El Cerrito Green Streets Project
Final Project Certification Report

APPENDIX II

WATER QUALITY MONITORING PROGRAM RESULTS

Submitted by: *San Francisco Estuary Partnership*

Date: *November, 2012*

Monitoring and Results for El Cerrito Rain Gardens

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This report should be cited as:
Gilbreath, A. N., Pearce, S. P. and McKee, L. J. (2012). Monitoring and Results for El Cerrito Rain Gardens. Contribution No. 683. San Francisco Estuary Institute, Richmond, California.

Acknowledgements

The authors would like to acknowledge funding, support and oversight from the San Francisco Estuary Partnership (SFEP). We were glad for the volunteer field support from Donna Bodine, an El Cerrito resident and LID enthusiast. We'd like to recognize our contracting laboratories, AXYS Analytical Services, Brooks Rand Laboratories, Delta Environmental, and Graham Matthews and Associates. Thank you to the SFEI data management team for their thorough review and timely turnaround of the data. The draft report received external review from Josh Bradt (SFEP) and Lori Schmitz (California State Water Board). This project was completed with $109k of funding provided by the California State Water Resources Control Board through the Clean Water State Revolving Fund Project.

Table of Contents

1. Introduction

The El Cerrito Green Streets pilot project retrofits a dense urban corridor with green stormwater infrastructure that detains and treats urban runoff to remove pollutants including pesticides, PCBs, mercury (Hg), and copper (Cu) as specified in San Francisco Bay Basin Water Quality Control Plan TMDLs. The highly-visible project ties in to the City's federally-funded Streetscape project and efforts to build high-density, pedestrian-oriented development along State Route 123 (also called San Pablo Avenue). The project integrates rain gardens into existing sidewalks and on-street parking areas, using curb cuts to direct stormwater into vegetated treatment basins that treat runoff from highly impervious landscape at two sites. This report considers one of those two sites that was selected for runoff monitoring.

El Cerrito is implementing several green infrastructure projects concurrently. The El Cerrito Green Streets rain gardens are located near a new City Hall, a LEED building that features bioswales and native plants. The City also recently removed three miles of turf from the San Pablo Avenue median, replacing it with low-water-use, drought-tolerant plants. These efforts enhance the public education value of the nearby rain gardens. In addition to the rain gardens providing on-site stormwater runoff treatment prior to discharge into local storm drain piping, the project is also intended to serve as a model for future green infrastructure efforts within the City and around the Bay Area. Project funders and developers believe its success helps to instill confidence in this emerging approach to urban stormwater management that is just getting traction in the Bay Area. In fact, these rain gardens have already inspired neighboring cities from San Pablo to Oakland to undertake green infrastructure projects along the length of San Pablo Avenue.

The project is being evaluated on many fronts, including design, construction, maintenance, monitoring, and outreach. This report details the performance observations of the site in the first rainy season after construction as well as water quality monitoring results from the second rainy season after construction. Pollutants in stormwater runoff from urban impervious landscapes degrade water quality and the bioretention rain gardens are intended to reduce those pollutant concentrations and loads to the receiving water bodies. In this study, stormwater concentrations of pesticides, PCBs, Hg, and Cu flowing into the rain garden are compared with concentrations flowing out of the rain garden to infer the effectiveness of the installation at reducing pollutants.

2. El Cerrito Rain Gardens Site Description

The monitored project site is located along the eastern side of San Pablo Avenue in El Cerrito, CA, between the cross streets of Eureka Avenue to the north end and Lincoln Avenue to the south (Figure 2.1). This location of the rain gardens along the heavily car and pedestrian traveled San Pablo Avenue gives the project high public visibility, providing a platform for outreach and education. The series of rain garden cells were constructed between the sidewalk area and the street, and each has a curb cut allowing street runoff into the rain garden cell. The drainage area to the rain gardens is 1.7 acres (6,850 m^2) of mixed transportation, commercial, and residential area. The bioretention system surface area accounts for approximately 1.6% of the entire drainage area, or 1.7-1.8% of the impervious drainage area. The northern most cell was monitored for water quality and this drainage area included 1 acre (4,080 m^2) of highly

impervious landscape, including 20% high density residential, 13% commercial offices, and 67% local roads (ABAG, 2006). The northernmost cell was chosen because it received the greatest amount of flow during all storm events.

Figure 2.1. Location of the project. **(A)** The El Cerrito Green Streets Pilot Project is in El Cerrito, California, on the east side of the San Francisco Bay. **(B)** The rain gardens are located along the east side of San Pablo Avenue, a highly traveled traffic corridor (at right; San Pablo Avenue highlighted in yellow and the rain garden location is in red). **(C)** View of the two monitoring cells (view looking north).

3. Methods

This study included three distinct phases: 1) input and observation of construction design to ensure the ability to sample water at the inlet and outlet using the intended instrumentation, 2) observation of rain garden performance in the first rain season after construction (Water Year (WY) 2011), and 3) water quality monitoring during the second rainy season after construction (WY 2012) (effectively months 12-18 after construction).

3.1 WY 2010: Input and Observation of Construction Design

Construction of the rain gardens occurred during spring, summer and early fall 2010. During this period, San Francisco Estuary Institute (SFEI) staff met regularly with San Francisco Estuary Partnership (SFEP), the City of El Cerrito, and the construction company (Golden Bay Construction) to collaborate on the design and construction process in order to ensure that the monitoring cells would be constructed in a manner that would allow for water quality monitoring. These elements included but were not limited to: installing conduit to house the sample tubing during sampling, installing a 1ft diameter sampling hatch at the outflow pipe of the rain garden cell to allow for outflow sampling of freefalling water prior to its mixing with the main storm drain water, pouring a level concrete pad for lock boxes to house pumping samplers for stormwater collection at the inlet, installing a properly located pole for the rain gage and solar panel, and re-routing runoff from the adjacent building into an existing landscape garden feature instead of directly into the rain garden near the outlet where it would filter minimally prior to exiting at the outlet. SFEI staff observed and photo-documented the progress and changes to the site.

3.2 WY 2011: Field Observations and Rain Garden Performance

After construction completion in fall 2010, SFEI installed monitoring equipment and performed observations at the site from December 2010 through May 2011. SFEI made routine visits to download rainfall data and generally observe the site as the plants established and grew throughout the first year. Three rain events were observed during the WY 2011 wet season: 12/5/10, 2/19/11, and 3/13/11, and additional observations were made on 12/9/10. During the 12/5/10 event, field staff focused on observing how the gardens filled during the storm, the sources of inflow, the relative volumes of outflow, and variations between the garden cells. A few days later, staff re-visited the site to observe sediment accumulation at the inlets, grain size characteristics of that sediment, and trash in the rain garden cells. During the 2/19/11 event, field staff focused on the transport and efficiency of water entering each cell, how sediment was deposited and transported in the gutter system, and how the overflow drains performed. During the 3/13/11 event, field staff focused on identifying the amount of rainfall needed before outflow was observed, and the approximate rate of flow exiting the gardens as outflow.

3.3 WY 2012: Water Quality Monitoring

In WY 2012, SFEI completed water quality sampling during four storm events. At the inlet, during the first three storms sampled, a composite sample was collected for each analyte consisting of four to five aliquots. This composite sampling was intended to represent average concentrations of storm runoff over the entire storm event. During the fourth storm, four discrete samples were collected at the inlet to help determine how concentrations for each of the analytes changed throughout the course of the storm. At the outlet during all four storm events, composite samples were collected. Sampling pacing was manually triggered throughout the storm.

Sampling at the inlet was completed with the use of ISCO automated pumping samplers. These samplers were housed in two lock boxes (second lock-box located to the right of the one pictured in Figure 3.3.1). The site was powered by a battery housed within the lock box and recharged via a solar panel (Figure 3.3.2). Tubing was installed from the samplers, passed through conduit that was integrated into the concrete during construction and terminated under the grate within the curb cut. The end of that tubing sat just above ground level within the curb cut inlet to the rain garden.

Figure 3.3.1. Photograph looking north showing the monitoring location at the Eureka Avenue garden. During WY 2012, inlet samples were collected via ISCO automatic samplers at Inlet #1. The ISCO was housed in the large brown lock box (a second lock box was installed to the right of the one pictured, and also housed an ISCO), and rainfall was monitored by the rain gage housed on the pole directly behind the lock box. Outlet samples were manually collected by accessing a pipe in the outlet sampling hatch that discharges water into the storm drain system.

Figure 3.3.2. (A) Rain gage and the solar panel (to charge the battery for the data logger). **(B)** The lock box (empty, with door open) that housed the battery, data logger, and the ISCO automatic sampler.

At the outlet sampling hatch, sample water was collected by passing tubing down the hatch and positioning it in the freefalling outflow between the rain garden and storm drain. A peristaltic Cole Parmer Masterflex E/S Portable Sampler was then used to pump the appropriate volume of water into each of the sample bottles.

A range of analytes were sampled for at the inlet and outlet of the system during each storm event and analyzed using appropriate techniques at laboratories known for their high quality services (Table 3.1) (see Appendix A for summary description of each analysis method). Ultra clean sampling techniques were employed. Teflon intake tubing was re-cleaned for each storm event. All silicon tubing was new and cleaned prior to each storm event, and the ends of the tubing were covered between all sample events throughout a storm. Composite sample dissolved analytes were filtered immediately at the end of each storm event using a "SingleSample" Disposable Groundwater Filter Capsule 0.45 µm, and discrete sample dissolved analytes were filtered inline (same filter type) during the storm event at the time of sample collection.

Table 3.1. Method of analysis and analyzing laboratory for analytes measured in water quality samples collected during WY 2012.

Analysis	**Method**	**Analyzing Laboratory**
PCBs	EPA 1668 Rev A (40 congeners)	AXYS Analytical Services Ltd. (AXYS), British Columbia, Canada
Pyrethroids	AXYS Method MLA-046	AXYS, British Columbia, Canada
SSC	ASTM D3977, Test Method B	Graham Matthews and Associates, California
Total & Dissolved Hg	EPA 1631 Rev E	Brooks Rand Labs LLC (BRL), Washington
Methyl Hg	EPA 1630	BRL, Washington
Total & Dissolved Cu	EPA 1638	BRL, Washington
Total and Dissolved Organic Carbon	SM 5310 C	Delta Environmental Laboratories LLC, California

Ancillary measurements of turbidity and electrical conductivity were collected at the inlet and outlet manually throughout each monitored storm event. Turbidity was measured using a Hach 2100 P portable turbidity instrument and electrical conductivity was measured using a YSI Model 556.

4. Results

4.1 WY 2010: Rain Garden Construction

SFEI staff watched and photo-documented the progress during construction, and provided key input towards specific sampling-related construction elements. Figures 4.1.1-4.1.2 show the rain garden construction process and specific design elements that were included to enable water quality sampling. Through negotiations with SFEP, the City of El Cerrito, and Golden Bay Construction, SFEI directed the installation of conduit between the inlet drain and the area under which the concrete pad was laid for placing the lock boxes (Figure 4.1.1, photos C-E). This conduit provided an enclosed run for tubing to extend between the lock boxes, where the automated pumping samplers were stored, and the inlet drain. SFEI also helped properly locate the installation of a pole for mounting the solar panel and rain gage (Figure 4.1.1, photo F). And finally, the collaborating partners worked to design the outlet sampling hatch such that water exiting the rain garden could be sampled prior to its mixing with the main storm drain (Figure 4.1.2, photo B).

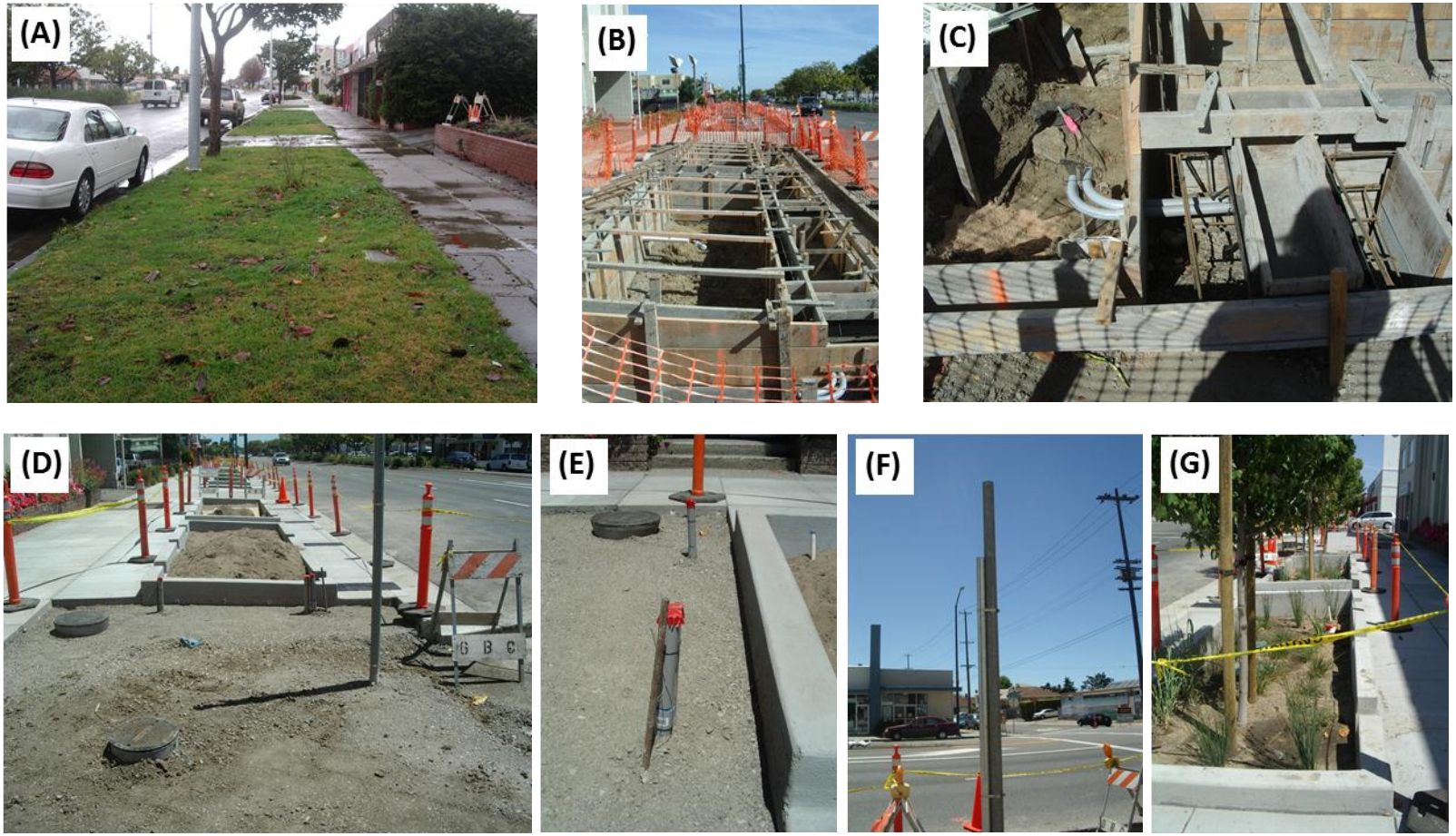

Figure 4.1.1. WY 2010 rain garden construction photos. **(A)** Pre-construction, looking north at the Eureka gardens site. **(B)** Building the forms for the monitoring cell location (June 2010). **(C)** Detail showing conduit being installed in the form to allow sampling tubing to be run between the inlet and the ISCO sampler (June 2010). **(D)** Concrete form built, and filter material placed in sampling cell (June 2010). **(E)** Detail showing two sets of conduit that connect the inlet to where the ISCO samplers will sit; also the outlet hatch is shown in the upper left (June 2010). **(F)** Pole installed for rain gauge, with conduit for wires attached (June 2010). **(G)** View looking north at sampling cell with plants installed (June 2010).

Figure 4.1.2. WY 2010 rain garden construction photos. **(A)** Detail showing curb grate and overflow drain (June 2010). **(B)** Looking down the sampling hatch. Water draining from the rain garden cell flows out from the pipe on the right into the storm drain below (June 2010). **(C)** Looking south at completed rain gardens (November 2010). **(D)** Detail showing the freshly poured concrete pad for the ISCO samplers (June 2010). **(E)** Curb inlets for sampling cells (November 2010). **(F)** Overflow drain (green cap in upper left corner of rain garden cell) (November 2010). **(G)** Looking north at completed sampling cells (November 2010).

4.2 Precipitation

Annual average rainfall in the vicinity of the rain gardens totals approximately 23 inches per WY (Oct 1 – Sept 30), but varies interannually over the 61-year period of record by over four-fold (Figure 4.2.1., WRCC, 2012). The observational WY 2011 was above average at approximately 133% of normal, while the water quality monitoring season, WY 2012, received 85% of normal.

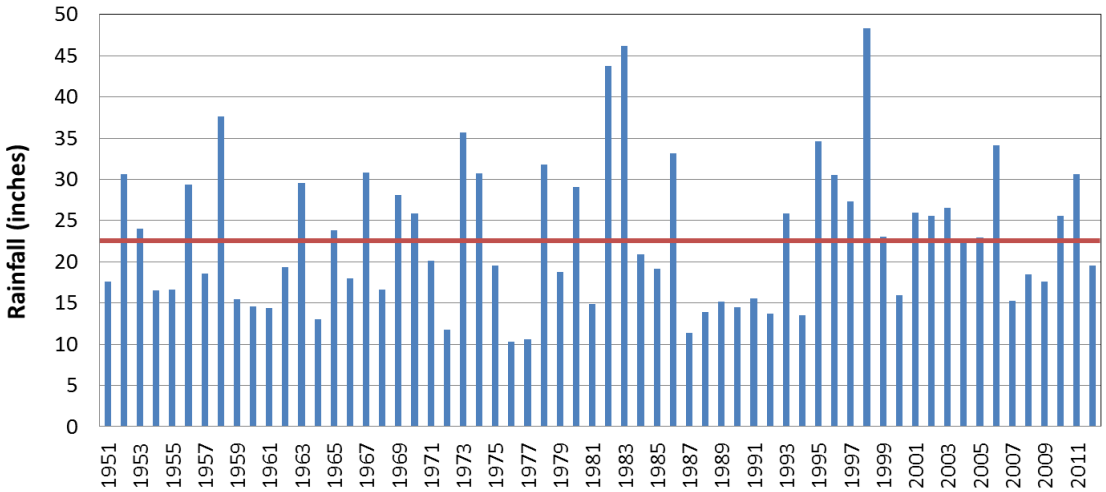

Figure 4.2.1. Annual rainfall by water year at the nearby Richmond COOP rainfall gage (WRCC, 2012; COOP ID 047414).

Precipitation data was collected onsite between 12/9/10 – 5/26/2011 and 9/13/2011 – 6/11/2012, recording accumulation every two minutes. The record was quality assessed against other nearby gages and deemed to be of high quality for most periods except for November 2011, at which time the tipping bucket had accumulated dirt which impaired its proper functioning, and the March 27, 2012 storm for unknown reasons. The record for those periods was replaced with the record from the nearby KCAKENSI3 gage in Kensington, CA[1]. The missing onsite record for the period prior to installation in December 2011 is substituted by the daily record at the KCAELCER1 gage in El Cerrito, CA[2]. Of the available gages each year, these two were the best aligned with the onsite gage.

Compared to the WY 2011 rain season which was comprised of numerous storm events (Figure 4.2.2), few punctuated storm events comprised the majority of rainfall during WY 2012 (Figure 4.2.3) and most of the opportunities for water quality monitoring that existed during the WY 2012 season were indeed monitored. WY 2012 began as one of the driest on record for the region, and by the new year fewer than 4 inches of rain had fallen (as compared to >10 inches in WY 2011). Both monitoring seasons had

[1] Online access at: http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KCAKENSI3
[2] Online access at: http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KCAELCER1

uncharacteristic extended dry periods in the months of January and February. Nevertheless, observations and water quality monitoring were completed at the gardens over a variety of intensities and durations of rain events, as well as during events with varying antecedent rainfall conditions (Table 4.1).

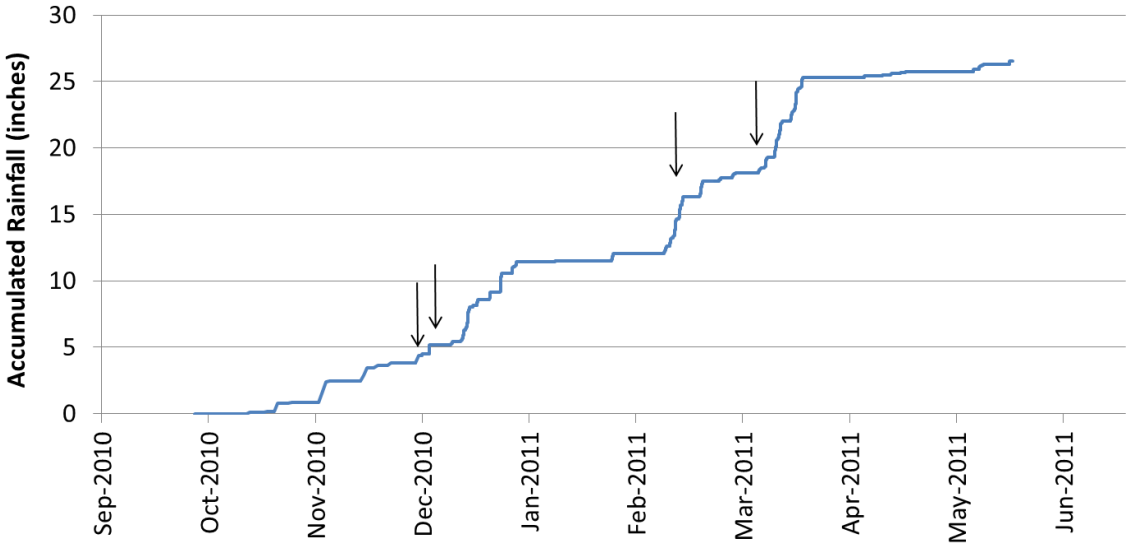

Figure 4.2.2. WY 2011 rainfall accumulation and observed events noted by the black arrows.

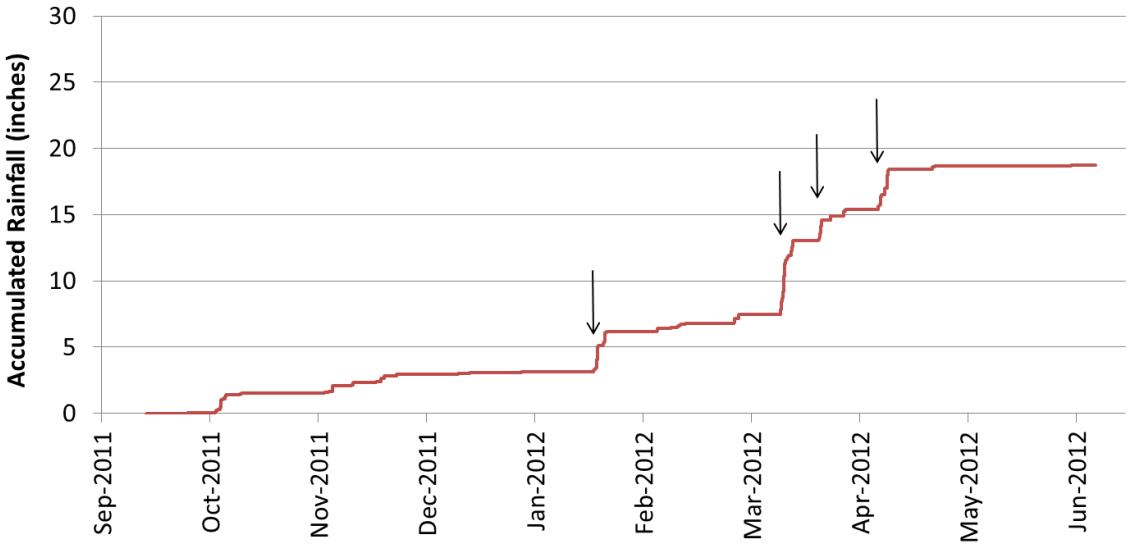

Figure 4.2.3. WY 2012 rainfall accumulation and notation of events monitored for water quality.

Table 4.1. Dates, peak rainfall intensity, storm duration, and number of antecedent dry days of observed/monitored events. Italics indicate data derived from nearby rainfall gages rather than our onsite rainfall gage.

	Storm Observation/ Monitoring Date	Storm Total Rainfall (in)	Storm Duration (hrs)	Peak Rainfall Intensity (in/hr)	# Antecedent Dry Days*
WY 2011	12/5/2010	*0.55*	*2:41*	*0.31*	7
	12/9/2010	NA	NA	NA	0
	2/19/2011	0.60	10:10	0.1	0
	3/13/2011	0.37	17:10	0.1	6
WY 2012	1/20/2012	1.56	8:46	0.58	0
	3/13/2012	0.96	9:20	0.17	11
	3/27/2012	*1.34*	*7:26*	*0.43*	1
	4/10/2012	0.34	9:06	0.1	9

* A day is considered dry if less than 0.05 inches of rain fell.

NA = observation not during a storm event.

Data for storm on 12/5/2010 is from local rainfall gage information downloaded from the El Cerrito gage (KCAELCER1)

Data for storm on 3/27/2012 is from local rainfall gage information downloaded from the Berkeley Highlands Terrace gage (KCAKENSI3)

4.3 WY 2011: Field Observations

A brief summary of selected observations from the WY 2011 storm monitoring is bulleted below, followed by the watershed delineation and photo-documentation (Figures 4.3.2 – 4.3.3) of the WY 2011 observations:

- The northernmost cell receives the greatest amount of runoff during all events. During large events, runoff towards the monitored inlet overflows and continues to the more southern inlets. During small events, most of the runoff enters at the northernmost inlet and little continues to the more southern inlets.
- Gardens will accumulate standing water even with very low rainfall totals. Outflow from the rain gardens to the main storm drain occurs during nearly every rain event greater than 0.05-0.1 inches. The timing of the start of outlet flow was observed in three events, during which flow began between 42 and 59 minutes after the initiation of rainfall and between 0.07 and 0.09 inches of rain.
- Individual cells perform differently along the block, e.g. some cells will pond while others will not. Some variation is due to the total volume of water entering the cell (based upon location north to south, as well as local inputs, e.g. runoff from the vacant building driveway), and some is likely due to variation in construction or the filter material.
- In some cases individual plants are placed directly in front of the main inlets and are partially blocking the inlet. This is the case in the northern most monitoring cell. Flow into the monitoring inlet backs up and causes overflow to pass down to more southern inlets.

- Maintenance is needed at the inlet locations, particularly during the initial storms of the year to ensure unimpeded inflow functionality. Significant sediment (sand-sized) accumulation was observed in the monitoring inlet after storms in December 2010.
- Continual maintenance is needed to remove trash in the rain garden cells. Trash observed consisted mainly of food containers and wrappers, drink bottles, and plastic bags. Although we did not monitor the likely sources, we speculate that trash buildup was from pedestrians traveling from nearby commercial food and convenience store establishments.
- The overflow drain elevation in the southern monitoring cell is lower than in the northern cell by approximately 2-3 inches. These overflow drains work like an overflow drain in a bathtub; the drains are located lower than the top of the rain garden cell such that water will drain through them prior to overflowing the top of the cell. To exit the system quickly to prevent overflow, the water entering the overflow drain bypasses filtration through the rain garden and instead directly enters the stormdrain. With the overflow in the southern monitoring cell positioned 2-3 inches lower, it means that as the gardens fill with runoff, a lesser volume of water is needed in the southern cell before filling high enough to enter the overflow and exit through the sampling hatch without being treated by the garden.
- The watershed boundary to the monitoring cell was delineated (see Figure 4.3.1). During storm conditions, the areas from which overland flow ran towards the rain garden cells were noted. On Kearney Street, runoff from the front yards of the homes flowed towards the street, while backyards were sloped such that runoff from those areas did not flow to Kearney Street, though runoff was observed coming from all portions of the corner lot on Kearney Street and Eureka Avenue. Several of the parking lots for businesses on San Pablo Avenue had drains within them and therefore did not contribute runoff to the catchment area, although the parking lot for the southern-most building in the watershed area on San Pablo Avenue did contribute runoff to the rain garden cells. The streets are all crowned and therefore the delineation extends to the centerline of each of the surrounding streets. We estimate the error of this delineated catchment area to be +/- 10%.

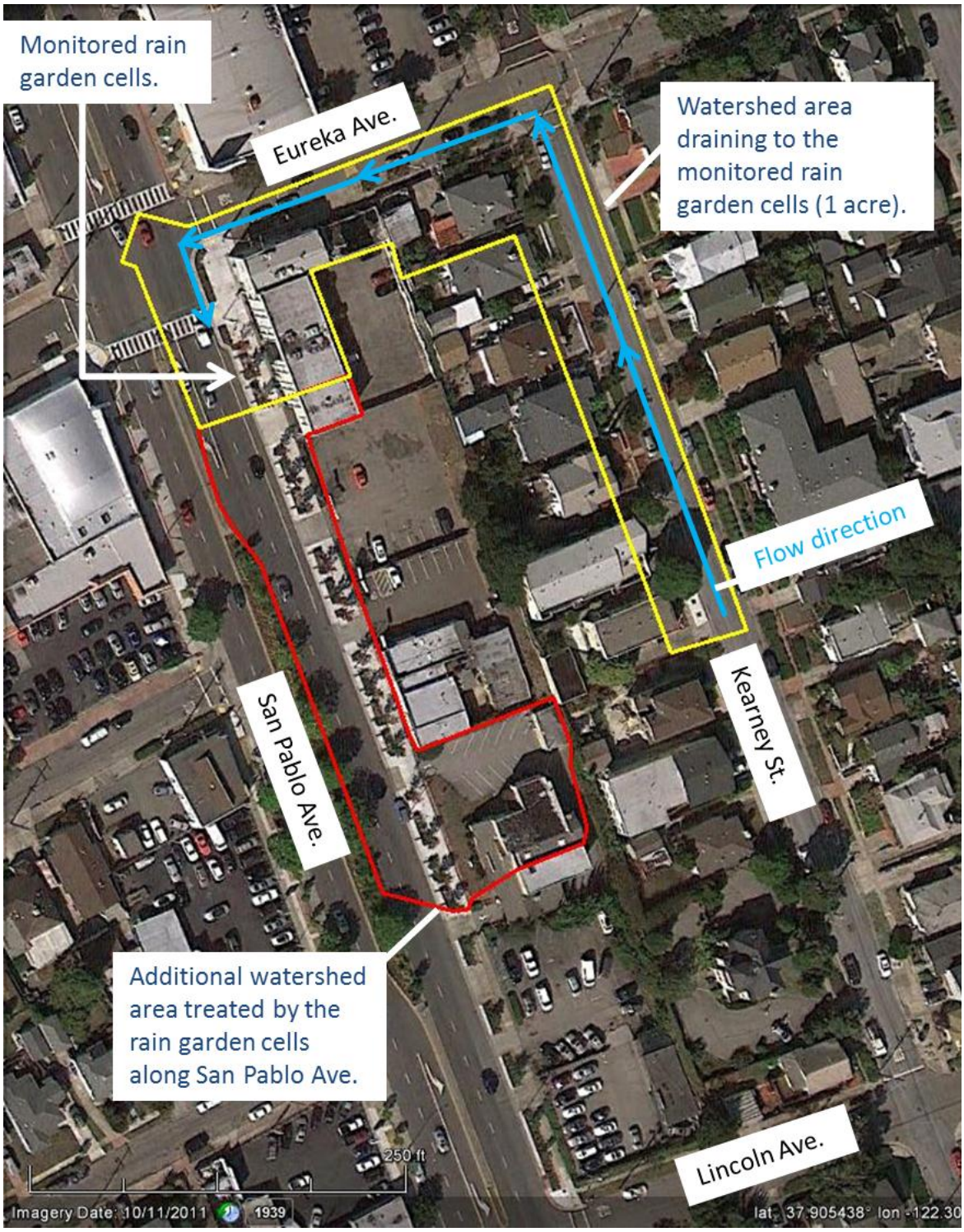

Figure 4.3.1. Aerial overview of the monitoring watershed study area at El Cerrito Rain Gardens. The yellow polygon defines the watershed boundary draining into the monitored rain garden cells, whereas the red polygon defines the additional watershed area treated by the more southern rain garden cells.

Figure 4.3.2. WY 2011 hydrologic monitoring observations. **(A)** Flow entering the inlets during the 12/5/10 storm. Local intense bursts of rain can cause high volumes of runoff from the impervious drainage area. **(B)** Unobstructed flow entering the monitoring cell inlet during the 2/19/11 rain event. **(C)** Ponded cell with educational sign installed during the 2/19/11 rain event. **(D)** More southern cell that is not ponded during the 3/13/11 rain event. **(E)** Accumulation of leaves found in each inlet, necessitating early season maintenance as a critical component to performance (11/2010). **(F)** Material (sand and organic debris) removed from the monitored inlet after the 12/5/10 storm. All of the inlets accumulated material; however the monitored inlet had the largest deposit because it is the furthest "upstream". **(G)** Sand-sized deposits removed from the inlets. **(H)** Example of food wrapper trash commonly found in the garden.

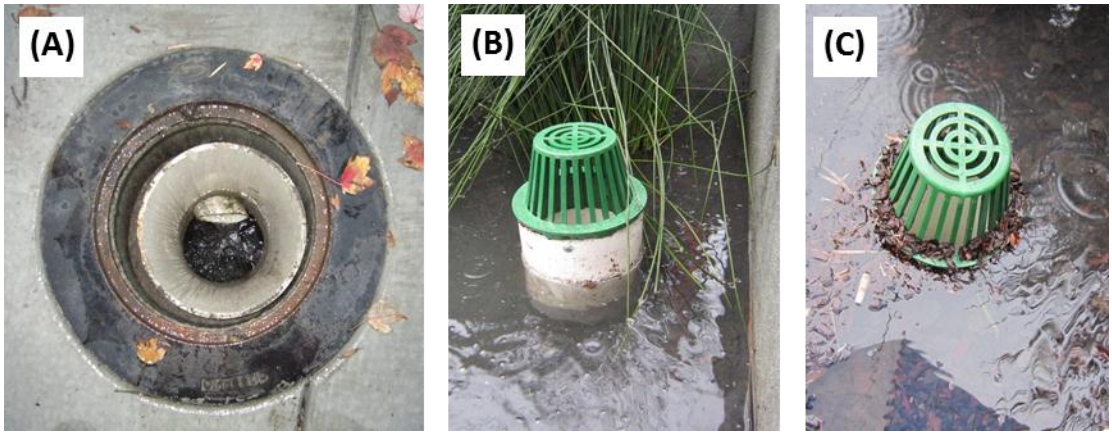

Figure 4.3.3. WY 2011 hydrologic monitoring observations. **(A)** Photograph looking down the sampling hatch. Manual sampling in WY 2012 collected the outflow that exited the garden from the PVC pipe (located approximately 1 m below the sidewalk surface) before it fell into the stormdrain system (approximately 0.5 m lower in elevation). **(B)** Overflow drain in the northern monitoring cell during the 2/19/11 rain event**. (C)** Overflow drain in the southern monitoring cell during the 2/19/11 rain event (taken at the same time as Figure 4.3.3 B). Because the drain is set at a lower elevation, water enters the overflow in this cell sooner than in the northern cell.

4.4 WY 2012 Water Quality Monitoring

4.4.1 Data QA/QC

Samples were analyzed for suspended sediment concentration (SSC) by Graham Matthews and Associates using ASTM D3977, Test Method B (see Appendix A), a filtration and drying method similar to Standard Methods 2540 D for total suspended solids (TSS), except avoiding subsampling variability by filtering the entire volume in a sample container (thus equivalent in practice to measurement of SSC following USGS methodology and terminology (e.g. Gray et al., 2000). We use the term SSC for the rest of the report. No samples were reported as non-detects (see Appendix B for quality assurance (QA) summary tables). Laboratory replicates were not possible for SSC as the entire volume was consumed for each analysis. The relative standard deviation (RSD) of one of the field samples and its duplicate was 5.03%, less than the 10% target for SSC, so no precision flags were applied.

Total and dissolved Hg and MeHgT samples were analyzed by Brooks Rand Laboratories using laboratory-specific variants of EPA Method 1631 Revision E (Hg) and 1630 (MeHg) (see Appendix A). Detection limits for Hg (average 0.7 ng/L) and MeHg (average 0.02 ng/L) were sufficient such that all samples were detected. No blank contamination was observed negating the need for blank correcting the results. Recoveries were well within the target range (<35% average error), and precision on laboratory replicates were also all within the desired range (<35% RSD).

Samples were analyzed for total and dissolved Cu by Brooks Rand Laboratories using a laboratory-specific variant of EPA Method 1638 (see Appendix A). Analyses were sufficiently sensitive so that detections were made in all samples. No blank contamination was observed negating the need for blank correcting the results. Recoveries on certified reference materials (CRMs) was good, averaging <25% error. Variability in sampling and analysis were evaluated via both field and laboratory replicates, showing good consistency with average RSDs <25%.

Total and dissolved organic carbon were analyzed by Delta Environmental Laboratories, LLC, California using SM 5310 C. Equipment malfunction during field sampling led to one DOC sample not being submitted for analysis. Of the remaining samples submitted, method sensitivity was sufficient such that no samples were non-detect. One method blank was reported for TOC and no blank contamination was found. Results were flagged as estimates and for insufficient QA/QC given that only one method blank for the project was measured instead of one per batch. Variability in field replicates (TOC RSD=4.42% and DOC RSD=1.89%) was within the target range (<5%). However, variability in laboratory replicates for TOC (RSD = 6.54%) and DOC (RSD=7.41%) was above the target (<5%), and the average error on laboratory fortified blanks (5.68% for both TOC and DOC) was also above the target, and therefore samples are qualified but not censored.

Samples were analyzed for PCB congeners by AXYS Analytical using Method MLA-010, a laboratory-specific variant of EPA Method 1668 Revision A (see Appendix A). Detection limits for the 40-congener analyses were sufficiently low that all PCBs were detected. About one-half of the congeners were detected in the method blank, but none at concentrations >1/3 those in field samples, so results were flagged but not censored. Precision on field samples replicates were generally good with RSD 16% or better, within the target 35%. There are no CRMs for PCBs in water, so recoveries were evaluated on blank spikes, with errors 18% or less, also within the 35% target.

Pyrethroids were analyzed by AXYS using Method MLA-046 by high-resolution gas chromatograph (DB-5 capillary) and using voltage selected ion detection. Detection limits were not sufficient to detect any of the pyrethroids in any samples, except for total Permethrin, which was detected in 45% of the samples. No blank contamination was observed and data were not blank corrected. Field replicates on field samples and replicates on blank spikes for total Permethrin were generally good having average RSDs below the target of 35%. Blank spike samples were used to evaluate accuracy, with the average % error generally below the target of <35%. Only two pyrethroids, Phenothrin and Resmethrin, were flagged for being above 35% but below 70% error, and therefore not censored.

4.4.2. Ancillary Measurements (Turbidity, Electrical Conductivity, Suspended Sediment and Organic Carbon)

The first storm event monitored in WY 2012 spanned from the early afternoon on January 20th through to the early morning hours of the following day. Prior to the initiation of sampling, a very light intensity rainfall began on the previous day and had dropped a total of 0.36 inches in the 24-hr period prior to the start of the monitored storm. Because the antecedent dry period had been so extended prior to January 19th, conceptually we could expect higher pollutant build-up on the watershed surface resulting in higher measured concentrations. However, the light intensity rainfall preceding the water quality monitoring may have dampened the effect. Nevertheless, at the inlet there is a clear pattern of elevated turbidity at the beginning of the monitoring and a relatively consistent decrease as the storm progressed (Figure 4.4.2). The low turbidity is consistent with other studies in small and highly impervious watersheds where little sediment is available for transport. In comparison, turbidity at the outlet changed little throughout the storm. In a similar way, electrical conductivity (EC) at the outlet is fairly constant whereas EC at the inlet varied more throughout the storm in a complex manner.

Storms 2 and 3, both sampled in March, had similar ancillary parameter patterns to one another. Turbidity at the inlet began in the 80-100 NTU range, quickly dropped for most of the storm and then rose again towards the end of the storm, while turbidity at the outlet remained fairly constant around 20 NTU. Electrical conductivity also followed this u-shape at the inlet for both storms, and outlet EC was generally higher than at the inlet and had less variation over the storm.

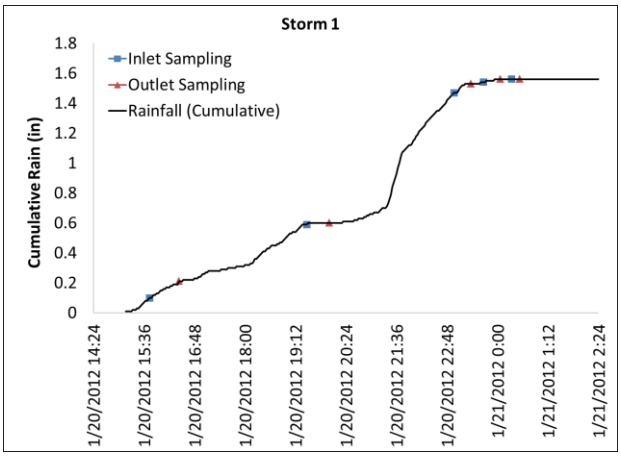

Figure 4.4.1. Storm 1 rainfall and water quality sample events.

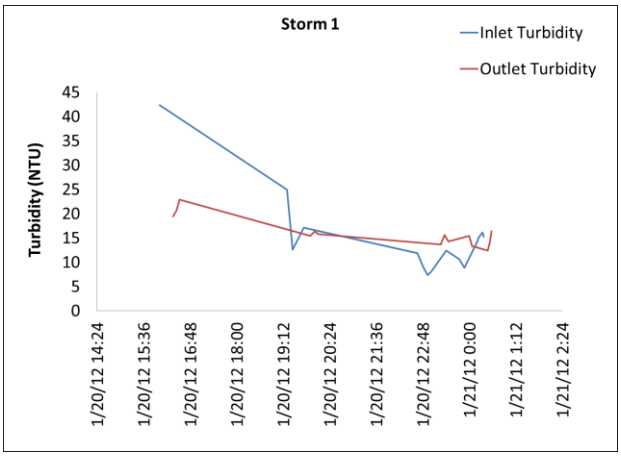

Figure 4.4.2. Storm 1 turbidity at the inlet and outlet.

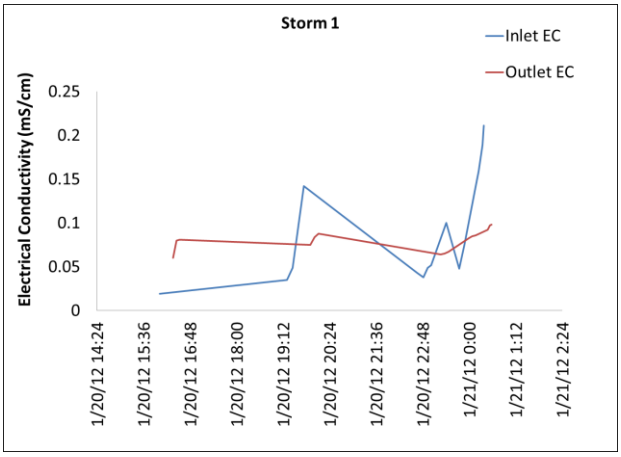

Figure 4.4.3. Storm 1 electrical conductivity at the inlet and outlet.

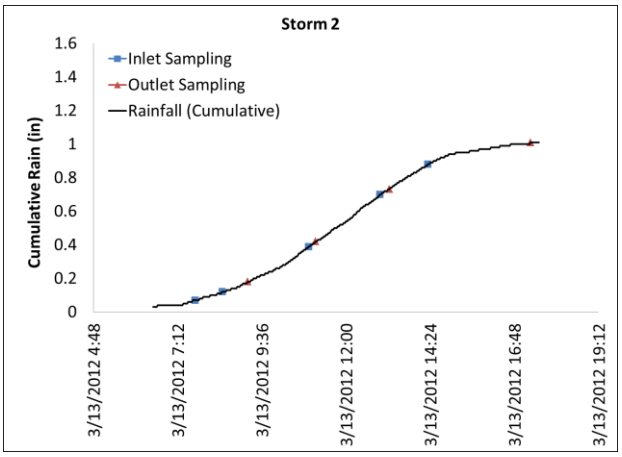

Figure 4.4.4. Storm 2 rainfall and water quality sample events.

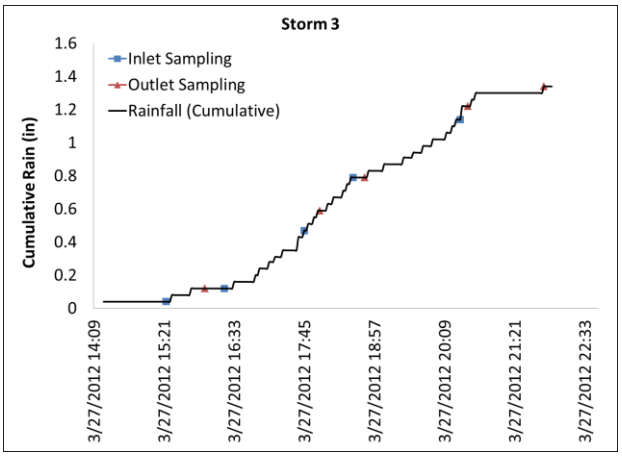

Figure 4.4.7. Storm 3 rainfall and water quality sample events.

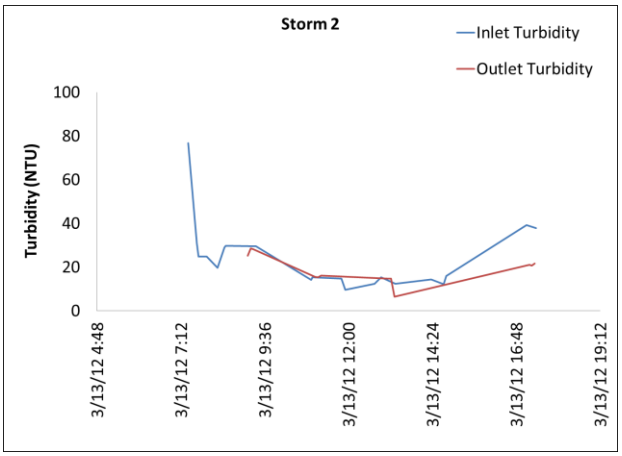

Figure 4.4.5. Storm 2 turbidity at the inlet and outlet.

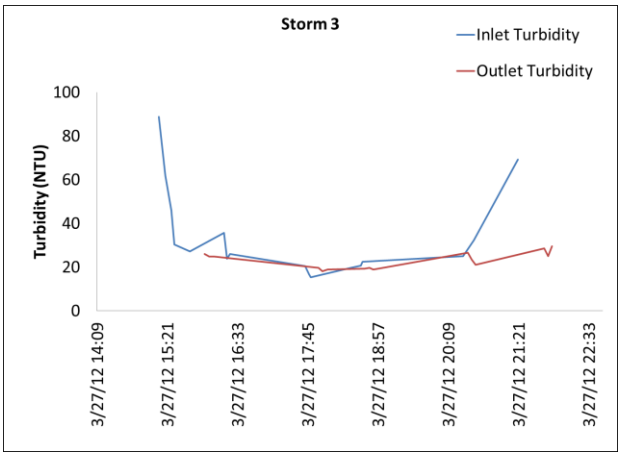

Figure 4.4.8. Storm 3 turbidity at the inlet and outlet.

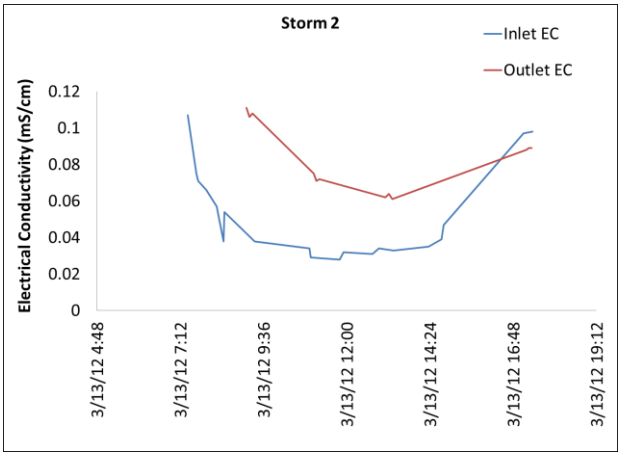

Figure 4.4.6. Storm 2 electrical conductivity at the inlet and outlet.

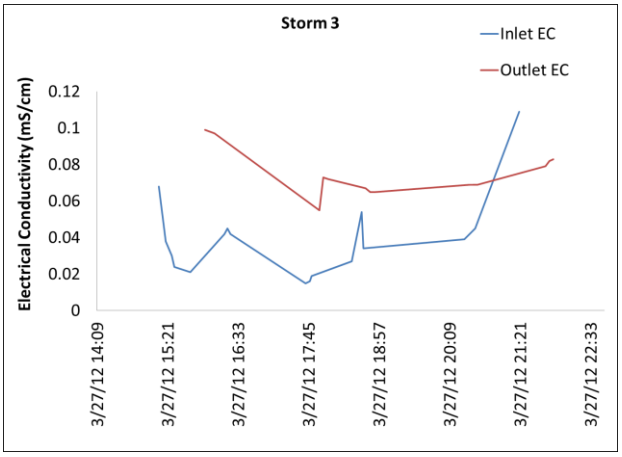

Figure 4.4.9. Storm 3 electrical conductivity at the inlet and outlet.

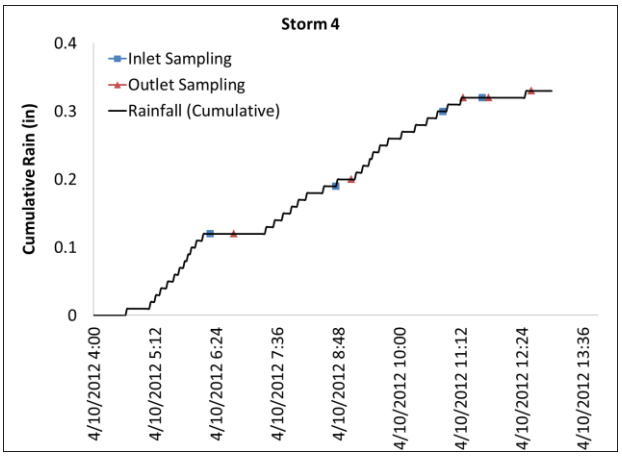

Figure 4.4.10. Storm 4 rainfall and water quality sample events.

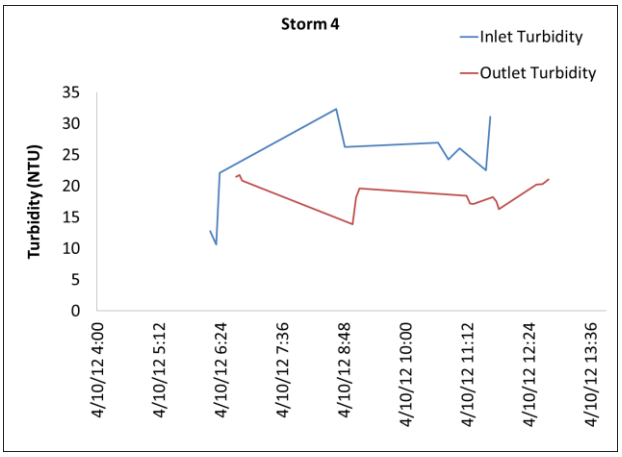

Figure 4.4.11. Storm 4 turbidity at the inlet and outlet.

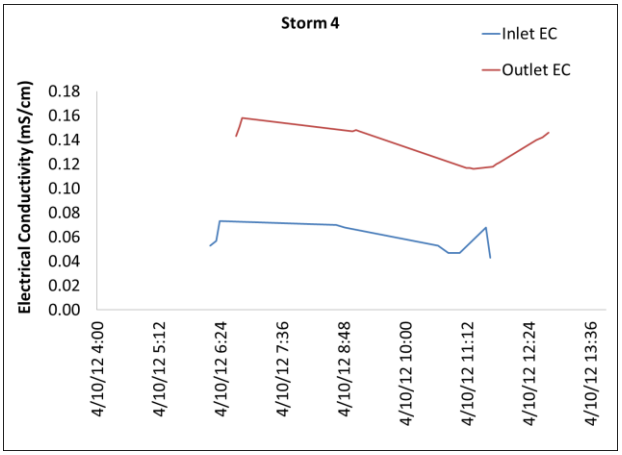

Figure 4.4.12. Storm 4 electrical conductivity at the inlet and outlet.

The final storm sampled in mid-April was quite different relative to the other three. In this event, turbidity was not elevated at the beginning of the storm and only slightly higher for most of the storm than at the outlet. EC at the inlet was constant around 0.6 mS/cm, and consistently 0.8-1.0 mS/cm higher at the outlet. Consistent with the other storms, the outlet turbidity was constant around 20 NTU.

Suspended sediment concentrations at the inlet ranged between 6.5 – 178 mg/L, with one outlier at 395 mg/L (turbidity for sample = 17.7

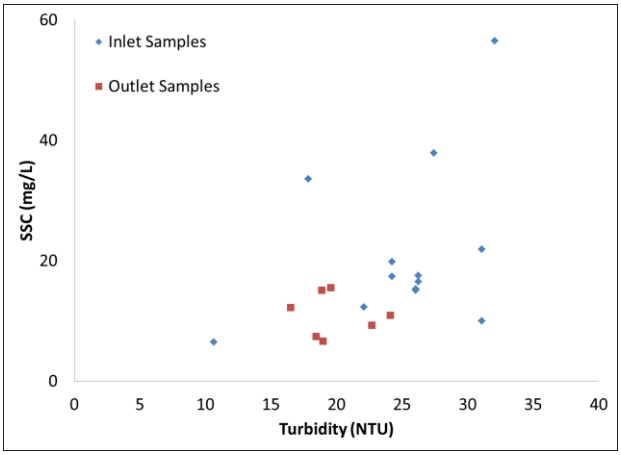

Figure 4.4.13. Suspended sediment concentration as a function of turbidity. Note that SSC sample of 178 mg/L could not be graphed due to a partial turbidity record for this sample.

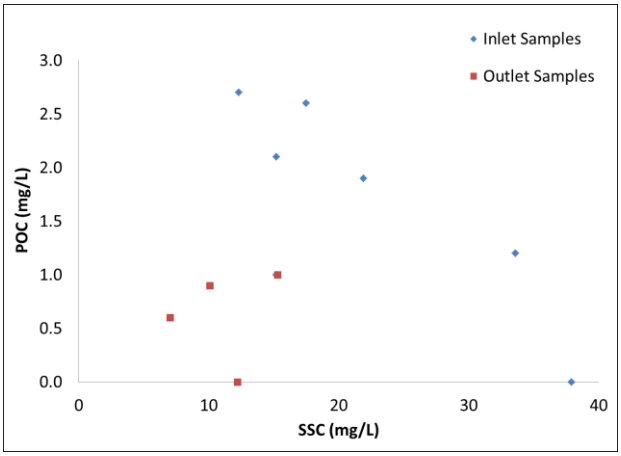

Figure 4.4.14. Particulate organic carbon as a function of suspended sediment concentration.

NTU). In this high outlier sample, there were larger particles that affected the SSC result while not reflected in the turbidity measurement. There was a positive correlation between SSC and turbidity, although the linear regression R^2 was not strong (0.14; Figure 4.4.13). Suspended sediment concentrations and turbidity varied much less at the outlet and spanned a small range (6.6 – 15.5 mg/L) with no detectable relationship.

Total and dissolved organic carbon (TOC and DOC) were also measured at the same frequency as the metals and organic analytes. Concentrations for TOC ranged between 6.9 – 20.5 mg/L, and DOC[3] ranged between 6.6 – 17.8 mg/L. Organic carbon was 83-100% dissolved. Particulate organic carbon (POC) was calculated as the difference between TOC and DOC, and had an inverse correlation with SSC at the inlet (R^2= 0.6; Figure 4.4.14). It appears that the proportions of organic versus inorganic sediment are variable either reflecting differing source characteristics during the course of a storm event or between storms, or reflecting the role of differing energy (velocity) regimes. During the first two storms for TOC and the first storm for DOC, concentrations increased after treatment through the rain garden, whereas concentrations during Storm 3 were very similar (Figure 4.4.15). As with turbidity and EC, TOC and DOC concentrations during the fourth storm event showed a different pattern.

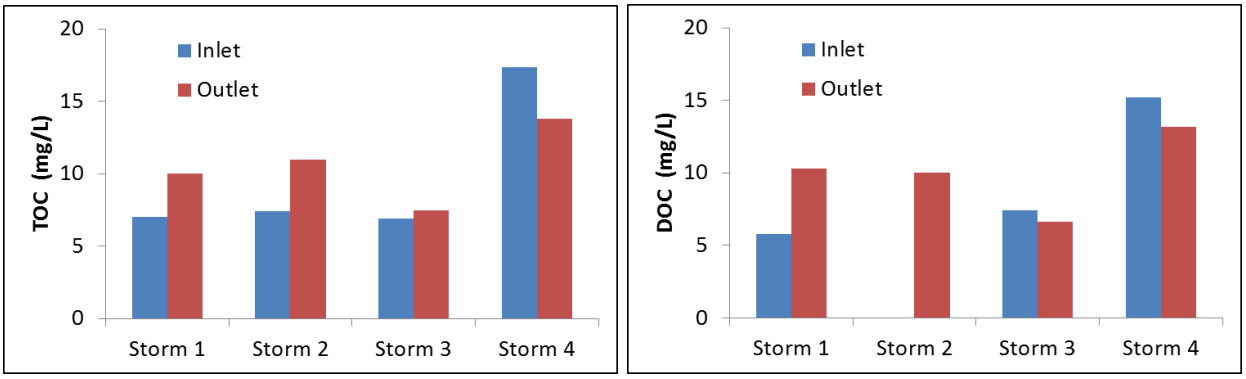

Figure 4.4.15.Measured TOC and DOC concentrations. Storm 4 inlet concentrations are the average of the four discrete samples collected; all others are composite samples. **(A)** TOC concentrations at the inlet and outlet. **(B)** DOC concentrations at the inlet and outlet. Storm 2 inlet DOC was not measured.

4.4.3. WY 2012 Pollutant Monitoring: Metal and Organic Pollutants

Stormwater Concentrations: Concentrations of each pollutant at the inlet versus outlet for each storm event monitored indicated that in most cases, effluent concentrations were lower than influent concentrations (Figure 4.4.16). Total and dissolved Cu, total methylmercury (MeHgT), total PCBs (the sum of 40 congeners), and pyrethroid pesticides all decreased between inlet and outlet samples, whereas HgT and HgD had a less clear pattern. Total Hg decreased in storms 1, 3 and 4, at the outlet relative to the untreated inlet stormwater between 3-52% (average 32%), and was on average 35% dissolved on the inlet and 50% dissolved on the outlet. Concentrations of HgD at the inlet and outlet are not very different from one another, and therefore HgD does not appear to be filtering out. Storm 2 was different in that the outlet concentration was nearly three-fold greater than at the inlet. Although we do not have an HgD concentration at the inlet during

[3] Note: DOC was not measured in Storm 2 due to equipment malfunction.

storm 2 due to equipment malfunction, if we assume that the inlet HgD is equal to or less than the inlet HgT (within uncertainty of the analytical measurement), then similar to the HgT pattern for this storm event, outlet HgD would also be greater than the inlet HgD (although this difference may not be significant depending on the percentage of HgT that is dissolved).

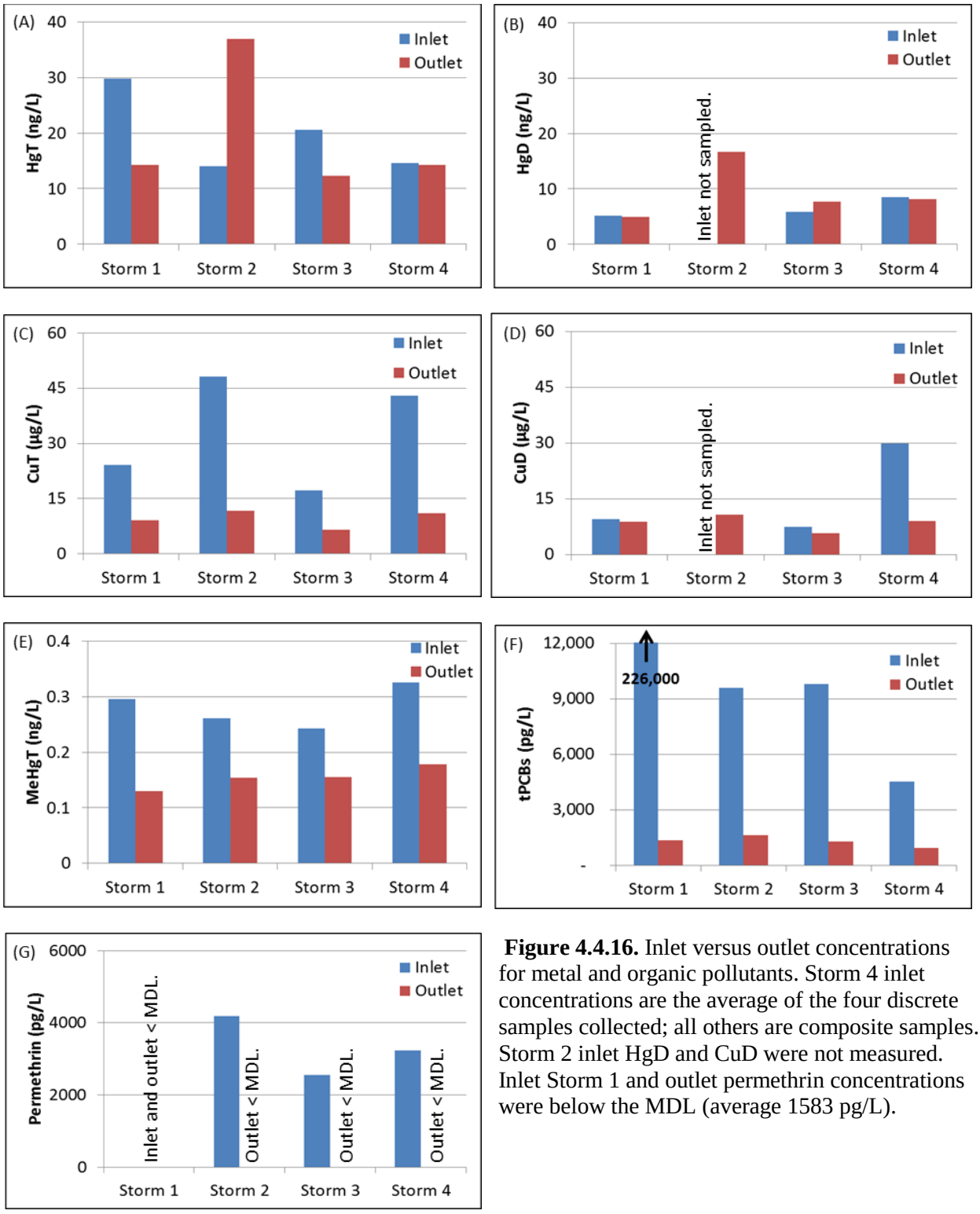

Figure 4.4.16. Inlet versus outlet concentrations for metal and organic pollutants. Storm 4 inlet concentrations are the average of the four discrete samples collected; all others are composite samples. Storm 2 inlet HgD and CuD were not measured. Inlet Storm 1 and outlet permethrin concentrations were below the MDL (average 1583 pg/L).

As with Hg, particle-bound Cu appears to be more effectively treated than CuD, although the missing inlet CuD[4] concentration during storm 2 makes it difficult to be certain of this. Total Cu concentrations decreased in the outlet samples in relation to the inlet samples between 62-76 % (average 69%)[5] in all four storms, and CuD decreased 8-70% (average 34%) in storms 1, 3 and 4. Inlet CuT was on average 50% dissolved, whereas outlet CuT was on average 90% dissolved. Whereas inlet concentrations of both CuT and CuD span a greater range between storm events, outlet concentrations are much more consistent.

Like CuT, MeHgT was consistently treated by the rain garden, the outlet concentrations decreasing 36-56% (average 45%) in each storm event monitored over the inlet concentrations. Inlet concentrations ranged from 0.24-0.33 ng/L, while outlet concentrations spanned 0.13-0.18 ng/L.

The rain gardens had the largest impact on reducing organic pollutants. The sum of PCBs measured (tPCBs) ranged from 4,520-226,000 pg/L at the inlet and decreased by 79-99% (average 87%) after treatment through the rain gardens. The only pyrethroid detected in this study was permethrin during the latter three storms, however the detection limit in the first storm was 6,410 pg/L and so it is possible that permethrin was present in similar concentrations as detected in the latter storms. The outlet sample results suggest that permethrin is filtered to below detectable levels as stormwater passes through the rain gardens.

First Flush Effect: As described in the precipitation section above, the first storm event monitored followed an extended dry period and we might have expected to measure elevated concentrations at the inlet as a result. Indeed, HgT and tPCBs both had higher inlet concentrations during the first storm than in the following storms. Total Hg was higher than the next highest sample measured at the inlet by approximately 50%, while tPCBs at the inlet during the first storm was 23-fold higher than the next highest sample. Other analytes did not show elevated concentrations in this storm event, however, this event began with a very light intensity rainfall for 24 hours prior to the initiation of sampling. In total, 0.36 inches of rain fell prior to sampling.

Concentration Variation within a Storm: During the final storm event, four discrete samples were collected at the inlet to investigate variation of pollutant concentrations over the course of a storm event. The storm event in which these samples were collected was 0.34 inches of rainfall over 9 hours, with rainfall intensity peaking at 0.1 inches/hr. Concentration variation was dependent on analyte. Copper species and HgD varied less than plus +/- 50% relative to the first sample of the storm, and MeHgT increased less than 100% (Figure 4.4.17). On the other hand, HgT and tPCBs peaked above the initial sample 250% and 350%, respectively. In particular,

[4] Note: CuD was not measured in Storm 2 due to equipment malfunction.

[5] A note on "percent removal": In this report, we use the percent removal/decrease/reduction metric between inlet and outlet concentrations to describe changes to the pollutant concentrations. This is a valid metric, but should be used with caution, particularly when comparing to other studies. In particular, the percent reduction can be more a function of the influent quality as opposed to the BMP effectiveness, a high percent removal does not necessarily mean that the effluent quality is acceptable relative to water quality standards, methods for calculating percent removal may be different in other studies, percent removal may be dominated by outliers, and percent removal does not take into consideration the effect of runoff volume reduction, an issue that is addressed in this study within the Discussion section.

tPCBs vary consistently with SSC, providing support that tPCBs are occurring at this location dominantly in particulate phase. Total mercury and total copper at this location are more in dissolved phase, and are both less variable throughout a storm and vary less consistently with SSC.

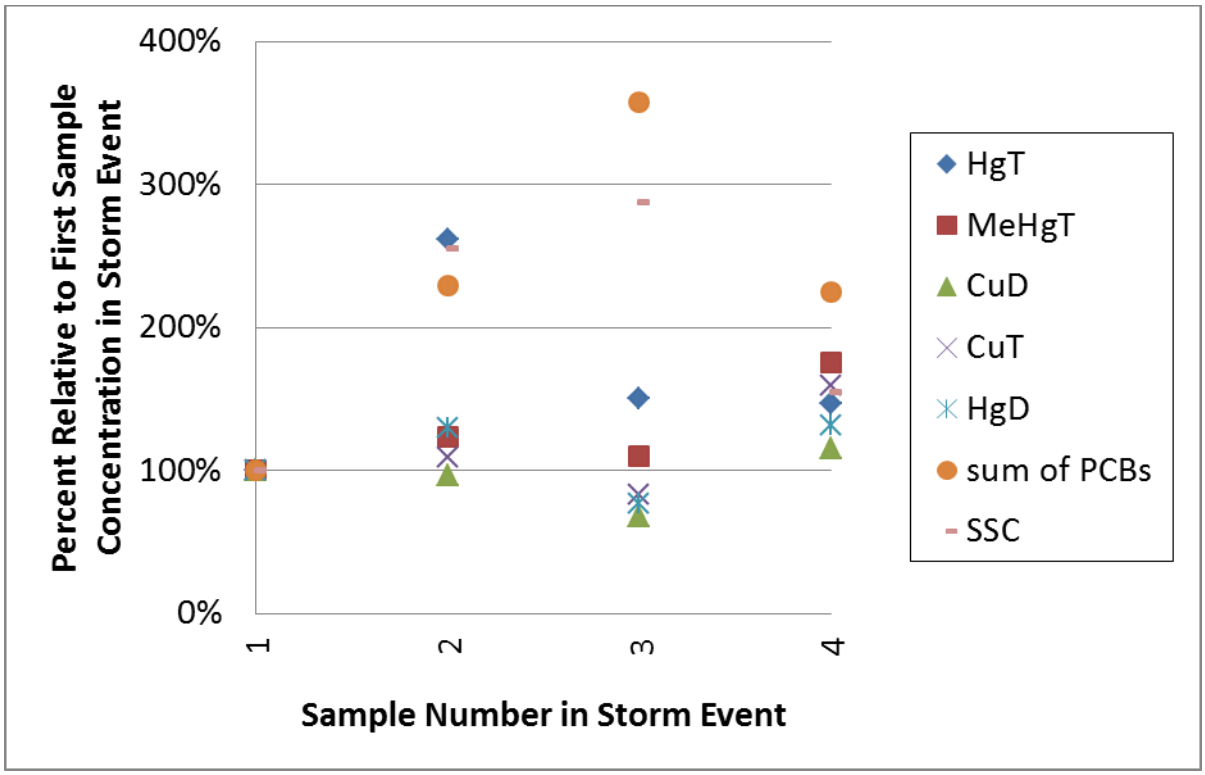

Figure 4.4.17. Discrete sample concentrations at the inlet for each analyte relative to the first sample collected during storm event 4. Graphic intended to show variation in sample concentrations during the course of the storm.

Particle Ratios: Concentrations of pollutants were normalized by the corresponding suspended sediment concentration to derive an estimate of particle concentration (mass of pollutant per mass of suspended sediment, e.g. pg PCB: mg SSC). The resulting ratio is an estimate of the particle concentration if we assume the pollutants are transported entirely in a particle form. Since this is likely not true for most of the pollutants, and certainly not for the pollutants in which we measured dissolved phase (Hg, Cu) (Figure 4.4.18), we instead use the term "particle ratio". Particle ratios for the metals are either similar between the inlet and outlet (CuT), or are greater at the outlet (HgT, MeHgT) (Table 4.2). These ratios increase because although the water concentrations are similar or greater at the inlet relative to the outlet (see bar graphs in Figure 4.4.16), SSC decreases by a greater proportion and the particle ratio becomes elevated. In other words, suspended sediment is being filtered by the rain garden more effectively than the total fraction of the metals. Since a much greater fraction is in dissolved phase when suspended sediment concentrations are low, we might expect to reach some asymptote of treatability often described as an irreducible concentration.

On the other hand, particle ratios for the organic pollutants decreased after being treated in the rain garden, despite the simultaneous decrease in SSC. As opposed to the metals, the organic

pollutants measured were filtered by the rain garden more effectively than suspended sediment, overall causing a decrease in the particle ratios –thus it appears that the organic pollutants (despite a portion likely being in liquid or dissolved phase), were better adsorbed or more "sticky" than some of the metals within the rain garden. Nevertheless, tPCBs also showed evidence of an irreducible concentration; regardless of the inlet concentrations, tPCBs in the samples measured were never treated to levels below about 1,000 pg/L.

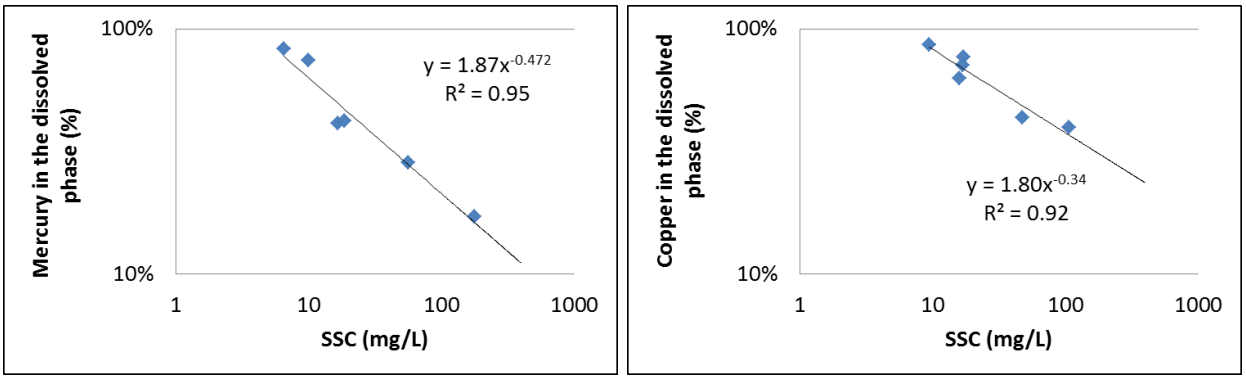

Figure 4.4.18. The relationship between suspended sediment concentration and the percentage of Mercury and copper in dissolved phase. At lower suspended sediment concentrations the data demonstrate that nearly 100% of these metals are found in dissolved phase in the run-off water from the rain gardens catchment area.

Table 4.2. Averaged particle ratios at the inlet and outlet of the rain garden.

Pollutant	Particle Ratio (inlet)	Particle Ratio (outlet)
Copper (Total)	903 mg/kg	897 mg/kg
Mercury (Total)	0.43 mg/kg	1.65 mg/kg
Methyl Mercury (Total)	0.008 mg/kg	0.015 mg/kg
PCBs	1.16 mg/kg	0.13 mg/kg
Pyrethroids	2.49 mg/kg	< MDL

5. Discussion

5.1 Stormwater Concentrations

In this study, water concentrations were measured at the inlet and outlet to infer the effectiveness of the rain garden at reducing pollutants in stormwater runoff to the estuary. The primary study design (collection of four or five aliquots over the course of a storm into a composite sample at the inlet and outlet) appears to have been generally successful at being able to make this inference; pollutants measured in samples at the inlet versus outlet generally followed a consistent trend for each analyte over the course of all four storms. Nevertheless, there was one anomalously high outlet mercury concentration in Storm 2, and this anomaly highlights the challenge with this sampling design and the low sample number. In an inlet-outlet monitoring design such as this, there is no way to ensure that the same water is being sampled at the outlet that was sampled at the inlet tens of minutes before. The runoff that is sampled at the inlet takes

some amount of time to filter through the rain garden before exiting at the outlet, and the transport pathway and timing of that runoff through the rain garden will vary depending on saturation of the rain garden and continued runoff characteristics into the rain garden. Therefore, it is never certain that the comparison of the inlet and outlet sample is based on the same water pre- and post-treatment through the rain garden. The consistency of the concentration differences between inlet and outlet samples provides some reassurance, however the anomalous high outlet mercury concentration in Storm 2 may be explained by the likelihood that the same water was not sampled at the inlet as the outlet. Another possible explanation for the elevated mercury concentration at the outlet in Storm 2 is that material high in mercury may have accumulated in the rain garden prior to the storm or in a previous storm event, and exited during the storm sampled. Collection of more aliquots per composite could help to improve the likelihood that similar inlet and outlet waters are being represented in the samples. Further, a greater number of samples per analyte would help to tease out further whether this data point is an outlier. Pilot level studies such as this are typical of monitoring designs for evaluating effectiveness of small green infrastructure improvements. Such studies will likely continue to be challenged by small sample numbers due to the high costs of stormwater monitoring and pollutant analyses and the needs to monitor both influent and effluent, effectively doubling the analysis budget.

Two other aspects of stormwater runoff were characterized by this study design: seasonal first flush and concentration variation over the course of the storm. Total mercury, and especially tPCBs, were both elevated at the inlet in the first storm sampled as compared to the other three storm events, and this may be attributed to a first flush effect. The difference in the effect on PCBs versus HgT may be indicative of the source category for PCBs, in which very little PCBs is sourced from atmospheric deposition, whereas for HgT, sources include both atmospheric deposition (likely a large component) and transport sources such as damage and spillage of raw elemental Hg from car lights, and combustion products from gasoline. In contrast, MeHgT, which is the product of biologically mediated methylation, and less of a source that builds up on the landscape surface from atmospheric deposition or traffic activities, showed consistent concentrations throughout the monitoring season. Of further note, because this storm began as a very light intensity rainfall prior to the greater intensity storm event that was actually sampled, concentrations may have been suppressed and the site may have more exaggerated seasonal first flushes in other years. In the fourth storm event, four discrete samples were collected at the inlet so that we might observe concentration variation throughout the storm in the untreated runoff. Variation was indeed measured in PCBs, SSC, and to a lesser degree, HgT. However, this was unfortunately a very small rainfall event. Concentration variations may be more amplified and for more of the analytes in larger storm events.

5.2 Particle Ratios

Normalizing water concentrations to sediment can be an important tool for analysis because water quality guidelines are often based on particle concentrations (e.g. 0.2 mg/kg for mercury in stormwater is described in the San Francisco Bay basin plan as one of the targets). And it can be a preferred means of comparing between sites/watersheds because particle ratios of hydrophobic pollutants tend to vary within the same waterway less than water concentrations. The particle ratio comparison between inlet and outlet in this study combines with the water concentration data to highlight several important points. The data illustrates that, given that water

concentrations generally decrease from inlet to outlet and yet the particle ratios increase for some pollutants, the comparison of particle ratios between inlet and outlet is not a good tool for evaluating the effectiveness of the rain garden at reducing pollutant export to the Bay. The particle ratio ignores that suspended sediment is filtered in addition to the pollutants, and therefore the ratio does not necessarily decrease as pollutant water concentrations decrease. Because filtration through the rain garden does not have much effect on the dissolved fractions, even if particles and the particulate fraction of a pollutant are filtered equally, the particle ratio can increase, as seen with HgT and MeHgT. In contrast to mercury, the average PCB particle ratio decreased 90%. While this decrease alone does not point to how effective the rain garden was at decreasing PCB loads, we can say that PCBs were filtered more effectively from the rain garden than sediment.

Our conceptual model is that the coarser the particle entering the rain garden, the more likely the rain garden will filter it out and detain its release at the outlet, while finer particles and pollutants in the dissolved phase will be less likely to be trapped within the rain garden. The total and dissolved water concentrations for Hg and Cu support this conceptual model. That data also suggests that while the dissolved portions are relatively unaffected by the rain garden, approximately 50% and 90% of the particulate-bound portions of Hg and Cu, respectively, are being detained by the rain garden. One would have to assume that Hg and Cu sources for this watershed are primarily from atmospheric deposition and vehicle residues, both sources of which are dissolved and fine particulate phase. It is unclear at this time why the rain garden is more effective at filtering out particulate Cu than particulate Hg, but the presumption is that Hg in this watershed is associated with finer particles than Cu. Along these same lines, the data suggests that in this watershed, either PCBs are more associated with coarser particles and that hardly any are in the dissolved phase, or that the rain garden is effective at adsorbing dissolved phase PCBs unlike the dissolved metals.

5.3 Loading Reduction Inferences

Total water concentrations and particle ratios describe only some aspects of the rain garden's effect on stormwater pollutants, while an additional very important piece of the story is how much mass (or, load) of each pollutant is withheld from release into the downstream receiving water body (in this case, the San Francisco Bay). Pollutant loads are a function of both concentration and the volume comprised of that concentration, however monitoring the influent and effluent volume was not within the scope of this study. Nevertheless, we can make rough estimates of *possible* load reductions under different runoff volume reduction scenarios. Table 5.1 summarizes the average change in concentration between paired inlet and outlet samples in this study, and the resulting total load reduction under different runoff volume reduction scenarios. This information is also useful for thinking about future designs. We demonstrate how important volume reduction can potentially be for achieving water quality attainment objectives in relation to loadings to a downstream water body. Note that even in cases where the average change in concentration was towards higher concentrations at the outlet (e.g. HgD and HgT (all data)), because load is a function of both concentration and volume, then volume reductions can tip the scales towards total load reduction. If bioretention systems, such as rain gardens, are sized to maximize the role of infiltration as a treatment mechanism, much greater load reductions will occur (compare the columns to the left in table 5.1 to those on the right). In some situations however, the risk of contamination of groundwater might need to be considered.

Table 5.1: Estimated load reductions under different volume reduction scenarios. HgT is presented both including all the data as well as excluding the anomalous Storm 2 data point. Pyrethroids are presented both assuming that non-detected samples have a concentration equal to 0 and equal to 0.5 the method detection limit.

	Average change in concentration (Inlet - Outlet)	Load reduction if volume reduced by:		
		25%	50%	75%
SSC	79%	84%	90%	95%
HgT (all data)	-17%	12%	42%	71%
HgT (excluding Storm 2)	32%	49%	66%	83%
HgD	-8%	19%	46%	73%
MeHgT	45%	59%	73%	86%
CuT	69%	77%	85%	92%
CuD	34%	51%	67%	84%
PCBs	87%	90%	94%	97%
Pyrethroids (ND=0.5 x MDL)	50%	63%	75%	88%
Pyrethroids (ND=0)	100%	100%	100%	100%

* Because the pyrethroids (permethrin) concentration results are near the method detection limit, how the non-detected data is treated has an effect on interpreting the concentration and load reduction between inlet and outlet.

Taking into account the likely size of error bars around our data (see the QA/QC section above), the relative order of load reduction for all the pollutants investigated in this study was:

Pyrethroids (NDs = 0) ≈ PCBs ≈ SSC > CuT ≈ Pyrethroids (NDs = 0.5 MDL) ≈ MeHgT ≈ CuD ≈ HgT (excluding Storm 2) > HgD ≈ HgT (all datapoints).

At approximately 1.8% of the total impervious area for the catchment, the rain gardens in this study cover a surface area that is less than the general guidance provided by the San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook (San Mateo Countywide Water Pollution Prevention Program 2009), which states as a "quick rule of thumb … the dedicated landscape space [should] be 4% of the total impervious catchment area". Despite covering a smaller area, the concentration data in this study shows that even smaller treatments can be effective. Although we don't know exactly what the volume reduction is for the system, the load reduction scenarios provide a framework for considering how much pollutant loads could be further decreased (assuming no additional benefit to reducing water concentrations) if the system were even larger with greater volume reduction capability.

Loading reduction in the Table 5.1 volume reduction scenarios is particularly dramatic for the dissolved fractions. Because the concentration of the dissolved species is relatively unchanging between inlet and outlet, the mechanism for reducing dissolved loads in this system and possibly others is by retaining volume. Volume retention prevents the dissolved pollutants from exiting the system and allows time for these fractions to phase change and adsorb to particulates in the rain garden for longer term storage.

6. Conclusions

The El Cerrito Green Streets Pilot Project treats runoff from 1.7 acres of a highly impervious, mixed-use urban watershed at the Eureka Avenue location. Shortly after initiation of rainfall, runoff from this watershed begins. Prior to construction of the rain gardens, this flow would have immediately passed into the stormdrain system and continued without treatment to the San Francisco Bay. Now, stormwater flows through curb cuts into a series of rain gardens along the highly vehicle and pedestrian-traveled San Pablo Avenue, where runoff first filters through the rain gardens prior to joining the main stormdrain system, and some portion of that runoff is likely being detained entirely.

Observations performed in the first year after construction improved the design of the water quality monitoring effort in the following year and provided guidelines for future rain garden construction projects. Three of these guidelines include: 1) Consideration to effects on stormwater runoff should be given when determining the elevation of the overflow drains in each garden cell, both in relation to the elevation of the surrounding sidewalk as well as in relation to one another. 2) Early season maintenance is critical to remove any debris (e.g., trash, dirt) that might obstruct flow into the rain gardens. 3) The flow path of water through the curb cut and into the rain garden should also be considered when placing plants within the rain garden so as to avoid obstructing flows into the rain garden cells.

Water quality monitoring data showed that the rain garden had mixed treatment effects on the concentrations depending on the pollutant and fraction studied, although generally a moderate to substantial decrease resulted from treatment. Of the total fractions, concentrations were found to be reduced for CuT, MeHgT, tPCBs, and pyrethroids, whereas HgT was only reduced in three of the four storm events. For dissolved concentrations, CuD indicated some treatment by the rain garden for one event but otherwise no significant differences were seen between inlet and outlet concentrations. While influent quality fluctuated between storm events for most analytes - possibly in part due to the seasonal first flush effect though not apparently affected by storm size - effluent quality remained fairly consistent for most analytes across all four storms.

Using the concentration results of this study to explore possible load reductions under different volume reduction scenarios, it was found that there are important management implications for sizing criteria in relation to targeting the reduction of specific types of pollutants. Although pollutant loads at the inlet and outlet could not be estimated due to lack of flow measurement, the data illustrated how some pollutant loads would be reduced even if volume was not reduced at all (e.g., tPCB loads would be reduced by approximately 87%, MeHgT by approximately 45%, and SSC by approximately 79%). On the other hand, for pollutants not well-treated by the rain gardens (e.g. the dissolved fraction pollutants), retention of the stormwater runoff volume is likely the more effective mechanism for reducing the loads, rather than through filtration.

7. Recommendations

Monitoring of green infrastructure is developing in the region (this study; bioretention monitoring at the Daly City Library (David et al., 2012), Fremont tree well filters (City of Fremont and SFEI study in progress), flow monitoring of multiple green infrastructure sites in San Francisco (SFPUC and SFEI study in progress), management practice monitoring to support water quality objectives for the Fitzgerald Marine Reserve (San Mateo County and SFEI study in progress), monitoring of multiple green infrastructure sites along the San Pablo Spine (SFEP and SFEI study design in development), and possibly others. Through these studies there is growing evidence for the following general concepts:

1. Bioretention systems capture particulate phase contaminants very well,
2. For particulate pollutants that have atmospheric and road related sources (e.g. Hg and Cu), capture is moderate, consistent with the likelihood that a greater portion is in dissolved phase or on particles that are potentially fine enough to pass through the system,
3. Dissolved phase contaminants are more poorly captured consistent with the notion that the retention time in the system is too short to facilitate phase changes from dissolved to particulate.

Future green infrastructure monitoring should focus on continuing to support or negate these concepts. Remaining data gaps include:

Data Gap 1. With regards to nutrients, and organic carbon (BOD), concern remains about whether bioretention systems are a net source or net sink, and how this may change with each year of maturation after construction,

Data Gap 2. With regards to methylmercury, concern remains that bioretention systems, if built or maintained improperly leading to increased prevalence of low oxygen or anoxic conditions, might be a net source rather than a net sink,

Data Gap 3, Little data exists for how the maintenance of each system is challenged by source areas and design configuration, and how these factors influence system function in relation to trash, leaf or other organic matter buildup at the inlets,

Data Gap 4. Virtually no data exists locally or in the literature as to how these systems change in function over time with system maturation. Do they continue to trap pollutants during years of maturation, when and how often will soil media need replacing, and how is this influenced by site and design characteristics?

Further water quality monitoring is anticipated at this site, possibly in WY2013 through the Bay Area Stormwater Management Agencies Association (Clean Water 4 Clean Bay project), and in WY 2015 for the San Pablo Stormwater Spine Project. For those studies, we recommend more aliquots per composited sample to ensure collection of a sample that is representative of the entire storm. By monitoring flows at the inlet and outlet, annual, seasonal, and storm-wise runoff volume reductions could be estimated and related to the event mean concentration data for estimated pollutant load reduction. While pyrethroids do not appear to be present at high concentrations in this catchment, measurement of polycyclic aromatic hydrocarbons (PAHs), for which traffic-related activities are a dominant source, would help to improve the regional dataset

on the effectiveness of green infrastructure at reducing that pollutant class. Finally, given the elevated PCB concentration measured at the inlet in the first storm event, further PCB measurements should be made. Additional high PCB concentrations may warrant a special investigation of sources in this very small catchment. Finally, a follow-up study in 3-5 years, structured to analyze similar pollutants, would help to address Data Gaps 1, 2, and 4 noted above.

8. References

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9. Appendices

9.1 Appendix A – Laboratory Analysis Methods

Polychlorinated Biphenyls (AXYS Analytical Service Ltd.; method MLA-010)

Samples were analyzed for PCB congeners by AXYS Analytical (AXYS), British Columbia, Canada using Method MLA-010, a laboratory-specific variant of EPA Method 1668 Revision A using a high-resolution mass spectrometer (HRMS) coupled to a high-resolution gas chromatograph (HRGC) equipped with a SPB-Octyl chromatography column (30 m, 0.25 mm i.d., 0.25 µm film thickness). The 40 congeners historically reported by San Francisco Bay Regional Monitoring Program were included.

Pyrethroids (AXYS Analytical Service Ltd.; method MLA-046)

Pyrethroids were analyzed by AXYS using Method MLA-046 by HRGC (DB-5 capillary) and using voltage selected ion detection.

Suspended Sediment Concentration (Graham Matthews and Associates; method ASTM D3977 Method B)

Samples were filtered through tared Gooch crucibles containing glass fiber filters, with a deionized water rinse of the sample container to remove adsorbed particles, and three ml rinses of the filter to remove entrapped dissolved solids. Crucibles were dried overnight at 105ºC. The increase in the weight of the crucible represents the suspended sediment in the sample, which was divided by the initial sample volume to obtain the suspended sediment concentration.

Total and Dissolved Mercury (Brooks Rand Laboratories; method BR-0006)

Concentrations of total and dissolved mercury in water were analyzed by Brooks Rand Laboratories using BR-0006, a lab specific variant of EPA Method 1631 Revision E. Dissolved mercury samples were filtered in the field using an acid-cleaned 0.45 µm polypropylene capsule filter in-line on the outlet of the peristaltic pump. All mercury species in the samples were converted to Hg2+ by addition of excess BrCl. Mercuric ions in the samples were reduced to Hg(0) with stannous chloride (SnCl2), and then purged onto gold-sand traps or gold wire traps as a means of pre-concentration. Trapped Hg was then thermally desorbed, and transported by carrier gas into a fluorescence cell for quantitation.

Total Methylmercury (Brooks Rand Laboratories; method BR-0011)

Methylmercury samples were analyzed by Brooks Rand Laboratories method BR-0011, a lab specific variant of EPA Method 1630. Samples were acidified to a final concentration of 0.4% v:v hydrochloric acid (HCl). Methylmercury samples were stored in the dark at 4°C until analysis. Sample aliquots were distilled to pre-concentrate samples, distillates collected, and ethylated using sodium tetraethyl borate, purged from solution onto a graphitic carbon trap, then thermally desorbed, with detection and quantification by CVAFS.

CuT and CuD (Brooks Rand Laboratories; method BR-0060)

Concentrations of total and dissolved copper were analyzed by Brooks Rand Laboratories using BR-0060. Dissolved copper samples were filtered in the field using an acid-cleaned 0.45 µm

polypropylene capsule filter in-line on the outlet of the peristaltic pump. In the laboratory, samples were first digested in a closed vessel in the presence of strong nitric acid in an 85^{o}C oven. Particulates were allowed to settle or were centrifuged to remove from suspension, and the extract run on a Perken Elmer ELAN DRC II ICPMS (dynamic reaction cell inductively coupled plasma mass spectrometer).

TOC and DOC (Delta Environmental Laboratories; method SM 5310 C)

Total and Dissolved Organic Carbon were analyzed by Delta Environmental Laboratories, LLC, California using SM 5310 C.

9.2 Appendix B – Quality Assurance Summary Tables

Table 1. Average method detection limit (MDL), field blank and laboratory blank concentrations for each analyte.

AnalyteName	Unit	AvgOfMDL	LabBlank	FieldBlank
Suspended Sediment Concentration	mg/L	1	NA	NA
Total Organic Carbon	ug/L	35	NA	NA
Dissolved Organic Carbon	ug/L	35	NA	NA
Total Copper	ug/L	0.26	<MDL	<MDL
Dissolved Copper	ug/L	0.32	<MDL	<MDL
Total Mercury	ug/L	0.0006	<MDL	<MDL
Dissolved Mercury	ug/L	0.0002	<MDL	<MDL
Mercury, Methyl	ng/L	0.02	<MDL	<MDL
PCB 008	pg/L	0.6	<MDL	0.91
PCB 018	pg/L	0.2	0.50	0.80
PCB 028	pg/L	0.2	1.01	1.46
PCB 031	pg/L	0.8	<MDL	1.05
PCB 033	pg/L	0.4	<MDL	0.72
PCB 044	pg/L	1.6	<MDL	2.34
PCB 049	pg/L	0.2	0.75	0.83
PCB 052	pg/L	2.2	<MDL	2.69
PCB 056	pg/L	0.2	0.47	0.67
PCB 060	pg/L	0.2	0.25	0.36
PCB 066	pg/L	0.2	1.39	1.40
PCB 070	pg/L	0.2	2.57	3.38
PCB 087	pg/L	2.0	<MDL	4.48
PCB 095	pg/L	0.4	<MDL	4.87
PCB 099	pg/L	0.4	2.02	2.40
PCB 101	pg/L	0.4	2.95	4.66
PCB 105	pg/L	0.4	1.40	1.99
PCB 110	pg/L	0.3	2.89	7.28
PCB 118	pg/L	0.4	2.54	3.99
PCB 128	pg/L	0.8	<MDL	1.38
PCB 132	pg/L	0.8	0.77	2.84
PCB 138	pg/L	0.6	4.68	5.88
PCB 141	pg/L	0.7	<MDL	<MDL
PCB 149	pg/L	0.6	2.15	4.41
PCB 151	pg/L	1.0	<MDL	1.81
PCB 153	pg/L	0.5	5.19	<MDL
PCB 156	pg/L	0.6	0.81	<MDL
PCB 158	pg/L	0.5	<MDL	0.48

Table 1 (cont). Average method detection limit (MDL), field blank and laboratory blank concentrations for each analyte.

AnalyteName	Unit	AvgOfMDL	LabBlank	FieldBlank
PCB 170	pg/L	1.1	<MDL	0.57
PCB 174	pg/L	0.3	0.55	0.74
PCB 177	pg/L	0.4	<MDL	<MDL
PCB 180	pg/L	0.2	2.54	1.95
PCB 183	pg/L	0.3	<MDL	0.69
PCB 187	pg/L	0.3	1.97	1.34
PCB 194	pg/L	0.2	0.51	<MDL
PCB 195	pg/L	0.3	<MDL	<MDL
PCB 201	pg/L	0.2	<MDL	<MDL
PCB 203	pg/L	0.4	<MDL	1.00
Allethrin	pg/L	1426	<MDL	<MDL
Bifenthrin	pg/L	319	<MDL	<MDL
Cyfluthrin, total	pg/L	1598	<MDL	<MDL
Cyhalothrin, lambda, total	pg/L	233	<MDL	<MDL
Cypermethrin, total	pg/L	617	<MDL	<MDL
Delta/Tralomethrin	pg/L	304	<MDL	<MDL
Esfenvalerate/Fenvalerate, total	pg/L	259	<MDL	<MDL
Fenpropathrin	pg/L	1042	<MDL	<MDL
Permethrin, total	pg/L	180	<MDL	<MDL
Phenothrin	pg/L	203	<MDL	<MDL
Prallethrin	pg/L	3230	<MDL	<MDL
Resmethrin	pg/L	372	<MDL	<MDL

Table 2. Certified reference material, matrix spike and blank spike recoveries.

		Certified Reference Material Recovery			Matrix Spike Recovery			Blank Spike Recovery		
AnalyteName	Unit	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Total Organic Carbon	ug/L				90%	93%	92%	88%	108%	97%
Dissolved Organic Carbon	ug/L							88%	110%	99%
Dissolved Copper	ug/L	101%	106%	104%	83%	110%	100%	102%	107%	104%
Total Copper	ug/L	101%	106%	104%	83%	110%	100%	102%	107%	104%
Dissolved Mercury	ug/L	100%	111%	105%	104%	117%	111%			
Total Mercury	ug/L	100%	111%	105%	104%	117%	111%			
Mercury, Methyl	ng/L				86%	121%	101%	54%	114%	94%
PCB 105	pg/L							90%	94%	92%
PCB 118	pg/L							93%	97%	95%
PCB 156	pg/L							89%	93%	91%
Allethrin	pg/L							45%	115%	70%
Bifenthrin	pg/L							24%	104%	74%
Cyfluthrin, total	pg/L							89%	112%	102%
Cyhalothrin, lambda, total	pg/L							73%	97%	83%
Cypermethrin, total	pg/L							94%	121%	100%
Delta/Tralomethrin	pg/L							68%	93%	79%
Esfenvalerate/Fenvalerate, total	pg/L							77%	95%	86%
Fenpropathrin	pg/L							74%	98%	85%
Permethrin, total	pg/L							65%	106%	87%
Phenothrin	pg/L							21%	88%	55%
Prallethrin	pg/L							57%	126%	76%
Resmethrin	pg/L							16%	65%	39%

Table 3. Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
Suspended Sediment Concentration	20/Jan/2012	15:37	ELC-100a	178			mg/L
Suspended Sediment Concentration	20/Jan/2012	15:44	ELC-100b	33.6			mg/L
Suspended Sediment Concentration	20/Jan/2012	15:55	ELC-100c	76.8			mg/L
Suspended Sediment Concentration	20/Jan/2012	16:22	ELC-110b	12.2			mg/L
Suspended Sediment Concentration	13/Mar/2012	7:40	ELC-200	395			mg/L
Suspended Sediment Concentration	13/Mar/2012	9:07	ELC-210a	15.5			mg/L
Suspended Sediment Concentration	13/Mar/2012	9:14	ELC-210b	15.1			mg/L
Suspended Sediment Concentration	27/Mar/2012	15:20	ELC-300a	56.5			mg/L
Suspended Sediment Concentration	27/Mar/2012	15:27	ELC-300b	37.9			mg/L
Suspended Sediment Concentration	27/Mar/2012	16:00	ELC-310a	10.9			mg/L
Suspended Sediment Concentration	27/Mar/2012	16:07	ELC-310b	9.28			mg/L
Suspended Sediment Concentration	10/Apr/2012	6:13	ELC-400a	6.47			mg/L
Suspended Sediment Concentration	10/Apr/2012	6:20	ELC-400b	12.3			mg/L
Suspended Sediment Concentration	10/Apr/2012	8:40	ELC-401a	16.5			mg/L
Suspended Sediment Concentration	10/Apr/2012	8:47	ELC-401b	17.5			mg/L
Suspended Sediment Concentration	10/Apr/2012	10:39	ELC-402a	18.6	1.70	9%	mg/L
Suspended Sediment Concentration	10/Apr/2012	10:46	ELC-402b	15.2	0.14	1%	mg/L
Suspended Sediment Concentration	10/Apr/2012	11:35	ELC-403a	10			mg/L
Suspended Sediment Concentration	10/Apr/2012	11:42	ELC-403b	21.9			mg/L
Suspended Sediment Concentration	10/Apr/2012	6:43	ELC-410a	7.43			mg/L
Suspended Sediment Concentration	10/Apr/2012	6:50	ELC-410b	6.64			mg/L
Total Organic Carbon	20/Jan/2012	15:37	ELC-100	7000			ug/L
Total Organic Carbon	20/Jan/2012	16:22	ELC-110	10000			ug/L
Total Organic Carbon	13/Mar/2012	7:40	ELC-200	7400			ug/L
Total Organic Carbon	13/Mar/2012	9:07	ELC-210	11000			ug/L
Total Organic Carbon	27/Mar/2012	15:20	ELC-300	6900			ug/L
Total Organic Carbon	27/Mar/2012	16:00	ELC-310	7500			ug/L
Total Organic Carbon	10/Apr/2012	6:13	ELC-400	20500			ug/L
Total Organic Carbon	10/Apr/2012	8:40	ELC-401	19200			ug/L
Total Organic Carbon	10/Apr/2012	10:39	ELC-402	12800	565.69	4%	ug/L
Total Organic Carbon	10/Apr/2012	11:35	ELC-403	17000			ug/L
Total Organic Carbon	10/Apr/2012	6:43	ELC-410	13800			ug/L
Dissolved Organic Carbon	20/Jan/2012	15:37	ELC-100	5800			ug/L
Dissolved Organic Carbon	20/Jan/2012	16:22	ELC-110	10300			ug/L
Dissolved Organic Carbon	13/Mar/2012	9:07	ELC-210	10000			ug/L
Dissolved Organic Carbon	27/Mar/2012	15:20	ELC-300	7400			ug/L
Dissolved Organic Carbon	27/Mar/2012	16:00	ELC-310	6600			ug/L
Dissolved Organic Carbon	10/Apr/2012	6:13	ELC-400	17800			ug/L
Dissolved Organic Carbon	10/Apr/2012	8:40	ELC-401	16600			ug/L
Dissolved Organic Carbon	10/Apr/2012	10:39	ELC-402	11250	212.13	2%	ug/L
Dissolved Organic Carbon	10/Apr/2012	11:35	ELC-403	15100			ug/L
Dissolved Organic Carbon	10/Apr/2012	6:43	ELC-410	13200			ug/L
Total Copper	20/Jan/2012	15:37	ELC-100	24.2			ug/L
Total Copper	20/Jan/2012	16:22	ELC-110	9.1105			ug/L
Total Copper	13/Mar/2012	7:40	ELC-200	48.2			ug/L
Total Copper	13/Mar/2012	9:07	ELC-210	11.7			ug/L
Total Copper	27/Mar/2012	15:20	ELC-300	17.2			ug/L
Total Copper	27/Mar/2012	16:00	ELC-310	6.599			ug/L
Total Copper	10/Apr/2012	6:13	ELC-400	36.4			ug/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
Total Copper	10/Apr/2012	8:40	ELC-401	39.8			ug/L
Total Copper	10/Apr/2012	10:39	ELC-402	30.15	1.20	4%	ug/L
Total Copper	10/Apr/2012	11:35	ELC-403	58.01			ug/L
Total Copper	10/Apr/2012	6:43	ELC-410	11			ug/L
Dissolved Copper	20/Jan/2012	15:37	ELC-100	9.57			ug/L
Dissolved Copper	20/Jan/2012	16:22	ELC-110	8.84			ug/L
Dissolved Copper	13/Mar/2012	9:07	ELC-210	10.8			ug/L
Dissolved Copper	27/Mar/2012	15:20	ELC-300	7.51			ug/L
Dissolved Copper	27/Mar/2012	16:00	ELC-310	5.72			ug/L
Dissolved Copper	10/Apr/2012	6:13	ELC-400	31.5			ug/L
Dissolved Copper	10/Apr/2012	8:40	ELC-401	30.5			ug/L
Dissolved Copper	10/Apr/2012	10:39	ELC-402	21.4	1.56	7%	ug/L
Dissolved Copper	10/Apr/2012	11:35	ELC-403	36.4			ug/L
Dissolved Copper	10/Apr/2012	6:43	ELC-410	9.05			ug/L
Total Mercury	20/Jan/2012	15:37	ELC-100	0.0298			ug/L
Total Mercury	20/Jan/2012	16:22	ELC-110	0.0142			ug/L
Total Mercury	13/Mar/2012	7:40	ELC-200	0.014			ug/L
Total Mercury	13/Mar/2012	9:07	ELC-210	0.0369			ug/L
Total Mercury	27/Mar/2012	15:20	ELC-300	0.0206			ug/L
Total Mercury	27/Mar/2012	16:00	ELC-310	0.0123			ug/L
Total Mercury	10/Apr/2012	6:13	ELC-400	0.00887			ug/L
Total Mercury	10/Apr/2012	8:40	ELC-401	0.0232			ug/L
Total Mercury	10/Apr/2012	10:39	ELC-402	0.01335	0.00	5%	ug/L
Total Mercury	10/Apr/2012	11:35	ELC-403	0.013			ug/L
Total Mercury	10/Apr/2012	6:43	ELC-410	0.0142			ug/L
Dissolved Mercury	20/Jan/2012	15:37	ELC-100	0.00511			ug/L
Dissolved Mercury	20/Jan/2012	16:22	ELC-110	0.00487			ug/L
Dissolved Mercury	13/Mar/2012	9:07	ELC-210	0.0167			ug/L
Dissolved Mercury	27/Mar/2012	15:20	ELC-300	0.00587			ug/L
Dissolved Mercury	27/Mar/2012	16:00	ELC-310	0.00773			ug/L
Dissolved Mercury	10/Apr/2012	6:13	ELC-400	0.00735			ug/L
Dissolved Mercury	10/Apr/2012	8:40	ELC-401	0.00954			ug/L
Dissolved Mercury	10/Apr/2012	10:39	ELC-402	0.00565	0.0014	25%	ug/L
Dissolved Mercury	10/Apr/2012	11:35	ELC-403	0.00966			ug/L
Dissolved Mercury	10/Apr/2012	6:43	ELC-410	0.0082			ug/L
Mercury, Methyl	20/Jan/2012	15:37	ELC-100	0.296			ng/L
Mercury, Methyl	20/Jan/2012	16:22	ELC-110	0.13			ng/L
Mercury, Methyl	13/Mar/2012	7:40	ELC-200	0.261			ng/L
Mercury, Methyl	13/Mar/2012	9:07	ELC-210	0.154			ng/L
Mercury, Methyl	27/Mar/2012	15:20	ELC-300	0.243			ng/L
Mercury, Methyl	27/Mar/2012	16:00	ELC-310	0.155			ng/L
Mercury, Methyl	10/Apr/2012	6:13	ELC-400	0.256			ng/L
Mercury, Methyl	10/Apr/2012	8:40	ELC-401	0.315			ng/L
Mercury, Methyl	10/Apr/2012	10:39	ELC-402	0.25	0.01	4%	ng/L
Mercury, Methyl	10/Apr/2012	11:35	ELC-403	0.449			ng/L
Mercury, Methyl	10/Apr/2012	6:43	ELC-410	0.178			ng/L
PCB 008	20/Jan/2012	15:37	ELC-100	214			pg/L
PCB 008	20/Jan/2012	16:22	ELC-110	1.03			pg/L
PCB 008	13/Mar/2012	7:40	ELC-200	23.5			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 008	13/Mar/2012	9:07	ELC-210	1.39			pg/L
PCB 008	27/Mar/2012	15:28	ELC-300	14.9			pg/L
PCB 008	27/Mar/2012	16:00	ELC-310	1.01			pg/L
PCB 008	10/Apr/2012	6:13	ELC-400	6.85			pg/L
PCB 008	10/Apr/2012	8:40	ELC-401	9.39			pg/L
PCB 008	10/Apr/2012	10:39	ELC-402	11.95	0.35	3%	pg/L
PCB 008	10/Apr/2012	11:35	ELC-403	7.34			pg/L
PCB 008	10/Apr/2012	6:43	ELC-410	0.84			pg/L
PCB 018	20/Jan/2012	15:37	ELC-100	319			pg/L
PCB 018	20/Jan/2012	16:22	ELC-110	1.84			pg/L
PCB 018	13/Mar/2012	7:40	ELC-200	41.8			pg/L
PCB 018	13/Mar/2012	9:07	ELC-210	2.37			pg/L
PCB 018	27/Mar/2012	15:28	ELC-300	26.2			pg/L
PCB 018	27/Mar/2012	16:00	ELC-310	2.02			pg/L
PCB 018	10/Apr/2012	6:13	ELC-400	7.93			pg/L
PCB 018	10/Apr/2012	8:40	ELC-401	13.2			pg/L
PCB 018	10/Apr/2012	10:39	ELC-402	15.4	0.28	2%	pg/L
PCB 018	10/Apr/2012	11:35	ELC-403	11.1			pg/L
PCB 018	10/Apr/2012	6:43	ELC-410	2.55			pg/L
PCB 028	20/Jan/2012	15:37	ELC-100	489			pg/L
PCB 028	20/Jan/2012	16:22	ELC-110	3.78			pg/L
PCB 028	13/Mar/2012	7:40	ELC-200	90.5			pg/L
PCB 028	13/Mar/2012	9:07	ELC-210	5.93			pg/L
PCB 028	27/Mar/2012	15:28	ELC-300	56.8			pg/L
PCB 028	27/Mar/2012	16:00	ELC-310	3.46			pg/L
PCB 028	10/Apr/2012	6:13	ELC-400	14.3			pg/L
PCB 028	10/Apr/2012	8:40	ELC-401	28.3			pg/L
PCB 028	10/Apr/2012	10:39	ELC-402	37	0.57	2%	pg/L
PCB 028	10/Apr/2012	11:35	ELC-403	25.7			pg/L
PCB 028	10/Apr/2012	6:43	ELC-410	4.16			pg/L
PCB 031	20/Jan/2012	15:37	ELC-100	707			pg/L
PCB 031	20/Jan/2012	16:22	ELC-110	3.02			pg/L
PCB 031	13/Mar/2012	7:40	ELC-200	74.1			pg/L
PCB 031	13/Mar/2012	9:07	ELC-210	3.78			pg/L
PCB 031	27/Mar/2012	15:28	ELC-300	45.6			pg/L
PCB 031	27/Mar/2012	16:00	ELC-310	2.51			pg/L
PCB 031	10/Apr/2012	6:13	ELC-400	12.1			pg/L
PCB 031	10/Apr/2012	8:40	ELC-401	22.6			pg/L
PCB 031	10/Apr/2012	10:39	ELC-402	30.55	1.63	5%	pg/L
PCB 031	10/Apr/2012	11:35	ELC-403	20.7			pg/L
PCB 031	10/Apr/2012	6:43	ELC-410	2.94			pg/L
PCB 033	20/Jan/2012	15:37	ELC-100	248			pg/L
PCB 033	20/Jan/2012	16:22	ELC-110	1.04			pg/L
PCB 033	13/Mar/2012	7:40	ELC-200	47.8			pg/L
PCB 033	13/Mar/2012	9:07	ELC-210	1.75			pg/L
PCB 033	27/Mar/2012	15:28	ELC-300	29.2			pg/L
PCB 033	27/Mar/2012	16:00	ELC-310	1.18			pg/L
PCB 033	10/Apr/2012	6:13	ELC-400	8.82			pg/L
PCB 033	10/Apr/2012	8:40	ELC-401	17.3			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 033	10/Apr/2012	10:39	ELC-402	22.5	1.56	7%	pg/L
PCB 033	10/Apr/2012	11:35	ELC-403	14.7			pg/L
PCB 033	10/Apr/2012	6:43	ELC-410	1.07			pg/L
PCB 044	20/Jan/2012	15:37	ELC-100	5800			pg/L
PCB 044	20/Jan/2012	16:22	ELC-110	11.4			pg/L
PCB 044	13/Mar/2012	7:40	ELC-200	138			pg/L
PCB 044	13/Mar/2012	9:07	ELC-210	16.9			pg/L
PCB 044	27/Mar/2012	15:28	ELC-300	125			pg/L
PCB 044	27/Mar/2012	16:00	ELC-310	13.6			pg/L
PCB 044	10/Apr/2012	6:13	ELC-400	25.3			pg/L
PCB 044	10/Apr/2012	8:40	ELC-401	50.8			pg/L
PCB 044	10/Apr/2012	10:39	ELC-402	83.65	0.35	0%	pg/L
PCB 044	10/Apr/2012	11:35	ELC-403	51.7			pg/L
PCB 044	10/Apr/2012	6:43	ELC-410	10.6			pg/L
PCB 049	20/Jan/2012	15:37	ELC-100	2980			pg/L
PCB 049	20/Jan/2012	16:22	ELC-110	5.84			pg/L
PCB 049	13/Mar/2012	7:40	ELC-200	70			pg/L
PCB 049	13/Mar/2012	9:07	ELC-210	8.19			pg/L
PCB 049	27/Mar/2012	15:28	ELC-300	62.9			pg/L
PCB 049	27/Mar/2012	16:00	ELC-310	6.18			pg/L
PCB 049	10/Apr/2012	6:13	ELC-400	11			pg/L
PCB 049	10/Apr/2012	8:40	ELC-401	23.3			pg/L
PCB 049	10/Apr/2012	10:39	ELC-402	39.05	0.49	1%	pg/L
PCB 049	10/Apr/2012	11:35	ELC-403	23.6			pg/L
PCB 049	10/Apr/2012	6:43	ELC-410	4.78			pg/L
PCB 052	20/Jan/2012	15:37	ELC-100	13300			pg/L
PCB 052	20/Jan/2012	16:22	ELC-110	21			pg/L
PCB 052	13/Mar/2012	7:40	ELC-200	253			pg/L
PCB 052	13/Mar/2012	9:07	ELC-210	32.8			pg/L
PCB 052	27/Mar/2012	15:28	ELC-300	254			pg/L
PCB 052	27/Mar/2012	16:00	ELC-310	21.1			pg/L
PCB 052	10/Apr/2012	6:13	ELC-400	38.4			pg/L
PCB 052	10/Apr/2012	8:40	ELC-401	80.1			pg/L
PCB 052	10/Apr/2012	10:39	ELC-402	137.5	0.71	1%	pg/L
PCB 052	10/Apr/2012	11:35	ELC-403	84.5			pg/L
PCB 052	10/Apr/2012	6:43	ELC-410	18.8			pg/L
PCB 056	20/Jan/2012	15:37	ELC-100	1870			pg/L
PCB 056	20/Jan/2012	16:22	ELC-110	5.78			pg/L
PCB 056	13/Mar/2012	7:40	ELC-200	57.3			pg/L
PCB 056	13/Mar/2012	9:07	ELC-210	7.09			pg/L
PCB 056	27/Mar/2012	15:28	ELC-300	50.9			pg/L
PCB 056	27/Mar/2012	16:00	ELC-310	4.53			pg/L
PCB 056	10/Apr/2012	6:13	ELC-400	13.2			pg/L
PCB 056	10/Apr/2012	8:40	ELC-401	32.8			pg/L
PCB 056	10/Apr/2012	10:39	ELC-402	47.8	4.53	9%	pg/L
PCB 056	10/Apr/2012	11:35	ELC-403	31.4			pg/L
PCB 056	10/Apr/2012	6:43	ELC-410	4.25			pg/L
PCB 060	20/Jan/2012	15:37	ELC-100	869			pg/L
PCB 060	20/Jan/2012	16:22	ELC-110	2.33			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 060	13/Mar/2012	7:40	ELC-200	29.4			pg/L
PCB 060	13/Mar/2012	9:07	ELC-210	2.86			pg/L
PCB 060	27/Mar/2012	15:28	ELC-300	26			pg/L
PCB 060	27/Mar/2012	16:00	ELC-310	2.95			pg/L
PCB 060	10/Apr/2012	6:13	ELC-400	6.85			pg/L
PCB 060	10/Apr/2012	8:40	ELC-401	16.5			pg/L
PCB 060	10/Apr/2012	10:39	ELC-402	23.1	1.13	5%	pg/L
PCB 060	10/Apr/2012	11:35	ELC-403	14.9			pg/L
PCB 060	10/Apr/2012	6:43	ELC-410	1.76			pg/L
PCB 066	20/Jan/2012	15:37	ELC-100	4270			pg/L
PCB 066	20/Jan/2012	16:22	ELC-110	9.15			pg/L
PCB 066	13/Mar/2012	7:40	ELC-200	116			pg/L
PCB 066	13/Mar/2012	9:07	ELC-210	13.8			pg/L
PCB 066	27/Mar/2012	15:28	ELC-300	107			pg/L
PCB 066	27/Mar/2012	16:00	ELC-310	10.9			pg/L
PCB 066	10/Apr/2012	6:13	ELC-400	23.4			pg/L
PCB 066	10/Apr/2012	8:40	ELC-401	56.7			pg/L
PCB 066	10/Apr/2012	10:39	ELC-402	87.45	4.17	5%	pg/L
PCB 066	10/Apr/2012	11:35	ELC-403	55.4			pg/L
PCB 066	10/Apr/2012	6:43	ELC-410	7.74			pg/L
PCB 070	20/Jan/2012	15:37	ELC-100	16700			pg/L
PCB 070	20/Jan/2012	16:22	ELC-110	16.3			pg/L
PCB 070	13/Mar/2012	7:40	ELC-200	335			pg/L
PCB 070	13/Mar/2012	9:07	ELC-210	26.3			pg/L
PCB 070	27/Mar/2012	15:28	ELC-300	298			pg/L
PCB 070	27/Mar/2012	16:00	ELC-310	16.4			pg/L
PCB 070	10/Apr/2012	6:13	ELC-400	65.9			pg/L
PCB 070	10/Apr/2012	8:40	ELC-401	156			pg/L
PCB 070	10/Apr/2012	10:39	ELC-402	243.5	10.61	4%	pg/L
PCB 070	10/Apr/2012	11:35	ELC-403	158			pg/L
PCB 070	10/Apr/2012	6:43	ELC-410	17.4			pg/L
PCB 087	20/Jan/2012	15:37	ELC-100	15000			pg/L
PCB 087	20/Jan/2012	16:22	ELC-110	36.7			pg/L
PCB 087	13/Mar/2012	7:40	ELC-200	457			pg/L
PCB 087	13/Mar/2012	9:07	ELC-210	49.3			pg/L
PCB 087	27/Mar/2012	15:28	ELC-300	460			pg/L
PCB 087	27/Mar/2012	16:00	ELC-310	27.9			pg/L
PCB 087	10/Apr/2012	6:13	ELC-400	86.6			pg/L
PCB 087	10/Apr/2012	8:40	ELC-401	225			pg/L
PCB 087	10/Apr/2012	10:39	ELC-402	345.5	20.51	6%	pg/L
PCB 087	10/Apr/2012	11:35	ELC-403	238			pg/L
PCB 087	10/Apr/2012	6:43	ELC-410	31.9			pg/L
PCB 095	20/Jan/2012	15:37	ELC-100	14200			pg/L
PCB 095	20/Jan/2012	16:22	ELC-110	48.5			pg/L
PCB 095	13/Mar/2012	7:40	ELC-200	426			pg/L
PCB 095	13/Mar/2012	9:07	ELC-210	78.9			pg/L
PCB 095	27/Mar/2012	15:28	ELC-300	450			pg/L
PCB 095	27/Mar/2012	16:00	ELC-310	50.1			pg/L
PCB 095	10/Apr/2012	6:13	ELC-400	68.3			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 095	10/Apr/2012	8:40	ELC-401	155			pg/L
PCB 095	10/Apr/2012	10:39	ELC-402	277.5	9.19	3%	pg/L
PCB 095	10/Apr/2012	11:35	ELC-403	181			pg/L
PCB 095	10/Apr/2012	6:43	ELC-410	50.5			pg/L
PCB 099	20/Jan/2012	15:37	ELC-100	11800			pg/L
PCB 099	20/Jan/2012	16:22	ELC-110	29.8			pg/L
PCB 099	13/Mar/2012	7:40	ELC-200	297			pg/L
PCB 099	13/Mar/2012	9:07	ELC-210	37.3			pg/L
PCB 099	27/Mar/2012	15:28	ELC-300	304			pg/L
PCB 099	27/Mar/2012	16:00	ELC-310	24.4			pg/L
PCB 099	10/Apr/2012	6:13	ELC-400	56.3			pg/L
PCB 099	10/Apr/2012	8:40	ELC-401	141			pg/L
PCB 099	10/Apr/2012	10:39	ELC-402	222.5	12.02	5%	pg/L
PCB 099	10/Apr/2012	11:35	ELC-403	151			pg/L
PCB 099	10/Apr/2012	6:43	ELC-410	22.4			pg/L
PCB 101	20/Jan/2012	15:37	ELC-100	22700			pg/L
PCB 101	20/Jan/2012	16:22	ELC-110	60.4			pg/L
PCB 101	13/Mar/2012	7:40	ELC-200	577			pg/L
PCB 101	13/Mar/2012	9:07	ELC-210	73.5			pg/L
PCB 101	27/Mar/2012	15:28	ELC-300	597			pg/L
PCB 101	27/Mar/2012	16:00	ELC-310	41.6			pg/L
PCB 101	10/Apr/2012	6:13	ELC-400	112			pg/L
PCB 101	10/Apr/2012	8:40	ELC-401	285			pg/L
PCB 101	10/Apr/2012	10:39	ELC-402	456.5	16.26	4%	pg/L
PCB 101	10/Apr/2012	11:35	ELC-403	295			pg/L
PCB 101	10/Apr/2012	6:43	ELC-410	43.9			pg/L
PCB 105	20/Jan/2012	15:37	ELC-100	8080			pg/L
PCB 105	20/Jan/2012	16:22	ELC-110	20.7			pg/L
PCB 105	13/Mar/2012	7:40	ELC-200	271			pg/L
PCB 105	13/Mar/2012	9:07	ELC-210	28.4			pg/L
PCB 105	27/Mar/2012	15:28	ELC-300	266			pg/L
PCB 105	27/Mar/2012	16:00	ELC-310	20			pg/L
PCB 105	10/Apr/2012	6:13	ELC-400	51.9			pg/L
PCB 105	10/Apr/2012	8:40	ELC-401	139			pg/L
PCB 105	10/Apr/2012	10:39	ELC-402	203.5	9.19	5%	pg/L
PCB 105	10/Apr/2012	11:35	ELC-403	135			pg/L
PCB 105	10/Apr/2012	6:43	ELC-410	14.4			pg/L
PCB 110	20/Jan/2012	15:37	ELC-100	22700			pg/L
PCB 110	20/Jan/2012	16:22	ELC-110	82.7			pg/L
PCB 110	13/Mar/2012	7:40	ELC-200	764			pg/L
PCB 110	13/Mar/2012	9:07	ELC-210	114			pg/L
PCB 110	27/Mar/2012	15:28	ELC-300	753			pg/L
PCB 110	27/Mar/2012	16:00	ELC-310	65.9			pg/L
PCB 110	10/Apr/2012	6:13	ELC-400	156			pg/L
PCB 110	10/Apr/2012	8:40	ELC-401	400			pg/L
PCB 110	10/Apr/2012	10:39	ELC-402	594.5	34.65	6%	pg/L
PCB 110	10/Apr/2012	11:35	ELC-403	430			pg/L
PCB 110	10/Apr/2012	6:43	ELC-410	80.5			pg/L
PCB 118	20/Jan/2012	15:37	ELC-100	19000			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 118	20/Jan/2012	16:22	ELC-110	43.6			pg/L
PCB 118	13/Mar/2012	7:40	ELC-200	579			pg/L
PCB 118	13/Mar/2012	9:07	ELC-210	62.1			pg/L
PCB 118	27/Mar/2012	15:28	ELC-300	583			pg/L
PCB 118	27/Mar/2012	16:00	ELC-310	42.7			pg/L
PCB 118	10/Apr/2012	6:13	ELC-400	110			pg/L
PCB 118	10/Apr/2012	8:40	ELC-401	282			pg/L
PCB 118	10/Apr/2012	10:39	ELC-402	420.5	19.09	5%	pg/L
PCB 118	10/Apr/2012	11:35	ELC-403	278			pg/L
PCB 118	10/Apr/2012	6:43	ELC-410	32.6			pg/L
PCB 128	20/Jan/2012	15:37	ELC-100	2840			pg/L
PCB 128	20/Jan/2012	16:22	ELC-110	21.7			pg/L
PCB 128	13/Mar/2012	7:40	ELC-200	157			pg/L
PCB 128	13/Mar/2012	9:07	ELC-210	27.4			pg/L
PCB 128	27/Mar/2012	15:28	ELC-300	167			pg/L
PCB 128	27/Mar/2012	16:00	ELC-310	20.9			pg/L
PCB 128	10/Apr/2012	6:13	ELC-400	31.7			pg/L
PCB 128	10/Apr/2012	8:40	ELC-401	80.5			pg/L
PCB 128	10/Apr/2012	10:39	ELC-402	121.5	6.36	5%	pg/L
PCB 128	10/Apr/2012	11:35	ELC-403	78.3			pg/L
PCB 128	10/Apr/2012	6:43	ELC-410	16.2			pg/L
PCB 132	20/Jan/2012	15:37	ELC-100	4400			pg/L
PCB 132	20/Jan/2012	16:22	ELC-110	29.2			pg/L
PCB 132	13/Mar/2012	7:40	ELC-200	261			pg/L
PCB 132	13/Mar/2012	9:07	ELC-210	39.3			pg/L
PCB 132	27/Mar/2012	15:28	ELC-300	280			pg/L
PCB 132	27/Mar/2012	16:00	ELC-310	29.5			pg/L
PCB 132	10/Apr/2012	6:13	ELC-400	55.3			pg/L
PCB 132	10/Apr/2012	8:40	ELC-401	154			pg/L
PCB 132	10/Apr/2012	10:39	ELC-402	215.5	14.85	7%	pg/L
PCB 132	10/Apr/2012	11:35	ELC-403	146			pg/L
PCB 132	10/Apr/2012	6:43	ELC-410	28.6			pg/L
PCB 138	20/Jan/2012	15:37	ELC-100	13100			pg/L
PCB 138	20/Jan/2012	16:22	ELC-110	134			pg/L
PCB 138	13/Mar/2012	7:40	ELC-200	800			pg/L
PCB 138	13/Mar/2012	9:07	ELC-210	147			pg/L
PCB 138	27/Mar/2012	15:28	ELC-300	886			pg/L
PCB 138	27/Mar/2012	16:00	ELC-310	133			pg/L
PCB 138	10/Apr/2012	6:13	ELC-400	164			pg/L
PCB 138	10/Apr/2012	8:40	ELC-401	428			pg/L
PCB 138	10/Apr/2012	10:39	ELC-402	636.5	44.55	7%	pg/L
PCB 138	10/Apr/2012	11:35	ELC-403	396			pg/L
PCB 138	10/Apr/2012	6:43	ELC-410	86.5			pg/L
PCB 141	20/Jan/2012	15:37	ELC-100	2070			pg/L
PCB 141	20/Jan/2012	16:22	ELC-110	53.8			pg/L
PCB 141	13/Mar/2012	7:40	ELC-200	141			pg/L
PCB 141	13/Mar/2012	9:07	ELC-210	29.6			pg/L
PCB 141	27/Mar/2012	15:28	ELC-300	156			pg/L
PCB 141	27/Mar/2012	16:00	ELC-310	28			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 141	10/Apr/2012	6:13	ELC-400	28.8			pg/L
PCB 141	10/Apr/2012	8:40	ELC-401	77.9			pg/L
PCB 141	10/Apr/2012	10:39	ELC-402	118	7.07	6%	pg/L
PCB 141	10/Apr/2012	11:35	ELC-403	68.5			pg/L
PCB 141	10/Apr/2012	6:43	ELC-410	15.3			pg/L
PCB 149	20/Jan/2012	15:37	ELC-100	7710			pg/L
PCB 149	20/Jan/2012	16:22	ELC-110	72.9			pg/L
PCB 149	13/Mar/2012	7:40	ELC-200	482			pg/L
PCB 149	13/Mar/2012	9:07	ELC-210	92.7			pg/L
PCB 149	27/Mar/2012	15:28	ELC-300	544			pg/L
PCB 149	27/Mar/2012	16:00	ELC-310	72.7			pg/L
PCB 149	10/Apr/2012	6:13	ELC-400	115			pg/L
PCB 149	10/Apr/2012	8:40	ELC-401	285			pg/L
PCB 149	10/Apr/2012	10:39	ELC-402	415.5	17.68	4%	pg/L
PCB 149	10/Apr/2012	11:35	ELC-403	274			pg/L
PCB 149	10/Apr/2012	6:43	ELC-410	62.4			pg/L
PCB 151	20/Jan/2012	15:37	ELC-100	2620			pg/L
PCB 151	20/Jan/2012	16:22	ELC-110	30.7			pg/L
PCB 151	13/Mar/2012	7:40	ELC-200	192			pg/L
PCB 151	13/Mar/2012	9:07	ELC-210	38			pg/L
PCB 151	27/Mar/2012	15:28	ELC-300	215			pg/L
PCB 151	27/Mar/2012	16:00	ELC-310	30			pg/L
PCB 151	10/Apr/2012	6:13	ELC-400	45.4			pg/L
PCB 151	10/Apr/2012	8:40	ELC-401	110			pg/L
PCB 151	10/Apr/2012	10:39	ELC-402	166.5	14.85	9%	pg/L
PCB 151	10/Apr/2012	11:35	ELC-403	108			pg/L
PCB 151	10/Apr/2012	6:43	ELC-410	26.3			pg/L
PCB 153	20/Jan/2012	15:37	ELC-100	8570			pg/L
PCB 153	20/Jan/2012	16:22	ELC-110	144			pg/L
PCB 153	13/Mar/2012	7:40	ELC-200	585			pg/L
PCB 153	13/Mar/2012	9:07	ELC-210	129			pg/L
PCB 153	27/Mar/2012	15:28	ELC-300	642			pg/L
PCB 153	27/Mar/2012	16:00	ELC-310	117			pg/L
PCB 153	10/Apr/2012	6:13	ELC-400	124			pg/L
PCB 153	10/Apr/2012	8:40	ELC-401	306			pg/L
PCB 153	10/Apr/2012	10:39	ELC-402	468	35.36	8%	pg/L
PCB 153	10/Apr/2012	11:35	ELC-403	275			pg/L
PCB 153	10/Apr/2012	6:43	ELC-410	62			pg/L
PCB 156	20/Jan/2012	15:37	ELC-100	2070			pg/L
PCB 156	20/Jan/2012	16:22	ELC-110	12			pg/L
PCB 156	13/Mar/2012	7:40	ELC-200	88.4			pg/L
PCB 156	13/Mar/2012	9:07	ELC-210	12.3			pg/L
PCB 156	27/Mar/2012	15:28	ELC-300	102			pg/L
PCB 156	27/Mar/2012	16:00	ELC-310	11.2			pg/L
PCB 156	10/Apr/2012	6:13	ELC-400	18.9			pg/L
PCB 156	10/Apr/2012	8:40	ELC-401	46.3			pg/L
PCB 156	10/Apr/2012	10:39	ELC-402	68.55	2.05	3%	pg/L
PCB 156	10/Apr/2012	11:35	ELC-403	40.2			pg/L
PCB 156	10/Apr/2012	6:43	ELC-410	7.62			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 158	20/Jan/2012	15:37	ELC-100	1530			pg/L
PCB 158	20/Jan/2012	16:22	ELC-110	10.1			pg/L
PCB 158	13/Mar/2012	7:40	ELC-200	86.1			pg/L
PCB 158	13/Mar/2012	9:07	ELC-210	13.6			pg/L
PCB 158	27/Mar/2012	15:28	ELC-300	94			pg/L
PCB 158	27/Mar/2012	16:00	ELC-310	10.6			pg/L
PCB 158	10/Apr/2012	6:13	ELC-400	17			pg/L
PCB 158	10/Apr/2012	8:40	ELC-401	45.2			pg/L
PCB 158	10/Apr/2012	10:39	ELC-402	65.8	6.22	9%	pg/L
PCB 158	10/Apr/2012	11:35	ELC-403	41.3			pg/L
PCB 158	10/Apr/2012	6:43	ELC-410	8.3			pg/L
PCB 170	20/Jan/2012	15:37	ELC-100	1670			pg/L
PCB 170	20/Jan/2012	16:22	ELC-110	42			pg/L
PCB 170	13/Mar/2012	7:40	ELC-200	142			pg/L
PCB 170	13/Mar/2012	9:07	ELC-210	38.5			pg/L
PCB 170	27/Mar/2012	15:28	ELC-300	174			pg/L
PCB 170	27/Mar/2012	16:00	ELC-310	47.3			pg/L
PCB 170	10/Apr/2012	6:13	ELC-400	33.6			pg/L
PCB 170	10/Apr/2012	8:40	ELC-401	79.4			pg/L
PCB 170	10/Apr/2012	10:39	ELC-402	129.5	10.61	8%	pg/L
PCB 170	10/Apr/2012	11:35	ELC-403	68.2			pg/L
PCB 170	10/Apr/2012	6:43	ELC-410	22.1			pg/L
PCB 174	20/Jan/2012	15:37	ELC-100	2360			pg/L
PCB 174	20/Jan/2012	16:22	ELC-110	44.7			pg/L
PCB 174	13/Mar/2012	7:40	ELC-200	229			pg/L
PCB 174	13/Mar/2012	9:07	ELC-210	55.9			pg/L
PCB 174	27/Mar/2012	15:28	ELC-300	251			pg/L
PCB 174	27/Mar/2012	16:00	ELC-310	54.4			pg/L
PCB 174	10/Apr/2012	6:13	ELC-400	61.3			pg/L
PCB 174	10/Apr/2012	8:40	ELC-401	119			pg/L
PCB 174	10/Apr/2012	10:39	ELC-402	205	9.90	5%	pg/L
PCB 174	10/Apr/2012	11:35	ELC-403	112			pg/L
PCB 174	10/Apr/2012	6:43	ELC-410	36.6			pg/L
PCB 177	20/Jan/2012	15:37	ELC-100	1170			pg/L
PCB 177	20/Jan/2012	16:22	ELC-110	22.5			pg/L
PCB 177	13/Mar/2012	7:40	ELC-200	108			pg/L
PCB 177	13/Mar/2012	9:07	ELC-210	27.3			pg/L
PCB 177	27/Mar/2012	15:28	ELC-300	125			pg/L
PCB 177	27/Mar/2012	16:00	ELC-310	29.6			pg/L
PCB 177	10/Apr/2012	6:13	ELC-400	26.8			pg/L
PCB 177	10/Apr/2012	8:40	ELC-401	58.2			pg/L
PCB 177	10/Apr/2012	10:39	ELC-402	104.35	9.40	9%	pg/L
PCB 177	10/Apr/2012	11:35	ELC-403	53.4			pg/L
PCB 177	10/Apr/2012	6:43	ELC-410	19.2			pg/L
PCB 180	20/Jan/2012	15:37	ELC-100	4760			pg/L
PCB 180	20/Jan/2012	16:22	ELC-110	140			pg/L
PCB 180	13/Mar/2012	7:40	ELC-200	493			pg/L
PCB 180	13/Mar/2012	9:07	ELC-210	129			pg/L
PCB 180	27/Mar/2012	15:28	ELC-300	518			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 180	27/Mar/2012	16:00	ELC-310	128			pg/L
PCB 180	10/Apr/2012	6:13	ELC-400	115			pg/L
PCB 180	10/Apr/2012	8:40	ELC-401	215			pg/L
PCB 180	10/Apr/2012	10:39	ELC-402	353	32.53	9%	pg/L
PCB 180	10/Apr/2012	11:35	ELC-403	187			pg/L
PCB 180	10/Apr/2012	6:43	ELC-410	66			pg/L
PCB 183	20/Jan/2012	15:37	ELC-100	2100			pg/L
PCB 183	20/Jan/2012	16:22	ELC-110	32			pg/L
PCB 183	13/Mar/2012	7:40	ELC-200	190			pg/L
PCB 183	13/Mar/2012	9:07	ELC-210	39.3			pg/L
PCB 183	27/Mar/2012	15:28	ELC-300	183			pg/L
PCB 183	27/Mar/2012	16:00	ELC-310	33.4			pg/L
PCB 183	10/Apr/2012	6:13	ELC-400	49.6			pg/L
PCB 183	10/Apr/2012	8:40	ELC-401	82.7			pg/L
PCB 183	10/Apr/2012	10:39	ELC-402	145	9.90	7%	pg/L
PCB 183	10/Apr/2012	11:35	ELC-403	83.3			pg/L
PCB 183	10/Apr/2012	6:43	ELC-410	25.7			pg/L
PCB 187	20/Jan/2012	15:37	ELC-100	3940			pg/L
PCB 187	20/Jan/2012	16:22	ELC-110	86			pg/L
PCB 187	13/Mar/2012	7:40	ELC-200	399			pg/L
PCB 187	13/Mar/2012	9:07	ELC-210	97			pg/L
PCB 187	27/Mar/2012	15:28	ELC-300	406			pg/L
PCB 187	27/Mar/2012	16:00	ELC-310	83.6			pg/L
PCB 187	10/Apr/2012	6:13	ELC-400	107			pg/L
PCB 187	10/Apr/2012	8:40	ELC-401	167			pg/L
PCB 187	10/Apr/2012	10:39	ELC-402	304.5	9.19	3%	pg/L
PCB 187	10/Apr/2012	11:35	ELC-403	170			pg/L
PCB 187	10/Apr/2012	6:43	ELC-410	65			pg/L
PCB 194	20/Jan/2012	15:37	ELC-100	1500			pg/L
PCB 194	20/Jan/2012	16:22	ELC-110	34			pg/L
PCB 194	13/Mar/2012	7:40	ELC-200	219			pg/L
PCB 194	13/Mar/2012	9:07	ELC-210	52.9			pg/L
PCB 194	27/Mar/2012	15:28	ELC-300	206			pg/L
PCB 194	27/Mar/2012	16:00	ELC-310	43			pg/L
PCB 194	10/Apr/2012	6:13	ELC-400	38.8			pg/L
PCB 194	10/Apr/2012	8:40	ELC-401	56.1			pg/L
PCB 194	10/Apr/2012	10:39	ELC-402	99.85	5.87	6%	pg/L
PCB 194	10/Apr/2012	11:35	ELC-403	55.5			pg/L
PCB 194	10/Apr/2012	6:43	ELC-410	19			pg/L
PCB 195	20/Jan/2012	15:37	ELC-100	507			pg/L
PCB 195	20/Jan/2012	16:22	ELC-110	10.2			pg/L
PCB 195	13/Mar/2012	7:40	ELC-200	63.3			pg/L
PCB 195	13/Mar/2012	9:07	ELC-210	15.7			pg/L
PCB 195	27/Mar/2012	15:28	ELC-300	65			pg/L
PCB 195	27/Mar/2012	16:00	ELC-310	16			pg/L
PCB 195	10/Apr/2012	6:13	ELC-400	12.8			pg/L
PCB 195	10/Apr/2012	8:40	ELC-401	21.6			pg/L
PCB 195	10/Apr/2012	10:39	ELC-402	34.95	5.59	16%	pg/L
PCB 195	10/Apr/2012	11:35	ELC-403	17.7			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
PCB 195	10/Apr/2012	6:43	ELC-410	6.67			pg/L
PCB 201	20/Jan/2012	15:37	ELC-100	390			pg/L
PCB 201	20/Jan/2012	16:22	ELC-110	5.91			pg/L
PCB 201	13/Mar/2012	7:40	ELC-200	48.5			pg/L
PCB 201	13/Mar/2012	9:07	ELC-210	8.45			pg/L
PCB 201	27/Mar/2012	15:28	ELC-300	39			pg/L
PCB 201	27/Mar/2012	16:00	ELC-310	5.49			pg/L
PCB 201	10/Apr/2012	6:13	ELC-400	11			pg/L
PCB 201	10/Apr/2012	8:40	ELC-401	14.8			pg/L
PCB 201	10/Apr/2012	10:39	ELC-402	26.35	4.17	16%	pg/L
PCB 201	10/Apr/2012	11:35	ELC-403	16.6			pg/L
PCB 201	10/Apr/2012	6:43	ELC-410	4.62			pg/L
PCB 203	20/Jan/2012	15:37	ELC-100	1820			pg/L
PCB 203	20/Jan/2012	16:22	ELC-110	35.6			pg/L
PCB 203	13/Mar/2012	7:40	ELC-200	255			pg/L
PCB 203	13/Mar/2012	9:07	ELC-210	55.6			pg/L
PCB 203	27/Mar/2012	15:28	ELC-300	232			pg/L
PCB 203	27/Mar/2012	16:00	ELC-310	37.7			pg/L
PCB 203	10/Apr/2012	6:13	ELC-400	52			pg/L
PCB 203	10/Apr/2012	8:40	ELC-401	62.8			pg/L
PCB 203	10/Apr/2012	10:39	ELC-402	108	8.49	8%	pg/L
PCB 203	10/Apr/2012	11:35	ELC-403	68			pg/L
PCB 203	10/Apr/2012	6:43	ELC-410	23.1			pg/L
Allethrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Allethrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Allethrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Allethrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Allethrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Allethrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Allethrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Allethrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Allethrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Allethrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Bifenthrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Bifenthrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Bifenthrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Bifenthrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Bifenthrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Bifenthrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Bifenthrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Bifenthrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Bifenthrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Bifenthrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Cyfluthrin, total	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Cyfluthrin, total	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Cyfluthrin, total	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Cyfluthrin, total	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Cyfluthrin, total	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Cyfluthrin, total	27/Mar/2012	16:00	ELC-310	<MDL			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
Cyfluthrin, total	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Cyfluthrin, total	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Cyfluthrin, total	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Cyfluthrin, total	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Cyhalothrin, lambda, total	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Cyhalothrin, lambda, total	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Cyhalothrin, lambda, total	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Cyhalothrin, lambda, total	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Cyhalothrin, lambda, total	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Cyhalothrin, lambda, total	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Cyhalothrin, lambda, total	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Cyhalothrin, lambda, total	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Cyhalothrin, lambda, total	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Cyhalothrin, lambda, total	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Cypermethrin, total	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Cypermethrin, total	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Cypermethrin, total	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Cypermethrin, total	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Cypermethrin, total	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Cypermethrin, total	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Cypermethrin, total	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Cypermethrin, total	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Cypermethrin, total	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Cypermethrin, total	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Delta/Tralomethrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Delta/Tralomethrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Delta/Tralomethrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Delta/Tralomethrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Delta/Tralomethrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Delta/Tralomethrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Delta/Tralomethrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Delta/Tralomethrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Delta/Tralomethrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Delta/Tralomethrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Esfenvalerate/Fenvalerate, total	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Esfenvalerate/Fenvalerate, total	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Fenpropathrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Fenpropathrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Fenpropathrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Fenpropathrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Fenpropathrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L

Table 3 (cont). Field sample results.

AnalyteName	SampleDate	SampleTime	FirstOfSampleID	ResultField	stdevField	RSDField	Unit
Fenpropathrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Fenpropathrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Fenpropathrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Fenpropathrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Fenpropathrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Permethrin, total	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Permethrin, total	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Permethrin, total	13/Mar/2012	7:40	ELC-200	4190			pg/L
Permethrin, total	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Permethrin, total	27/Mar/2012	15:28	ELC-300	2550			pg/L
Permethrin, total	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Permethrin, total	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Permethrin, total	10/Apr/2012	8:40	ELC-401	5540			pg/L
Permethrin, total	10/Apr/2012	10:39	ELC-402	7385	2001.11	27%	pg/L
Permethrin, total	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Phenothrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Phenothrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Phenothrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Phenothrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Phenothrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Phenothrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Phenothrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Phenothrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Phenothrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Phenothrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Prallethrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Prallethrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Prallethrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Prallethrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Prallethrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Prallethrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Prallethrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Prallethrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Prallethrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Prallethrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L
Resmethrin	20/Jan/2012	15:37	ELC-100	<MDL			pg/L
Resmethrin	20/Jan/2012	16:22	ELC-110	<MDL			pg/L
Resmethrin	13/Mar/2012	7:40	ELC-200	<MDL			pg/L
Resmethrin	13/Mar/2012	9:07	ELC-210	<MDL			pg/L
Resmethrin	27/Mar/2012	15:28	ELC-300	<MDL			pg/L
Resmethrin	27/Mar/2012	16:00	ELC-310	<MDL			pg/L
Resmethrin	10/Apr/2012	6:13	ELC-400	<MDL			pg/L
Resmethrin	10/Apr/2012	8:40	ELC-401	<MDL			pg/L
Resmethrin	10/Apr/2012	10:39	ELC-402	<MDL	NA		pg/L
Resmethrin	10/Apr/2012	6:43	ELC-410	<MDL			pg/L

Table 4. Results summarized.

AnalyteName	Unit	Count	Count <MDL	Min	Max	Average	StandardDeviation
Suspended Sediment Concentration	mg/L	23		6.5	395	44	85
Total Organic Carbon	ug/L	12		6900	20500	12158	4777
Dissolved Organic Carbon	ug/L	11		5800	17800	11391	3982
Dissolved Copper	ug/L	12		5.7	36	18	11
Total Copper	ug/L	16		6.4	59	26	18
Dissolved Mercury	ug/L	12		0.0013	0.017	0.0073	0.0038
Total Mercury	ug/L	13		0.0012	0.037	0.017	0.0092
Mercury, Methyl	ng/L	13		0.13	0.45	0.23	0.10
PCB 008	pg/L	12		1	214	25	60
PCB 018	pg/L	12		2	319	38	89
PCB 028	pg/L	12		3	489	66	136
PCB 031	pg/L	12		3	707	80	199
PCB 033	pg/L	12		1	248	35	69
PCB 044	pg/L	12		11	5800	534	1659
PCB 049	pg/L	12		5	2980	273	853
PCB 052	pg/L	12		19	13300	1198	3812
PCB 056	pg/L	12		4	1870	181	532
PCB 060	pg/L	12		2	869	85	247
PCB 066	pg/L	12		8	4270	404	1218
PCB 070	pg/L	12		16	16700	1523	4781
PCB 087	pg/L	12		28	15000	1442	4273
PCB 095	pg/L	12		49	14200	1355	4048
PCB 099	pg/L	12		22	11800	1109	3368
PCB 101	pg/L	12		42	22700	2142	6478
PCB 105	pg/L	12		14	8080	786	2299
PCB 110	pg/L	12		66	22700	2228	6453
PCB 118	pg/L	12		33	19000	1821	5414
PCB 128	pg/L	12		16	2840	307	800
PCB 132	pg/L	12		29	4400	488	1236
PCB 138	pg/L	12		87	13100	1462	3676

Table 4 (cont). Results summarized.

AnalyteName	Unit	Count	Count <MDL	Min	Max	Average	StandardDeviation
PCB 141	pg/L	12		15	2070	242	578
PCB 149	pg/L	12		62	7710	878	2158
PCB 151	pg/L	12		26	2620	312	730
PCB 153	pg/L	12		62	8570	991	2395
PCB 156	pg/L	12		8	2070	212	586
PCB 158	pg/L	12		8	1530	166	431
PCB 170	pg/L	12		22	1670	215	461
PCB 174	pg/L	12		37	2360	311	650
PCB 177	pg/L	12		19	1170	154	322
PCB 180	pg/L	12		66	4760	621	1312
PCB 183	pg/L	12		26	2100	259	583
PCB 187	pg/L	12		65	3940	511	1087
PCB 194	pg/L	12		19	1500	202	414
PCB 195	pg/L	12		7	507	67	140
PCB 201	pg/L	12		5	390	50	108
PCB 203	pg/L	12		23	1820	238	504
Allethrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Bifenthrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Cyfluthrin, total	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Cyhalothrin, lambda, total	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Cypermethrin, total	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Delta/Tralomethrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Esfenvalerate/Fenvalerate, total	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Fenpropathrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Permethrin, total	pg/L	11	6	<MDL	8800	2459	3183
Phenothrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Prallethrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL
Resmethrin	pg/L	11	11	<MDL	<MDL	<MDL	<MDL