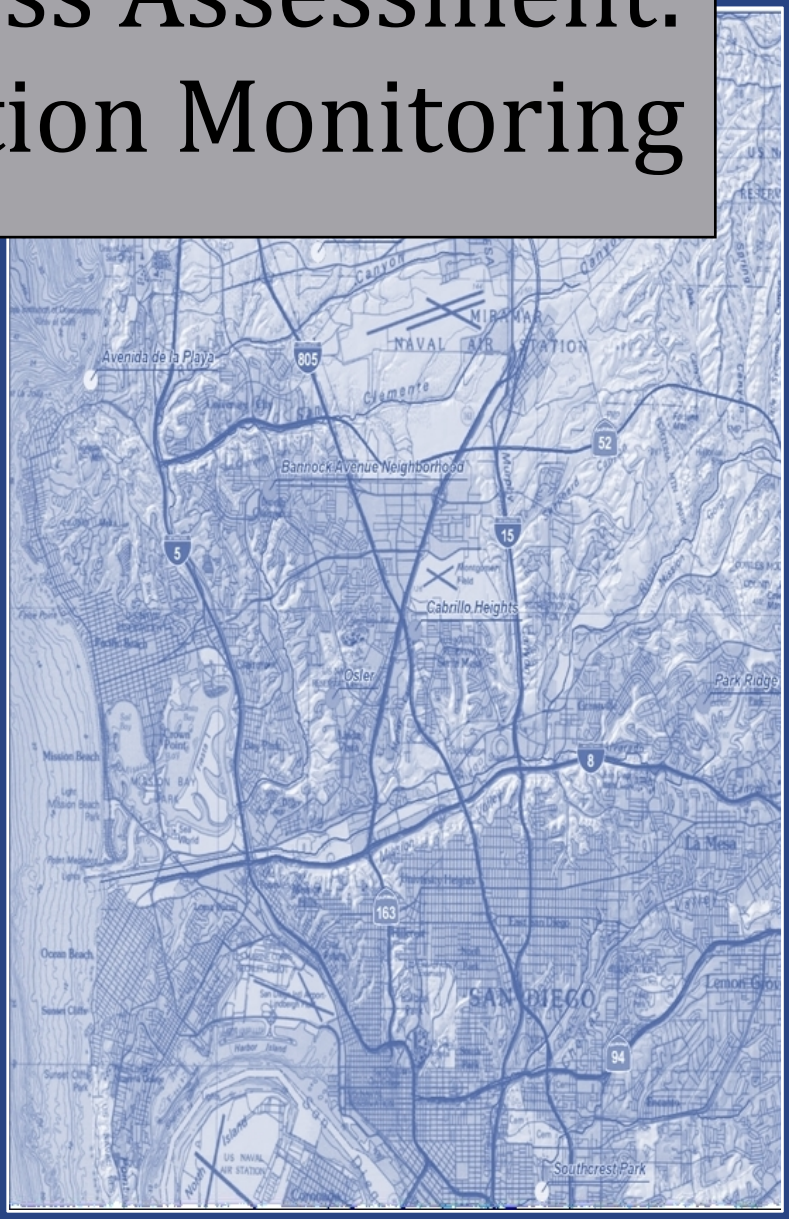
# BMP Effectiveness Assessment: Pre-Construction Monitoring




**June 2010**

City of San Diego

Storm Water Department

# BMP Effectiveness Assessment: Pre-Construction Monitoring

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# BMP Effectiveness Assessment Monitoring

Storm water best management practices (BMPs) are an effective tool to reduce urban runoff and improve water quality. Pollutants associated with urban runoff generally include trash, oil and grease, sediment, bacteria, heavy metals and pesticides. Urban runoff occurs in both wet weather and dry weather. Dry weather runoff is composed of flows such as runoff from car washing and over-watering. Wet weather flows are the result of precipitation events. Wet weather runoff is a source of pollutants of concern such as trash, oil and grease, sediment, and heavy metals to surface waters, while dry weather runoff presents a separate set of pollutants of concern, including pesticides and bacteria.

To evaluate the effectiveness of storm water BMPs, the City of San Diego has undertaken a monitoring program aimed at characterizing water quality conditions before and after the construction of select structural BMPs. Aimed at reducing urban runoff and therefore, enhancing water quality throughout the San Diego region, BMP projects are planned for several selected sites and will include BMPs such as dry weather diversion, porous pavement and sidewalks, infiltration areas, bioretention areas or planter systems, hydrodynamic separators, and bacterial treatment BMP systems. Each of these BMP systems will have unique objectives and limitations specific to the chosen site. For example, BMP selection is based on available space, drainage area, and water quality and quantity concerns.

The City's *Strategic Plan for Watershed Activity Implementation* identifies types of BMPs to be implemented in the year 2010 by watershed. The City's approach for BMP implementation is tiered with nonstructural BMPs (Tier I) and structural low impact development (LID) BMPs (Tier II) which are to be generally to be implemented first and then assessed, prior to implementing Tier III BMPs. Tier III BMPs are implemented where Tier I and II BMPs are not sufficiently effective but can be tested as Tier I and Tier II BMPs are implemented. The identified BMPs are as follows:

**Table 1. Selected Watersheds and Storm Water BMPs**

| Watershed | BMPs |
|---|---|
| Chollas Creek | One large LID and one trash segregation project |
| Tecolote Creek | One green street and one treatment train system |
| San Diego River | One green lot and one treatment train system |
| Los Peñasquitos | One green mall and one peak and erosion control project |

The City identified City-owned properties within each watershed for implementation of BMPs. Sites were selected based on an evaluation of the site properties, a field evaluation of possible sites to confirm site attributes, and geotechnical investigations of possible sites for infiltrative capacity. (Weston, 2009) Additional considerations in choosing sites were safe conditions for field monitoring crews; sites where reliable flow monitoring could be conducted at a centralized collection point; and representativeness of the flow at the collection point of large portions of the drainage areas (MACTEC, 2009).

This report presents the data and analysis of storm water runoff quantity and quality data from multiple monitoring sites in the San Diego region prior to construction and implementation of the BMPs selected during the conceptual design phase. Monitoring occurred during the 2009 – 2010 wet weather season.

The monitoring project, its associated watershed, identified water quality concerns, and selected BMPs are presented in Table 2.

**Table 2. Monitoring location information.**

| Project Name | Watershed Management Area | BMP Type | Water Quality Parameters |
|---|---|---|---|
| Avenida de la Playa | Mission Bay and La Jolla | Dry Weather Diversion | Bacteria |
| Southcrest Park | San Diego Bay | Porous Pavement Infiltration Trench | Bacteria, Heavy Metals, Pesticides, and Sediment |
| Mira Mesa Library | Los Peñasquitos | Bioretention Area | Bacteria, Nutrients, Sediment, and Total Dissolved Solids |
| Marindusty (Removed) | Los Peñasquitos | Hydrodynamic Separator | Trash, Sediment, and Oil and Grease |
| Osler | Mission Bay & La Jolla | Hydrodynamic Separator | Trash, Sediment, and Oil and Grease |
| Bannock Avenue Neighborhood | Mission Bay & La Jolla | Biorentention Planter System; Pervious Sidewalks; AbTech Bacterial Treatment System | Bacteria, Heavy Metals, Nutrients, Pesticides, and Sediment |
| Cabrillo Heights Park | San Diego River | Rain Garden (Biorentention Basin) | Trash, Oil and Grease |
| Park Ridge | San Diego River | Hydrodynamic Separator; AbTech Bacterial Treatment System | Bacteria, Trash, Nutrients, Sediment, and Total Dissolved Solids |

Preconstruction monitoring was undertaken for future evaluation of BMP effectiveness. The objective of wet weather monitoring was to characterize pre-construction wet weather water quality. Wet weather pre-construction monitoring will be presented for the following sites: Southcrest Park, Mira Mesa Library, Osler, Bannock Avenue Neighborhood, Cabrillo Heights Park, and Park Ridge. Wet weather monitoring that was conducted as a separate study under the City of San Diego Chollas Creek Storm Drain Characterization Study includes monitoring at the following sites: Osler, Bannock Avenue Neighborhood, Cabrillo Heights Park, and Park Ridge. Land Use information for these sites was also determined under this study, and data from the Land Use sites will be used in the future to calibrate

loadings from different land use types for watershed modeling and will be used to characterize the pre-construction pollutant loads.

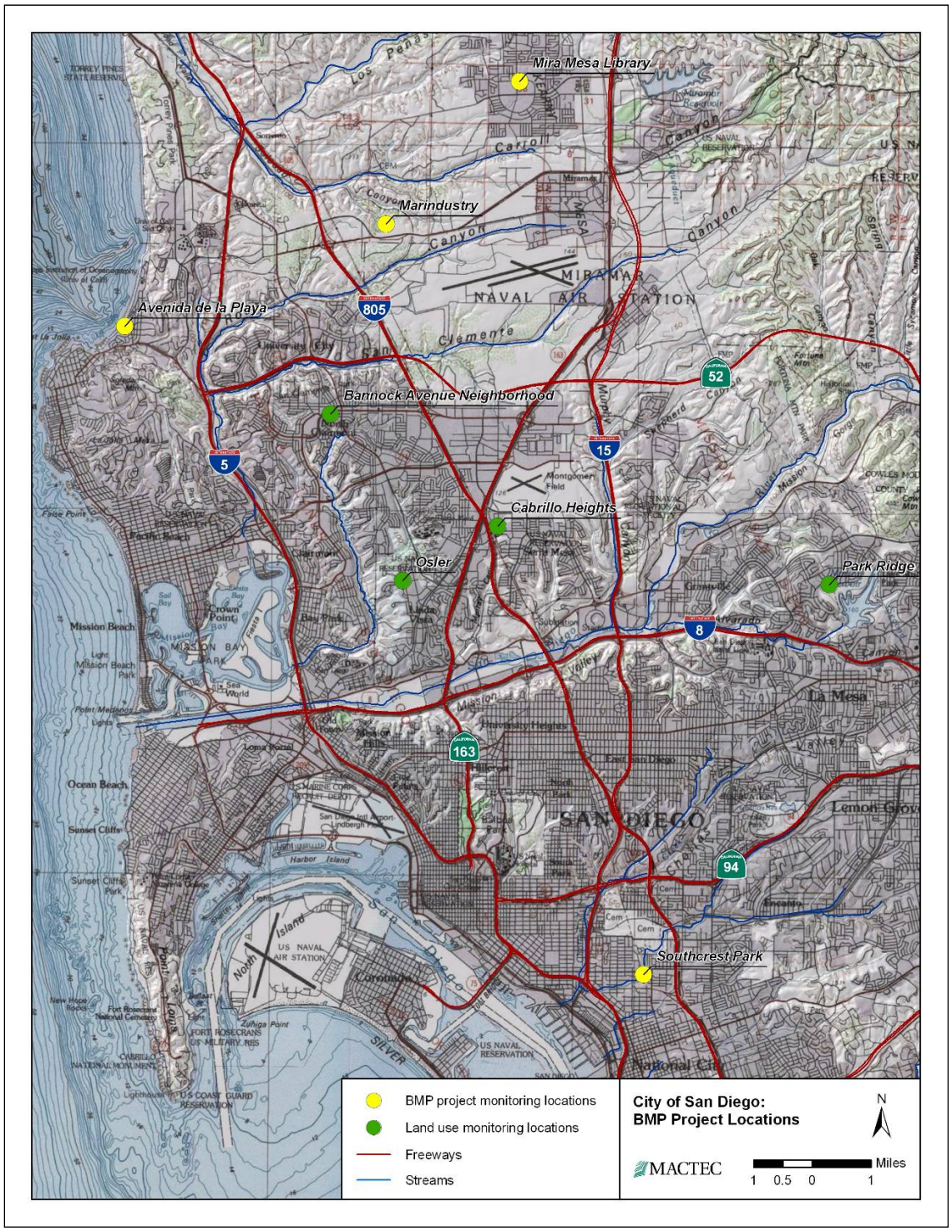


**Figure 1. BMP site monitoring locations. (Source: MATEC, 2010)**

# Monitoring Site Data and Analyses

Pre-construction monitoring was conducted during the 2009 -2010 wet season to characterize either flow conditions only, or to characterize relative contributions of pollutants of concern in wet weather runoff. Two sites were monitored during one wet weather event, and the four sites that were monitored under the Chollas Creek Storm Drain Characterization Study were monitored during two wet weather events. One site was monitored during a period of extended dry weather during the 2009 – 2010 wet season.

The *Effectiveness Assessment Monitoring for 2008 BMP Concept Design Monitoring Plan* (March 2010), identified the following monitoring sample types and frequencies for each site, as follows:

**Table 3. Monitoring sites and types of samples.**

| Project Name | Weather | Type of Samples Per Site | Number of Events | BMP Project or Land Use Project? |
|---|---|---|---|---|
| *Dry Weather* | | | | |
| Avenida de la Playa | Dry Weather (dry weather during 2009-2010 wet season) | • Extended Flow Monitoring for 1 week;<br>• 24-hr Time-weighted Composite Sample | 1 | BMP Project |
| *Wet Weather* | | | | |
| Southcrest Park | Wet Weather | • Flow-weighted Composite;<br>• 3 Microbiology Grab Samples | 1 | BMP Project |
| Mira Mesa Library | Wet Weather | • Time-weighted Composite Sample;<br>• 3 Microbiology Grab Samples | 1 | BMP Project |
| Osler | Wet Weather | • 8 Pollutograph samples<br>• 8 Microbiology grab samples | 2 | Land Use Project (Residential) |
| Bannock Avenue Neighborhood | Wet Weather | • 8 Pollutograph samples<br>• 8 Microbiology grab samples | 2 | Land Use Project (Residential) |
| Cabrillo Heights Park | Wet Weather | • 8 Pollutograph samples<br>• 8 Microbiology grab samples | 2 | Land Use Project (Municipal) |
| Park Ridge | Wet Weather | • 8 Pollutograph samples<br>• 8 Microbiology grab samples | 2 | Land Use Project (Residential) |

Actual sample collection types, and numbers of samples varied from the proposed sampling plan at times, due to adjustments in the field. Additionally, Marindustry was a planned site for BMP construction; however, preconstruction monitoring was removed from the project list prior to commencement of the wet season monitoring period due to a change in project location.

The applied lab analytical methods for individual water quality constituents are presented in Table 4. These methods were used for all samples from the monitoring sites presented in this report. The table also includes laboratory method detection limits (MDLs), reporting limits (RLs), and units.

For the use of data in calculations (e.g., flow-weighted average), if a water quality constituent was reported as non-detect (ND) value, which indicates it was measured at a concentration below a constituent-specific MDL, the constituent concentration was assumed to be a half of the MDL. If the result of that calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol. Estimated values, flagged as detected not quantified or DNQ, were used in all calculations as detected values.

**Table 4. Laboratory analytical methods.**

| Constituent | | Method | MDL | RL | Unit |
|---|---|---|---|---|---|
| **General Chemistry** | Conductivity in Water Determination | SM 2510 | 0.001 | 0.001 | mS/cm |
| | pH in Water Determination | SM 4500 H+ | 0.1 | 0.2 | pH Unit |
| | Total Hardness as $CaCO_3$ in Water Determination | SM 2340 B | 1 | 5 | mg/L |
| | Total Suspended Solids in Water Determination | SM 2540-D | 0.5 | 5 | mg/L |
| | Turbidity in Water Determination | EPA 180.1 | 1 | 2 | NTU |
| **Trace Metals (Total and Dissolved)** | Aluminum (Al) | EPA 200.8(m) | 5 | 10 | µg/L |
| | Antimony (Sb) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| | Arsenic (As) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Barium (Ba) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Beryllium (Be) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Cadmium (Cd) | EPA 200.8(m) | 0.2 | 0.4 | µg/L |
| | Chromium (Cr) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| | Cobalt (Co) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| | Copper (Cu) | EPA 200.8(m) | 0.4 | 0.8 | µg/L |
| | Iron (Fe) | EPA 200.8(m) | 5 | 10 | µg/L |
| | Lead (Pb) | EPA 200.8(m) | 0.05 | 0.1 | µg/L |
| | Manganese (Mn) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Molybdenum (Mo) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Nickel (Ni) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Selenium (Se) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Silver (Ag) | EPA 200.8(m) | 0.5 | 1 | µg/L |
| | Strontium (Sr) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |

| Constituent | | Method | MDL | RL | Unit |
|---|---|---|---|---|---|
| | Thallium (Tl) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| | Tin (Sn) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| | Titanium (Ti) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Vanadium (V) | EPA 200.8(m) | 0.2 | 0.5 | µg/L |
| | Zinc (Zn) | EPA 200.8(m) | 0.1 | 0.5 | µg/L |
| **Microbiology** | Total Coliform | SM 9221B | 20[(a)] | 20 | MPN/100mL |
| | Fecal Coliform | SM 9221E | 20[(a)] | 20 | MPN/100mL |
| | Entercoccus | EPA 9000-1600 | 10[(b)] | 10 | CFU/100mL |
| **Nutrients** | Total Nitrogen | SM 4500-N | 2 | 4 | mg/L |
| | Total Phosphorus | SM 4500- P E | 0.016 | 0.05 | mg/L |
| **Pesticides** | 4,4'-DDE | EPA 625m | 1 | 5 | ng/L |
| | Chlordane-alpha | EPA 625m | 1 | 5 | ng/L |
| | Chlordane-gamma | EPA 625m | 1 | 5 | ng/L |
| | trans-Nonachlor | EPA 625m | 1 | 5 | ng/L |
| | Malathion | EPA 625m | 3 | 6 | ng/L |

[(a)] Upper Limit (UL) = 1,600,000 MPN/100mL

[(b)] Upper Limit (UL) = 1,200,000 CFU/100mL

Each site monitored during the wet season preconstruction period is described in full detail below, along with the presentation and analysis of data for each site.

## Avenida de la Playa

### *Site Description*

- Location: On Avenida de la Playa between La Jolla Shores Drive and ocean outfall
- Latitude and longitude: 32°51′13.59″ N and 117°15′15.46″ W
- Site ID: AV001
- Monitoring date: April 8-9, 2010
- Weather condition: Dry weather (partly cloudy)
- Last rain before the monitoring: > 72 hours

**Figure 2. View of catch basin, from above, at Avenida de la Playa site.**

### *Introduction*

The existing storm drain system within Avenida de la Playa discharges to La Jolla Shores Beach to the west of the street through a double 51-inch concrete pipe headwall and attached concrete structure. (Weston, 2008) Most dry weather flows are intercepted by a dry weather diversion structure that was installed by the City and diverts dry weather flows to the sanitary sewer system. Between the diversion structure located near the intersection of El Paseo Grande and the outfall, water continues to enter the storm drain, including inflow of seawater during high tides and periods of large wave activity, and stagnates at the outfall. It has been identified as a source of bacterial discharge to the beach when wet weather flows flush stagnant water from the storm drain outlet. (Weston, 2008)

The existing storm drain system within Avenida de la Playa drains a watershed of approximately 844 acres. The location of the discharge is within the La Jolla Shores Area of Special Biological Significance, designated as such because of its unique ecological habitat. A second dry weather diverter is the proposed BMP for this site, located closer to the outfall, to direct dry weather flows entering the outfall to the sanitary sewer. The goal of this project is convey all dry weather flows to the sanitary sewer, eliminating stagnation of collected dry weather flows at the outfall and subsequent bacterial growth. (Weston, 2008)

### *Methods*

The purpose of the dry weather monitoring is to characterize flow volumes and the relative contributions of pollutants of concern to the dry weather water quality at the Avenida de la Playa dry weather diversion. Flow monitoring was conducted over 24 hour period, using a HACH 950 flow meter, to gauge fluctuations in dry weather flows.

**Figure 3. Sampling at the Avenida de la Playa Monitoring Site.**

A composite sample was collected using a HACH 900MAX or SD900 peristaltic pump and composited based on time, such that sample aliquots were collected at equally spaced time increments over a 24 hour period. The monitoring location was chosen at a point in the storm drain along Avenida de la Playa between La Jolla Shores Drive and the ocean outfall in an effort to avoid any influence of tidal inflow during monitoring.

### *Results and Discussion*

Dry weather flow samples were collected at this site between April 8$^{th}$ and 9$^{th}$, 2010. General monitoring characteristics and field measurements were recorded in the field data log sheets as presented below:
Odor: none

- Color: none
- Clarity: clear

- Floatable: none
- Deposits: sediment/gravel
- Vegetation: none
- Water flow: flowing
- Temperature: 18 °C

The flow conditions of the site are presented in Figure 4. Time-weighted samples were composited and analyzed to estimate the conditions of general chemistry, trace metals (total and dissolved), microbiology (bacteria), nutrients, and pesticides for the monitoring site as presented in Table 5. Elevated values for conductivity and hardness values indicate that the sample was potentially affected by tidal input. No pesticides were detected from the sample. Results to note are the exceptionally high results for selenium, which exceed California Toxics Rule (CTR) criteria (5 µg/l 4 day average). The source of selenium to the outfall is unknown.

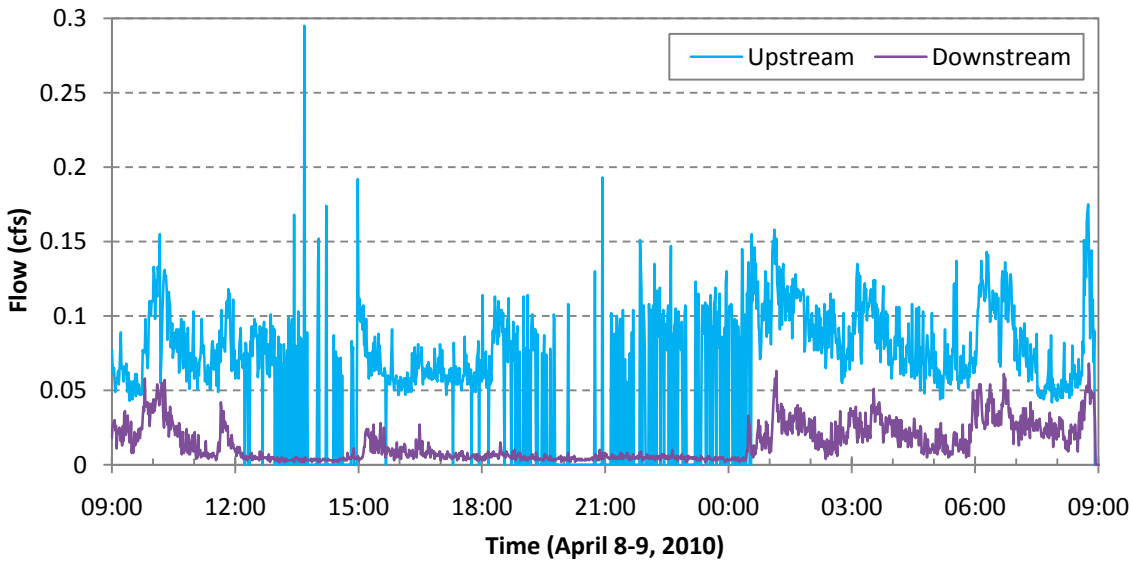


**Figure 4. Flow conditions for dry weather flow at the Avenida de la Playa site. Note: Upstreammonitoring is before the current flow diversion weir; Downstream is after the current flow diversion weir in the storm water pipe.**

**Table 5. Water qaulity conditions at the Avenida de la Playa site.**

| | Constituent | Unit | Result | Total | Dissolved | Ocean Plan Daily Max | Ocean Plan 30-day Avg |
|---|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 5.46 | | | | |
| | pH | pH Units | 8.2 | | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 2,398.2 | | | | |
| | Total Suspended Solids | mg/L | 3.2 | | | | |
| | Turbidity | NTU | 4 | | | | |
| Trace metals | Aluminum (Al) | µg/L | | 56 | 10 | | |
| | Antimony (Sb) | µg/L | | 0.5 | 0.6 | | 1200 |
| | Arsenic (As) | µg/L | | 6.4 | 4.5 | 32 | |
| | Barium (Ba) | µg/L | | 55.3 | 51.6 | | |

| | Constituent | Unit | Result | Total | Dissolved | Ocean Plan Daily Max | Ocean Plan 30-day Avg |
|---|---|---|---|---|---|---|---|
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | | 0.033 |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 4 | |
| | Chromium (Cr) | µg/L | | 0.5 | 0.4 | 8 | |
| | Cobalt (Co) | µg/L | | 0.9 | 0.9 | | |
| | Copper (Cu) | µg/L | | 8.3 | 7.5 | 12 | |
| | Iron (Fe) | µg/L | | 4,182 | 4,001 | | |
| | Lead (Pb) | µg/L | | 0.31 | 0.1 | 8 | |
| | Manganese (Mn) | µg/L | | 8.6 | 5.3 | | |
| | Molybdenum (Mo) | µg/L | | 2 | 2.2 | | |
| | Nickel (Ni) | µg/L | | 6.7 | 6.3 | 20 | |
| | Selenium (Se) | µg/L | | 109.4 | 107.7 | 60 | |
| | Silver (Ag) | µg/L | | 0.8 | 0.8 | 2.8 | |
| | Strontium (Sr) | µg/L | | 3,929 | 3,796 | | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | | 2 |
| | Tin (Sn) | µg/L | | 0.2 | 0.1 | | |
| | Titanium (Ti) | µg/L | | 3.2 | 1.3 | | |
| | Vanadium (V) | µg/L | | 2 | 1.9 | | |
| | Zinc (Zn) | µg/L | | 6.5 | 4 | 80 | |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 5,000 | | | 10,000 | |
| | Fecal Coliform | MPN/100mL | 80 | | | 400 | |
| | Enterococci | CFU/100mL | 790 | | | 104 | |
| Nutrients | Total Nitrogen | mg/L | 4.1 | | | | |
| | Total Phosphorus as P | mg/L | 0.092 | | | | |
| Pesticides | 4,4'-DDE | ng/L | | < 1 | | | |
| | Chlordane-alpha | ng/L | | < 1 | | | 0.000023 |
| | Chlordane-gamma | ng/L | | < 1 | | | 0.000023 |
| | trans-Nonachlor | ng/L | | < 1 | | | 0.000023 |
| | Malathion | ng/L | | < 3 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. WQO for chlordane is also used for alpha, gamma-chlordane and trans-nonachlor.

## Southcrest Park

### *Site Description*

- Address: 4149 Newton Ave., San Diego, CA 92113
- Location: Bounded by 40th Street and 43rd Street on the east and west, Newton Street and Alpha Street on the north and south.
- Latitude and longitude: 32°41′42.19″N and 117°6′14.97″W
- Monitoring date: April 1, 2010
- Weather condition: Raining
- Last rain before the monitoring: not specified

### *Introduction*

Southcrest Park was identified and recommended as a site for BMP implementation due to the potential of the site for a large infiltration BMP. Southcrest Park is slated to be the future site of three infiltration areas in addition to porous pavement throughout the parking areas. These BMPs are designed to reduce runoff from the park and associated parking areas to Chollas Creek. This site is located near the downtown of San Diego, adjacent to 40th Street and 43rd Street on the east and west, Newton Street and Alpha Street on the north and south. (Weston, 2008)

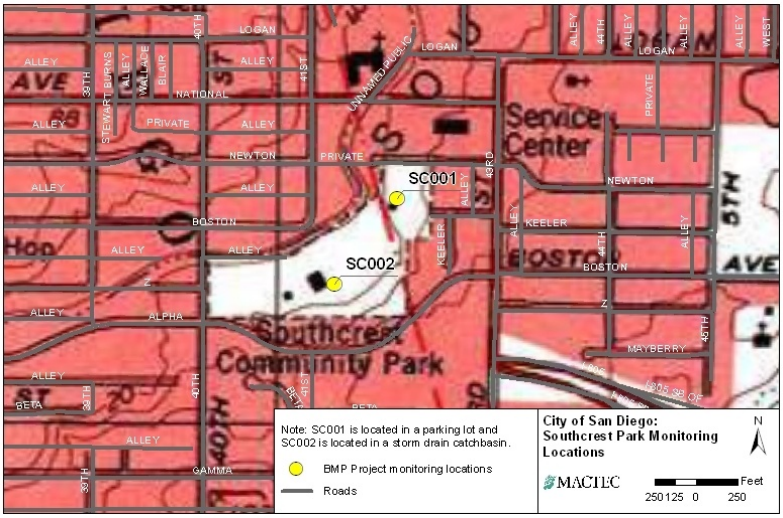


**Figure 5. Southcrest Park Monitoring Locations.**

The project drainage area consists of Southcrest Park and its storm drain system, to which the project BMPs would be connected. New storm drains would divert runoff from the existing storm drain system to the infiltration areas. The goal of the project is to capture and infiltrate a volume from the tributary watershed equal to runoff from the 5-year, 6-hour storm event. In addition, runoff from impervious areas around the park would be infiltrated via pervious pavement or routing flows to the infiltration basins. The project is anticipated to reduce pollutant loadings of pollutants of concern, including bacteria, heavy metals, pesticides, and sediment, and runoff volume entering Chollas Creek. Treatment of runoff for bacteria is intended to achieve a 99 percent reduction in bacteria. (Weston, 2008)

### *Methods*

Two monitoring locations were chosen to represent pre-construction conditions. The first monitoring location (SC001) is a pipe accessed by a manhole in the parking lot located at the east end of the park near Keeler Street. Only flow monitoring was conducted at SC001 because the planned infiltration basin for treating runoff will include influent and effluent water quality monitoring. The drainage area for this sampling location represents the inflow into Infiltration Areas 1 and 2. The second site (SC002) was located in a storm drain catchment, at the south end of the park where flow and water quality monitoring was conducted. The sample for water quality analysis was a flow-weighted composite sample. In addition, three microbiological grab samples were collected. The drainage area characterized by this sample location is the drainage from the parking lot, uninfluenced by surrounding areas (i.e., no influent from outside). The goal of monitoring at this sample location is to determine pollutant load reductions for pervious pavement installations by comparing the observed data from pre- and post-installations.

Equipment for wet weather monitoring included a data-logging flow meter (HACH 950); automated composite sampler; tipping bucket rain gauge; 12-VDC power supply and laboratory cleaned and blanked silicon and/or Teflon tubing.

### *Results and Discussion*

While the monitoring data at monitoring location SC001 include flow data only, data presented for monitoring location SC002 consist of rainfall, flow, and water quality data. Rainfall and flow data were recorded at 1-minute intervals.

Rainfall and flow conditions for SC001 are presented in Figure 6. Rainfall data shown were collected at the SC002 monitoring location. The total rainfall depth and flow volume between 2:00 AM and 8:00 AM on April 1, 2010 were 0.5 inches and 14,226.4 cubic feet, respectively.

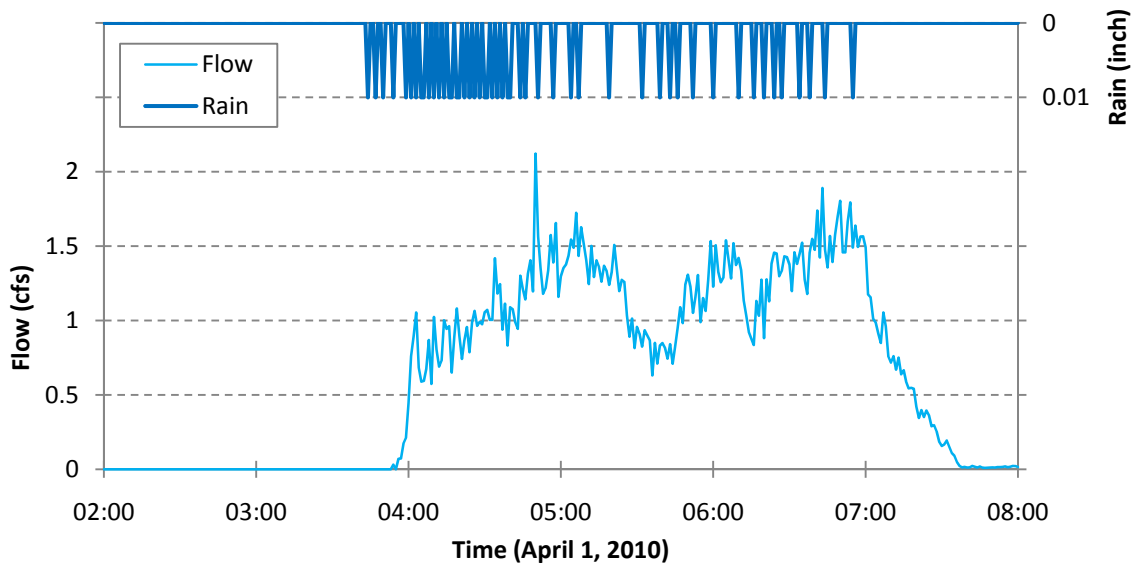


**Figure 6. Rainfall and flow conditions at SC001 in Southcrest Park.**

Rainfall, flow, and water quality data collected on April 1, 2010 at SC002 are presented below. Bacteria concentrations were determined for three grab samples; other water quality data were analyzed using a flow-weighted composite sample. The rainfall hyetograph and flow hydrograph of the event are shown in Figure 7. Actual sampling times for the three bacteria samples and the flow-weighted composite sample are also presented in this figure. The total rainfall depth and flow volume between 2:00 AM and 8:00 AM on April 1, 2010 were 0.5 inches and 230.2 cubic feet, respectively.

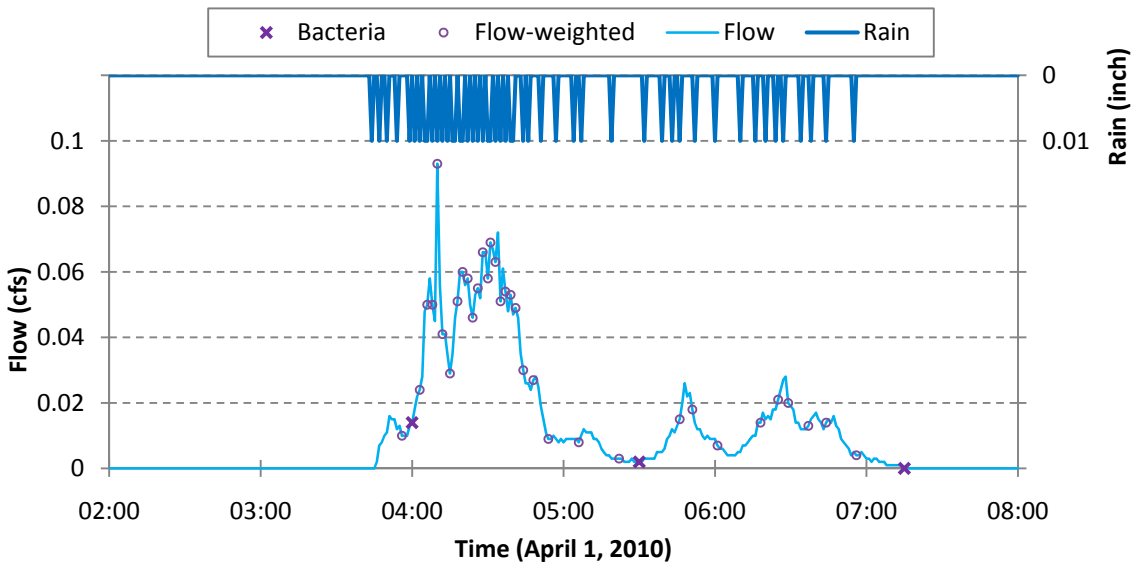


**Figure 7. Rainfall, flow, and sampling time at SC002 in Southcrest Park.**

From the field data log sheet at monitoring location SC002, general runoff characteristics and field measurements are presented below.

- Odor: none
- Color: yellow
- Clarity: clear
- Floatable: trash, foam
- Deposits: sediment
- Vegetation: none
- Water flow: flowing
- Temperature: 14.6 °C
- pH: 6.1
- Conductivity: 63 µS/cm

Monitoring results for general chemistry parameters, trace metals (total and dissolved), bacteria, nutrients, and pesticides at monitoring location SC002 are presented in Table 6. Total nitrogen was reported as less than MDL. No pesticides were detected from the sample. Results indicate that concentrations of some metals, such as copper and zinc, in the runoff are at concentrations of concern, approaching or exceeding CTR criteria.

**Table 6. Water quality conditions at SC002 in Southcrest Park**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.096 | | | |
| | pH | pH Units | 6.4 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 22.8 | | | |
| | Total Suspended Solids | mg/L | 77.7 | | | |
| | Turbidity | NTU | 30.6 | | | |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| Trace metals | Aluminum (Al) | µg/L | | 486 | 30 | |
| | Antimony (Sb) | µg/L | | 0.9 | 0.7 | 14 |
| | Arsenic (As) | µg/L | | 1 | 0.3 | 150 |
| | Barium (Ba) | µg/L | | 34.4 | 10.5 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.8 |
| | Chromium (Cr) | µg/L | | 0.6 | < 0.1 | 11 |
| | Cobalt (Co) | µg/L | | 0.5 | < 0.1 | |
| | Copper (Cu) | µg/L | | 17 | 6.2 | 3 |
| | Iron (Fe) | µg/L | | 647 | 67 | |
| | Lead (Pb) | µg/L | | 7.38 | 0.08 | 0.5 |
| | Manganese (Mn) | µg/L | | 53.9 | 15.2 | |
| | Molybdenum (Mo) | µg/L | | 1 | < 0.2 | |
| | Nickel (Ni) | µg/L | | 1.2 | 0.6 | 15 |
| | Selenium (Se) | µg/L | | < 0.2 | < 0.2 | 5 |
| | Silver (Ag) | µg/L | | 0.5 | < 0.5 | 0.3 |
| | Strontium (Sr) | µg/L | | 70.1 | 55.3 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.1 | 0.1 | |
| | Titanium (Ti) | µg/L | | 16 | 0.8 | |
| | Vanadium (V) | µg/L | | 4.2 | 1.8 | |
| | Zinc (Zn) | µg/L | | 212.4 | 60.3 | 34 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 13,477 | | | |
| | Fecal Coliform | MPN/100mL | 1,082 | | | |
| | Enterococci | CFU/100mL | 4,681 | | | |
| Nutrients | Total Nitrogen | mg/L | < 2 | | | |
| | Total Phosphorus as P | mg/L | 0.541 | | | |
| Pesticides | 4,4'-DDE | ng/L | | < 1 | | 0.00059 |
| | Chlordane-alpha | ng/L | | < 1 | | 0.00057 |
| | Chlordane-gamma | ng/L | | < 1 | | 0.00057 |
| | trans-Nonachlor | ng/L | | < 1 | | 0.00057 |
| | Malathion | ng/L | | < 3 | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.
4. WQO for chlordane is also used for alpha, gamma-chlordane and trans-nonachlor.

The time-dependent concentrations of total coliform, fecal coliform, and Enterococci are presented in Figure 8 along with the storm event hydrograph. As shown in the figure, no first-flush effects were found on bacteria concentrations at this site for the storm event.

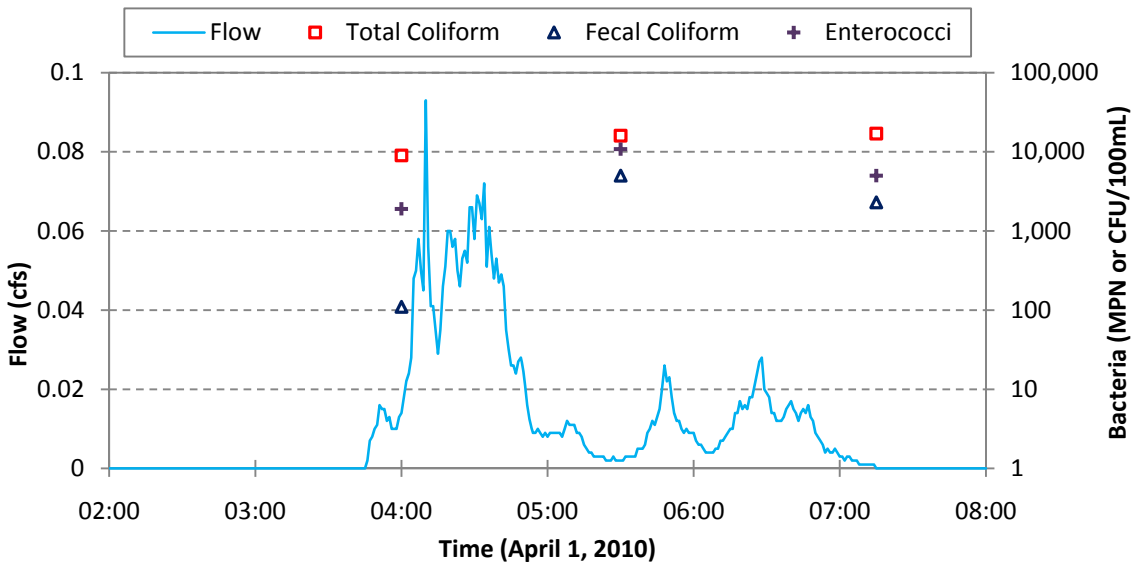


**Figure 8. Time-dependent bacteria concentrations at SC002 in Southcrest Park**

## Mira Mesa Library

### *Site Description*

- Address: 8405 New Salem St., San Diego, CA 92126
- Location: Camino Ruiz and New Salem Street
- Latitude and longitude: 32°54′56.53″N and 117°8′33.77″W
- Monitoring date: March 6, 2010
- Weather condition: Raining
- Last rain prior to the monitoring event: > 72 hours

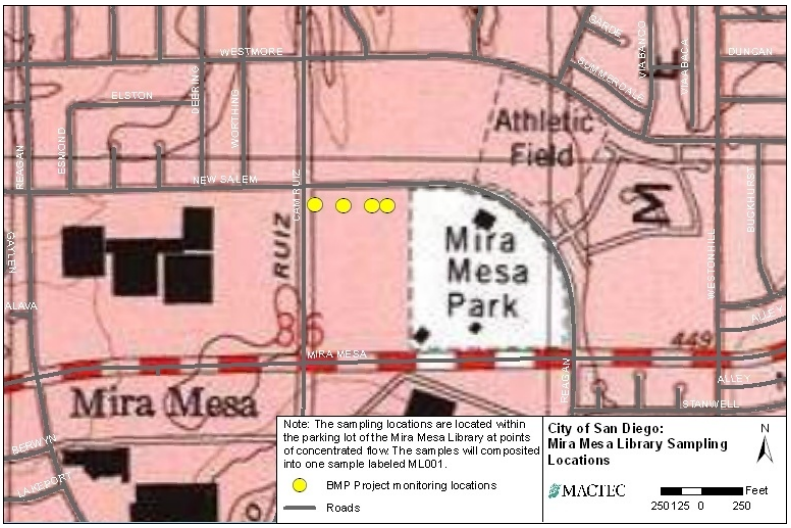


**Figure 9. Mira Mesa Library Monitoring Location.**

### *Introduction*

The BMP identified for future construction at the Mira Mesa Library is a bioretention area designed to treat runoff from the associated parking areas. This site is located in northern San Diego, north of the Miramar Naval Air Station and adjacent to Camino Ruiz and New Salem Street. (Weston, 2008)

The site drains only the Mira Mesa Library facilities. The bioretention area is an unpaved area on the site, which will be excavated, lined, fitted with a gravel reservoir, and vegetated with native soil and plants. Catch basins will be added to collect runoff from the parking lot and the building, and a new storm drain

will be added to direct flow from the catch basins to the biorentention area. Four rain barrels are also planned for building downspouts, which will drain to raised concrete planters. (Weston, 2008)

The goal is to capture runoff from the 5-year, 6-hour storm event from the site and to capture the roof runoff with rain barrels. Pollutants of concern for the project are bacteria, nutrients, sediment and total dissolved solids. The project will be designed to achieve a 99 percent reduction in bacteria in treated flow. (Weston, 2008)

### *Methods*

Pre-construction monitoring occurred at one to three locations onsite; time-weighted samplers were used at the monitoring locations. Because flow at the site is mainly overland sheet flow, flow monitoring was not conducted, and samples collected at the sites were collected on a time-weighted basis and combined to form one composite site representative of the parking lot runoff for water quality monitoring.

### *Results and Discussion*

Rainfall records at 1-minute intervals and 0.01-inch resolution were reported from the Mira Mesa Library site. A total of 0.07 inches of rainfall was recorded between 3/6/2010 17:00 and 3/7/2010 07:00 at this site. The hyetograph of the event is presented in Figure 10. Sample collection times for bacteria are also presented in this figure.

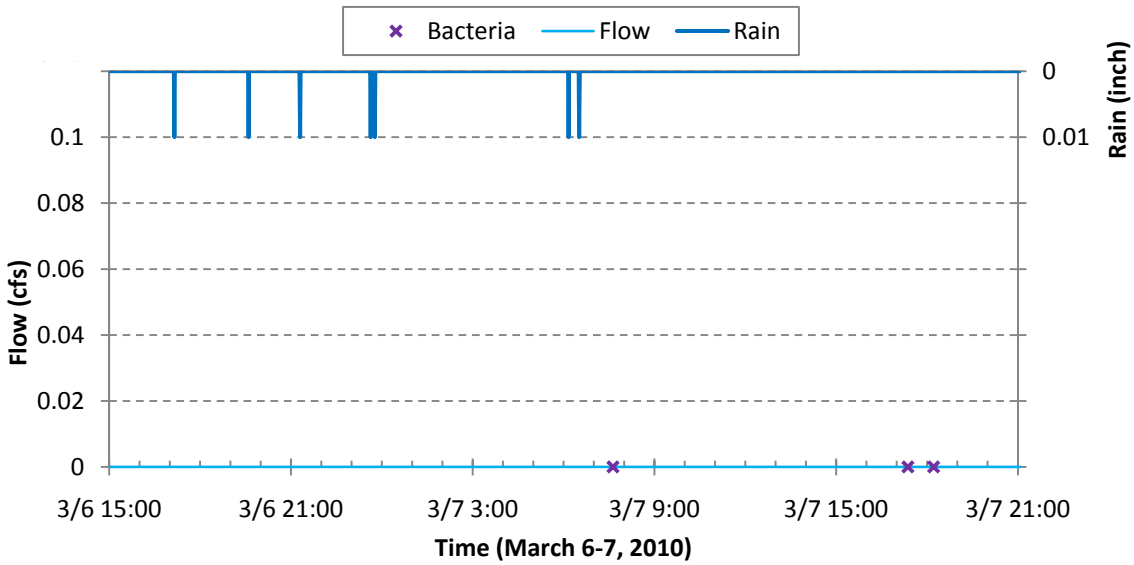


**Figure 10. Rainfall and sampling time at the Mira Mesa Library site. No flow data were reported from this site.**

From the field data log sheet, general runoff characteristics and field measurements were recorded as:

- Odor: none
- Color: brown
- Clarity: clear
- Floatable: sheen, leaves
- Deposits: sediment/gravel
- Vegetation: none
- Water flow: flowing

- Temperature: 12.1 °C
- pH: 7.29
- Conductivity: 119.3 µs/cm

Results of the water quality data analysis are presented below. General chemistry parameters, trace metals (total dissolved), bacteria, nutrients, and pesticides at the Mira Mesa Library site are presented in Table 7. Conductivity and pH were not reported in the laboratory analysis, but were measured in the field. No pesticides were detected from the sample. A total of three samples were analyzed for the bacteria concentrations. Results indicate that concentrations of copper in the runoff are at concentrations of concern, approaching or exceeding water quality standards.

**Table 7. Water quality conditions at the Mira Mesa Library site.**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | | | | |
| | pH | pH Units | | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 25.5 | | | |
| | Total Suspended Solids | mg/L | 71.5 | | | |
| | Turbidity | NTU | 19.1 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 351 | 20 | |
| | Antimony (Sb) | µg/L | | 1.7 | 1.5 | 14 |
| | Arsenic (As) | µg/L | | 0.9 | 0.6 | 150 |
| | Barium (Ba) | µg/L | | 16 | 8 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.8 |
| | Chromium (Cr) | µg/L | | 0.7 | 0.3 | 11 |
| | Cobalt (Co) | µg/L | | < 0.1 | < 0.1 | |
| | Copper (Cu) | µg/L | | 16 | 10.7 | 3 |
| | Iron (Fe) | µg/L | | 359 | 57 | |
| | Lead (Pb) | µg/L | | 3.14 | < 0.05 | 0.6 |
| | Manganese (Mn) | µg/L | | 33.2 | 0.4 | |
| | Molybdenum (Mo) | µg/L | | 0.2 | 0.4 | |
| | Nickel (Ni) | µg/L | | 1.8 | 1.1 | 16 |
| | Selenium (Se) | µg/L | | < 0.2 | < 0.2 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | 0.5 | 0.4 |
| | Strontium (Sr) | µg/L | | 55.2 | 52.6 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.5 | 0.5 | |
| | Titanium (Ti) | µg/L | | 7.1 | 0.9 | |
| | Vanadium (V) | µg/L | | 3.5 | 2.6 | |
| | Zinc (Zn) | µg/L | | 58.8 | 27.5 | 38 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 878 | | | |
| | Fecal Coliform | MPN/100mL | 47 | | | |
| | Enterococci | CFU/100mL | 362 | | | |
| Nutrients | Total Nitrogen | mg/L | 2.5 | | | |
| | Total Phosphorus as P | mg/L | 0.356 | | | |
| Pesticides | 4,4'-DDE | ng/L | | < 1 | | 0.00059 |
| | Chlordane-alpha | ng/L | | < 1 | | 0.00057 |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| | Chlordane-gamma | ng/L | | < 1 | | 0.00057 |
| | trans-Nonachlor | ng/L | | < 1 | | 0.00057 |
| | Malathion | ng/L | | < 3 | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.
4. WQO for chlordane is also used for alpha, gamma-chlordane and trans-nonachlor.

Time-dependent concentrations of total coliform, fecal coliform, and Enterococci are presented in Figure 11. As shown in the figure, Enterococci bacteria concentrations were measured at fairly consistent levels across the period of the wet weather event, while fecal coliform concentrations decreased over the same period. No flow data were reported from this site for the storm event.

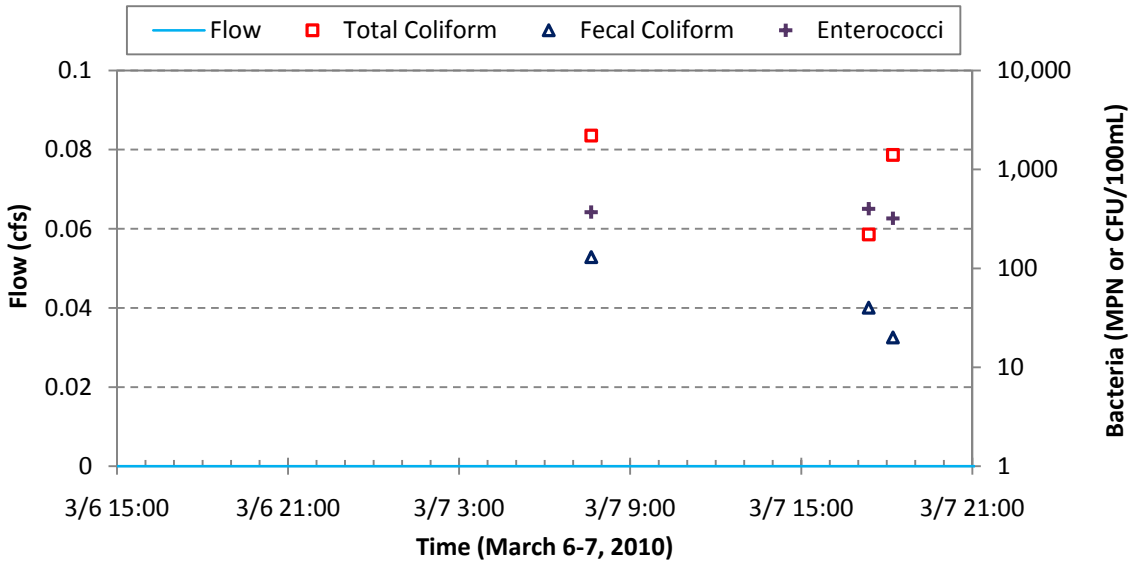


**Figure 11. Time-dependent bacteria concentrations at the Mira Mesa Library site. No flow data were reporte from this site.**

# Osler

### *Site Description*

- Location: Osler Street and Ulrich Street
- Latitude and longitude: 32°47′31.20″N and 117°10′32.40″W
- Site ID: CHR04
- Monitoring event #1
    - Date: December 7, 2009
    - Weather condition: Raining
    - Last rain prior to monitoring event: > 72 hours
- Monitoring event #2
    - Date: January 18, 2010
    - Weather condition: Raining
    - Last rain prior to monitoring event: > 72 hours

### *Introduction*

Osler Street is located on the northern end of Linda Vista Park. Storm water flows from the park, associated facilities, a neighboring elementary school, and a surrounding high-density neighborhood drain to an existing 24-inch storm drain that traverses the park and discharges into Tecolote Canyon. The storm drain serves a drainage area of approximately 25 acres. Pollutants of concern during storm events were determined to be trash, sediment, and oil and grease. The planned BMP for this site includes an inline hydrodynamic separator in the existing storm drain system. The project goal for BMP performance is 100 percent capture of all floatables up to the unit's design treatment capacity. Unit design will also include treating of 75 to 90 percent of the annual runoff volume and removing 80 percent of the total suspended solids load and greater than 90 percent of the floatable free oil. The design flow capacity for the unit will be the 5-year storm event. (MWH, 2008)

### *Methods*

Wet season monitoring was conducted during the early part of the 2009-2010 wet season, and consisted of automated flow monitoring and pollutograph sampling during two wet weather events. Samples were collected in the storm drain pipe. Eight pollutographs samples and a minimum of eight bacteria grab samples were collected during each sampling event. Monitoring was conducted using an automated flow meter and logger, and an automated sampler.

Pollutograph samples consisted of eight discrete samples collected at specific intervals during the storm event. The resulting pollutographs estimate contaminant discharge as a function of time. A flow meter was used to monitor the stage and calculate flows during the storm event. The last sample was collected at a point when the rain ended, determined as six hours or less of 0.10 inch of rain, when flow had decreased 50 percent from peak flow rates, and seven samples have previously been collected. A sample was collected every 30 minutes as the level in the storm water conveyance was rising and every 1 to 2 hours as the water level was decreasing.

### *Results and Discussion*

Rainfall, flow, and water quality data were reported from the Osler site from two storm events dated on December 7, 2009 and January 18, 2010. Rainfall and flow data were recorded at 1-minute intervals. The

hyetograph and hydrograph of event #1 is presented in Figure 12. A total of 0.84 inches rainfall was recorded between 5:00 AM and 11:24 AM on December 7, 2009. The total flow volume at the monitoring location was 16,376.9 cubic feet during the same period. Twelve samples were collected and analyzed for bacteria; eight samples were collected and analyzed for other water quality constituents. Sample collection times are also presented in Figure 12.

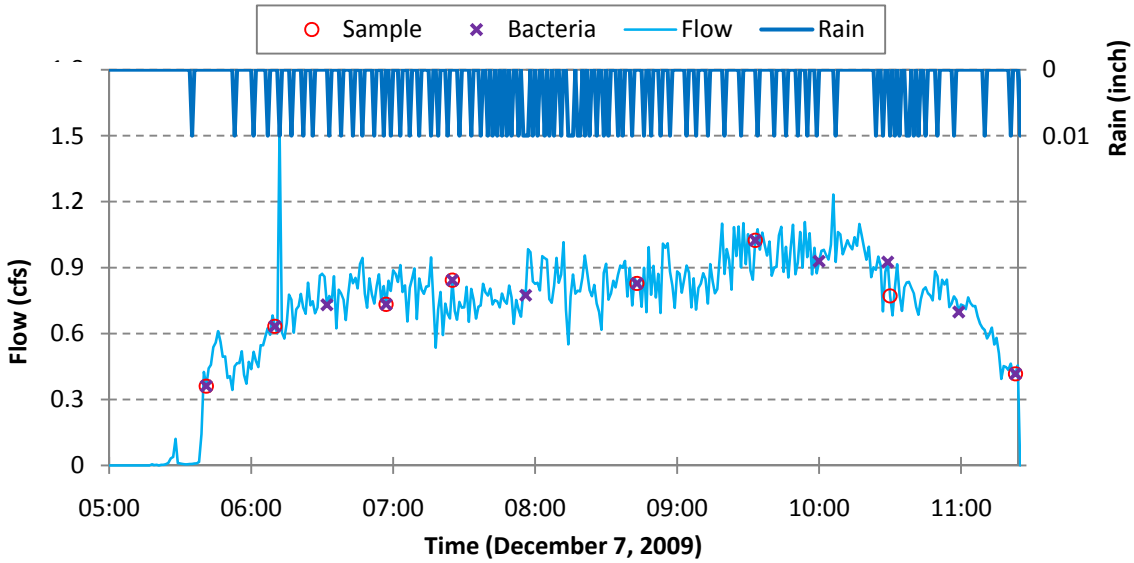


**Figure 12. Rainfall, flow, and sampling time at the Osler site (Monitoring event #1). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by the x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #1 are presented below.

- Odor: musty
- Color: brown
- Clarity: slightly cloudy
- Floatable: twigs, rubber gloves, cloths
- Deposits: fine particles
- Vegetation: normal
- Water flow: flowing

Results of sample analysis for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for the first wet weather sampling event at the Osler site are presented in Table 8. Pesticide data were not reported. Data shown indicates that concentrations of metals such as copper, lead, and zinc could possibly cause an exceedance of CTR criteria for these parameters in the receiving water for the runoff, based on the hardness collected at the time of sample.

**Table 8. Water quality conditions at the Osler site (Monitoring event #1).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.173 | | | |
| | pH | pH Units | 7.2 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 31.9 | | | |
| | Total Suspended Solids | mg/L | 120.1 | | | |
| | Turbidity | NTU | 44.0 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 745.4 | 82.0 | |
| | Antimony (Sb) | µg/L | | 2.3 | 1.6 | 14 |
| | Arsenic (As) | µg/L | | 1.3 | 1.2 | 150 |
| | Barium (Ba) | µg/L | | 37.8 | 12.6 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | 0.2 | < 0.2 | 1.0 |
| | Chromium (Cr) | µg/L | | 4.8 | 3.4 | 11 |
| | Cobalt (Co) | µg/L | | 0.7 | 0.3 | |
| | Copper (Cu) | µg/L | | 33.1 | 17.4 | 4 |
| | Iron (Fe) | µg/L | | 1,080.7 | 163.7 | |
| | Lead (Pb) | µg/L | | 10.9 | 2.9 | 0.7 |
| | Manganese (Mn) | µg/L | | 81.5 | 41.2 | |
| | Molybdenum (Mo) | µg/L | | 3.3 | 3.1 | |
| | Nickel (Ni) | µg/L | | 9.2 | 6.7 | 20 |
| | Selenium (Se) | µg/L | | < 0.2 | 0.2 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.6 |
| | Strontium (Sr) | µg/L | | 90 | 75.1 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.9 | 1.1 | |
| | Titanium (Ti) | µg/L | | 31.4 | 4.0 | |
| | Vanadium (V) | µg/L | | 12.2 | 6.7 | |
| | Zinc (Zn) | µg/L | | 247.6 | 146.2 | 46 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 23,687 | | | |
| | Fecal Coliform | MPN/100mL | 7,274 | | | |
| | Enterococci | CFU/100mL | 20,483 | | | |
| Nutrients | Total Nitrogen | mg/L | 4.6 | | | |
| | Total Phosphorus as P | mg/L | 0.375 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria for event #1 at the Osler site are presented with the event hydrograph in Figures 13 through 17. As shown in the figures, concentrations of TSS and trace metals exhibited a first-flush effect; bacteria did not.

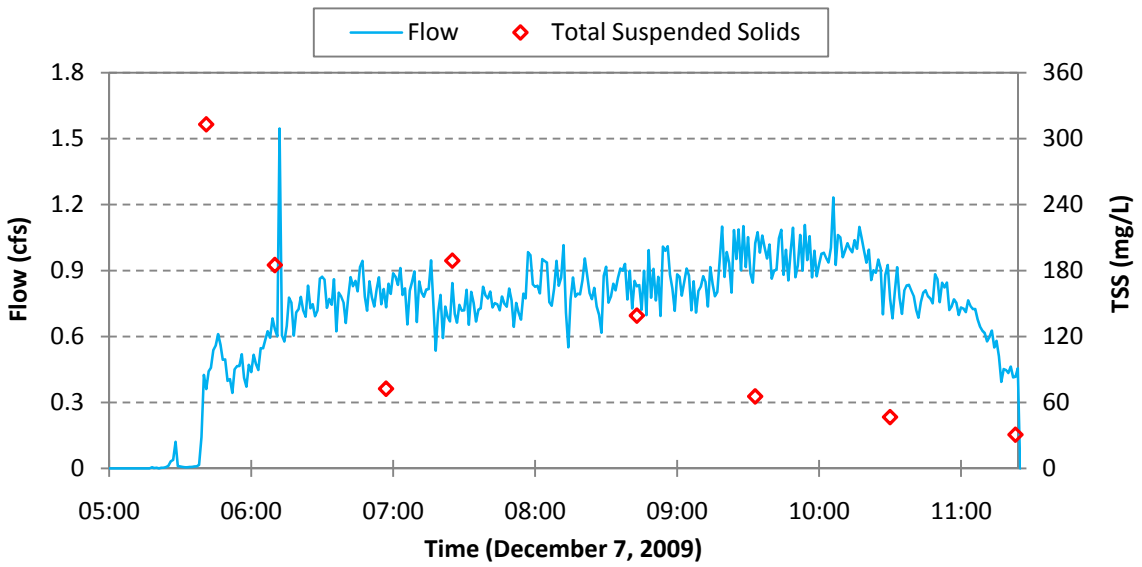


**Figure 13. Hydrograph and pollutograph (TSS) at the Osler site (Monitoring event #1).**

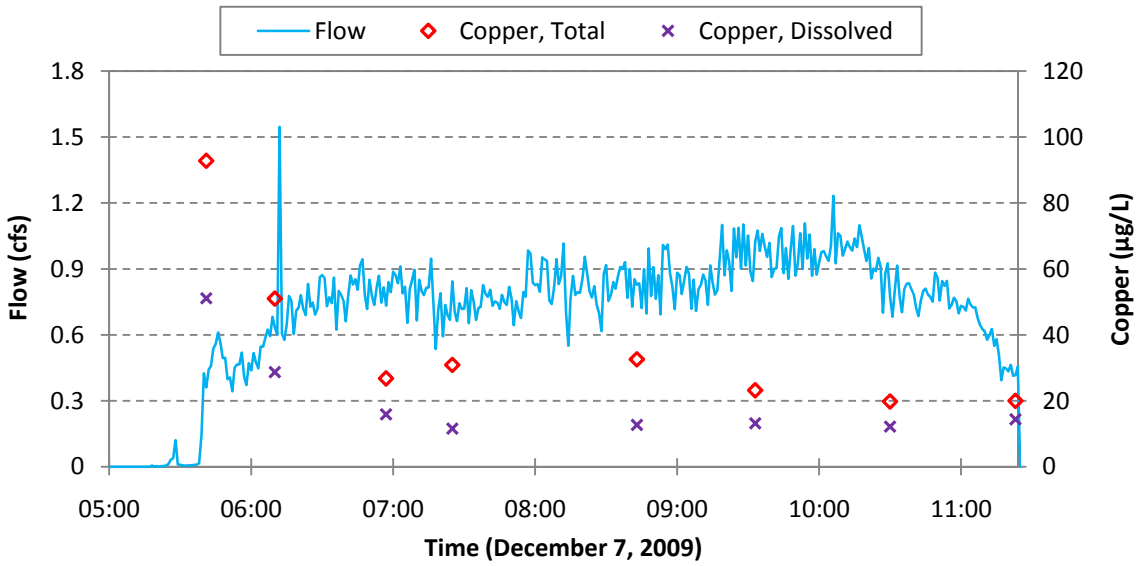


**Figure 14. Hydrograph and pollutograph (Copper) at the Osler site (Monitoring event #1).**

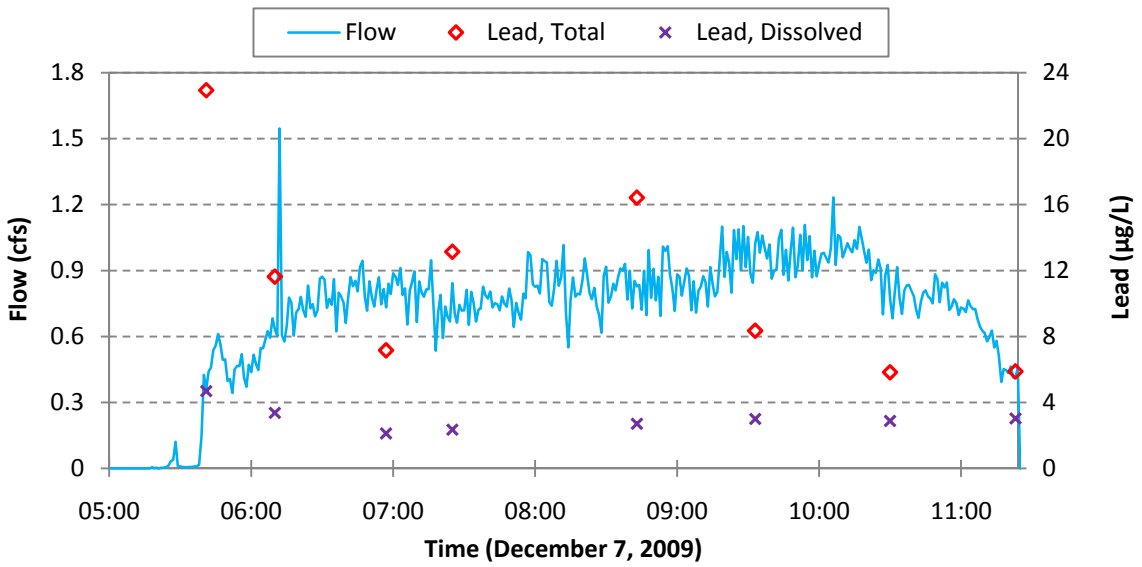


**Figure 15. Hydrograph and pollutograph (Lead) at the Osler site (Monitoring event #1).**

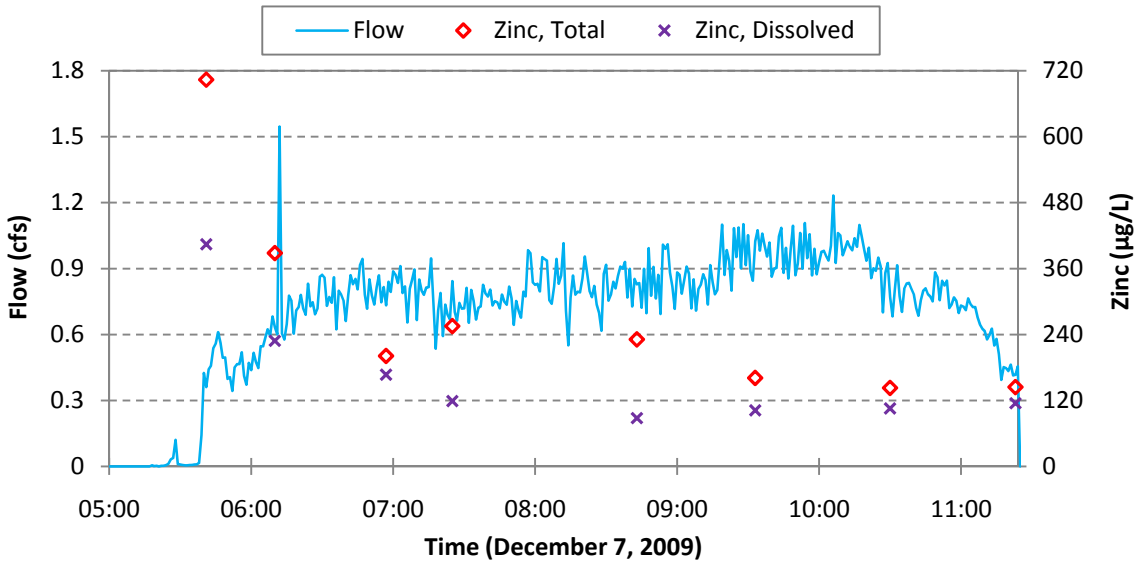


**Figure 16. Hydrograph and pollutograph (Zinc) at the Osler site (Monitoring event #1).**

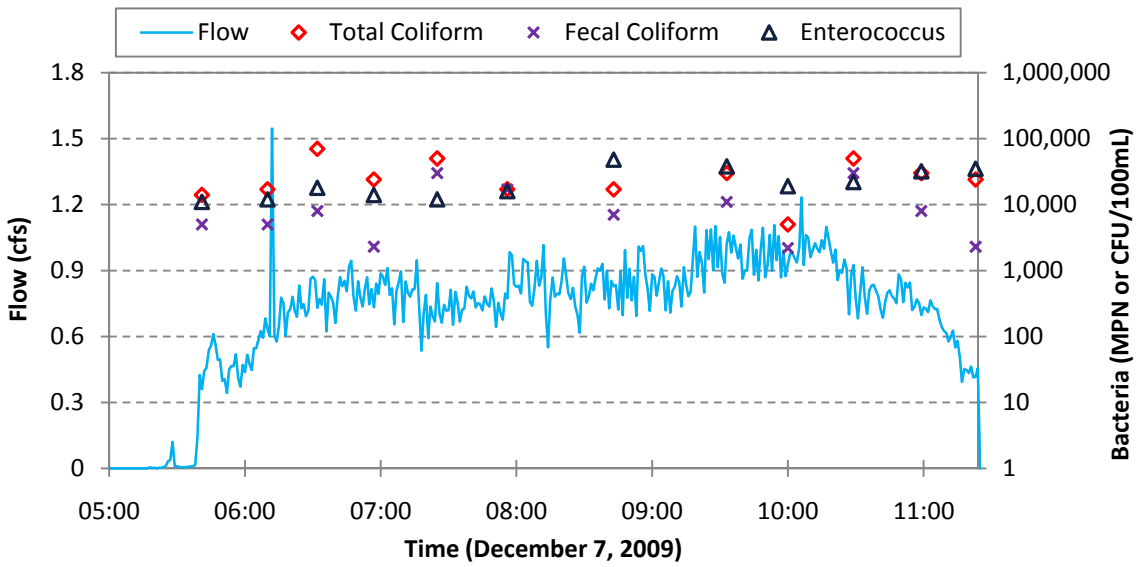


**Figure 17. Hydrograph and pollutograph (Bacteria) at the Osler site (Monitoring event #1).**

The hyetograph and hydrograph for the second wet weather monitoring event is presented in Figure 18. A total of 1.84 inches rainfall was recorded between 2:00 PM and 5:46 PM on January 18, 2010. The total flow volume at the monitoring location was 12,000.8 cubic feet during the same period. Bacteria concentrations are presented from nine individual samples, while eight samples were taken for analysis for other water quality constituents. Times during the event when samples were collected are also presented in Figure 18.

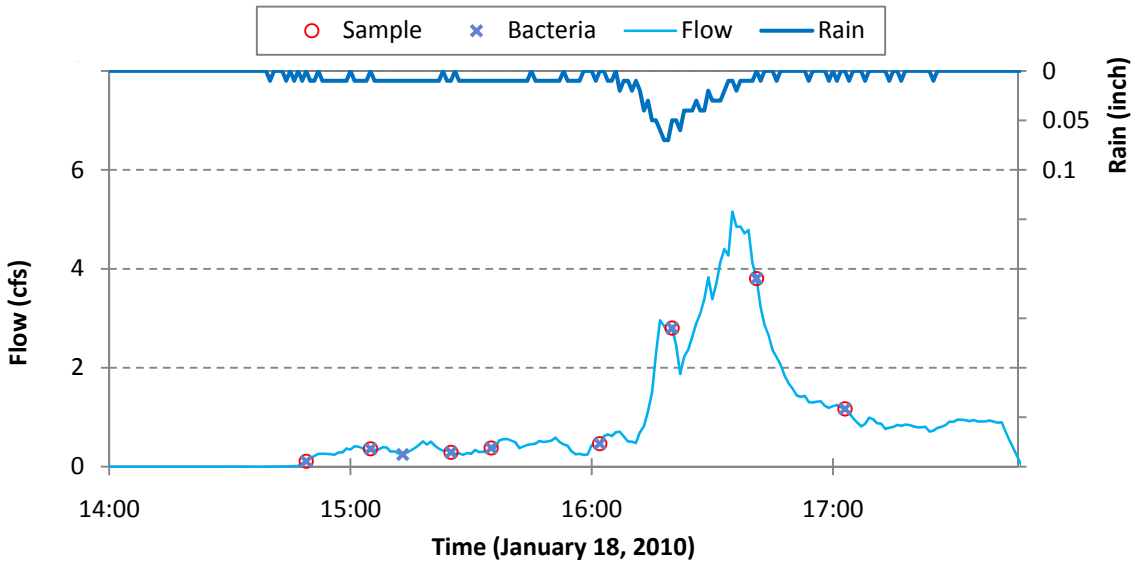


**Figure 18. Rainfall, flow, and sampling time at the Osler site (Monitoring event #2). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by the x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #2 are presented below.

- Odor: none
- Color: brown
- Clarity: slightly cloudy
- Floatable: none
- Deposits: none
- Vegetation: none
- Water flow: flowing

The results of analysis for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #2 at the Osler site are presented in Table 9. Pesticide data were not reported. Data indicate that levels of aluminum in the runoff at this site often exceeded standards for drinking water, while levels of copper and zinc indicate these parameters may cause an exceedance of CTR criteria in the receiving water for the discharge of storm water.

**Table 9. Water quality conditions at the Osler site (Monitoring event #2).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.065 | | | |
| | pH | pH Units | 6.9 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 13.2 | | | |
| | Total Suspended Solids | mg/L | 217.0 | | | |
| | Turbidity | NTU | 92.3 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 1,212.8 | 116.6 | |
| | Antimony (Sb) | µg/L | | 1.1 | 0.4 | 14 |
| | Arsenic (As) | µg/L | | 1.3 | 0.7 | 150 |
| | Barium (Ba) | µg/L | | 52.0 | 7.2 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | 0.3 | < 0.2 | 0.5 |
| | Chromium (Cr) | µg/L | | 3.0 | 1.2 | 11 |
| | Cobalt (Co) | µg/L | | 1.4 | < 0.1 | |
| | Copper (Cu) | µg/L | | 21.6 | 4.6 | 2 |
| | Iron (Fe) | µg/L | | 1,343.20 | 96.8 | |
| | Lead (Pb) | µg/L | | 23.4 | 0.9 | 0.2 |
| | Manganese (Mn) | µg/L | | 101 | 7.2 | |
| | Molybdenum (Mo) | µg/L | | 0.5 | 0.6 | |
| | Nickel (Ni) | µg/L | | 3.4 | 1.0 | 9 |
| | Selenium (Se) | µg/L | | 0.3 | 0.3 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.1 |
| | Strontium (Sr) | µg/L | | 43.3 | 27.8 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.2 | 0.1 | |
| | Titanium (Ti) | µg/L | | 47.6 | 5.3 | |
| | Vanadium (V) | µg/L | | 6.5 | 1.7 | |
| | Zinc (Zn) | µg/L | | 162.5 | 25 | 22 |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 28,403 | | | |
| | Fecal Coliform | MPN/100mL | 4,912 | | | |
| | Enterococci | CFU/100mL | 38,711 | | | |
| Nutrients | Total Nitrogen | mg/L | < 2 | | | |
| | Total Phosphorus as P | mg/L | 0.589 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria of event #2 at the Osler site are presented with the event hydrograph in Figures 19 through 23. As shown in the following pollutographs, a first-flush effect was evident for TSS and trace metals, but not for bacteria levels.

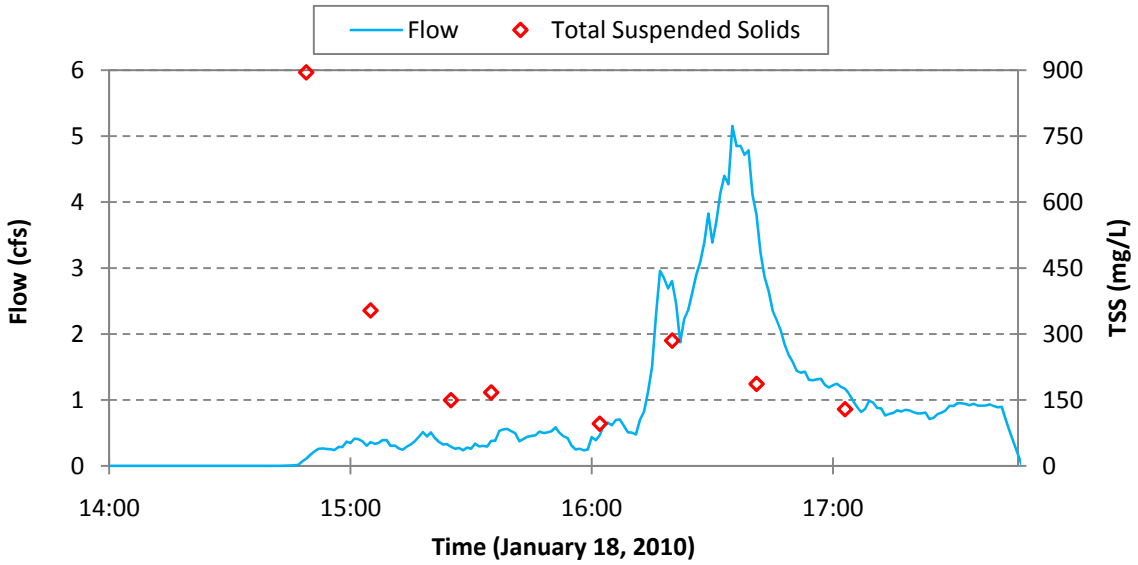


**Figure 19. Hydrograph and pollutograph (TSS) at the Osler site (Monitoring event #2).**

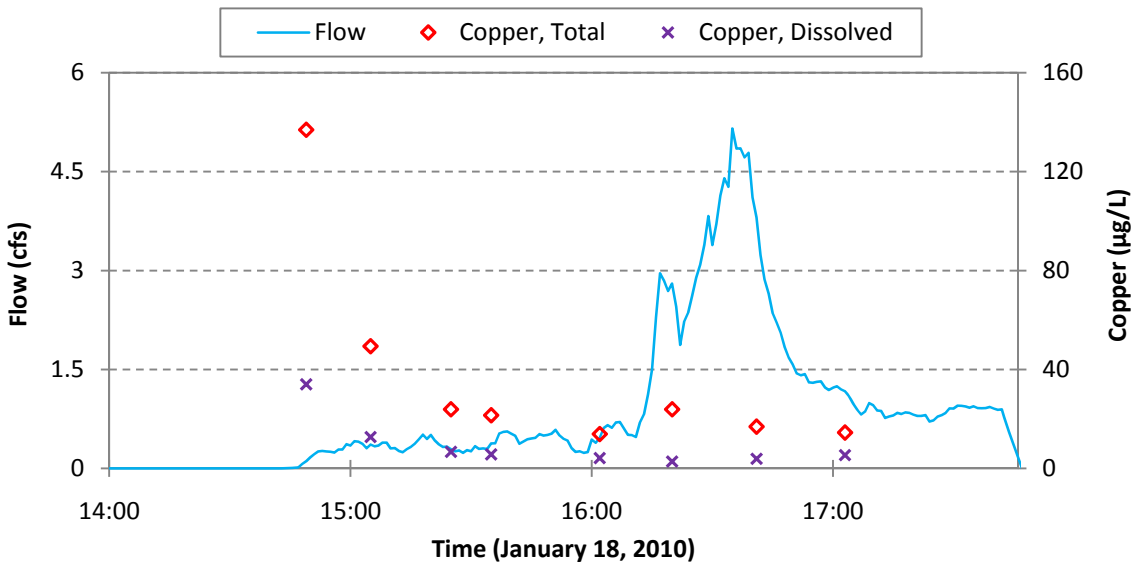


**Figure 20. Hydrograph and pollutograph (Copper) at the Osler site (Monitoring event #2).**

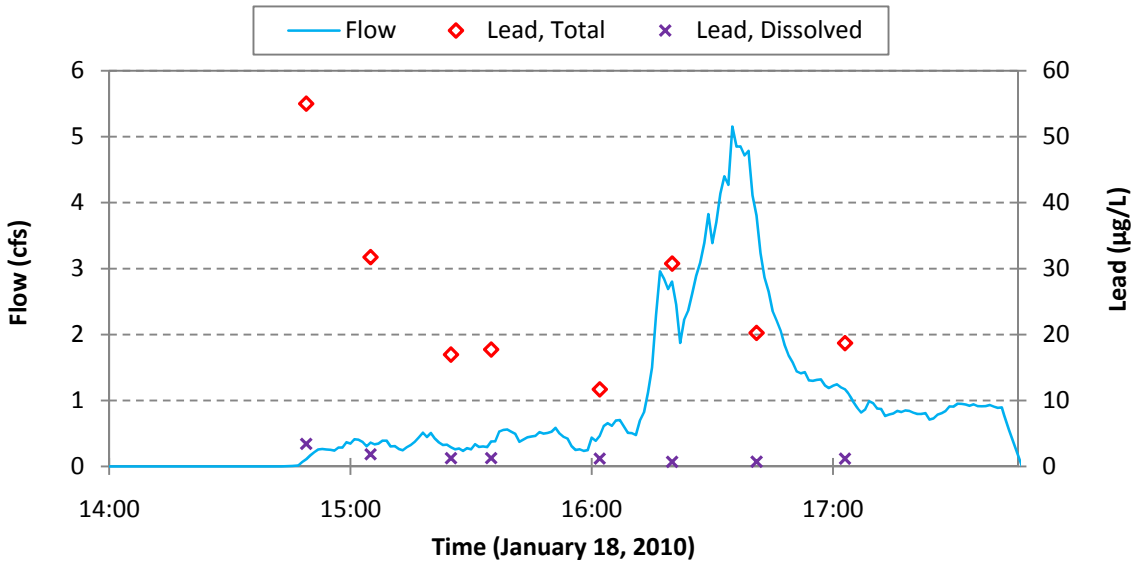


**Figure 21. Hydrograph and pollutograph (Lead) at the Osler site (Monitoring event #2).**

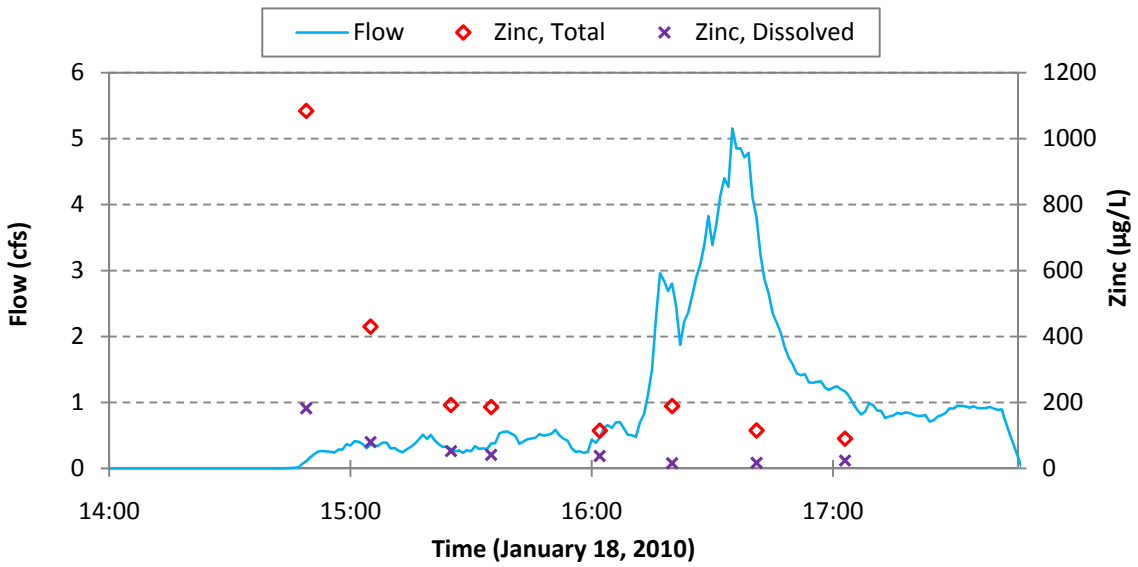


**Figure 22. Hydrograph and pollutograph (Zinc) at the Osler site (Monitoring event #2).**

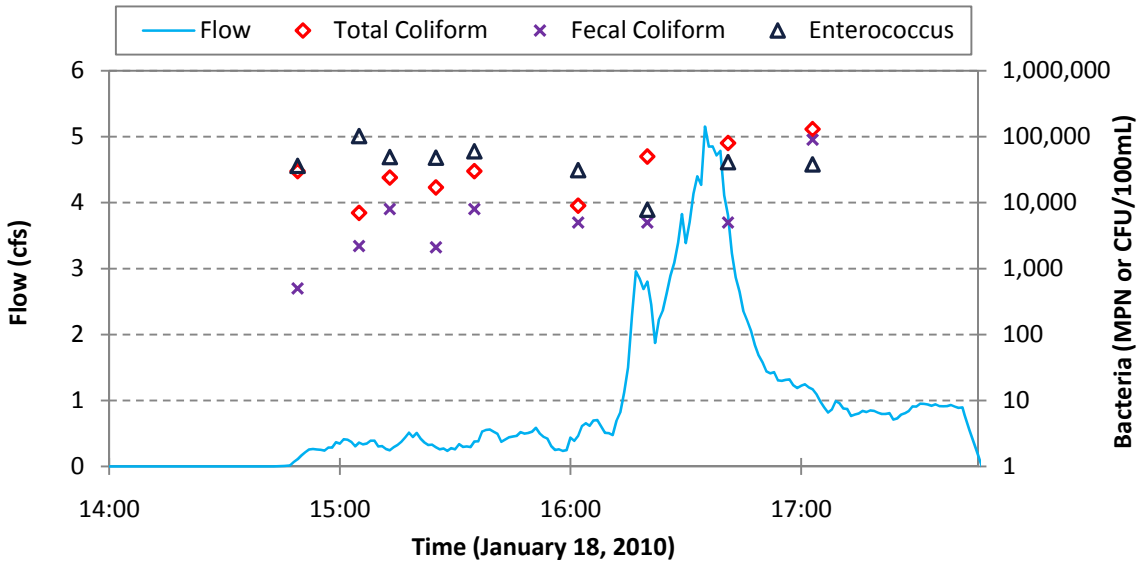


**Figure 23. Hydrograph and pollutograph (Bacteria) at the Osler site (Monitoring event #2).**

# Bannock Avenue Neighborhood

### *Site Description*

- Address: 4421 Bannock Avenue, San Diego CA
- Location: Manitou Way and Bannock Avenue
- Latitude and longitude: 32°49′58.92″N and 117°11′50.26″W
- Monitoring event #1
    - Date: December 7, 2009
    - Weather condition: Raining
    - Last rain prior to monitoring event: > 72 hours
- Monitoring event #2
    - Date: January 18, 2010
    - Weather condition: Raining
    - Last rain prior to monitoring event: > 72 hours

### *Introduction*

An existing 30-inch reinforced concrete pipe located in North Clairemont Park serves an approximate 65-acre tributary area. BMPs planned for construction for this site include vegetated planter areas with curb cuts to allow flows to enter and exit the planter areas, pervious sidewalks, trash segregation units in the storm drain followed in series with and bacterial treatment BMP system. Flows will be diverted through the treatment system and then back to the natural drainage at the existing storm drain system outlet headwall. The diversion structure will be sized to divert the 85$^{th}$ percentile storm event. The goal of the project is to reduce the pollutant load and volume of runoff to the storm drain. Pollutants of concern are bacteria, heavy metals, nutrients, pesticides, and sediment. (Weston, 2008)

The performance goal for planter BMPs is to capture and infiltrate a volume from approximately the first 0.25 inch of rainfall at the paved section tributary to each planter area. The treatment goal for planters BMPs is to remove 99 percent of bacteria in treated water. The treatment goal for the hydrodynamic separator and bacterial treatment BMP system is full treatment up to the 85$^{th}$ percentile flow rate. (Weston, 2008)

### *Methods*

Wet season monitoring was conducted during the early part of the 2009-2010 wet season, and consisted of automated flow monitoring and pollutograph sampling during two wet weather events. Samples were collected in the storm drain pipe. Eight pollutographs samples and at least eight bacteria grab samples were collected during each sampling event. Monitoring was conducted using an automated flow meter and logger, and an automated sampler.

Pollutograph samples consisted of eight discrete samples collected at specific intervals during the storm event. The resulting pollutographs estimate contaminant discharge as a function of time. A flow meter was used to monitor the stage and calculate flows during the storm event. The last sample was collected at a point when the rain ended, determined as six hours or less of 0.10 inch of rain, when flow had decreased 50 percent from peak flow rates, and seven samples have previously been collected. A sample was collected every 30 minutes as the level in the storm water conveyance was rising and every 1 to 2 hours as the water level was decreasing.

### *Results and Discussion*

Rainfall, flow, and water quality data were reported for the Bannock Avenue Neighborhood monitoring site for two storm events that occurred on December 7, 2009 and January 18, 2010. Rainfall and flow data were recorded at 1-minute intervals. The hyetograph and hydrograph of the first wet weather event (event #1) is presented in Figure 24. A total of 0.85 inches rainfall was recorded between 5:00 AM and 11:29 AM on December 7, 2009. The total flow volume at the monitoring location was 93,565.0 cubic feet during the same period. Twelve samples were collected for bacteriological analysis and eight samples were collected for analysis for other water quality constituents. Sample collection times are also presented in Figure 24.

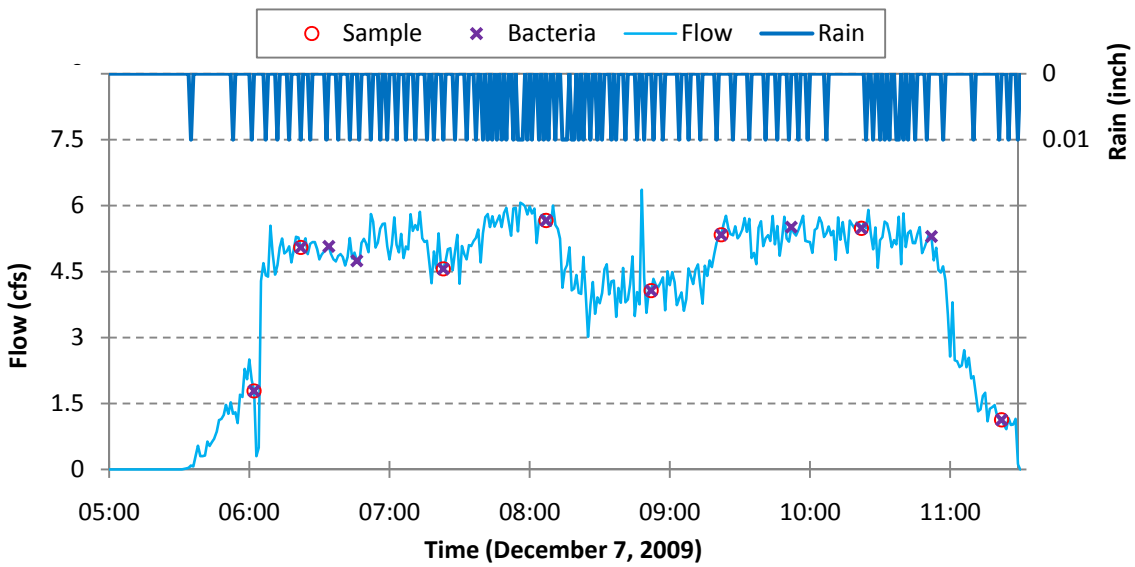


**Figure 24. Rainfall, flow, and sampling time at the Bannock Avenue Neighborhood site (Monitoring event #1). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by the x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #1 are presented below:

- Odor: none
- Color: brown
- Clarity: slightly cloudy
- Floatable: trash, bubbles/foam
- Deposits: sediment/gravel, fine particles
- Vegetation: limited
- Water flow: flowing

The results of analysis for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #1 at the Bannock Avenue Neighborhood site are presented in Table 10. Pesticide

concentrations were not reported. Data indicate that concentrations of copper and zinc are at levels of concern.

**Table 10. Water quality conditions at the Bannock Avenue Neighborhood site (Monitoring event #1).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.118 | | | |
| | pH | pH Units | 7.1 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 21.3 | | | |
| | Total Suspended Solids | mg/L | 88.4 | | | |
| | Turbidity | NTU | 54.3 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 651.3 | 61.7 | |
| | Antimony (Sb) | µg/L | | 2.9 | 1.4 | 14 |
| | Arsenic (As) | µg/L | | 5.4 | 5.3 | 150 |
| | Barium (Ba) | µg/L | | 40.4 | 11.6 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | 0.3 | < 0.2 | 0.7 |
| | Chromium (Cr) | µg/L | | 5 | 3.5 | 11 |
| | Cobalt (Co) | µg/L | | 0.4 | < 0.1 | |
| | Copper (Cu) | µg/L | | 44.6 | 21.5 | 2 |
| | Iron (Fe) | µg/L | | 898.9 | 115 | |
| | Lead (Pb) | µg/L | | 13.5 | 2.4 | 0.4 |
| | Manganese (Mn) | µg/L | | 58.4 | 19.6 | |
| | Molybdenum (Mo) | µg/L | | 1.1 | 2.4 | |
| | Nickel (Ni) | µg/L | | 7.7 | 5.4 | 14 |
| | Selenium (Se) | µg/L | | < 0.2 | < 0.2 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.3 |
| | Strontium (Sr) | µg/L | | 67.1 | 53.6 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.7 | 0.4 | |
| | Titanium (Ti) | µg/L | | 22.7 | 3.3 | |
| | Vanadium (V) | µg/L | | 6.6 | 3.7 | |
| | Zinc (Zn) | µg/L | | 201.5 | 114.5 | 32 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 65,486 | | | |
| | Fecal Coliform | MPN/100mL | 10,017 | | | |
| | Enterococci | CFU/100mL | 12,758 | | | |
| Nutrients | Total Nitrogen | mg/L | 3.2 | | | |
| | Total Phosphorus as P | mg/L | 0.477 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria from event #1 at the Bannock Avenue Neighborhood site are presented with the event hydrograph in Figures 25 through 29. As shown in the figures, first-flush effects were evident for zinc and copper, but not for other constituents.

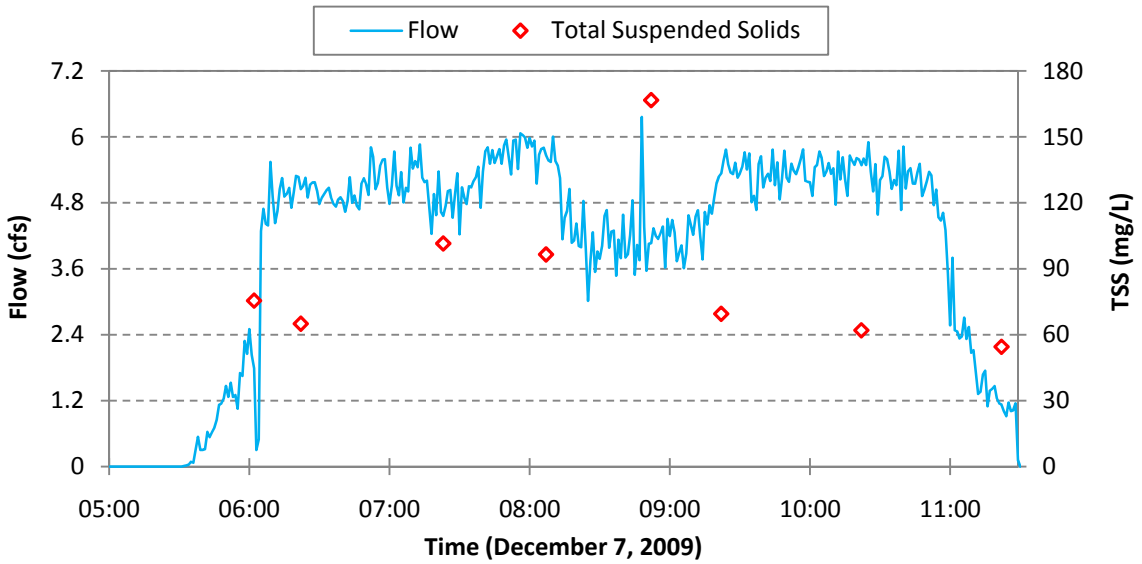


**Figure 25. Hydrograph and pollutograph (TSS) at the Bannock Avenue Neighborhood site (Monitoring event #1).**

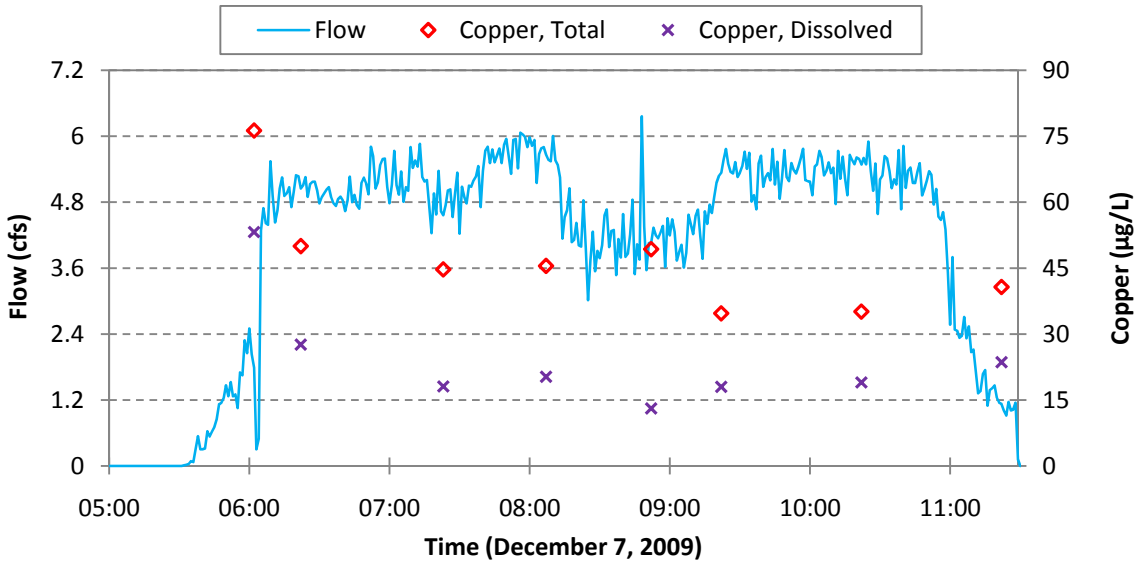


**Figure 26. Hydrograph and pollutograph (Copper) at the Bannock Avenue Neighborhood site (Monitoring event #1).**

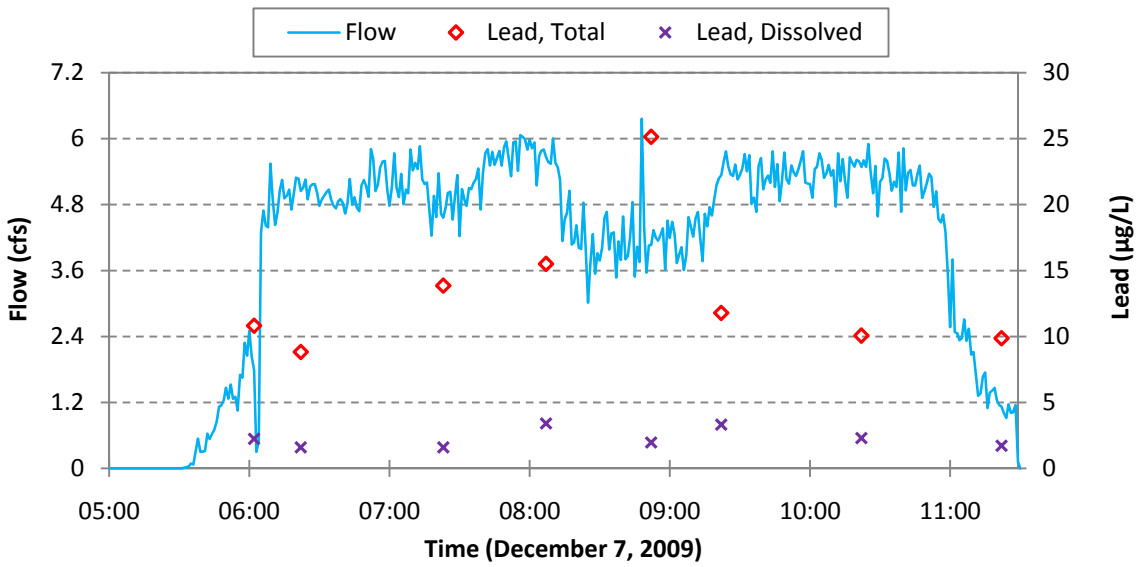


**Figure 27. Hydrograph and pollutograph (Lead) at the Bannock Avenue Neighborhood site (Monitoring event #1).**

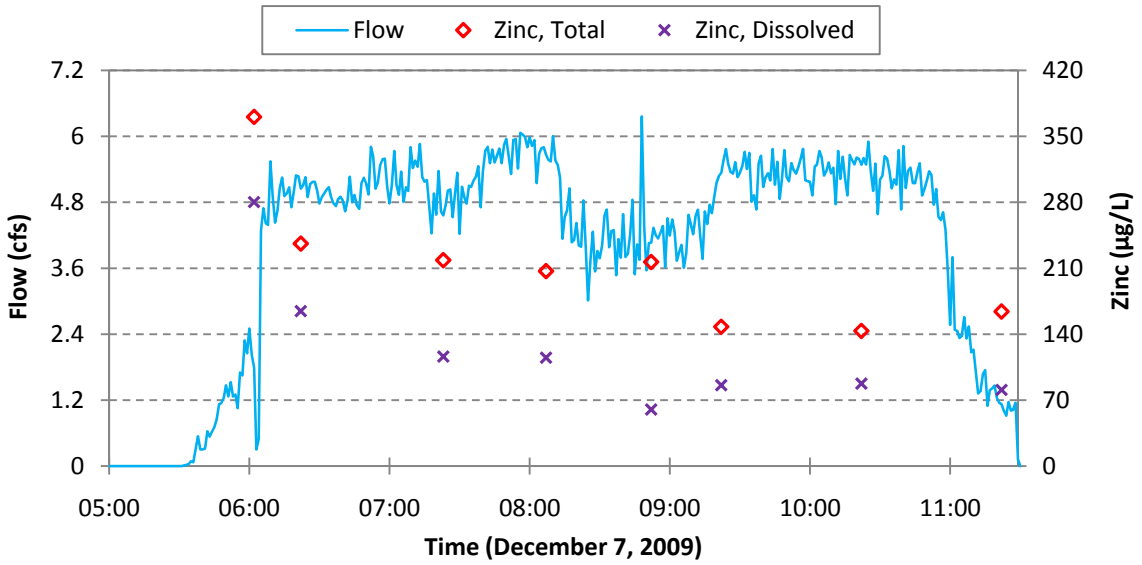


**Figure 28. Hydrograph and pollutograph (Zinc) at the Bannock Avenue Neighborhood site (Monitoring event #1).**

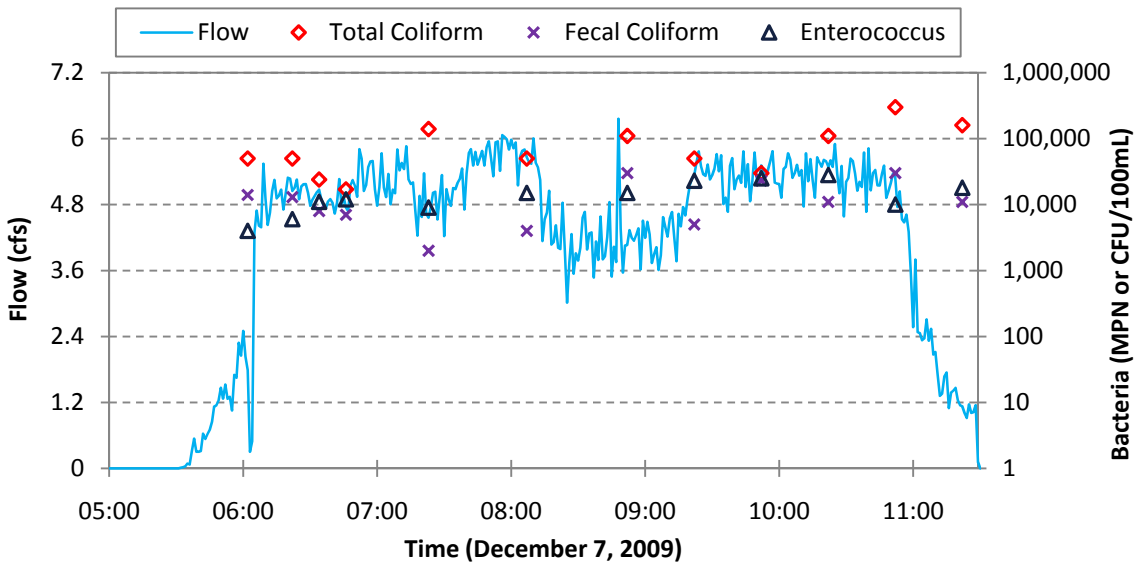


**Figure 29. Hydrograph and pollutograph (Bacteria) at the Bannock Avenue Neighborhood site (Monitoring event #1).**

The hyetograph and hydrograph of event #2 is presented in Figure 30. A total of 1.84 inches rainfall was recorded between 2:00 PM and 6:29 PM on January 18, 2010. The total flow volume at the monitoring location was 27,302.7 cubic feet during the same period. Eleven samples were collected for bacteriological analysis, and eight samples were collected for analysis of other water quality parameters. Sample collection times are also presented in Figure 30.

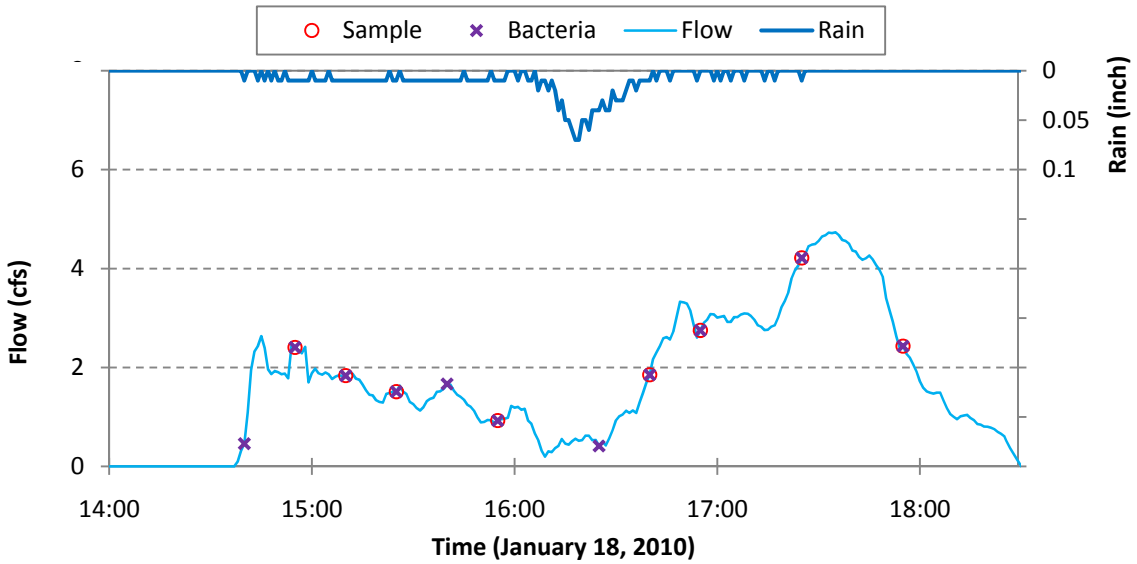


**Figure 30. Rainfall, flow, and sampling time at the Bannock Avenue Neighborhood site (Monitoring event #2). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #2 are presented below:

- Odor: rotten eggs
- Color: gray
- Clarity: slightly cloudy
- Floatable: bubbles/foam
- Deposits: fine particles
- Vegetation: normal
- Water flow: flowing

Results of analysis for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #2 at the Bannock Avenue Neighborhood site are presented in Table 11. Pesticide concentrations were not reported. Copper and lead concentrations in the discharge may be present at levels that may cause or contribute to an exceedance of the CTR criteria for these parameters in the receiving water.

**Table 11. Water quality conditions at the Bannock Avenue Neighborhood site (Monitoring event #2).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.168 | | | |
| | pH | pH Units | 6.9 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 31.1 | | | |
| | Total Suspended Solids | mg/L | 98.9 | | | |
| | Turbidity | NTU | 56.3 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 619.4 | 123.9 | |
| | Antimony (Sb) | µg/L | | 1.8 | 0.8 | 14 |
| | Arsenic (As) | µg/L | | 2.7 | 2.4 | 150 |
| | Barium (Ba) | µg/L | | 35.1 | 11.4 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | 0.3 | < 0.2 | 1 |
| | Chromium (Cr) | µg/L | | 3.2 | 2.1 | 11 |
| | Cobalt (Co) | µg/L | | 0.6 | < 0.1 | |
| | Copper (Cu) | µg/L | | 27.8 | 11.6 | 3 |
| | Iron (Fe) | µg/L | | 756.3 | 113.8 | |
| | Lead (Pb) | µg/L | | 14.7 | 1.4 | 0.7 |
| | Manganese (Mn) | µg/L | | 48.7 | 10.5 | |
| | Molybdenum (Mo) | µg/L | | 1.7 | 1.4 | |
| | Nickel (Ni) | µg/L | | 3.7 | 2.2 | 19 |
| | Selenium (Se) | µg/L | | 0.5 | 0.6 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.5 |
| | Strontium (Sr) | µg/L | | 85 | 78.3 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.2 | 0.1 | |
| | Titanium (Ti) | µg/L | | 20.7 | 6.1 | |
| | Vanadium (V) | µg/L | | 4.5 | 2.5 | |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| | Zinc (Zn) | µg/L | | 130.9 | 45.8 | 45 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 27,246 | | | |
| | Fecal Coliform | MPN/100mL | 5,963 | | | |
| | Enterococci | CFU/100mL | 47,271 | | | |
| Nutrients | Total Nitrogen | mg/L | 2.0 | | | |
| | Total Phosphorus as P | mg/L | 0.727 | | | |

(Notes)

1. All water quality data are flow-weighted averages except microbiology (bacteria). Microbiology (bacteria) data are geometric means followed by regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria for event #2 at the Bannock Avenue Neighborhood site are presented with the event hydrograph in Figures 31 through 35. As shown in the figures, first-flush effects were evident for in TSS and trace metals in the runoff, but not for bacteria.

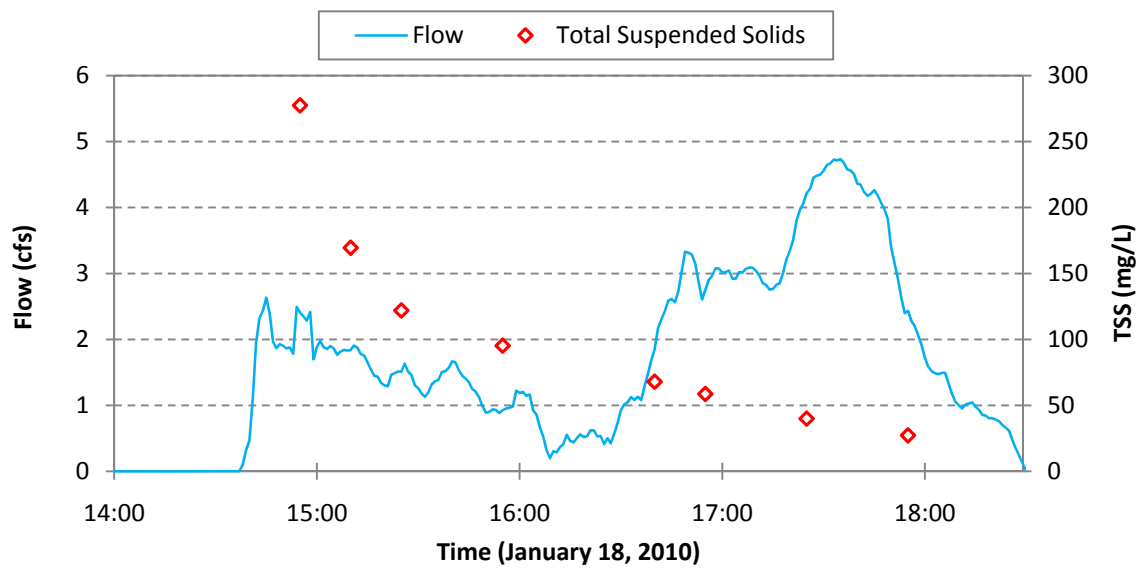


**Figure 31. Hydrograph and pollutograph (TSS) at the Bannock Avenue Neighborhood site (Monitoring event #2).**

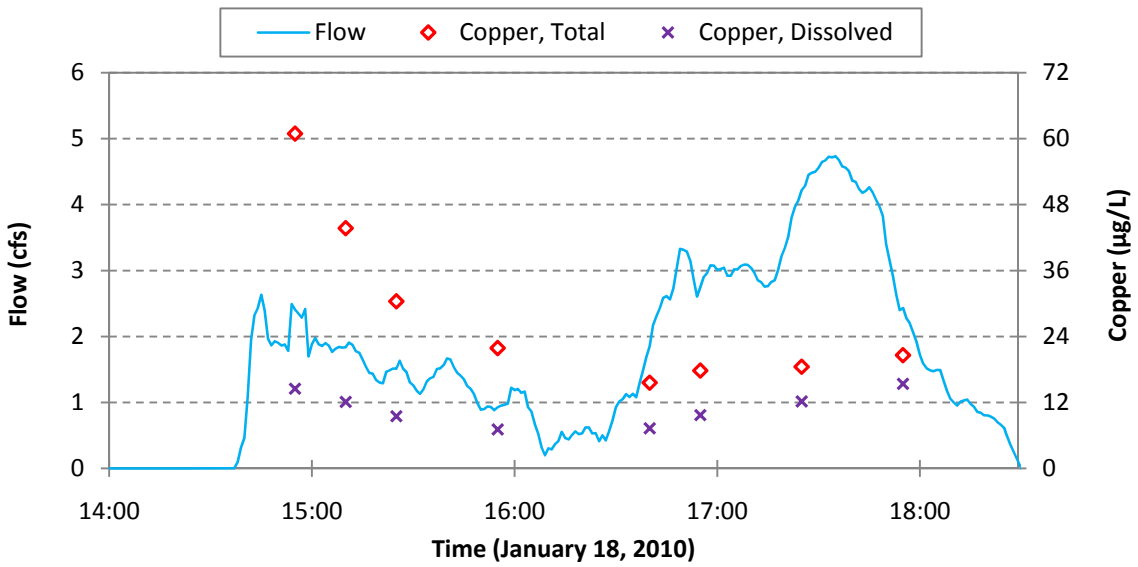


**Figure 32. Hydrograph and pollutograph (Copper) at the Bannock Avenue Neighborhood site (Monitoring event #2).**

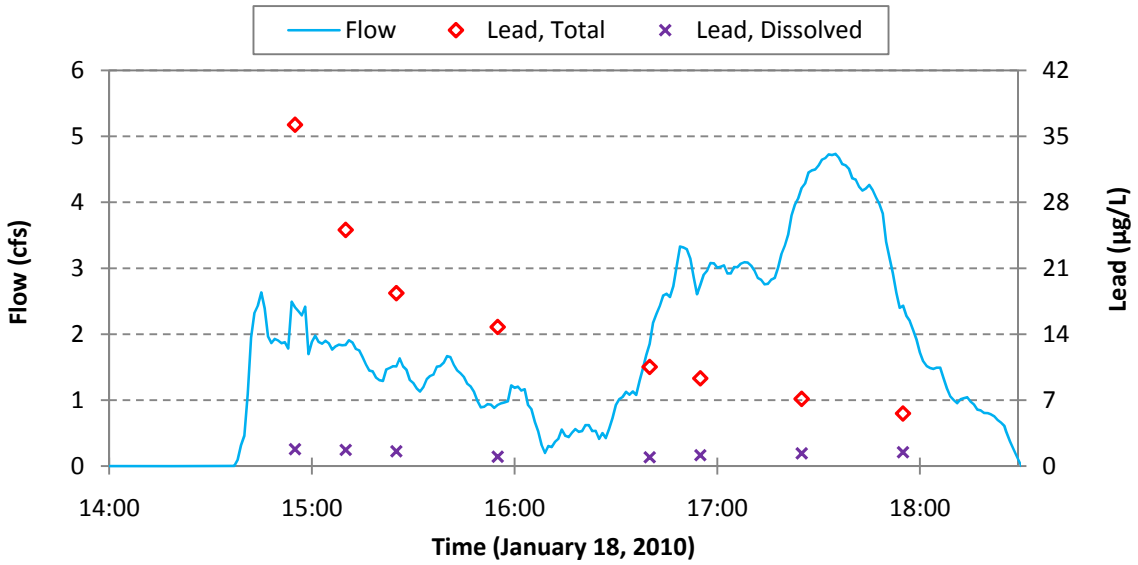


**Figure 33. Hydrograph and pollutograph (Lead) at the Bannock Avenue Neighborhood site (Monitoring event #2).**

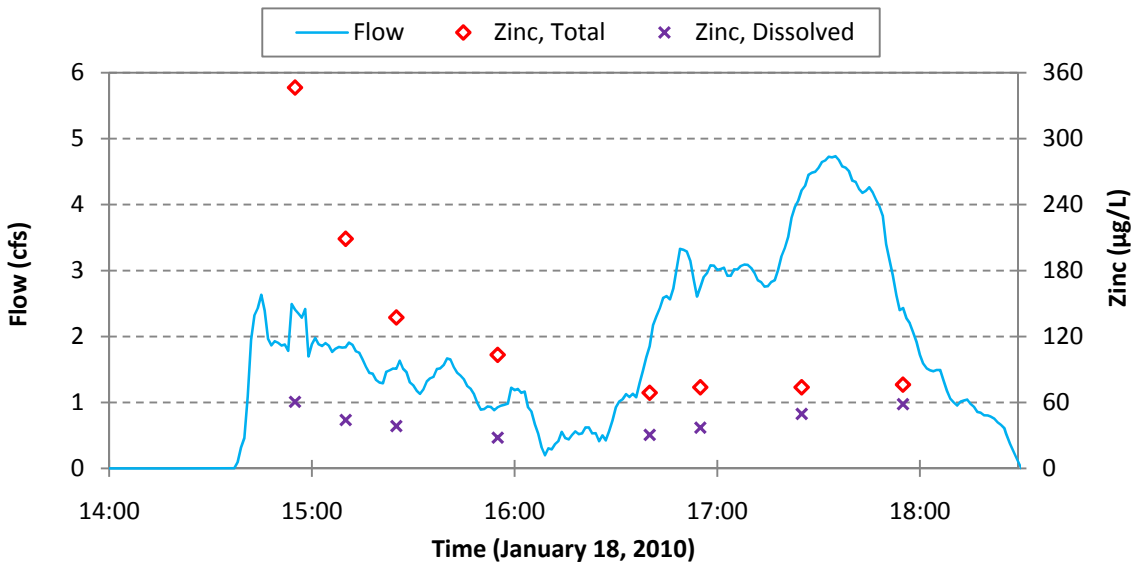


**Figure 34. Hydrograph and pollutograph (Zinc) at the Bannock Avenue Neighborhood site (Monitoring event #2).**

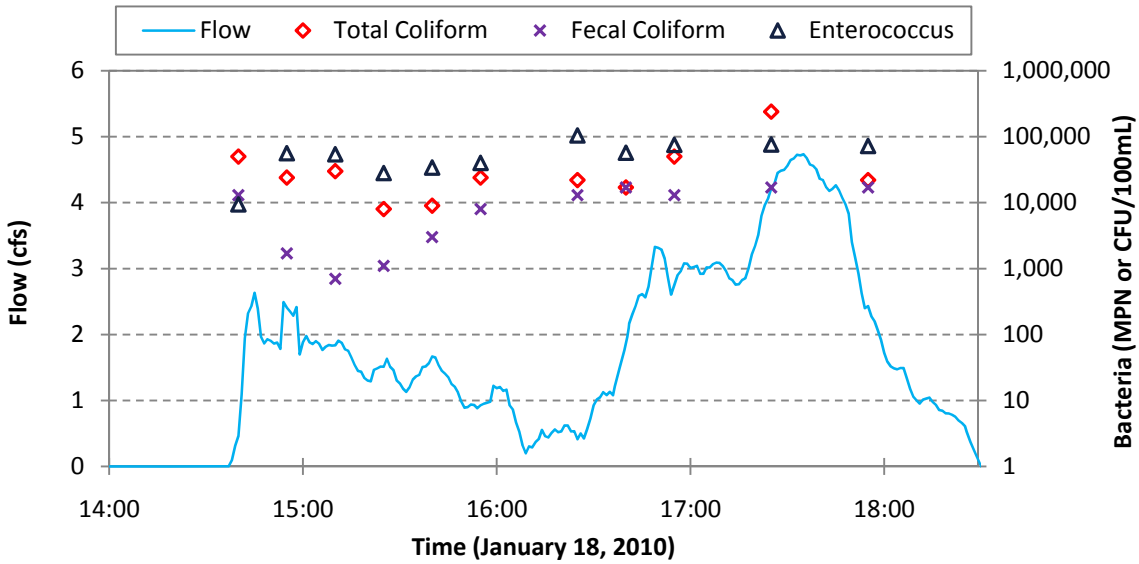


**Figure 35. Hydrograph and pollutograph (Bacteria) at the Bannock Avenue Neighborhood site (Monitoring event #2).**

# Cabrillo Heights Park

### *Site Description*

- Location: Hurlbut Street and Afton Road
- Latitude and longitude: 32°48′20.40″N and 117°8′52.80″W
- Monitoring event #1
  - Date: December 7, 2009
  - Weather condition: Raining
  - Last rain prior to monitoring event: > 72 hours
- Monitoring event #2
  - Date: January 18, 2010
  - Weather condition: Raining
  - Last rain prior to monitoring event: > 72 hours

### *Introduction*

Cabrillo Heights Park consists of an upper area that consists of a tot lot, open space and two small structures, and a lower space that consists of 4 baseball fields, open space, and several small structures. Parking lots are found on the west, south, and east side of the park. The approximate size of the drainage area is 26 acres. BMPs planned for the site are two rain gardens, one located at the western edge of the park to treat runoff from the western parking lot, and one on the eastern side of the park to treat runoff from Angier Elementary School and the parking lot on the east side of the park. Runoff flows will be directed to catch basins, and distribution piping will convey flows to the rain gardens. Catch basins located at the first site will include grating and inserts to prevent large solids from entering the distribution piping and to prevent trash and other debris from entering the rain gardens. (MWH, 2008)

Rain garden size will be designed to accommodate the 5-year storm event, based on an infiltration flow rate of 4 – 6 inches per hour. Rain gardens will be underlain with underdrain piping to convey flows to the existing 60-66 inch storm drain located on the north side of the park. (MWH, 2008)

### *Methods*

Wet season monitoring was conducted during the early part of the 2009-2010 wet season, and consisted of automated flow monitoring and pollutograph sampling during two wet weather events. Samples were collected in the storm drain pipe. Eight pollutographs samples and a minimum of eight bacteria grab samples were collected during each sampling event. Monitoring was conducted using an automated flow meter and logger, and an automated sampler.

Pollutograph samples consisted of eight discrete samples collected at specific intervals during the storm event. The resulting pollutographs estimate contaminant discharge as a function of time. A flow meter was used to monitor the stage and calculate flows during the storm event. The last sample was collected at a point when the rain ended, determined as six hours or less of 0.10 inch of rain, when flow had decreased 50 percent from peak flow rates, and seven samples have previously been collected. A sample was collected every 30 minutes as the level in the storm water conveyance was rising and every 1 to 2 hours as the water level was decreasing.

### *Results and Discussion*

Rainfall, flow, and water quality data were reported from the Cabrillo Heights Park site for two storm events which occurred on December 7, 2009 and January 18, 2010. Rainfall and flow data were recorded at 1-minute intervals. The hyetograph and hydrograph of event #1 is presented in Figure 36. A total of 0.86 inches rainfall was recorded between 5:00 AM and 11:26 AM on December 7, 2009. The total flow volume at the monitoring location was 3,240.7 cubic feet during the same period. Twelve samples were taken and analyzed for bacteria, and eight samples were taken and analyzed for other water quality constituents. Sampling times are also presented in Figure 36.

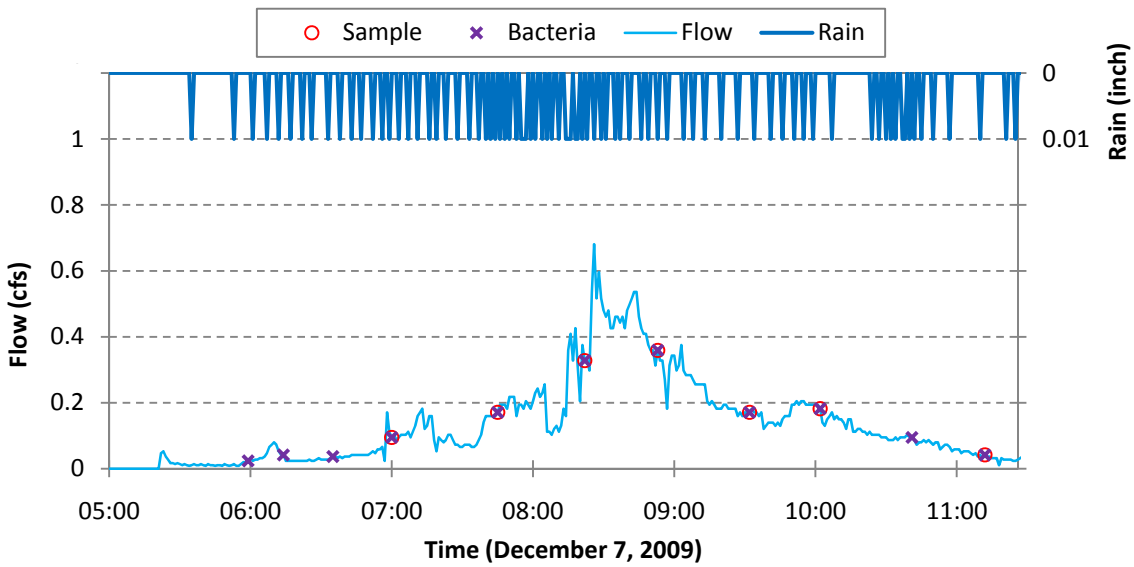


**Figure 36. Rainfall, flow, and sampling time at the Cabrillo Heights Park site (Monitoring event #1). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #1 are presented below.

- Odor: none
- Color: yellow
- Clarity: slightly cloudy
- Floatable: none
- Deposits: fine particles
- Vegetation: limited
- Water flow: flowing

Analytical results for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #1 at the Cabrillo Heights Park site are presented in Table 12. Pesticide concentrations were not reported. Metal concentrations appear to be less than applicable CTR criteria, based on the hardness value of the runoff.

**Table 12. Water quality conditions at the Cabrillo Heights Park site (Monitoring event #1).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.096 | | | |
| | pH | pH Units | 7.2 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 20.9 | | | |
| | Total Suspended Solids | mg/L | 114.3 | | | |
| | Turbidity | NTU | 40.8 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 696.6 | 51.5 | |
| | Antimony (Sb) | µg/L | | 0.6 | 0.3 | 14 |
| | Arsenic (As) | µg/L | | 1.2 | 1.1 | 150 |
| | Barium (Ba) | µg/L | | 24.1 | 6.7 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.7 |
| | Chromium (Cr) | µg/L | | 0.9 | 0.2 | 11 |
| | Cobalt (Co) | µg/L | | 0.7 | < 0.1 | |
| | Copper (Cu) | µg/L | | 12.6 | 6.7 | 2 |
| | Iron (Fe) | µg/L | | 820.1 | 78 | |
| | Lead (Pb) | µg/L | | 5.4 | 1.4 | 0.4 |
| | Manganese (Mn) | µg/L | | 74.6 | 21.6 | |
| | Molybdenum (Mo) | µg/L | | < 0.2 | 0.4 | |
| | Nickel (Ni) | µg/L | | 2.4 | 1.2 | 14 |
| | Selenium (Se) | µg/L | | < 0.2 | < 0.2 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.3 |
| | Strontium (Sr) | µg/L | | 54.6 | 44.8 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.7 | 0.7 | |
| | Titanium (Ti) | µg/L | | 30.9 | 2.7 | |
| | Vanadium (V) | µg/L | | 6.7 | 3.3 | |
| | Zinc (Zn) | µg/L | | 179 | 86.8 | 32 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 6,934 | | | |
| | Fecal Coliform | MPN/100mL | 1,840 | | | |
| | Enterococci | CFU/100mL | 2,367 | | | |
| Nutrients | Total Nitrogen | mg/L | 2.6 | | | |
| | Total Phosphorus as P | mg/L | 0.500 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria concentrations for event #1 at the Cabrillo Heights Park site are presented with the event hydrograph in Figures 37 through 41. As shown in the figures, first-flush effects were not clearly indicated in the pollutographs for any parameter.

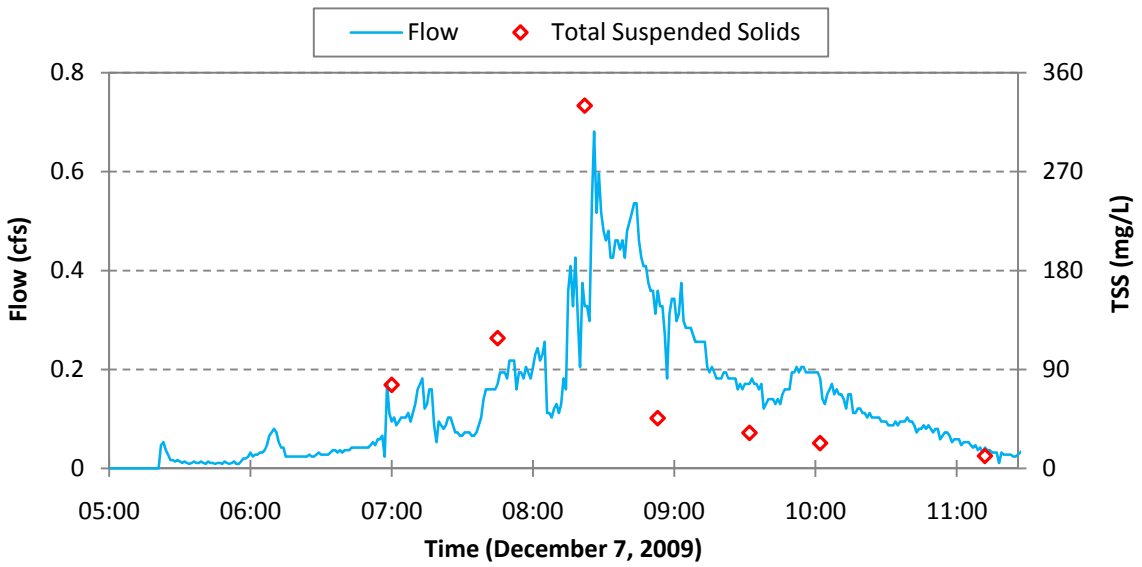


**Figure 37. Hydrograph and pollutograph (TSS) at the Cabrillo Heights Park site (Monitoring event #1).**

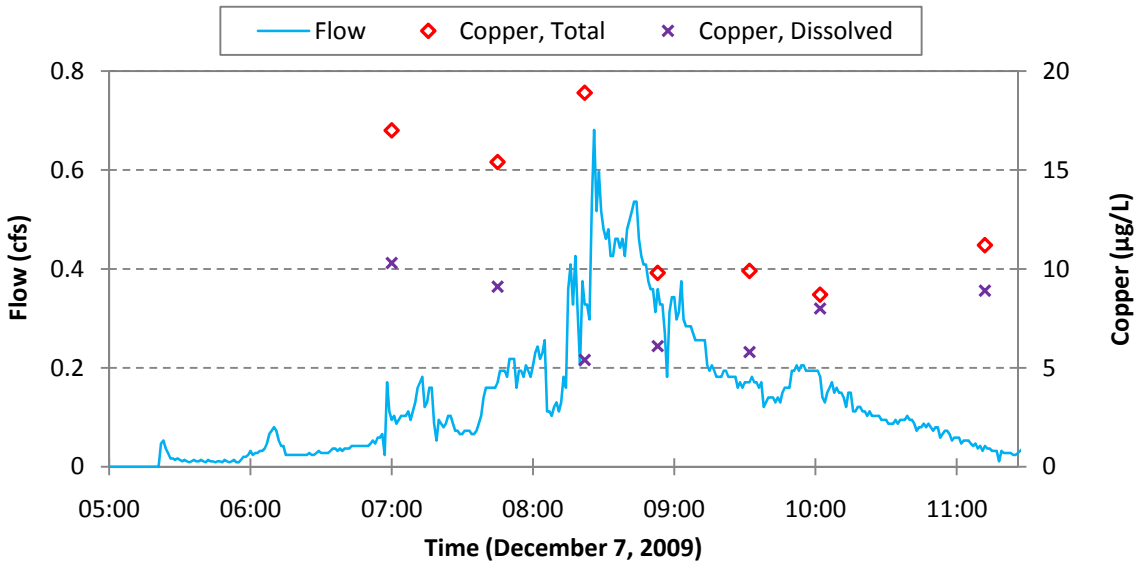


**Figure 38. Hydrograph and pollutograph (Copper) at the Cabrillo Heights Park site (Monitoring event #1).**

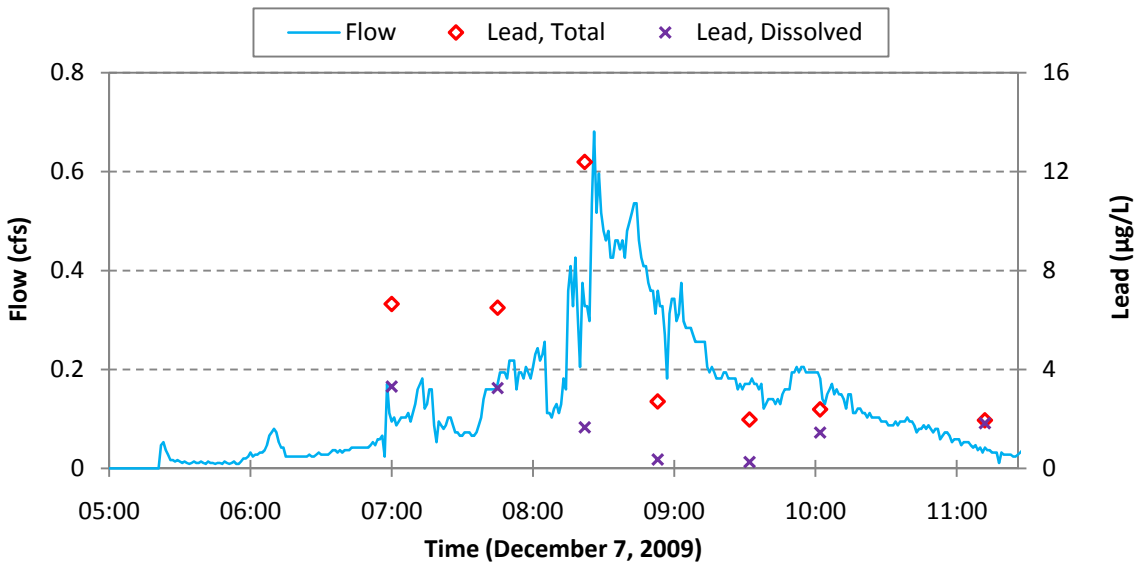


**Figure 39. Hydrograph and pollutograph (Lead) at the Cabrillo Heights Park site (Monitoring event #1).**

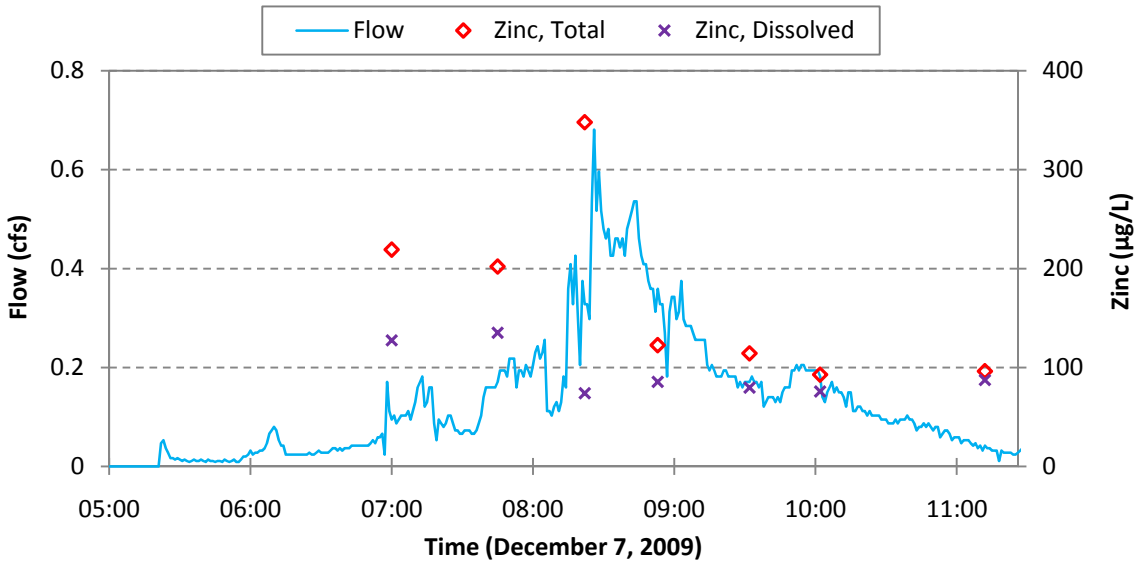


**Figure 40. Hydrograph and pollutograph (Zinc) at the Cabrillo Heights Park site (Monitoring event #1)**

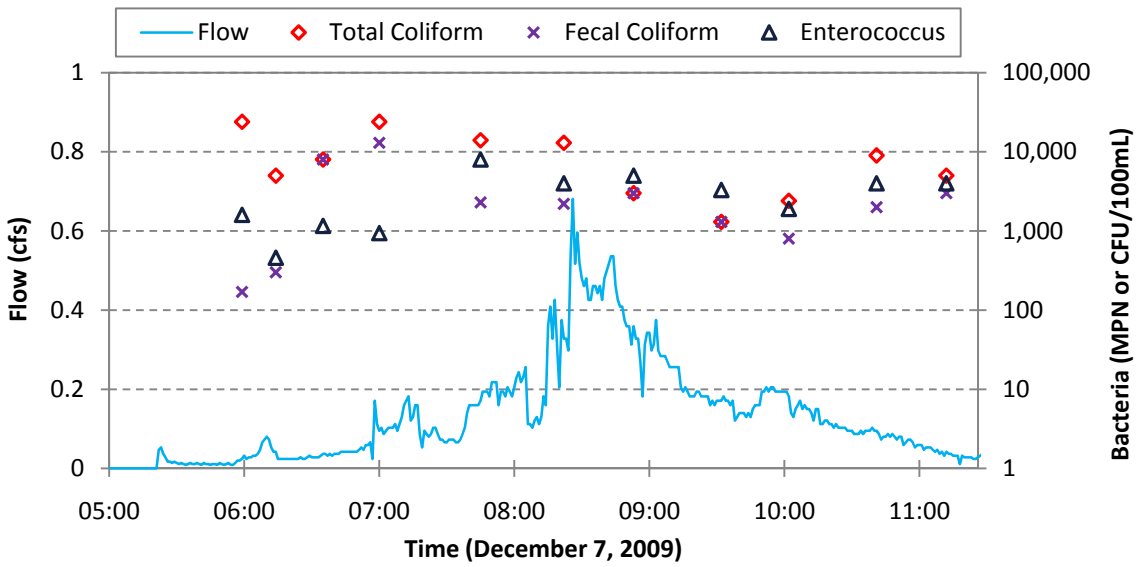


**Figure 41. Hydrograph and pollutograph (Bacteria) at the Cabrillo Heights Park site (Monitoring event #1).**

The hyetograph and hydrograph of event #2 is presented in Figure 42. A total of 1.84 inches rainfall was recorded between 2:00 PM and 7:03 PM on January 18, 2010. The total flow volume at the monitoring location was 8,916.9 cubic feet during the same period. Nine samples were collected for analysis of bacteria concentrations and eight samples were collected for analysis of other water quality constituents. Sample collection times are also presented in Figure 42.

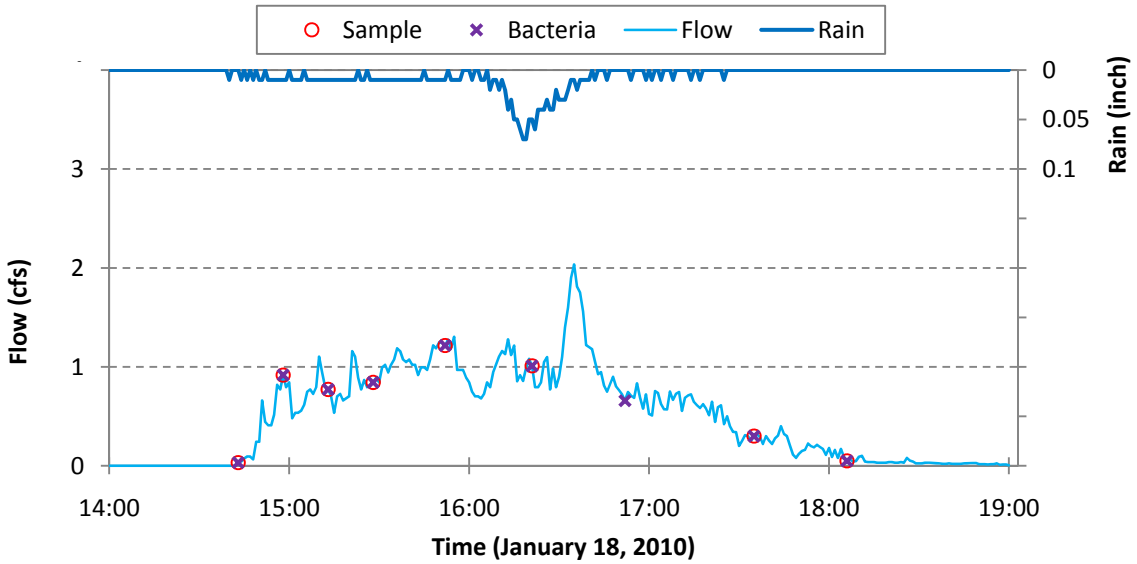


**Figure 42. Rainfall, flow, and sampling time at the Cabrillo Heights Park site (Monitoring event #2). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #2 are presented below:

- Odor: none
- Color: yellowish (possibly from pollen)
- Clarity: opaque
- Floatable: plant material
- Deposits: sediment/gravel
- Vegetation: limited
- Water flow: flowing

Analytical results for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #2 at the Cabrillo Heights Park site are presented in Table 13. Pesticide concentrations were not reported. Comparison of analytical results for metals to applicable water quality criteria indicate that concentrations of pollutants in the runoff are below levels of concern.

**Table 13. Water quality conditions at the Cabrillo Heights Park site (Monitoring event #2).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.065 | | | |
| | pH | pH Units | 6.8 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 12.6 | | | |
| | Total Suspended Solids | mg/L | 147.2 | | | |
| | Turbidity | NTU | 40.6 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 909.7 | 182.5 | |
| | Antimony (Sb) | µg/L | | 0.5 | 0.2 | 14 |
| | Arsenic (As) | µg/L | | 1.1 | 0.7 | 150 |
| | Barium (Ba) | µg/L | | 29.9 | 5.2 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.4 |
| | Chromium (Cr) | µg/L | | 1.3 | 0.3 | 11 |
| | Cobalt (Co) | µg/L | | 1.4 | 0.4 | |
| | Copper (Cu) | µg/L | | 11.2 | 4.1 | 2 |
| | Iron (Fe) | µg/L | | 931.4 | 114.0 | |
| | Lead (Pb) | µg/L | | 8.9 | 0.9 | 0.2 |
| | Manganese (Mn) | µg/L | | 77.2 | 13.2 | |
| | Molybdenum (Mo) | µg/L | | 0.3 | 0.3 | |
| | Nickel (Ni) | µg/L | | 2.0 | 0.8 | 9 |
| | Selenium (Se) | µg/L | | 0.3 | 0.3 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.1 |
| | Strontium (Sr) | µg/L | | 36.8 | 27.5 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.1 | 0.1 | |
| | Titanium (Ti) | µg/L | | 33.9 | 6.6 | |
| | Vanadium (V) | µg/L | | 5.6 | 2.2 | |
| | Zinc (Zn) | µg/L | | 163.8 | 53.4 | 21 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 9,833 | | | |
| | Fecal Coliform | MPN/100mL | 395 | | | |
| | Enterococci | CFU/100mL | 5,204 | | | |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| Nutrients | Total Nitrogen | mg/L | < 2 | | | |
| | Total Phosphorus as P | mg/L | 0.412 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria for event #2 at the Cabrillo Heights Park site are presented with the event hydrograph in Figures 43 through 47. The graphs indicate first-flush effects for levels of TSS and trace metals. No first-flush effects were found for bacteria levels in the runoff.

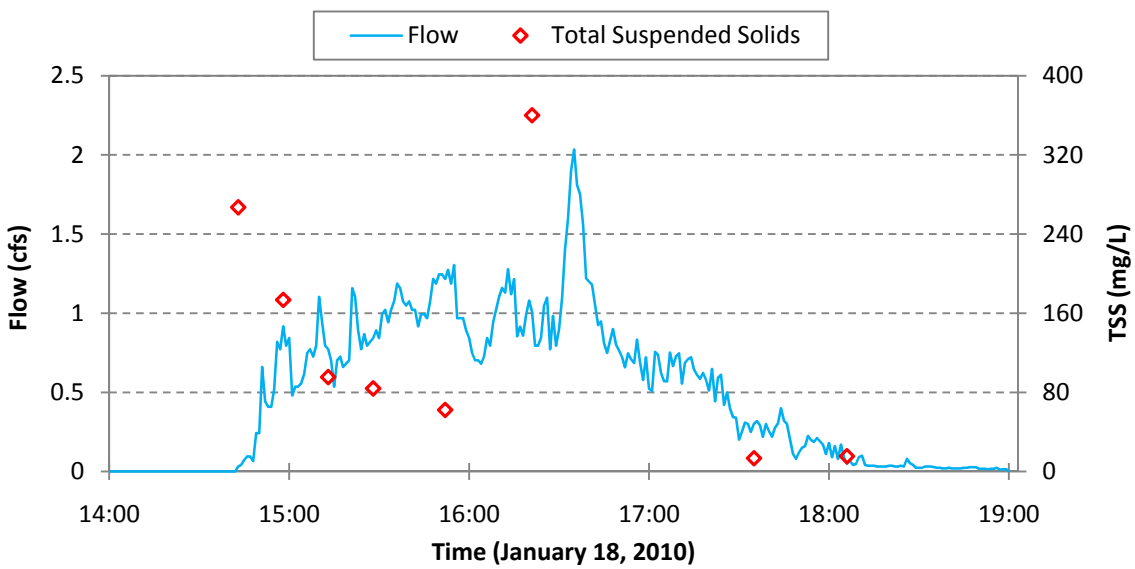


**Figure 43. Hydrograph and pollutograph (TSS) at the Cabrillo Heights Park site (Monitoring event #2).**

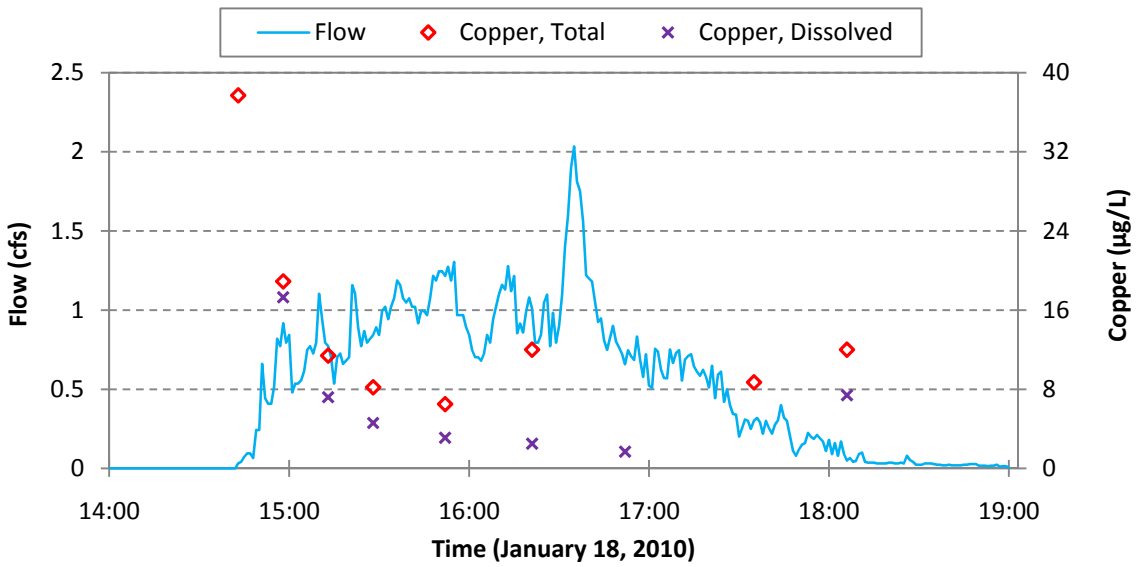


**Figure 44. Hydrograph and pollutograph (Copper) at the Cabrillo Heights Park site (Monitoring event #2).**

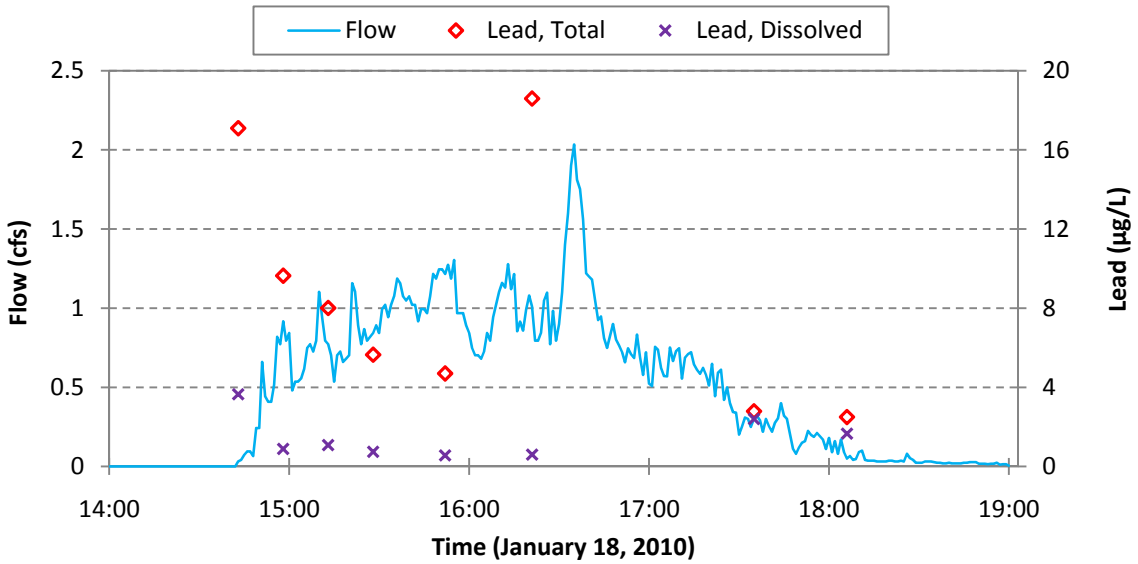


**Figure 45. Hydrograph and pollutograph (Lead) at the Cabrillo Heights Park site (Monitoring event #2).**

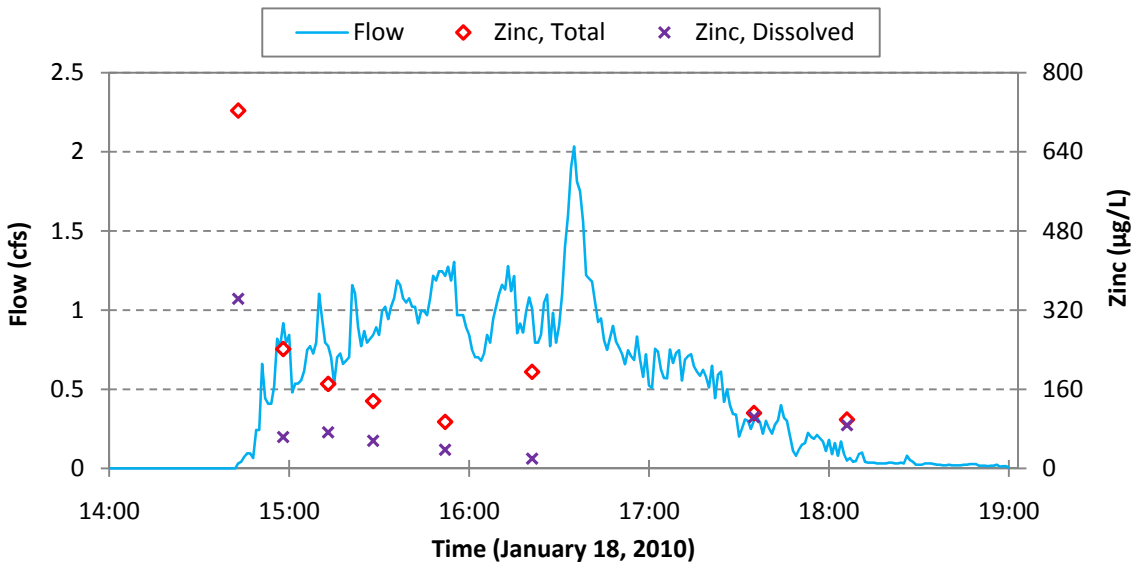


**Figure 46. Hydrograph and pollutograph (Zinc) at the Cabrillo Heights Park site (Monitoring event #2).**

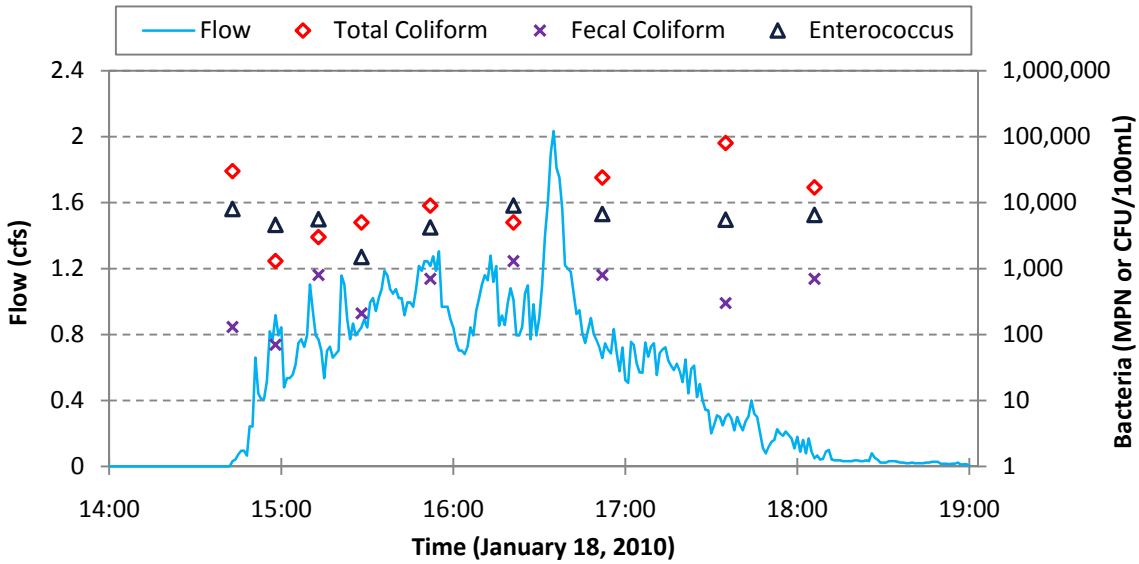


**Figure 47. Hydrograph and pollutograph (Bacteria) at the Cabrillo Heights Park site (Monitoring event #2).**

# Park Ridge

### *Site Description*

- Location: Madra Street and Crystalaire Street
- Latitude and longitude: 32°48′01.00″N and 117°2′57.21″W
- Monitoring event #1
  - Date: December 7, 2009
  - Weather condition: Raining
  - Last rain prior to monitoring event: > 72 hours
- Monitoring event #2
  - Date: January 18, 2010
  - Weather condition: Raining
  - Last rain prior to monitoring event: > 72 hours

### *Introduction*

The project is located at the storm drain located at the southern terminus of Park Ridge Boulevard. The drainage area for the storm drain is approximately 25 acres. Flows from the drainage area on the east side of Park Ridge Boulevard were not included due to economic feasibility. A new catch basin, storm drain, trash segregation unit, and bacterial treatment BMP system will be installed. The project goal is to treat runoff with the segregator and AbTech unit at the 85$^{th}$ percentile flow rate. Pollutants of concern are bacteria, trash, nutrients, sediment, and total dissolved solids. The performance goal for the bacterial treatment BMP system is a 99 percent reduction in bacteria for the treated flow. (Weston, 2008)

### *Methods*

Wet season monitoring was conducted during the early part of the 2009-2010 wet season, and consisted of automated flow monitoring and pollutograph sampling during two wet weather events. Samples were collected in the storm drain pipe. Eight pollutograph samples and a minimum of eight bacteria grab samples were collected during each sampling event. Monitoring was conducted using an automated flow meter and logger, and an automated sampler.

Pollutograph samples consisted of eight discrete samples collected at specific intervals during the storm event. The resulting pollutographs estimate contaminant discharge as a function of time. A flow meter was used to monitor the stage and calculate flows during the storm event. The last sample was collected at a point when the rain ended, determined as six hours or less of 0.10 inch of rain, when flow had decreased 50 percent from peak flow rates, and seven samples have previously been collected. A sample was collected every 30 minutes as the level in the storm water conveyance was rising and every 1 to 2 hours as the water level was decreasing.

### *Results and Discussion*

Rainfall, flow, and water quality data were reported from the Park Ridge site for two storm events which occurred on December 7, 2009 and January 18, 2010. Rainfall and flow data were recorded at 1-minute intervals. The hyetograph and hydrograph of event #1 is presented in Figure 48. A total of 0.79 inches rainfall was recorded between 5:00 AM and 10:47 AM on December 7, 2009. The total flow volume at the monitoring location was 49,312.9 cubic feet during the same period. Twelve samples were taken for

bacteriological analysis and eight samples were collected for other water quality constituents. Sample collection times are also indicated in Figure 48.

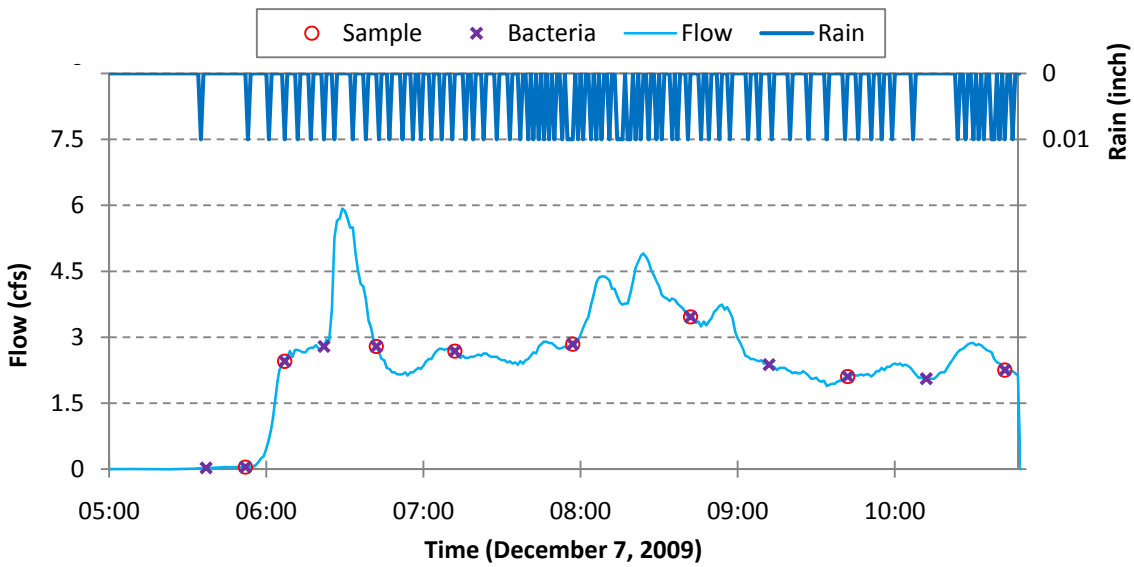


**Figure 48. Rainfall, flow, and sampling time at the Park Ridge site (Monitoring event #1). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #1 are presented below:

- Odor: none
- Color: brown, gray
- Clarity: slightly cloudy
- Floatable: none
- Deposits: sediment/gravel, fine particles
- Vegetation: normal
- Water flow: flowing

Analytical results for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #1 at the Park Ridge site are presented in Table 14. Pesticide concentrations were not reported. Metal results indicate the runoff may contain concentrations of copper at levels of concern.

**Table 14. Water quality conditions at the Park Ridge site (Monitoring event #1).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.082 | | | |
| | pH | pH Units | 7.5 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 19.6 | | | |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| | Total Suspended Solids | mg/L | 80.3 | | | |
| | Turbidity | NTU | 24.7 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 523.6 | 17.8 | |
| | Antimony (Sb) | µg/L | | 1.1 | 0.6 | 14 |
| | Arsenic (As) | µg/L | | 1.8 | 1.0 | 150 |
| | Barium (Ba) | µg/L | | 30.6 | 6.9 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.7 |
| | Chromium (Cr) | µg/L | | 1.4 | 0.4 | 11 |
| | Cobalt (Co) | µg/L | | 0.2 | < 0.1 | |
| | Copper (Cu) | µg/L | | 18.1 | 6.7 | 2 |
| | Iron (Fe) | µg/L | | 839.2 | 50.8 | |
| | Lead (Pb) | µg/L | | 6.8 | 0.3 | 0.4 |
| | Manganese (Mn) | µg/L | | 54.5 | 4.2 | |
| | Molybdenum (Mo) | µg/L | | 0.5 | 0.4 | |
| | Nickel (Ni) | µg/L | | 3.2 | 1.9 | 13 |
| | Selenium (Se) | µg/L | | < 0.2 | < 0.2 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.2 |
| | Strontium (Sr) | µg/L | | 35.7 | 29.2 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.3 | 0.1 | |
| | Titanium (Ti) | µg/L | | 16.2 | 0.8 | |
| | Vanadium (V) | µg/L | | 7.6 | 4.3 | |
| | Zinc (Zn) | µg/L | | 92.7 | 31.7 | 30 |
| Microbiology (bacteria) | Total Coliform | MPN/100mL | 5,155 | | | |
| | Fecal Coliform | MPN/100mL | 324 | | | |
| | Enterococci | CFU/100mL | 1,786 | | | |
| Nutrients | Total Nitrogen | mg/L | < 2 | | | |
| | Total Phosphorus as P | mg/L | 0.224 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria for event #1 at the Park Ridge site are presented with the event hydrograph in Figures 49 through 53. The plots indicate first-flush effects for TSS and trace metals levels in the runoff, except during the very low flow conditions at the beginning of the storm event. No first-flush effects were evident for bacteria.

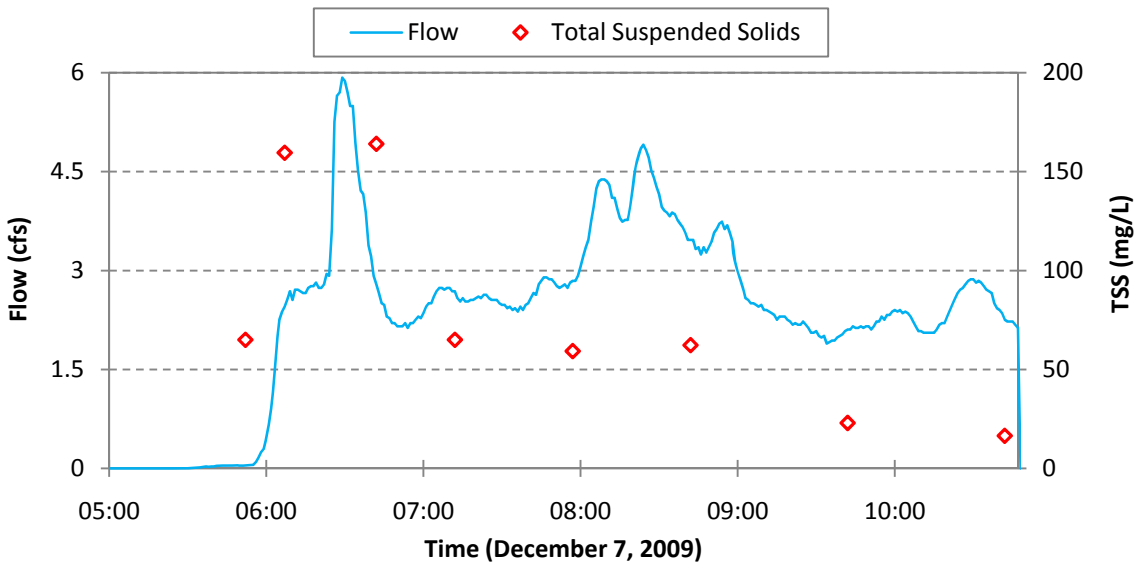


**Figure 49. Hydrograph and pollutograph (TSS) at the Park Ridge site (Monitoring event #1).**

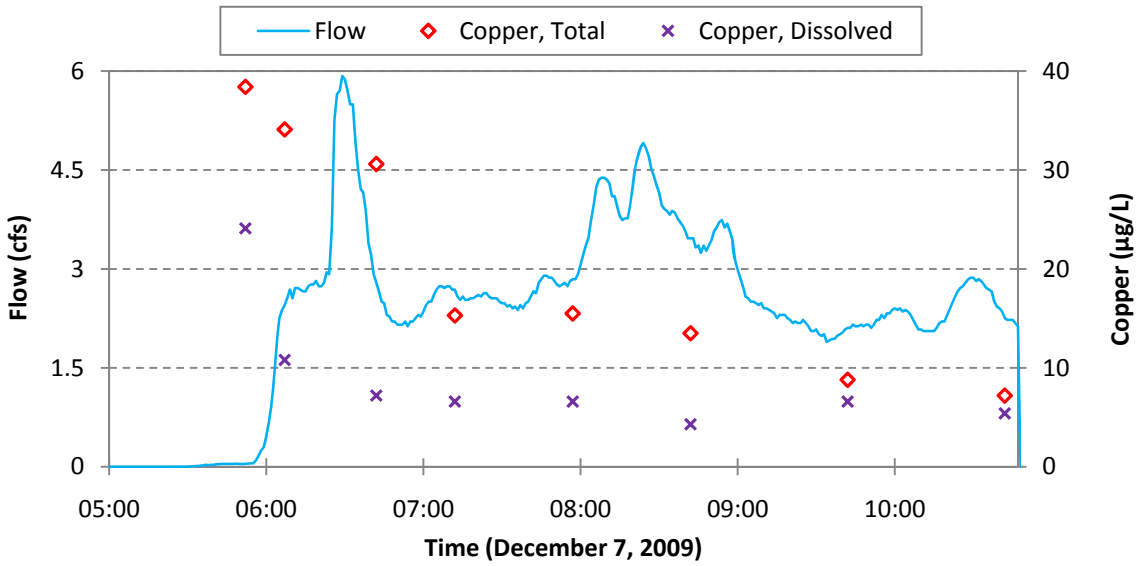


**Figure 50. Hydrograph and pollutograph (Copper) at the Park Ridge site (Monitoring event #1).**

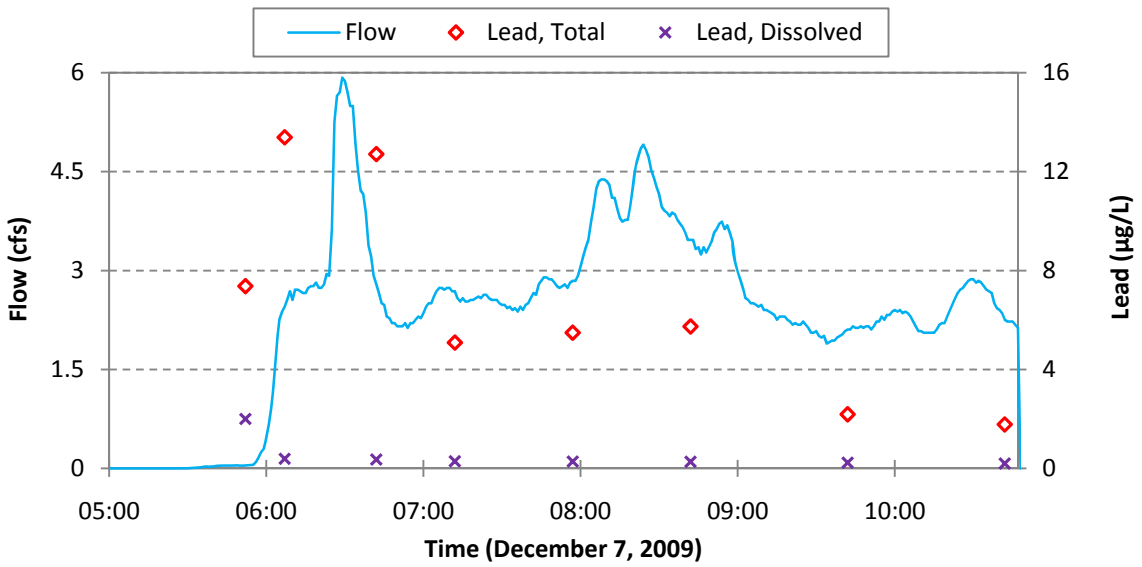


**Figure 51. Hydrograph and pollutograph (Lead) at the Park Ridge site (Monitoring event #1).**

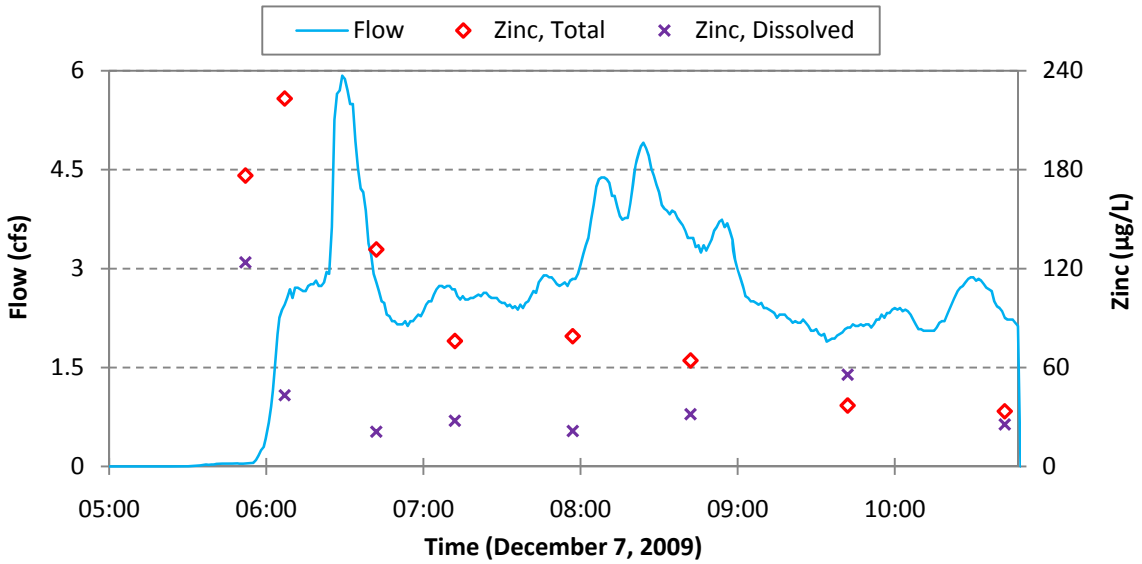


**Figure 52. Hydrograph and pollutograph (Zinc) at the Park Ridge site (Monitoring event #1).**

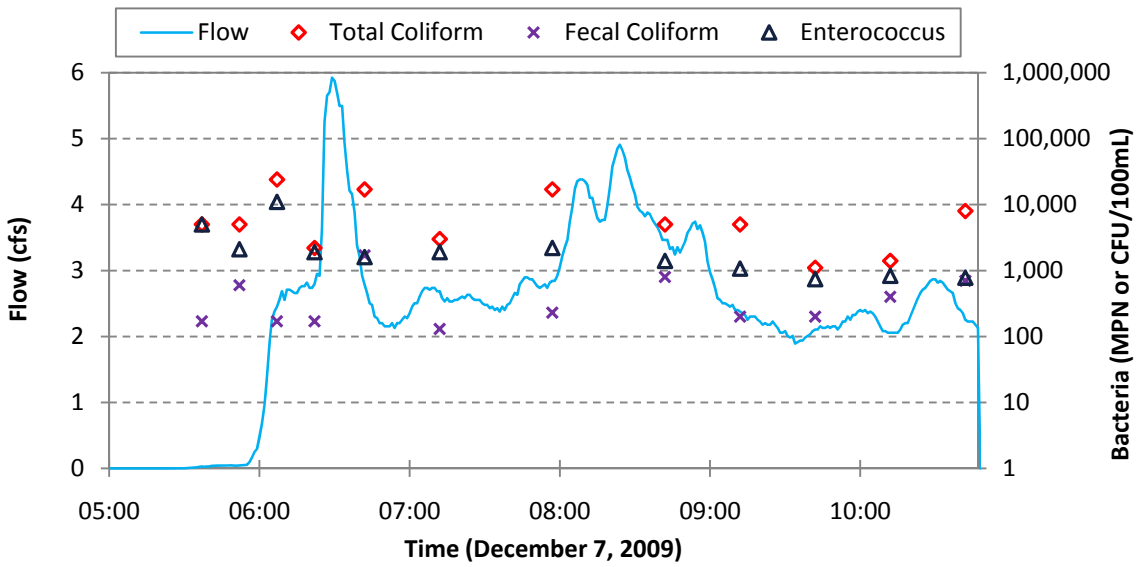


**Figure 53. Hydrograph and pollutograph (Bacteria) at the Park Ridge site (Monitoring event #1).**

The hyetograph and hydrograph of event #2 is presented in Figure 54. A total of 1.84 inches rainfall was recorded between 2:00 PM and 5:43 PM on January 18, 2010. The total flow volume at the monitoring location was 49,821.7 cubic feet during the same period. Nine samples were collected for determination of bacteria concentrations and eight samples were collected and analyzed for other water quality constituents. Sampling times are also presented in Figure 54.

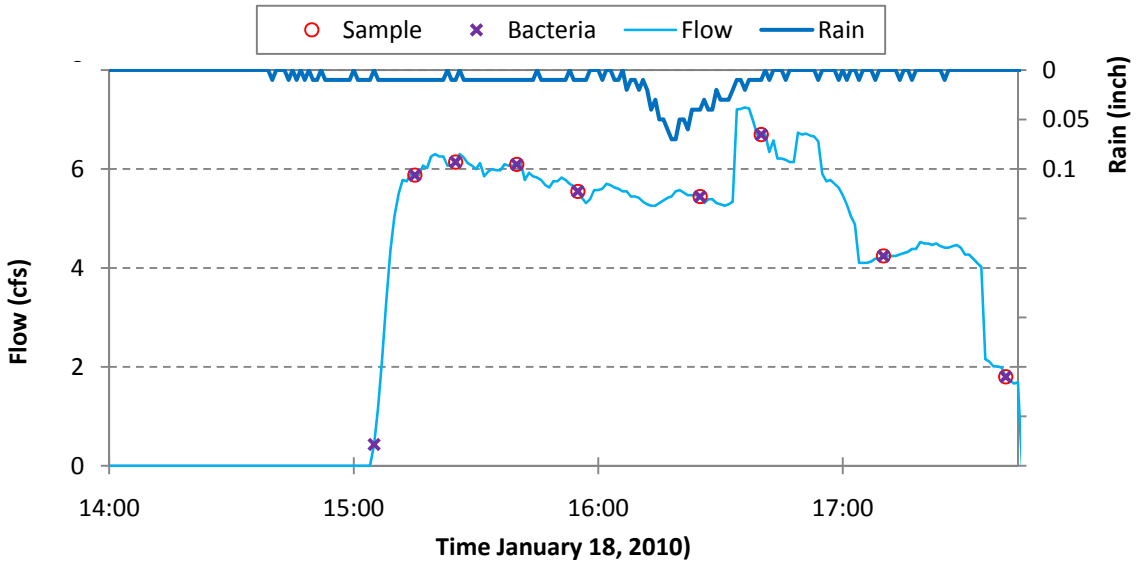


**Figure 54. Rainfall, flow, and sampling time at the Park Ridge site (Monitoring event #2). Water quality samples other than bacteria analysis are indicated by open circles. Bacteria samples are indicated by x's.**

From the field data log sheet, the general runoff characteristics and field measurements of event #2 are presented below.

- Odor: none
- Color: brown
- Clarity: slightly cloudy
- Floatable: trash
- Deposits: sediment/gravel, fine particles
- Vegetation: limited
- Water flow: flowing

Analytical results for general chemistry parameters, trace metals (total and dissolved), bacteria, and nutrients for event #2 at the Park Ridge site are presented in Table 15. Pesticide concentrations were not reported. Concentrations of metals are below CTR criteria for the applicable parameters, based on the hardness of the runoff at the time of sampling.

**Table 15. Water quality conditions at the Park Ridge site (Monitoring event #2).**

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| General chemistry | Conductivity | mS/cm | 0.070 | | | |
| | pH | pH Units | 7.0 | | | |
| | Total Hardness as $CaCO_3$ | mg/L | 13.3 | | | |
| | Total Suspended Solids | mg/L | 164.4 | | | |
| | Turbidity | NTU | 50.3 | | | |
| Trace metals | Aluminum (Al) | µg/L | | 752.1 | 30.8 | |
| | Antimony (Sb) | µg/L | | 0.9 | 0.4 | 14 |
| | Arsenic (As) | µg/L | | 7.5 | 2.6 | 150 |
| | Barium (Ba) | µg/L | | 47.5 | 4.9 | |
| | Beryllium (Be) | µg/L | | < 0.2 | < 0.2 | |
| | Cadmium (Cd) | µg/L | | < 0.2 | < 0.2 | 0.5 |
| | Chromium (Cr) | µg/L | | 2.0 | 0.4 | 11 |
| | Cobalt (Co) | µg/L | | 0.8 | < 0.1 | |
| | Copper (Cu) | µg/L | | 23.5 | 3.4 | 2 |
| | Iron (Fe) | µg/L | | 1,419.10 | 43.5 | |
| | Lead (Pb) | µg/L | | 12.6 | 0.6 | 0.2 |
| | Manganese (Mn) | µg/L | | 127.1 | 6.8 | |
| | Molybdenum (Mo) | µg/L | | 0.6 | 0.4 | |
| | Nickel (Ni) | µg/L | | 3.1 | 1.0 | 9 |
| | Selenium (Se) | µg/L | | 0.2 | 0.3 | 5 |
| | Silver (Ag) | µg/L | | < 0.5 | < 0.5 | 0.1 |
| | Strontium (Sr) | µg/L | | 36.1 | 21.7 | |
| | Thallium (Tl) | µg/L | | < 0.1 | < 0.1 | |
| | Tin (Sn) | µg/L | | 0.2 | < 0.1 | |
| | Titanium (Ti) | µg/L | | 19.0 | 1.4 | |
| | Vanadium (V) | µg/L | | 13.9 | 5.3 | |
| | Zinc (Zn) | µg/L | | 119.2 | 14.3 | 22 |
| Microbiology | Total Coliform | MPN/100mL | 18,386 | | | |

| | Constituent | Unit | Result | Total | Dissolved | Most Stringent CTR WQO |
|---|---|---|---|---|---|---|
| (bacteria) | Fecal Coliform | MPN/100mL | 1,397 | | | |
| | Enterococci | CFU/100mL | 4,040 | | | |
| Nutrients | Total Nitrogen | mg/L | < 2 | | | |
| | Total Phosphorus as P | mg/L | 0.369 | | | |

Notes:

1. All water quality data are flow-weighted averages except microbiology (bacteria) which is the geometric means following standard regulatory requirements.
2. If the result of the calculation was less than the MDL, this was indicated by flagging the results with a "<" symbol (e.g., "< 1" if the MDL is 1).
3. Criteria for CTR hardness-based metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) are calculated using the hardness of the sample.

Pollutographs for total suspended solids (TSS), copper, lead, zinc, and bacteria of event #2 at the Park Ridge site are presented with the event hydrographs in Figures 55 through 59. As shown in the figures, below, none of the parameters exhibited first-flush effects when plotted against the event hydrograph.

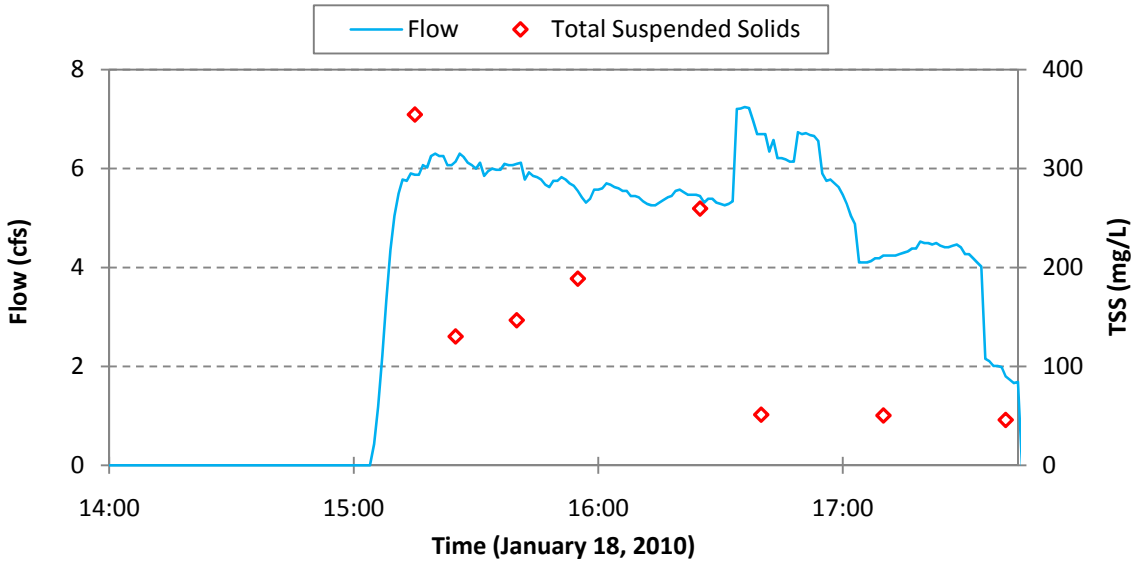


**Figure 55. Hydrograph and pollutograph (TSS) at the Park Ridge site (Monitoring event #2).**

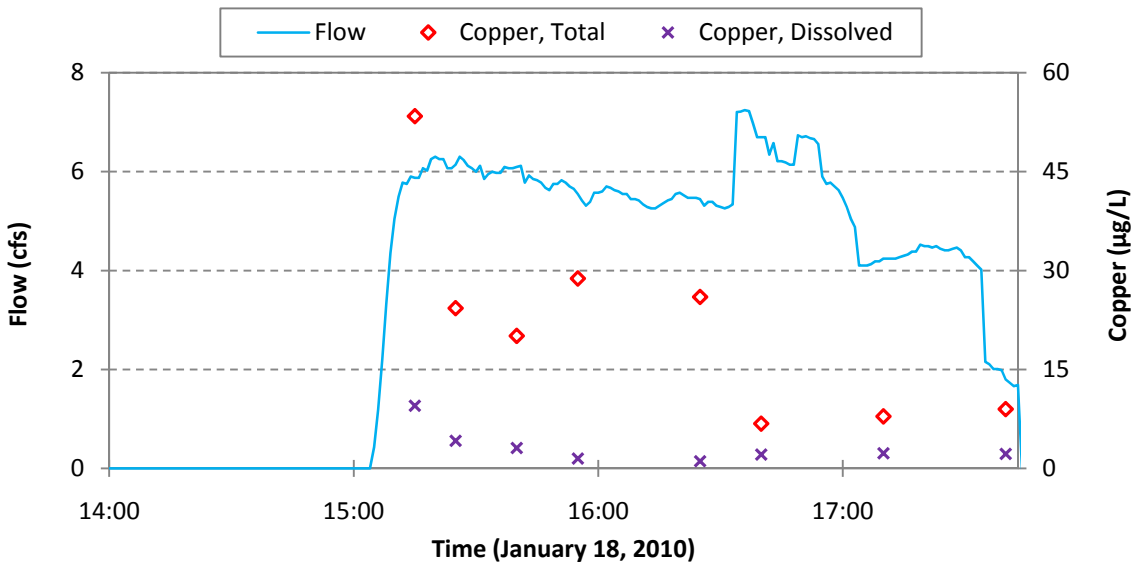


**Figure 56. Hydrograph and pollutograph (Copper) at the Park Ridge site (Monitoring event #2).**

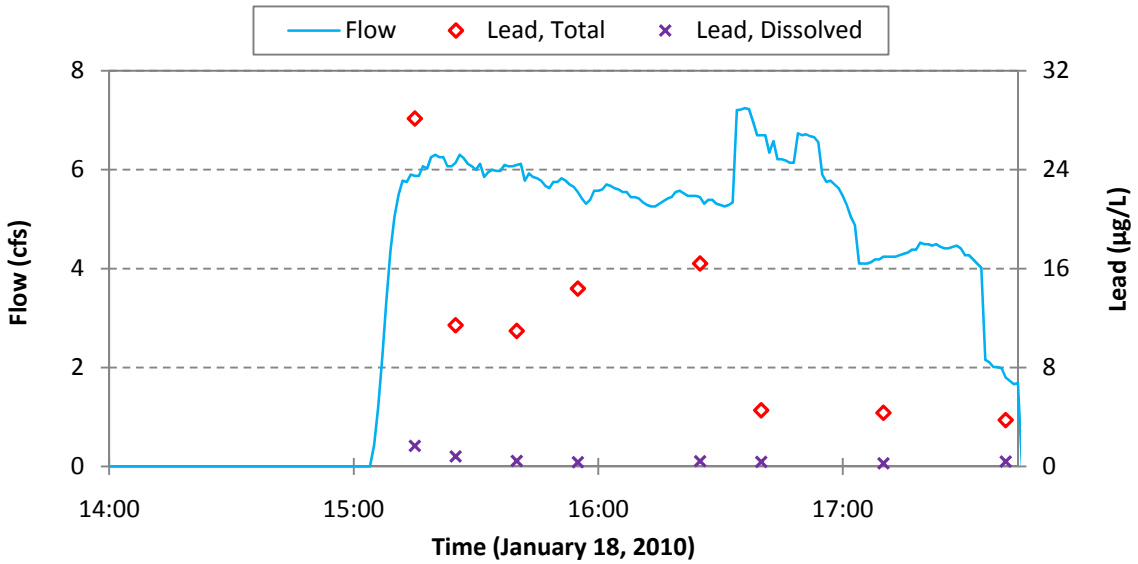


**Figure 57. Hydrograph and pollutograph (Lead) at the Park Ridge site (Monitoring event #2).**

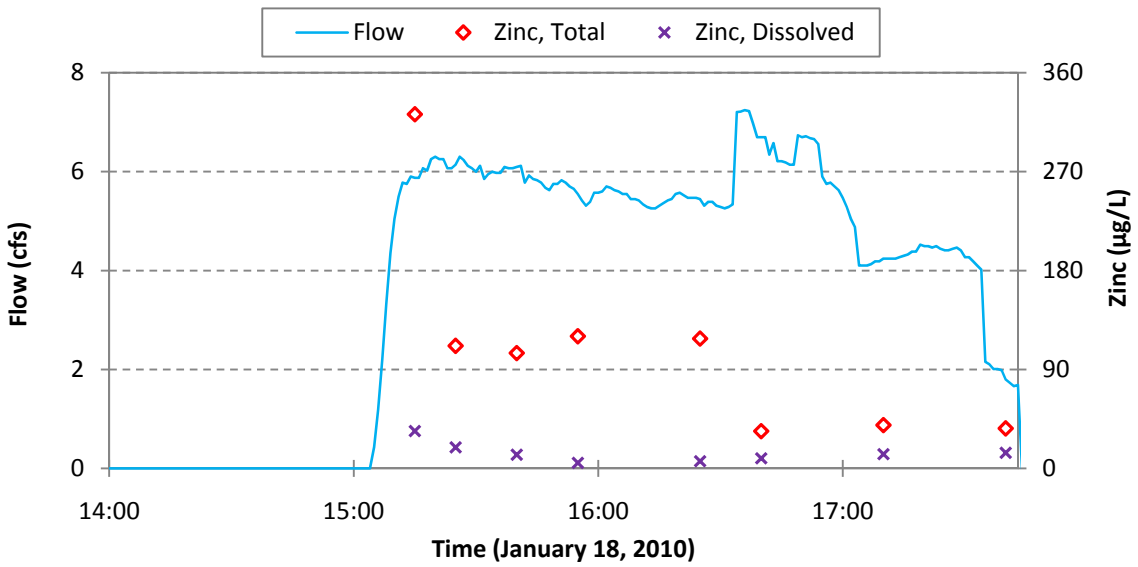


**Figure 58. Hydrograph and pollutograph (Zinc) at the Park Ridge site (Monitoring event #2).**

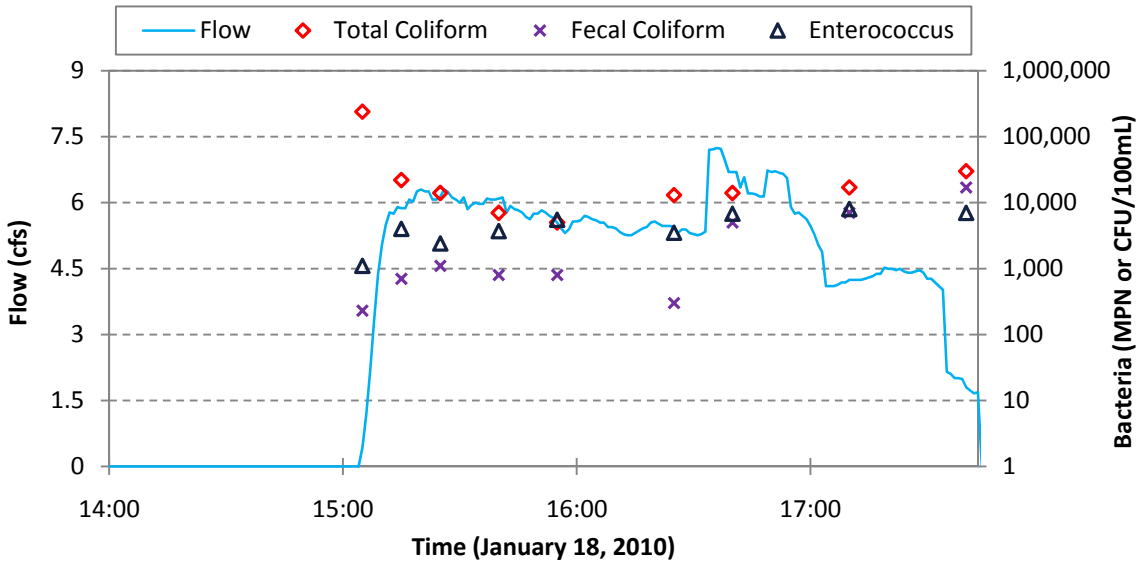


**Figure 59. Hydrograph and pollutograph (Bacteria) at the Park Ridge site (Monitoring event #2).**

# Summary and Conclusions

Monitoring data for rainfall, flow, and water quality constituents from the seven sites in San Diego area were summarized in this report. While the monitoring data of the Avenida de la Playa site were collected from dry weather flows, data for the remaining sites were collected during wet weather conditions. High-frequency rainfall and flow data were reported at 1-minute intervals for the sampling data sets. The field data logs were summarized for the individual events and sites. The reported data were summarized for individual sites as well as storm events for rainfall depth, flow volume, general chemistry, trace metals (total and dissolved), microbiology (bacteria), nutrients, and pesticides. Using the water quality data and their sampling times, pollutographs were also presented. Some events clearly indicate first-flush effects, particularly for parameters such as TSS and metals, while bacteria levels remained fairly constant over the course of the wet weather event.

Data collected during these monitoring events represent pre-construction conditions, which can be used to determine appropriate BMP sizing. Data collected will also be used in the future, after BMP implementation is complete, to determine the effectiveness of the installed BMPs at each site.

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