstream of UV bulbs). For all *E. coli* and Enterococcus, values were usually reduced from ~100-1000 MPN/100, to < 10 MPN/100 ml (see figures below). Total coliform was generally reduced to <10 MPN/100 ml. It is recommended that the dilution be increased for the outlet samples, so that the lower limit is <1, rather tan <10 MPN/100 ml.

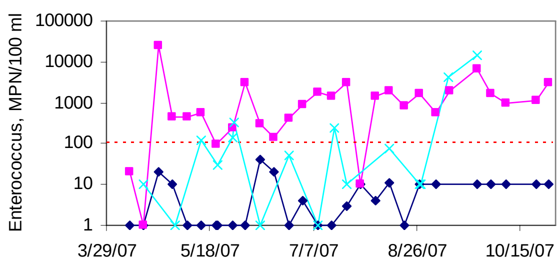


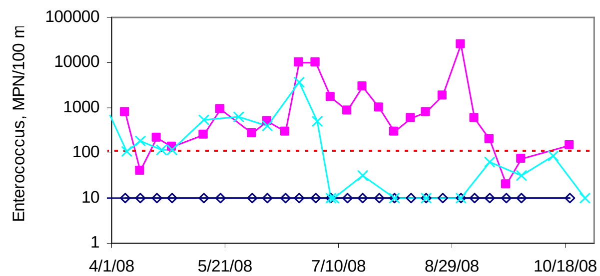
Weekly data demonstrating effectiveness of Westside SURF Project in reducing indicator bacteria concentrations. For Enterococcus, open symbols respresent data less than 10 MPN/100 ml.

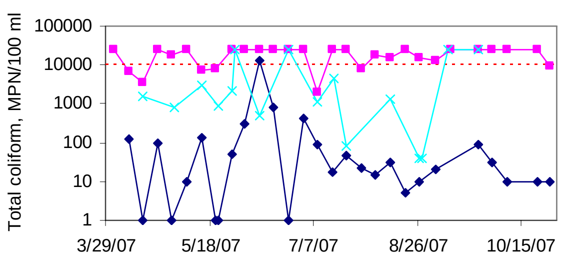
A comparison of indicator bacteria data between the inlet port and the Westside Drain shows that often, the facility has not treated the entire flow. When the system is fully functional, the Westside Drain numbers should be equal or slightly higher than the outlet numbers for E. coli and Enterococcus, and definitely below the AB411 stds.

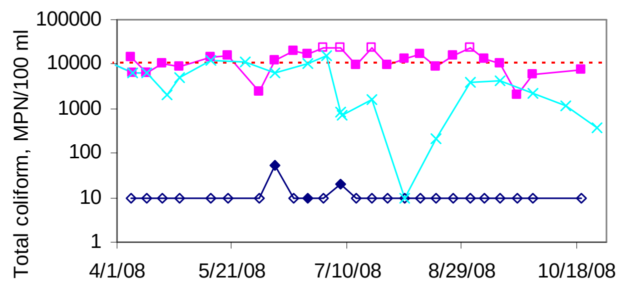




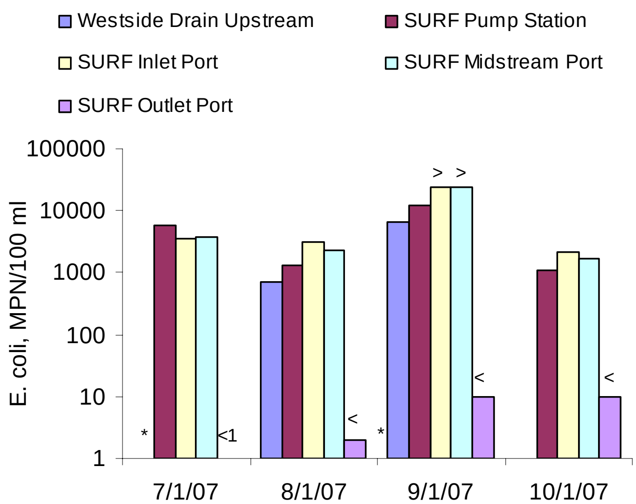


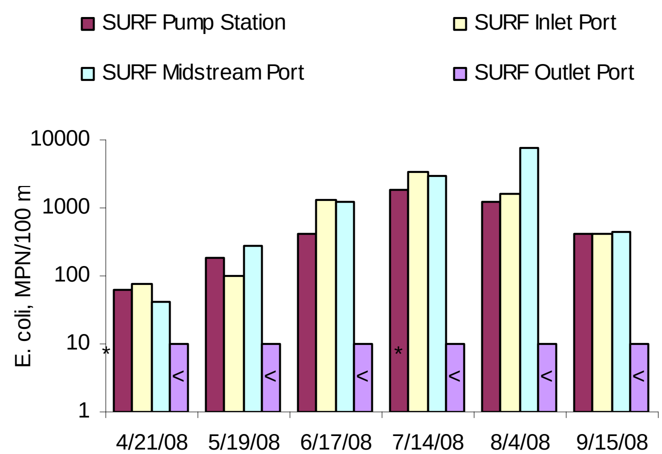


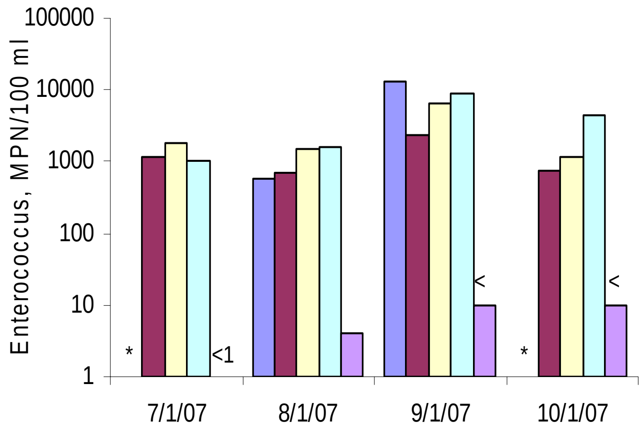


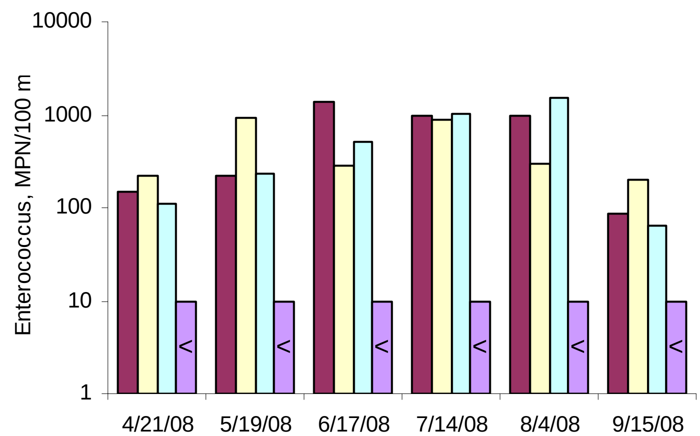


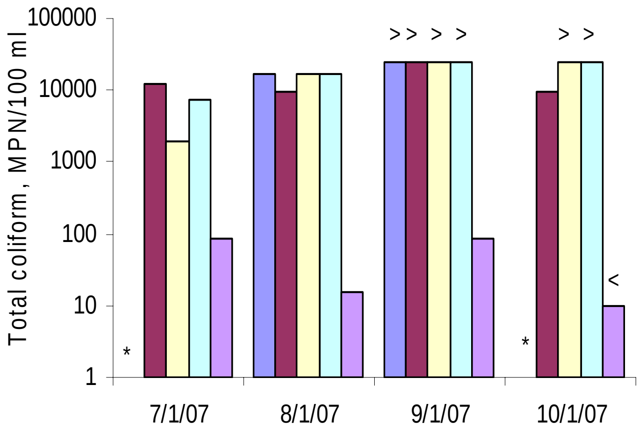
Monthly sampling was conducted to test indicator bacteria values at locations within the SURF Project (see figures below). Results showed no consistent patterns among sample locations. There was a suggestive pattern of higher indicator bacteria concentrations in the pump station, inlet port, and midstream port (downstream of media filters). The media filters do not remove bacteria. It is recommended that this sampling continue in order to confirm that biofilms are not increasing bacteria levels from the pump station to the midstream port. Because there is no systematic difference between the pump station and the inlet port, it is fine to continue collecting water from the inlet port as the "upstream" sample. It is much easier than collecting from the pump station.

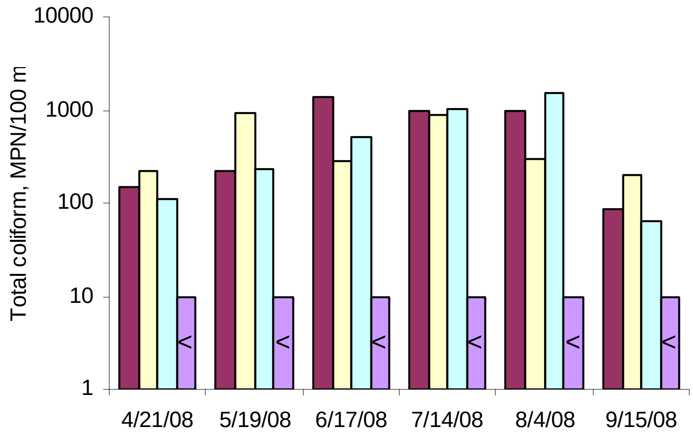










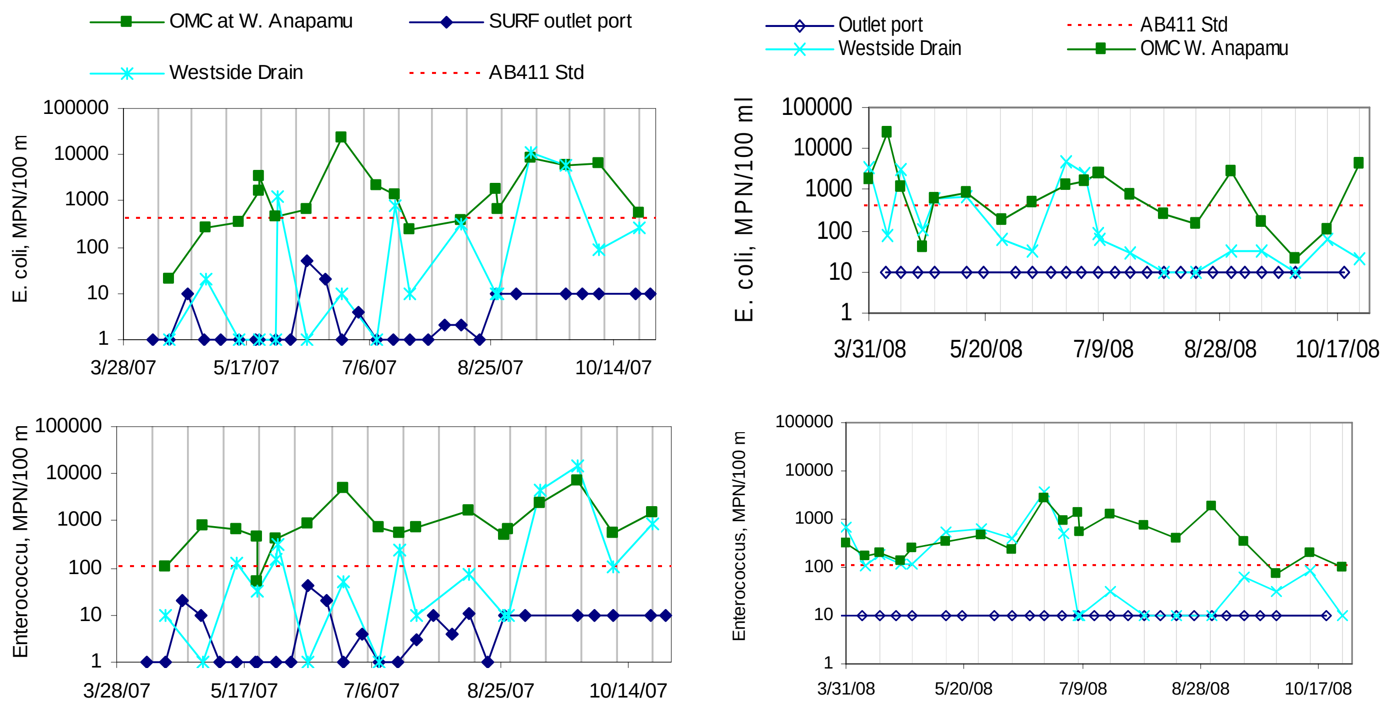


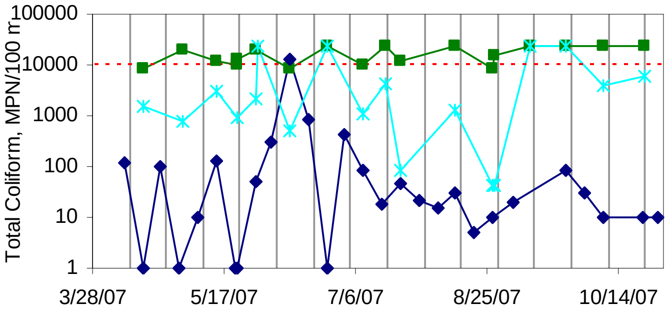
Monthly sampling data showing impact of Project components. Asterisk represents missing data, and >,< symbols represent values greater or less than thresholds.

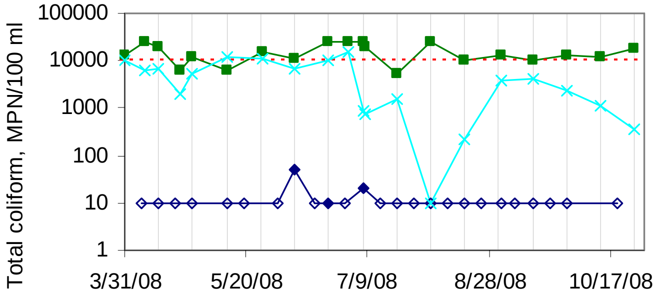
Downstream Impacts

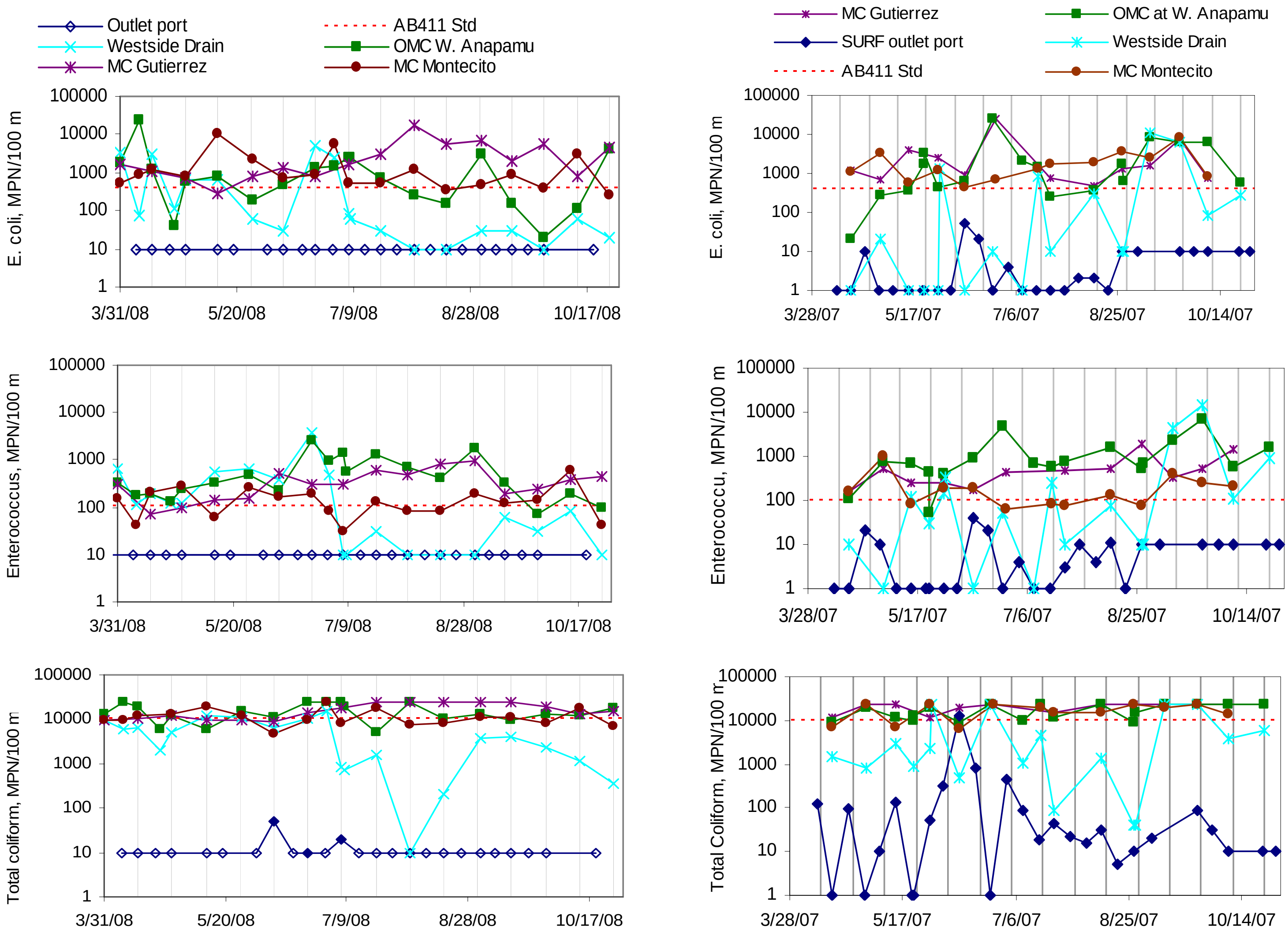
The downstream impact of the diversion Projects is of chief interest to the Creeks Division and the local community. When the system if functioning properly, bacteria levels at the Westside Drain outlet, immediately downstream of the Project, are variable but lower than the background levels at W. Anapamu. At the next downstream site, Old Mission Creek at W. Anapamu St., indicator bacteria levels were consistently at background levels in Mission Creek, as shown by the results from Mission Creek at Gutierrez. Even further downstream, i.e., at Mission Creek at Montecito Street, indicator bacteria concentrations did not appear to relate with the results from Westside SURF Project (see figure below). These results are not surprising, given similar results at other UV disinfection facilities and the mounting evidence for indicator bacteria survival and growth in sediments and decaying plant material.

It is important to note however, that whether or not the Project impacts downstream indicator bacteria concentrations, the creek and ocean certainly have fewer pathogens than prior to Project installation. The importance of the SURF Project in keeping water safe for swimming is highlighted by results from the City's research with Dr. Patricia Holden, which has identified signals of human waste at the Westside Storm Drain, as discussed below in Additional Benefits.




Total Coliform, MPN/100 m
100000
10000
1000
100
10
1
3/28/07
5/17/07
7/6/07
8/25/07
10/14/07

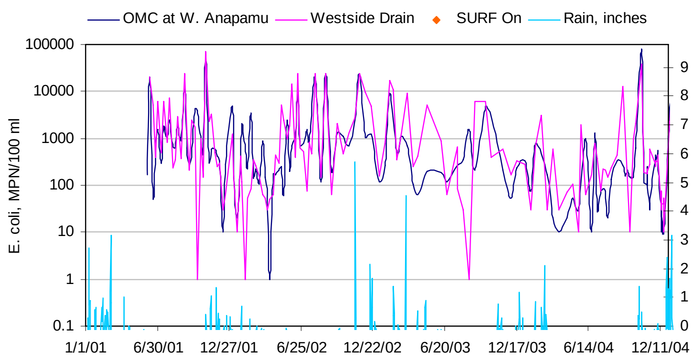

Total coliform, MPN/100 ml
100000
10000
1000
100
10
1
3/31/08
5/20/08
7/9/08
8/28/08
10/17/08

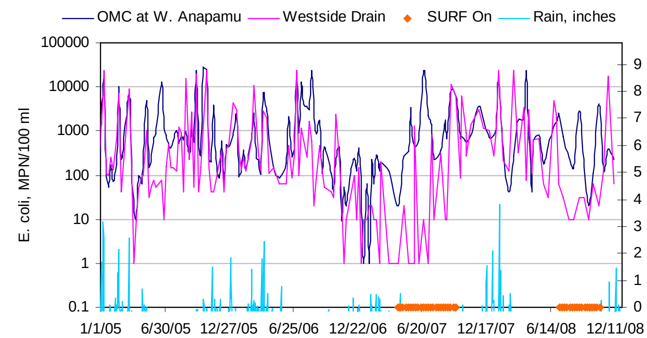


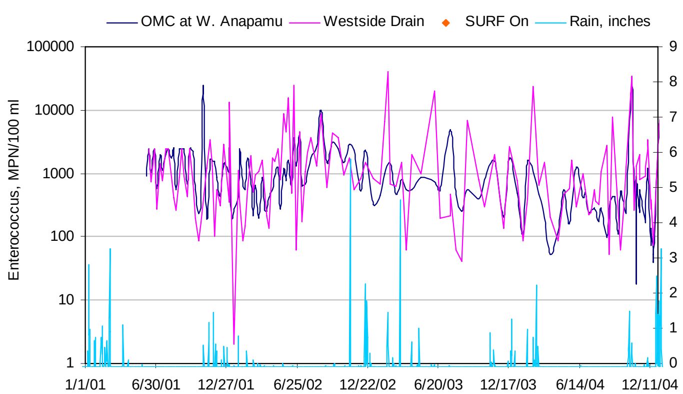
Downstream impacts of Westside SURF Project in Old Mission Creek.

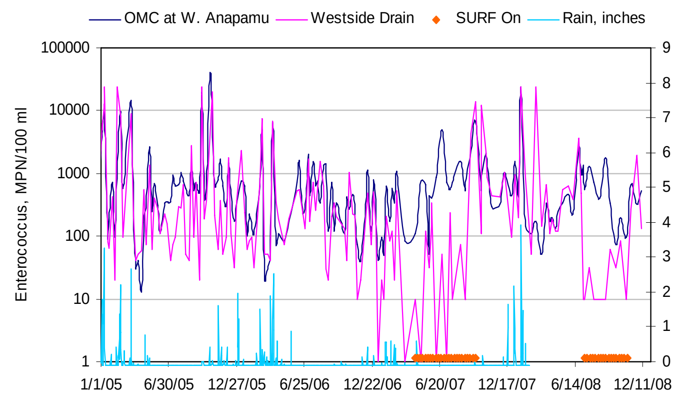
Long Term Changes

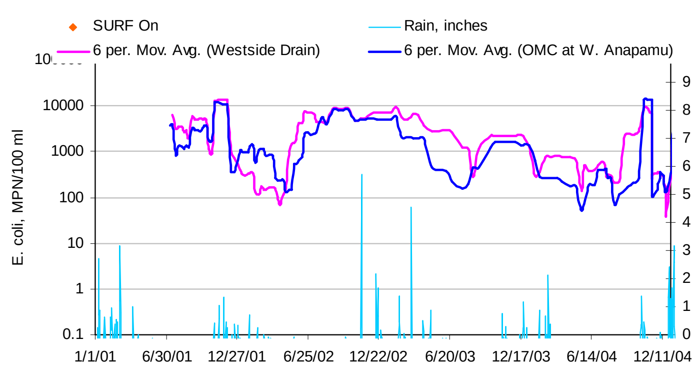
And additional topic analyzed this year was that of long-term changes in E. coli and Enterococcus levels. The following figures show long term data from the Westside Drain and OMC at W. Anapamu. The top panels show the raw data, including rainfall and when the SURF facility was in operation. The lower panels show moving averages (6-period) for the same data. In general, the two stations track each other well. The SURF project dos not appear to have an impact on the water quality at W. Anapamu. Interestingly, the values at the Westside Drain were among their lower ever prior the initiation of operation – this is possibly due to the very low rainfall during the previous winter and the fact that coffer dams were in place during construction.

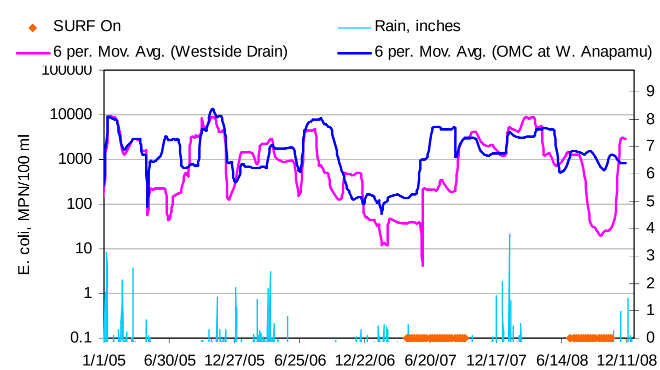


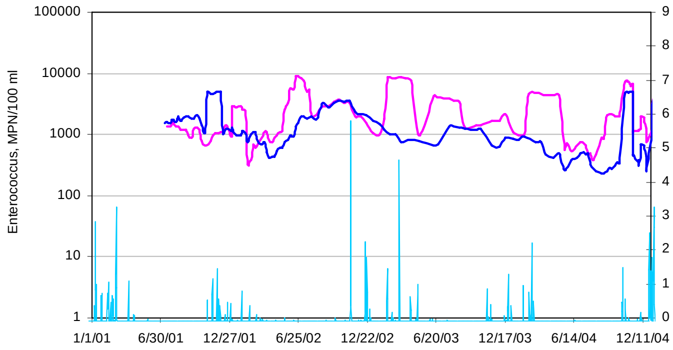




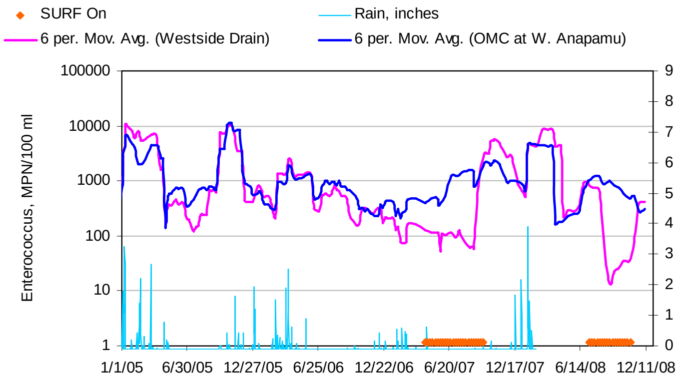








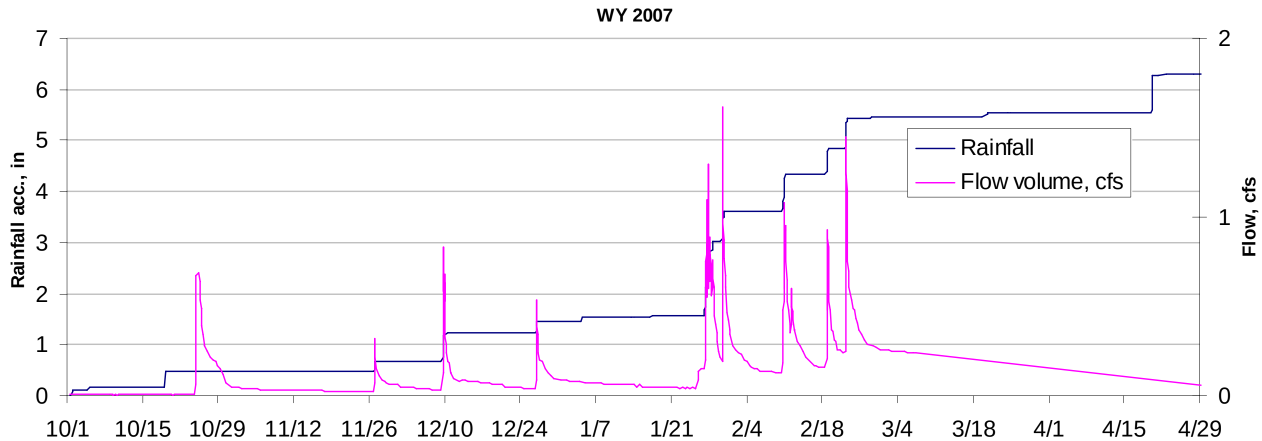
100000
10000
1000
100
10
1
Enterococcus, MPN/100 ml
9
8
7
6
5
4
3
2
1
0
1/1/01
6/30/01
12/27/01
6/25/02
12/22/02
6/20/03
12/17/03
6/14/04
12/11/04

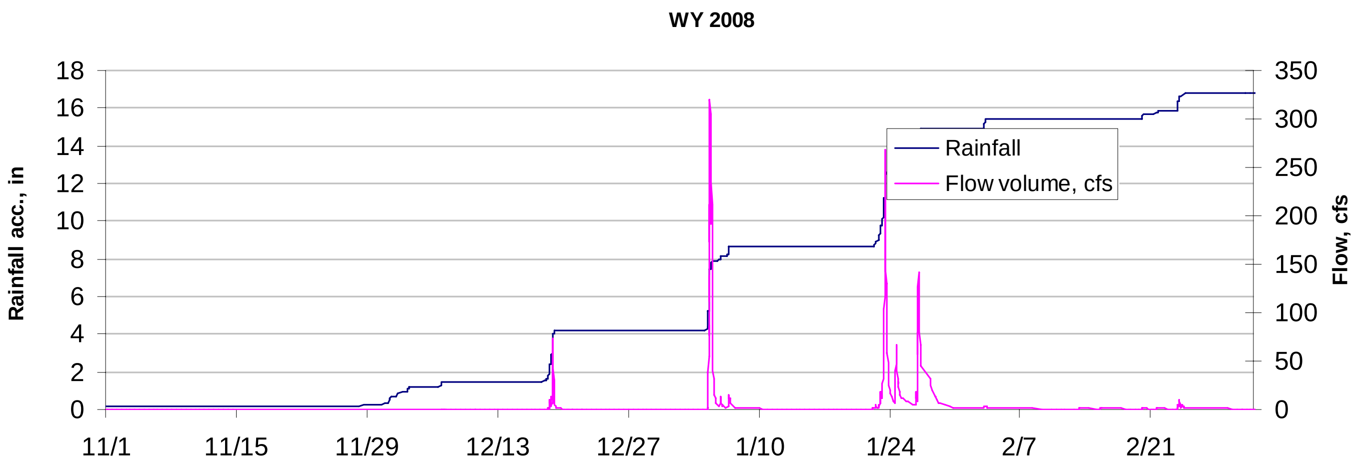


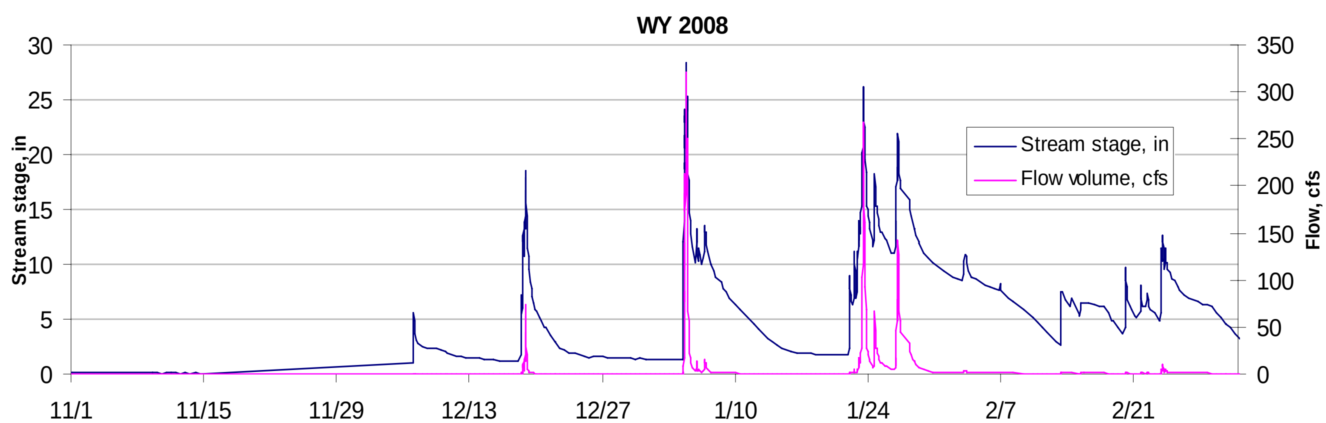
SURF On
Rain, inches
6 per. Mov. Avg. (Westside Drain)
6 per. Mov. Avg. (OMC at W. Anapamu)
100000
10000
1000
100
10
1
Enterococcus, MPN/100 ml
9
8
7
6
5
4
3
2
1
0
1/1/05
6/30/05
12/27/05
6/25/06
12/22/06
6/20/07
12/17/07
6/14/08
12/11/08

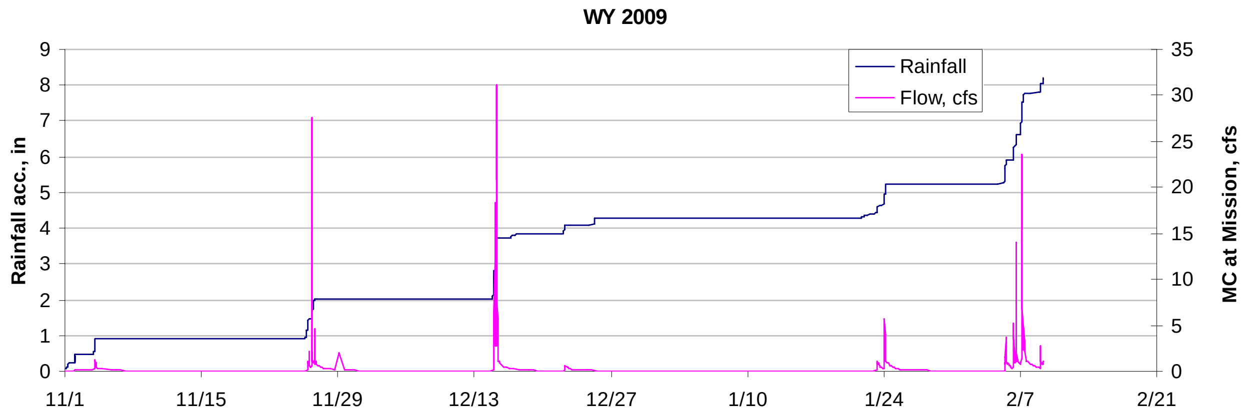
MISSION CREEK FISH PASSAGE

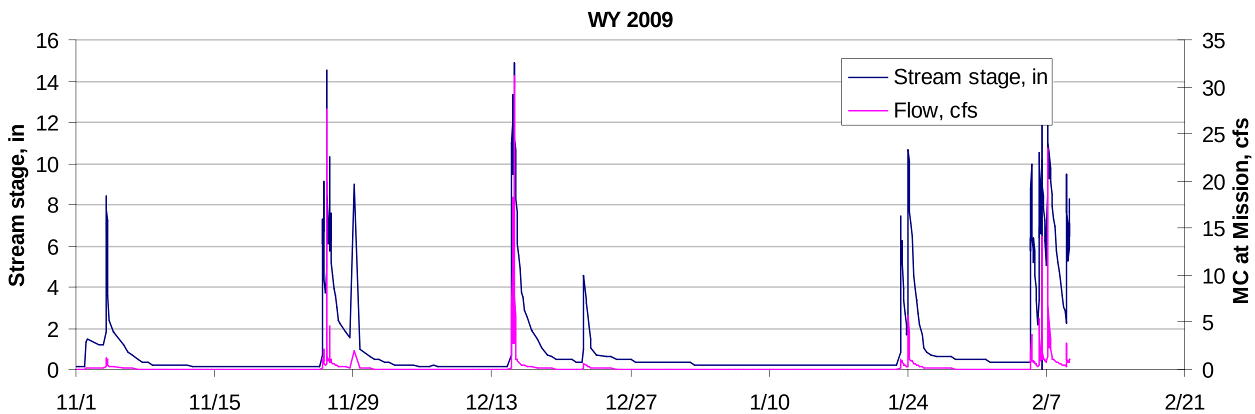
The following graphs show flow data from Mission Creek at Olivos (also called Mission at Mission), which is in the concrete channel. The graphs show flow and water elevation patterns following rain events. For WY 2008 and WY 2009, data illustrates the water elevation recedes more slowly than the flow volume, which may be of interest to the channel design for fish passage. This result is a function of the stage-discharge curve relationship.





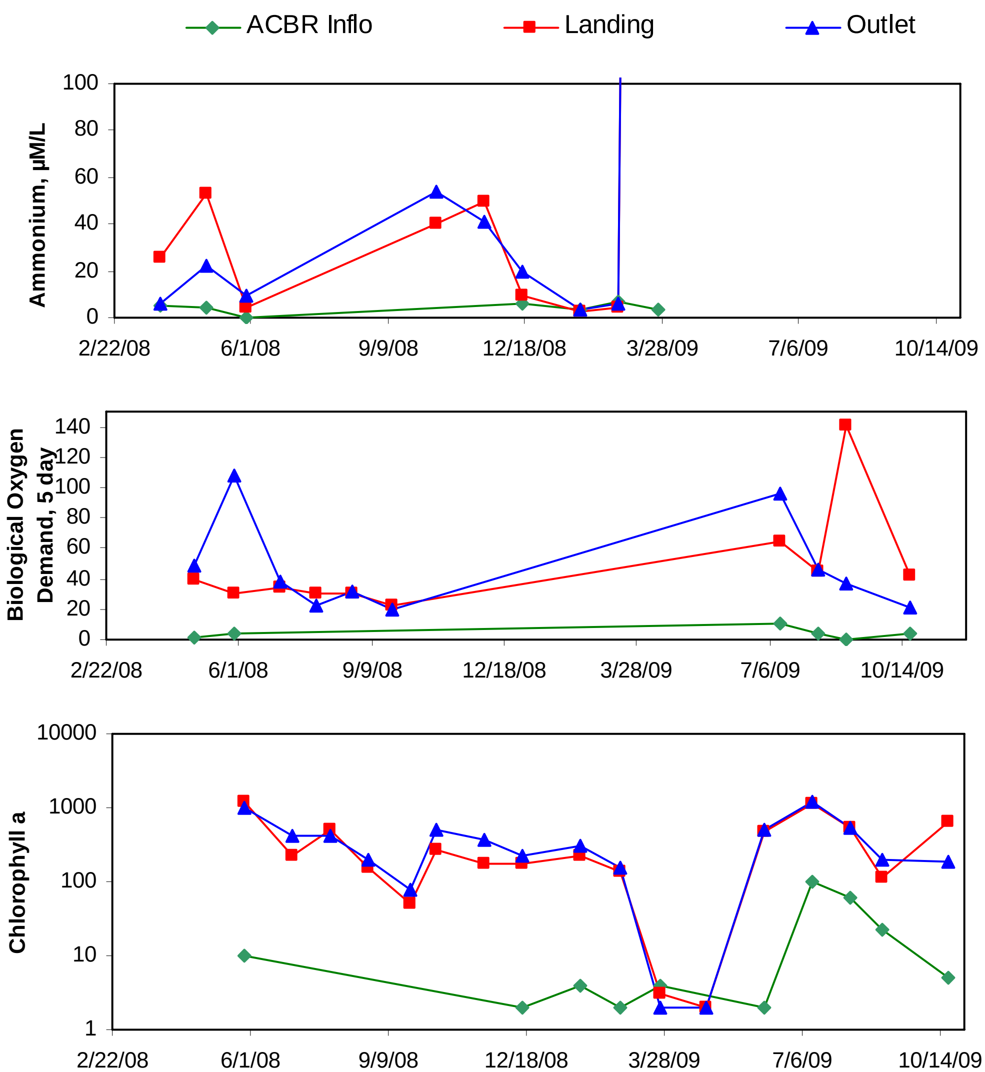


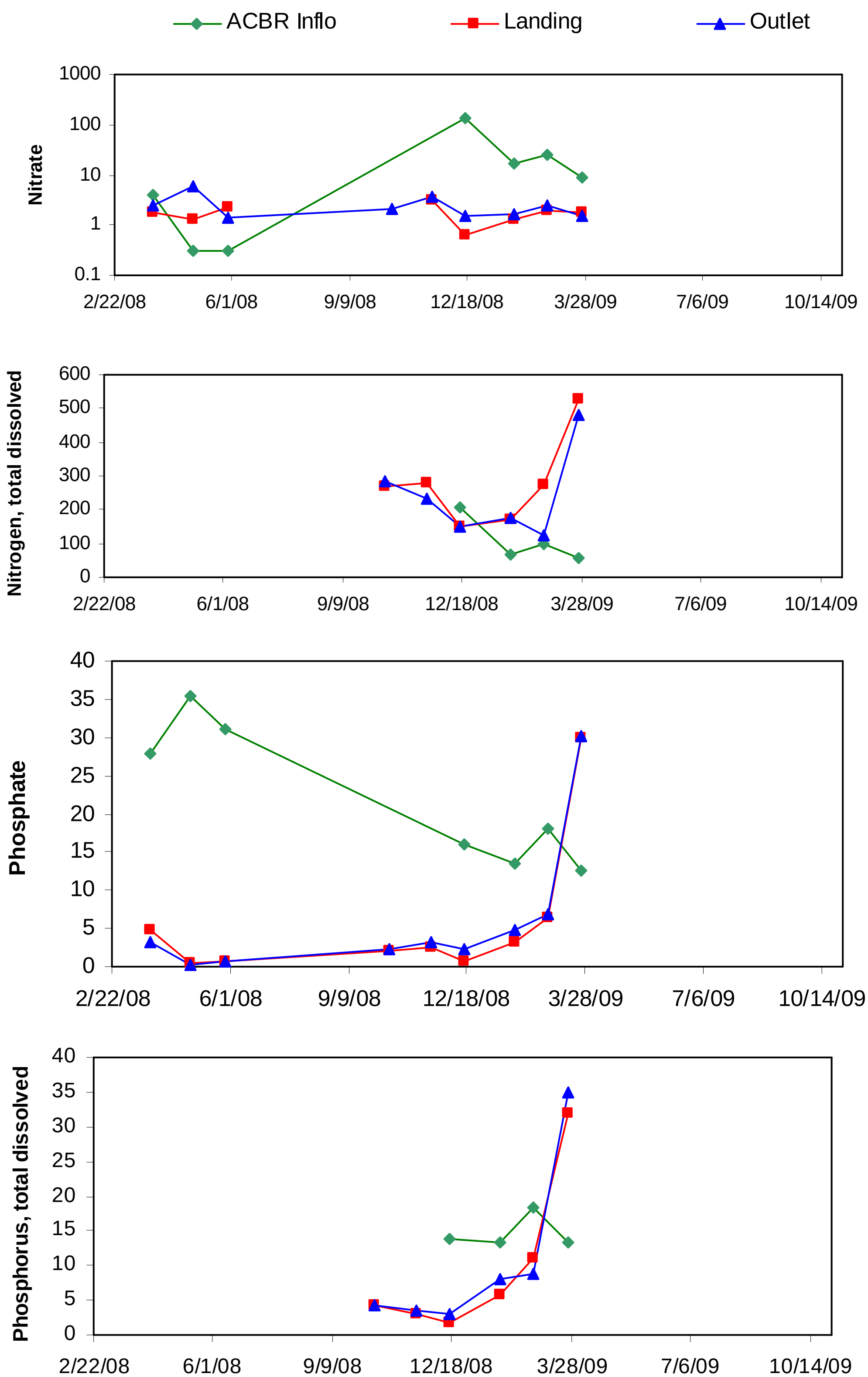

WY 2009
Rainfall
Flow, cfs
Rainfall acc., in
MC at Mission, cfs
11/1
11/15
11/29
12/13
12/27
1/10
1/24
2/7
2/21


WY 2009
Stream stage, in
Flow, cfs
Stream stage, in
MC at Mission, cfs
11/1
11/15
11/29
12/13
12/27
1/10
1/24
2/7
2/21

ANDRE CLARK BIRD REFUGE

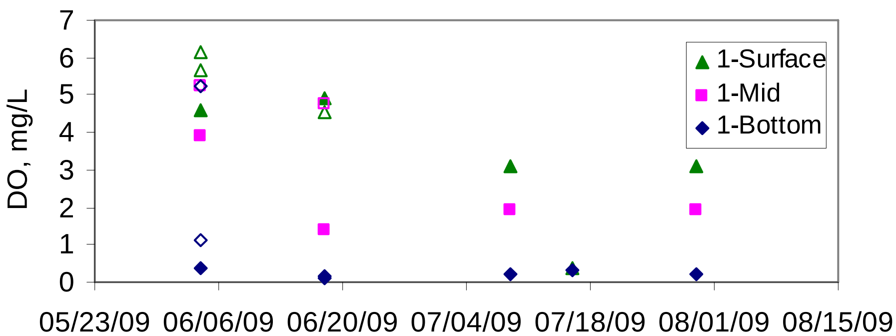
The Creeks Division began testing the Bird Refuge on a monthly basis in spring 2008. Below are plots from the sampling thus far. Indicator bacteria, dissolved oxygen, and updated results and analysis will be presented in the Annual Report. Preliminary analysis shows that the inflow to the Bird Refuge contains high levels of phosphate and nitrate (at one sample point, extremely high likely toxic levels). At the landing and the outlet, nutrient levels are lower, but chlorophyll a and biological oxygen demand are higher, signs that nutrients have been converted into algal and microbial biomass.

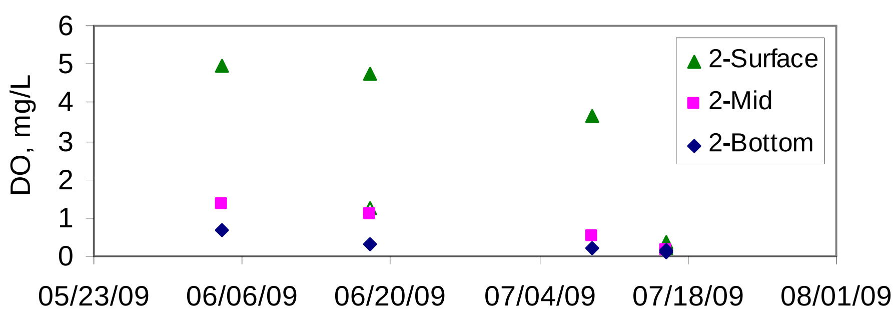


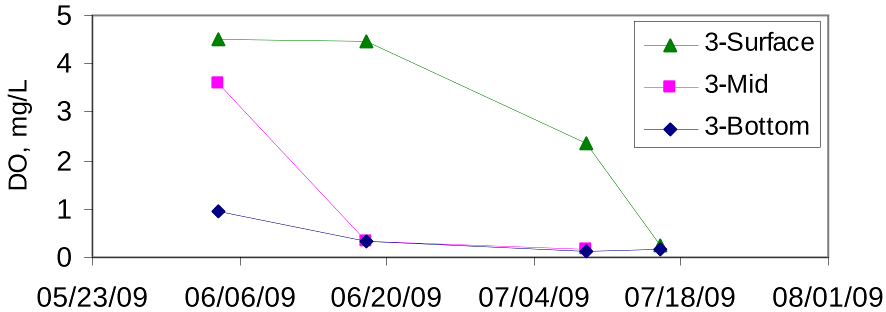

ACBR Inflo
Landing
Outlet
Nitrate
1000
100
10
1
0.1
Nitrogen, total dissolved
600
500
400
300
200
100
0
Phosphate
40
35
30
25
20
15
10
5
0
Phosphorus, total dissolved
2/22/08
6/1/08
9/9/08
12/18/08
3/28/09
7/6/09
10/14/09

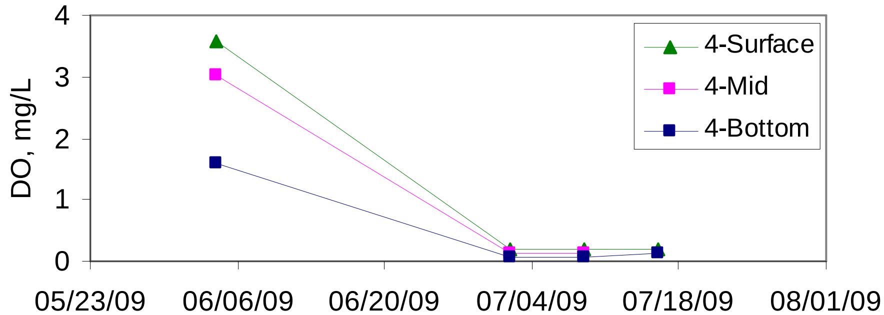
The Parks Division implemented a pilot study to test the effect of microbial augmentation on the Bird Refuge. The sampling locations are marked in the following map of the outlet arm:

Results:









MIXING

1. During the first day of application, sufficient mixing took place to make DO levels high at the bottom.
2. Subsequently, not enough mixing took place.
3. In July, no amount of mixing would have helped, due to low DO levels at the surface.

WATER and SEDIMENT DEPTH

In the outlet arm of the Bird Refuge, water depth averaged 1.55', sludge (watery sediment) depth averaged 0.54', and sediment depth (depth to which a pole could be pushed by hand) averaged 6.8'. There was no change during the pilot study.

IV. STORM MONITORING

Table of storm events sampled in FY09.

Name	**Date**
First Flush I	Oct. 4, 2008
First Flush II	Nov. 1, 2008
Tea Fire	Nov. 25, 2009
West Fig	Dec. 14, 2008
Parking Lot LID	Jan. 22, 2009
Golf Course	Feb. 5, 2009

FIRST-FLUSH SAMPLING AT INTEGRATOR SITES (OCTOBER 4 / NOVEMBER 1, 2008)

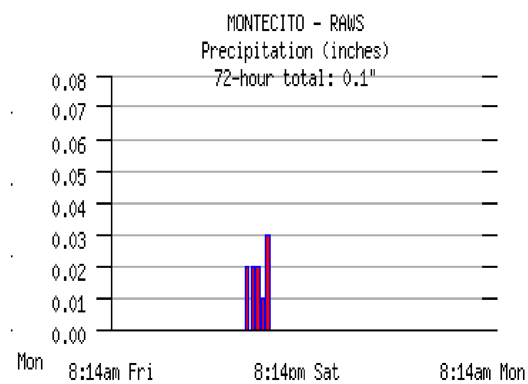
Introduction

The goal of this sampling event was to catch the "first flush" storm of the 2008-09 water year: the first storm of the season to cause substantial runoff to the creeks. A first flush event such as this should typically produce the highest concentrations of polluted runoff of the year, as the first substantial rain washes away pollutants that have been collecting since the previous rainy season.

An early-season storm was predicted to hit the Santa Barbara area on Saturday, October 4th and was expected to last through Sunday the 5th. Rainfall was expected to reach 0.25 to 0.5 of an inch in most coastal areas, with as much as 1 inch in the coastal mountains. As the storm approached, however, it stalled over the ocean and weakened somewhat before finally reaching the Santa Barbara area early Saturday morning.

Light rain fell Saturday morning, the 4th, with continued cloud cover throughout the day and not much if any rain. At approximately 7:45 AM, when adequate runoff was observed on the streets, the decision was made by Leigh Ann to meet at the office and begin sampling.

Once in the field rain was found to be so light that only Laguna Drain and Laguna Channel were sampled. Sycamore Creek, Mission Creek and Arroyo Burro did not have sufficient signs of runoff to warrant sampling.



Two teams of two staff members (1) Leigh Ann and Thomas and (2) Liz and Casey each went out for sampling. The four Integrator Sites were to be sampled:

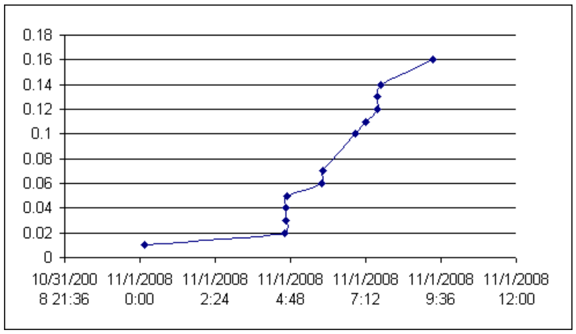
Sycamore Creek at the railroad bridge (near the Zoo)
Laguna Channel at Chase Palm Park
Mission Creek at Montecito Street
Arroyo Burro at Cliff Drive

At sites Sycamore, Mission, and Arroyo Burro, staff confirmed that the creeks were not receiving runoff; flow was not visibly higher than normal and there were no other visible signs of runoff (foam, brown coloration, and oily sheen) observed. The exception was Laguna Channel, which was flowing and was therefore sampled.

Due to inadequate rainfall during the October 4th rain event a follow up "first flush" sampling occurred with the second storm of the season on November 1st. The November 1st storm was predicted to hit the Santa Barbara area on Saturday, November 1st and was expected to last through Sunday the 2nd. Rainfall was expected to reach 0.25 to 0.5 of an inch in most coastal areas, with as much as 1 inch in the coastal mountains.

Light rain fell Saturday morning, the 1st, with continued rain and cloud cover throughout the day. At approximately 7:30 AM, when adequate runoff was observed on the streets, the decision was made by Jill Murray to meet at the office and begin sampling.

Once in the field rain and runoff was found to be sufficient enough to sample Laguna Channel, Arroyo Burro and Mission Creek. Sycamore Creek did not have sufficient signs of runoff to warrant sampling.



This graph shows cumulative rainfall through the duration of the storm, using rainfall amounts recorded at the City of Santa Barbra Engineering Building.

Two teams of staff members (1) Liz and Thomas, and (2) Jill each went out for sampling. The four Integrator Sites were to be sampled.

Sycamore Creek at the railroad bridge (near the Zoo)
Laguna Channel at Chase Palm Park
Mission Creek at Montecito Street
Arroyo Burro at Cliff Drive

At sites Laguna, Mission, and Arroyo Burro, staff confirmed that the creeks were receiving sufficient runoff; flow was visibly higher than normal and other visible signs of runoff (foam, brown coloration, and oily sheen) were observed. The exception was Sycamore, which was not flowing due to constructed damns in the area and was therefore not sampled.

Methods

At each site, samples were collected from the stream using either a) a plastic bucket and rope lowered off of a bridge or b) a plastic beaker dipped directly into the stream. The bucket and/or beaker were rinsed thoroughly at each site before use. Sample bottles were filled directly from the bucket and/or beaker in the field. In-stream parameters were measured using the Creeks multi-meter, and flow measurements were taken at site 4 (Arroyo Burro) but not at the other sites.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Monday morning.

The next week, rainfall totals for the October 4th storm showed that a total of 0.10 inches had fallen over the course of the storm at the Montecito RAWS. The next week, rainfall totals for the November 1st storm showed that a total of 0.49 inches had fallen over the course of the storm at the Santa Barbara Airport. Totals were checked on the National Weather Service website: http://www.wrh.noaa.gov/

Results from this storm study are summarized in a table on the following page. Nutrient results are not included as they are not yet available from UCSB.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected.

Constituent	Laguna Channel at Chase Palm Park	Mission Creek at Montecito St.	Arroyo Burro Creek at Cliff Dr.	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)				
Arsenic, total	ND	ND	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	ND	.00027 (EPA CCC, old)
Calcium, total	97	110	130	no criteria
Chromium, total	ND	ND	ND	.086 (EPA CCC, old)
Copper, total	0.011	0.032	0.01	.0094 (EPA CCC, old)
Copper, dissolved	0.0059	0.014	0.0026	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	0.0069	0.014	0.0055	.0053 (EPA CCC, old)
Mercury, total	ND	ND	ND	.00091 (EPA CCC, old)
Nickel, total	0.0029	0.0047	.0069	.052 (EPA CCC, old)
Iron, total	0.78	1.6	2.5	no criteria
Magnesium, total	37	36	59	no criteria
Manganese, total	0.290	0.860	0.590	no criteria
Potassium, total	6.7	5.6	6.8	no criteria
Sodium, total	120	82	130	no criteria
Zinc, total	0.040	0.093	0.025	.12 (EPA CCC, old)
Pesticides and Herbicides				
EPA 8151A[1] (µg/L)	ND	ND	ND	no criteria
EPA 8081A[2] (µg/L)	ND	ND	ND	no criteria
EPA 8141A[3] (mg/L)	ND	ND	ND	limited criteria[4]
Glyphosate (µg/L)	ND	ND	ND	.7
Other				
Total suspended solids (mg/L)	22	64	66	no criteria
Oil and grease (mg/L)	ND	ND	ND	Visible sheen (BP)
MBAS (mg/L)	0.35	0.41	0.30	.2 (BP)
Toxicity (TUa)	0.00	0.00	0.41	.3 (OP)
Dissolved Organic Carbon (mg/L)	18	23	17	no criteria
Chloride (mg/L)	180	84	220	230 (EPA CCC, old)

Sulfate (mg/L)	180	250	350	no criteria
Alkalinity (mg/L)	260	270	280	>20 (EPA CCC, old)
Hardness (mg/L)	440	600	550	no criteria

[1] Chlorinated herbicides: Dalapon; Dicamba; MCPP; MCPA; Dichlorprop; 2,4-D; 2,4,5-TP; 2,4,5-T; 2,4-DB; Dinoseb

[2] Chlorinated pesticides: Alpha-BHC; Gamma-BHC; Beta-BHC; Heptachlor; Delta-BHC; Aldrin; Heptachlor Epoxide; Endosulfan I; Dieldrin; 4,4'-DDE; Endrin; Endrin Aldehyde; 4,4'-DDD; Endosulfan II; 4,4'DDT; Endosulfan Sulfate; Methoxychlor; Chlordane; Toxaphene; Endrin Ketone

[3] Organophosphorus pesticides: Azinphos Methyl; Bolstar; Chlorpyrifos; Coumaphos; Demeton-o; Demeton-s; Diazinon; Dichlorvos; Disulfoton; Ethoprop; Fensulfothion; Fenthion; Malathion; Merphos; Methyl Parathion; Mevinphos; Naled; Phorate; Ronnel; Stirophos; Tokuthion; Trichloronate

[4] Criteria are limited. Criteria do not exist for some constituents. Criterion for Malathion (.0001 mg/L) is less than the minimum detection limit (.0012 mg/L) therefore it is unknown if criteria was exceeded. Criterion for Parathion (.000013 mg/L) was not exceeded. Criterion for Chlorpyrifos (.000041 mg/L) is less than the minimum detection limit (.0024 mg/L) therefore it is unknown if the criterion was exceeded.

Acronyms used:
EPA- USEPA's Current National Recommended Water Quality Criteria (US EPA, 2005)
CTR- California Toxics Rule (US EPA, 2000). Does not supply criteria for total metals.
BP- RWQCB's Basin Plan (CA EPA, 1994). Does not distinguish between CCC and CMC.
CCC- Continuous Concentration Criteria
CMC- Continuous Maximum Concentration
OP- California Ocean Plan (CA EPA, 2005).

Discussion

The results of this first flush sampling had both similarities and differences when compared with previous storms. With metals, total lead and total copper exceeded criteria this time; in the past there have typically been many more than this (lead, nickel, zinc, cadmium, and chromium). Arsenic, Cadmium, Chromium and Mercury were the only metals not detected at all during this storm.

Previous results from Creeks Division sampling showed high levels of dissolved copper, at levels that were considered to be harmful to aquatic life. However, the toxicity of different forms of copper was not understood, and new criteria were in development by the USEPA. The new criteria for copper is based on the Biological Ligand Model (BLM) and requires the input of ten parameters, including temperature, pH, calcium, magnesium, sodium, chloride, sulfate, alkalinity, and dissolved organic carbon. In sites analyzed thus far, pH variations have the most impact on calculate criteria.

Pesticides and herbicides were not detected in any samples during this storm, and have rarely been detected in past storms. It is important to note that the aquatic life criteria for some organophosphorus pesticides (EPA 8141A) are lower than the minimum detection limit of our laboratory, therefore it is unknown whether those particular criteria were exceeded.

Other pollutants were detected in higher levels during this storm than in the past, and several exceeded criteria. MBAS was detected in and exceeded the criteria in all samples. MBAS was only detected in one sample last year, compared to all samples this year (also using the same detection limit). Before last two years, however, MBAS was rarely detected.

This was the third time the City has tested for toxicity during a storm; however hold times were exceeded deeming the results inconclusive.

Several new constituents were added this year for use in calculating criteria for dissolved copper (calcium, magnesium, sodium, chloride, sulfate, alkalinity, and dissolved organic carbon). All of these were detected, none of which exceeded standards. High levels of chloride (as well as sulfate, magnesium, and calcium) are normal for this region due to easily-eroded marine sediments in the local geology.

TEA FIRE STORM EVENT (11/25/08)

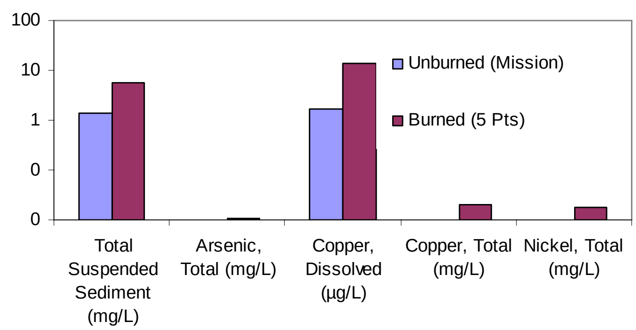
Summary

After the recent Tea Fire, the Creeks Division conducted stream monitoring to test the effect of the fire on stream water quality. Previous research in Southern California has shown that wildfire can lead to increased levels of metals, PAHs, nutrients, and suspended sediments in storm water. It is not known yet whether the increased metals and nutrients are due to the larger sediment loads, or if they are associated with burned organic material and sediment.

The Tea Fire provided an interesting test case to look at fire effects, because the burn area was largely contained within the upper Sycamore Creek watershed, and a large portion of the upper watershed was burned (67%). During the first rain storm after the fire, Creeks staff set out to test whether water quality in runoff from burned and unburned areas would be different. Creeks staff collected samples from the burned watershed (Sycamore Creek at 5 Points) and a similar sized watershed, upper Mission Canyon. In addition, samples were collected from the lowermost sampling site on Sycamore Creek, near Hwy 101, in order to compare results with pre-fire data from previous years. Water was collected and sent off to an outside lab to test for metals, PAHs, and suspended sediment.

Creek water was collected during the first 0.10" of rainfall, which contained mostly surface runoff from nearby streets. At the 5 Points site, the water smelled of soot and ash, and looked black, whereas the Mission Creek runoff looked brown and did not have an odor. It was clear from visual observation the storm water did not contain sediment-laden runoff from the upper watersheds. After the initial rainfall, an evacuation order was issued and Creeks staff did not remain in the field. The following morning, after substantial rain had fallen, a sample was collected from Sycamore Creek at Punta Gorda St., to test for the parameters listed above plus Oil and Grease and MBAS (a surfactant in detergents).

Results showed that there were higher levels of suspended sediment and several metals in the burned site versus the unburned site (see graph). The levels of metals were well below standards known to cause toxicity in aquatic organisms. All PAHs and the metals lead, cadmium, chromium, selenium, and silver were not detected at either site. Samples from the downstream Sycamore Creek site, collected after more rain had fallen, did not show high levels of any metals or PAHs compared to storm sampling in previous years.



Details

Goals:

1. Test burn vs. nonburn area for total metals, total suspended sediment, and PAH's.
2. Collect first-flush samples for Sycamore Creek if it flows at the 101.

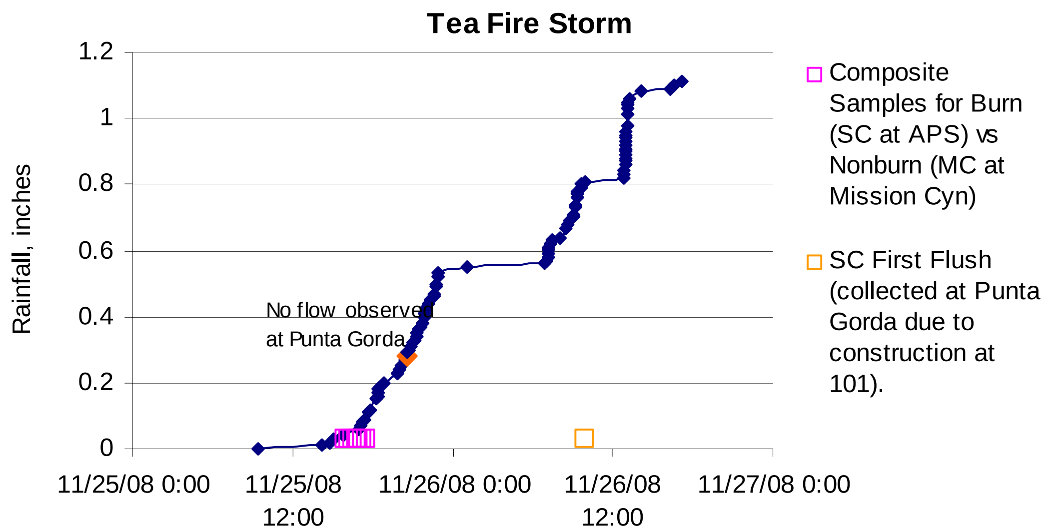
Sites

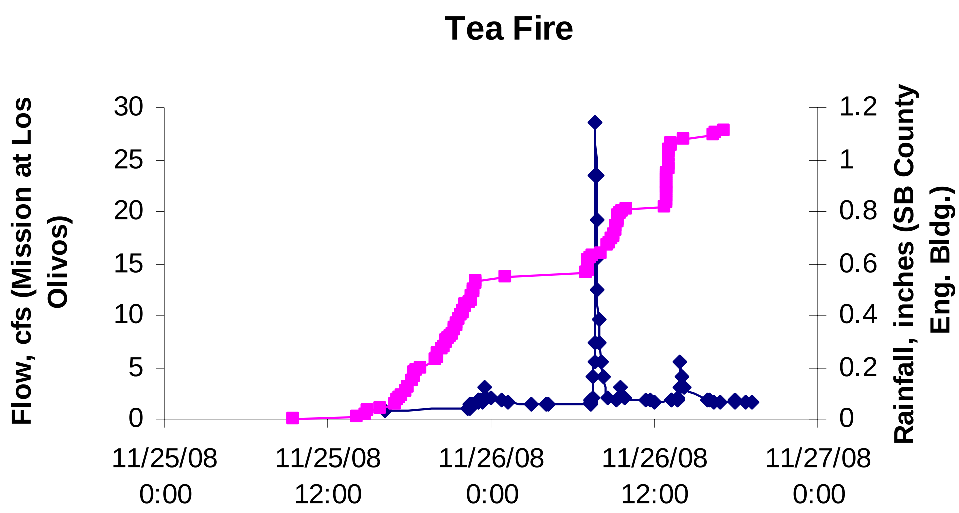
1. Burned watershed: Sycamore Creek at APS (5 points), approximately 2300 acres, 65% burned.
2. Non-burned watershed: Mission Creek at Mission Canyon, approximately 1700 acres, 0% burned.

The third storm of the season was predicted to hit the Santa Barbara area on Tuesday, November 25th and was expected to last through Thursday the 27th. Rainfall was expected to reach 0.5 to 1.5 of an inch in most coastal areas, with as much as 2 inches in the coastal mountains.

Light rain fell Tuesday evening, the 25th, with continued cloud cover and scattered showers throughout the following two days. At approximately 5:00 PM, when adequate rainfall was observed, the decision was made by Jill Murray to assemble and begin sampling.

Once in the field rain was found sufficient to sample Mission Canyon and Sycamore Canyon along APS but Sycamore Canyon at the Railroad had to be sampled the following day due to lack of stream flow. Sycamore Canyon at the Railroad was flowing the following day November 26th.





Methods

At each site, samples were collected from the stream using a plastic beaker dipped directly into the stream. The beaker was rinsed thoroughly at each site before use. Sample bottles were filled directly from the beaker in the field. In-stream parameters were measured using the Creeks multi-meter.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Wednesday morning.

The next week, rainfall totals for the November 25th storm showed that a total of 1.11 inches had fallen over the course of the storm at the SB County Flood Control Downtown Station.

Results from this storm study are summarized in a table on the following page.

Field Sampling:

1. Collected 1 L every 15 m 7 samples once it started raining. Tested for field parameters (MC). Sampling effort terminated upon mandatory evacuation order at sampling site.
2. Sampled Sycamore Creek at Punta Gorda after sufficient rainfall for it to flow. Filled all bottles (full suite of constituents) and tested for field parameters.
3. Kept all samples on ice until returned to office.

Creeks Office:

1. Composited 500 ml from each sample bottle to have 3.5 L, well-mixed per site. Filled bottles for total metals, dissolved Cu, PAHs, and total suspended sediment for each site.
2. Tested field parameters for SC samples.
3. Kept samples on ice.
4. Filled out chain of custody

Results

Observations

1. **1.** SC site smelled like ash upon start of rain.
2. **2.** Creek appeared to have runoff with ash/soot, but not heavy sediment loads of upper watershed.

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected. A blank cell indicates that that particular constituent was not sampled for.

Constituent	**Mission Cyn Composite**	**Sycamore Creek at APS**	**Sycamore Creek at Railroad**	**Criteria in mg/L unless otherwise noted (source)**
Metals (mg/L)				
Arsenic, total	ND	0.011	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	ND	.00027 (EPA CCC, old)
Calcium, total			94	no criteria
Chromium, total	ND	ND	ND	.086 (EPA CCC, old)
Copper, total	ND	0.022	0.011	.0094 (EPA CCC, old)
Copper, dissolved	0.0017	0.014	0.0049	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	ND	0.014	ND	.0053 (EPA CCC, old)
Mercury, total			ND	.00091 (EPA CCC, old)
Nickel, total	ND	0.018	0.0093	.052 (EPA CCC, old)
Iron, total			1.6	no criteria
Magnesium, total			54	no criteria
Manganese, total			0.071	no criteria
Potassium, total			7.5	no criteria
Sodium, total			90	no criteria
Zinc, total	ND	0.31	0.044	.12 (EPA CCC, old)
Pesticides and Herbicides				
EPA 8151A[1] (µg/L)				no criteria
EPA 8081A[2] (µg/L)				no criteria
EPA 8141A[3] (mg/L)				limited criteria[4]
Glyphosate (µg/L)			ND	.7
Other				
Total suspended solids (mg/L)	ND	55	29	no criteria
Oil and grease (mg/L)				Visible sheen (BP)
MBAS (mg/L)				.2 (BP)
Toxicity (TUa)				.3 (OP)
Dissolved Organic Carbon (mg/L)			15	no criteria
Chloride (mg/L)			100	230 (EPA CCC, old)
Sulfate (mg/L)			390	no criteria
Alkalinity (mg/L)			140	>20 (EPA CCC, old)
Hardness (mg/L)			490	no criteria
PAH (µg/L)	ND	ND		

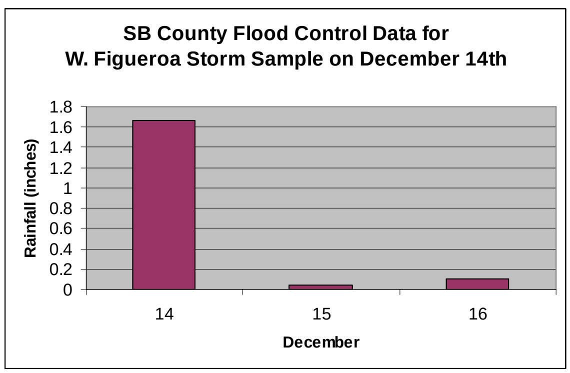
WEST FIGUEROA STORM (12/14/08)

Introduction

The goal of this sampling event was to collect upstream and downstream water quality data during the first 0.25" of rainfall. The restoration design will treat approximately the first quarter inch of rainfall.

A substantial storm was predicted to hit the Santa Barbara area on Sunday, December 14th and was expected to last through Tuesday the 16th. Rainfall was expected to reach 1 inch in most coastal areas, with as much as 2 inches in the coastal mountains.

Heavy rain fell Sunday evening, the 14th, with continued cloud cover and scattered showers throughout Tuesday. At approximately 9:00 PM on Sunday, when adequate runoff was observed on the streets, the decision was made by Thomas Oretsky to begin sampling. One team of composed of one staff member (1) Thomas Oretsky sampled W. Figueroa lower and W. Figueroa upper.



This graph shows rainfall through the duration of the storm, using rainfall amounts recorded by Santa Barbara County Flood Control District at the downtown flood control station

Methods

At each site, samples were collected from the stream using a plastic beaker dipped directly into the stream. The beaker was rinsed thoroughly at each site before use. Sample bottles were filled directly from the bucket and/or beaker in the field. In-stream parameters were measured using the Creeks multi-meter.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Monday morning.

The next week, rainfall totals for the December 14th storm showed that a total of 1.8 inches had fallen over the course of the storm at the downtown SB Flood Control Station.

Results from this storm study are summarized in a table on the following page. Nutrient results are not included as they are not yet available from UCSB.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected. A blank cell indicates that that particular constituent was not sampled for.

Discussion

The results of this W. Figueroa sampling had both similarities and differences when compared with previous storms. With metals, total lead as well as total copper (W. Fig. lower), dissolved copper and total zinc (W. Fig. lower) exceeded criteria this time; in the past there have typically been many more than this (lead, nickel, zinc, cadmium, and chromium). Arsenic, Cadmium, Chromium were the only metals not detected at all during this storm.

Constituent	W. Figueroa Lower	W. Figueroa Upper	
Metals (mg/L)			
Arsenic, total	ND	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	.00027 (EPA CCC, old)
Calcium, total	81	9.1	no criteria
Chromium, total	0.017	ND	.086 (EPA CCC, old)
Copper, total	0.026	ND	.0094 (EPA CCC, old)
Copper, dissolved	0.0078	0.0070	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	0.036	0.0059	.0053 (EPA CCC, old)
Mercury, total			.00091 (EPA CCC, old)
Nickel, total	0.022	ND	.052 (EPA CCC, old)
Iron, total	9.6	2.8	no criteria
Magnesium, total	25	2.5	no criteria
Manganese, total	0.38	0.091	no criteria
Potassium, total	7.9	3.7	no criteria
Sodium, total	48	5.1	no criteria
Zinc, total	0.14	0.069	.12 (EPA CCC, old)
Other			
Total suspended solids (mg/L)	140	76	no criteria
Dissolved Organic Carbon (mg/L)	27	17	no criteria
Chloride (mg/L)			230 (EPA CCC, old)
Sulfate (mg/L)	180	9.9	no criteria
Alkalinity (mg/L)	170	17	>20 (EPA CCC, old)
Hardness (mg/L)	320	34	no criteria

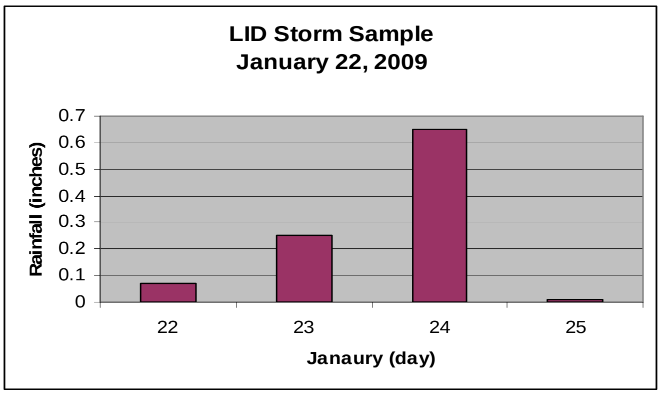
PARKING LOT LOW IMPACT DEVELOPMENT (LID) STORM SAMPLE (1/22/09)

Introduction

The goal of this sampling event was to collect outflow water quality data during the first 0.10" of rainfall. The LID design is aimed to treat 1.0" of rainfall. The goal of sampling the first 0.25" is to collect data on the highest concentrations that might be seen in the effluent.

The LID storm was predicted to hit the Santa Barbara area on Wednesday, January 21st and was expected to last through Sunday the 25th. Rainfall was expected to reach 0.25 to 0.5 of an inch in most coastal areas, with as much as 1 inch in the coastal mountains.

Light rain fell Wednesday evening, the 21st, with continued sprinkles throughout the evening. At approximately 3:45 AM, when adequate runoff was observed on the streets, the decision was made by Thomas Oretsky to meet at the office and begin sampling.



Methods

One team of one staff member (1) Thomas Oretsky went out for sampling. The outflow from Parking Lot 4, on Chapala between W. Figueroa and W. Anapamu was sampled.

Samples were collected from the runoff using either a plastic beaker dipped directly into the parking lot overflow. The beaker was rinsed thoroughly before use. Sample bottles were filled directly from the beaker in the field. In-flow parameters were measured using the Creeks multi-meter

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Monday morning.

The next week, rainfall totals for the January 22nd storm showed that a total of 0.98 inches had fallen over the course of the storm at the Santa Barbara County Flood Control District at the downtown flood control station.

Results from this storm study are summarized in a table on the following page.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected. No result means that that constituent was not tested for.

Constituent	LID (Lot 4 between Chapala and W. Figueroa)	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)		
Arsenic, total	ND	.15 (EPA CCC, old)
Cadmium, total	ND	.00027 (EPA CCC, old)
Calcium, total	13	no criteria
Chromium, total	0.0058	.086 (EPA CCC, old)
Copper, total	0.049	.0094 (EPA CCC, old)
Copper, dissolved	0.021	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	0.0068	.0053 (EPA CCC, old)
Mercury, total		.00091 (EPA CCC, old)
Nickel, total	ND	.052 (EPA CCC, old)
Iron, total	2.7	no criteria
Magnesium, total	3.8	no criteria
Manganese, total	0.097	no criteria
Potassium, total	4.4	no criteria
Sodium, total	9.7	no criteria
Zinc, total	0.24	.12 (EPA CCC, old)
Other		
Total suspended solids (mg/L)	210	no criteria
Oil and grease (mg/L)	11	Visible sheen (BP)
MBAS (mg/L)		.2 (BP)
Toxicity (TUa)		.3 (OP)
Total Organic Carbon (mg/L)	30	no criteria
Chloride (mg/L)		230 (EPA CCC, old)
Sulfate (mg/L)	12	no criteria
Alkalinity (mg/L)	22	>20 (EPA CCC, old)
Hardness (mg/L)	46	no criteria
PAH ((µg/L)	All non-detects except Pyrene (0.24)	
TPH	ND	

1

Discussion

The results of this LID storm sampling had both similarities and differences when compared with previous storms. With metals, total copper, dissolved copper, total lead and total zinc exceeded criteria this time; in the past there have typically been many more than this (cadmium, and chromium). Nickel, Arsenic, Cadmium, and Mercury were the only metals not detected at all during this storm.

Other pollutants were detected in higher levels during this storm than in the past, and several exceeded criteria. Oil and grease as well as Alkalinity were found to be higher than standards allow.

GOLF COURSE SAMPLING (2/5/09)

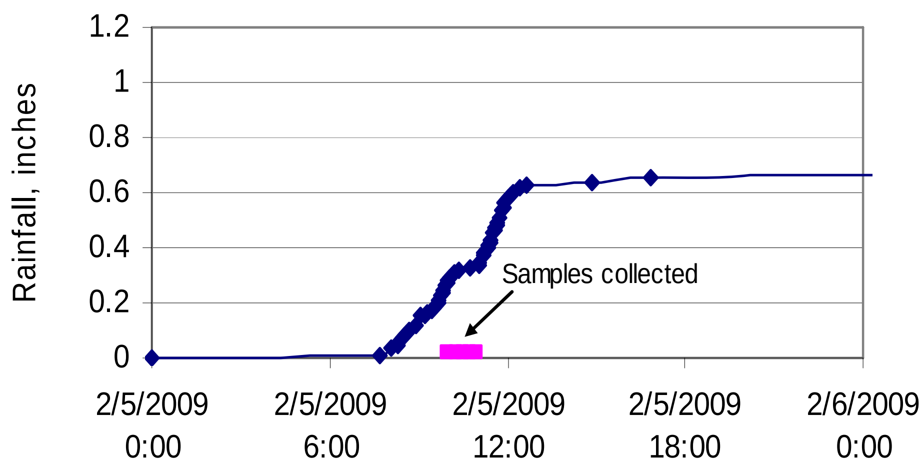
Introduction

The goal of this sampling event was to collect samples from inflow and outflow sites for water quality data during a storm that is large enough to create discharge from the "East Basin," generally over 1" of rain (depends on how intense the rainfall is).

The storm was predicted to hit the Santa Barbara area on Thursday, February 5th and was expected to last through Friday, February 6th. Rainfall was expected to reach 0.5 to 1.25 of an inch in most coastal areas, with as much as 1 to 2 inches in the coastal mountains.

Heavy rain fell Thursday morning, the 5th, with continued cloud cover and showers throughout the day. At approximately 9:45 AM, when adequate runoff was observed on the streets, the decision was made by Jill Murray and Thomas Oretsky to meet at the office and begin sampling.

Once in the field rain was found to be sufficient enough to sample sites: 1) San Jose, 4) Santa Barbara Golf Course West, 5) Santa Barbara Golf Course East, 6) Adams compilation, and 7) Adams Las Positas drain. Santa Barbara Golf Course South West (2) and Santa Barbara Golf Course South West Earl Warren (3) did not have sufficient signs of runoff to warrant sampling. Please see description of sites below in Table 1.

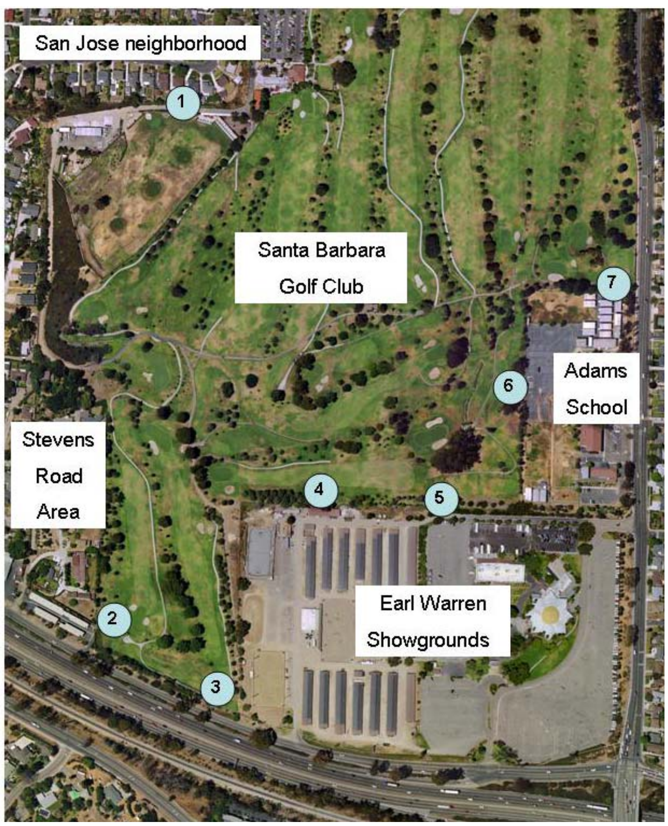


This graph shows cumulative rainfall through the duration of the storm.

One team of two staff members Jill Murray and Thomas Oretsky went out for sampling. The Santa Barbara Municipal Golf Course was to be sampled:

Sites Table 1

Site No. (see map)	Access Name	Description
1	SBGCSanJos	San Jose Lane drainage.This site contains runoff from a residential neighborhood, which flows onto the golf course. INFLOW
2	SBGC SW	SW corner drainage, below "farm" and other homes. This site contains runoff from the Stevens Road residential area, as well as from the golf course. OUTFLOW
3	SBGC SWEW	SW corner of Earl Warren. This site contains runoff from the golf course and from the Earl Warren Showgrounds. OUTFLOW
4	SBGC W	Golf Course, western runoff. This site is one of the main drainage points for the golf course, also called “Basin 4.”OUTFLOW
5	SBGC E	Golf course Eastern drainage: This site is another main drainage point for the golf course, also called “East Basin.”OUTFLOW
6	Adams comp	Composite of Adams School drains. This is a composite of several drains that discharge behind the school. INFLOW
7	Adams LPdr	Drain flowing to Adams School NE corner from Las Positas. This drain contains runoff from Las Positas Road and neighborhoods to the east. INFLOW



Methods

At each site, samples were collected from the stream using a plastic beaker dipped directly into the stream. The beaker was rinsed thoroughly at each site before use. Sample bottles were filled directly from the beaker in the field. In-stream parameters were measured using the Creeks multi-meter.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Monday morning.

Results from this storm study are summarized in a table on the following page. Nutrient results are not included as they are not yet available from UCSB.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected.

Constituent	San Jose	SBGCW	SBGC E	Adams Comp	Adams LP dr	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)						
Arsenic, total	0.021	ND	ND	ND	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	ND	ND	ND	.00027 (EPA CCC, old)
Calcium, total	13.0	10.0	7.1	5.0	6.2	no criteria
Chromium, total	0.037	ND	ND	ND	0.0084	.086 (EPA CCC, old)
Copper, total	0.033	0.010	0.013	ND	0.047	.0094 (EPA CCC, old)
Copper, dissolved	0.0049	0.0079	0.0085	0.0090	0.0073	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	0.042	ND	0.0064	ND	0.0077	.0053 (EPA CCC, old)
Mercury, total						.00091 (EPA CCC, old)
Nickel, total	0.023	ND	ND	ND	0.011	.052 (EPA CCC, old)
Iron, total	17.0	0.68	2.4	0.22	4.3	no criteria
Magnesium, total	6.7	5.6	2.9	0.67	1.9	no criteria
Manganese, total	0.28	ND	0.049	0.063	0.068	no criteria
Potassium, total	9.0	11.0	3.8	0.87	1.4	no criteria
Sodium, total	6.1	18.0	6.2	2.2	1.9	no criteria
Zinc, total	0.16	ND	0.033	0.18	0.15	.12 (EPA CCC, old)
Other						
Total suspended solids (mg/L)	200	31	83	13	99	no criteria
Chloride (mg/L)						230 (EPA CCC, old)
Sulfate (mg/L)	9.1	26.0	8.0	5.4	4.9	no criteria
Alkalinity (mg/L)	24.0	40.0	23.0	7.0	7.5	>20 (EPA CCC, old)
Hardness (mg/L)	54.0	50.0	28.0	16	16	no criteria

Discussion

The results of this Golf Course Storm Sampling had both similarities and differences when compared with previous storms. With metals, total lead and total copper exceeded criteria this time; in the past there have typically been many more than this (lead, nickel, zinc, cadmium, and chromium). Cadmium was the only metals not detected at all during this storm.

Previous results from Creeks Division sampling showed high levels of dissolved copper, at levels that were considered to be harmful to aquatic life. However, the toxicity of different forms of copper was not understood, and new criteria were in development by the USEPA. The new criteria for copper is based on the Biological Ligand Model (BLM) and requires the input of ten parameters, including temperature, pH, calcium, magnesium, sodium, chloride, sulfate, alkalinity, and dissolved organic carbon. In sites analyzed thus far, pH variations have the most impact on calculate criteria. Other pollutants were detected in higher levels during this storm than in the past, and several exceeded criteria. Alkalinity and total Zinc were detected in and exceeded the criteria in most samples.

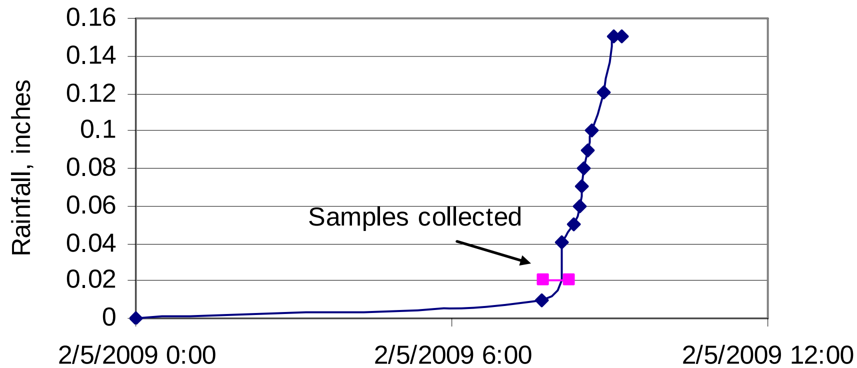
WEST FIGUEROA STORM (2/5/09)

Introduction

The goal of this sampling event was to collect upstream and downstream water quality data during the first 0.25" of rainfall. The restoration design will treat approximately the first quarter inch of rainfall.

The storm was predicted to hit the Santa Barbara area on Thursday, February 5th and was expected to last through Friday, February 6th. Rainfall was expected to reach 0.5 to 1.25 of an inch in most coastal areas, with as much as 1 to 2 inches in the coastal mountains.

Heavy rain fell Thursday morning, the 5th, with continued cloud cover and showers throughout the day. At approximately 7:45 AM, when adequate runoff was observed on the streets, the decision was made by Thomas Oretsky to meet at the office and begin sampling.



Methods

At each site, samples were collected from the stream using a plastic beaker dipped directly into the stream. The beaker was rinsed thoroughly at each site before use. Sample bottles were filled directly from the bucket and/or beaker in the field. In-stream parameters were measured using the Creeks multi-meter.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on Monday morning.

This graph shows cumulative rainfall through the duration of the storm

Results from this storm study are summarized in a table on the following page. Nutrient results are not included as they are not yet available from UCSB.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected. A blank cell indicates that that particular constituent was not sampled for.

Discussion

The results of this W. Figueroa sampling had both similarities and differences when compared with previous storms. With metals, total lead as well as dissolved copper, total copper and total zinc (W. Fig. upper) exceeded criteria this time; in the past there have typically been many more than this (lead, nickel, zinc, cadmium, and chromium). Arsenic, Cadmium, Chromium were the only metals not detected at all during this storm.

Constituent	W. Figueroa Lower	W. Figueroa Upper	
Metals (mg/L)			
Arsenic, total	ND	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	.00027 (EPA CCC, old)
Calcium, total	130	16	no criteria
Chromium, total	ND	0.0054	.086 (EPA CCC, old)
Copper, total	ND	0.033	.0094 (EPA CCC, old)
Copper, dissolved	0.0023	0.019	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	0.016	0.0098	.0053 (EPA CCC, old)
Mercury, total			.00091 (EPA CCC, old)
Nickel, total	ND	ND	.052 (EPA CCC, old)
Iron, total	2.1	2.8	no criteria
Magnesium, total	40	4.0	no criteria
Manganese, total	0.10	0.15	no criteria
Potassium, total	2.5	5.2	no criteria
Sodium, total	83	8.1	no criteria
Zinc, total	0.032	0.13	.12 (EPA CCC, old)
Other			
Total suspended solids (mg/L)	38	66	no criteria
Dissolved Organic Carbon (mg/L)	3.2	25	no criteria
Chloride (mg/L)			230 (EPA CCC, old)
Sulfate (mg/L)	250	17	no criteria
Alkalinity (mg/L)	280	28	>20 (EPA CCC, old)
Hardness (mg/L)	500	60	no criteria

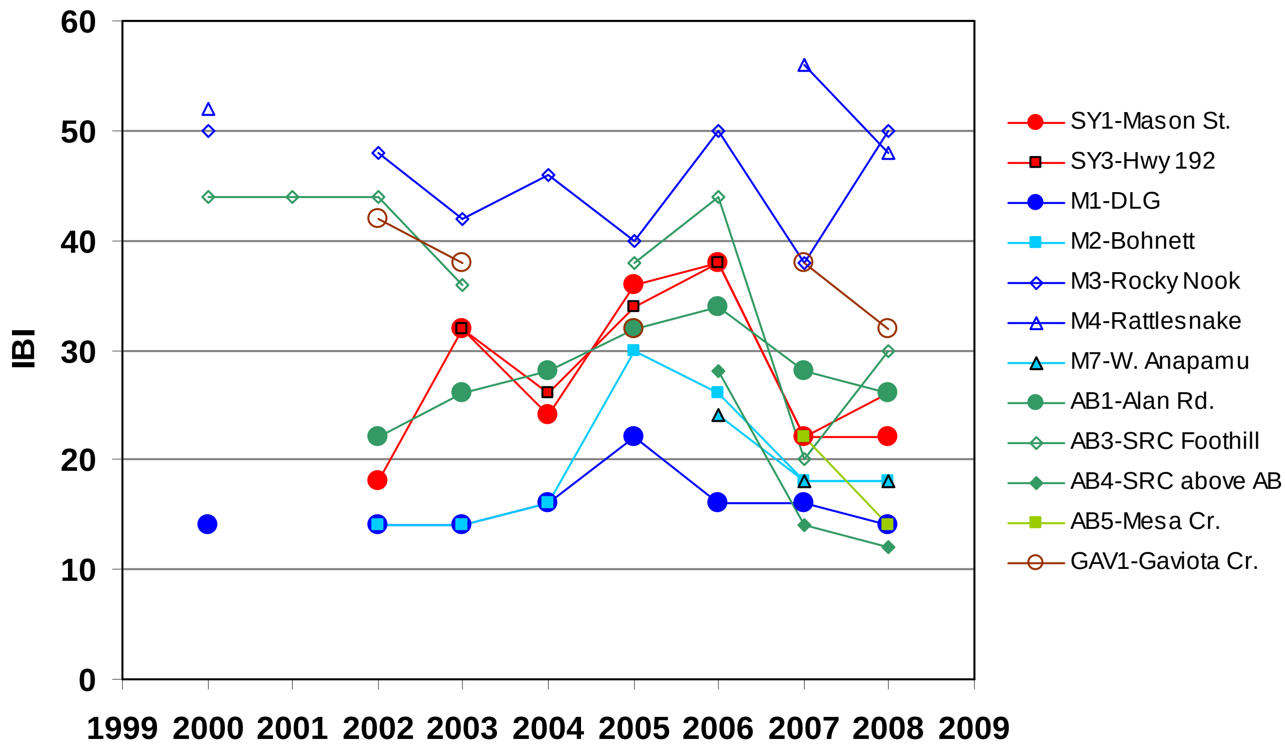
V. BIOASSESSMENT

The following text is taken from the Santa Barbara City Creeks Bioassessment Program 2008 Annual Report, produced for the City by Jeff Brink (Ecology Consultants):

Introduction
This report summarizes the results of the 2008 Santa Barbara City Creeks Bioassessment Program. The Program was initiated in 2000 to assess and monitor the "biological integrity" of local creeks as they respond through time to natural and human influences. The Program involves annual collection and analysis of benthic macroinvertebrate (BMI) samples and other pertinent physiochemical and biological data in study creek reaches using USEPA endorsed rapid bioassessment techniques. BMI samples are analyzed in the laboratory, and six "core metrics" specified in the *Index of Biotic Integrity (IBI) for Southern Santa Barbara County Streams* are calculated for each study reach. The IBI provides a measurement of biological integrity for study streams based on the evaluation of the core metrics, which reflect many aspects of the BMI community including diversity, composition, and trophic structure.

2008 Results
Overall, IBI scores were very similar this year compared to 2007. As a whole, IBI scores for 2007 and 2008 were lower compared to the previous two years (2005 and 2006), mostly due to dramatic increases in the percentage of non-insects and Dipterans, and a corresponding decrease in the percentage of Ephemeroptera, Plecoptera, and Tricoptera taxa. In 2007, a lack of scouring discharges the previous winter was thought to be the cause of this trend. This past winter had average rainfall and three scouring discharges in excess of 100 cfs, but was still relatively mild in comparison to the winter preceding 2005, and to a lesser degree 2006. IBI scores for individual study reaches this year were in all cases within the classifications (i.e., Very Poor, Poor, Fair, Good, or Excellent) established in previous years of study.

The following graph shows all of the IBI scores generated thus far, for all years and sites. The contract for Bioassessment in 2009 includes development of a new IBI and presenting and analyses of multiple years of data, as in the graph shown below.



IBI Scores over Ten Year. Open symbols denotes relatively undisturbed habitat, and closed symbols denote more impacted habitat. Red denotes Sycamore Watershed, blue denotes Mission Watershed, green denotes Arroyo Burro, and brown denotes Gaviota Creek. With the exception of M7, the symbol shapes refer to elevation: circle for lowermost, square for mid watershed, diamonds and triangles for upper sites.

Preliminary analysis shows IBI scores improved for all lower-scoring sites after the heavy rains of winter 2005, and that the ongoing dry period has led to a reduction in IBI scores. In addition, the up-to-downstream reduction in IBI scores is most evident for Mission Creek. In Arroyo Burro, scores are closer to each other, and may relate more to degree of development. Gaviota Creek, a relatively undisturbed low-gradient site, has relatively high IBI scores, suggesting that the low scores in Mission Creek are not merely a reflection of gradient. Each of these observations will be tested statistically in the next Bioassessment report. T

VI. MICROBIAL SOURCE TRACKING

Microbial source tracking is used to develop better tools for tracking fecal pollution in creeks and to identify sources of indicator bacteria. The Creeks Division has gathered extensive data on the presence of indicator bacteria throughout its watersheds, the specific sources of pollution and the degree to which the recreational waters are harmful to human health are not known.

The Laguna Watershed Study, which involved dry weather hydrology and microbial source tracking, was completed in Fiscal Year 2009. Results from the Laguna Watershed Study were used to form a recommendation for installing ultraviolet disinfection at the discharge of Laguna Channel. Ongoing source tracking in the Laguna Channel storm drain network has identified locations with relatively high concentrations of fecal contamination. These sites are under ongoing investigation to determine locations of inputs. Sampling for the Source Tracking Protocol Development Project began in August 2009. Additional sampling will take place through October 2010. A preproposal to the Water Environment Research Federation, for to test canine scent tracking as a source tracking tool, was selected for full proposal submission in October 2009.

VII. CREEK WALKS

Creek walks from the ocean to upper watersheds are used to identify problem areas and track changes due to natural processes and human activity. Problem areas may include sources of polluted input to the creeks, sites of habitat degradation, or failing bank structures. Problem areas that are typically not seen from roads can be identified, cleaned up, and monitored. In FY09, the second year of baseline data was collected for monitoring the effectiveness of catch basin screens in the Old Mission Creek drainage. The following results were obtained:

Summer 2007

Trash type	Section 1	Section 2	Section 3	Total
"soft" plastics	166	35	110	311
"hard" plastics	73	30	34	137
glass bottles	50	10	13	73
aluminum cans	40	9	14	63
bulk trash	51	9	8	68
styrofoam	17	5	3	25
toys/balls	14	6	9	29
paper goods	3	5	13	21
clothing/fabric	13	3	4	20
other	5	1	0	6
				753

Summer 2008

Trash type	Section 1	Section 2	Section 3	Total
"soft" plastics	295	76	81	452
"hard" plastics	116	55	8	179
glass bottles	82	12	9	103
aluminum cans	56	6	2	64
bulk trash	82	30	2	114
styrofoam	27	8	3	38
toys/balls	21	2	0	23
paper goods	3	1	0	4
clothing/fabric	46	1	2	49
other	25	8	0	33
				1059

Summer 2009

Trash type	Section 1	Section 2	Section 3	Total
"soft" plastics	180	66	160	406

"hard" plastics	70	17	13	100
glass bottles	53	6	10	69
aluminum cans	23	7	6	36
bulk trash	24	3	2	29
styrofoam	41	10	8	59
toys/balls	28	7	1	36
paper goods	0	0	3	3
clothing/fabric	6	2	2	10
other	22	19	0	41
				789

VIII. REGULATORY CHANGES, EMERGING ISSUES, AND LITERATURE UPDATES

2008 303(D) LISTINGS

In 2008, the Central Coast Regional Water Quality Control Board made the following changes to the listing of impaired water bodies, within Santa Barbara, under Section 303(d) of the Clean Water Act.

Arroyo Burro Creek

- Off the list for pathogens
- Now listed for E. coli
- Now listed for fecal coliform

Arroyo Burro Beach

- Still listed for total coliform
- Now listed for Enterococcus

Mission Creek

- Still listed for Unknown Toxicity
- Now listed for E. coli
- Now listed for fecal coliform
- Now listed for low dissolved oxygen

East Beach at Mission Creek

- Still listed for total coliform and fecal coliform
- Now listed list for Enteroccus

Sycamore Creek

- Now listed list for fecal coliform
- Now listed list for sodium, under Ag beneficial use
- Now listed list for, chloride, under Ag beneficial use

East Beach at Sycamore Creek

- Off the list for total coliform

- Now listed for Enterococcus

Leadbetter Beach
- Off the list for indicator bacteria
- Now listed for total coliform

SLURRY SEAL, FOAM, AND PAHS

The City began gathering information about slurry sealing, parking lots, and a possible connection to foam, based on visual observation and a publication on PAHs associated with parking lot seal coats. The following is an outline of the information gathered.

1. Previous work (City of Austin, USGS) shows that runoff from coal-sealed parking lots contains high PAHs, with similar signature of what's in lake sediments. There is some disagreement about whether the PAH accumulation in sediments is really due in such a large part to parking lot runoff. The City of Austin created a ban on coal-based sealants, as a result. There is a test for it, based on use vegetable oil and a black light, with an associated $2,000 fine.
2. In more recent work; the dust from asphalt and coal-based parking lots contains high levels of PAHs, but the coal based is much worse.
   Emulsifier can definitely cause long-lived foam, at least locally. Emulsifier is in coal and asphalt based product. The City of Austin forwarded pictures of foam from a simulated rain event.
3. There haven't been any studies done on road "slurry seal." Slurry seal has a bigger aggregate, but everything else is the same. They tend to be longer wearing (8 years, as opposed to 2-3), but the matrix may wear just as fast. "Bituminous" is descriptive of both asphalt and coal. In roadways, the term refers to asphalt materials not coal containing.
4. Although California is supposed to be asphalt based (geography and lawsuits?), there is probably coal-based sealant in use.
5. Testing/surfactants. There may be a reason why our MBAS results were not particularly high. Emulsifiers include cationic surfactants. MBAS tests for anionic surfactants (MBAS Fact Sheet from http://h2o.enr.state.nc.us/lab/qa/MBAS_000.pdf.pdf). There may be a test for cationic surfactants – DSBAS (Cationic Surfactants). Cationic surfactants are in fabric softener, but it is not known if they produce foam.

IX. RECOMMENDATIONS

Fiscal Year 2010 Monitoring and Research Plan

Goals: The Water Quality Monitoring Program provides data for the Creeks Division to establish baselines of water quality, track long term changes, and assess project performance. This information is needed to understand sources and routes of pollution to creeks, prioritize future projects for the Division, and to provide a basis for understanding the effectiveness of the current program. The Creeks Division strives to maintain a dynamic, adaptive monitoring program that is driven by specific research questions.

The goals of the monitoring program for FY10 have been updated to:

1. Quantify the levels (concentration and 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, as well as post construction data collection.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.

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.

The monitoring program consists of seven key elements:

7. Watershed Assessment
8. Beach Water Quality
9. Source Tracking/Illicit Discharge Detection
10. Storm Monitoring
11. Restoration and Water Quality Project Assessment
12. Creek Walks
13. Bioassessment

See the attached Research Plan for a list of questions addressed by each element and a sampling table derived from the questions.

Changes from FY09 - The goals for FY10 were expanded to include identifying sources of pollution and evaluating long term trends in water quality (see attached research plan). In order to meet these goals, a Beach Water Quality Element was added to directly address beach warnings. The Microbial Source Tracking element was expanded to include additional pollutant categories, such as PAHs, and additional techniques used in more traditional illicit discharge detection. In addition, eutrophication/low dissolved oxygen was added as specific concern in the watershed assessment element. It is recommended that sediment be tested for the final year in FY10, with subsequent testing focusing on specific sites and pollutants of concern that have been identified. Fire will again be a concern, and the Mission Creek site will be tested for post-fire water quality during the first storm. Based on results obtained in the past year, testing for dissolved copper will no longer continue, nor will toxicity during dry weather. In the coming year, parking lot and street slurry coats will be investigated as a source of PAHs and foam in creeks. Please see the attached document for the program elements, research questions, and the sampling table.

APPENDIX A. FY09 RESEARCH AND MONITORING PLAN

City of Santa Barbara Creeks Division
Water Quality Monitoring Program

FY09 RESEARCH PLAN

Note: Sampling plan will go into effect in March 2007.

Routine Watershed Assessment

1. Conduct biweekly sampling for FIB/field paramters at integrator sites for each watershed in order to track long term changes (see attached sampling schedule and map).
2. Conduct quarterly snapshot sampling for each watershed (see map and table below) in order to track long term changes and to identify pollutant routes to creeks
    a. Include FIB and field parameters at all sites (5-10 per watershed).
    b. Include chemical pollutants and nutrients at several sites.
    c. Include toxicity at integrator sites.
    d. Include sediment sampling at lagoon sites.
3. Develop tools to track fluxes and loads.
    a. Estimate flow rates at most sample sites
        i. Obtain staff training to conduct flow estimates in creeks when sampling.
        ii. Develop stage-discharge curves where possible.
        iii. Sample at sites with existing gauges (USGS and UCSB).
    b. Develop capability to measure flows in storm drains with dynamic flow rates and flow-triggered sampling (semi portable system).
        i. Add one drain system in FY08 (some equipment will overlap with storm system).
        ii. Add additional drains, pending grant funding.
4. Conduct FIB/field sampling at drain outlets and up drainage networks of key storm drains.
    a. Use Bacterial Reduction Study (2002) and City's Storm Drain Atlas as a guide.
    b. Conduct ground surveys to understand point sources, including sumps and groundwater pumps.
    c. Use automated samplers when feasible and otherwise collect multiple samples/flow measurements.
    d. Use flow, FIB, and DNA-based tools for sample analysis (see source tracking below).
5. Conduct rapid response to persistent beach warnings (sanitary surveys)
    a. Sample up creeks and drains when beach warnings are posted for three of four sampling dates.
6. Investigate watershed models to improve interpretation of monitoring data. Begin with H20Map, which the City also uses to model the sanitary sewer system.
7. Develop strategy to use GIS to organize, present, and analyze water quality data.

Restoration and Water Quality Project Assessment

1. AB Estuary Restoration
    a. Upstream/downstream sites for comparison pre with pre-project data.
    b. Sites: AB at Cliff Drive, AB Lagoon Mouth, AB Surf, Mesa Above, Mesa Below.
    c. Biweekly FIB/field parameters.
    d. Quarterly nutrients and metals.
    e. Quarterly spatial intensives for FIB/field parameters in Old Mission Creek (10 samples per intensive).
2. SURF Water Quality Improvement Project
    a. Weekly estimates of FIB load treated during 2007 AB411 dates (sample inlet port in vault); grant requirement.
    b. Biweekly FIB/field parameters at downstream sites for comparison with pre-project data (Westside Drain, OMC at W. Anapamu, MC at Guitierrez, MC at Montecito).
    c. Monthly testing within treatment facility (FIB/field).
    d. Quarterly spatial intensive for FIB/field.
3. Old Mission Creek Restoration Project
    a. Biweekly FIB/field parameters at upstream/downstream sites for comparison with pre-project data (Westside Drain, OMC at W. Anapamu; overlaps with SURF).
    b. Quarterly spatial intensive (overlaps with SURF).
4. Hope and Haley Diversions
    a. Monthly load estimates by sampling in manholes.
    b. Biweekly FIB/field parameters at downstream sites (AB below SRC and MC at Guitierrez).
5. Las Positas Storm Water Management Project
    a. Sample during storms, including constituents and FIB/field parameters.
6. W. Figeroa Storm Water Project
    a. Sample during storms at W. Anapamu Bridge, including constituents and FIB/field parameters.
7. Laguna Channel Water Quality Improvement
    a. Biweekly baseline at integrator site (FIB/field parameters).
    b. Quarterly snapshot

Storm Monitoring

1. Develop capability to conduct automated, flow-triggered sampling at integrator sites (Mission Creek, Arroyo Burro, and Sycamore Creek).
    a. Begin with Mission Creek integrator site in FY07.
    b. Add Arroyo Burro in FY08.
    c. Add Sycamore Creek in FY09.
    d. Investigate feasibility in Laguna Channel
2. Develop capability to conduct automated, flow-triggered sampling in storm drains sites (semi-portable systems).
    a. Add one drain systems in FY08.
    b. Use County’s new online system for storm tracking.
3. Conduct first-flush sampling at integrator sites.
    a. Use first quarter inch of rainfall as sampling point for sites without real-time flow data.
    b. Use flow-weighted composite sampling for sites with real-time flow data.
    c. Include full suite of constituents, including pesticides/herbicides and toxicity.

    d. Do not include indicator bacteria, due to short holding times.
4. Conduct load assessment at two additional storms per year at sites with gauges/autosamplers (limited constituents).
5. Conduct sampling at project assessment sites during two storms per year.
6. Conduct indicator bacteria studies in Mission Creek during two storms per year.
7. Conduct visual study of foam inputs to creeks during one storm.

Source Tracking

1. Maintain research with Dr. Patricia Holden (UCSB) and continue to pursue additional grant funding.
2. Analyze select samples from drain studies in Routine Watershed Assessment for DNA markers.
3. Outsource samples for a microbial source tracking study using E. Coli ribotyping to estimate the percent of different sources in Arroyo Burro Estuary, Mission Lagoon, and Laguna Channel.

Summary of Sites and Sampling Frequency

	ROUTINE WATERSHED			PROJECT ASSESSMENT			STORM		
SITE	**FIB/field**	**Constit.**	**Nuts.**	**FIB/field**	**Constit.**	**Nuts.**	**FIB/field**	**Constit.**	**Nuts.**
Arroyo Burro Watershed									
ABSurf				biweekly					
AB Lagoon Mouth				biweekly	quarterly	quarterly			
AB Lagoon, Lower		quar-sed							
AB1850	Biweekly-F	quarterly+ toxicity			quarterly	quarterly		First Flush+2	First Flush+2
Mesa below				Biweekly-F	quarterly	quarterly			
Mesa above				Biweekly					
AB above LPC	quarterly	Quarterly							
LPC above AB	quarterly	Quarterly							
AB below SRC				Biweekly*					
AB above SRC	quarterly	Quarterly							
SRC above AB	quarterly	Quarterly							
Barger	quarterly	Quarterly							
Jesusita	quarterly	Quarterly							
Golf Course				Storm	storm	storm			
Hope Drain-Load				Monthly					
Spatial Intensive at AB				quarterly					
Mission Creek Watershed									
Surf Zone	quarterly								
MC Lagoon Mouth	quarterly								
MC Lagoon Upper		quar-sed							
MC at Montecito	Biweekly-*F	quarterly+toxicity	quarterly					First Flush+2	First Flush+2
MC Guiterrez				Biweekly					
MC above confluence	Quarterly								
MC at Mission	Quarterly	quarterly	quarterly						
MC at Rocky Nook	Quarterly	quarterly	quarterly						
Rattlesnake	Quarterly	quarterly	quarterly						
OMC above confluence	Quarterly	quarterly	quarterly						
OMC at W. Anapamu				Biweekly	quarterly	quarterly			
Westside Drain				Biweekly	quarterly	quarterly			
SURF-load				weekly during dry					
SURF-month				monthly during dry					
Haley Drain-load				Monthly					
W. Fig-site(s)				storm	storm				
LC (if joined)	Quarterly								
Spatial Intensive at Bohnett				quarterly					
Laguna Watershed									
LC @ CPP	Biweekly	quarterly+sed+tox	quarterly					First Flush+2	First Flush+2
LC at Garden				quarterly	quarterly				
Manhole 1 (TBD)				quarterly	quarterly				
Manhole 2 (TBD)				quarterly	quarterly				
Manhole 3 (TBD)				quarterly	quarterly				
Sycamore Watershed									
SC Surf	Quarterly								
SC Outlet (if running)	Quarterly								
SC at 101	Biweekly-*F	quarterly+sed+tox	quarterly					First Flush+2	First Flush +2
SC at Cacique	Quarterly	quarterly	quarterly						
SC at APS	Quarterly	quarterly	quarterly						
SC at Stanwood	Quarterly	quarterly	quarterly						
Additional									
Lighthouse	Quarterly								
Honda	Quarterly								
Additional Drains (TBD)	125	20							
Additional Storm (TBD)							100	20	10

F-Flow for biweekly
* - Safety

Sampling Plan for Quarterly Snapshots

Arroyo Burro

Site	Flow	FIB/Field	Constituents	Nutrients
Jesusita	estimate area/velocity	water	water	water
Barger	estimate area/velocity	water	water	water
SRC above AB	estimate area/velocity	water	water	
AB above SRC	estimate area/velocity	water	water	water
AB above LPC	estimate area/velocity	water	water	
LPC above AB	estimate area/velocity	water	water	water
Mesa low	TBD	water	water	water
AB at Cliff	TBD (LTER)	water	water+tox	water
Lagoon, lower			sediment	
Lagoon Mouth	estimate area/velocity	water	water	
Surf	n/a	water		

Mission Creek

MC at Rattlesnake	estimate area/velocity	water	water	water
MC at Rocky Nook	USGS gauge	water	water	water
MC at Mission	USGS gauge	water	water	water
MC above confluence	TBD	water		
OMC above confluence	bucket/timer	water	water	water
OMC WSD	flow gauge/bucket timer	water	water	water
OMC Bohnett Park	n/a	water	water	water
Montecito	estimate/LTER gauge	water	water+toxicity	water
Laguna Channel (if lagoons joined)	estimate area/velocity	water		
Upper Lagoon	n/a		sediment	
Lagoon Mouth	estimate area/velocity	water		
Surf	n/a	water		

Sycamore Creek

Surf	n/a	water		
Outlet-if running	estimate area/velocity	water		
SC at 101	estimate area/velocity	water	water+sed+tox	water
SC at Cacique	estimate area/velocity	water	water	water
SC at APS	estimate area/velocity	water	water	water
SC at Stanwood	estimate area/velocity	water		water

Laguna Channel

LC at Chase Palm Park	n/a	water		
LC at Garden Onramp	estimate area/velocity	water		
Manhole 1 (TBD)	virtual bucket	water	water+sed	water
Manhole 2 (TBD)	virtual bucket	water	water	water
Manhole 3 (TBD)	virtual bucket	water	water	water

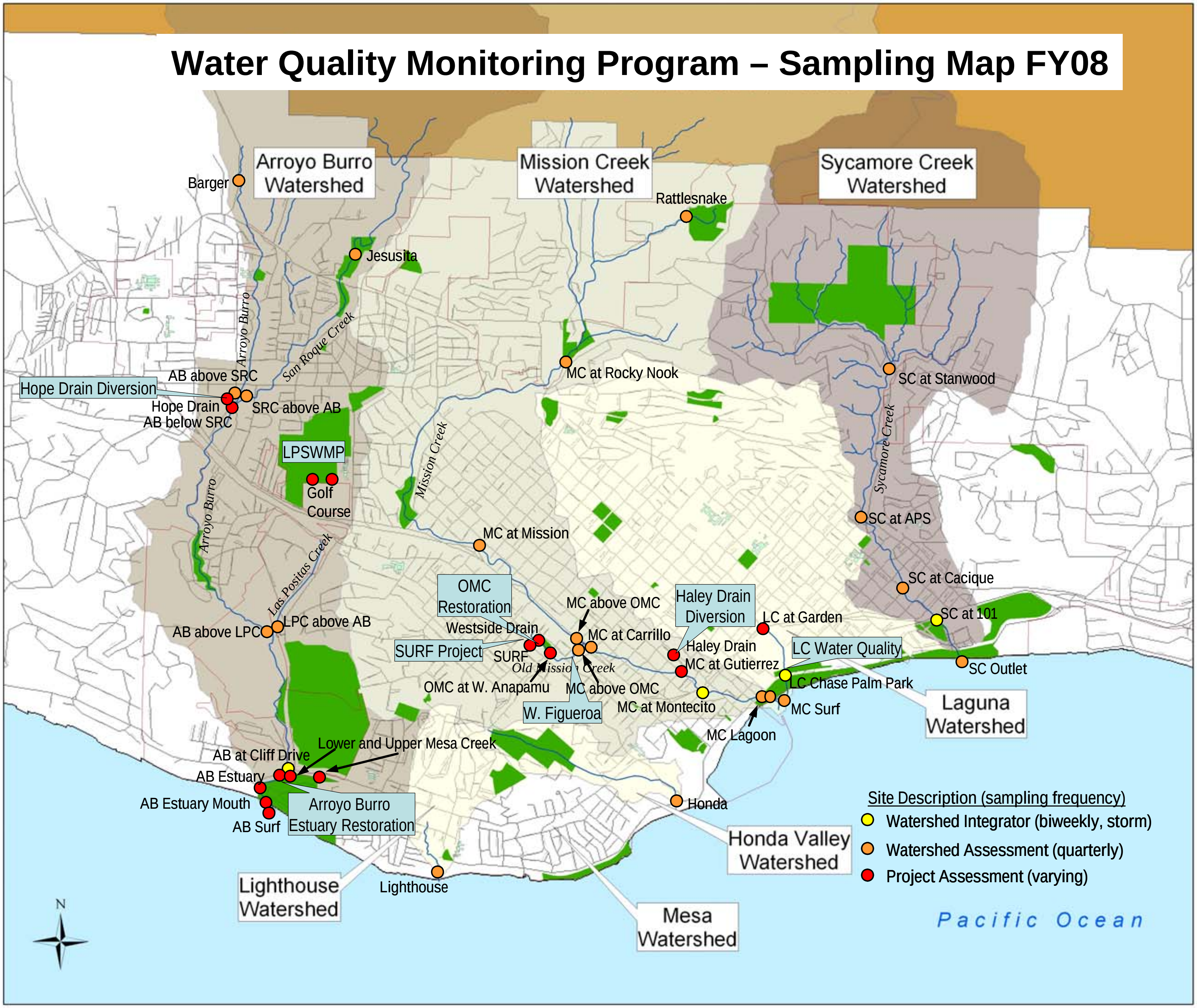
Additional creeks

Site	Flow	FIB/Field	Constituents	Nutrients
Lighthouse	estimate area/velocity	water		
Honda	estimate area/velocity	water		

Sediment does not have to be on same day.

Constituent Lists

	First Flush	Basic Storm	Quarterly	Quarterly with Toxicity
Hardness	X	X	X	X
TSS	X	X	X	X
Oil and Grease	X	X		
MBAS	X	X		
Dissolved copper	X	X	X	X
MBAS	X	X		
EPA 8081A	X			
EPA 8141A	X			
EPA 8151A	X			
Glyphosate	X			
Total Digestion (metals)	X	X	X	X
Total Metals (group)	X	X	X	X
Toxicity (% survival)	X			X


Water Quality Monitoring Program – Sampling Map FY08
Arroyo Burro Watershed
Mission Creek Watershed
Sycamore Creek Watershed
Barger
Rattlesnake
Jesusita
Arroyo Burro
San Roque Creek
AB above SRC
Hope Drain Diversion
Hope Drain
AB below SRC
SRC above AB
MC at Rocky Nook
SC at Stanwood
LPSWMP
Golf Course
Mission Creek
Sycamore Creek
Arroyo Burro
SC at APS
MC at Mission
Las Positas Creek
SC at Cacique
OMC Restoration
MC above OMC
Haley Drain Diversion
LC at Garden
SC at 101
AB above LPC
LPC above AB
Westside Drain
MC at Carrillo
SURF Project
SURF
Haley Drain
LC Water Quality
Old Mission Creek
MC at Gutierrez
SC Outlet
OMC at W. Anapamu
MC above OMC
LC Chase Palm Park
W. Figueroa
MC at Montecito
MC Surf
Laguna Watershed
MC Lagoon
Lower and Upper Mesa Creek
AB at Cliff Drive
AB Estuary
AB Estuary Mouth
Arroyo Burro Estuary Restoration
AB Surf
Honda
Site Description (sampling frequency)
Watershed Integrator (biweekly, storm)
Watershed Assessment (quarterly)
Project Assessment (varying)
Honda Valley Watershed
Lighthouse Watershed
Lighthouse
Mesa Watershed
Pacific Ocean
N

APPENDIX B. FY10 RESEARCH AND MONITORING PLAN

City of Santa Barbara Creeks Division
Water Quality Monitoring Program

FY10 RESEARCH PLAN

The goals of the monitoring program are to:

1. Quantify the levels (concentration and 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.

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.

PROGRAM ELEMENTS AND QUESTIONS

A. Watershed Assessment

Research questions:

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
2. How contaminated and/or toxic is sediment at creek outfall sites?
3. What is the impact of eutrophication on Santa Barbara creeks?

B. Storm Monitoring

Research Questions:

1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms? Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?
2. What are the impacts of the Jesusita Fire on water quality?
3. What are the loads of pollutants discharged from Santa Barbara creeks during storms?
4. What are the sources and routes of pollutants during storms?
   a. How do concentrations and loads vary during storms and from site to site?
      - Fecal indicator bacteria
      - Slurry seal/PAHs/Foam
      - Metals
      - Nutrients
5. How do restoration/treatment projects impact water quality during storm events?

C. Restoration and Water Quality Project Assessment

The Creeks Division has completed several restoration and water quality improvement capital projects over the past several years. Project assessment is used to determine the success of projects in lowering microbial and chemical pollution levels and improving water quality for aquatic organisms. In some cases project monitoring is grant-required, and the remaining is for internal review of project success. Additional monitoring is conducted to ensure that the facility is performing as intended.

Research Questions:

1. Do Creeks Division projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
2. What is the baseline water quality at future restoration/treatment sites?
3. What are the mechanisms of project success?

4. Are installed projects functioning correctly?

List of Projects

1. Westside SURF and Old Mission Creek Restoration
2. Arroyo Burro Restoration, including Mesa Creek daylighting
3. Hope and Haley Diversions
4. Laguna Channel Disinfection (Source Tracking)
5. Golf Course Project (Storm)
6. San Pascual Drain (Source Tracking)
7. Parking Lot LID (Storm)
8. Debris Screens (Creek Walks)
9. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)
10. Bird Refuge

D. Beach water quality

Research questions:

1. How to creeks and storm drains relate to beach water quality and warnings?
2. How do other factors (kelp, tides, temperature, and beach use) relate to beach warnings?
3. What are the causes of persistent beach warnings that occur?
4. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?

E. Source Tracking/Illicit Discharge Detection

Research questions:

1. Which subdrainages and/or contribute the greatest loads of pollutants to creeks in Santa Barbara? (CBI)
2. Where, when and how is human waste and/or sewage entering storm drains and creeks?
    a. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?
    b. How does presence of human waste relate to beach warnings?
3. Do rotting plant material and sediment contribute to high FIB levels in storm drains?
4. What are the impacts of reservoir flushing on metals?
5. Are new hot spots emerging?
6. Specific areas of concern: Barger Canyon, Las Positas Creek, Haley Drain

F. Creeks Walks/Clean ups

Research Questions:

1. Are there new problems in creeks that need to be addressed?
2. Is the amount of trash in creeks decreasing over time?
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?

G. Bioassessment

The biological assessment element is used to assess and monitor the biological integrity of local creeks as they respond through time to natural and human influences.

Research Questions:

1. What is the baseline of biological integrity for benthic macroinvertebrates in creeks?
2. Are there differences between upper watershed and lower watershed sites?
3. Are there differences among watersheds?
4. How does the biological integrity in our creeks change over time?
5. How does the biological integrity respond to water quality and restoration projects?

H. Methods Development

1. Can we use the following potential new tools?
    a. Can a chemical fingerprint be used to identify types of sources?
    b. Can the Microtox assay be used?
    c. Can screening kits be used?

d. K-9 forensics?

PROGRAM ELEMENT and QUESTIONS	**CONSTITUENTS/METHODS**	**SITES**	**FREQUENCY**	**PROJECTED COST**
A. Watershed Assessment				
1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?	Indicator bacteria, field parameters, flow	Integrator Sites Honda and Lighthouse	Biweekly Quarterly	$3,024
2. How contaminated and/or toxic is sediment at creek outfall sites?	Metals, PAHs, Toxicity, Herbicides, Pesticides, including Pyrethroids. Add transnonachlor and sublethal toxicity.	Estuarine or lower creek sites	Yearly, in late summer	$8,760
B. Storm Monitoring				
1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms? Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?	Metals, Herbicides, Pesticides, Nutrients, Oil and Grease, Toxicity	Integrator Sites and four storm drains	Yearly, first flush. Collect creek samples early during runoff event. Collect drain samples second.	$9,256
2. What are the impacts of the Jesusita Fire on water quality.?	Metals, PAHs, Sediment, Nutrients, field parameters, toxicity	Mission Canyon at Mission. Mission at Montecito later in storm.	Yearly, first flush.	$1,500
3. What are the loads of pollutants discharged from Santa Barbara creeks during storms?	Metals	Arroyo Burro at Cliff (location of flow gauge and autosampler)	Conduct composite sampling according to Caltrans (2008) during a 1" forecasted storm.	$850
4. What are the sources and routes of pollutants during storms?	Fecal indicator bacteria, Sediment, MBAS (or cationic surfactants), PAHs. Visual observation for foam during storm event.	Arroyo Burro at Cliff Simulated rain and runoff from recently sealed parking lots and/or streets.	Conduct composite sampling according to Caltrans (2008) during a 1" forecasted storm.	$3,745
5. How do restoration/treatment projects impact water quality during storm events?	Bacteria, nutrients, metals, sediment Bacteria, nutrients, metals, sediment, oil and grease, MBAS and toxicity	Seven sites at Golf Course Parking Lot Four	Three storms post project for Golf Course. First flush for Parking Lot 4.	$4,737

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
C. Restoration and Water Quality Project Assessment				
1. Westside SURF and Old Mission Creek Restoration (see annual report for details)	Indicator bacteria and field parameters	SURF up, SURF down, Westside Drain, OMC at W. Anapamu, 10 sites between Westside Drain and W. Anapamu	Weekly for SURF operation, biweekly for downstream impacts, and quarterly for regrowth study	$4,509
2. Arroyo Burro Restoration, including Mesa Creek daylighting (Suspension of quarterly testing until results from biweekly testing warrant a change).	Indicator bacteria and field parameters	AB at Cliff, Mesa upper, Mesa lower, AB Estuary upper, AB Estuary Mouth, AB Surf	Biweekly	$4212
3. Hope and Haley Diversions	Indicator bacteria and field parameters	Hope Diversions, Haley Pump	Biannual	$108
4. Laguna Channel Disinfection (Source Tracking)	Indicator bacteria and field parameters	Laguna at Chase Palm (already covered by routine)	Biweekly	Included above.
5. Golf Course Project (Storm)	See storm monitoring			Included above.
6. Parking Lot LID (Storm)	See storm monitoring			Included above.
7. Debris Screens (Creek Walks)	See creek walks			No lab cost.
8. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)	Dissolved Oxygen, pH, temperature, conductivity	MC Lagoon, MC upper reaches	Install probes for summer months, collect data continuously	No lab cost.
9. Bird Refuge	Indicator bacteria, chlorophyll a, nutrients, and field parameters	Bird Refuge Inflow, Landing and Outlet	Monthly	$1,884
D. Beach water quality				
1. How to creeks and storm drains relate to beach water quality and warnings, along with other factors such as kelp, tides, temperature (air,	Multivariate statistical model on retrospective data. Also see source tracking.			No lab cost.

PROGRAM ELEMENT and QUESTIONS	**CONSTITUENTS/METHODS**	**SITES**	**FREQUENCY**	**PROJECTED COST**
creek, ocean), beach use?				
2. Is growth on sediment and/or kelp responsible for beach warnings?	Sample plan to be determined.			$2,700
3. 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			$1,350
4. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?	Use forthcoming epidemiology studies in Southern California to conduct simple model of illness rates at Santa Barbara beaches.			No lab cost.
E. Source Tracking/Illicit Discharge Detection				
1. Which subdrainages and/or contribute the greatest loads of pollutants to creeks in Santa Barbara? (CBI)	Source Tracking Grant			Grant funded..
2. Where, when and how is human waste and/or sewage entering storm drains and creeks?	Source Tracking Grant			Grant funded.
3. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?	Source Tracking Grant			Grant funded.
4. How does presence of human waste relate to beach warnings?	Source Tracking Grant			Grant funded.
5. Do rotting plant material and sediment contribute to high FIB levels in storm drains?	Work with Streets Division to conduct pilot study on catch basin and storm drain cleaning on indicator bacteria levels.	Possible site: Montecito St. in Laguna Channel Watershed. Ideal sites are located at terminal upstream end of storm drain, with easy access for cleaning and sampling.	Monthly.	$2,700
6. What are the impacts of reservoir flushing on metals?	Metals, sediment.	Rattlesnake Creek and Reservoir outlet.	Single event.	$575

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
7. Are new hot spots emerging?	Observation, enforcement.	Serena Drain and others		
8. Specific areas of concern: Barger Canyon Las Positas Creek Lower Mission Mid Arroyo Burro	Chemical fingerprint (Fluoride, potassium, ammonium, boron, MBAS) , indicator bacteria	Barger Canyon (5 sites upstream) Las Positas Creek (Modoc to Arroyo Burro, 5 sites) Lower Mission (5 sites between OMC and Montecito Street) Mid Arroyo Burro (5 sites SRC and LPC)	Quarterly	$12,000
F. Creeks Walks/Clean ups				
1. Are there new problems in creeks that need to be addressed?	Creek clean ups			No lab cost.
2. Is the amount of trash in creeks decreasing over time?	Weight of trash removed each year.			No lab cost.
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?	Continue measuring and marking GPS coordinates of trash in Old Mission Creek and Lower Mission Creek (Oak Park to beach).			No lab cost.
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?	See 3.			No lab cost.
G. Bioassessment	See Bioassessment Proposal and Reports.			No lab cost.
H. Methods Development				
1. Can a chemical fingerprint be used to identify types of sources?	Chemical fingerprint (Fluoride, potassium, ammonium, boron, MBAS)	Fingerprint sources: groundwater, city water, reclaimed water, irrigation runoff, wastewater influent.		$3,000
2. Can the Microtox assay be used?	Investigate costs and options.			No lab cost.
3. Investigate field screening kits.	Investigate costs and options.			
4. K-9 forensics?	Investigate costs and options.			No lab cost.

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
TOTAL LAB COST				$64,910