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First Flush Report

November 7, 2002

In the Cities of Capitola, Monterey, Pacific Grove, and Santa Cruz, CA

Made Possible by:
Monterey Bay National Marine Sanctuary, Cities of Monterey, Pacific Grove, Capitola, and Santa Cruz, Central Coast Regional Water Quality Control Board, California State Water Resources Control Board, Coastal Watershed Council, Monterey Bay Sanctuary Foundation, Monterey Regional Water Pollution Control Agency, Department of Fish and Game's Marine Pollution Laboratory and University of California at Santa Cruz.

Executive Summary

On November 7th 2002, a storm drenched the entire west coast and produced the First Flush Event that engaged our network of volunteer monitors. First Flush occurs when sheeting rain flushes roadways and impermeable surfaces and carries months of accumulated contaminants and debris into the ocean. More than an inch of rain pelted the Central Coast with water and winds that brought down trees. Capitola and Santa Cruz volunteers mobilized at 2:30 AM while Monterey and Pacific Grove volunteers eagerly waited until 5:30 PM for the storm to arrive on the south end of the bay.

Many thanks to the dedicated and enthusiastic volunteers that made this event possible! Because of them, we have valuable information that has never been collected before.

The Monterey Bay Sanctuary Citizen Watershed Monitoring Network and the Coastal Watershed Council in collaboration with the Cities of Capitola, Monterey, Pacific Grove, and Santa Cruz coordinated First Flush 2002. When the storm arrived, 19 storm drain outfalls were monitored. All sites were monitored two to four times at approximately 30 minute intervals to determine any change in contaminants over time.

All of the sites were monitored for the parameters listed below. Beside the parameter, in parenthesis, is the range of concentrations that were detected during this event.

- conductivity (70 – 1200 µS)
- water temperature (12°C - 19°C)
- pH (6.2 – 7.5)
- nitrate as N (1.2 – 7.6 mg-N/l)
- orthophosphate as P (0.05 – 3.15 mg-P/l)
- total coliform (155,000 - > 240,000 MPN/100 ml)
- Escherichia coli (*E. coli)* or fecal coliform (300 – 240,000 MPN/100ml)
- zinc (40 – 1000 µg/l)
- copper (30 – 340 µg/l)
- lead (10 – 92 µg/l)
- oil and grease (non-detect – 8.3 mg/l)
- total suspended solids (TSS) (11 – 820 mg/l)
- total dissolved solids (TDS) (31 – 560 mg/l)
- toxicity

This was the third annual First Flush monitoring event in Monterey and Pacific Grove and the second annual event in Capitola and Santa Cruz. With three years of data, time series results and the additional toxicity analysis, some very interesting conclusions are possible. There are distinct trends between sites and between years. For example, copper, lead and zinc concentrations have increased every year at the majority of sites. Asilomar, in Pacific Grove, has had the highest average copper, lead and total suspended solids concentrations for the past several years. Average nitrate concentrations have been consistently below action levels for all three years. Examples of trends between sites include:

- Asilomar, Steinbeck Plaza, Merced and Woodrow had higher average copper concentrations than the other sites in both 2001 and 2002.
- Steinbeck Plaza and Delaware had the highest average zinc concentrations for the past two years.
- Steinbeck Plaza and Lover's Point had the highest average orthophosphate concentrations for all three years.

Toxicity analysis of three different marine organisms indicated that the water from the First Flush was toxic to the test organisms at the majority of sites. Preliminary findings identify high copper and zinc concentrations as possibly contributing to the toxicity. In the statistical analysis, five sites were considered toxic for every organism at every dilution. All of the sites were toxic to the mussels at every dilution. Further investigations to isolate toxic contaminants is warranted.

This event is a testimony to the value of citizen monitoring programs and the valuable information they provide. The data that was collected indicates that there are sites that stand out from the rest with high pollutant concentrations. Each city had at least one site that warrants more investigation and upstream monitoring. The Network Coordinator will work closely with the Coastal Watershed Council and participating cities to evaluate what future monitoring can be done to track sources and reduce the amount of pollutants entering the Bay.

Background

Urban runoff carrying non-point source pollution is the nation's leading threat to water quality. Pollutants may include toxic metals, hydrocarbons, nutrients, suspended solids, and many other chemicals that are detrimental to aquatic life. Urbanization and increases in population directly affect the type of pollution that enters storm drains. Impermeable surfaces such as roads, prevent storm water from soaking into the ground. These surfaces become conduits for pollutants. Some examples include oil and grease that wash off roads, fertilizers and pesticides from lawns, and detergents from car washing and commercial activities.

Kelleen Harter at Central & 13th in PG

It is important to identify pollutants in urban runoff that flow into the Monterey Bay National Marine Sanctuary. In addition, a dry weather monitoring program, called Urban Watch, has been conducted by citizen monitors for the past five years in Monterey, four years in Pacific Grove, one year in Santa Cruz, and two years in Capitola. Volunteers monitor storm drain outfalls twice a month between June and November. The pollution detection kit that is used for Urban Watch was developed according to the National Pollutant Discharge Elimination System (NPDES) Phase 1 dry weather monitoring requirements and is designed to detect illegal storm drain connections and discharges. Because of this program, it is generally known which outfalls commonly discharge urban runoff that contain contaminants and education efforts are under way to reduce the pollutants.

This First Flush event is the finale to the Urban Watch season. The same outfalls are monitored for both programs. First Flush marks the change from the dry weather urban watch season to the beginning of the rainy season. This year was the third time an organized wet weather monitoring was conducted in Monterey and Pacific Grove and the second time in Capitola and Santa Cruz. This is vital information because the heavy rains flush contaminants that have collected on impermeable surfaces during the long dry season. The pollutants are washed into storm drains and subsequently out into the Bay. The samples collected during the First Flush may represent the worst case scenario of the amount of pollutants flowing into the Sanctuary when it rains.

Ross Clark, in Santa Cruz, observing a mountain of bubbles

Methods

The same storm drain outfalls that are regularly monitored by the Urban Watch volunteers were also monitored for this event. Two to four sets of water samples were taken at each of the sites. (see Attachment 1 for more information about the sites).

Monterey	Pacific Grove	Capitola	Santa Cruz
Twin 51's	8th Street	Nob Hill	Delaware
Eldorado (aka Major Sherman)	Central & 13th (aka Greenwood Park)	Mid Nob Hill	Merced
Library	Lover's Point	Capitola Village Bridge	Bay
San Carlos	Pico	Auto Plaza	Woodrow
Steinbeck Plaza	Asilomar		
	Congress		

Every site in all four cities had a designated team and set of equipment. Each team had a team leader responsible for the monitoring equipment and sample bottles. The criteria used for mobilization included sheeting water on the roadways, heavy flow through the storm drain system and conductivity levels around 500 microSiemens (μS). Conductivity measures the amount of ions in the water. Background levels can be greater than 1500 μS at some locations. Measurements below 500 μS indicated that it was the storm water flowing from the outfall and not the typical urban runoff that flows year round.

At the majority of sites, three suites of samples were gathered at 30 minute intervals, observations were made continuously, and changes were recorded. An automated water sampler was deployed at two locations, Woodrow in Santa Cruz and Lover's Point in Pacific Grove. The water samplers were ISCO 2900's (Lincoln, NE) provided by the University of California at Santa Cruz and the Monterey Regional Water Pollution Control Agency. Teams were also at these locations to record physical parameters and document observations.

When the volunteers arrived at their designated site, conductivity measurements were used to indicate if it was indeed storm water runoff flowing from the outfalls. The field data sheet was used by all monitoring teams to follow a standard protocol (See Attachment 2-Field Data Sheet). On station, the volunteers measured conductivity using either an Oakton TDSTester 3 or 4. Water temperature was measured using a spirit bulb thermometer. The pH was measured using Macherey-Nagel non-bleeding pH test strips with a range of 4.5-10. Physical observations such as trash, odor, bubbles, scum, and oil sheen were also recorded on the field data sheet. As the on-site measurements were collected, sample bottles were filled for future analysis in a certified laboratory. The lab analysis included nitrate as nitrogen, orthophosphate as phosphorus, total coliform, *E. coli* (or fecal coliform), zinc, copper, lead, oil and grease, total suspended solids (TSS), and total dissolved solids (TDS) (see Attachment 3 for analytical methods).

Added to the list of laboratory analyses this year was toxicity. Three separate tests were conducted using the bay mussel (*Mytilus galloprovincialis*) 48 hour embryo-larval development test; purple sea urchin (*Strongylocentrotus purpuratus*) 20 minute sperm exposure followed by a 20 minute fertilization period after the eggs were added, fertilization test; and a 7 day topsmelt (*Atherinops affinis*) survival and growth test. Storm water samples were received at the Marine Pollution Studies Laboratory on November 8, 2002. The salinity of the samples was increased to 34 (marine salinity)

using Tropic Marin© artificial sea salts or hypersaline brine produced by freezing filtered seawater. Mussel embryo-larval development tests were initiated immediately. Purple urchin fertilization tests and topsmelt survival and growth tests were initiated on November 12, 2002. The test protocols are described in US EPA 1995, "Short-Term Methods For Estimating The Chronic Toxicity Of Effluents And Receiving Waters To West Coast Marine And Estuarine Organisms".

Quality Assurance/Quality Control

- All volunteers were trained in the use of monitoring equipment and protocols for collecting water samples.
- The conductivity meters were calibrated before being assigned to each team.
- Field data sheets were provided with written instructions on how to complete them so that each team followed the same protocols.
- Each sample had a unique sample identification number.
- Field replicates and container blanks were collected.
- All lab data was reviewed for QA/QC and validated by the Network Coordinator
- % Error for conductivity measurements has not been calculated
- The error range for lab analysis of nutrients was 0- 10% based on the combined accuracy and precision of lab batch QA/QC
- The error range for lab analysis of metals was 0 – 10% for copper and lead and 10% - 20% for zinc based on the combined accuracy and precision of lab batch QA/QC
- All data is tabulated in a CCAMP Excel dB file

Results and Discussion

More than 1.24 inches of rain accumulated as a result of the storm that pelted the Central Coast on November 7, 2002. The rains began earlier in the north so Capitola and Santa Cruz volunteers mobilized at 2:00 AM while Monterey and Pacific Grove volunteers eagerly waited until 5:30 PM for the storm to arrive. In both cases, volunteers were on site and collecting samples as the heavy rain began.

In order to evaluate the data that were collected during this event, it is customary to compare the results to benchmarks that may relate to the beneficial uses of a waterbody. Metal results were compared to the Central Coast Basin Plan Water Quality Objectives for the protection of marine aquatic life. Because there are no numerical water quality objectives in the Basin Plan for total coliform, *E. coli*, nitrate, orthophosphate, TSS, and TDS, those results were compared with the Central Coast Ambient Monitoring Program's (CCAMP) action levels. CCAMP's action levels are benchmarks that are set at levels which may potentially impact beneficial uses, and are typically either levels representing existing regulatory standards, levels derived from the literature or other agency references, or levels which are elevated relative to the data distribution for that parameter on the Central Coast. It is important to note, both Basin Plan water quality objectives and CCAMP action levels are established for receiving waters and NOT for discharge waters. A significant amount of dilution may occur in the receiving water within a short distance of the outfall.

Field Observations

While on site, volunteers documented observations (odors) of bubbles, scum, trash, sewage odor, and oil sheen. Bubbles were observed at 13 of the 19 stations indicating the possible presence of detergents. Seven sites observed trash and no site recorded a sewage odor or oil sheen.

Conductivity measurements ranged from 1200 µS at the Library site to 70 µS in Capitola. Average conductivity measurement in the urban runoff in Monterey and Pacific Grove were greater than 1500 µS (Urban Watch 2002). At the majority of sites, the conductivity measurements started high and declined. Most of the measurements were below 400 µS.

Values for pH were reported between 6.2 and 7.5. Most of the site's pH measurements remained constant through the time series. Woodrow had the lowest pH of 6.2 measured in the laboratory. Steinbeck Plaza and Asilomar reported measurements of 7.5, 7.0, and 6.5 consecutively.

Water temperature measurements were recorded between 12°C (at two locations in Capitola) and 19°C (at Eldorado in Monterey). Eldorado and Mid Nob Hill had water temperatures that increased two degrees during the time series monitoring. At all of the other sites, the measurements remained within one degree of each other.

Nutrients

Nitrogen is an element that is needed for plant growth. It is much more readily available in the environment than phosphorus because nitrate is more soluble than phosphate. Plant growth is generally limited by phosphate, and not nitrate concentrations. Some sources of nitrate include runoff from fertilized lawns, agricultural and pasture lands, construction sites and septic leachate. The action level established by CCAMP for nitrate (NO_3-N) is 2.25 mg-N/l. In the time series all of the sites were well below the action level except for the Library site in Monterey and Woodrow in Santa Cruz. The second sample from the Library site had a nitrate concentration of 7.63 mg-N/l while the first and third samples collected during the time series were 0.19 and 0.44 mg-N/l. Nitrate concentrations typically are lower in large rain events because of dilution. In most cases, nitrate concentrations seemed to increase over time rather than decrease which may suggest that nitrate concentration was diluted during the period of greatest flow (see Figure 1). Over the past three years, average nitrate concentrations were all below the action level at the majority of sites.

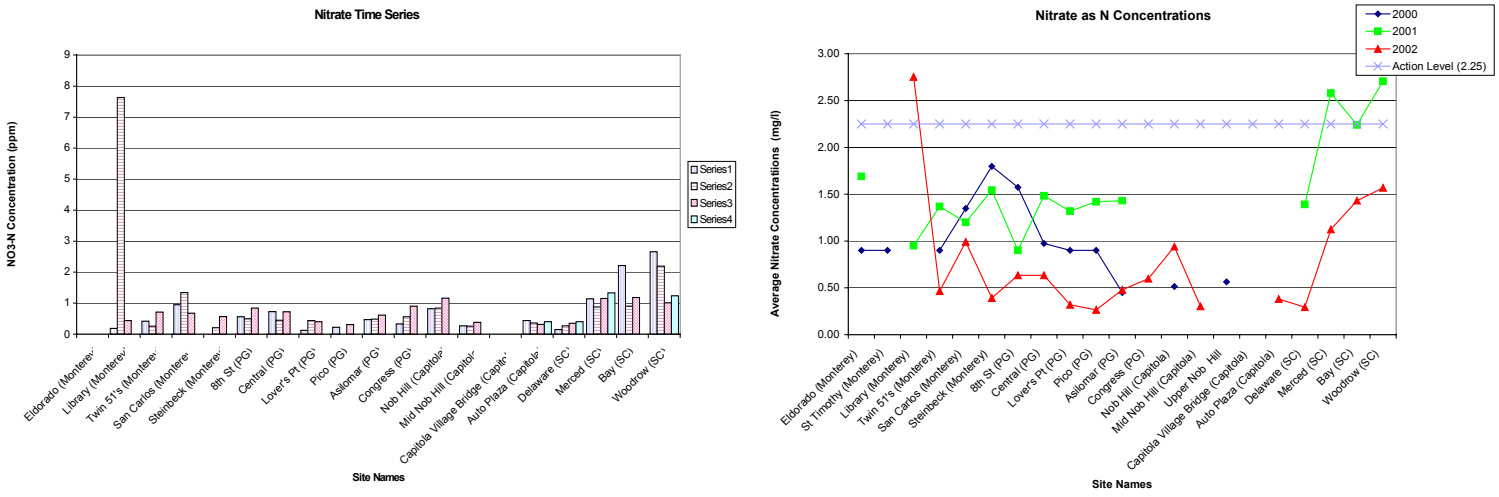

Figure 1. The sites are grouped by city across the bottom. The CCAMP informal action level for nitrate as nitrogen is 2.25 mg-N/l. (1a) Graph of nitrate as nitrogen concentrations in the First Flush 2002 time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (1b) Graph of 3-year trend. Average concentrations are represented.

Phosphorus is an essential element for plant growth. It is usually the growth-limiting factor because it is present in very low concentrations in the environment. Orthophosphate is a form of phosphorus commonly found bound to soil particles, in sewage, fertilizers, and in detergents that contain phosphates. Orthophosphate is rapidly taken up by algae and other larger marine plants. With excessive amounts present, large algal blooms can occur. The CCAMP action level for orthophosphate (PO_4^{3-} -P) is 0.16 parts per million (ppm) or (mg-P/l). All sites in every city exceeded the CCAMP action level at least one time during the time series. Steinbeck Plaza and Lover's Point had the highest concentrations and the most variability between time series samples. Steinbeck Plaza's highest concentration was 3.15 mg-P/l in the first sample and the concentrations decreased to 1.82 mg-P/l and 1.00 mg-P/l. Lover's Point's initial concentration was 2.64 mg-P/l, tapering off to 0.99 mg-P/l and 0.80 mg-P/l. The next highest concentration was 0.62 mg-P/l at the Woodrow site in Santa Cruz. There was not much variability in the concentrations in time series and no observable trends appeared at many of the sites. Steinbeck Plaza and Lover's Point outfalls had the highest levels of orthophosphate during the previous two First Flush events as well (see Figure 2).

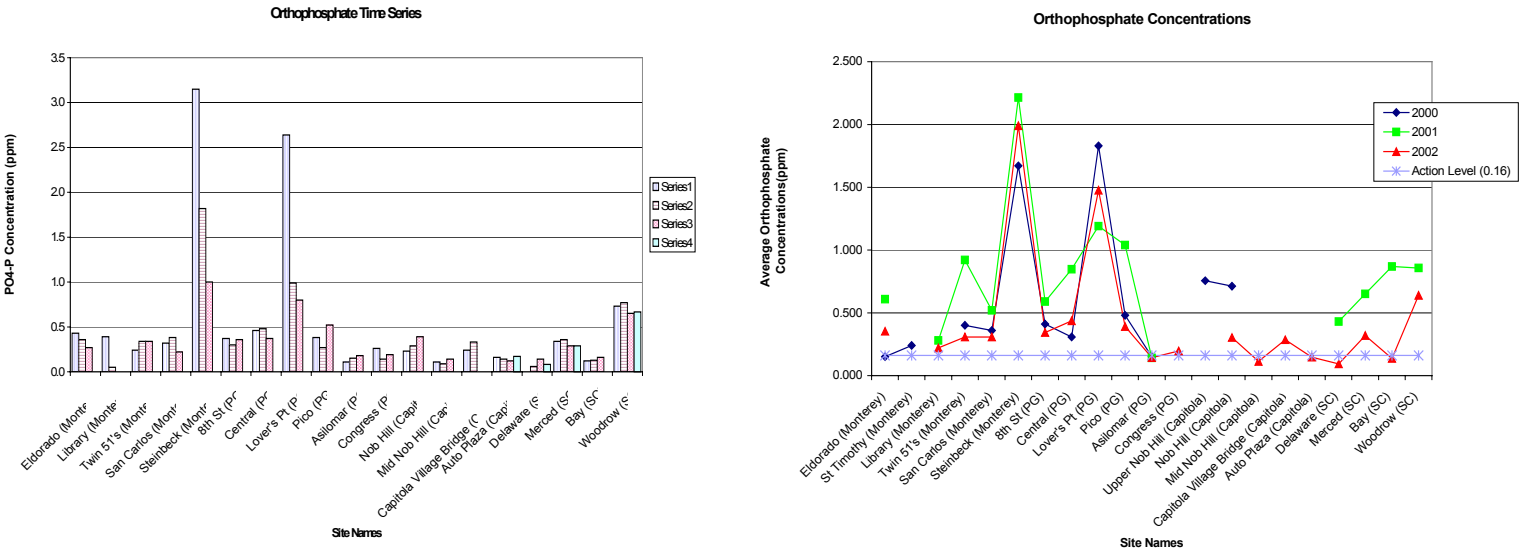

Figure 2. The sites are grouped by city. The CCAMP action level for orthophosphate as phosphorus is 0.16 mg-P/l. (2a) Graph of orthophosphate as phosphorus concentrations in the First Flush 2002 time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (2b) Graph of 3-year trend. Average concentrations are represented.

Bacteria

Total coliform, fecal coliform and *Escherichia coli* (*E. coli)* are types of bacteria. They are pollutants of concern mostly because of their human health effects. *E. coli* is a member of the fecal coliform group which is a part of the total coliform group. The presence of these types of bacteria indicate there could be pathogens present. Pathogens are the organisms that are harmful to both humans and marine organisms. Because of its aquatic effects, the CCAMP action level for total coliform is 10,000 Most Probable Number (MPN)/100 ml. The CCAMP action level for *E. coli* and fecal coliform is the same, 400 MPN/100 ml. *E. coli* and fecal coliform were treated the same in this report for ease of comparison.

Capitola and Santa Cruz samples were analyzed for fecal coliform by the Santa Cruz County Department of Environmental Health. Monterey and Pacific Grove samples were analyzed at the Monterey Regional Water Pollution Control Agency for *E. coli*. All locations exceeded the CCAMP Action level of 400 MPN/100ml. Pico's initial sample contained more than 240,000 MPN/100 ml. This was, by far, the highest concentration at all of the sites. The Library site had the next highest concentration of 155,000 MPN/100 ml. The sites in Capitola and Santa Cruz were substantially lower than Monterey and Pacific Grove sites. There did not appear to be any pattern in the time series (see Figure 3).

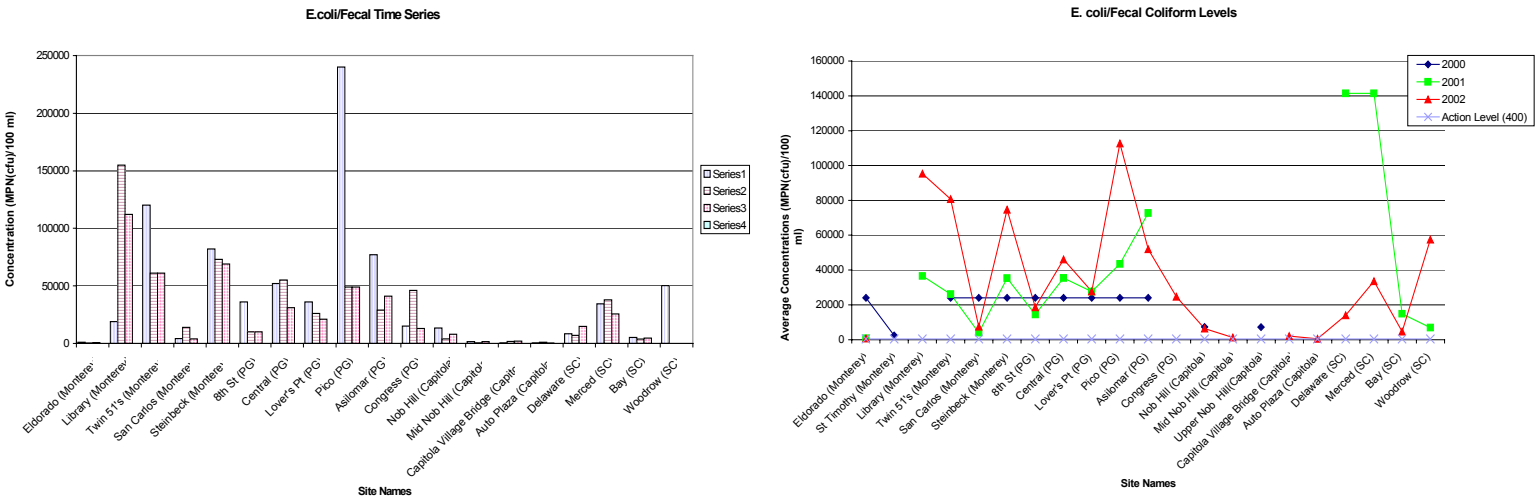

Figure 3. The sites are grouped by city. Santa Cruz and Capitola values represent fecal coliform (cfu/100 ml); Monterey and Pacific Grove are for E.coli (MPN/100 ml). (3a) The first column (Series 1) represents the first sample of the time series and each subsequent column represents the following time series samples, usually taken 30 minutes apart. (3b) Average concentrations for the past 3 First Flush events.

Metals

Storm water runoff in coastal urban areas has been known to produce significant toxicity to early life stages of aquatic organisms due to the presence of trace metals. The effects include reduced reproduction, developmental deformities, and mortality. In this monitoring event, samples were analyzed for zinc (Zn), copper (Cu), and lead (Pb). The California Basin Plan has established water quality criteria for these metals.

The background concentration for zinc (Zn) in sea water on the Central Coast is 8 parts per billion (ppb) or micrograms per liter (µg/l). The Basin Plan water quality objective for Zn is 200 µg/l. Zinc concentrations in the First Flush ranged from 40 – 1000 µg/l. All of the sites in all four cities, except for Woodrow in Santa Cruz, exceeded the Basin Plan objective at least once in the time series. Three sites in Monterey (Eldorado, Twin 51's, and Steinbeck), Capitola Village Bridge and in Santa Cruz, Delaware and Merced had concentrations close to or exceeding 800 µg/l. Steinbeck Plaza's first time series sample reported the highest concentration of 1000 µg/l. Most of the site's initial sample had the highest concentration. Interesting to note, at Delaware in Santa Cruz, the zinc concentration spiked to 750 µg/l one hour and 45 minutes after the first sample was taken. Eldorado, Steinbeck Plaza and Delaware have had the average highest concentrations for the last two First Flush events (see Figure 4).

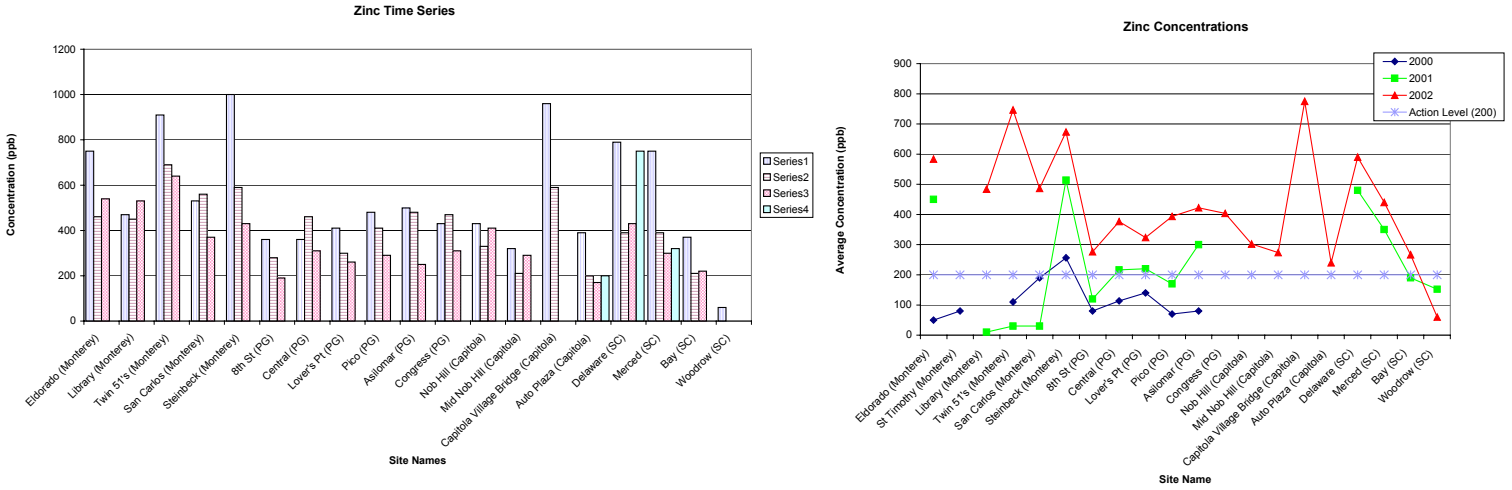

Figure 4. The sites are grouped by city. The Basin Plan Water Quality Objective for zinc is 200 µg/l. (4a) Graph of zinc concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (4b) Graph of 3-year trend. Average concentrations are represented.

The background concentration for Cu in sea water is 2 µg/l . Copper concentrations in storm water samples ranged from 30 – 340 µg/l. The Basin Plan standard established for Cu is 30 □g/l (ppb). All of the sites in every city exceeded the Basin Plan objective of 30 µg/l for copper. The majority of sites showed a pattern of the highest concentration occurring during the first sample of the time series. Two sites stood out from the rest with copper concentrations of 340 µg/l. They were Asilomar in Pacific Grove and Merced in Santa Cruz. Asilomar's second and third time series concentrations remained high at 280 µg/l and 160 µg/l while Merced's second and third samples dropped dramatically to 90 µg/l and 60 µg/l. Monterey sites were consistently higher than the other three cities averaging greater than 100 µg/l. Asilomar's average copper concentrations were the highest of all the sites in both 2001 and 2002 (see Figure 5).

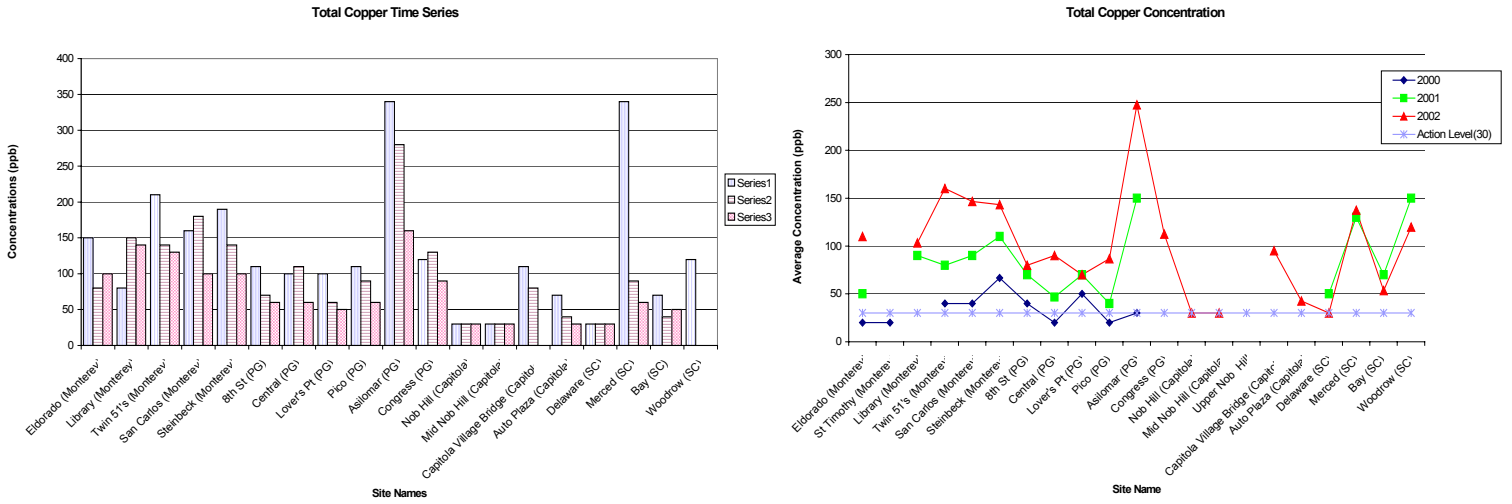

Figure 5. The sites are grouped by city. The Basin Plan Water Quality Objective copper is 30 µg/l. (5a) Graph of copper concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (5b) Graph of 3-year trend. Average concentrations are represented.

Lead (Pb) concentrations ranged from 10 - 92 µg/l. The Basin Plan water quality objective for lead is 30 µg/l. Eleven of the 19 sites exceeded the Basin Plan objective of 30 µg/l at least one time during the time series. The values were very erratic both in concentrations and in pattern. Capitola Village had the highest concentration measuring 92 µg/l in the first sample and dropped to 20 µg/l in the second time series sample. The other three Capitola sites had very low lead concentrations in the first time series and non-detect in the second and third samples. Pacific Grove had the most sites with high lead concentrations. All of the sites except for Lover's Point had values that were two times higher than the Basin Plan objective. Asilomar's average lead concentration has been the highest in all of the cities for all three years (see Figure 6).

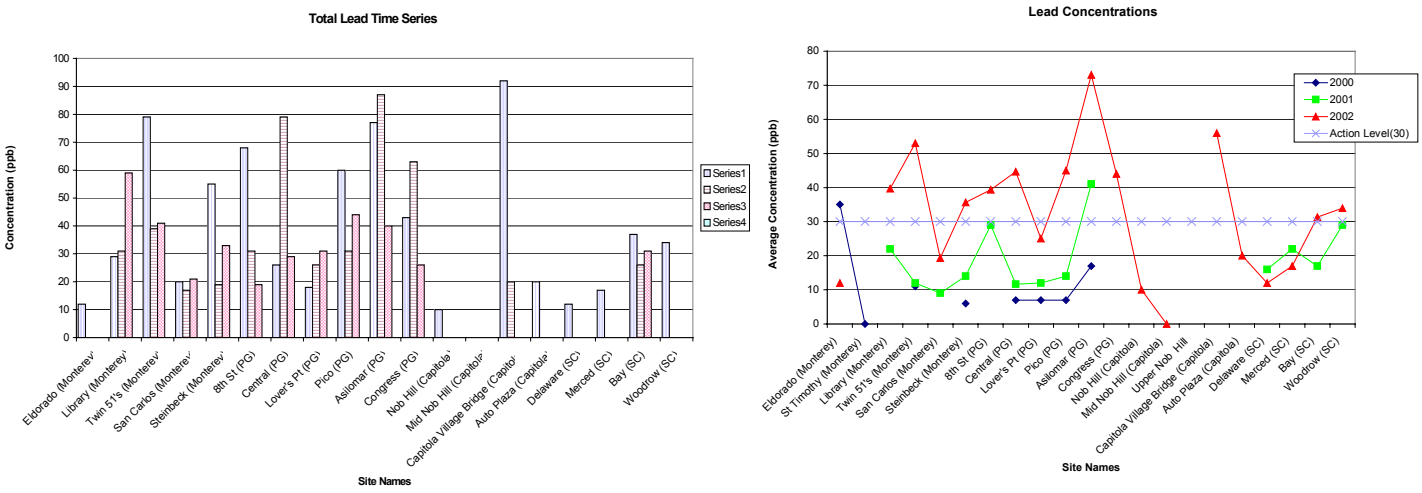

Figure 6. The sites are grouped by city. The Basin Plan Water Quality Objective for lead is 30 µg/l. (6a) Graph of lead concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (6b) Graph of 3-year trend. Average concentrations are represented.

Oil and Grease

Nine of the nineteen sites had samples that contained oil and grease. All were in the range of 5 to 8.3 mg/l. In five of the nine samples, the oil and grease was detected in the first sample taken. No oil sheen was reported on any of the field data sheets. Some volunteers wrote that it was too dark to tell if sheen was present or not (see Figure 7). There was no oil and grease detected in laboratory analysis for First Flush 2001. In 2000, just two sites in Pacific Grove reported concentrations of less than 5.0 mg/l.

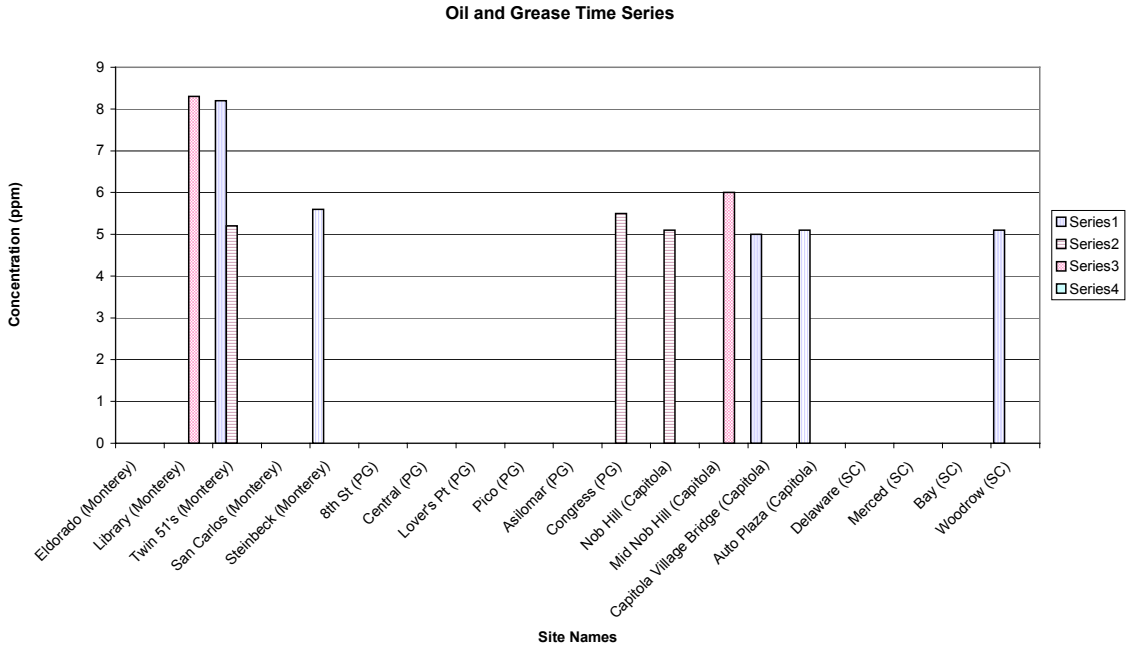

Figure 7. Graph of oil and grease concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. The sites are grouped by city. There is no numerical CCAMP action level for oil and grease.

Total Suspended Solids(TSS)

Total suspended solids (TSS) are important to measure because the suspended solids carry pollutants. The suspended solids provide a media or polar charge to attract contaminants. High amounts of sediment are present are harmful to fish populations because they destroy habitat, can suffocate eggs, and/or limit the food supply. It also may clog gills or impair an organism's vision when feeding.

Five sites had TSS measurements exceeding the CCAMP action level of 500 mg/l. The highest TSS measurement was the second sample taken at Asilomar with a concentration of 820 mg/l. Mid Nob Hill's third sample had a concentration of 721 mg/l. There was no pattern or consistency in the TSS concentrations (see Figure 8). Over the past three years, Asilomar has had the highest average concentration of all the sites.

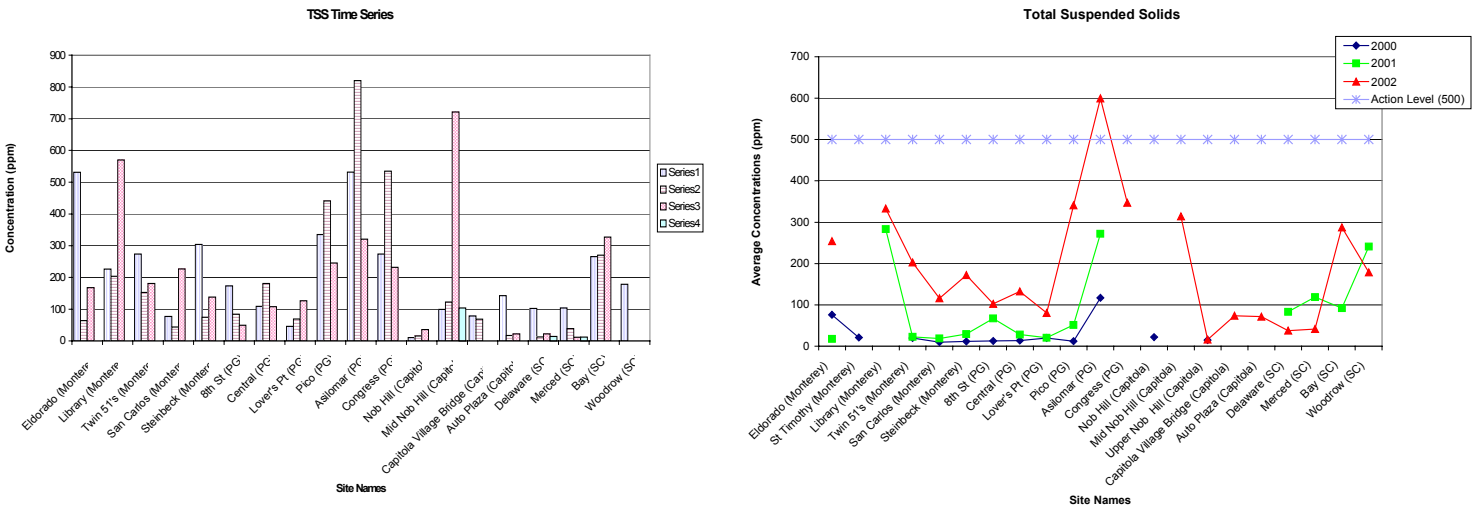

Figure 8. The sites are grouped by city. The CCAMP action level for TSS is 500 mg/l. (8a) Graph of total suspended solid concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (8b) Graph of 3-year trend. Average concentrations are represented.

Total Dissolved Solids (TDS)

Total dissolved solids are a measurement of the amount of dissolved solids in a sample of water. These solids are usually ions of salts such as sodium, chloride, calcium, carbonate, potassium, or magnesium. These dissolved ions are conductors of electricity and therefore the results can be compared to conductivity measurements taken with the pocket meter.

All of the total dissolved solids (TDS) samples were well below the CCAMP action level of 1000 mg/l. The Library had the highest concentrations with the first sample measuring 560 mg/l, second sample 430 mg/l and the final sample jumped back up to 558 mg/l. Woodrow reported a concentration of 470 mg/l. Most other Santa Cruz and Capitola samples were less than 100 mg/l. In general, Capitola and Santa Cruz sites (except for Woodrow) reported lower TDS values than Monterey and Pacific Grove sites (see Figure 9).

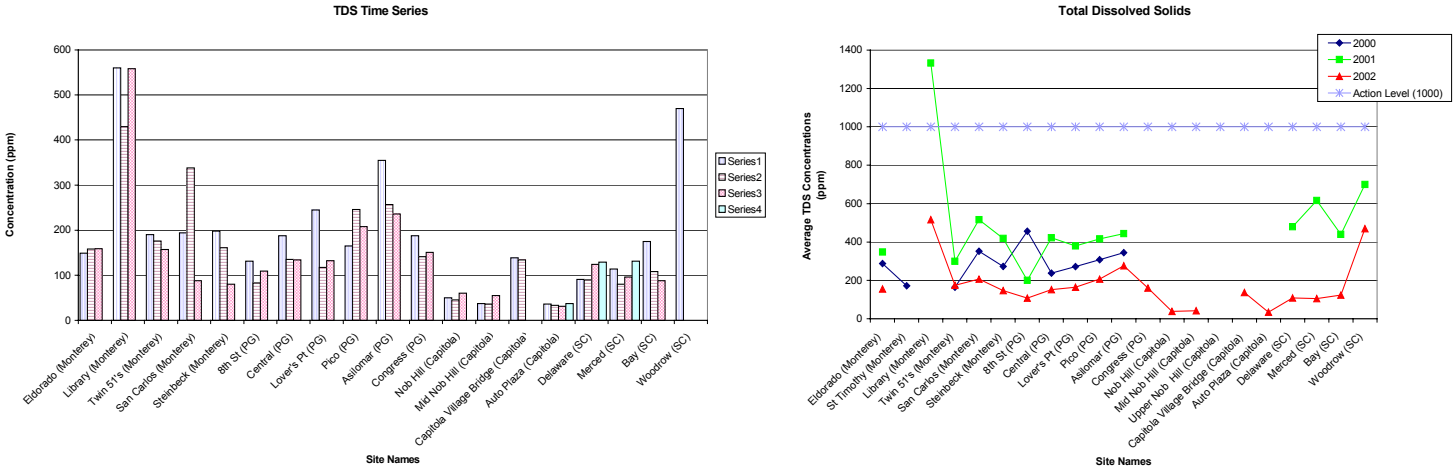

Figure 9. The sites are grouped by city. The CCAMP action level for TDS is 500 mg/l. (9a) Graph of total dissolved solid concentrations in a time series. The first column (Series 1) represents the first sample taken and each subsequent column represents the time series samples, usually taken 30 minutes apart. (9b) Graph of 3-year trend. Average concentrations are represented.

Toxicity
Toxicity tests were conducted on three different types of marine organisms; each test with varied results.

Purple Sea Urchin Test A 20 minute sperm exposure followed by a 20 minute fertilization period after the eggs were added, fertilization test was conducted. Because purple sea urchin (*Strongylocentrotus purpuratus*) gametes are sensitive to artificial salts, hypersaline brine was used to adjust the salinity. The brine dilutes the sample; therefore only 25% and 50% dilutions were tested. At the lowest dilution, greater than 60% fertilization occurred in every sample except for the Eldorado site in Monterey, which demonstrated 48% fertilization. At the 50% dilution, nine of the fifteen sites demonstrated fertilization rates greater than 60%. Four sites were in the range of 20% fertilization. San Carlos in Monterey experienced 18% fertilization, while Woodrow reported 5% fertilization.

Bay Mussel Test Dilutions of 25%, 50% and full strength concentrations were used in the bay mussel (*Mytilus galloprovincialis*) 48 hour embryo-larval development test. In the 25% dilution, five sites met or exceeded 40% survival. These sites included Pico and Asilomar in Pacific Grove and Merced, Delaware, and Bay in Santa Cruz. At three sites, survival was below 14%. No survival occurred at Twin 51's, San Carlos, 8th, Central, Lover's Point, Auto Plaza and Woodrow. In the 50% dilution, Bay reported a survival rate of 48%. There was no survival at any other site. At full strength, there was no survival.

Topsmelt Test In the 7 day topsmelt (*Atherinops affinis*) survival and growth test, samples were tested at full strength only. Twelve sites exceeded 60% survival. Woodrow had a 48% survival, and Steinbeck Plaza had a 16% survival. There was no survival at Eldorado.

A statistical analysis was run by the Marine Pollution lab personnel to determine whether a site was considered "toxic" or not. The toxicity threshold has two criteria. The first is that the response in the sample has to be significantly different from the response in the control. Significant difference is determined with a separate variance t-test. The second criterion is the response in the sample (expressed as a percent of the control) has to be less than the minimum significant difference (MSD, expressed as a percent of the control) for that organism. For topsmelt and mussels it is 80% and for urchin fertilization it is 88%. The table below shows whether the site was statistically considered "toxic" or not.

Table 1. Statistical analysis of toxicity at each site for the three different test organism and corresponding dilutions. A "yes" indicates the sample was toxic, a "no" indicates the sample was not toxic.

Station Name	topsmelt (no dilution)	mussels (no dilution)	mussels (50% dilution)	mussels (25% dilution)	sea urchin (50% dilution)	sea urchin (25% dilution)
Eldorado	YES	YES	YES	YES	YES	YES
Library	YES	YES	YES	YES	YES	NO
Twin 51's	NO	YES	YES	YES	YES	YES
San Carlos Beach	YES	YES	YES	YES	YES	YES
Steinbeck Plaza	YES	YES	YES	YES	YES	YES
8th St	NO	YES	YES	YES	YES	NO
Central & 13th	NO	YES	YES	YES	YES	NO
Lover's Point	NO	YES	YES	YES	YES	YES
Pico	NO	YES	YES	YES	YES	YES
Asilomar	NO	YES	YES	YES	NO	NO
Auto Plaza	NO	YES	YES	YES	NO	YES
Delaware	NO	YES	YES	YES	YES	YES
Merced	NO	YES	YES	YES	YES	YES
Bay	NO	YES	YES	NO	NO	NO
Woodrow	YES	YES	YES	YES	YES	YES

Conclusions

This was the third annual First Flush monitoring event in the Monterey Bay area. With all of the external factors and uncertainty that accompany not knowing when the first big storm of the season is going to arrive, this event went amazingly well. There were enough volunteers available to monitor all nineteen sites in four cities. While every site potentially has its own "microclimate" and drainage features, we feel strongly that water samples were collected within the first hour of the storm, and in some locations, the first 15 minutes of the storm. Because of the different drainage characteristics and the logistics of mobilizing volunteers, a variation of sampling times occurred during the storm. This is an additional benefit of collecting time series samples at every site. The ability to have three sets of samples at one site, collected over 1 ½ to 2 hours, gives more reliability and comparability to the data. The values reported in this document are representative of what was in the water flowing into the Monterey Bay National Marine Sanctuary during the First Flush of 2002.

The results of the laboratory analysis indicated that concentrations of most of the parameters were higher this year than in previous years. More rain this year than other years is likely responsible for higher metals, oil and grease, TSS, and bacteria and lower nitrate concentrations because of dilution. All of the sites in every city exceeded the Basin Plan Water Quality Objective for copper and zinc in receiving waters. Eleven of 19 sites exceeded the same objective for lead. *E. coli* values were much higher this year in Monterey and Pacific Grove than in Santa Cruz and Capitola. Nitrate concentrations were the lowest in three years but this may be due to the fact that this was a larger storm. Nitrate dilutes in water so it is common to see lower concentrations in heavier flows. Orthophosphate levels were down from last year but still exceeded the CCAMP action level at every site. All of the Monterey and Pacific Grove sites have exceeded the orthophosphate action level for all three years.

Toxicity analysis of three different marine organisms indicated that the water from the First Flush was toxic to the test organisms. Preliminary findings indicate high copper and zinc concentrations may have been the primary cause of mussel and urchin toxicity. The effects thresholds for mussels are about 10 μg/L for copper and about 170 μg/L for zinc. Total metal concentrations far exceeded this threshold. In the statistical analysis, five sites were considered toxic for every organism at every dilution. All sites were toxic to the mussels at every dilution.

There are sites that stand out from the rest with high pollutant concentrations. Each city had at least one site that warrants upstream monitoring. In Monterey, the Steinbeck Plaza drainage should be further investigated; in Pacific Grove, Asilomar; in Capitola, the Capitola Village Bridge, and in Santa Cruz, Woodrow. It is time to take further actions to determine the causes of these high concentrations. The cities may use this data in their illicit discharge programs to investigate where the pollutant loading may be coming from. The Marine Pollution lab, with funding from the SWRCB, hopes to follow up with Toxicity Identification Evaluations (TIEs) at some of the more toxic sites. Using the TIE procedures, we should be able to characterize, and possibly identify, the causes of the toxicity. This monitoring event and report, along with more community outreach may help to educate the general population that our actions do contribute to the quality of the water flowing off our streets. The information that we have gained as a result of the dedicated citizens who gathered this data will be used to identify sources of pollution and in the long term, help to improve the quality of the water flowing into the Sanctuary.

Attachment 1

Station Name	Station ID	Drainage Area (acres)	Primary Land Use	Description	Location	Receiving Water
Nob Hill (Capitola)	CSD1				Sample at left bank drain from parking lot and loading areas behind Nob Hill Market and Longs Drugs	Creek
Auto Plaza (Capitola)	CSD3				Sample right bank outfall with dissipater draining Auto Plaza Road	Creek
Capitola Village Bridge (Capitola)	CSD4				Sample at the right bank drain at base of NW end of bridge at corner of Cliff Dr. and Warf Dr.	Creek
Mid Nob Hill (Capitola)	CSD5					Creek
Eldorado (aka Major Sherman) (Monterey)	MSD1		80% residential 20% commercial	Drainage ditch	Intersection of Major Sherman Lane Eldorado Street	Lake
Twin's (Monterey)	MSD3	365	90% residential 10% commercial	Two 51' diameter concrete pipes	Below walking path at Heritage Harbor-adjacent to Wharf I, west ~500ft.	Ocean
San Carlos (Monterey)	MSD4	70	40% commercial 35% residential 25% public land	36' diameter concrete pipe	On the beach adjacent to the west side of Coast Guard pier.	Ocean
Steinbeck (Monterey)	MSD5	37	90% commercial 10% residential	36' diameter concrete pipe	At Steinbeck Plaza on Cannery Row at the end of Prescott Street	Ocean
Library (Monterey)	MSD6	467	100% residential	Drainage ditch	665 Pacific Street adjacent to the Monterey Public Library on the Northeast side of Pacific Street.	Ocean

8th Street (Pacific Grove)	PGSD1	35	100% residential	Concrete pipe	West of Ocean View Blvd. between 7th and 8th.	Ocean
Central & 13th (aka Greenwood) (Pacific Grove)	PGSD2	250	90% residential 10% commercial	Concrete pipe	Greenwood Park at the corner of 13th and Central Ave.	Ocean
Lover's Pt (Pacific Grove)	PGSD3	222	90% residential 10% commercial	Concrete pipe	At the top of the cliff on the SE side of main beach at Lover's Pt	Ocean
Pico (Pacific Grove)	PGSD4	131	100% residential	Concrete pipe	On the W side of Sunset Drive approx. 60 ft. N of Pico St.	Ocean
Asilomar (Pacific Grove)	PGSD5	94	90% residential 10% commercial	Drainage ditch	On the W side of Sunset Drive due W of the Asilomar Convention Ctr.	Ocean
Delaware (Santa Cruz)	SCSD1	352	90% residential 5% commercial 5% open space	Concrete pipe	On S side of W. Cliff Dr. at Monterey St.	Creek
Merced Ave (Santa Cruz)	SCSD2	1289	40% residential 10% commercial 50% open space	Concrete pipe	On S. side of W. Cliff Dr. at Merced Ave.	Ocean
Bay Street (Santa Cruz)	SCSD3	285	95% commercial 5% residential	Surface drainage	On S side of W. Cliff Dr. at Bay St.	Creek
Woodrow (time series) (Santa Cruz)	SCSD4	736	80% residential 10% commercial 10% open space	Surface drainage	On S side of W. Cliff Dr. at Woodrow Ave.	Ocean

Attachment 2a

Monterey Bay National Marine Sanctuary

First Flush 2002

Field Data Sheet

Date:			
City		**Arrival Time**	
Station ID		**Departure Time**	
Time Rain Began		**Station Name**	

Team Members with phone #'s

1	**4**
2	**5**
3	**6**

Detailed description of weather:

Field Measurements:

Instrument ID:	**Time**		**Parameter**	**Taken by:**
		H20 Temp	**F or C**	
		pH		
		Conductivity	**□S**	
		Transparency	**cm**	

Notes (include any observations from back side, ie. types of trash, biological observations, etc.

Attachment 2b

Time Series Data			Station ID							
			(answer yes or no to the observations below)					FLOW (cm)		
Time	Conductivity (µS)	Murkiness	Rain	Trash	Sewage	Oil Sheen	Bubbles/ Scum	Velocity (gpm)	Depth (cm)	Width (cm)

Sample Collection:

Sample ID	Time	Collected by:	Container Type
			glass amber - O&G
			clear 100 ml - bacteria
			sq. white plastic - metals
			sq. white plastic - nutrients
			clear 1 L w/handle - TDS/TSS
			clear glass wide mouth - toxicity
			clear glass wide mouth - toxicity
			clear glass wide mouth - toxicity
			clear glass wide mouth - toxicity
			clear glass wide mouth - toxicity
			clear glass wide mouth - toxicity

Duplicates or blanks collected: Yes or No

Sample Custody:

Relinquished By: **Date /Time** **Received By:** **Date/Time**

Attachment 3

METHODS USED IN THE FIRST FLUSH 2002 SAMPLING EVENT

	Constituent	Detection Limits	Units	Laboratory	Method #	Method Principles
Field Measurements						
	Conductivity	10	µS	Field		Electrodes
	Water Temp.	- 5	°C	Field		Spirit bulb
	pH	4.5		Field		Non-bleeding test strips
Nutrients						
	Nitrate as N	0.05	mg/l	Monterey Bay Analytical	EPA 300.0	
	Orthophosphate as P	0.05	mg/l	Monterey Bay Analytical	EPA 300.0	
Bacteria						
	Total coliform	1	MPN/100 ml	MRWPCA	Colilert	Chromogenic Substrate
	E. coli	1	MPN/100 ml	MRWPCA	Colilert	Chromogenic Substrate
	Total coliform	1	cfu/100 ml	SC Cty Dept of Env. Health	Standard Methods for the Examination of Water and Wastewater	Membrane filtration
	fecal coliform	1	cfu/100 ml	SC Cty Dept of Env. Health	Standard Methods for the Examination of Water and Wastewater	Membrane filtration
Total Metals						
	Zinc	20	µg/l	Monterey Bay Analytical	SM3111B	acid digestion, AA flame
	Copper	20	µg/l	Monterey Bay Analytical	SM3111B	acid digestion, AA flame
	Lead	10	µg/l	Monterey Bay Analytical	SM3113B	acid digestion, graphite furnace
WQ parameters						
	Oil&Grease as HEM	5	mg/l	Monterey Bay Analytical	EPA 1664	Gravimetric: liquid-liquid extraction with Hexane, volatilization of solvent, weighing of residue
	total suspended solids (TSS)	10	mg/l	MRWPCA	SM2540D	Gravimetric: filtration thru 1.1um, glass fiber drying and weighing of particulates
	total dissolved solids (TDS)	10	mg/l	MRWPCA	SM2540C	Gravimetric: drying and weighing of 1.1um filtrate