



**Monterey Bay Sanctuary Citizen Watershed Monitoring Network**  
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# **2006 Dry Run & First Flush Monitoring Report**

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**Made Possible by:**

**Monterey Bay National Marine Sanctuary; California State Coastal Conservancy; Santa Cruz County; San Mateo County; Cities of Santa Cruz, Capitola, Seaside, Monterey, and Pacific Grove; Save the Whales through a B-WET grant; Coastal Watershed Council; Monterey Bay Sanctuary Foundation; Monterey Regional Water Pollution Control Agency; Sewer Authority Mid-Coastside, Gulf of the Farallones National Marine Sanctuary**

### **Executive Summary**

Since 1997, teams of citizen monitors have been collecting urban runoff water quality data in the Monterey Bay area through the Urban Watch and First Flush programs. Storm drain water monitoring provides valuable information about water quality flowing into the Monterey Bay National Marine Sanctuary that is not typically collected through traditional monitoring programs. Therefore, the 10 years of data collected by citizen volunteers is the area's primary source of urban runoff pollution information. It helps to establish trends, identify problem areas, and establish a baseline data set for future use. Ultimately, these programs will be used to provide feedback on current urban runoff control efforts.

On September 30<sup>th</sup>, a Dry Run (DR) monitoring event took place in preparation for First Flush (FF) in the cities of Santa Cruz, Capitola, Seaside, Monterey, and Pacific Grove. Besides providing training for volunteers, similar samples were collected at the Dry Run event as the First Flush event; this allowed for a comparable analysis of pollutant concentrations in dry weather months. Half Moon Bay, Seaside, and most of the Capitola sites were dry and no sampling was conducted.

### **Dry Run Range of Results<sup>1</sup>**

conductivity (420 – 1800 $\mu$ S)	Escherichia coli ( <i>E. coli</i> ) (<20 - 20,529 MPN/100ml)
pH (6.5 – 7.5)	Enterococcus (not measured)
total copper (<20 $\mu$ g/l)	total coliform (86 – 120, 980 MPN/100ml)
total lead (<5 $\mu$ g/l)	nitrate as N (0.16 – 4.71 mg-N/l)
total zinc (<20 – 27 $\mu$ g/l)	orthophosphate as P (<0.05 – 0.38 mg-P/l)
total suspended solids (TSS) (<5 – 33 mg/l)	urea (<10 – 485 $\mu$ g/l)

The First Flush occurred on four different occasions in 2006. The first cities to mobilize were Half Moon Bay and Santa Cruz on October 4<sup>th</sup>. Capitola mobilized on November 2<sup>nd</sup>. Pacific Grove and the western-most sites in Monterey mobilized on November 3<sup>rd</sup>. Finally, on November 11<sup>th</sup> the Library, Eldorado and Del Monte sites in Monterey as well as the two Seaside sites were monitored. Even though the rain showers were scattered, approximately 0.15 inches of rain had fallen when the teams mobilized.

### **First Flush Range of Results<sup>1</sup>**

conductivity (20 – 1200 $\mu$ S)	Escherichia coli ( <i>E. coli</i> ) (1336 – 241,960 MPN/100ml)
pH (6.5 – 7.5)	Enterococcus (202 – >241,960 MPN/100ml)
total copper (11 – 147 $\mu$ g/l)	total coliform (120,333 - >241,960 MPN/100ml)
total lead (<5 – 30 $\mu$ g/l)	nitrate as N (0.5 – 2.67 mg-N/l)
total zinc (32 – 724 $\mu$ g/l)	orthophosphate as P (<0.05 – 10.4 mg-P/l)
total suspended solids (TSS) (3.3 – 408 mg/l)	urea (42 – 5210 $\mu$ g/l)

<sup>1</sup> All of the sites (see Attachment 1 for more information) were monitored for the parameters listed. Beside each parameter in parenthesis is the range of concentrations that were detected during each of the events. Units are represented as milligrams per liter (mg/l), micrograms per liter ( $\mu$ g/l), Most Probable Number per 100 milliliters (MPN/100ml), and micro Siemens ( $\mu$ S).

## **Introduction**

Volunteer monitoring programs have become an increasingly popular way for jurisdictions to characterize the water flowing from the many storm water and dry season urban runoff collection outfalls that discharge directly into the Monterey Bay National Marine Sanctuary (MBNMS). Citizen volunteers play a vital role in helping agencies assess water quality and other resources. In 1997, the Coastal Watershed Council (CWC) recognized this fact and created the Urban Watch (UW) volunteer monitoring program. To date, this program in partnership with the MBNMS and local cities has collected 10 years of data characterizing the quality of water flowing from storm drain outfalls from June through October. In 2000, the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (Network) started the First Flush (FF) volunteer monitoring program as a way to characterize storm drain runoff into the MBNMS during the first large storm of the season.

## **Methods**

The DR is a discrete sampling event that is intended to be a comparison of the dry season outfall flow and flow from outfalls during the first major rain event. FF includes three discrete time series sampling at outfalls during this first significant rain event. Every site had a designated team and a set of equipment. On each team, a team leader was responsible for coordinating their team, monitoring equipment and sample bottles. At each site, three sets of measurements and water samples were taken.

Many of the same volunteers in the UW program volunteer for FF. However, since the methods used are different, separate trainings were conducted in each city for the FF event. In addition to the FF classroom training, the “Dry Run” was conducted on a specified day in which volunteers met at a designated outfall in each city and learned the procedures in the field. Samples were collected and measurements recorded at every outfall with flowing water. The Dry Run occurred on September 30<sup>th</sup> in Santa Cruz, Capitola, Seaside, Monterey, and Pacific Grove.

Leading up to the FF event, the Network and CWC Coordinators closely monitored the weather, notifying volunteers early of approaching storms. When a storm had the potential to generate enough rainfall for the event, the Coordinators placed the volunteers on standby until the mobilization criteria were met. Mobilization criteria included sheeting water on roadways, heavy flow through the storm drain system and conductivity levels less than 1000 microSiemens ( $\mu\text{S}$ ) and declining. Since conductivity measures the amount of ions in the water, low conductivity measurements indicate rainfall runoff as opposed to typical dry weather runoff. Samples were collected at 30 minute intervals and visual observations were noted continuously.

The field data sheet was used by all monitoring teams in order ensure consistent information was collected and documented (See Attachment 2). Volunteers measured conductivity using either an Oakton ECTester 3 or 4. Water temperature was measured using a spirit bulb thermometer. 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 later analysis at a certified laboratory. Lab analysis included nitrate as nitrogen, orthophosphate as phosphorus, total coliform, *E. coli*, enterococcus, total zinc, total copper, total lead, hardness, total suspended solids (TSS) and total dissolved solids (TDS). Additionally, one composite sample for oil and grease, and at least one urea sample were also analyzed in each city (See Attachment 3 for Analytical Methods).

### **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.
- Standardized 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 Quality Assurance/Quality Control (QA/QC) and validated by the Network Coordinator
- All data and meta-data is stored in an Access database file.

### **Results and Discussion**

Since no regulatory standards exist currently for storm water discharges, results were evaluated using receiving water standards established by the Central Coast Regional Water Quality Control Board. Receiving water standards are target ambient concentrations for a given water body such as a stream, lake or ocean. They are not designed for end-of-pipe applications such as this. However, lacking any other standard, they serve as the only means by which perspective can be provided for the results.

Metal results were compared to the Central Coast Basin Plan Water Quality Objectives (WQO) 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, and total suspended solids (TSS), those results were compared with the Central Coast Ambient Monitoring Program's (CCAMP) attention levels. CCAMP's attention levels are benchmarks that are set at levels for receiving water concentrations at which pollutants may impact cold-water fish or human health. These are typically either levels representing existing regulatory standards, levels derived from the literature or other agency references, or levels that are elevated relative to the data distribution for that parameter on the Central Coast. It is important to note that both Basin Plan water quality objectives and CCAMP attention levels are established for receiving waters and NOT for discharge waters, and a significant amount of dilution usually occurs in the receiving waters within a short distance of each outfall.

### **Nutrients**

Nitrogen and phosphate are elements needed for plant growth. Sources of **nitrate** include runoff from fertilized lawns, agricultural and pasture lands, construction sites and septic and sewer system leachate. The attention level established by CCAMP for nitrate (NO<sub>3</sub>-N) is 2.25 mg-N/l.

During the DR, most sites reported nitrate concentrations below the CCAMP attention level, except for two sites in Monterey which were San Carlos at 3.92 mg-N/l and Steinbeck at 4.71 mg-N/l, and two sites in Santa Cruz, Merced at 3.87 mg-N/l and Woodrow at 2.41 mg-N/l.

During the First Flush, most sites were below the attention level except for Arroyo Seco in Santa Cruz which reported a concentration of 2.67 mg-N/L collected during the first time series. Nitrate concentrations are typically lower in large rain events because of dilution. Over the past seven years, the nitrate concentrations averaged below the attention level at the majority of sites (see Figure 1).

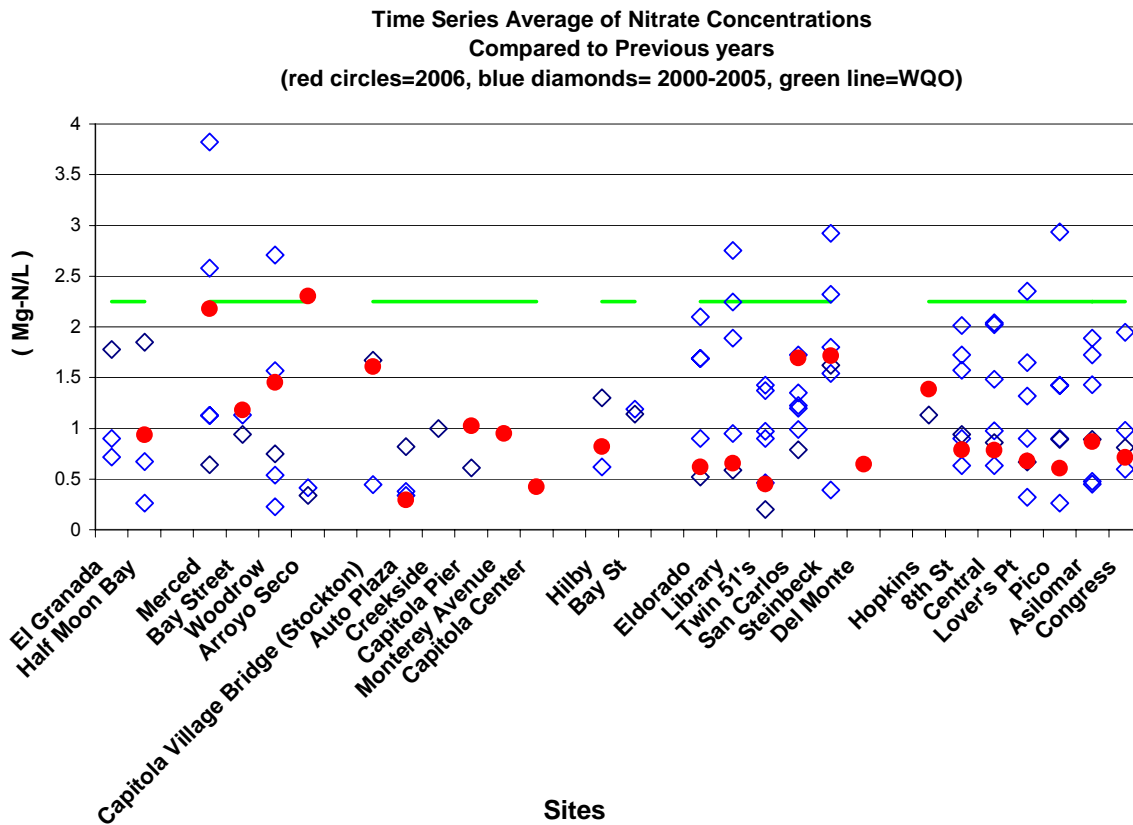


Figure 1. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP informal attention level as nitrogen is 2.25 mg-N/L. Graph of 7-year trend. Average First Flush time series concentrations are represented.

Phosphorus is an essential element for plant growth, affecting it in low concentrations. **Orthophosphate** is a form of phosphorus commonly found bound to soil particles, in sewage, fertilizers, and in detergents that contain phosphates. In aquatic systems, orthophosphate is rapidly taken up by algae and aquatic plants. With excessive amounts present, large algal blooms can occur which can lead to degraded water quality conditions

toxic to aquatic life. The CCAMP attention level for orthophosphate ( $\text{PO}_4\text{-P}$ ) is 0.12 mg-P/l.

During the DR, just three sites reported detections for orthophosphate. Of these three sites, two sites in Monterey reported concentrations over the WQO: Twin 51's at 0.35 mg-P/l and Steinbeck, at 0.38 mg-P/l.

During FF this year, Capitola Center had the highest concentrations of orthophosphate, with a time series average of 6.7 mg-P/l. Steinbeck Plaza, which had the highest concentrations last year, came in second with an average of 3.0 mg-P/l. Of the 25 sites measured for orthophosphate, only 5 were under the CCAMP attention level of 0.12 mg-P/l. In the first five years of the program, all of the Monterey and Pacific Grove sites exceeded the attention levels. Last year, Eldorado, Library, and Asilomar did not. This year, Eldorado, Library, and Del Monte did not; however, Asilomar was back over the attention level with an average concentration of 0.3 mg-P/l (see Figure 2).

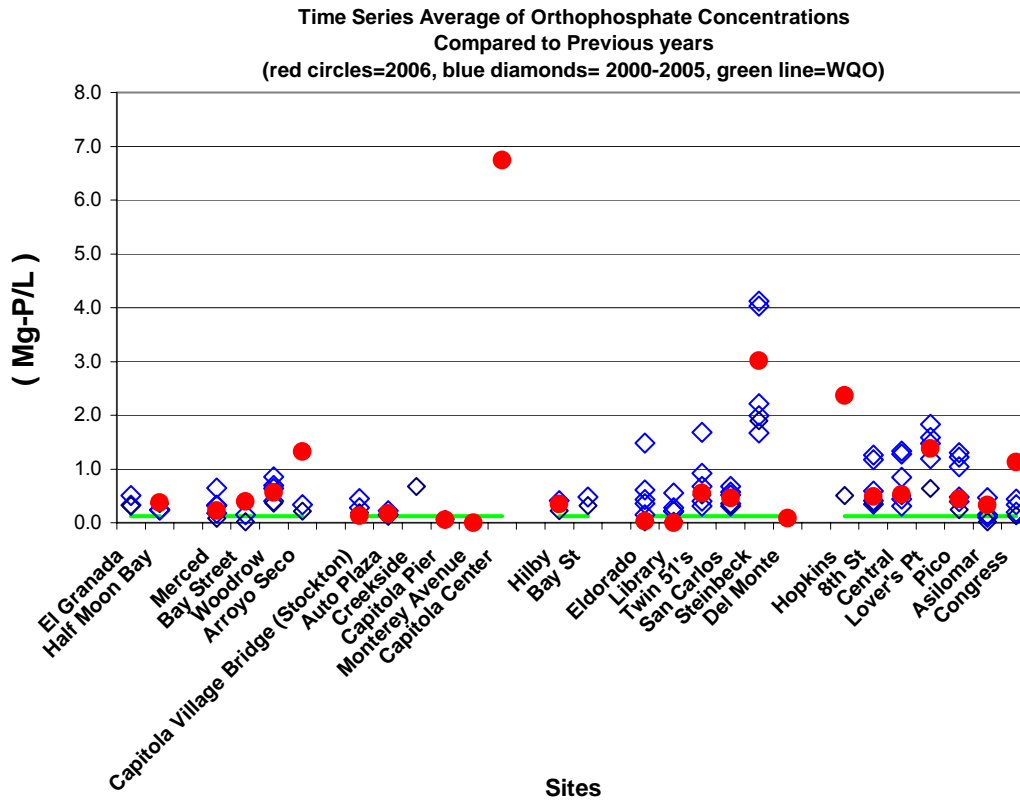


Figure 2. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP attention level for orthophosphate as phosphorus is 0.12 mg-P/l. Graph of 7-year trend. Average time series concentrations are represented.

**Urea**

This was the first year that urea was analyzed during the Dry Run and First Flush. Urea is an organic compound that is often used in agricultural fertilizers. In water, urea has been known to create toxic algal blooms. It is also an irritant to the eyes and skin of humans and marine mammals. During sampling, Greenwood Park in Pacific Grove stood out from all of the sites monitored during the Dry Run with an average concentration of 485 µg/l. During the First Flush, Santa Cruz and Half Moon Bay sampled urea only during the first time series. All other cities have urea results for all three time series. Four sites had urea concentrations greater than 1,000 µg/l. They included two in Santa Cruz, Merced and Arroyo Seco, at 1,000 and 1,680 µg/l respectively. The other two sites were in Pacific Grove and Monterey, at Hopkins and Steinbeck Plaza. These time series concentrations averaged 3,263 and 4,777 µg/l respectively (see Figure 3).

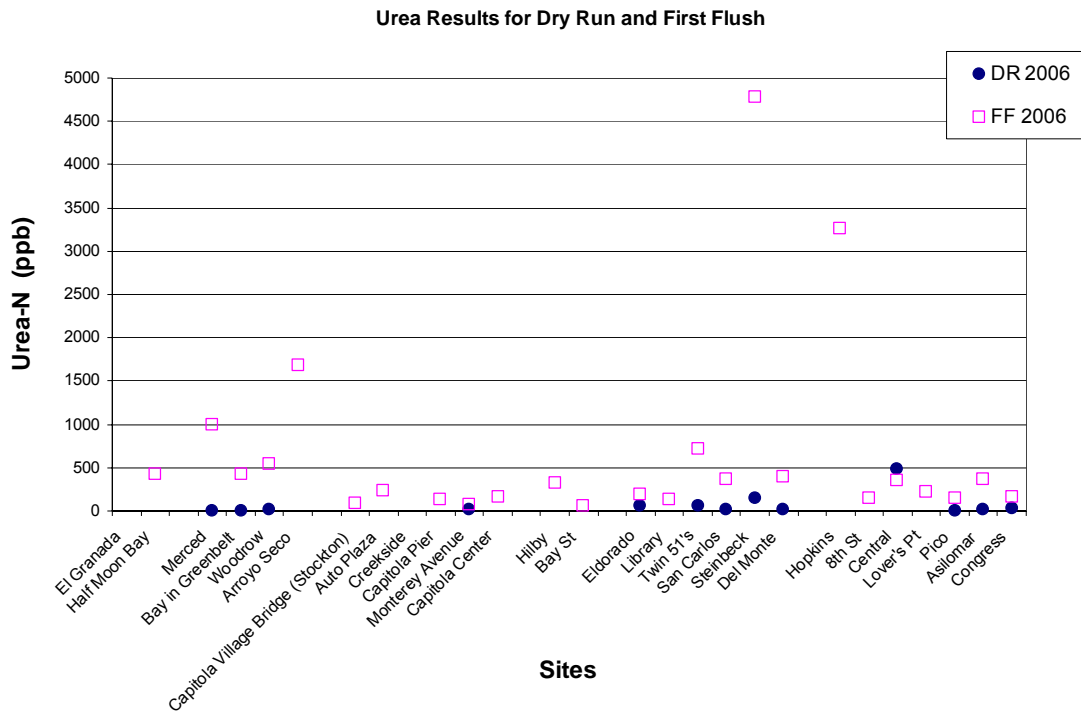


Figure 3. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove).

**Bacteria**

Total coliform, *Escherichia coli* (*E. coli*), and Enterococcus are types of indicator bacteria. While they do not cause disease in humans, they are pollutants of concern because they indicate the presence of waste and the associated pathogens that can cause disease in humans and wildlife. *E. coli* is a member of the fecal coliform group, a subset of the total coliform group. The U.S. Environmental Protection Agency criteria for each

are: total coliform, 10,000 Most Probable Number (MPN)/100ml; *E. coli*, 400 MPN/100 ml; and Enterococcus, 104 MPN/100 ml.

Seven of the thirteen sites monitored in the DR exceeded the criteria for *E. coli*. Most sites were located in Monterey and Pacific Grove, but there was one site each in Santa Cruz and Capitola. Greenwood Park in Pacific Grove had the highest concentration of 20,529 MPN/100 ml and Merced in Santa Cruz had the second highest concentration of 10,344 MPN/100 ml. Enterococcus was not measured during the Dry Run.

All twenty-five sites exceeded the *E. coli* and Enterococcus water quality objectives during the First Flush. Merced in Santa Cruz and Hopkins in Pacific Grove had the highest average *E. coli* concentrations at 213,076 and 196,179 MPN/100 ml respectively. Steinbeck Plaza and Twin 51's in Monterey and Asilomar, Hopkins and Lover's Point in Pacific Grove all had concentrations over 100,000 MPN/100 ml (see Figure 4). This was the first year Enterococcus was monitored. Steinbeck Plaza and Twin 51's in Monterey had average concentrations greater than 190,000 MPN/100 ml. All of the sites averaged at least 170 times higher than the EPA criteria of 104 MPN/100 ml and were usually higher than average *E. coli* concentrations.

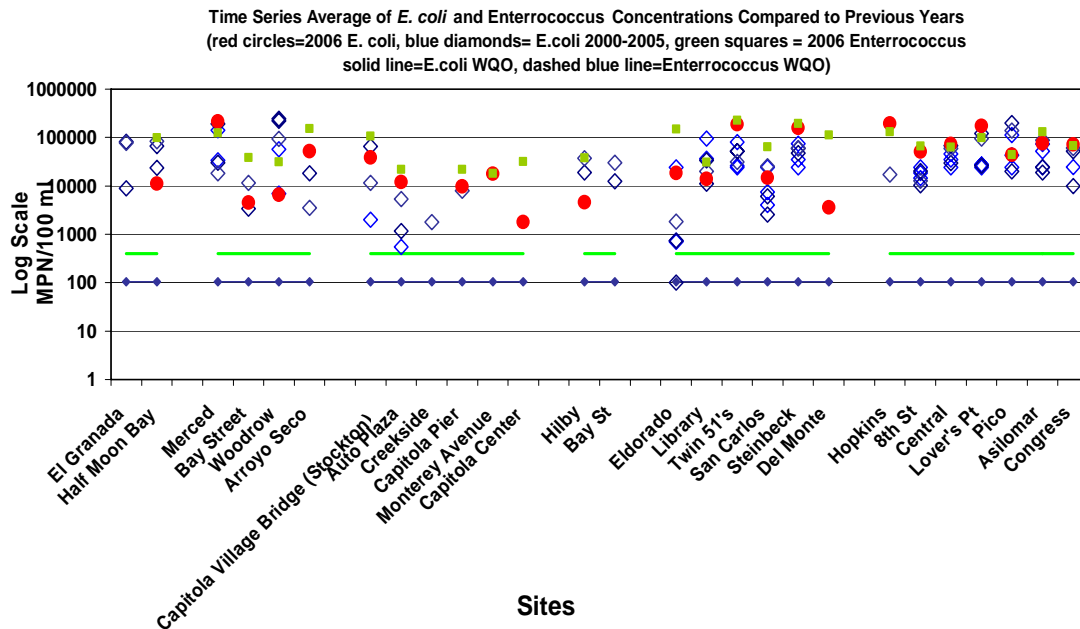


Figure 4. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The EPA Water Quality Criteria for *E. coli* is 400 MPN/100 ml and for Enterococcus 104 MPN/100 ml. Average time series concentrations for the past 7 First Flush events are represented.

**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 minerals. The effects include reduced reproduction, developmental deformities, and mortality. In this monitoring event, samples were analyzed for total zinc (Zn), total copper (Cu), and total



lead (Pb). The California Basin Plan has established water quality criteria for these metals. Common sources of metals include automobile brake pads, industrial waste, and metal roofs or downspouts.

The background concentration for **zinc** (Zn) in seawater on the Central Coast is 8.0 micrograms per liter ( $\mu\text{g/l}$ ). The Basin Plan water quality objective for Zn is  $<200 \mu\text{g/l}$ . During the DR, only one detection for zinc was found – at Greenwood Park in Pacific Grove – and it was far below the WQO.

This year, forty-eight percent of the samples exceeded the Basin Plan WQO for Zn during the First Flush, up nine percent from last year. Sites with exceedances were more spread out this year: they included HMB, two sites from Santa Cruz and Capitola, three from Monterey and two from Pacific Grove. In 2005, no sites in Santa Cruz had any exceedances. Steinbeck Plaza and Twin 51's in Monterey have historically had the highest zinc concentrations; this year, the highest concentrations were at Merced in Santa Cruz, with an average concentration of 695  $\mu\text{g/l}$  (see Figure 5).

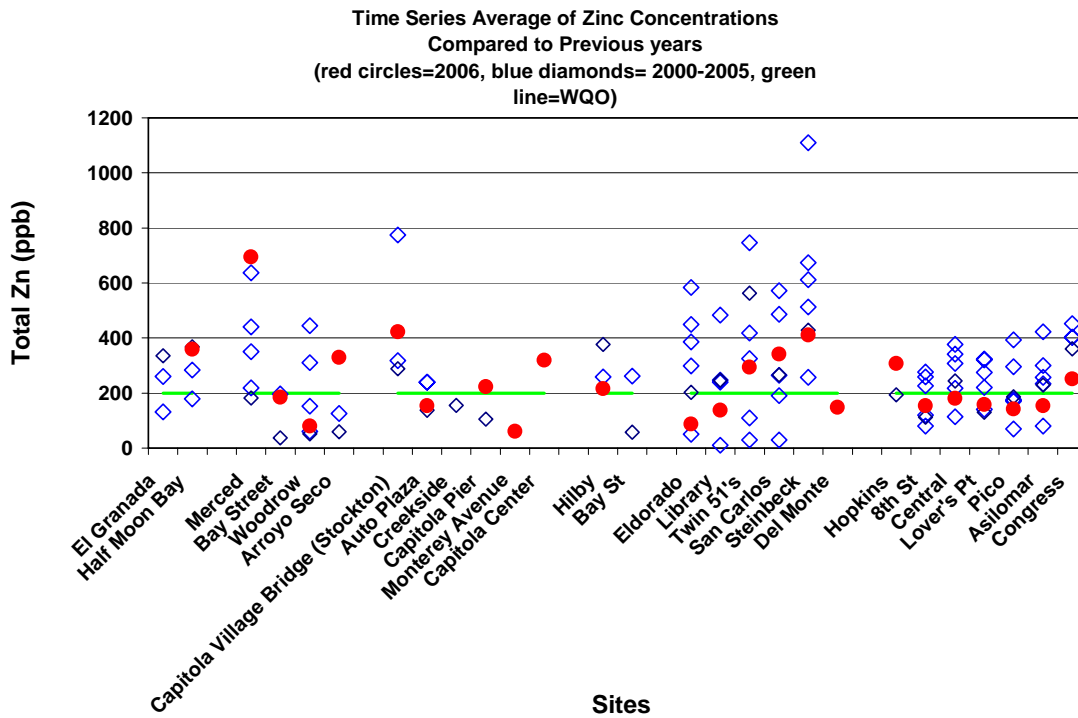


Figure 5. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for zinc is  $200 \mu\text{g/l}$  (ppb). Graph of 7-year trend. Average time series concentrations are represented.

The background concentration for **copper** in sea water is 2.0 µg/l. The Basin Plan standard established for Cu is 30 µg/l. During the DR there were no detections of copper. While copper concentrations varied during the First Flush (from non-detect to 139 µg/l), seventy-six percent of the sites exceeded the copper WQO, up from sixty percent last year. The highest concentrations of copper were found in Monterey at San Carlos (139 µg/l) and Steinbeck Plaza (125 µg/l). Each year prior, Asilomar in Pacific Grove had one of the highest concentration of copper, but this year it was much lower (see Figure 6).

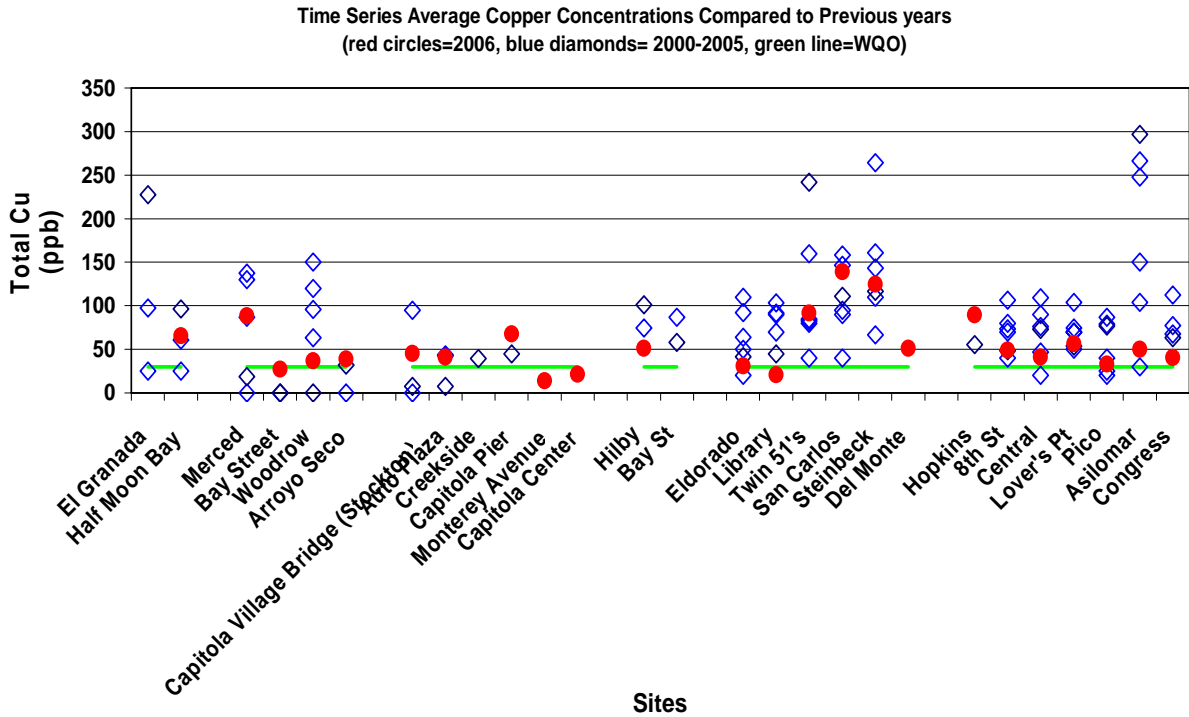


Figure 6. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for copper is 30 µg/l(ppb). Graph of 7-year trend. Time series average concentrations are represented.

The Basin Plan water quality objective for **lead** (Pb) is 30 µg/l. There were no detections of lead during the Dry Run. In the 2005 FF event, four sites exceeded the WQO for lead. During the FF this year, Asilomar in Pacific Grove was the only site to meet or exceed the WQO of 30 µg/l. Average lead concentrations ranged from non-detect to 18 µg/l (see Figure 7).

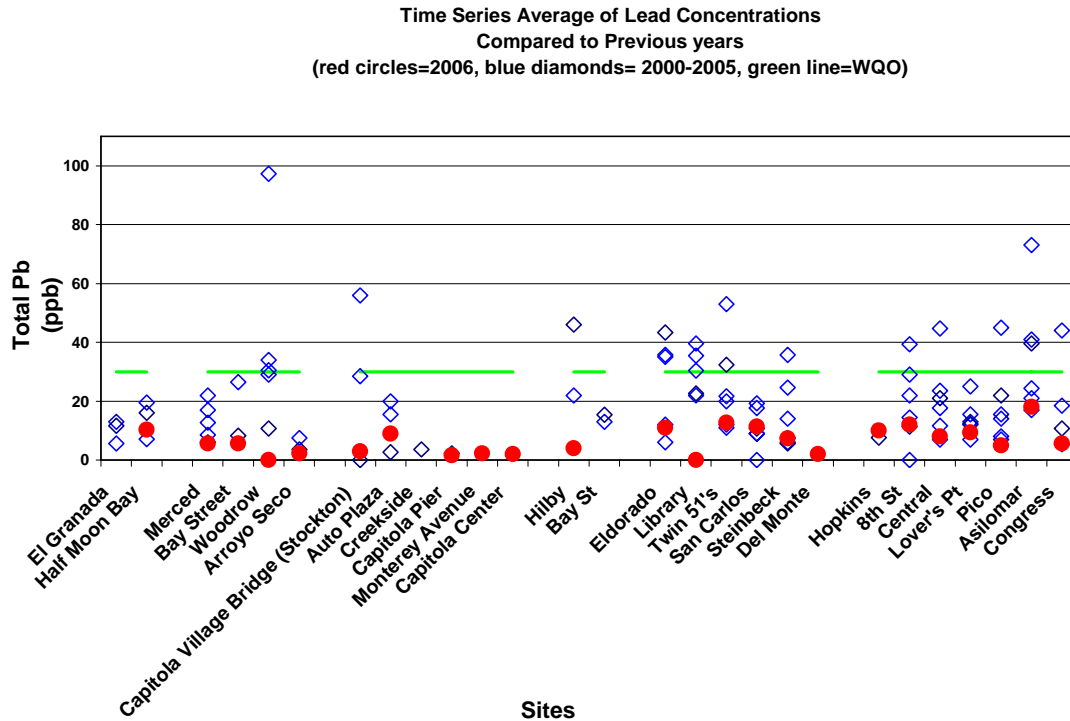


Figure 7. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The Basin Plan Water Quality Objective for lead is 30 µg/l(ppb). Graph of 7-year trend. Time series average concentrations are represented.

**Total Suspended Solids (TSS)**

Total suspended solids (TSS) are important to measure because suspended solids carry pollutants. Suspended solids provide a media or polar charge to attract contaminants. High amounts of sediment are harmful to fish populations because they can destroy habitat, suffocate eggs in fresh water systems, and/or limit the food supply. It also may clog gills or impair an organism’s vision when feeding. However, high TSS can also mitigate metal toxicity.

The attention level for TSS is 500 mg/l. During the DR event, all sites were well below this attention level. Of the sites with detections, they averaged only 9.4 mg/l. In the 2005 FF event, Asilomar and Pico in Pacific Grove were the only sites to exceed the attention level. In 2006, no sites exceeded this level during First Flush. The highest concentration was seen at Asilomar with a concentration of 241 mg/l (see Figure 8).

**Time Series Average of Total Suspended Solids Concentrations Compared to Previous years**  
 (red circles=2006, blue diamonds= 2000-2005, green line=WQO)

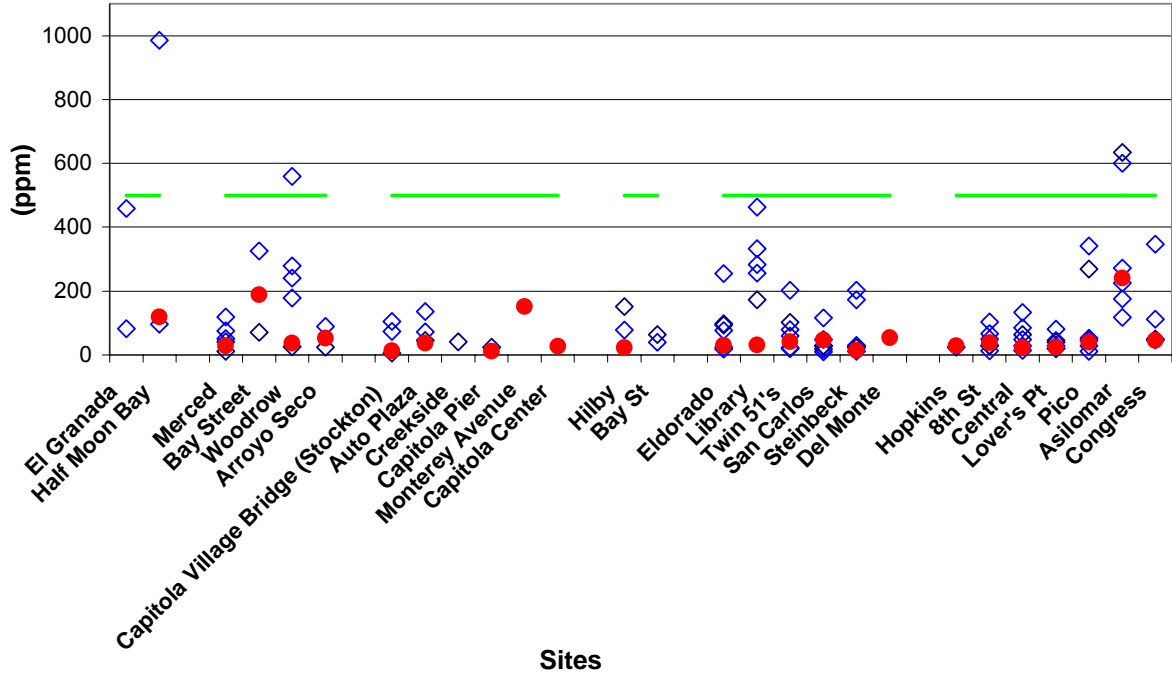


Figure 8. The sites are grouped by city from north to south (El Granada, HMB, Santa Cruz, Capitola, Seaside, Monterey, Pacific Grove). The CCAMP attention level for TSS is 500 mg/l. Graph of 7-year trend. Average time series concentrations are represented.

**Visual Observations**

At each site during the DR and FF events, visual observations included trash, oil sheen, sewage (odor), and bubbles or scum. During the DR, trash was observed and documented at all four Santa Cruz sites. One of those sites also reported scum present. During the First Flush, trash was recorded at 12 sites, up from 7 sites in 2005. A sewer smell was reported at Bay Street in Santa Cruz and the Capitola Pier. Oil sheen was reported at Bay Street in Santa Cruz and three of four Capitola sites. Scum was observed at all four Santa Cruz sites, two Capitola sites, and one Pacific Grove site.

**Results by City**

**Half Moon Bay**

On the north coast of San Mateo County, outfalls were dry during the DR, so no samples were collected. The FF occurred on October 4<sup>th</sup>. Teams mobilized at approximately 7:45pm and began collecting samples at 7:50pm. During the FF, all copper samples exceeded the WQO, with a minimum concentration of 49 µg/L and an average of 73 µg/L. Zinc concentrations were also above the WQO, averaging 359 µg/L. Lead concentrations, however, were below the WQO for every time series, and averaged 11 µg/L. Nitrate concentrations, as last year, stayed consistently below the WQO, and orthophosphate again exceeded the WQO, averaging 0.35 mg/L. Urea was measured during the first time series with a concentration of 430 ppb. *E.coli* concentrations ranged between 6,828 and > 15,525 MPN/100ml. Enterococcus was the highest during the last time series and had a concentration of 241,957 MPN/100ml (see Figure 9).

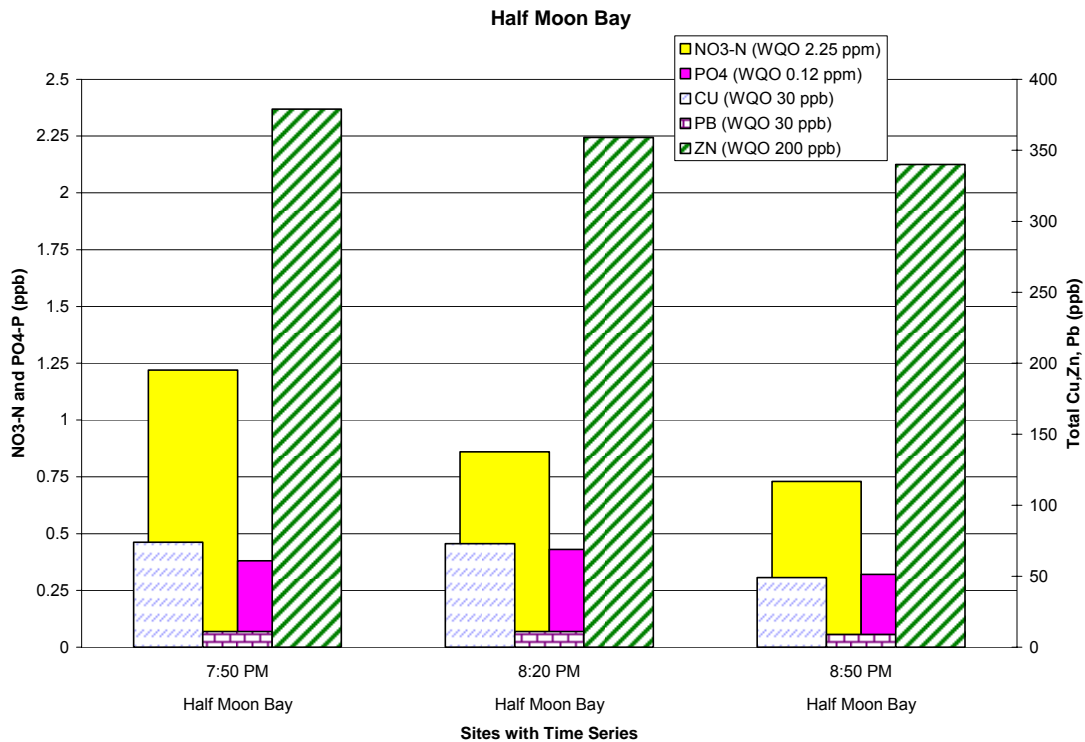


Figure 9. First Flush results at the Half Moon Bay site for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu, and Pb concentrations on the secondary y-axis (right side).

**Santa Cruz**

The Dry Run in Santa Cruz had no detection of metals or orthophosphate at any sites. Merced was the only site to exceed the nitrate WQO with a concentration of 3.87 mg/L and the E. coli WQO with a concentration of 10,344 MPN/100ml.

Santa Cruz teams mobilized for the First Flush on October 4<sup>th</sup>, and samples were taken at four locations. This year’s event was truly one of the first rain events of the season. In past years, several small rain events occurred prior to mobilizing and samples may have been more diluted. This might explain the higher metal concentrations than previous years. Nine of the twelve samples taken for copper were over the WQO, the highest concentrations found at Merced. Zinc concentrations also exceeded the WQO at all sites except Woodrow. All sites were below the WQO for lead, and most were non-detect. In general, metal concentrations had typically been lower in past FF events.

During the FF, Merced and Arroyo Seco exceeded the WQO for nitrate-N; however, all sites exceeded the WQO for orthophosphate-P. The Arroyo Seco site was 9 times higher than the WQO during each time series (see Figure 10). The highest urea concentration in Santa Cruz was detected at Arroyo Seco with a concentration of 1,680 ppb.

Like most cities this year during FF, all sites in Santa Cruz exceeded the WQO for *E. coli*. The lowest concentration detected was at Bay Street 1,677 MPN/100ml and the highest concentration was measured at Merced Avenue, >241,952 MPN/100ml. The lowest Enterococcus concentration (31,062 MPN/100ml) was detected during the second time series at Woodrow. Merced had the highest concentration at 241,960 MPN/100ml during the last time series. All of the Santa Cruz sites exceeded the WQO for total coliform as well, with concentrations greater than 241,960 MPN/100ml.

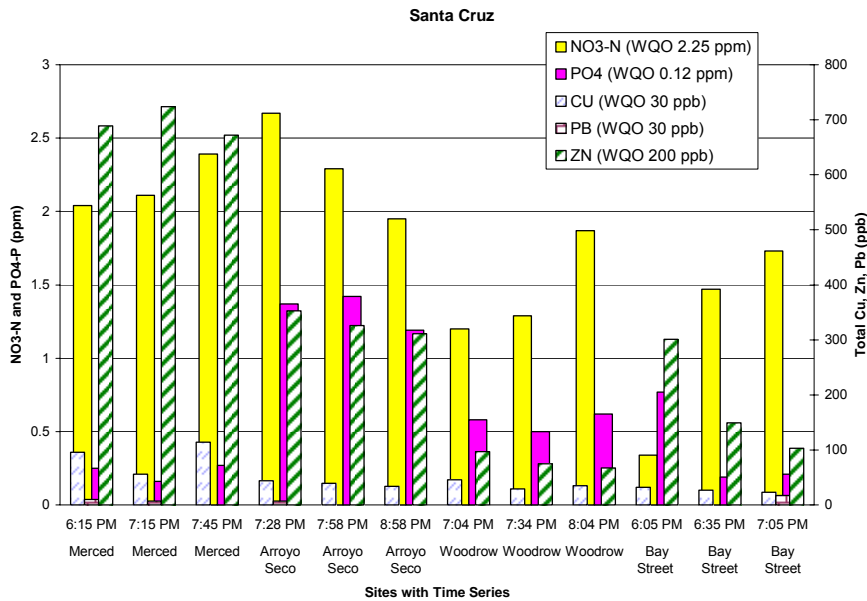


Figure 10. First Flush results at Santa Cruz sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb results on the secondary y-axis (right side).

### Capitola

During the Dry Run in Capitola, only one site was flowing—Monterey Avenue. There were no detections for metals, but high detections for *E. coli* (8,211 MPN/100ml) and total coliform (19,608 MPN/100ml). The site also had a urea concentration of 11 ppb.

For the FF in Capitola, rains began at about 3:00 pm on November 2<sup>nd</sup> and teams mobilized, with the Monterey Avenue volunteers taking the first samples as early as 3:55pm. The Auto Plaza, Capitola Village Bridge, and the Capitola Pier sites all reported copper concentrations that exceeded the WQO. Capitola Pier exceeded the WQO for Zinc, as did two samples from the Capitola Village Bridge and Capitola Center. No sites exceeded the WQO for lead or nitrate-N. All samples from the Auto Plaza exceeded the WQO for orthophosphate, as did one sample from the Capitola Village Bridge, one from the Pier, and two from Capitola Center. Both of the Capitola Center exceedences were over the WQO by an average of 84 times. (see Figure 11). As for bacteria in Capitola, concentrations of *E. coli* ranged between 1336 MPN/100ml at Capitola Center to 38,732 MPN/100ml at the Capitola Bridge. Enterococcus concentrations ranged from 2,014 MPN/100ml in the first time series at Capitola Pier to 120,333 MPN/100ml during the first time series at Capitola Bridge.

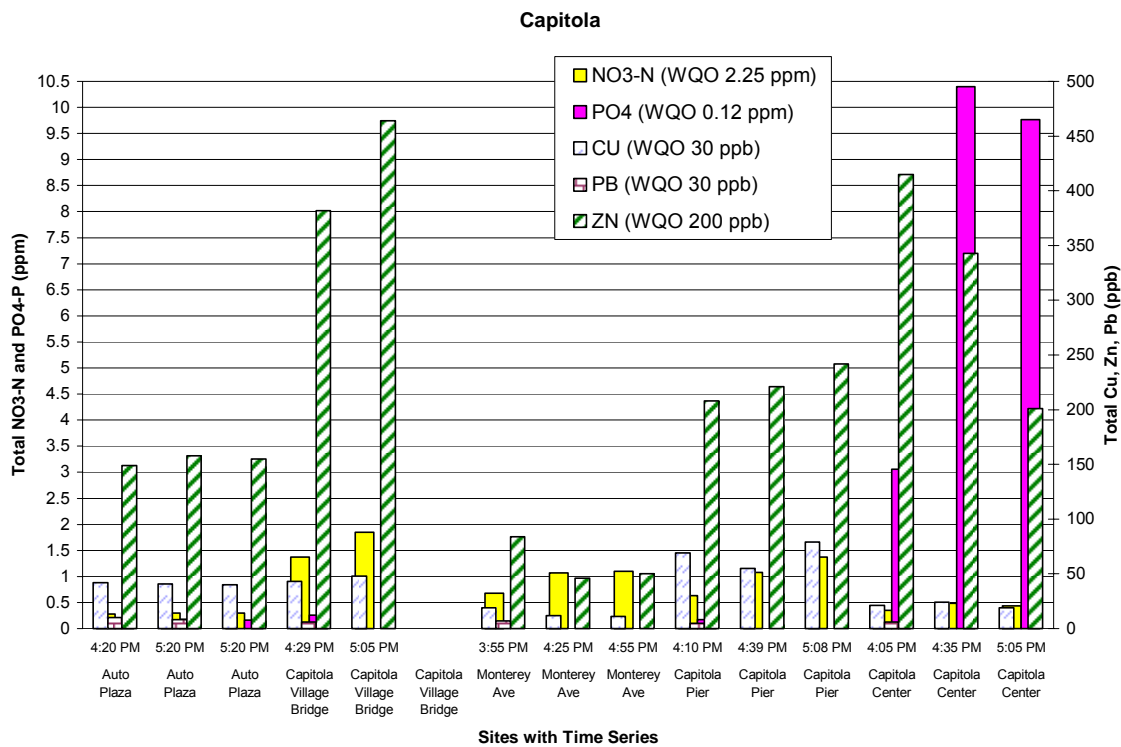


Figure 11. First Flush results at Capitola sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb results on the secondary y-axis (right side).

**Seaside**

Seaside sites were dry during the DR, so no samples were taken. The First Flush occurred early in the morning of November 11<sup>th</sup>. There are only two outfalls in Seaside; one at Hilby Avenue and the other at Bay Street. Results for both sites are reported in this section, however, the Bay Street results were intentionally omitted from the rest of the report because the First Flush was not captured due to the fact that there was not enough rain to flush the dry weather accumulation from the storm drain culvert (conductivity 1200  $\mu$ S). The samples that were collected had probably been sitting in the pipe for a while. The information is still valuable because that water eventually was discharged into the MBNMS but it should not be compared to the other FF results. Hilby had exceedences for copper, lead, and orthophosphate, whereas Bay Street exceeded WQO limits for zinc and orthophosphate, and far exceeded the WQO for nitrates with concentrations of 13.2 ppm for each sample. This concentration is almost 6 times above the WQO (see Figure 12). Urea concentrations averaged 325 ppb at Hilby and just 59 ppb at Bay St.

*E. coli* concentrations, while above the WQO, had the lowest average of all the cities. The highest concentration at Bay Street was 979 MPN/100ml and the highest concentration at Hilby was 4,882 MPN/100ml. Enterococcus results were higher with the highest being 516 MPN/100 ml at Bay St and 48,844 MPN/100ml at Hilby.

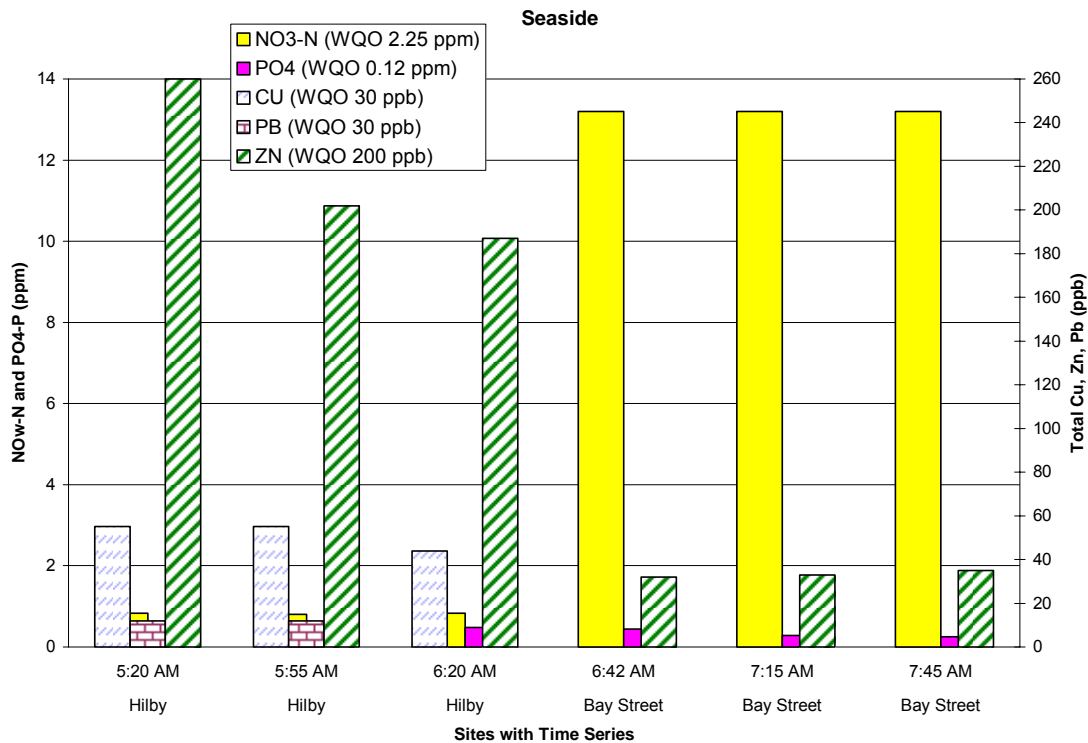


Figure 12. First Flush results for Seaside sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu, and Pb concentrations on the secondary y-axis (right side).



**Monterey**

During the Dry Run event in Monterey on September 30<sup>th</sup>, three Monterey sites had no detection for metals. Two sites, San Carlos and Steinbeck Plaza, reported high concentrations of nitrate. Additionally, Steinbeck Plaza and Twin 51's had the only two hits of orthophosphate in Monterey, and both were over the WQO at 0.35 ppm and 0.38 ppm respectively. Steinbeck Plaza reported the highest urea concentration: 152 ppb. Library, Steinbeck, and San Carlos had high concentrations of *E. coli*, each over the WQO with 8,036 MPN/100ml, 2,602 MPN/100ml, and 798 MPN/100ml respectively.

Monterey teams hit the ground for First Flush on November 3<sup>rd</sup> and 11<sup>th</sup>. There was plenty of runoff at the Twin 51's, San Carlos, and Steinbeck Plaza on the 3<sup>rd</sup> but not at the more easterly sites of Eldorado and the Library. Those sites were monitored on November 11<sup>th</sup> with the Seaside sites. Twin 51's, San Carlos, and Steinbeck Plaza average time series concentrations exceeded the WQO for copper, zinc, and orthophosphate (see Figure 13). In general, samples from the Library and Eldorado sites had lower concentrations than the other sites. This may be due to the different storm events. Steinbeck Plaza has historically shown high levels of metals and nutrients during the First Flush. Urea concentrations were much higher here than all of the other sites with the highest concentration being 5,210 ppb. *E. coli* concentrations ranged between 1,967 MPN/100ml at Del Monte to 241,957 MPN/100ml at Twin 51's; all sites far exceeding the WQO. Enterococcus concentrations were much higher than the *E. coli* results with San Carlos reporting the lowest concentration of 21,426 MPN/100ml and both Twin 51's and Steinbeck Plaza reporting the highest values greater than 241,960 MPN/100 ml.

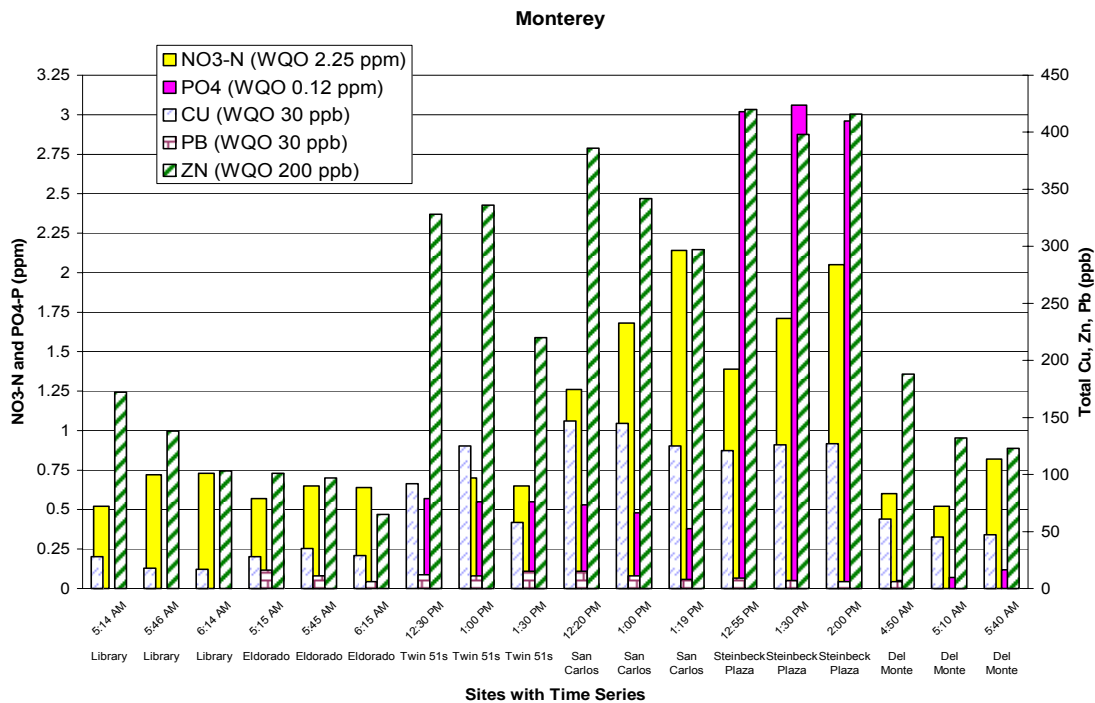


Figure 13. First Flush results at Monterey sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb results on the secondary y-axis (right side).

**Pacific Grove**

Just four sites had water flowing and were monitored in Pacific Grove for the Dry Run event. There were no detections for copper, lead or zinc. Two of the four sites, Pico and Greenwood Park, had *E. coli* concentrations higher than the WQO; 606 MPN/100ml and 20,529 MPN/ml respectively. The highest urea concentration was 485 ppb, reported during the DR, measured at Greenwood Park.

Seven sites were monitored in Pacific Grove for the First Flush, which occurred on November 3<sup>rd</sup>. Teams mobilized at approximately 11:30AM that day, and sampling began shortly after. All sites exceeded the WQO for copper and orthophosphate, with the highest concentrations of both coming from Hopkins. Hopkins also exceeded the WQO for zinc during each time series, as did Congress and one sample from Asilomar. Asilomar was also the only site to exceed the WQO for lead during the first time series (see Figure 14). Hopkins had the second highest urea concentrations of all the cities with an average of 3,263 ppb.

*E. coli* concentrations in the city of Pacific Grove were high. None were under 32,000 MPN/100ml. At the low end was the 8<sup>th</sup> Street outfall with a concentration of 32,554 MPN/100ml; the highest concentration was found at Hopkins, at greater than 241,960 MPN/100ml. Enterococcus concentrations were high as well averaging between 43,965 MPN/100 ml at Pico to 131,808 MPN/100ml at Asilomar.

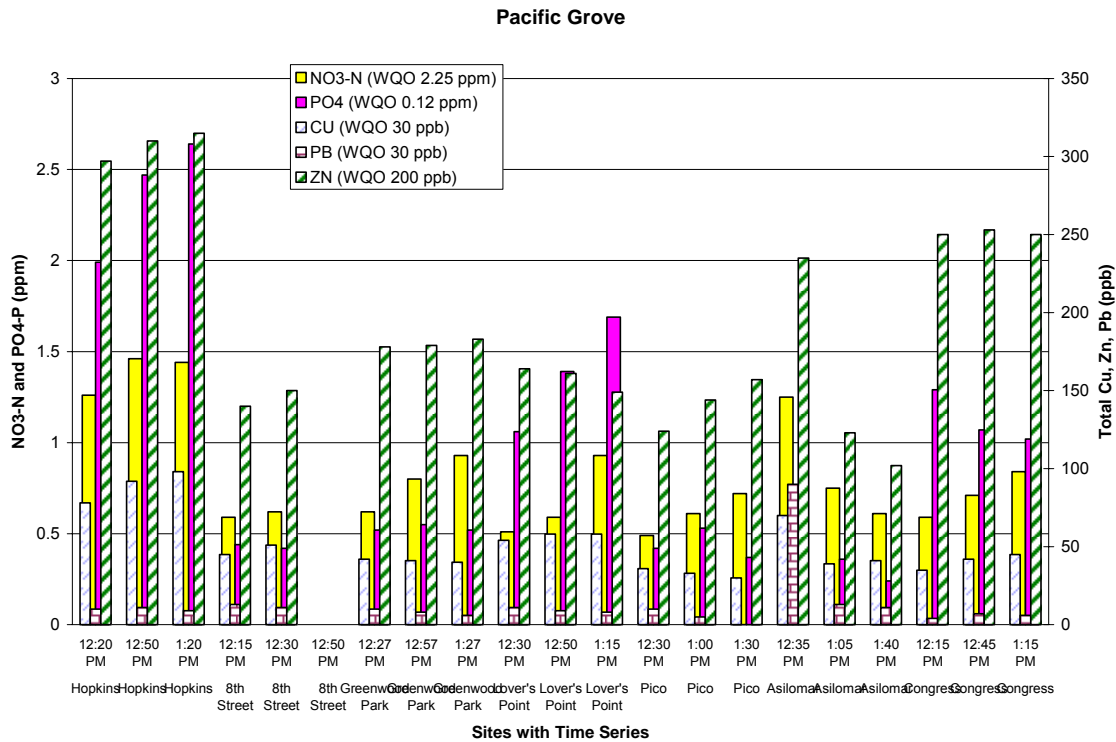


Figure 14. First Flush results at Pacific Grove sites for each time series. Nitrate-N and orthophosphate-P results on the primary y-axis (left side) and Zn, Cu and Pb results on the secondary y-axis (right side).

## Conclusions

The Dry Run and First Flush results continue to provide valuable information about the quality of water flowing from urban storm water outfalls around Monterey Bay and Half Moon Bay. The Dry Run is a single sample that is intended to be a comparison of the water quality flowing from the outfalls during the dry weather season and the first major rain of the season. Results from the Dry Run indicated that the water quality was better than that of the First Flush but not as good as the Dry Run in 2005.

- Metal concentrations were very low during the Dry Run. Just one site, Greenwood Park in Pacific Grove, had a detection for zinc and it was well below the WQO. During the First Flush, 48% of the sites exceeded the WQO for zinc, up 9% from 2005; 76% of the outfalls exceeded the WQO for copper, up 16% from 2005 and just one site exceeded the WQO for lead which was at Asilomar in Pacific Grove.
- Nitrate concentrations were low in both events, but as in the past, were higher in Santa Cruz than other cities. Three sites exceeded the WQO during the Dry Run and just one site during the First Flush.
- Orthophosphate concentrations were much higher during the First Flush than the Dry Run. Three sites exceeded the WQO during the Dry Run with concentrations in the range of 0.35 mg-P/l. During the First Flush 80% of the sites exceeded the WQO. Capitola Center had the highest concentration of 6.7 mg-P/l.
- Just over half of the sites exceeded the WQO for *E.coli* during the Dry Run. 100% of the sites exceeded the WQO for both *E.coli* and Enterococcus during the First Flush. Enterococcus concentrations were 170 times higher than the WQO and usually higher than the *E.coli* concentrations.
- The discharges were very low in total suspended solids for both events. TSS averaged 9.4 mg/l during the Dry Run and 54.4 mg/l during the First Flush.
- Trash was only observed in Santa Cruz during the Dry Run and reported at 50% of the sites during the First Flush.

The next step for resource managers and local jurisdictions is to focus on watersheds that reported exceptionally high concentrations of particular constituents, this year and in the past, and determine their possible sources. It is also important to begin to look at the inter-tidal areas near these outfalls to determine if we can see an impact from the urban pollutants flowing into the ocean during dry weather flows and the First Flush event.

## Attachment 1

<u>Station Name</u> (Cities listed in order from North to South)	<u>Station ID</u>	<u>Drainage Area</u> (acres)	<u>Primary Land Use</u>	<u>Description</u>	<u>Location</u>	<u>Receiving Water</u>
Half Moon Bay	HMB1			Concrete pipe	Storm drain in Half Moon Bay at Main Street and Pilarcitos Creek	Ocean
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
Arroyo Seco (Santa Cruz)	SCSD5					
Woodrow (Santa Cruz)	SCSD4	736	80% residential 10% commercial 10% open space	Surface drainage	On S side of W. Cliff Dr. at Woodrow Ave.	Ocean
Auto Plaza (Capitola)	CSD-03		2% residential 98% commercial	Corrugated metal pipe	Corrugated metal pipe discharging to a cement box culvert w/dissipater	Creek
Stockton Bridge (Capitola)	CSD-04		100% residential	Corrugated metal pipe		Creek
Capitola Center (Capitola)	CSD-05					
Monterey Ave. (Capitola)	CSD-08					
Capitola Pier (Capitola)	CSD-09		100% residential	Cement culvert (metal 'flap' gate)		Ocean
Bay Ave. (Seaside)	SSD2			Concrete box culvert	At the end of Bay Ave. and Sand Dunes Rd.	Ocean
Hilby (Seaside)	SSD1			Concrete pipe	At the south side of intersection of Hilby Ave and Canyon Del Rey Blvd.	Lake
Eldorado (aka Major Sherman) (Monterey)	MSD1		80% residential 20% commercial	Surface drainage	Intersection of Major Sherman Lane and El Dorado 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
Hopkins (Pacific Grove)	PGSD7			Concrete pipe	Located high on the beach between the Monterey Bay Aquarium and Hopkins Marine facility	Ocean
8 <sup>th</sup> Street (Pacific Grove)	PGSD1	35	100% residential	Concrete pipe	West of Oceanview Blvd. between 7 <sup>th</sup> and 8 <sup>th</sup> Street.	Ocean
Central & 13 <sup>th</sup> (aka Greenwood) (Pacific Grove)	PGSD2	250	90% residential 10% commercial	Concrete pipe	Greenwood Park at the corner of 14 <sup>th</sup> 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 the 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
Congress (Pacific Grove)	PGSD6	37	90% residential 10% commercial	Concrete pipe	Approx. 300 yards S of Congress and Sunset Blvds.	Riparian area flows to ocean

Attachment 2a – 1<sup>st</sup> page of Field Data Sheet

<b>Monterey Bay National Marine Sanctuary</b>				
<b>First Flush 2004</b>				
<b>Field Data Sheet</b>	<b>Date:</b>			
<b>City</b>			<b>Arrival Time</b>	
<b>Station ID</b>			<b>Departure Time</b>	
<b>Time Rain Began</b>		<b>Station Name</b>		
<b>Team Members with phone #'s</b>				
1			4	
2			5	
3			6	
<b>Detailed description of weather conditions (drizzle, rain, wind, visibility, cloud cover, darkness, etc.):</b>				
<b>Field Measurements:</b>		<b>Time Bucket Filled _____ : _____ am / pm</b>		
<b>Instrument ID:</b>	<b>Person taking Measurement</b>	<b>Parameter</b>	<b>Measurement</b>	<b>Replicate</b>
		H2O Temp	F or C	F or C
		pH		
		Conductivity	$\mu S$	$\mu S$
		Transparency	cm	cm
<b>Notes (include any observations from back side, ie. types of trash, biological observations, etc.</b>				



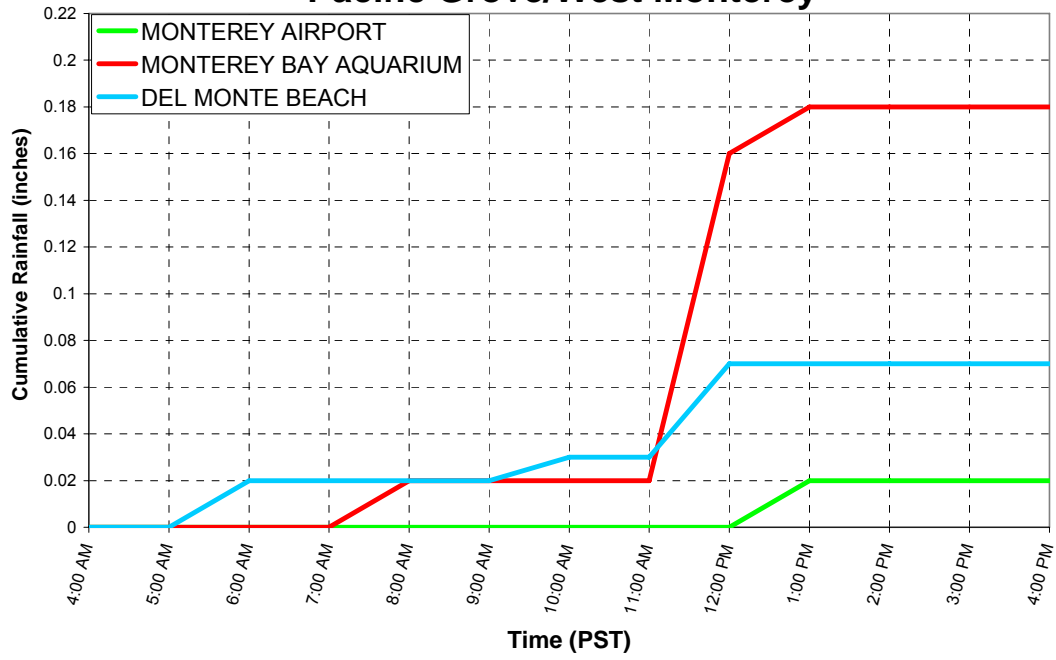
**Attachment 3  
METHODS USED IN THE FIRST FLUSH 2006 SAMPLING EVENT**

	<b>Constituent</b>	<b>Detection Limits</b>	<b>Units</b>	<b>Laboratory</b>	<b>Method #</b>	<b>Method Principles</b>
<b>Field Measurements</b>						
	Conductivity	10	μS	Field		Electrodes
	Water Temp.	-5	°C	Field		Spirit bulbs
	pH	4.5	pH	Field		Non-bleeding test Strips
	Transparency	2	cm	Field		Transparency Tube
<b>Nutrients</b>						
	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	
	Urea	10	μg/l	Monterey Bay Analytical	Mulvenna & Salvidge	
<b>Bacteria</b>						
	Total coliform	1	MPN/100 ml	Monterey Bay Analytical	Colilert	Chromogenic Substrate
	E. coli	1	MPN/100 ml	Monterey Bay Analytical	Colilert	Chromogenic Substrate
	Enterococcus	1	MPN/100 ml	Monterey Bay Analytical	Enterolert	Florescence enzyme substrate
<b>Total Metals</b>						
	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	3	μg/l	Monterey Bay Analytical	SM3111B	acid digestion, AA flame
<b>Other WQ parameters</b>						
	total suspended solids (TSS)	10	mg/l	Monterey Bay Analytical	SM2540D	Gravimetric: filtration thru 1.1μm, glass fiber drying and weighing of particulates
	total dissolved solids	10	mg/l	Monterey Bay Analytical	SM2540C	Gravimetric: drying and weighing of 1.1μm filtrate
	Oil and Grease	1	mg/l	Monterey Bay Analytical	EPA 1664	



Attachment 4 – Rainfall (November 3<sup>rd</sup> and 11<sup>th</sup>)

**First Flush 2006 - November 3  
Pacific Grove/West Monterey**



### First Flush 2006 - November 11th North Monterey/Seaside

