ATTACHMENT C

CITY OF SEATTLE
2011 NPDES PHASE I MUNICIPAL STORMWATER PERMIT
STORMWATER MONITORING REPORT

Prepared by
Seattle Public Utilities

March 20, 2012

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1 Introduction

1.1 Introduction

This document serves as the City of Seattle's (City) water year 2011 monitoring report as required by Special Conditions S8.H and S9 of the 2007 National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit (Permit). The Permit became effective on February 16, 2007 and was modified on June 17, 2009 and September 1, 2010 by the Washington Department of Ecology (Ecology) under the NPDES and State Waste Discharge General Permits for discharges from Large and Medium Municipal Separate Storm Sewer Systems (MS4s).

The City was required to fully implement the monitoring program as described in Special Condition 8 (S8) of the Permit on February 16, 2009. Special Condition S8.H of the Permit requires the City to provide a report annually on the monitoring that occurred during the previous water year (WY). A water year starts on October 1 and ends on September 30 of the following year. This report summarizes monitoring activities performed during the second complete water year stipulated in the 2007 Permit as WY2009 was a partial water year beginning in February 2009.

1.2 Background

The Permit requires three types of monitoring under section S8:

Stormwater Characterization (S8.D) – Stormwater characterization is monitoring which is intended to characterize stormwater runoff quantity and quality to allow analysis of loadings and changes in conditions over time and generalization across the Permittee's jurisdiction. Ecology stated in the Permit Fact Sheet that the purpose of requiring Permittees to engage in stormwater characterization monitoring is to gain knowledge of pollutant loads from areas within the municipality.

The City's implementation of this requirement consists of three in-pipe stormwater monitoring locations that are considered to be representative of the land uses that they are intended to characterize. The first monitoring location is located in northwest Seattle in the Venema neighborhood and represents predominantly residential land use. The second monitoring location is in northeast Seattle located adjacent to the University of Washington and represents predominantly commercial land use. The third monitoring location is in south Seattle near the City's border with Tukwila and represents a predominantly industrial land use.

Program Effectiveness (S8.E) – Program effectiveness monitoring is intended to improve stormwater management efforts by providing a feedback loop to help determine if a stormwater management program element is meeting the desired environmental outcome. The Permit requires the City to select two specific aspects of the Stormwater Management Program to evaluate; the effectiveness of a targeted action and the effectiveness of achieving a targeted environmental outcome.

The potential impact of urban stormwater runoff on the water quality of receiving waters is of great concern in the Seattle area. While new development and redevelopment may have a large number of options for providing water quality treatment through structural controls, existing developed areas have limited choices for retrofitting their stormwater systems. Thus, nonstructural measures, also known as source control, offer perhaps the greatest potential for improvement of water quality. Roads and other transportation related surfaces make up 26 percent of the land use within the City; the Permit requires that the City establish practices to reduce stormwater impacts associated with runoff from paved surfaces. Street sweeping is one of the source control tools available to meet this Permit requirement and the City has recently expanded its sweeping program, with a focus on removing pollutants from roadways that discharge to the City's Municipal Separate Storm Sewer System (MS4). Because of this, the City has chosen to evaluate the program effectiveness of street sweeping for both required aspects:

- **Targeted action** - *Does street sweeping result in improvements in stormwater quality and quality of sediments in stormwater discharges or both*? This aspect evaluated the effectiveness of regenerative air street sweeping technology at a frequency of every two weeks to potentially provide treatment at a level similar to structural stormwater best management practices (BMPs) by reducing the quarterly average street dirt pollutant load 60 percent for fine particles (less than 250 microns in diameter).
- **Targeted outcome** - *Does street sweeping reduce the discharge of certain pollutants below a targeted annual load amount*? This was evaluated through development of a spreadsheet model that predicts a targeted annual load reduction, using total suspended solids as a surrogate pollutant, for varying conditions, such as sweeping frequency, sweeping velocity and parking enforcement compliance.

The program effectiveness study is now complete and two deliverables will be submitted to satisfy the Permit requirements for Section S8.E: 1) the targeted action work is documented in a report titled "Program Effectiveness Report - Sweet Sweeping for Water Quality" dated March 2012 which is submitted under separate cover and submitted concurrently with this report; and 2) the targeted outcome work's deliverable is a spreadsheet model named "Sweeping to Reduce Contaminants" (STORC) which will be submitted to Ecology on compact disk.

BMP Effectiveness (S8.F) – The Permit's best management practice (BMP) effectiveness monitoring requires the City to monitor two types of structural stormwater controls required for use by project proponents in new development and re-development projects that trigger the Stormwater Code requirement for water quality treatment or flow control of stormwater. Ecology designed the Permit requirement so that full scale field monitoring would evaluate the effectiveness and operation and maintenance requirements of stormwater treatment and hydrologic management BMPs applied in Phase I jurisdictions.

The first treatment BMP monitored by the City is the Stormwater Management StormFilter® (StormFilter) configured in two CatchBasin StormFilter™ (CBSFs) stormwater treatment systems utilizing zeolite-perlite-granular activated carbon (ZPG™) cartridges installed in West Seattle. The CBSF treatment BMP is frequently installed by the Seattle Department of Transportation (SDOT) to treat roadway stormwater runoff. The City was interested in monitoring the effectiveness of this BMP because the cartridge technology (the "StormFilter") has received a basic treatment General Use Level Designation (GULD) by Ecology via testing within a larger vault configuration, not in the smaller catch basin configuration. The study was conducted from February 2009 through September 2011 with a total of 37 storm events sampled across the two CBSFs monitored. The complete results of this study are documented in a separate report titled "CatchBasin StormFilter Performance Evaluation Report" dated March 5, 2012 and submitted under separate cover concurrently with the WY2011 annual report.

For the second treatment BMP, the City is partnering with Washington State University (WSU) to satisfy the Permit obligations for stormwater treatment BMP monitoring as allowed by special condition S3.B of the Permit. The City is participating in a WSU Low Impact Development (LID) research effort where WSU will be monitoring the pollutant removal capacity of various bioretention soil mixes. The City has developed a Memorandum of Understanding (MOU) with WSU to obtain the monitoring results from four bioretention mesocosms at the WSU Puyallup LID research facility to meet the S8.F.2 Permit monitoring requirements for a basic/metals/phosphorus treatment BMP. The MOA specifies that WSU will conduct water quality monitoring on four mesocosms, which are identical in size and all contain a 60/40 mix of aggregate/compost, which is the current soil mix for bioretention facilities specified in the City's Stormwater Code (SMC 22.800-22.808). Construction is now complete on the research facility. During WY2011, WSU completed installation and testing of monitoring equipment and monitoring began in early WY2012. Monitoring information will be provided to the City and included in the WY2012 Annual Report.

In addition to the two water quality treatment BMPs, the Permit requires the City to monitor a flow reduction strategy that is in use or planned for installation within the city in a paired study or against a predicted outcome. To meet this requirement, the City has monitored one bioretention swale located in the High Point community in South West Seattle. Flow was monitored in the swale continuously for two years. The results of this work were summarized in the City's WY2009 Annual Report submitted to Ecology on March 29, 2010.

2 S8.D Stormwater Monitoring

2.1 Overview

As stated in the introduction, stormwater characterization monitoring is a requirement of the 2007 NPDES Phase I Municipal Stormwater Permit (Permit) Special Condition 8 (S8). Ecology designed the stormwater characterization monitoring requirements to characterize stormwater runoff quantity and quality to allow analysis of loadings and changes in conditions over time and generalization across the Permittees' jurisdiction.

The monitoring work as described in the Permit was performed by Seattle Public Utilities (SPU) or contractors under the direction of SPU in accordance with a draft Quality Assurance Project Plan (QAPP) dated February 10, 2008, and approved by Ecology on September 26, 2008. The final QAPP was submitted to Ecology on February 12, 2009 with a revised final QAPP submitted on March 31, 2011. A brief summary of information provided in the QAPP is presented below.

WY2011 represents the second full water year of stormwater characterization monitoring for the City and is a continuation of work that began in February 2009. The Permit required monitoring to begin on February 16, 2009 which was approximately five months after the beginning of WY2009. As part of the characterization monitoring, the City was required to conduct first-flush toxicity tests once during the five year Permit cycle. Toxicity monitoring was successfully completed in WY2010 at each of the three monitoring locations. Toxicity results were presented in the WY2010 Annual Report.

2.1.1 Monitoring Goals and Objectives

The goal of the stormwater characterization monitoring is to meet the requirements of Section S8.D of the Permit. Ecology's purpose for requiring the City to conduct stormwater characterization monitoring is to obtain knowledge of average event mean concentrations (EMCs) and pollutant loads from representative areas drained by municipal storm sewer systems. In addition, Ecology hopes that the information will be useful for determining whether the comprehensive stormwater management programs are making progress toward the goal of reducing the amount of pollutants discharged and protecting water quality.

2.2 Sampling Location Descriptions

The Permit requires each Permittee to select three monitoring sites within the municipal storm sewer system that represent the three types of land uses: residential, commercial and industrial. As required by the Permit, the City proposed, and received approval from Ecology in December

2007, for the three monitoring sites to meet these requirements. Details on the three monitoring sites are described below in Table 2.2 and presented visually in the Vicinity Map – Figure 2.2.

Table 2.2. Stormwater Characterization Basin Summary

Land Use Category	Station ID (Basin Name)	Storm Sewer System Type
Residential	R1 (Venema)	Separated, ditch & culvert system
Commercial	C1 (University District)	Partially separated
Industrial	I1 (Norfolk)	Partially separated

To determine locations for stormwater monitoring, the City's geographic information system (GIS) was used to display the stormwater infrastructure and identify possible catchments in the separated areas of the city that represent a discernible type of land use. Field visits were then conducted to evaluate hydrology (base flow, turbulent flow, tidal influence, etc.), the feasibility of monitoring (access, potential for vandalism, safety of monitoring personnel, equipment installation needs, etc.) and the suitability of the site for long-term monitoring.

Following the initial site selection, a walking survey of each basin was performed to confirm or correct the drainage area maps.

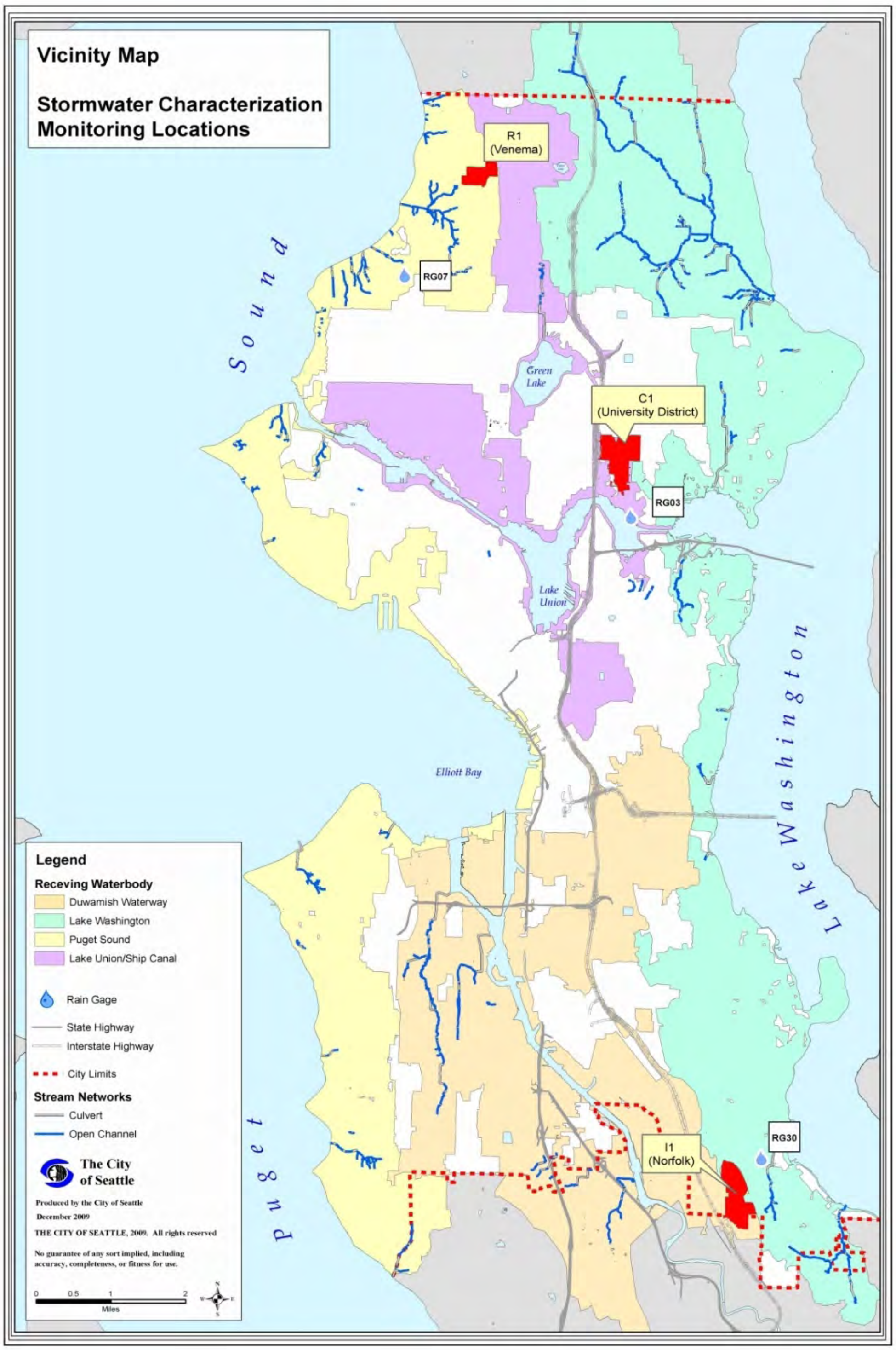
2.2.1 Basin Descriptions

Information about the basins monitored is summarized in Table 2.2.1 below.

Table 2.2.1. Stormwater Characterization Monitoring Location Summary

Represented Land Use	Residential	Commercial	Industrial
Basin	**R1 (Venema)**	**C1 (U- District)**	**I1 (Norfolk)**
Surface Area Distribution			
Total Area (acres)	85.3	181.0	164.2
Area Draining to MS4 Estimate (acres)	85.3	152.0	137.2
Area Draining to Combined System Estimate (acres)	0.0	29.0	27.0
Impervious Area Estimate (%) - for area draining to MS4	50.2	61.1	51.2
Land Use Distribution Estimate- for area draining to MS4			
Residential (%)	95	37	32
Industrial (%)	0	0	37
Commercial (%)	5	61	13
Open Space (%)	0	2	18
Hydrologic Information			
Rain Gauge	RG07	RG03	RG30
Receiving Water Body	Venema/Piper's Creek	Lake Union	Duwamish River

Figure 2.2. Vicinity Map – Stormwater Characterization Monitoring Locations



The Permit set the following goal for stormwater characterization monitoring locations: "ideally, to represent a particular land use, no less than 80 percent of the area served by the conveyance will be classified as having that land use." The City was unable to find basins that met this goal due to the ultra-urban mixed use nature of Seattle. The City selected basins that best represented the land use type in the City and had infrastructure suitable for installation of monitoring equipment. The information on land use percentages for each monitoring sampling location was provided to Ecology in the Permit required summary description of the monitoring program (S8.G.1.a) in October, 2007 and approved by Ecology in December, 2007.

SPU used the following method to determine the land use area for each stormwater characterization monitoring basin. Land use data are derived using GIS from the King County Parcel Database, which classifies each parcel into one of the eight general following categories: single family, multi-family, commercial, schools, other/NA, government/public facility, industrial, parks/open space and vacant. Land that is not classified as a parcel is considered right-of-way.

The King County Parcel Database further groups land use into four general categories: (1) residential which includes single family and multi-family and may include other/NA; (2) commercial which includes commercial, schools, government/public facility and may include other/NA; (3) industrial which includes industrial and may include vacant; and (4) open which includes parks/open space and may include vacant.

SPU used GIS to determine the percentage of each land use type that drains to the MS4. The impervious area for each land use category is estimated using citywide averages based on GIS analysis. For basins that are partially separated, the equivalent area draining to the MS4 is less than the total basin area because some stormwater in the basin is conveyed via the combined sewer system.

The three monitoring basins are briefly described below. A description of each related monitoring station is described in Section 2.2.2.

2.2.1.1 R1 (Venema)

The R1 basin represents a typical residential area in the separated portion of the City. This basin is located in the northwest portion of Seattle and discharges to Venema Creek which flows into Piper's Creek and then Puget Sound. The basin is approximately 85.3 acres[1] in size with 95

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[1] In the original QAPP (2008), the R1 basin size was listed as 157 acres. In early February 2009, some of the stormwater that previously drained through the monitoring station was diverted to outfalls north of the monitoring station by plugging several 4-way catch basins in the original basin. The catch basin plugging was performed for two reasons: 1) to limit flows to a storm pipe downstream of the monitoring station which

percent residential land use. The basin's sewer system is 100 percent separated. The R1 basin is delineated on Figure 2.2.1.1.

2.2.1.2 C1 (University District)

The C1 basin is located in a partially separated portion of the northeast portion of Seattle and represents a mix of commercial uses such as the University of Washington and neighborhood businesses that serve the surrounding residential population. This basin is located north of Lake Union and east of I-5 and drains to Lake Union. The majority land use in the 181-acre basin is commercial which represents approximately 61 percent of the basin. The C1 basin is delineated on Figure 2.2.1.2.

2.2.1.3 I1 (Norfolk)

The I1 industrial basin is served by the partially separated stormwater system and contains business activities typical of industrial land uses in Seattle. It is one of the few industrial basins in Seattle that is not tidally influenced and therefore is considered the best industrial land use basin in the City for meeting the monitoring requirements even though the percent of industrial land use in this basin does not meet the Permit goal of ideally "no less than 80 percent" industrial land use. The I1 basin is located in southern Seattle adjacent and immediately north of the border between the City of Seattle and the City of Tukwila and drains under I-5 to the west into the Duwamish waterway. The 164.2-acre basin is 37 percent industrial, 32 percent residential, 13 percent commercial and 18 percent open space. The I1 basin is delineated on Figure 2.2.1.3.

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requires repair; and 2) to allow a constant known area to drain to the monitoring station (4-way catch basins distribute flows in two directions with the flow distribution being dependent on flow intensity, gradients and the structural condition of the catch basin so the rainfall to runoff ratio is variable). The catch basin plugging reduced the size of the area draining to the R1 monitoring station to 85.3 acres.

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Figure 2.2.1.1. Site Map – R1 (Venema)

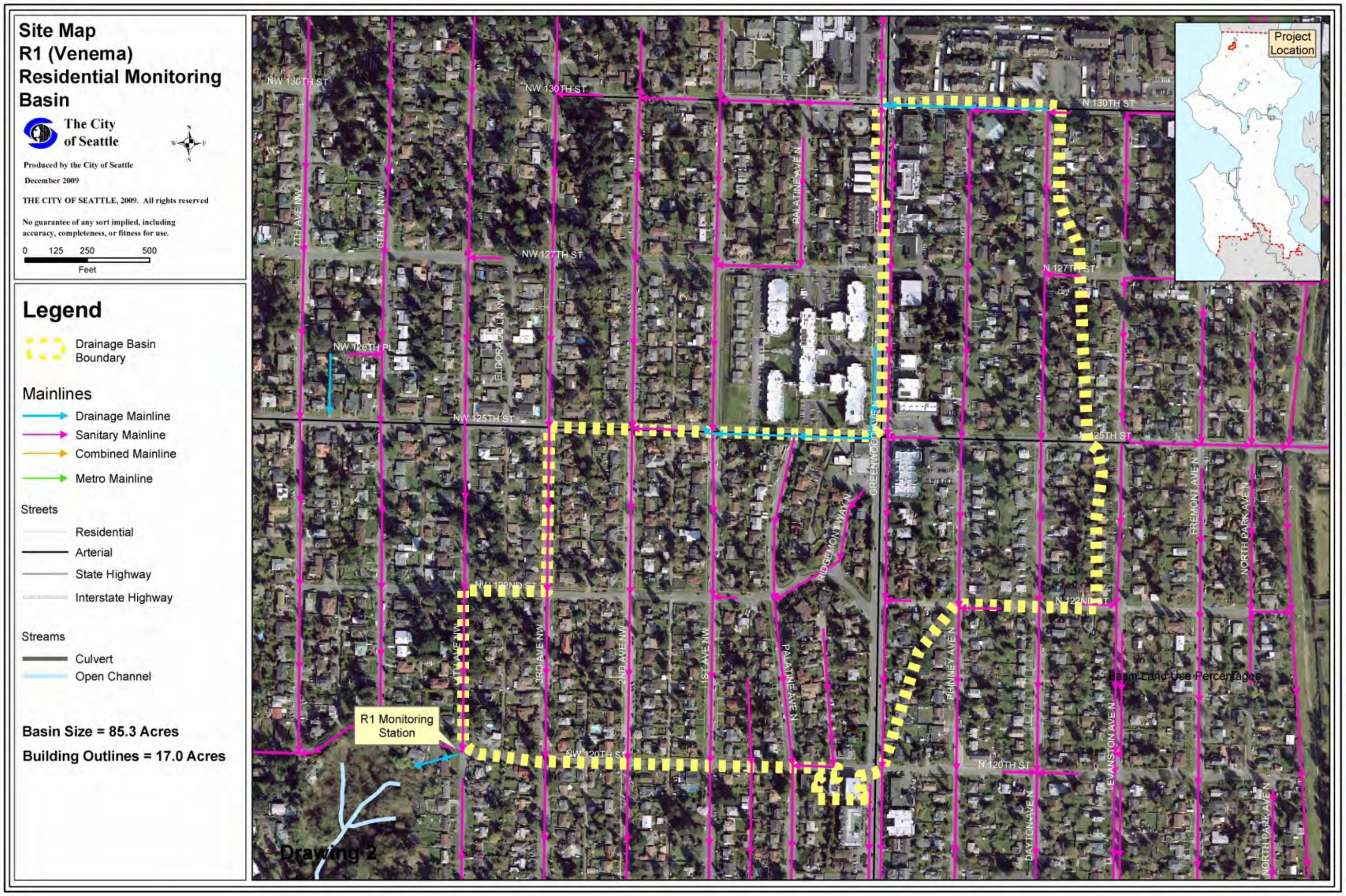
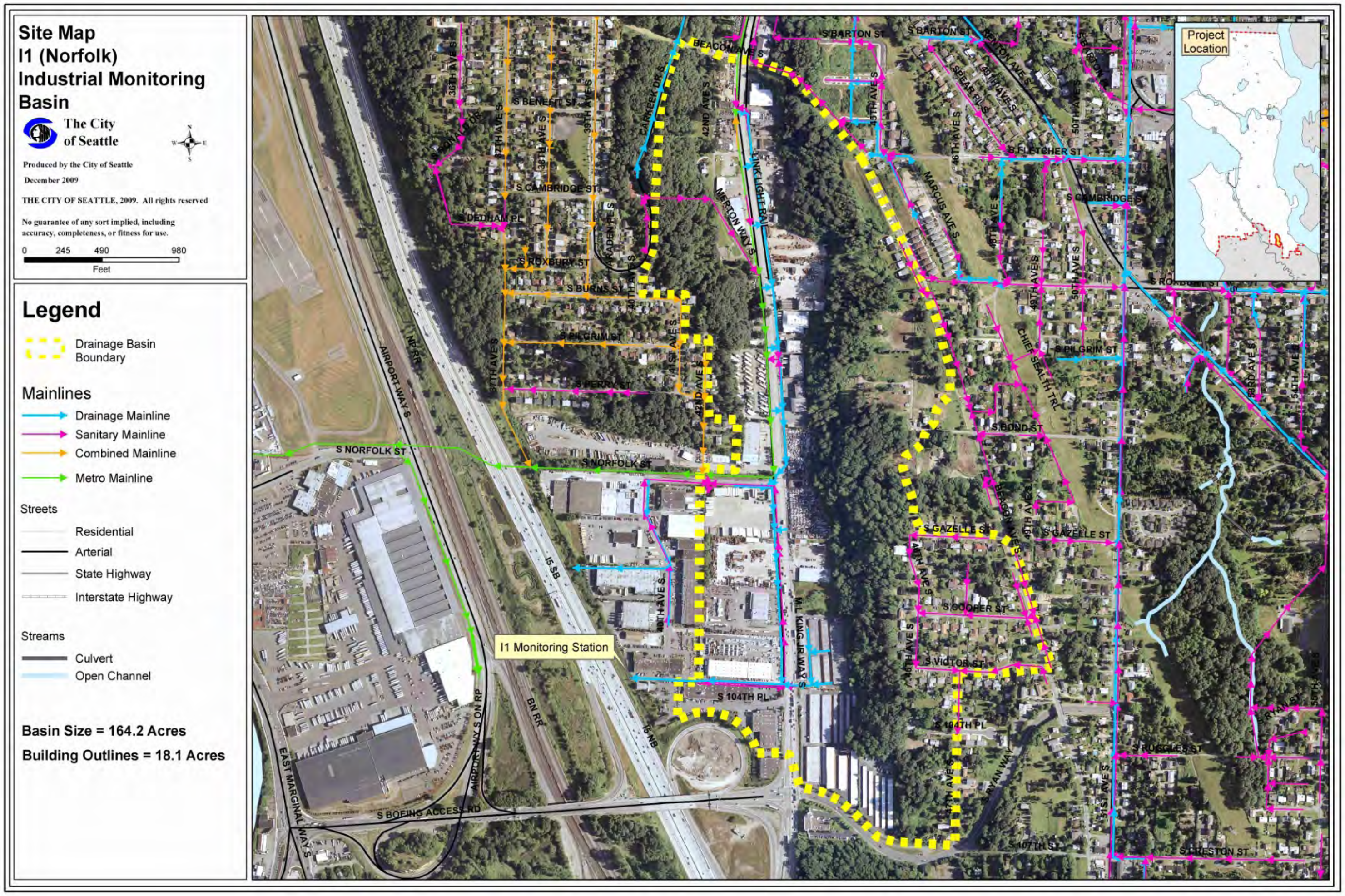


Figure 2.2.1.2. Site Map – C1 (University District)

City of Seattle

Figure 2.2.1.3. Site Map – I1 (Norfolk)



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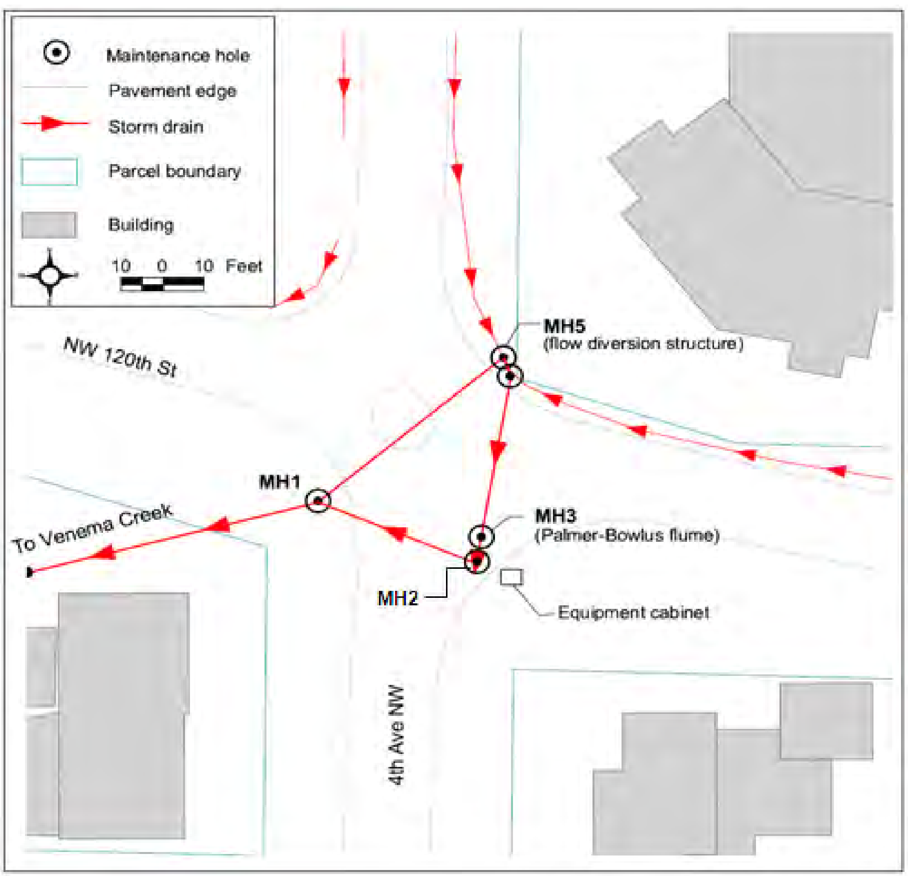
2.2.2 Monitoring Station Descriptions

Each of the three stormwater monitoring stations is configured with a flow monitor, automatic sampler, wireless telemetry and sediment traps. The specific monitor locations and equipment used at each site are detailed below with additional details being listed in the QAPP.

2.2.2.1 R1 (Venema)

The monitoring station R1 is composed of several maintenance holes, related storm drain piping, buried conduit and equipment enclosure at the intersection of NW 120th Street and 4th Avenue NW. The drainage system at this intersection was modified in June 2008 so that hydrologic conditions would be conducive to monitoring. Upgrades included adding a flow control weir (which acts as a diversion structure) and installing a 24-inch Palmer-Bowlus flume as a primary flow measurement device in a new section of storm drain piping with reduced slope (refer to Figure 2.2.1.1a).

Figure 2.2.2.1a. R1 Monitoring Station Overview



All stormwater flows into Maintenance Hole (MH) 5. Most flows are directed to the 24-inch Palmer-Bowlus flume in MH3 and then flow back to the original storm pipe via MH2 and MH1. High flows, exceeding rates of 14.6 cubic feet second (cfs), overtop the sharp crested flow-control weir in MH5 and flow directly to MH1 via the original section of storm pipe.

The Palmer-Bowlus flume is a hydraulic structure of rectangular cross-section that constricts and reshapes the flow, developing a hydraulic head proportional to flow. These flumes consist of a converging section at the inlet, a throat and diverging section at the outlet.

Figure 2.2.2.1b. Photo of R1 Palmer-Bowlus Flume

Flow is monitored at two points at this monitoring location:

- The primary flow measurement point is a 24-inch Palmer-Bowlus flume installed in MH3. The water level in the flume is measured using a Campbell Scientific, Inc (CSI) CS408 pressure transducer (sensor).

- The secondary flow measurement point utilizes the weir in MH5. A portion of the higher flows overtop the weir, bypassing the flume in MH3. The water level behind the weir is measured using a CSI CS448 pressure transducer.

A CSI CR1000 data logger records level and flow at five minute intervals. The data logger calculates flow from the level data using flume and weir equations. The flow in the flume and the flow over the weir (if any) are summed into one overall flow rate for the residential site. The two pressure transducer cables are routed to MH3 and MH5, respectively, through buried conduits connecting the maintenance holes to the equipment cabinet.

Water quality samples are collected at a single location in MH2. A modified Isco 6712 sampler collects volume-proportional stormwater composite samples as controlled by the CR1000 data logger. The sampler is enabled by a change in water level in the flume, and the sampler pacing is based on the flow calculated from the flume. The data logger and Isco sampler are installed in the equipment cabinet and the sampler tubing is run to MH2 through buried conduit. The sample intake tubing and strainer are mounted in MH2 and collect water quality samples from the sump just below the invert of the outlet pipe.

Figure 2.2.2.1c. Photo of R1 Equipment Cabinet

Wireless telemetry provides remote communications with the CR1000 and both the data logger and sampler are powered by AC power.

Two sediment traps are installed in MH-2 with the mouths of the bottles located approximately 1-inch above the invert of the outlet pipe.

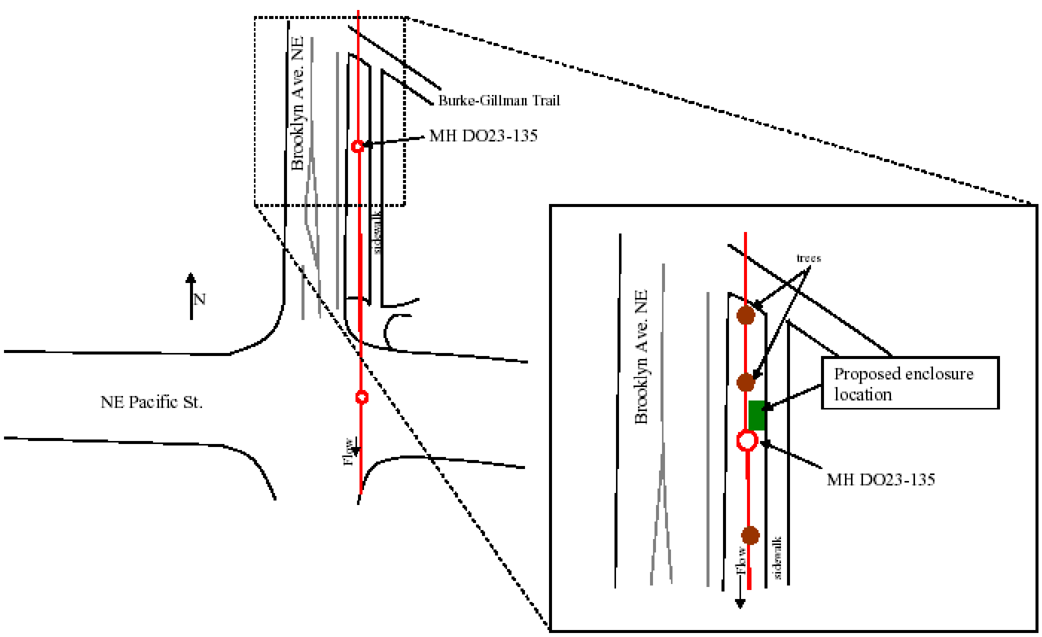
Figure 2.2.2.1d. Photo of R1 Sediment Traps

SPU rain gauge RG07 (45-S007) is used to represent rainfall in the R1 basin. RG07 is located at Whitman Middle School which is located near the corner of 15th Avenue NW and NW 92nd Street, roughly 1.5 miles southwest of the monitoring station.

2.2.2.2 C1 (University District)

Monitoring station C1 is accessed via MH D023-135 on the east side of Brooklyn Ave NE, which is situated on a relatively straight section of 36-inch diameter concrete reinforced pipe installed in 1972. The straightness of the pipe produces a relatively linear flow path through the maintenance hole. The pipe has a steep gradient with the upstream pipe slope at approximately 6.4 percent and the downstream pipe slope at approximately 7.6 percent.

Figure 2.2.2.2a. C1 Monitoring Station Overview



Flow is measured using an Isco 2150 area-velocity (AV) type flow monitor. The AV sensor is mounted upstream of the MH, at the invert of the 36-inch concrete pipe using stainless steel mounting rings. Flow is calculated at five minute intervals based on measured level and velocity data and site-specific information (pipe size and pipe shape) using the continuity equation. This is the only stormwater characterization monitoring station where non-stormwater base flow is present.

A modified Isco 6712 sampler collects volume-proportional stormwater composite samples. The sampler's strainer is affixed to the AV sensor mounting ring, with the intake being positioned in the pipe invert just downstream of the AV sensor.

Figure 2.2.2.2b. Photograph of C1 Equipment Cabinet

Note – monitoring MH D023-135 visible behind cabinet under truck bumper.

Wireless telemetry provides remote communications to both the flow meter and sampler via a CSI CR1000 data logger. The CR1000 controls the collection of samples by pacing the automatic sampler.

The sampler, logger and modem are housed in an enclosure installed in the parking strip adjacent to MH D023-135.

Two sediment traps are installed downstream of the MH with the traps' housing mounted to the pipe's invert.

Figure 2.2.2.2c. Photograph of C1 Sediment Traps

SPU rain gauge RG03 (45-S003) is used to represent rainfall in the C1 basin. RG03 located on the roof of the Harris Hydraulics Laboratory on the University of Washington Campus near Lake Union. It is approximately 0.3 miles southeast of the monitoring site.

2.2.2.3 I1 (Norfolk)

The I1 monitoring station is located within a new pipe and flow diversion structure vault that was constructed as part of an upgrade to the drainage system in this basin. The former 36-inch storm drain pipe, which partially collapsed, was replaced during a construction project that was started in the winter of 2008/09 and finished in July 2009. The new storm drain pipe is located between Martin Luther King Jr. Way and the Washington Department of Transportation (WSDOT) ditch located on the east side of Interstate 5. This pipeline runs along the south property boundary of the Papé Material Handling property (9892 40th Avenue South, Seattle, WA 98118) and parallels the boundary between the City of Seattle and the City of Tukwila.

The new pipe is a 64-inch, ductile-iron pipe (DIP). A 6-foot by 10-foot precast vault is installed at the downstream end of the new storm pipe. A high-flow outlet weir is installed at the downstream end of the vault with a crest elevation of 11.75 feet (NAVD88 datum). The purpose of the weir is to divert low flow to an oil control structure located under the Papé drive north of the new pipe. The weir, which discharges to the WSDOT ditch, also helps to dissipate flow energy of higher flows by spreading flow over the length of the weir. The following two figures present the I1 monitoring station layout in plan and side view, respectively.

Figure 2.2.2.3a. I1 Monitoring Station Overview

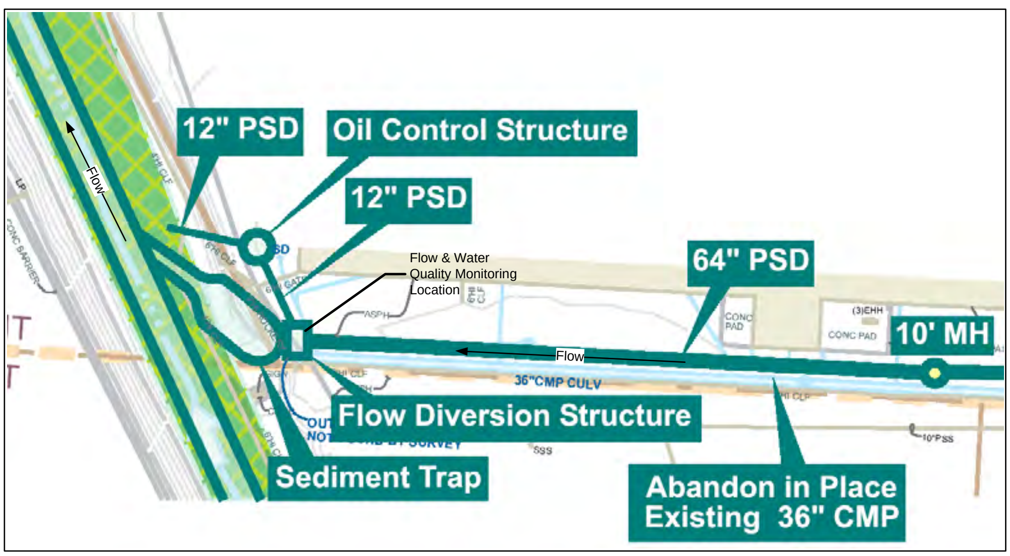
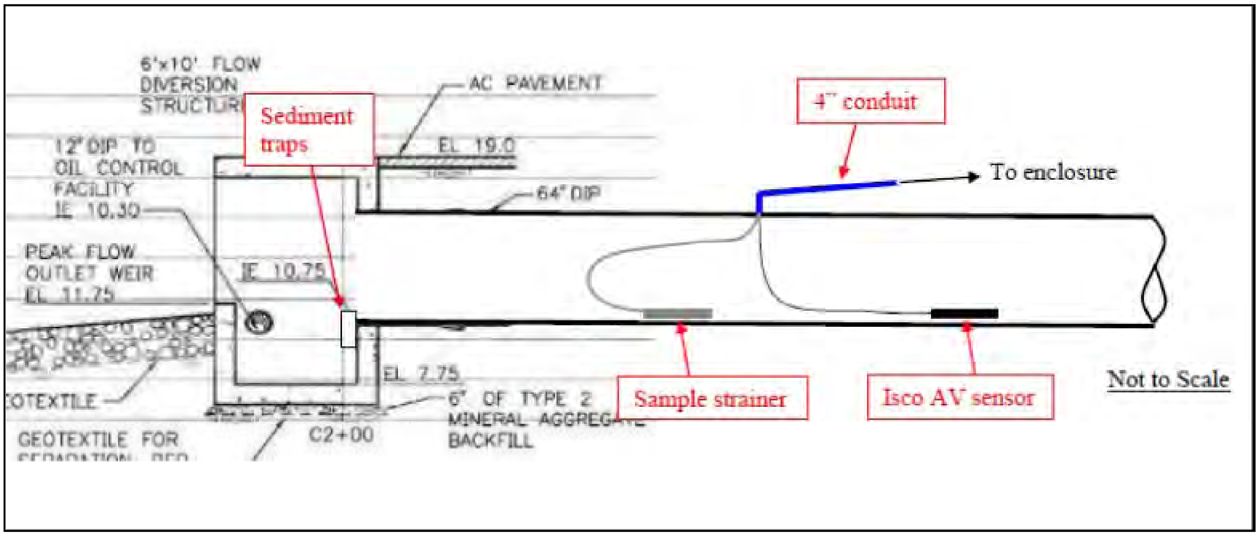


Figure 2.2.2.3b. I1 Station Cross Section View



Flow at the I1 station is measured using an Isco 2150 AV-type meter. The AV sensor is mounted upstream of the flow diversion vault, at the invert of the 64-inch DIP pipe using stainless steel mounting rings. Flow is calculated at five minute intervals based on measured level and velocity data and site-specific information (pipe size and pipe shape) using the continuity equation.

Figure 2.2.2.3c. Photograph of I1 Diversion Structure and Outfall

A modified Isco 6712 sampler collects volume-proportional stormwater composite samples. The sampler's strainer is affixed to the AV sensor mounting ring, with the intake being positioned in the pipe invert just downstream of the sensor.

Wireless telemetry provides remote communications to both the flow meter and sampler via a CSI CR1000 data logger. The CR1000 controls the collection of samples by pacing the automatic sampler.

The sampling equipment, logger and modem are housed in an enclosure installed in the Pape drive adjacent to the top of the diversion vault.

Figure 2.2.2.3d. Photograph of I1 Equipment Cabinet

Two sediment traps are installed in diversion structure vault with the mouths of the bottles located approximately 2-inches above the standing water level inside the structure.

Figure 2.2.2.3e. Photograph of I1 Sediment Traps

SPU rain gauge RG30 (45-S030) is used to represent rainfall in the I1 basin. RG30 is located on the roof of the Seattle Public Library at 9125 Rainier Ave. S. It is approximately miles 0.5 northeast of the monitoring site.

2.3 Sampling and Monitoring Procedures

TEC Inc. [(TEC), formerly Taylor Associates, Inc.], under contract with the City, performed all weather tracking, flow monitoring, stormwater sampling and sediment sampling activities.

2.3.1 Weather Tracking/Storm Criteria

Weather and rainfall data were continuously monitored using multiple forecasting, radar and satellite sources to target storms that meet the criteria for a qualifying event, listed in the table below.

Table 2.3.1. Qualifying Event Criteria

Criteria	Wet season	Dry season	Base Flow	Toxicity
Period	October 1 through April 30	May 1 through September 30	October 1 through September 30	August or September (ideally)
Rainfall volume	0.20" minimum, no fixed maximum	0.20" minimum, no fixed maximum	NA - none	No fixed minimum or maximum
Rainfall duration	No fixed minimum or maximum	No fixed minimum or maximum	NA	No fixed minimum or maximum
Antecedent dry period	≤ 0.02" rain in the previous 24 hours	≤ 0.02" rain in the previous 72 hours	≤ 0.02" rain in the previous 24 hours	One week
Storm capture coverage	75% (for storms longer than 24 hours, 75% of first 24 hours)	75% (for storms longer than 24 hours, 75% of first 24 hours)	100%/24 hrs	75% (for storms longer than 24 hours, 75% of first 24 hours)
Inter-event dry period	6 hours	6 hours	NA	NA

Notes-
NA – not applicable, no criteria

TEC made recommendations for storms to target for sampling with the final "go/no-go" decision made by the City's stormwater monitoring lead.

2.3.2 Precipitation Monitoring Procedures

SPU collects precipitation data from a network of 17 tipping bucket rain gages located throughout Seattle. Precipitation data are collected over one-minute intervals and transmitted via wireless telemetry to a centralized server. The rain gage network is operated and maintained under contract by ADS Environmental Services, Inc. (ADS).

Rain gage inspection and maintenance is performed on a quarterly basis. Maintenance includes: checking the levelness of the gage and re-leveling, if necessary; and cleaning of filter screens, drain holes and siphons. Gages are verified and calibrated annually by sending a known volume of water through the gage a minimum of two times, averaging the gage's measurement and comparing the average to the known volume. If the measurement is greater than +/- 2 percent of the actual volume, the gage is adjusted in the field until it reads within 2 percent or replaced with another gage, with the inaccurate gage sent back to the manufacturer for calibration.

All maintenance and calibration activities and any observed problems are recorded on a data sheet to be used to edit data raw rain data (discussed in Section 2.3.8.1).

2.3.3 Flow Monitoring Procedures

Flow monitoring equipment type and configuration per each station are described in Section 2.2.2. Level, velocity (if applicable) and flow data are logged at five-minute intervals. Flow monitoring quality assurance/quality control procedures are discussed in Section 2.3.8.2).

2.3.4 Stormwater Grab Sampling Procedures

Grab samples were collected by lowering a decontaminated stainless steel bailer, utilizing a swing arm sampler mounted on a telescoping pole, into the flow stream and pouring the contents into analyte-specific bottles. Ideally, all grab samples were collected between the first and last volume-proportional composite sample aliquot at each site. However, if the rain/runoff ended before the field crew could be present to collect the grab sample; a makeup grab sample was collected for that event during another event that met the storm criteria.

2.3.5 Stormwater Composite Sampling Procedures

Volume-proportioned stormwater composite samples were collected using modified Isco 6712 automatic samplers. The samplers utilize a peristaltic pump to draw stormwater from a strainer (a perforated stainless steel sample head affixed to the end of the sampler tube) installed in the flow channel and distribute it to composite bottles in the sampler base. The samplers' bases and distribution arms were modified to allow the use of eight discrete 2.5-gallon [9.46 Liter (L)] glass bottles which increases the volume of stormwater that can be collected. This increases the chances of obtaining sufficient volume, increases flexibility if storm sizes change and reduces staffing needed to visit stations to replace bottles as they fill during a sampling event.

Figure 2.3.5a. Photo of Modified Automatic Sampler

The data loggers were programmed to trigger the samplers every time a specified volume (referred to as the "trigger volume") passes the monitoring location. Each trigger sent results in the collection of one stormwater aliquot deposited in the composite bottle. As each bottle is filled (after a discrete number of aliquots), the sampler's distributor arm advances to the next bottle. Bottles were removed and replaced as necessary over the course of the event.

Since stormwater samples, specifically stormwater solids concentrations and related contaminants, are readily biased without proper processing procedures; all composite samples were composited and split in the project analytical laboratory [Analytical Resources Inc. (ARI) in Tukwila, WA] using a combination of polytetrafluoroethylene (PTFE) cone splitters and 14L PTFE churn splitters for all events. The cone splitters were used to evenly split the original composite samples into subsamples that are theoretically equal in chemical quality and sediment concentration to any other subsample. One of the subsamples from the cone splitter was then poured into the churn splitter to split the sample into analyte-specific containers.

Figure 2.3.5b. Photo of Compositing Samples Using Cone Splitter

2.3.6 Sediment Trap Samples

Two sediment traps were installed at each monitoring location by bolting the stainless steel trap mounting assembly directly to the pipe invert (C1), or wall of the catch basin or diversion structure (R1 and I1, respectively). One PTFE, 1L, wide-mouth sample bottle is placed in each mounting assembly and held in place by a retainer ring. When installed to the pipe invert (C1), the mouth of the bottle was approximately 9-inches above the invert. When the traps were installed in structures with standing water (R1 and I1), the mouths of the bottles were positioned 1-2 inches above the static water level.

Sediment traps were inspected on a monthly basis following installation, checking for damage, blockage or under- or over-accumulation. Inspections were adjusted to an as-needed basis when site characteristics were known. As bottles become partially full with sediment, there is a risk that new sediment will not be effectively captured by the trap. If sediment was observed to be over half full in any of the bottles, they were removed and replaced with new bottles. The removed bottles were archived in a secure refrigerator for processing with the newer bottles at the end of the water year.

Bottles were removed at the end of the water year and replaced with clean bottles for the following water year. The removed bottles, including any archived bottles, were delivered to ARI where laboratory personnel separate the solids and water by centrifuging. The solids from all bottles collected at each location over the water year were composited in the laboratory to form one sample from each monitoring location and then transferred to analyte-specific containers for testing. The priority list in the Permit was used to determine which analytical tests to perform if insufficient sediment quantity was captured to run all tests.

2.3.7 Decontamination Procedures

All water quality sampling equipment and sediment trap bottles - which includes stainless steel beakers, sampler tubing/strainers, sample bottles, and churn/cone splitters - were decontaminated with the following procedure:

1. Wash in a solution of laboratory-grade, non-phosphate soap and tap (city) water.
2. Rinse in tap water.
3. Wash in a 10 percent nitric acid/deionized water solution.*
4. Rinse in deionized water.
5. Wash with 10% methanol/isopropyl alcohol
6. Final rinse in deionized water.

** Nitric wash omitted for stainless steel beakers*

Sampling equipment was decontaminated prior to every use with the exception of sampler tubing. Following the initial wash, sampler tubing was rinsed with deionized water immediately prior to each sampling event and is replaced at the start of each water year.

2.3.8 Sampling and Monitoring Quality Assurance/Quality Control (QA/QC) Procedures

2.3.8.1 Precipitation Monitoring QA/QC Procedures

All raw rainfall data was reviewed by ADS on a monthly basis. Data was reviewed for errors such as periods of no recorded rainfall when nearby rain gages record rain, excessive or unrealistic measured rainfall, periods of non-rain tips due to calibration or other activity and other indicators of inaccurate data. Field maintenance and calibration data sheets were reviewed to inform the data evaluation. Raw rainfall data were edited to remove erroneous or test tips which are recorded on a monthly edit log. Areas of missing data were either filled using transposed data from the nearest working gage or data is replaced with "*". All rain data were flagged with one of the four following qualifiers: 1) "*" - no data, 2) "R" – raw, unedited data, 3) "T" – data transposed from the nearest rain gage with validated data and 4) "V" – validated data (confirmed accurate or made accurate by deletion of erroneous data). Only finalized rain data are presented in this report.

2.3.8.2 Flow Monitoring QA/QC Procedures

Routine flow monitor maintenance visits were performed on a monthly or as-needed based on remote real-time monitor checks or data reviews. Each maintenance visit included visual inspection and cleaning of the sensors, calibration checks and calibration of the level sensor, if necessary. If the actual and measured level values differed more than 0.02 feet, the level sensor was calibrated. If level drift continued after correction, the level sensor was removed and replaced.

Level, flow and velocity data were downloaded on a weekly basis for maintenance purposes and on an as-needed basis around storm events. During each weekly data download, the data were inspected for any significant trends in reliability and/or accuracy (i.e., substantial level jump, spikes, flat-line data or no data). If anomalies were observed, a maintenance team was sent to the monitoring site to test and troubleshoot any issues found.

After each routine monthly maintenance visit, a thorough review of the data was completed for the preceding period between maintenance visits. Because each maintenance visit included an actual measurement of the water level, level data were corrected for level drift if the difference between the actual and measured level was greater than 0.02 ft. The adjusted level data were then used to recalculate the flow using sensed velocity data or the level-flow relationship at each site.

Both raw and edited/finalized flow data are stored in the City's time-series database. Only finalized data are used for calculations and presented in this report.

2.3.8.3 Field QC Sample Collection Procedures

During WY2011, numerous field QC samples were collected to evaluate the sampling operation and to quantify and document bias that can occur in the field. QC samples provide the ability to assess the quality of the data produced by field sampling and a means for quantifying sampling bias.

The following table lists the types of QC samples collected, description of how the QC samples were collected, the purpose and information provided by each sample and the number of samples collected during WY2011.

Table 2.3.8.3. QC Sample Summary

QC Sample Type	Code	Description	Purpose/Info Provided	Number Collected WY2011	Collected on
Field Duplicate Sample	FDS	Simultaneous sample collected at same location as Primary Environmental Sample (PES)	Quantify variability from field sampling activities Quantify variability from laboratory procedures	4	Stormwater grab samples
Field Split Sample	FSS	PES split by field staff	Quantify variability from laboratory procedures	4	Stormwater composite samples
Field Blank Sample	FBS	Blank water passed through decontaminated or new equipment in lab	Tests cleaning procedures or cleanliness of new, disposable equipment in a controlled environment	2	Composite bottle and splitting equipment (churn and cone splitters)
Field Residual Blank	FRB	Blank water passed through equipment after sampling but without decontamination	Quantifies cross-contamination between samples and quantifies contamination from field sampling activities	6	Sampler tubing
Trip Blank	TRB	Sample container filled with blank water by lab that accompanies sample bottles from lab to field and back	Identify sample handling and transport bias Quantify sample cross-contamination	22	Used to accompany NWTPH-G grab samples

The field duplicate samples were collected in the field by lowering two analyte-specific bottles into the stormwater channel and filling simultaneously. The field split samples were generated in the laboratory by field staff by filling two identical analyte-specific containers simultaneously from the churn splitter. Field duplicates and split samples were collected at frequency of approximately 10 percent of the stormwater samples collected.

Excluding the trip blanks, all other field blanks were made by field staff passing reagent grade deionized water over or through new or decontaminated sample equipment and capturing the blank water in analyte-specific bottles. The sampler tubing and stainless steel bailers were not fully decontaminated, but rinsed with deionized water (consistent with Ecology's *Standard Operating Procedure for Automatic Sampling for Stormwater Monitoring – ECY002*, dated September 16, 2009) prior to sample or blank collection.

The trip blanks were generated by the primary environmental laboratory (ARI) by filling 40-milliter (mL) volatile organic analysis (VOA) vials with reagent grade deionized water. The trip blanks accompanied all sample bottles used for Northwest Total Petroleum Hydrocarbon – Gasoline range (NWTPH-G) analyses from the time the empty bottles left the laboratory until the filled bottles were relinquished to the laboratory.

2.3.8.4 Field Audits

During one sampling event per year, the SPU project manager audited the performance of the field sampling staff. Staff were observed prepping automatic sampling equipment prior to the event, collecting the grab sample during the event, retrieving the composite sample at the end of the event and processing the samples at the analytical laboratory. Any deficiencies observed were verbally conveyed for immediate correction and all sampling staff were informed of the corrective action procedures, if needed. If the deficiencies were significant, additional follow-up audits will be performed.

2.4 Analytical QA/QC Procedures, Methods and Reporting Limits

2.4.1 Analytical Data QA/QC Procedures

All laboratory data packages received included a hardcopy report and an electronic data deliverable (EDD). The laboratory case narratives were reviewed with each sample delivery group for quality control issues and corrective action taken. The data were evaluated for required method, reporting limit (RL), package completeness, holding time, blank contamination, accuracy and precision.

Each EDD was imported into a validation and review database, where deviations from the Measurement Quality Objectives (MQOs – in QAPP) were identified and associated samples were qualified accordingly. Qualification details are included in the QA/QC report in Appendix C.1.

2.4.2 Analytical Methods and Reporting Limits

Refer to Appendix C.1 for a list of analytical parameters, methods and reporting limits used for this project and a related discussion.

2.5 Pollutant Load Calculation Procedures

The primary goal of the stormwater characterization monitoring is to gain knowledge of stormwater pollutant loads from areas within the municipality. Specifically, the Permit requires that *"for each stormwater monitoring site calculate the Event Mean Concentrations (EMCs), total annual pollutant load, the seasonal pollutant load, for the wet and dry seasons based on the water year. The loading shall be expressed as pounds and pounds per acre, and must take into account the potential pollutant load from base flow."*

The EMC for each event is the analyte concentration reported by the laboratory as analyzed on the event's composite sample since each composite consists of multiple subsamples (aliquots) representing the runoff of the entire event. The basic concept of a pollutant load calculation is deceptively simple, but it can be problematic to perform and requires several decisions to be made to resolve problems inherent in any load calculation. Due to these problems, most literature referred to this calculation as pollutant load *estimation* and many different methods can be employed to estimate the load using the same data set, resulting in a range of loads calculated from the same data. Below is a summary of load calculation methods to help explain why the City selected methods used in this report.

The load is simply the mass or weight of a pollutant that passes a point in the stormwater sewer system (e.g., a monitoring station) over a specific amount of time. To calculate load, the mass concentration of a pollutant is multiplied by the total volume of water passing the monitoring location over a period (i.e., seasonally or annually). The total flow volume is calculated by aggregating the flow measured by the continuous flow monitoring equipment. Although flow is essentially measured continuously, the pollutant concentration is only measured several times over a period (e.g., 11 times annually from the 11 events sampled) so the concentrations for the majority of the periods when the stormwater is not measured must be estimated using one of several methods.

The total pollutant load, whether seasonal or annual, is the sum of base flow load (where present) and stormwater load. Since the end result of the calculation as specified in the Permit is to determine the stormwater load, the base flow contribution is essential “removed” (or subtracted) from the total load to derive the stormwater load. For the purposes of this analysis, base flow loading is defined as the annual mass of a chemical constituent from non-stormwater sources that passes a point in the stormwater sewer system. These non-stormwater flows can include groundwater and shallow subsurface stormwater flow, or surface flows such as irrigation or springs. A practical measure of the presence of base flow is to review the continuous flow record from each monitoring site to determine if flows do not return to zero during dry periods. Of the City’s three monitoring sites, only the commercial site (C1) has base flow.

Of the five or more estimator methods commonly used for load estimation, SPU used two for this report which are discussed below: 1) the mean method; which is also referred to as “the Ecology method” since it is the method outlined in Ecology’s Standard Operating Procedure (SOP) and 2) the volume-proportional method – which is the method outlined in the City’s QAPP and thus will be referred to as the “QAPP method.” The two methods used by SPU are summarized in Sections 2.5.1 and 2.5.2.

In addition to selecting a method to estimate loads, a method of substituting values for analytes not detected at or above laboratory reporting limits ("non-detects") must also be chosen. Methods for non-detect substitutions used by SPU are discussed in Section 2.5.3

Lastly, the method to remove the base flow load from the total load that SPU used is discussed in Section 2.5.4.

2.5.1 Ecology Method

The method described in Ecology's SOP – which is typically referred to as the mean concentration estimator method - simply averages all EMCs from storms sampled in the period to create one period mean EMC. The period mean EMC is multiplied by total flow volume during that period to calculate period load. This method assumes there is no correlation between stormwater volume and concentration so it weighs all EMCs equally and assumes the resulting mean concentration represents average concentration of stormwater discharged over a period. This method is detailed in the Ecology SOP ECY004 - *Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges*, dated September 16, 2009. This is the method used to calculate the base flow loads in this report since the base flow volume is relatively constant during dry weather sampling events so there is no relationship between measured concentration and volume.

2.5.2 QAPP Method

The method outlined in the City's stormwater characterization QAPP – the volume-weighted method - assumes there is a correlation between concentration and volume of flow. This estimator calculates a volume weighted concentration (VWC) representing the storms sampled in the period (dry season or wet season) and then multiplies the VWC times the storm volume over that period. The VWC is derived by dividing the sum of loads for each sampled event by the sum of flow volumes from each sampled event. The VWC of each period is multiplied by total flow volume during the period to calculate period load. Equations and stepwise procedures for this method are detailed in the City's QAPP. The City selected this method because our literature review indicated it was considered the best overall estimator for stormwater concentrations since it attained smaller biases when compared to other estimator methods. This is the method used in this report to estimate stormwater loads.

2.5.3 Non-Detect Substitution

Most types of environmental monitoring data, including stormwater data, contain analytical results reported as non-detect (ND) at or above the laboratory reporting limit (RL), rather than a specific numerical value. These non-detected values are statistically known as "left-censored" measurements because the actual concentrations are unknown and are assumed to fall within a range between 0 and the RL. Environmental data have been historically reported with inconsistent treatment of non-detects with many, both simple and complex, substitution methods used. Non-detect substitution is required when performing statistical analysis or loading calculations since an actual numerical value is required.

The City's QAPP states the following regarding non-detect substitutions: *In the event an estimated value below the reporting limit is not provided, the value will be estimated at half of the reporting limit.*

Since the QAPP was finalized, several discussions have occurred between the Phase I Permittees and Ecology regarding non-detect substitution with no formal agreement on the best method. With large data sets, complex statistical substitutions have been proven to yield less bias than simple substitutions but no complex substitutions work when sample numbers become small such as for this project where the maximum sample number for a wet season is 7-9 and the dry season is 2-4. To allow for a consistent comparison with other Permittees, the City has elected to expand on the method stated in our QAPP and use three non-detect substitution methods for load. Each non-detect value will be substituted with 0.0, 0.5 and 1.0 times the RL for that analyte. The three different substitutions result in a range of loads for each analyte which we consider more accurate than a single load and demonstrate some of the error that is inherent in load estimation. The range of loads estimated becomes larger as the ratio of non-detects to detected values increases.

If an analyte was non-detect across the entire period's data set, no load will be calculated for that analyte since the load would be based entirely on a theoretical presence of an analyte based on an arbitrary substitution.

2.5.4 Removal of Base Flow Load

Since the Permit requires that the load from stormwater-only is determined; any load from base flow, if present, must be subtracted from the stormwater load. Only the City's commercial monitoring site (C1) has base flow present. A total of four base flow events, two in the wet season and two in the dry season, were sampled during WY2011. The EMCs from each season's events were averaged to calculate a seasonal base flow concentration for each analyte. Each seasonal concentration was multiplied by the average base flow volume recorded for each of the stormwater events sampled during each season to calculate a seasonal base flow load (per the Ecology method). The base flow load was then subtracted from the total pollutant load (which is a combination of stormwater load and base flow load) to estimate the stormwater load.

2.6 Sampling Event Summary

This section presents a summary of events sampled during WY2011. This was the third year collecting stormwater samples under the 2007 Permit and the second complete water year. WY2011 began on October 1, 2010 and ended on September 30, 2011. The City was very successful at collecting all routine storm, base flow and sediment samples required by the Permit with no qualifications.

2.6.1 Precipitation Summary

The table below summarizes precipitation data for each of the three sampling locations for WY2011 based on a review of rain gage data.

Table 2.6.1. Total Precipitation – October 1, 2009 to September 30, 2011

Monitoring Station	R1	C1	I1
Rain Gage	RG07	RG03	RG30
Precipitation (inches)	43.28	40.51	49.04

2.6.2 Stormwater Sampling Summary

The stormwater monitoring frequency required by the Permit is "*sixty-seven percent of the forecasted qualifying storms which result in actual qualifying are required to be sampled, up to a maximum of eleven (11) storm events per water year. Qualifying storm event sampling must be distributed throughout the year, approximately reflecting the distribution of rainfall between wet and dry seasons (with a goal of 60-80% of the samples collected during the wet season and a goal of 20-40% of the sample collected in the dry season).*"

Eleven stormwater events, evenly distributed across the water year, were successfully sampled at each of the three stations. Nine samples were collected during the wet season and two samples were collected from each station during the dry season. The storm hydrologic data for each event, including precipitation, flow and sample information are presented in Table 2.6.2. All criteria for all events were met were met with no exceptions.

Although there are no criteria that state that grab samples must be collected during the same period that a composite sample is collected at a monitoring site, every attempt was made to collect grab samples during composite sample collection time period. During two events during WY2011, field crews were unable to collect the grab samples within the composite sample period so the missing grabs were collected during similar event conditions (i.e., during qualifying storms for missing storm event grabs or during dry periods for missing base flow grabs) at a later date. The missed grab from C1 during storm event SE-20 on March 24-25, 2011 was collected during a storm on March 28, 2011. The missed grab from C1 during the base flow event BF-05 on January 26-27, 2011 was collected during a dry period on February 1, 2011. All other grab samples were collected within the time period of the composite sample.

Annual and event specific flow, rainfall and aliquot information are graphically presented on hydrographs in Appendix C.2. Analytical results from stormwater samples are presented in the *Sampling Results* section of this report.

2.6.3 Base Flow Sampling

Base flow is present at only one of the three monitoring stations – C1. To quantify the chemical concentration in the base flow for the purposes of removing the base flow load from the total load, two wet season and two dry season base flow sampling events were sampled at C1. The base flow was sampled using the samplers to collect a time-proportional composite sample by collecting aliquots at 15 minute intervals over a 24-hour period when no rainfall occurred. Analytical results from base flow events are presented in the *Sampling Results* section of this report.

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Table 2.6.2. Stormwater Characterization Event Hydrologic Summary

Analyte Name	Goal	SE-12	SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22	SE-23	SE-24
Residential Zone (R1)														
Storm Event Start	NA	WY2010	WY2010	08-OCT-2010 22:50	23-OCT-2010 08:55	30-OCT-2010 09:05	17-NOV-2010 08:00	29-NOV-2010 18:00	06-JAN-2011 20:30	12-JAN-2011 05:20	20-JAN-2011 19:35	12-FEB-2011 14:00	14-MAY-2011 18:00	17-SEP-2011 20:15
Storm Event End	NA	WY2010	WY2010	10-OCT-2010 09:45	24-OCT-2010 16:00	31-OCT-2010 04:00	18-NOV-2010 03:20	30-NOV-2010 21:30	07-JAN-2011 23:05	12-JAN-2011 20:00	21-JAN-2011 18:00	12-FEB-2011 19:40	15-MAY-2011 17:10	18-SEP-2011 07:25
Storm Event Duration (hrs)	>1	WY2010	WY2010	34.9	31.1	18.9	19.3	27.1	26.6	14.7	22.4	5.7	23.2	11.2
24-hour Antecedent Rainfall (inches)(a)	<= 0.02(a)	WY2010	WY2010	0	0	0	0	0.02	0.01	0	0	0	NA	NA
72-hour Antecedent Rainfall (inches)(b)	<= 0.02(b)	WY2010	WY2010	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0.01
Storm Event Rainfall (inches)	>= 0.20	WY2010	WY2010	1.21	1.07	0.44	0.35	0.82	0.47	1.12	0.48	0.52	1.38	0.3
Storm Event Rainfall Max (in/hr)	NA	WY2010	WY2010	0.14	0.13	0.07	0.09	0.08	0.07	0.34	0.08	0.19	0.2	0.08
Storm Event Rainfall Mean (in/hr)	NA	WY2010	WY2010	0.03	0.03	0.02	0.02	0.03	0.02	0.07	0.02	0.09	0.06	0.03
Storm Event Runoff Baseflow Volume (cf)	NA	WY2010	WY2010	0	0	0	0	0	0	0	0	0	0	0
Storm Event Total Flow Max (cfs)	NA	WY2010	WY2010	1.41	1.38	0.23	1.27	0.54	0.30	1.35	0.83	1.65	1.69	0.46
Storm Event Total Flow Mean (cfs)	NA	WY2010	WY2010	0.11	0.13	0.04	0.07	0.15	0.05	0.51	0.13	0.50	0.31	0.02
Storm Event Total Flow Volume (cf)	NA	WY2010	WY2010	13281	14879	3004	5045	14745	4935	26883	10478	10249	25530	867
Storm Event Composite Sample Aliquots	>= 10(c)	WY2010	WY2010	30	15	17	14	32	22	48	29	26	46	32
Storm Event Runoff Volume Sampled (%)	>= 75(d)	WY2010	WY2010	96.5	94.4	94.7	90.8	94.8	97.1	96.9	96.8	94.2	94.2	95.9
Commercial Zone (C1)														
Storm Event Start	NA	WY2010	08-OCT-2010 23:00	30-OCT-2010 07:30	17-NOV-2010 08:05	29-NOV-2010 18:00	07-DEC-2010 16:05	12-FEB-2011 14:00	01-MAR-2011 06:40	24-MAR-2011 20:30	01-APR-2011 07:30	25-MAY-2011 10:30	17-SEP-2011 19:00	NS
Storm Event End	NA	WY2010	10-OCT-2010 12:00	31-OCT-2010 07:45	18-NOV-2010 11:00	01-DEC-2010 02:00	08-DEC-2010 12:00	12-FEB-2011 20:00	02-MAR-2011 00:50	25-MAR-2011 09:00	02-APR-2011 10:00	25-MAY-2011 22:45	18-SEP-2011 10:35	NS
Storm Event Duration (hrs)	>1	WY2010	37	24.3	26.9	32	19.9	6	18.2	12.5	26.5	12.3	15.6	NS
24-hour Antecedent Rainfall (inches)(a)	<= 0.02(a)	WY2010	0	0	0.01	0.02	0.02	0	0	0	0	0	NA	NS
72-hour Antecedent Rainfall (inches)(b)	<= 0.02(b)	WY2010	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	NS
Storm Event Rainfall (inches)	>= 0.20	WY2010	1.44	0.43	0.41	0.74	1.1	0.42	0.25	0.22	0.91	0.23	0.32	NS
Storm Event Rainfall Max (in/hr)	NA	WY2010	0.2	0.08	0.25	0.07	0.26	0.16	0.04	0.08	0.11	0.05	0.09	NS
Storm Event Rainfall Mean (in/hr)	NA	WY2010	0.04	0.02	0.02	0.02	0.06	0.07	0.01	0.02	0.03	0.02	0.02	NS
Storm Event Runoff Baseflow Volume (cf)	NA	WY2010	43956	22698	44574	24192	24378	5400	26160	11250	25758	13230	12903	NS
Storm Event Total Flow Max (cfs)	NA	WY2010	35.23	9.80	39.97	5.05	42.50	23.73	3.95	4.35	9.49	7.12	11.72	NS
Storm Event Total Flow Mean (cfs)	NA	WY2010	4.04	2.02	1.95	1.64	4.87	6.31	1.51	0.77	2.06	1.65	1.24	NS
Storm Event Total Flow Volume (cf)	NA	WY2010	538200	176590	189160	188890	349440	136400	98429	34864	196780	72736	69300	NS
Storm Event Composite Sample Aliquots	>= 10(c)	WY2010	56	30	29	77	42	24	27	12	32	21	26	NS
Storm Event Runoff Volume Sampled (%)	>= 75(d)	WY2010	81.7	97.2	96.3	98.1	98.7	95.2	92.4	84.7	90.2	92.1	82.8	NS

Analyte Name	Goal	SE-12	SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22	SE-23	SE-24
Industrial Zone (I1)														
Storm Event Start	NA	08-OCT-2010 23:00	05-NOV-2010 16:05	09-NOV-2010 08:00	29-NOV-2010 18:00	07-DEC-2010 02:05	12-JAN-2011 00:40	20-JAN-2011 20:20	12-FEB-2011 14:50	24-MAR-2011 16:00	14-MAY-2011 18:00	25-MAY-2011 11:55	NS	NS
Storm Event End	NA	10-OCT-2010 06:00	07-NOV-2010 02:35	09-NOV-2010 18:10	01-DEC-2010 02:20	08-DEC-2010 12:00	12-JAN-2011 18:25	21-JAN-2011 22:05	12-FEB-2011 19:30	25-MAR-2011 12:00	15-MAY-2011 15:45	25-MAY-2011 20:55	NS	NS
Storm Event Duration (hrs)	>1	31	34.5	10.2	32.3	33.9	17.8	25.8	4.7	20	21.8	9	NS	NS
24-hour Antecedent Rainfall (inches)(a)	<= 0.02(a)	0	0	0	0.01	0	0	0	0	0.02	NA	NA	NS	NS
72-hour Antecedent Rainfall (inches)(b)	<= 0.02(b)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.02	NS	NS
Storm Event Rainfall (inches)	>= 0.20	1.72	1.05	0.2	0.76	1.22	1.11	0.89	0.55	0.35	1.51	0.33	NS	NS
Storm Event Rainfall Max (in/hr)	NA	0.19	0.13	0.07	0.08	0.36	0.17	0.13	0.23	0.14	0.18	0.12	NS	NS
Storm Event Rainfall Mean (in/hr)	NA	0.06	0.03	0.02	0.02	0.03	0.06	0.03	0.11	0.02	0.07	0.04	NS	NS
Storm Event Runoff Baseflow Volume (cf)	NA	0	0	0	0	0	0	0	0	0	0	0	NS	NS
Storm Event Total Flow Max (cfs)	NA	7.36	6.33	1.68	2.84	12.74	10.23	6.41	10.88	5.14	8.06	3.81	NS	NS
Storm Event Total Flow Mean (cfs)	NA	1.24	0.62	0.20	0.51	0.71	2.87	1.35	2.79	0.41	2.52	0.64	NS	NS
Storm Event Total Flow Volume (cf)	NA	138090	77455	7220	59408	86490	183680	125070	46882	29196	197450	20600	NS	NS
Storm Event Composite Sample Aliquots	>= 10(c)	56	56	14	24	41	51	45	21	32	50	28	NS	NS
Storm Event Runoff Volume Sampled (%)	>= 75(d)	99.5	100/71.6 (e)	88.3	97.5	96.5	97.2	96.9	83.6	95.0	94.7	88.3	NS	NS

Notes:
NA - not applicable
j - did not meet storm criteria goal, conditional use only.
(a) - applies to wet season (Oct 1 to Apr 30)
(b) - applies to dry season (May 1 to Sept 30)
(c) - 10 aliquots is the goal but greater than 7 is acceptable
(d) - if storm exceeds 24 hours, required to sample 75% of the first 24 hours. Percent runoff sampled in first 24 hours displayed. Unless otherwise noted, percent runoff sampled over entire storm shown.
(e) I1, SE-13 - 100% runoff sampled first 24 hrs, 71.6% over entire storm.

NS - Not sampled during WY2010
WY2010 - event sampled during prior water year.

2.6.4 Sediment Sampling

The sediment trap bottles representing WY2011 were deployed on September 30, 2010 during the removal and replacement of the bottles from the previous water year. The traps were inspected monthly for debris or rapid accumulations of sediment. The only noteworthy observation was the rapid accumulation of trash (plastic bags, food wrappers, etc.) and organic debris on the traps in C1, which would often partially or completely cover the mouths of the bottles. Debris was removed during every confined space entry made for flow monitoring maintenance, storm setup and routine sediment trap checks; but debris accumulation will likely be a long-term problem at this site even with frequent site visits.

Bottles at R1 were observed to be approximately half full with sediment on March 30, 2011 so were removed, archived and replaced with new bottles during the visit. The removed bottles were archived in a secured refrigerator and relinquished and combined with the second set of bottles (deployed from March through the end of the water year) to create one annual sediment composite for each site.

Bottles from all three locations were removed and replaced with new bottles on September 30, 2011.

2.7 Sampling Results

The following section discusses results for samples collected during WY2011. All analytical work for the stormwater characterization project was performed by ARI or their subcontractors (Pacific Agricultural Lab and Am Test).

2.7.1 Stormwater Samples

The analytical results for all the stormwater events sampled are summarized in site specific tables on the following pages (refer to Tables 2.7.1a to c).

2.7.2 Base Flow Samples

The main purpose for the collection of base flow samples at C1 was to generate a seasonal average base flow concentration for each analyte to calculate a base flow load. The base flow load is then subtracted from the total load to calculate the stormwater load for that site. Base flow analytical data from C1 is presented in Table 2.7.2.

2.7.3 Sediment Samples

The results of sediment trap samples collected from the three monitoring stations are summarized in Table 2.7.3.

Table 2.7.1a. Stormwater Analytical Summary – Residential Site (R1)

Analyte	Units	SE-14 R1 10/08/2010	SE-15 R1 10/23/2010	SE-16 R1 10/30/2010	SE-17 R1 11/17/2010	SE-18 R1 11/29/2010	SE-19 R1 01/06/2011	SE-20 R1 01/12/2011	SE-21 R1 01/20/2011	SE-22 R1 02/12/2011	SE-23 R1 05/14/2011	SE-24 R1 09/17/2011
Flow-weighted composite - automatic												
Nutrients												
Nitrate + Nitrite	mg-N/L	0.108 J	0.132 J	0.132 J	0.113 J	0.1 J	0.314	0.281	0.223	0.175	0.136	0.655
Nitrogen, Total Kjeldahl	mg-N/L	1 J	0.77 J	0.78 J	1.66 J	0.85 J	0.95 J	1.15 J	0.78 J	4.2 J	1.29 J	2.92 J
Phosphorus, Total	mg-P/L	0.146	0.142	0.232	0.298	0.174	0.142 J	0.19	0.152	0.643	0.12	0.435
Orthophosphate	mg-P/L	0.022	0.013	0.013	0.016	0.017	0.01	0.01	0.008	0.014	0.009	0.132
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate	ug/L	1 U	2.6	1 U	1 U	3.5	1.6	1.6	2.4	5.1	1 U	1 U
Butylbenzylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Diethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dimethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Di-n-Butylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Di-n-Octyl phthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1-Methylnaphthalene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
2-Methylnaphthalene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Acenaphthene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Acenaphthylene	ug/L	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(a)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(a)pyrene	ug/L	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(g,h,i)perylene	ug/L	0.11	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 UJ
Benzofluoranthenes, Total	ug/L	0.16	0.11	0.1 U	0.1 U	0.1 U	0.1 U	0.14	0.1 U	0.12	0.1 U	0.1 U
Chlorpyrifos	ug/L	0.2 U	0.21 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chrysene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.12	0.1 U	0.1 U	0.1 U	0.1 U
Diazinon	ug/L	0.2 U	0.21 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Dibenz(a,h)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dibenzofuran	ug/L	0.13	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dichlobenil	ug/L	0.024 UJ	0.024 U	0.34	0.024 UJ	0.024 U	0.16	0.27	0.13	0.03	0.025	1.1
Fluoranthene	ug/L	0.12	0.1 U	0.1 U	0.11	0.1 U	0.15	0.16	0.1 U	0.1 U	0.1 U	0.1 UJ
Fluorene	ug/L	0.11 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Indeno(1,2,3-cd)pyrene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Malathion	ug/L	0.2 U	0.21 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4 U
Naphthalene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Pentachlorophenol	ug/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Phenanthrene	ug/L	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Prometon	ug/L	0.56	0.024 U	0.026	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U
Pyrene	ug/L	0.1	0.1 U	0.1 U	0.12	0.1 U	0.11	0.15	0.1 U	0.1 U	0.1 U	0.1 U

		SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22	SE-23	SE-24
		R1	R1	R1	R1	R1	R1	R1	R1	R1	R1	R1
Analyte	Units	10/08/2010	10/23/2010	10/30/2010	11/17/2010	11/29/2010	01/06/2011	01/12/2011	01/20/2011	02/12/2011	05/14/2011	09/17/2011
Metals												
Cadmium, Total	ug/L	0.2 U	0.2 U	0.2 U	0.2	0.2 U	0.2 U	0.2 U	0.2 U	0.3	0.1	0.3
Cadmium, Dissolved	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U
Copper, Total	ug/L	11.5	9.3	9.7	21.8	13.4	14.6	16.5	12.3	30.2	11.6	35
Copper, Dissolved	ug/L	4.9	3	4.8	4.4	4.3	4.8	2.8	2.8	3.5	4.3	25.7
Lead, Total	ug/L	12	11	9	27	15	16	22	15	42	13.3	21.7
Lead, Dissolved	ug/L	1 U	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	0.4	2.6
Zinc, Total	ug/L	39	37	35	71	51	52	86	44	97	31	63
Zinc, Dissolved	ug/L	11	12	15	14	17	16	34	13	11	11	32
Hardness	mg/L CaCO3	12	9.7	12	18	14	16	26	13	23	10	26
Miscellaneous Organics												
2,4-D	ug/L	1 U	1 U	1 U	1 U	1 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 U	3
MCPP	ug/L	250 U	250 U	250 U	250 U	250 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 U	1.4
Triclopyr	ug/L	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.25 J	0.08 U	0.08 U	0.08 U
Conventionals												
Conductivity	umho/cm	26.9	22	26.1	19.3	183	52.2	1060	36	30.9	24.1	85.7
pH	std units	6.56	6.71	7.31	6.22	6.62	6.76	6.57	6.88	7.22	6.43	7.2
Solids, Total Suspended	mg/L	39.7	42.9	29.5	108	57	38.5	84.2	47.4	163	36.4	67.9
Turbidity	NTU	24	18	20	52.1	62	52	30	43.8	102	24	38
Chloride	mg/L	0.6	1.2	0.7	2.1	42.4	5.7	349	2.9	2.6	1.2	7.8
Biochemical Oxygen Demand	mg/L	3.6	2.5	2.9	5.4	2.8	2.4	2.1	1.9	3.5	3.9	17.6
Surfactants	mg/L	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.038	0.025 U	0.035
Grab - manual												
Petroleum Hydrocarbons												
Diesel Range Hydrocarbons	mg/L	0.22	0.24	0.24 J	0.39	0.27	0.32	0.14	0.14	0.19	0.21	1.2
Gasoline Range Hydrocarbons	mg/L	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Motor Oil	mg/L	0.46	0.67	0.48	2.5 J	1.1	1.5	0.98	0.66	1.2	0.36	1.4
Bacteria												
Fecal Coliform	CFU/100 mL	2660	1780	3200	1080 J	900	250	53	91	490	6	3200

Notes:
U - Analyte was not detected above the reported result.
J- Analyte was positively identified. The reported result is an estimate.
UJ- Analyte was not detected above the reported estimate.

Table 2.7.1b. Stormwater Analytical Summary – Commercial Site (C1)

		SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22	SE-23
		C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1
Analyte	Units	10/08/2010	10/30/2010	11/17/2010	11/29/2010	12/07/2010	02/12/2011	03/01/2011	03/24/2011*	04/01/2011	05/25/2011	09/17/2011
Flow-proportional composite - automatic												
Nutrients												
Nitrate + Nitrite	mg-N/L	0.067 J	0.209	0.208	0.175 J	0.087 J	0.219	0.427	1.08	0.174	0.463	0.969
Nitrogen, Total Kjeldahl	mg-N/L	1.69 J	1.23 J	1.93 J	1.62 J	2.75 J	25	1.53 J	1.08 J	1.14 J	2.27 J	4.54 J
Phosphorus, Total	mg-P/L	0.254	0.26	0.292	0.31	0.352	0.26	0.26	0.226	0.165	0.256	0.698
Orthophosphate	mg-P/L	0.03	0.044	0.042	0.028	0.024	0.027	0.027	0.064	0.016	0.005	0.275
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate	ug/L	4.3	2.6	3.3	5.1 J	4.9	6.4	6.6	1.6	5.3	1.7	6.2
Butylbenzylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Diethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dimethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.8
Di-n-Butylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Di-n-Octyl phthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1-Methylnaphthalene	ug/L	0.17	0.1 U	0.15 U	0.1 U	0.1 UJ	0.1 U	0.55	1.6	0.1	0.1 UJ	0.1 U
2-Methylnaphthalene	ug/L	0.13	0.1 U	0.1 U	0.15	0.1 U	0.1 U	1.1	2.5	0.18	0.1 UJ	0.1 U
Acenaphthene	ug/L	0.19	0.14 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Acenaphthylene	ug/L	0.18 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Anthracene	ug/L	0.15	0.1 U	0.1 U	0.1 U	0.2	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Benzo(a)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.27	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(a)pyrene	ug/L	0.12 J	0.1 U	0.1 U	0.1 U	0.24	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(g,h,i)perylene	ug/L	0.17	0.1 U	0.12	0.1 U	0.3 J	0.1 UJ	0.1 U	0.1 U	0.11	0.1 UJ	0.1 UJ
Benzofluoranthenes, Total	ug/L	0.28	0.1 U	0.37	0.1 U	0.62	0.11	0.1	0.1 U	0.18	0.1 U	0.14
Chlorpyrifos	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chrysene	ug/L	0.11	0.1 U	0.14 J	0.1 U	0.28	0.1 U	0.1 U	0.1 U	0.17	0.1 U	0.1 U
Diazinon	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Dibenz(a,h)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.21	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dibenzofuran	ug/L	0.33	0.1 U	0.1 U	0.1 U	0.11	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Dichlobenil	ug/L	0.024 UJ	0.024 U	0.024 UJ	0.025 U	0.024 U	0.025 U	0.024 U	0.026	0.024 U	0.032	0.037
Fluoranthene	ug/L	0.27	0.13	0.23	0.1	0.59	0.1	0.15	0.1 U	0.24	0.1 U	0.18 J
Fluorene	ug/L	0.3	0.1 U	0.1 U	0.1 U	0.14	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Indeno(1,2,3-cd)pyrene	ug/L	0.11	0.1 U	0.1 U	0.1 U	0.24 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 UJ
Malathion	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4 U	0.4 U
Naphthalene	ug/L	0.15	0.1 U	0.1 U	0.31	0.1 UJ	0.1 U	0.95	2.2	0.15	0.16 J	0.1 U
Pentachlorophenol	ug/L	0.5 U	0.5 U	0.5 U	0.5 U	0.63	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Phenanthrene	ug/L	0.23	0.11	0.13	0.1 U	0.36	0.1 U	0.15	0.1 U	0.13	0.1 U	0.14
Prometon	ug/L	0.024 U	0.024 U	0.024 U	0.025 U	0.024 U	0.025 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U
Pyrene	ug/L	0.1 U	0.13	0.26	0.16	0.52 J	0.1	0.14	0.1 U	0.3	0.1 U	0.18

		SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22	SE-23
		C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1
Analyte	Units	10/08/2010	10/30/2010	11/17/2010	11/29/2010	12/07/2010	02/12/2011	03/01/2011	03/24/2011*	04/01/2011	05/25/2011	09/17/2011
Metals												
Cadmium, Total	ug/L	0.2	0.2 U	0.2	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.4
Cadmium, Dissolved	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U
Copper, Total	ug/L	34.2	23	41.3	59.6	61.8	42.8	70.6	36.1	32.4	55.3	74.7
Copper, Dissolved	ug/L	11.6	8	10.5	17	7.9	7.2	20.2	20.1	8.7	22.7	40.1
Lead, Total	ug/L	16	10	20	21	44	33	23	13.7	16.9	15.6	21.3
Lead, Dissolved	ug/L	1 U	1	1	1	1 U	1 U	1 U	0.9	0.7	1.3	2
Mercury, Total	ug/L	0.0234	0.02 U	0.0221	0.02 U	0.0362	0.0299	0.02 U	0.02 U	0.02 U	0.0281	0.0452
Mercury, Dissolved	ug/L	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Zinc, Total	ug/L	111	93	145	142	204	170	153	120	101	196	270
Zinc, Dissolved	ug/L	38	40	49	37	25	28	29	55	26	97	109
Hardness	mg/L CaCO3	21	29	35	31	31	33	54	68	26	44	69
Miscellaneous Organics												
2,4-D	ug/L	1 U	1 U	1 U	1 U	1 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
MCPP	ug/L	250 U	250 U	250 U	250 U	250 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
Triclopyr	ug/L	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
Conventionals												
Conductivity	umho/cm	55.1	70.9	81.8	191	95.1	63.4	227	180	56.1	104	173
pH	std units	6.67	7.12	6.77	6.92	7.23	7.13	8.26	7.19	7.22	7.16	7.1
Solids, Total Suspended	mg/L	56	38.4	77.3	92.4	182	146	78	54.4	61.6	57.2	105
Turbidity	NTU	11.8	20	37.6	82.5	42.9	44	86.6	22	19	40	30
Chloride	mg/L	1.4	2.2	4.3	33.8	13.7	4.3	34	9.7	1.5	4	8.2
Biochemical Oxygen Demand	mg/L	11.1	7.2	16	7.5	9.4	8.2	12 U	15.1	5	13.4	53.4
Surfactants	mg/L	0.025 U	0.025 U	0.025 U	0.025 U	0.24	0.058	0.12	0.13	0.046	0.025 U	0.079
Grab - manual												
Petroleum Hydrocarbons												
Diesel Range Hydrocarbons	mg/L	0.65	0.36 J	0.93	0.21	0.47	0.19	0.79	0.31	0.43	2.1	2.7
Gasoline Range Hydrocarbons	mg/L	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Motor Oil	mg/L	1.6	0.98	3.3	0.83	1.8	1	3.1	1.2	1.8	2.3	3.8
Bacteria												
Fecal Coliform	CFU/100 mL	4000	6600	2960	2400	2040	430	1730	2600	4910	4200	40300

Notes:
U - Analyte was not detected above the reported result.
J- Analyte was positively identified. The reported result is an estimate.
UJ- Analyte was not detected above the reported estimate.
* - The grab sample for the 3/24/2011 event was not collected during the composite period, but collected on 3/28/2011 at 22:00.

Table 2.7.1c. Stormwater Analytical Summary – Industrial Site (I1)

		SE-12	SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22
		I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1
Analyte	Units	10/08/2010	11/05/2010	11/09/2010	11/29/2010	12/07/2010	01/12/2011	01/20/2011	02/12/2011	03/24/2011	05/14/2011	05/25/2011
Flow-weighted composite - automatic												
Nutrients												
Nitrate + Nitrite	mg-N/L	0.135 J	0.418	0.436	0.212	0.21	0.332	0.3	0.258	0.425	0.26	0.334
Nitrogen, Total Kjeldahl	mg-N/L	0.58 J	0.65 J	0.56 J	0.96 J	3.23 J	1.07 J	0.91 J	1.65 J	0.85 J	1.58 J	1.09 J
Phosphorus, Total	mg-P/L	0.156	0.162	0.112	0.288	0.632	0.224	0.278	0.428	0.117	0.19	0.128
Orthophosphate	mg-P/L	0.07	0.108	0.027	0.117	0.079	0.074	0.083	0.02	0.01	0.07	0.007
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate	ug/L	1.8	1.6	1.6	3.2	3.6	1.4	1.2	11	1 U	2.8	1.3
Butylbenzylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Diethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dimethylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Di-n-Butylphthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Di-n-Octyl phthalate	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1-Methylnaphthalene	ug/L	0.1 U	0.15	0.1 U	0.1 U	0.1 J	0.91	0.1 U	0.1 U	0.18	0.1 U	0.1 UJ
2-Methylnaphthalene	ug/L	0.1 U	0.15	0.1 U	0.11	0.1 U	1.9	0.1 U	0.1 U	0.27	0.1 U	0.1 UJ
Acenaphthene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Acenaphthylene	ug/L	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Anthracene	ug/L	0.1 U	0.1 UJ	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Benzo(a)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.12	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(a)pyrene	ug/L	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U	0.24	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(g,h,i)perylene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.18 J	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 UJ
Benzofluoranthenes, Total	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.35	0.11	0.1 U	0.17	0.1 U	0.1 U	0.1 U
Chlorpyrifos	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chrysene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.21	0.1 U	0.1 U	0.13	0.1 U	0.1 U	0.1 U
Diazinon	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Dibenz(a,h)anthracene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dibenzofuran	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Dichlobenil	ug/L	0.033 J	0.043 J	0.044 J	0.024	0.024 U	0.024 U	0.024 U	0.077	0.024 U	0.031	0.04
Fluoranthene	ug/L	0.1 U	0.1 U	0.11	0.1 U	0.37	0.13	0.1 U	0.24	0.1 U	0.1 U	0.1 U
Fluorene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Indeno(1,2,3-cd)pyrene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.13 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
Malathion	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4 U
Naphthalene	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.11 J	2.1	0.1 U	0.1 U	0.18	0.1 U	0.1 UJ
Pentachlorophenol	ug/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Phenanthrene	ug/L	0.1 U	0.1 U	0.1 U	0.1	0.23	0.13	0.1 U	0.13	0.1 U	0.1 U	0.1 U

		SE-12	SE-13	SE-14	SE-15	SE-16	SE-17	SE-18	SE-19	SE-20	SE-21	SE-22
		I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1
Analyte	Units	10/08/2010	11/05/2010	11/09/2010	11/29/2010	12/07/2010	01/12/2011	01/20/2011	02/12/2011	03/24/2011	05/14/2011	05/25/2011
Prometon	ug/L	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.025 U	0.024 U
Pyrene	ug/L	0.1 U	0.14	0.11	0.1	0.41 J	0.11	0.1 U	0.21	0.1 U	0.1 U	0.1 U
Metals												
Cadmium, Total	ug/L	0.2 U	0.2 U	0.2 U	0.2	0.7	0.2 U	0.2 U	0.3	0.1	0.1	0.2
Cadmium, Dissolved	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
Copper, Total	ug/L	11.1	11	16	18.2	54.4	15.2	13	28.5	11.2	10.2	18.1
Copper, Dissolved	ug/L	5.1	5	8.1	5.2	3.6	4.1	3.7	4.1	4.7	4.6	7.8
Lead, Total	ug/L	4	4	4	8	36	6	5	14	4.5	3.3	4.8
Lead, Dissolved	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2	0.2	0.4
Mercury, Total	ug/L	0.02 U	0.02 U	0.02 U	0.02 U	0.0466	0.02 U	0.02 U	0.0219	0.02 U	0.02 U	0.02 U
Mercury, Dissolved	ug/L	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Zinc, Total	ug/L	84	106	118	147	330	94	99	186	95	71	125
Zinc, Dissolved	ug/L	44	61	77	47	12	32	40	34	57	34	66
Hardness	mg/L CaCO3	27	50	93	54	80 J	58	72	89	1300	54	91
Miscellaneous Organics												
2,4-D	ug/L	1 U	1 U	1 U	1 U	1 U	0.08 U	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 U
MCPP	ug/L	250 U	250 U	250 U	250 U	250 U	0.08 U	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 U
Triclopyr	ug/L	0.08 UJ	0.08 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 UJ	0.51	0.32	0.08 U	0.59
Conventionals												
Conductivity	umho/cm	70.7	116	201	140	120	144	158	180	285	125	198
pH	std units	7.18	7.32	7.23	7.35	7.57	7.21	7.46	7.5	7.46	7.26	7.19
Solids, Total Suspended	mg/L	28.8	25.7	20.6	62.8	455	63.2	63.7	162	25.2	38	24.4
Turbidity	NTU	14.4	24	21	60	175	38 J	46.2	87.5	24	30	25
Chloride	mg/L	1.1	2	3.4	9.3	5.2	11.1	4.6	5.1	10.6	2.8	4.9
Biochemical Oxygen Demand	mg/L	3.6	2.9	3.5	3.6	7.7	2 U	2.3	6.9	5.8	3	4.6
Surfactants	mg/L	0.025 U	0.025 U	0.025 U	0.025 U	0.051	0.025 U	0.025 U	0.025 U	0.18	0.058	0.025 U
Grab - manual												
Petroleum Hydrocarbons												
Diesel Range Hydrocarbons	mg/L	0.91	0.41	0.64	0.91	0.85	0.15	0.75	0.52	0.27 J	0.23	1.2
Gasoline Range Hydrocarbons	mg/L	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Motor Oil	mg/L	2.5	0.87	2	1.5	1.7	0.74	2.7	1.3	0.89	0.34	1.9
Bacteria												
Fecal Coliform	CFU/100 mL	1480	2800	740	580	400	160	164	2	106	1700	1180

Notes:
U - Analyte was not detected above the reported result.
J- Analyte was positively identified. The reported result is an estimate.
UJ- Analyte was not detected above the reported estimate.

Table 2.7.2. Base Flow Analytical Summary – Commercial Site (C1)

		BF-05		BF-06		BF-07		BF-08	
		C1		C1		C1		C1	
Analyte	Units	01/26/2011*		02/09/2011		06/21/2011		08/01/2011	
Time-proportional composite - automatic									
Nutrients									
Nitrate + Nitrite	mg-N/L	2.17		2.47		2.02		1.63	
Nitrogen, Total Kjeldahl	mg-N/L	0.96	J	0.57	J	1.46	J	1.08	J
Phosphorus, Total	mg-P/L	0.122		0.134		0.258		0.304	
Orthophosphate	mg-P/L	0.079		0.102		0.096		0.218	
Semivolatile Organics									
bis(2-Ethylhexyl)phthalate	ug/L	1	U	1.9		2	U	1.2	
Butylbenzylphthalate	ug/L	1	U	1	U	1	U	1	U
Diethylphthalate	ug/L	1	U	1	U	1	U	1	U
Dimethylphthalate	ug/L	1	U	1	U	1	U	1	U
Di-n-Butylphthalate	ug/L	1	U	1	U	1	U	1	U
Di-n-Octyl phthalate	ug/L	1	U	1	U	1	U	1	U
1-Methylnaphthalene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
2-Methylnaphthalene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Acenaphthene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Acenaphthylene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Anthracene	ug/L	0.1	U	0.1	U	0.1	U	0.1	UJ
Benzo(a)anthracene	ug/L	0.11	UJ	0.1	U	0.1	U	0.1	UJ
Benzo(a)pyrene	ug/L	0.1	U	0.1	U	0.1	U	0.1	UJ
Benzo(g,h,i)perylene	ug/L	0.1	U	0.1	UJ	0.1	U	0.1	UJ
Benzofluoranthenes, Total	ug/L	0.21		0.1	U	0.11		0.1	U
Chlorpyrifos	ug/L	0.2	U	0.2	U	0.2	U	0.2	U
Chrysene	ug/L	0.12	J	0.1	U	0.1	U	0.1	U
Diazinon	ug/L	0.2	U	0.2	U	0.2	U	0.2	U
Dibenz(a,h)anthracene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Dibenzofuran	ug/L	0.1	U	0.1	U	0.1	U	0.1	UJ
Dichlobenil	ug/L	0.024	U	0.024	U	0.024	U	0.024	U
Fluoranthene	ug/L	0.1	UJ	0.1	U	0.19		0.1	UJ
Fluorene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Indeno(1,2,3-cd)pyrene	ug/L	0.1	U	0.1	U	0.1	U	0.1	UJ
Malathion	ug/L	0.2	U	0.2	U	0.4	U	0.4	U
Naphthalene	ug/L	0.1	U	0.1	U	0.1	U	0.1	U
Pentachlorophenol	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
Phenanthrene	ug/L	0.1	UJ	0.1	U	0.1	U	0.1	UJ

Analyte	Units	BF-05		BF-06		BF-07		BF-08	
		C1		C1		C1		C1	
		01/26/2011*		02/09/2011		06/21/2011		08/01/2011	
Prometon	ug/L	0.024	U	0.024	U	0.024	U	NM	
Pyrene	ug/L	0.1	U	0.1	U	0.14		0.1	U
Metals									
Cadmium, Total	ug/L	0.2	U	0.2	U	0.1		0.1	U
Cadmium, Dissolved	ug/L	0.2	U	0.2	U	0.1	U	0.1	U
Copper, Total	ug/L	7.1		5		11.1		10.7	
Copper, Dissolved	ug/L	4.2		4.1		6.1		8.1	
Lead, Total	ug/L	2		1	U	4.2		1.6	
Lead, Dissolved	ug/L	1	U	1	U	0.5		0.2	
Mercury, Total	ug/L	0.02	U	0.02	U	0.02	U	0.02	U
Mercury, Dissolved	ug/L	0.02	U	0.02	U	0.02	U	0.02	U
Zinc, Total	ug/L	39		29		76		31	
Zinc, Dissolved	ug/L	28		25		47		20	
Hardness	mg/L CaCO3	130		130		170		160	
Miscellaneous Organics									
2,4-D	ug/L	0.08	UJ	0.08	U	0.08	U	0.08	U
MCPP	ug/L	0.08	UJ	0.08	U	0.08	U	0.08	U
Triclopyr	ug/L	0.08	UJ	0.08	U	0.08	U	0.08	U
Conventionals									
Conductivity	umho/cm	343		367		394		408	
pH	std units	8.06		8		7.38		8.18	
Solids, Total Suspended	mg/L	6.8		2.4		13.9		5.6	
Turbidity	NTU	3.7		2.6		6.8		2.9	
Chloride	mg/L	18.8		17.1		15.7		11.8	
Biochemical Oxygen Demand	mg/L	434		3.6		4.1		1.4	J
Surfactants	mg/L	0.025	U	0.08		0.025	U	0.025	U
Grab - manual									
Petroleum Hydrocarbons									
Diesel Range Hydrocarbons	mg/L	0.1	U	0.1	U	0.1	U	0.1	
Gasoline Range Hydrocarbons	mg/L	0.25	U	0.25	U	0.25	U	0.25	U
Motor Oil	mg/L	0.2	U	0.2	U	0.2	U	0.2	U
Bacteria									
Fecal Coliform	CFU/100 mL	15000		216		1450		108	

Notes:
U - Analyte was not detected above the reported result.
J- Analyte was positively identified. The reported result is an estimate.
UJ- Analyte was not detected above the reported estimate.
NM – Not measured. The lab mistakenly did not analyze the sample for Prometon.
* - The grab sample for the 1/26/2011 event was not collected during the composite period but collected on 2/1/2011 at 14:15.

Table 2.7.3. Sediment Analytical Summary (all sites)

		R1		C1		I1	
Analyte	Units	09/30/2011		09/30/2011		09/30/2011	
Semivolatile Organics							
Chlorpyrifos	ug/kg	160	U	280	U	140	U
2,4,5-Trichlorophenol	ug/kg	10	UJ	10	UJ	10	UJ
Chrysene	ug/kg	260		840		220	
2,4,6-Trichlorophenol	ug/kg	10	UJ	10	UJ	10	UJ
Diazinon	ug/kg	160	U	280	U	140	U
2,4-Dichlorophenol	ug/kg	10	UJ	10	UJ	10	UJ
Dibenz(a,h)anthracene	ug/kg	79		240		54	
2,4-Dimethylphenol	ug/kg	10	UJ	10.9	J	10	UJ
Dibenzofuran	ug/kg	29	U	59	U	34	U
2,4-Dinitrophenol	ug/kg	10	UJ	10	UJ	10	UJ
Fluoranthene	ug/kg	670		2100		430	
2-Chlorophenol	ug/kg	10	UJ	10	UJ	10	UJ
Fluorene	ug/kg	29	U	110		34	U
2-Methylphenol	ug/kg	39.3	J	14.1	J	10	UJ
Indeno(1,2,3-cd)pyrene	ug/kg	160		400		130	
2-Nitrophenol	ug/kg	10	UJ	10	UJ	10	UJ
Malathion	ug/kg	210	U	360	U	180	U
4,6-Dinitro-2-Methylphenol	ug/kg	10	UJ	10	UJ	10	UJ
Naphthalene	ug/kg	29	U	59	U	34	U
Phenanthrene	ug/kg	310		950		190	
4-Chloro-3-methylphenol	ug/kg	10	UJ	10	UJ	10	UJ
Pyrene	ug/kg	430		1300		370	
4-Methylphenol	ug/kg	1560	J	169	J	22.5	J
4-Nitrophenol	ug/kg	10	UJ	10	UJ	10	UJ
bis(2-Ethylhexyl)phthalate	ug/kg	800	J	15000	J	6100	J
Butylbenzylphthalate	ug/kg	56	U	740		96	
Diethylphthalate	ug/kg	140	U	390	U	150	U
Dimethylphthalate	ug/kg	56	U	160	U	60	U
Di-n-Butylphthalate	ug/kg	56	U	200	U	60	U
Di-n-Octyl phthalate	ug/kg	56	U	530		2800	
Pentachlorophenol	ug/kg	25.7	J	13.5	J	10	UJ
Phenol	ug/kg	636	J	22.8	J	10	UJ
1-Methylnaphthalene	ug/kg	29	U	59	U	34	U
2-Methylnaphthalene	ug/kg	29	J	110	J	34	U

		R1		C1		I1	
Analyte	Units	09/30/2011		09/30/2011		09/30/2011	
Acenaphthene	ug/kg	29	U	59	U	34	U
Acenaphthylene	ug/kg	29	U	59	U	34	U
Anthracene	ug/kg	35		140		44	
Benzo(a)anthracene	ug/kg	210		620		150	
Benzo(a)pyrene	ug/kg	220		720		200	
Benzo(g,h,i)perylene	ug/kg	180		540		190	
PCBs							
Aroclor 1016	ug/kg	NR		32	U	32	U
Aroclor 1242	ug/kg	NR		32	U	32	U
Aroclor 1248	ug/kg	NR		32	U	32	U
Aroclor 1254	ug/kg	NR		62		41	
Aroclor 1260	ug/kg	NR		32	U	48	U
Aroclor 1221	ug/kg	NR		32	U	32	U
Aroclor 1232	ug/kg	NR		32	U	32	U
Metals							
Cadmium, Total	mg/kg	0.639		1.33		1.09	
Copper, Total	mg/kg	45.6		157		97.3	
Lead, Total	mg/kg	97.1		120		69.9	
Mercury, Total	mg/kg	NR		0.21		0.12	
Zinc, Total	mg/kg	213		765		764	
Conventionals							
Solids, Total	%	55.2	J	52.5	J	45.1	J
Total Organic Carbon	%	8.15		8.18		8.73	
Misc.							
Gravel	%	15.2		3.6		0.2	
Very Coarse Sand	%	18.4		5.3		2	
Coarse Sand	%	19.3		10.1		2.5	
Fine Sand	%	10		15.8		1.9	
Medium Sand	%	19.3		14.9		2.4	
Very Fine Sand	%	4.7		11.1		2.1	
Coarse Silt	%	2		16.7		9.1	
Medium Silt	%	3.4		8.1		20.1	
Fine Silt	%	2.5		4.6		22.1	
Very Fine Silt	%	1.9		3.2		16.5	
9-10 Phi Clay	%	0.7		1.2		4.4	
8-9 Phi Clay	%	1.2		1.8		9.1	
>10 Phi Clay	%	1.4		3.6		7.7	
Total Fines	%	13.1		39.2		89	

Notes:
U - Analyte was not detected above the reported result.
J- Analyte was positively identified. The reported result is an estimate**.**
UJ- Analyte was not detected above the reported estimate.
NR – Not required. PCB and mercury analysis are not required at the residential site.

2.8 Stormwater Sample Statistics

Summary statistics for stormwater sample data from WY2011 for each of the three monitoring locations are displayed in Tables 2.8a-c. The substitution factor for non-detects is 0.5 time the reporting limit.

2.9 Annual Load Estimation Results

As discussed previously, the City will estimate annual load using three non-detect substitution methods. Each non-detect value will be substituted with 0.0, 0.5 and 1.0 times the RL.

If an analyte contained no non-detectable results throughout the entire data set at each monitoring site, then the substitution factor is not applicable which means the estimated load will be the same using each of the three substitution methods. If an analyte was non-detect across the entire period's data set, no load will be calculated for that analyte since the load would be based entirely on a theoretical presence of an analyte based on an arbitrary substitution. Thus, the non-detect substitution only applies to analytes which contain a mix of detects and non-detects.

No load is estimated for fecal coliform, hardness, conductivity, pH or turbidity since these analytes are not reported as concentration per volume so these values cannot be converted into pounds per acre.

Table 2.8a. WY2011 Summary Statistics – Residential Site (R1) Stormwater

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
Petroleum Hydrocarbons													
TPH-D	mg/L	11	11	0.14	0.324	1.2	0.3	0.09	0.14	0.2	0.24	0.295	0.795
TPH-G	mg/L	11	0	0.13	0.125	0.125	0	0	0.125	0.125	0.125	0.125	0.125
Motor Oil	mg/L	11	11	0.36	1.028	2.5	0.624	0.39	0.41	0.57	0.98	1.3	2
Bacteria													
Fecal Coliform	CFU/100 mL	11	11	6	453 (a)	3200	1262	2E+06	29.5	170.5	900	2220	3200
Nutrients													
Nitrate + Nitrite	mg-N/L	11	11	0.1	0.215	0.655	0.163	0.026	0.104	0.123	0.136	0.252	0.4845
TKN	mg-N/L	11	11	0.77	1.486	4.2	1.097	1.204	0.775	0.815	1	1.475	3.56
Orthophosphate	mg-P/L	11	11	0.01	0.024	0.132	0.036	0.001	0.0085	0.01	0.013	0.017	0.077
Phosphorus, Total	mg-P/L	11	11	0.12	0.243	0.643	0.161	0.026	0.131	0.144	0.174	0.265	0.539
Semivolatile Organics													
1-Methylnaphthalene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
2-Methylnaphthalene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Acenaphthene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Acenaphthylene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Anthracene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Benzo(a)anthracene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Benzo(a)pyrene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Benzo(g,h,i)perylene	ug/L	11	1	0.05	0.055	0.11	0.018	3E-04	0.05	0.05	0.05	0.05	0.08
Benzofluoranthenes, Total	ug/L	11	4	0.05	0.08	0.16	0.043	0.002	0.05	0.05	0.05	0.115	0.15
Butylbenzylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Chlorpyrifos	ug/L	11	0	0.1	0.1	0.105	0.002	2E-06	0.1	0.1	0.1	0.1	0.1025
Chrysene	ug/L	11	1	0.05	0.056	0.12	0.021	4E-04	0.05	0.05	0.05	0.05	0.085
Di-n-Butylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Di-n-Octyl phthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Diazinon	ug/L	11	0	0.1	0.1	0.105	0.002	2E-06	0.1	0.1	0.1	0.1	0.1025
Dibenz(a,h)anthracene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Dibenzofuran	ug/L	11	1	0.05	0.057	0.13	0.024	6E-04	0.05	0.05	0.05	0.05	0.09
Dichlobenil	ug/L	11	7	0.01	0.191	1.1	0.323	0.104	0.012	0.012	0.03	0.215	0.72
Diethylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Dimethylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Fluoranthene	ug/L	11	4	0.05	0.081	0.16	0.045	0.002	0.05	0.05	0.05	0.115	0.155
Fluorene	ug/L	11	1	0.05	0.055	0.11	0.018	3E-04	0.05	0.05	0.05	0.05	0.08
Indeno(1,2,3-cd)pyrene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Malathion	ug/L	11	0	0.1	0.11	0.2	0.03	9E-04	0.1	0.1	0.1	0.1	0.1525
Naphthalene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Pentachlorophenol	ug/L	11	0	0.25	0.25	0.25	0	0	0.25	0.25	0.25	0.25	0.25
Phenanthrene	ug/L	11	1	0.05	0.055	0.1	0.015	2E-04	0.05	0.05	0.05	0.05	0.075
Prometon	ug/L	11	2	0.01	0.063	0.56	0.165	0.027	0.012	0.012	0.012	0.012	0.293
Pyrene	ug/L	11	4	0.05	0.075	0.15	0.037	0.001	0.05	0.05	0.05	0.105	0.135
bis(2-Ethylhexyl) phthalate	ug/L	11	6	0.5	1.755	5.1	1.526	2.329	0.5	0.5	1.6	2.5	4.3
Metals													
Cadmium, Dissolved	ug/L	11	0	0.05	0.091	0.1	0.02	4E-04	0.05	0.1	0.1	0.1	0.1
Cadmium, Total	ug/L	11	4	0.1	0.145	0.3	0.082	0.007	0.1	0.1	0.1	0.15	0.3
Copper, Dissolved	ug/L	11	11	2.8	5.936	25.7	6.605	43.62	2.8	3.25	4.3	4.8	15.3
Copper, Total	ug/L	11	11	9.3	16.9	35	8.569	73.42	9.5	11.55	13.4	19.15	32.6

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
Hardness	mg/L CaCO3	11	11	9.7	16.34	26	6.103	37.25	9.85	12	14	20.5	26
Lead, Dissolved	ug/L	11	3	0.4	0.727	2.6	0.64	0.41	0.45	0.5	0.5	0.5	1.8
Lead, Total	ug/L	11	11	9	18.55	42	9.453	89.35	10	12.65	15	21.85	34.5
Zinc, Dissolved	ug/L	11	11	11	16.91	34	8.227	67.69	11	11.5	14	16.5	33
Zinc, Total	ug/L	11	11	31	55.09	97	21.79	474.7	33	38	51	67	91.5
Miscellaneous Organics													
2,4-D	ug/L	11	1	0.04	0.518	3	0.855	0.73	0.04	0.04	0.5	0.5	1.75
MCPP	ug/L	11	1	0.04	56.96	125	65.14	4243	0.04	0.04	1.4	125	125
Triclopyr	ug/L	11	1	0.04	0.059	0.25	0.063	0.004	0.04	0.04	0.04	0.04	0.145
Conventionals													
BOD	mg/L	11	11	1.9	4.418	17.6	4.482	20.09	2	2.45	2.9	3.75	11.5
Chloride	mg/L	11	11	0.6	37.84	349	103.9	10797	0.65	1.2	2.6	6.75	195.7
Conductivity	umho/cm	11	11	19.3	142.4	1060	308.1	94925	20.65	25.1	30.9	68.95	621.5
Solids, Total Suspended	mg/L	11	11	29.5	64.96	163	40.14	1611	32.95	39.1	47.4	76.05	135.5
Surfactants	mg/L	11	2	0.01	0.017	0.038	0.01	9E-05	0.0125	0.013	0.013	0.013	0.0365
Turbidity	NTU	11	11	18	42.36	102	24.64	607.2	19	24	38	52.05	82
pH	std units	11	11	6.22	6.77	NA	0.349	0.122	6.325	6.565	6.71	7.04	7.265

Notes: n – sample number, #D – number detected, min – minimum, avg – average, max – maximum, std dev – standard deviation, var – variance. pctile –percentile, med –median, (a) – geometric mean presented instead of average for bacteria data, NA – not applicable

Table 2.8b. WY2011 Summary Statistics – Commercial Site (C1) Stormwater

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
Petroleum Hydrocarbons													
TPH-D	mg/L	11	11	0.19	0.831	2.7	0.82029	0.67287	0.2	0.335	0.47	0.86	2.4
TPH-G	mg/L	11	0	0.125	0.125	0.125	0	0	0.125	0.125	0.125	0.125	0.125
Motor Oil	mg/L	11	11	0.83	1.973	3.8	1.0253	1.0512	0.905	1.1	1.8	2.7	3.55
Bacteria													
Fecal Coliform	CFU/100 mL	11	11	430	3359 (a)	40300	11316	128050000	1080	2220	2960	4555	23450
Nutrients													
Nitrate + Nitrite	mg-N/L	11	11	0.067	0.37	1.08	0.34614	0.11981	0.077	0.174	0.209	0.445	1.0245
TKN	mg-N/L	11	11	1.08	4.07	25	7.0111	49.156	1.11	1.38	1.69	2.51	14.77
Orthophosphate	mg-P/L	11	11	0.005	0.05	0.275	0.07525	0.0056627	0.0105	0.025	0.028	0.043	0.1695
Phosphorus, Total	mg-P/L	11	11	0.165	0.30	0.698	0.13919	0.019373	0.1955	0.255	0.26	0.301	0.525
Semivolatile Organics													
1-Methylnaphthalene	ug/L	11	4	0.05	0.25	1.6	0.4703	0.22118	0.05	0.05	0.05	0.135	1.075
2-Methylnaphthalene	ug/L	11	5	0.05	0.40	2.5	0.7628	0.58187	0.05	0.05	0.05	0.165	1.8
Acenaphthene	ug/L	11	1	0.05	0.065	0.19	0.04204	0.0017673	0.05	0.05	0.05	0.05	0.13
Acenaphthylene	ug/L	11	1	0.05	0.062	0.18	0.0392	0.0015364	0.05	0.05	0.05	0.05	0.115
Anthracene	ug/L	11	2	0.05	0.073	0.2	0.05179	0.0026818	0.05	0.05	0.05	0.05	0.175
Benzo(a)anthracene	ug/L	11	1	0.05	0.07	0.27	0.06633	0.0044	0.05	0.05	0.05	0.05	0.16
Benzo(a)pyrene	ug/L	11	2	0.05	0.074	0.24	0.05904	0.0034855	0.05	0.05	0.05	0.05	0.18
Benzo(g,h,i)perylene	ug/L	11	4	0.05	0.095	0.3	0.07917	0.0062673	0.05	0.05	0.05	0.115	0.235
Benzofluoranthenes, Total	ug/L	11	7	0.05	0.18	0.62	0.17893	0.032016	0.05	0.05	0.11	0.23	0.495
Butylbenzylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Chlorpyrifos	ug/L	11	0	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.1	0.1
Chrysene	ug/L	11	4	0.05	0.096	0.28	0.07502	0.0056273	0.05	0.05	0.05	0.125	0.225
Di-n-Butylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Di-n-Octyl phthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Diazinon	ug/L	11	0	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.1	0.1
Dibenz(a,h)anthracene	ug/L	11	1	0.05	0.064	0.21	0.04824	0.0023273	0.05	0.05	0.05	0.05	0.13
Dibenzofuran	ug/L	11	2	0.05	0.081	0.33	0.08455	0.0071491	0.05	0.05	0.05	0.05	0.22
Dichlobenil	ug/L	11	3	0.012	0.017	0.037	0.00946	8.942E-05	0.012	0.012	0.012	0.01925	0.0345
Diethylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Dimethylphthalate	ug/L	11	1	0.5	0.709	2.8	0.69348	0.48091	0.5	0.5	0.5	0.5	1.65
Fluoranthene	ug/L	11	9	0.05	0.19	0.59	0.15205	0.02312	0.05	0.1	0.15	0.235	0.43
Fluorene	ug/L	11	2	0.05	0.081	0.3	0.07752	0.0060091	0.05	0.05	0.05	0.05	0.22
Indeno(1,2,3-cd)pyrene	ug/L	11	2	0.05	0.073	0.24	0.05833	0.0034018	0.05	0.05	0.05	0.05	0.175
Malathion	ug/L	11	0	0.1	0.118	0.2	0.04045	0.0016364	0.1	0.1	0.1	0.1	0.2
Naphthalene	ug/L	11	6	0.05	0.379	2.2	0.65885	0.43409	0.05	0.05	0.15	0.235	1.575
Pentachlorophenol	ug/L	11	1	0.25	0.285	0.63	0.11457	0.013127	0.25	0.25	0.25	0.25	0.44
Phenanthrene	ug/L	11	7	0.05	0.132	0.36	0.09453	0.0089364	0.05	0.05	0.13	0.145	0.295
Prometon	ug/L	11	0	0.012	0.0121	0.012	0.0002	4.091E-08	0.012	0.012	0.012	0.012	0.0125
Pyrene	ug/L	11	8	0.05	0.176	0.52	0.14066	0.019785	0.05	0.075	0.14	0.22	0.41

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
bis(2-Ethylhexyl) phthalate	ug/L	11	11	1.6	4.36	6.6	1.8222	3.3205	1.65	2.95	4.9	5.75	6.5
Metals													
Cadmium, Dissolved	ug/L	11	0	0.05	0.082	0.1	0.02523	0.0006364	0.05	0.05	0.1	0.1	0.1
Cadmium, Total	ug/L	11	10	0.1	0.245	0.4	0.09342	0.0087273	0.15	0.2	0.2	0.3	0.4
Copper, Dissolved	ug/L	11	11	7.2	15.82	40.1	9.8526	97.074	7.55	8.35	11.6	20.15	31.4
Copper, Total	ug/L	11	11	23	48.35	74.7	16.95	287.3	27.7	35.15	42.8	60.7	72.65
Hardness	mg/L CaCO 3	11	11	21	40.09	69	16.586	275.09	23.5	30	33	49	68.5
Lead, Dissolved	ug/L	11	7	0.5	0.9	2	0.45607	0.208	0.5	0.5	0.9	1	1.65
Lead, Total	ug/L	11	11	10	21.32	44	9.6033	92.224	11.85	15.8	20	22.15	38.5
Mercury, Dissolved	ug/L	11	0	0.01	0.01	0.01	0	0	0.01	0.01	0.01	0.01	0.01
Mercury, Total	ug/L	11	6	0.01	0.0214	0.045	0.01248	0.0001557	0.01	0.01	0.022	0.029	0.0407
Zinc, Dissolved	ug/L	11	11	25	48.46	109	28.686	822.87	25.5	28.5	38	52	103
Zinc, Total	ug/L	11	11	93	155	270	52.655	2772.6	97	115.5	145	183	237
Miscellaneous Organics													
2,4-D	ug/L	11	0	0.04	0.249	0.5	0.24023	0.057709	0.04	0.04	0.04	0.5	0.5
MCPP	ug/L	11	0	0.04	56.84	125	65.258	4258.6	0.04	0.04	0.04	125	125
Triclopyr	ug/L	11	0	0.04	0.04	0.04	0	0	0.04	0.04	0.04	0.04	0.04
Conventionals													
BOD	mg/L	11	10	5	13.85	53.4	13.618	185.44	5.5	7.35	9.4	14.25	34.7
Chloride	mg/L	11	11	1.4	10.65	34	12.095	146.29	1.45	3.1	4.3	11.7	33.9
Conductivity	umho /cm	11	11	55.1	117.95	227	62.528	3909.7	55.6	67.15	95.1	176.5	209
Solids, Total Suspended	mg/L	11	11	38.4	86.21	182	43.527	1894.6	46.4	56.6	77.3	98.7	164
Surfactants	mg/L	11	6	0.01 25	0.0669	0.24	0.07227	0.0052224	0.0125	0.012	0.046	0.099	0.185
Turbidity	NTU	11	11	11.8	39.673	86.6	24.631	606.7	15.4	21	37.6	43.45	84.55
pH	std units	11	11	6.67	NA	8.26	0.4093	0.16753	6.72	7.01	7.13	7.205	7.745

Notes: n – sample number, # D– number detected, min – minimum, avg – average, max – maximum, std dev – standard deviation, var – variance. pctile –percentile, med – median, (a) – geometric mean presented instead of average for bacteria data, NA – not applicable

Table 2.8c. WY2011 Summary Statistics – Industrial Site (I1) Stormwater

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
Petroleum Hydrocarbons													
TPH-D	mg/L	11	11	0.15	0.62182	1.2	0.33532	0.11244	0.19	0.34	0.64	0.88	1.055
TPH-G	mg/L	11	0	0.125	0.125	0.125	0	0	0.125	0.125	0.125	0.125	0.125
Motor Oil	mg/L	11	11	0.34	1.4945	2.7	0.74979	0.56219	0.54	0.88	1.5	1.95	2.6
Bacteria													
Fecal Coliform	CFU/100 mL	11	11	2	344 (a)	2800	868.19	753750	54	162	580	1330	2250
Nutrients													
Nitrate + Nitrite	mg-N/L	11	11	0.135	0.30182	0.436	0.0983	0.0096622	0.172	0.235	0.3	0.376	0.4305
TKN	mg-N/L	11	11	0.56	1.1936	3.23	0.76531	0.58571	0.57	0.75	0.96	1.335	2.44
Orthophosphate	mg-P/L	11	11	0.007	0.06045	0.117	0.03852	0.0014835	0.008	0.023	0.07	0.081	0.1125
Phosphorus, Total	mg-P/L	11	11	0.112	0.24682	0.632	0.15881	0.02522	0.114	0.142	0.19	0.283	0.53
Semivolatile Organics													
1-Methylnaphthalene	ug/L	11	4	0.05	0.15364	0.91	0.25512	0.065085	0.05	0.05	0.05	0.125	0.545
2-Methylnaphthalene	ug/L	11	4	0.05	0.25273	1.9	0.55067	0.30324	0.05	0.05	0.05	0.13	1.085
Acenaphthene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Acenaphthylene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Anthracene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Benzo(a)anthracene	ug/L	11	1	0.05	0.05636	0.12	0.02111	0.0004455	0.05	0.05	0.05	0.05	0.085
Benzo(a)pyrene	ug/L	11	1	0.05	0.06727	0.24	0.05729	0.0032818	0.05	0.05	0.05	0.05	0.145
Benzo(g,h,i)perylene	ug/L	11	1	0.05	0.06181	0.18	0.0392	0.0015364	0.05	0.05	0.05	0.05	0.115
Benzofluoranthenes, Total	ug/L	11	3	0.05	0.09363	0.35	0.0933	0.0087055	0.05	0.05	0.05	0.08	0.26
Butylbenzylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Chlorpyrifos	ug/L	11	0	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.1	0.1
Chrysene	ug/L	11	2	0.05	0.071818	0.21	0.05173	0.0026764	0.05	0.05	0.05	0.05	0.17
Di-n-Butylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Di-n-Octyl phthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Diazinon	ug/L	11	0	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.1	0.1
Dibenz(a,h)anthracene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Dibenzofuran	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Dichlobenil	ug/L	11	7	0.012	0.03090	0.077	0.02002	0.0004007	0.012	0.012	0.031	0.041	0.0605
Diethylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Dimethylphthalate	ug/L	11	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5
Fluoranthene	ug/L	11	4	0.05	0.10909	0.37	0.10492	0.011009	0.05	0.05	0.05	0.12	0.305
Fluorene	ug/L	11	0	0.05	0.05	0.05	0	0	0.05	0.05	0.05	0.05	0.05
Indeno(1,2,3-cd)pyrene	ug/L	11	1	0.05	0.05727	0.13	0.02412	0.0005818	0.05	0.05	0.05	0.05	0.09
Malathion	ug/L	11	0	0.1	0.10909	0.2	0.03015	0.0009091	0.1	0.1	0.1	0.1	0.15
Naphthalene	ug/L	11	3	0.05	0.25364	2.1	0.61375	0.37669	0.05	0.05	0.05	0.08	1.14
Pentachlorophenol	ug/L	11	0	0.25	0.25	0.25	0	0	0.25	0.25	0.25	0.25	0.25
Phenanthrene	ug/L	11	4	0.05	0.08545	0.23	0.0582	0.0033873	0.05	0.05	0.05	0.115	0.18
Prometon	ug/L	11	0	0.012	0.01204	0.012	0.00015	2.273E-08	0.012	0.012	0.012	0.012	0.0123
Pyrene	ug/L	11	6	0.05	0.12091	0.41	0.10849	0.011769	0.05	0.05	0.1	0.125	0.31
bis(2-Ethylhexyl) phthalate	ug/L	11	10	0.5	2.7273	11	2.8969	8.3922	0.85	1.35	1.6	3	7.3
Metals													
Cadmium, Dissolved	ug/L	11	0	0.05	0.08636	0.1	0.02336	0.0005455	0.05	0.075	0.1	0.1	0.1

Analyte Name	Units	n	# D	Min	Avg	Max	Std Dev	Var	5th Pctile	25th Pctile	Med	75th Pctile	95th Pctile
Cadmium, Total	ug/L	11	6	0.1	0.19091	0.7	0.18141	0.032909	0.1	0.1	0.1	0.2	0.5
Copper, Dissolved	ug/L	11	11	3.6	5.0909	8.1	1.5142	2.2929	3.65	4.1	4.7	5.15	7.95
Copper, Total	ug/L	11	11	10.2	18.809	54.4	12.917	166.86	10.6	11.15	15.2	18.15	41.45
Hardness	mg/L CaCO3	11	11	27	178.91	1300	372.39	138680	38.5	54	72	90	696.5
Lead, Dissolved	ug/L	11	3	0.2	0.43636	0.5	0.1206	0.0145	0.2	0.45	0.5	0.5	0.5
Lead, Total	ug/L	11	11	3.3	8.5091	36	9.6059	92.273	3.65	4	4.8	7	25
Mercury, Dissolved	ug/L	11	0	0.01	0.01	0.01	0	0	0.01	0.01	0.01	0.01	0.01
Mercury, Total	ug/L	11	2	0.01	0.01440	0.046	0.01126	0.0001	0.01	0.01	0.01	0.01	0.0343
Zinc, Dissolved	ug/L	11	11	12	45.818	77	18.406	338.76	22	34	44	59	71.5
Zinc, Total	ug/L	11	11	71	132.27	330	72.933	5319.2	77.5	94.5	106	136	258
Miscellaneous Organics													
2,4-D	ug/L	11	0	0.04	0.24909	0.5	0.24023	0.057	0.04	0.04	0.04	0.5	0.5
MCPP	ug/L	11	0	0.04	56.84	125	65.258	4258.6	0.04	0.04	0.04	125	125
Triclopyr	ug/L	11	3	0.04	0.15818	0.59	0.2117	0.044	0.04	0.04	0.04	0.18	0.55
Conventionals													
BOD	mg/L	11	10	1	4.0818	7.7	2.0074	4.029	1.65	2.95	3.6	5.2	7.3
Chloride	mg/L	11	11	1.1	5.4636	11.1	3.4136	11.653	1.55	3.1	4.9	7.25	10.85
Conductivity	umho/cm	11	11	70.7	157.97	285	57.009	3250	93.35	122.5	144	189	243
Solids, Total Suspended	mg/L	11	11	20.6	88.127	455	128.23	16442	22.5	25.45	38	63.45	308.5
Surfactants	mg/L	11	3	0.012	0.03536	0.18	0.05085	0.0025	0.012	0.012	0.012	0.031	0.119
Turbidity	NTU	11	11	14.4	49.555	175	46.661	2177.3	17.7	24	30	53.1	131.25
pH	std units	11	11	7.18	NA	7.57	0.13831	0.019	7.185	7.22	7.32	7.46	7.535

Notes: n – sample number, # D– number detected, min – minimum, avg – average, max – maximum, std dev – standard deviation, var – variance. pctile –percentile, med – median, (a) – geometric mean presented instead of average for bacteria data, NA – not applicable

No load is estimated for fecal coliform, hardness, conductivity, pH or turbidity since these analytes are not reported as concentration per volume so these values cannot be converted into pounds per acre.

The area used for the load calculation for each basin is the area of that basin draining to the municipal separated storm sewer system (MS4) and does not include acreage draining to the combined sewer system.

2.9.1 Residential Site (R1) Load Estimation

The following analytes were not detected in any stormwater from any events at R1 so no load was calculated:

Gasoline Range Hydrocarbons	Chlorpyrifos	Malathion
1-Methylnaphthalene	Di-n-Butylphthalate	Naphthalene
2-Methylnaphthalene	Di-n-Octyl phthalate	Pentachlorophenol
Acenaphthene	Diazinon	Cadmium, Dissolved
Acenaphthylene	Dibenz(a,h)anthracene	
Anthracene	Diethylphthalate	
Benzo(a)pyrene	Dimethylphthalate	
Butylbenzylphthalate	Indeno(1,2,3-cd)pyrene	

Sormwater loads for detected parameters are presented in Table 2.9.1. No base flow is present at this site.

2.9.2 Commercial Site (C1) Load Estimation

The following analytes were not detected in any stormwater from any events at C1 so no load was calculated:

Gasoline Range Hydrocarbons	Diazinon	Mercury, Dissolved
Butylbenzylphthalate	Dimethylphthalate	2,4-D
Chlorpyrifos	Malathion	MCPP
Di-n-Butylphthalate	Prometon	Triclopyr
Di-n-Octyl phthalate	Cadmium, Dissolved	

Sormwater loads for detected parameters are presented in Table 2.9.2a., which displays loads with the base flow load removed.

The following analytes were not detected in any base flow samples at C1 so no base flow load was calculated:

Gasoline Range Hydrocarbons	Di-n-Octyl phthalate	Pentachlorophenol
1-Methylnaphthalene	Diazinon	Phenanthrene
2-Methylnaphthalene	Dibenz(a,h)anthracene	Prometon
Acenaphthene	Dibenzofuran	Cadmium, Dissolved
Acenaphthylene	Dichlobenil	Mercury, Dissolved

Benzo(a)anthracene	Diethylphthalate	Mercury, Total
Benzo(a)pyrene	Dimethylphthalate	2,4-D
Benzo(g,h,i)perylene	Fluorene	MCPP
Butylbenzylphthalate	Indeno(1,2,3-cd)pyrene	Triclopyr
Chlorpyrifos	Malathion	
Di-n-Butylphthalate	Naphthalene	

Base flow loads for C1 are presented in Table 2.9.2b.

Note – for analytes detected in some or all of the stormwater samples from C1 but not detected in some or all of base flow samples, the stormwater loads can decrease as the non-detect substitution factor increases since more base flow load will be removed from the total load as the non-detect replacement value becomes higher.

2.9.3 Industrial Site (I1) Load Estimation

The following analytes were not detected in any stormwater from any events at I1 so no load was calculated:

Gasoline Range Hydrocarbons	Diazinon	Prometon
Acenaphthene	Dibenz(a,h)anthracene	Cadmium, Dissolved
Acenaphthylene	Dibenzofuran	Mercury, Dissolved
Anthracene	Diethylphthalate	2,4-D
Butylbenzylphthalate	Dimethylphthalate	MCPP
Chlorpyrifos	Fluorene	
Di-n-Butylphthalate	Malathion	
Di-n-Octyl phthalate	Pentachlorophenol	

Stormwater loads for detected parameters are presented in Table 2.9.3. No base flow is present at this site.

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Table 2.9.1. Load Estimation – Residential Site (R1) Stormwater

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Diesel Range Hydrocarbons	12.37	0.15	0.75	0.01	13.12	0.15	12.37	0.15	0.75	0.01	13.12	0.15	12.37	0.15	0.75	0.01	13.12	0.15
Gasoline Range Hydrocarbons	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nutrients																		
Nitrate + Nitrite	10.77	0.13	0.47	0.01	11.24	0.13	10.77	0.13	0.47	0.01	11.24	0.13	10.77	0.13	0.47	0.01	11.24	0.13
Nitrogen, Total Kjeldahl	76.11	0.89	4.14	0.05	80.24	0.94	76.11	0.89	4.14	0.05	80.24	0.94	76.11	0.89	4.14	0.05	80.24	0.94
Orthophosphate	0.79	0.01	0.04	0.00	0.83	0.01	0.79	0.01	0.04	0.00	0.83	0.01	0.79	0.01	0.04	0.00	0.83	0.01
Phosphorus, Total	12.88	0.15	0.40	0.00	13.28	0.16	12.88	0.15	0.40	0.00	13.28	0.16	12.88	0.15	0.40	0.00	13.28	0.16
Semivolatile Organics																		
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	0.00082	0.00001	0.00000	0.00000	0.00082	0.00001	0.00337	0.00004	0.00015	0.00000	0.00353	0.00004	0.00592	0.00007	0.00031	0.00000	0.00623	0.00007
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.00182	0.00002	0.00000	0.00000	0.00182	0.00002	0.00398	0.00005	0.00015	0.00000	0.00414	0.00005	0.00615	0.00007	0.00031	0.00000	0.00645	0.00008
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	0.00097	0.00001	0.00000	0.00000	0.00097	0.00001	0.00352	0.00004	0.00015	0.00000	0.00368	0.00004	0.00607	0.00007	0.00031	0.00000	0.00638	0.00007
Dichlobenil	0.00606	0.00007	0.00019	0.00000	0.00625	0.00007	0.00639	0.00007	0.00019	0.00000	0.00657	0.00008	0.00671	0.00008	0.00019	0.00000	0.00690	0.00008
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	0.00406	0.00005	0.00000	0.00000	0.00406	0.00005	0.00556	0.00007	0.00015	0.00000	0.00572	0.00007	0.00707	0.00008	0.00031	0.00000	0.00738	0.00009
Fluorene	0.00082	0.00001	0.00000	0.00000	0.00082	0.00001	0.00337	0.00004	0.00015	0.00000	0.00353	0.00004	0.00592	0.00007	0.00031	0.00000	0.00623	0.00007
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	0.00075	0.00001	0.00000	0.00000	0.00075	0.00001	0.00330	0.00004	0.00015	0.00000	0.00345	0.00004	0.00584	0.00007	0.00031	0.00000	0.00615	0.00007
Prometon	0.00424	0.00005	0.00000	0.00000	0.00424	0.00005	0.00483	0.00006	0.00004	0.00000	0.00487	0.00006	0.00542	0.00006	0.00007	0.00000	0.00550	0.00006
Pyrene	0.00367	0.00004	0.00000	0.00000	0.00367	0.00004	0.00518	0.00006	0.00015	0.00000	0.00533	0.00006	0.00669	0.00008	0.00031	0.00000	0.00699	0.00008
bis(2-Ethylhexyl)phthalate	0.12343	0.00145	0.00000	0.00000	0.12343	0.00145	0.12945	0.00152	0.00154	0.00002	0.13099	0.00154	0.13547	0.00159	0.00308	0.00004	0.13855	0.00162
Metals																		
Cadmium, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium, Total	0.00231	0.00003	0.00033	0.00000	0.00263	0.00003	0.00728	0.00009	0.00033	0.00000	0.00761	0.00009	0.01227	0.00014	0.00033	0.00000	0.01259	0.00015
Copper, Dissolved	0.21107	0.00247	0.01541	0.00018	0.22648	0.00266	0.21107	0.00247	0.01541	0.00018	0.22648	0.00266	0.21107	0.00247	0.01541	0.00018	0.22648	0.00266
Copper, Total	0.89296	0.01047	0.03810	0.00045	0.93106	0.01091	0.89296	0.01047	0.03810	0.00045	0.93106	0.01091	0.89296	0.01047	0.03810	0.00045	0.93106	0.01091
Lead, Dissolved	0.00832	0.00010	0.00145	0.00002	0.00978	0.00011	0.03337	0.00039	0.00145	0.00002	0.03483	0.00041	0.05843	0.00068	0.00145	0.00002	0.05988	0.00070
Lead, Total	1.10970	0.01301	0.04182	0.00049	1.15152	0.01350	1.10970	0.01301	0.04182	0.00049	1.15152	0.01350	1.10970	0.01301	0.04182	0.00049	1.15152	0.01350
Zinc, Dissolved	1.09120	0.01279	0.03600	0.00042	1.12720	0.01321	1.09120	0.01279	0.03600	0.00042	1.12720	0.01321	1.09120	0.01279	0.03600	0.00042	1.12720	0.01321
Zinc, Total	3.56070	0.04174	0.09872	0.00116	3.65942	0.04290	3.56070	0.04174	0.09872	0.00116	3.65942	0.04290	3.56070	0.04174	0.09872	0.00116	3.65942	0.04290
Miscellaneous Organics																		
2,4-D	0.0000	0.0000	0.0003	0.0000	0.0003	0.0000	0.0156	0.0002	0.0004	0.0000	0.0160	0.0002	0.0311	0.0004	0.0005	0.0000	0.0317	0.0004
MCPP	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	3.5966	0.0422	0.0003	0.0000	3.5969	0.0422	7.1931	0.0843	0.0004	0.0000	7.1935	0.0843
Triclopyr	0.0015	0.0000	0.0000	0.0000	0.0015	0.0000	0.0036	0.0000	0.0001	0.0000	0.0037	0.0000	0.0057	0.0001	0.0002	0.0000	0.0059	0.0001
Conventionals																		
Biochemical Oxygen Demand	161.63	1.89	13.40	0.16	175.03	2.05	161.63	1.89	13.40	0.16	175.03	2.05	161.63	1.89	13.40	0.16	175.03	2.05
Chloride	5719.20	67.05	4.36	0.05	5723.56	67.10	5719.20	67.05	4.36	0.05	5723.56	67.10	5719.20	67.05	4.36	0.05	5723.56	67.10
Solids, Total Suspended	4098.70	48.05	115.30	1.35	4214.00	49.40	4098.70	48.05	115.30	1.35	4214.00	49.40	4098.70	48.05	115.30	1.35	4214.00	49.40
Surfactants	0.22	0.00	0.00	0.00	0.22	0.00	0.88	0.01	0.04	0.00	0.92	0.01	1.54	0.02	0.08	0.00	1.61	0.02

Notes-
Loads estimated by QAPP method.
ND – Not detected. Analyte not detected in any samples from period so no load calculated.

Table 2.9.2. Load Estimation – Commercial Site (C1) Stormwater (with Base Flow Load Removed)

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Diesel Range Hydrocarbons	402.45	2.65	109.21	0.72	511.66	3.37	398.00	2.62	109.00	0.72	507.00	3.34	393.55	2.59	108.79	0.72	502.34	3.30
Gasoline Range Hydrocarbons	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nutrients																		
Nitrate + Nitrite	85.04	0.56	17.14	0.11	102.18	0.67	85.04	0.56	17.14	0.11	102.18	0.67	85.04	0.56	17.14	0.11	102.18	0.67
Nitrogen, Total Kjeldahl	2590.30	17.04	144.04	0.95	2734.34	17.99	2590.30	17.04	144.04	0.95	2734.34	17.99	2590.30	17.04	144.04	0.95	2734.34	17.99
Orthophosphate	14.80	0.10	4.94	0.03	19.74	0.13	14.80	0.10	4.94	0.03	19.74	0.13	14.80	0.10	4.94	0.03	19.74	0.13
Phosphorus, Total	198.79	1.31	19.24	0.13	218.03	1.43	198.79	1.31	19.24	0.13	218.03	1.43	198.79	1.31	19.24	0.13	218.03	1.43
Semivolatile Organics																		
1-Methylnaphthalene	0.08942	0.00059	0.00000	0.00000	0.08942	0.00059	0.10775	0.00071	0.00187	0.00001	0.10962	0.00072	0.12608	0.00083	0.00374	0.00002	0.12982	0.00085
2-Methylnaphthalene	0.13312	0.00088	0.00000	0.00000	0.13312	0.00088	0.14572	0.00096	0.00187	0.00001	0.14759	0.00097	0.15831	0.00104	0.00374	0.00002	0.16205	0.00107
Acenaphthene	0.04134	0.00027	0.00000	0.00000	0.04134	0.00027	0.06586	0.00043	0.00187	0.00001	0.06773	0.00045	0.09038	0.00059	0.00374	0.00002	0.09412	0.00062
Acenaphthylene	0.03918	0.00026	0.00000	0.00000	0.03918	0.00026	0.06227	0.00041	0.00187	0.00001	0.06414	0.00042	0.08536	0.00056	0.00374	0.00002	0.08910	0.00059
Anthracene	0.06092	0.00040	0.00042	0.00000	0.06134	0.00040	0.07695	0.00051	0.00166	0.00001	0.07861	0.00052	0.09298	0.00061	0.00374	0.00002	0.09671	0.00064
Benzo(a)anthracene	0.03815	0.00025	0.00000	0.00000	0.03815	0.00025	0.06483	0.00043	0.00187	0.00001	0.06670	0.00044	0.09151	0.00060	0.00374	0.00002	0.09525	0.00063
Benzo(a)pyrene	0.06003	0.00039	0.00000	0.00000	0.06003	0.00039	0.07606	0.00050	0.00187	0.00001	0.07793	0.00051	0.09208	0.00061	0.00374	0.00002	0.09582	0.00063
Benzo(g,h,i)perylene	0.09733	0.00064	0.00000	0.00000	0.09733	0.00064	0.10555	0.00069	0.00187	0.00001	0.10742	0.00071	0.11378	0.00075	0.00374	0.00002	0.11752	0.00077
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.08220	0.00054	0.00000	0.00000	0.08220	0.00054	0.09273	0.00061	0.00187	0.00001	0.09460	0.00062	0.10327	0.00068	0.00374	0.00002	0.10701	0.00070
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.02967	0.00020	0.00000	0.00000	0.02967	0.00020	0.05658	0.00037	0.00187	0.00001	0.05845	0.00038	0.08349	0.00055	0.00374	0.00002	0.08723	0.00057
Dibenzofuran	0.08738	0.00057	0.00000	0.00000	0.08738	0.00057	0.10340	0.00068	0.00187	0.00001	0.10527	0.00069	0.11943	0.00079	0.00374	0.00002	0.12317	0.00081
Dichlobenil	0.00037	0.00000	0.00158	0.00001	0.00194	0.00001	0.00842	0.00006	0.00148	0.00001	0.00989	0.00007	0.01647	0.00011	0.00138	0.00001	0.01785	0.00012
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	0.00000	0.00000	0.06259	0.00041	0.06259	0.00041	0.33974	0.00224	0.07011	0.00046	0.40985	0.00270	0.67949	0.00447	0.07762	0.00051	0.75711	0.00498
Fluoranthene	0.20724	0.00136	0.00322	0.00002	0.21046	0.00138	0.20333	0.00134	0.00419	0.00003	0.20752	0.00137	0.19941	0.00131	0.00515	0.00003	0.20456	0.00135
Fluorene	0.08507	0.00056	0.00000	0.00000	0.08507	0.00056	0.10109	0.00067	0.00187	0.00001	0.10296	0.00068	0.11712	0.00077	0.00374	0.00002	0.12086	0.00080
Indeno(1,2,3-cd)pyrene	0.05786	0.00038	0.00000	0.00000	0.05786	0.00038	0.07389	0.00049	0.00187	0.00001	0.07576	0.00050	0.08992	0.00059	0.00374	0.00002	0.09366	0.00062
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.13711	0.00090	0.00375	0.00002	0.14086	0.00093	0.14971	0.00098	0.00445	0.00003	0.15416	0.00101	0.16231	0.00107	0.00515	0.00003	0.16746	0.00110

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Pentachlorophenol	0.08903	0.00059	0.00000	0.00000	0.08903	0.00059	0.22357	0.00147	0.00935	0.00006	0.23292	0.00153	0.35812	0.00236	0.01870	0.00012	0.37682	0.00248
Phenanthrene	0.13505	0.00089	0.00313	0.00002	0.13818	0.00091	0.13771	0.00091	0.00388	0.00003	0.14159	0.00093	0.14037	0.00092	0.00463	0.00003	0.14500	0.00095
Prometon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	0.14984	0.00099	0.00343	0.00002	0.15327	0.00101	0.15680	0.00103	0.00440	0.00003	0.16120	0.00106	0.16377	0.00108	0.00536	0.00004	0.16913	0.00111
bis(2-Ethylhexyl)phthalate	3.42830	0.02255	0.17347	0.00114	3.60177	0.02370	3.40520	0.02240	0.16926	0.00111	3.57446	0.02352	3.38210	0.02225	0.16504	0.00109	3.54714	0.02334
Metals																		
Cadmium, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium, Total	0.17786	0.00117	0.01322	0.00009	0.19108	0.00126	0.17576	0.00116	0.01301	0.00009	0.18877	0.00124	0.17367	0.00114	0.01279	0.00008	0.18646	0.00123
Copper, Dissolved	8.10840	0.05334	1.36930	0.00901	9.47770	0.06235	8.10840	0.05334	1.36930	0.00901	9.47770	0.06235	8.10840	0.05334	1.36930	0.00901	9.47770	0.06235
Copper, Total	33.23000	0.21862	2.87570	0.01892	36.10570	0.23754	33.23000	0.21862	2.87570	0.01892	36.10570	0.23754	33.23000	0.21862	2.87570	0.01892	36.10570	0.23754
Lead, Dissolved	0.29267	0.00193	0.07228	0.00048	0.36495	0.00240	0.47344	0.00311	0.07228	0.00048	0.54572	0.00359	0.65421	0.00430	0.07228	0.00048	0.72649	0.00478
Lead, Total	17.72900	0.11664	0.81781	0.00538	18.54681	0.12202	17.70600	0.11649	0.81781	0.00538	18.52381	0.12187	17.68300	0.11634	0.81781	0.00538	18.50081	0.12172
Mercury, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury, Total	0.01355	0.00009	0.00167	0.00001	0.01522	0.00010	0.01544	0.00010	0.00159	0.00001	0.01702	0.00011	0.01733	0.00011	0.00150	0.00001	0.01883	0.00012
Zinc, Dissolved	24.33000	0.16007	4.43060	0.02915	28.76060	0.18921	24.33000	0.16007	4.43060	0.02915	28.76060	0.18921	24.33000	0.16007	4.43060	0.02915	28.76060	0.18921
Zinc, Total	103.62000	0.68171	10.18600	0.06701	113.80600	0.74872	103.62000	0.68171	10.18600	0.06701	113.80600	0.74872	103.62000	0.68171	10.18600	0.06701	113.80600	0.74872
Miscellaneous Organics																		
2,4-D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MCPP	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Triclopyr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Conventionals																		
Biochemical Oxygen Demand	13088.00	86.11	1485.10	9.77	14573.10	95.88	12850.00	84.54	1485.10	9.77	14335.10	94.31	12611.00	82.97	1485.10	9.77	14096.10	92.74
Chloride	5497.50	36.17	161.26	1.06	5658.76	37.23	5497.50	36.17	161.26	1.06	5658.76	37.23	5497.50	36.17	161.26	1.06	5658.76	37.23
Solids, Total Suspended	70020.00	460.66	3607.60	23.73	73627.60	484.39	70020.00	460.66	3607.60	23.73	73627.60	484.39	70020.00	460.66	3607.60	23.73	73627.60	484.39
Surfactants	43.69	0.29	1.77	0.01	45.46	0.30	48.64	0.32	1.95	0.01	50.59	0.33	53.59	0.35	2.14	0.01	55.73	0.37

Notes-
Loads estimated by Ecology method.
ND – Not detected. Analyte not detected in any samples from period so no load calculated.
* - Area used for load calculation is basin area draining to MS4 (152.0 acres), not total basin area.

Table 2.9.2b. Load Estimation – Commercial Site (C1) Base Flow

Analyte Name	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Diesel Range Hydrocarbons	0.00	0.00	10.93	0.07	10.93	0.07	17.68	0.12	16.40	0.11	34.08	0.22	35.35	0.23	21.87	0.14	57.22	0.38
Gasoline Range Hydrocarbons	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nutrients																		
Nitrate + Nitrite	820.20	5.40	399.14	2.63	1219.34	8.02	820.20	5.40	399.14	2.63	1219.34	8.02	820.20	5.40	399.14	2.63	1219.34	8.02
Nitrogen, Total Kjeldahl	270.46	1.78	277.81	1.83	548.27	3.61	270.46	1.78	277.81	1.83	548.27	3.61	270.46	1.78	277.81	1.83	548.27	3.61
Orthophosphate	31.99	0.21	34.33	0.23	66.33	0.44	31.99	0.21	34.33	0.23	66.33	0.44	31.99	0.21	34.33	0.23	66.33	0.44
Phosphorus, Total	45.25	0.30	61.46	0.40	106.71	0.70	45.25	0.30	61.46	0.40	106.71	0.70	45.25	0.30	61.46	0.40	106.71	0.70
Semivolatile Organics																		
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	0.00000	0.00000	0.01093	0.00007	0.01093	0.00007	0.01768	0.00012	0.01640	0.00011	0.03408	0.00022	0.03535	0.00023	0.02187	0.00014	0.05722	0.00038
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.02121	0.00014	0.00000	0.00000	0.02121	0.00014	0.03005	0.00020	0.01093	0.00007	0.04098	0.00027	0.03889	0.00026	0.02187	0.00014	0.06076	0.00040
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlobenil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	0.00000	0.00000	0.02078	0.00014	0.02078	0.00014	0.01768	0.00012	0.02624	0.00017	0.04391	0.00029	0.03535	0.00023	0.03171	0.00021	0.06706	0.00044
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Analyte Name	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)	Wet Period Baseflow Load (LB)	Wet Period Baseflow Load by Area* (LB/acre)	Dry Period Baseflow Load (LB)	Dry Period Baseflow Load by Area* (LB/acre)	Annual Baseflow Load (LB)	Annual Baseflow by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Prometon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	0.00000	0.00000	0.01531	0.00010	0.01531	0.00010	0.01768	0.00012	0.02078	0.00014	0.03845	0.00025	0.03535	0.00023	0.02624	0.00017	0.06159	0.00041
bis(2-Ethylhexyl)phthalate	0.33583	0.00221	0.13123	0.00086	0.46706	0.00307	0.42408	0.00279	0.24057	0.00158	0.66465	0.00437	0.51262	0.00337	0.34989	0.00230	0.86251	0.00567
Metals																		
Cadmium, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium, Total	0.00000	0.00000	0.01093	0.00007	0.01093	0.00007	0.03535	0.00023	0.01640	0.00011	0.05175	0.00034	0.07071	0.00047	0.02187	0.00014	0.09258	0.00061
Copper, Dissolved	1.46710	0.00965	1.55290	0.01022	3.02000	0.01987	1.46710	0.00965	1.55290	0.01022	3.02000	0.01987	1.46710	0.00965	1.55290	0.01022	3.02000	0.01987
Copper, Total	2.13860	0.01407	2.38370	0.01568	4.52230	0.02975	2.13860	0.01407	2.38370	0.01568	4.52230	0.02975	2.13860	0.01407	2.38370	0.01568	4.52230	0.02975
Lead, Dissolved	0.00000	0.00000	0.07656	0.00050	0.07656	0.00050	0.17675	0.00116	0.07656	0.00050	0.25331	0.00167	0.35350	0.00233	0.07656	0.00050	0.43006	0.00283
Lead, Total	0.35350	0.00233	0.63426	0.00417	0.98776	0.00650	0.44187	0.00291	0.63426	0.00417	1.07613	0.00708	0.53042	0.00349	0.63426	0.00417	1.16468	0.00766
Mercury, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury, Total	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc, Dissolved	9.36710	0.06163	7.32540	0.04819	16.69250	0.10982	9.36710	0.06163	7.32540	0.04819	16.69250	0.10982	9.36710	0.06163	7.32540	0.04819	16.69250	0.10982
Zinc, Total	12.01900	0.07907	11.70000	0.07697	23.71900	0.15605	12.01900	0.07907	11.70000	0.07697	23.71900	0.15605	12.01900	0.07907	11.70000	0.07697	23.71900	0.15605
Miscellaneous Organics																		
2,4-D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MCPP	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Triclopyr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Conventionals																		
Biochemical Oxygen Demand	77350.00	508.88	601.49	3.96	77951.49	512.84	77350.00	508.88	601.49	3.96	77951.49	512.84	77350.00	508.88	601.49	3.96	77951.49	512.84
Chloride	6345.50	41.75	3007.20	19.78	9352.70	61.53	6345.50	41.75	3007.20	19.78	9352.70	61.53	6345.50	41.75	3007.20	19.78	9352.70	61.53
Solids, Total Suspended	1626.00	10.70	2132.40	14.03	3758.40	24.73	1626.00	10.70	2132.40	14.03	3758.40	24.73	1626.00	10.70	2132.40	14.03	3758.40	24.73
Surfactants	14.14	0.09	0.00	0.00	14.14	0.09	16.35	0.11	2.73	0.02	19.08	0.13	18.56	0.12	5.47	0.04	24.03	0.16

Notes-
Base flow loads estimated by Ecology method.
ND – Not detected. Analyte not detected in any samples from period so no load calculated.
* - Area used for load calculation is basin area draining to MS4 (152.0 acres), not total basin area.

Table 2.9.3. Load Estimation – Industrial Site (I1) Stormwater

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Diesel Range Hydrocarbons	155.36	1.13	8.46	0.06	163.82	1.19	155.36	1.13	8.46	0.06	163.82	1.19	155.36	1.13	8.46	0.06	163.82	1.19
Gasoline Range Hydrocarbons	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nutrients																		
Nitrate + Nitrite	70.44	0.51	7.02	0.05	77.46	0.56	70.44	0.51	7.02	0.05	77.46	0.56	70.44	0.51	7.02	0.05	77.46	0.56
Nitrogen, Total Kjeldahl	299.26	2.18	40.31	0.29	339.57	2.48	299.26	2.18	40.31	0.29	339.57	2.48	299.26	2.18	40.31	0.29	339.57	2.48
Orthophosphate	19.38	0.14	1.68	0.01	21.07	0.15	19.38	0.14	1.68	0.01	21.07	0.15	19.38	0.14	1.68	0.01	21.07	0.15
Phosphorus, Total	69.81	0.51	4.84	0.04	74.65	0.54	69.81	0.51	4.84	0.04	74.65	0.54	69.81	0.51	4.84	0.04	74.65	0.54
Semivolatile Organics																		
1-Methylnaphthalene	0.06527	0.00048	0.00000	0.00000	0.06527	0.00048	0.07165	0.00052	0.00131	0.00001	0.07296	0.00053	0.07803	0.00057	0.00263	0.00002	0.08066	0.00059
2-Methylnaphthalene	0.12701	0.00093	0.00000	0.00000	0.12701	0.00093	0.13385	0.00098	0.00131	0.00001	0.13516	0.00099	0.14069	0.00103	0.00263	0.00002	0.14332	0.00104
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.00351	0.00003	0.00000	0.00000	0.00351	0.00003	0.01481	0.00011	0.00131	0.00001	0.01613	0.00012	0.02611	0.00019	0.00263	0.00002	0.02874	0.00021
Benzo(a)pyrene	0.00703	0.00005	0.00000	0.00000	0.00703	0.00005	0.01833	0.00013	0.00131	0.00001	0.01964	0.00014	0.02963	0.00022	0.00263	0.00002	0.03226	0.00024
Benzo(g,h,i)perylene	0.00527	0.00004	0.00000	0.00000	0.00527	0.00004	0.01657	0.00012	0.00131	0.00001	0.01789	0.00013	0.02787	0.00020	0.00263	0.00002	0.03050	0.00022
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.00822	0.00006	0.00000	0.00000	0.00822	0.00006	0.01872	0.00014	0.00131	0.00001	0.02003	0.00015	0.02922	0.00021	0.00263	0.00002	0.03185	0.00023
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlobenil	0.00449	0.00003	0.00084	0.00001	0.00532	0.00004	0.00621	0.00005	0.00084	0.00001	0.00705	0.00005	0.00794	0.00006	0.00084	0.00001	0.00877	0.00006
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	0.02301	0.00017	0.00000	0.00000	0.02301	0.00017	0.03028	0.00022	0.00131	0.00001	0.03160	0.00023	0.03755	0.00027	0.00263	0.00002	0.04018	0.00029
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.00381	0.00003	0.00000	0.00000	0.00381	0.00003	0.01511	0.00011	0.00131	0.00001	0.01642	0.00012	0.02640	0.00019	0.00263	0.00002	0.02903	0.00021

Analyte Name	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)	Wet Period Storm Load (LB)	Wet Period Storm Load by Area* (LB/acre)	Dry Period Storm Load (LB)	Dry Period Storm Load by Area* (LB/acre)	Annual Storm Load (LB)	Annual Storm by Area* (LB/acre)
Substitution Factor for Non-Detects	**0.0 x Reporting Limit**						**0.5 x Reporting Limit**						**1.0 x Reporting Limit**					
Petroleum Hydrocarbons																		
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.13565	0.00099	0.00000	0.00000	0.13565	0.00099	0.14334	0.00104	0.00131	0.00001	0.14465	0.00105	0.15103	0.00110	0.00263	0.00002	0.15366	0.00112
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	0.01891	0.00014	0.00000	0.00000	0.01891	0.00014	0.02529	0.00018	0.00131	0.00001	0.02661	0.00019	0.03168	0.00023	0.00263	0.00002	0.03431	0.00025
Prometon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	0.02815	0.00021	0.00000	0.00000	0.02815	0.00021	0.03310	0.00024	0.00131	0.00001	0.03441	0.00025	0.03805	0.00028	0.00263	0.00002	0.04068	0.00030
bis(2-Ethylhexyl)phthalate	0.61260	0.00447	0.06988	0.00051	0.68248	0.00497	0.61754	0.00450	0.06988	0.00051	0.68742	0.00501	0.62249	0.00454	0.06988	0.00051	0.69237	0.00505
Metals																		
Cadmium, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium, Total	0.03029	0.00022	0.00288	0.00002	0.03317	0.00024	0.04829	0.00035	0.00288	0.00002	0.05117	0.00037	0.06630	0.00048	0.00288	0.00002	0.06918	0.00050
Copper, Dissolved	1.12320	0.00819	0.12889	0.00094	1.25209	0.00913	1.12320	0.00819	0.12889	0.00094	1.25209	0.00913	1.12320	0.00819	0.12889	0.00094	1.25209	0.00913
Copper, Total	4.86700	0.03547	0.28780	0.00210	5.15480	0.03757	4.86700	0.03547	0.28780	0.00210	5.15480	0.03757	4.86700	0.03547	0.28780	0.00210	5.15480	0.03757
Lead, Dissolved	0.00198	0.00001	0.00576	0.00004	0.00773	0.00006	0.12465	0.00091	0.00576	0.00004	0.13041	0.00095	0.24733	0.00180	0.00576	0.00004	0.25309	0.00184
Lead, Total	2.36970	0.01727	0.09050	0.00066	2.46020	0.01793	2.36970	0.01727	0.09050	0.00066	2.46020	0.01793	2.36970	0.01727	0.09050	0.00066	2.46020	0.01793
Mercury, Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury, Total	0.00171	0.00001	0.00000	0.00000	0.00171	0.00001	0.00381	0.00003	0.00026	0.00000	0.00408	0.00003	0.00592	0.00004	0.00053	0.00000	0.00644	0.00005
Zinc, Dissolved	9.93440	0.07241	0.97342	0.00709	10.90782	0.07950	9.93440	0.07241	0.97342	0.00709	10.90782	0.07950	9.93440	0.07241	0.97342	0.00709	10.90782	0.07950
Zinc, Total	33.56600	0.24465	2.00110	0.01459	35.56710	0.25924	33.56600	0.24465	2.00110	0.01459	35.56710	0.25924	33.56600	0.24465	2.00110	0.01459	35.56710	0.25924
Miscellaneous Organics																		
2,4-D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MCPP	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Triclopyr	0.01127	0.00008	0.00147	0.00001	0.01273	0.00009	0.02045	0.00015	0.00242	0.00002	0.02286	0.00017	0.02963	0.00022	0.00337	0.00002	0.03300	0.00024
Conventionals																		
Biochemical Oxygen Demand	815.52	5.94	82.84	0.60	898.36	6.55	877.74	6.40	82.84	0.60	960.58	7.00	939.98	6.85	82.84	0.60	1022.82	7.45
Chloride	1523.20	11.10	78.83	0.57	1602.03	11.68	1523.20	11.10	78.83	0.57	1602.03	11.68	1523.20	11.10	78.83	0.57	1602.03	11.68
Solids, Total Suspended	26121.00	190.39	965.37	7.04	27086.37	197.42	26121.00	190.39	965.37	7.04	27086.37	197.42	26121.00	190.39	965.37	7.04	27086.37	197.42
Surfactants	3.27	0.02	1.38	0.01	4.66	0.03	5.98	0.04	1.41	0.01	7.39	0.05	8.68	0.06	1.44	0.01	10.12	0.07

Notes:
Loads estimated by QAPP method.
ND - Not detected. Analyte not detected in any samples from period so no load calculated. * - Area used for load calculation is basin area draining to MS4 (137.2 acres), not total basin area.

2.10 QA/QC Results

Refer to Appendix C.1 for the full QA/QC report.

2.11 Discussion of Results and Follow-up Actions

Permit-required analyses were successfully completed on 37 water samples and three sediment samples during WY2011.

Stormwater chemistry data were screened as they were received from the analytical laboratory looking for outliers or anomalies. Screening resulted in follow-up investigation in the C1 basin which is discussed in the section below.

2.11.1 Commercial Basin Source Investigation

Four base flow samples were collected at the commercial monitoring location (C1) during the previous water year (WY2010). The fecal coliform results for those samples ranged from 6 to 920 CFU/100 mL. The City's Illegal Discharge, Detection and Elimination (IDDE) program uses 5,000 CFU/100 mL as the fecal coliform trigger level in base flow for conducting follow-up investigations since lower trigger levels have typically resulted in tracing non-human sources of bacteria. Thus, no follow-up investigation was performed as a result of the WY2010 results.

During WY2011, four additional base flow samples were collected at C1. Those fecal coliform results ranged from 108 to 15,000 CFU/100mL (see Table 2.7.2). Since one of the four samples did exceed the 5,000 CFU/100 mL fecal coliform trigger level, the City's IDDE team performed an investigation to search for the elevated bacteria source in the C1 basin.

The IDDE investigation occurred throughout July and August 2011. The IDDE team traced the storm sewer system from the C1 monitoring site upstream until no base flow was encountered. In addition to visual, olfactory and test kit screening, the team took over 27 base flow grab samples for bacteria and chemical analysis. The noteworthy results of this investigation are summarized below.

On July 14, 2011, a sample from the maintenance hole located approximately 300 feet upstream from the C1 monitoring site had a fecal coliform concentration of 2,000 CFU/100 ml. Additional fecal coliform sample results from samples collected at this maintenance hole on the August 3 and August 16, 2011 were non-detect and 364 CFU/100mL, respectively.

On July 28, 2011, a sample collected approximately 575 feet directly upstream from C1 had a fecal coliform concentration of 21,000 CFU/100ml. An additional sample at this same maintenance hole on August 16, 2011 had a fecal coliform concentration of 1,000 cfu/100ml. The base flow and IDDE sample results suggested that the source of the fecal coliform was sporadic in nature as opposed to an illicit sanitary connection.

While collecting additional samples on August 16, 2011 in a maintenance hole approximately 850 feet upstream from the C1, an illicit discharge consisting of soapy water was observed. This discharge was immediately source traced to a multi-use building located at the NE corner of NE 41st Street and Brooklyn Ave NE. Occupants of several businesses in the building were using an area floor drain in an enclosed courtyard as the disposal site for mop water. This secluded courtyard contained multiple mop buckets and cleaning products with visible staining from mop water dumping on the floor and walls surrounding the drain (see photo). It is unknown how long this illicit discharging had been occurring

Figure 2.11.1. Photo of Illicit Mop Water Disposal Drain

SPU Environmental Compliance Inspectors performed outreach and education to the business owners on proper techniques for disposal of mop and cleaning water, specifically dumping the water down toilets and not the courtyard drain.

To assure that no plumbing errors or illicit connections were present in the area, a closed caption television (CCTV) inspection was performed in the main storm sewer in Brooklyn Ave NE. This inspection began in the first maintenance hole upstream from C1 and extended to the maintenance hole where the illicit discharged mop water was discovered. No signs of illicit connections were found during this inspection.

The 181-acre C1 basin has many potential threats to stormwater quality. During the IDDE field work, many sources of contaminants were observed and addressed, including: a broken transmission fluid line, leaching concrete products from a construction site and the illegally discharged mop water discussed previously. In addition, there are several large construction projects, mostly housing for the University of Washington, which were under construction in the summer of 2011, that have the potential to impact stormwater quality.

The City's current assumption is that the illicitly dumped mop water was the source of the elevated fecal coliform concentrations measured at the C1 monitoring site. Ongoing stormwater monitoring performed throughout WY2012 will help determine if the source was controlled or additional investigation is necessary.

2.12 SWMP Activities

The City's Stormwater Management Program (SWMP) Activities are described in Attachment A of the 2011 NPDES Annual Report. The City applies all of the activities in the SWMP throughout the areas of the City that are served by the MS4, which includes the R1, C1 and I1 monitoring station drainage basins.

2.13 Summary of Stormwater Characterization Monitoring

The City was successful in meeting Permit sampling goals in Section S8.D for WY2011 which was the second complete year of stormwater characterization monitoring performed under the 2007 Permit. The required number of routine stormwater events was captured with all events meeting all weather and sampling criteria. Continuous flow and rain data were collected for all sites.

Elevated fecal coliform results from the C1 site resulted in a follow up investigation performed during July and August 2011. This investigation found several businesses illegally discharging cleaning water down the storm sewer which is considered the source of the elevated bacteria. Outreach and education was performed to prevent future illegal discharges from these businesses.

2.14 Acknowledgements

Stormwater sampling is very challenging environmental monitoring work due to, among other factors: the difficulties of forecasting weather and targeting storms; operating and maintaining automatic sampling equipment continuously within a drainage system; working in traffic and confined spaces at irregular hours in inclement weather, etc. Data in reports such as this are presented in a matter-of-fact style which typically does not acknowledge that sampling and laboratory personnel are constantly required to rearrange their work and personal schedules to prioritize capturing stormwater samples. Once samples are collected, laboratory personnel must be available to process and preserve samples to meet holding times, and then analyze and manage large amounts of samples and data. The Permit's requirements were very ambitious regarding the large number of samples required using restrictive storm event and sample criteria. During WY2011, the project team met all storm event sampling and weather criteria without exception. This was due to the hard work of many dedicated scientists who collaborated very effectively on this project.

The City of Seattle would like to acknowledge the dedication of the following staff:

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Kim Nickerson
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Mark Harris (project manager) and staff

Seattle Public Utilities
Doug Hutchinson (project manager, report author)
Amy Minichillo, Lea Beard (data validators)

3 S8.E Stormwater Management Program Effectiveness

The program effectiveness monitoring component requires the City to select two specific aspects of the Stormwater Management Program to evaluate. One aspect to be evaluated is to determine the effectiveness of a targeted action. A second aspect to be evaluated is the effectiveness of achieving a targeted environmental outcome. This monitoring is intended to improve stormwater management efforts by providing a feedback loop to help determine if a stormwater management program element is meeting the desired environmental outcome.

The potential impact of urban stormwater runoff on the water quality of receiving waters is of great concern in the Seattle area. While new development and redevelopment may have a large number of options for providing water quality treatment through structural controls, existing developed areas have limited choices for retrofitting their stormwater systems. Thus, nonstructural measures, also known as source control, offer perhaps the greatest potential for improvement of water quality. Roads and other transportation related surfaces make up 26 percent of the land use within the City; the Permit requires that the City establish practices to reduce stormwater impacts associated with runoff from paved surfaces. Street sweeping is one of the source control tools available to meet this permit requirement and the City has recently expanded its sweeping program, with a focus on removing pollutants from roadways that discharge to the City's Municipal Separate Storm Sewer System (MS4). Because of this, the City has chosen to evaluate the program effectiveness of street sweeping for both required aspects:

- **Targeted action** - Does street sweeping result in improvements in stormwater quality and quality of sediments in stormwater discharges or both? This aspect will evaluate the effectiveness of regenerative air street sweeping technology at a frequency of every two weeks to potentially provide treatment at a level similar to structural stormwater BMPs by reducing the quarterly average street dirt pollutant load 60 percent for fine particles (less than 250 microns in diameter).
- **Targeted outcome** - Does street sweeping reduce the discharge of certain pollutants below a targeted annual load amount? This aspect will be evaluated with a spreadsheet model that predicts a targeted annual load reduction, using total suspended solids as a surrogate pollutant, for varying conditions, such as sweeping frequency, sweeping velocity, and parking enforcement compliance.

3.1 Targeted Action

Determining the effectiveness of street sweeping, which captures the full size spectrum of potential pollutants – from silt to gross solids, when compared to structural BMPs, which typically capture solids suspended in the water column, is difficult due to the following factors: other studies (USGS 2007) have not been able to show a direct correlation between street sweeping and a reduction of potential pollutant concentrations in the stormwater water column; BMP basic treatment performance standards are concentration-based for total suspended solids (TSS) within the water column; and finally, street sweeping performance is variable and sampling results are solids-based.

However, the effectiveness of both structural BMPs and street sweeping is dependent on the particle size distribution (PSD) of stormwater solids, which also affects the fate and transportation of potential pollutants associated with the particulate matter (PM) and therefore the impact to the beneficial uses of the receiving environment. Therefore, an understanding of the PSD may be used to help compare the effectiveness.

In order to show that street sweeping using a regenerative air sweeper on a biweekly basis has the potential to reduce the street dirt load at a level similar to structural stormwater BMPs, we assume that: (1) particles with a diameter less than 250 microns (μm) will be suspended in the water column once washed off the street surface and (2) a removal efficiency of 60 percent of the street dirt load meets regulatory performance criterion for typical Seattle conditions. We can then compare the pilot study results for street sweeping, which typically accounts for performance by measuring the pollutant load removed across the entire size spectrum (from silt to gross solids), with stormwater structural BMPs, which typically account for performance by measuring the suspended solids removed from the water column.

Archived quarterly composite street dirt and sweeper waste samples collected during the "Seat*tle Street Sweeping Pilot Study" (SPU & Herrera 2009)* were thawed, split into four particle grain size fractions (silt and clay (<75 μm), fine sand (75 to 250 μm), coarse to medium sand (250 to 2,000 μm), and gravel (> 2,000 μm)) and each fraction was analyzed for seven metals (arsenic, cadmium, chromium, copper, lead, silver, and zinc).

The pilot study samples were collected at two residential basins (West Seattle and Southeast Seattle) from June 20, 2006 through June 19, 2007 and one industrial basin (Diagonal Duwamish) from November 24, 2006 through June 15, 2007. The split samples were analyzed April and May of 2008 from excess sample volume that had been frozen and archived during the pilot study.

Street dirt represents the material potentially available to wash off the street into the drainage system, blow off, or be picked up by a sweeper. Three street dirt samples were collected every four weeks, one from each of the three basins using a vacuum. The individual samples were weighed and analyzed for moisture before combining into a basin quarterly composite sample that was analyzed for grain size and pollutant concentrations.

Sweeper waste samples represent the material picked up by a regenerative air sweeper sweeping between four and six miles per hour and a biweekly frequency over three basins. Each basin has two routes, swept on opposite weeks, for a total of six unique routes. Three sweeper waste samples were collected every four weeks from material representing six routes swept twice during the four-week period. The individual samples were weighed and analyzed for moisture before combining into a basin quarterly composite sample that was analyzed for grain size and pollutant concentrations.

The study found that under average quarterly conditions there is inferred potential for regenerative air street sweeping technology implemented on a biweekly basis to provide a level of treatment similar to structural BMPs by reducing the stormwater suspended solids, chromium, copper, lead, and zinc street dirt load by 60 percent for particle diameters less than fine sand as well as all particles combined.

- The median quarterly average sediment load picked up by the sweeper is significantly greater than the target removal load (60 percent of the median available quarterly average street dirt load) for silt and clay (<75 µm), fine sand (75 to 250 µm), coarse to medium sand (250 to 2,000 µm), and gravel (> 2,000 µm), with p-values of 0.14, 0.25, 0.91, and 0.99, respectively.

- For fines <250 µm, the median quarterly average metal load picked up by the sweeper is significantly greater than the target removal load (60 percent of the median available quarterly average street dirt load) for chromium, copper, lead, and zinc (p-values of 0.12, 0.21, 0.23, and 0.073, respectively).

- For all particle size classes combined, the median quarterly average metal load picked up by the sweeper is significantly greater than the target removal load (60 percent of the median available quarterly average street dirt load) for chromium, copper, lead, and zinc (p-values of 0.20, 0.09, 0.41, and 0.23, respectively).

Given the findings, it is recommended:

- That Seattle Public Utilities continue to support and grow the "Street Sweeping for Water Quality Program," which kicked off February 22, 2011.

- That additional studies be considered to determine the site specific conditions and sweeping operation characteristics needed to maximize the pollutant load removed by sweeping in the most cost effective manner. Study variables may include frequency, seasonality (in particular, dry season, leaf season, and wet season), and sweeping velocity.

3.2 Targeted Outcome

A Microsoft Excel™ spreadsheet model was developed to assist with optimizing the City "Street Sweeping for Water Quality Program" by accounting for factors that affect cost-effective removal of transportation-derived pollutants.

The cost-effectiveness of street sweeping is based on estimates of several variables, some based on assumptions and some quantifiable, such as:

- **Resource availability** to implement a street sweeping program, including labor availability and cost, equipment availability and cost, disposal costs, and parking compliance costs.
- **Optimum pollutant load** that could potentially be removed under the Seattle Pilot Study conditions (e.g. biweekly sweeping with a regenerative air broom between four and six miles per hour with full parking compliance). This includes the available street inventory (curb miles classified with traffic volume street class, land use, and the presence of curbs), sweeper removal rates by street class and land use, and impact of sweeping frequency on the optimum load available for pickup.
- **Pickup efficiency** the efficiency of the sweeper at picking up the available street dirt load for varying sweeping velocity, access to the curb, and street surface conditions.

The value of these variables is estimated based on the most probable information and is influenced by a great number of factors. The model allows the user to consider the effects of likely changes in the key variables on the viability of a street sweeping program. The model also provides the ability to update the assumptions as new information becomes available. describes the assumptions currently used in the model.

Table 3.1. Summary of Model Assumptions.

Category	Physical Process	Model Input Assumption	Notes
Optimal pollutant load the sweeper can remove	Sediment build up	Available street inventory	The available curb miles by land use and street traffic volume class from GIS. Used to estimate the total probable load that could be removed by street sweeping curbed streets within the City.
	Sediment build up	Pollutant load by land use and traffic volume	Based on pilot study data [2]. Includes Seattle specific build up and wash off conditions with regenerative air sweepers sweeping biweekly with full parking compliance at 4 to 6 mph. Ongoing data collection to scale these assumptions to program level is needed.
	Sediment build up and wash off rate [3]	Sweeping Frequency	Assume build up to steady state condition, where buildup and wash off are in equilibrium, is 9 days. Extrapolated from air quality models [4]. Data will be collected from sweeping to better calibrate this assumption
Sweeping Pickup Efficiency	Vacuum effectiveness	Sweeping velocity	A performance factor to account for removal efficiencies affected by sweeper velocity. Assuming a straight line relationship, the slope (-0.0274) is extrapolated from 10 years of data published by the City of Racine and the y-intercept (1.14) is adjusted to match the Pilot Study results (average of 0.122 short wet tons picked up per curb mile). [5] Additional data needed to verify this assumption.
	Access to pollutant load	Access to the curb-line	A performance factor to account for incomplete sweeping of streets from parked cars. A range of 0.5 (low – no parking compliance and heavily parked cars) to 1.0 (high – full parking compliance) is estimated using best professional judgment from Pilot Study data. Assume parking will be most problematic in residential areas. Additional data needed to verify this assumption.
	Vacuum effectiveness	Street condition	A performance factor to account for removal efficiencies affected by pavement roughness, which is a function of surface type and age. A range of 0.9 (low – poor – pitting, cracking, pot holes) to 1.1 (high – smooth, new concrete) is estimated using best professional judgment. Additional data needed to verify this assumption. Based on anecdotal evidence from sweeper operators there is likely an inverse relationship between total sediment and pollutants removed depending on street condition (e.g., poor street condition generates increased sediment load, but the source is deteriorating pavement, not transportation-derived pollutants).

[2] Seattle Street Sweeping Pilot Study Monitoring Report. Prepared by Seattle Public Utilities and Herrera Environmental Consultants. April 22, 2009.

[3] We assume that build up loading, which is primarily a function of land use activity and traffic volume, reaches an equilibrium value between deposition and removal processes, e.g. the amount of material washed off or resuspended matches the amount of material replenished (absent significant application of sanding material for snow and ice tracking, mud/dirt carryout from construction activities in the area, and deposition from wind and/or water erosion of surrounding un-stabilized areas). Sediment wash off is primarily a function of precipitation frequency and intensity. Minor factors include resuspension from heavy traffic loads traveling at higher speeds and high wind velocities.

[4] Maricopa Association of Governments (MAG). PM-10 Certified Street Sweepers. http://www.mag.maricopa.gov/pdf/cms.resource/TIP_2008_CMAQ-Methodology-for-PM10-Street-Sweepers17106.pdf. Downloaded October 21, 2009.

[5] Estimated from data collected by City of Racine from 1984 – 2004 (http://www.cityofracine.org/City/Departments/PublicWorks/Dynamic.aspx?id=1234). Data source at http://www.cityofracine.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=1235&libID=1256

To supplement the assumptions used in the model, Seattle Public Utilities residential customers were asked if they are willing to park elsewhere one day a week at posted times to facilitate street sweeping for pollutant reduction. The 2011 Residential Customer Survey results indicate that three of five respondents are willing to park elsewhere. However, there is a geographical difference, with north Seattle residents more willing to park elsewhere and Duwamish, northeast, and Lake Union residents less willing to park elsewhere.

The model provides the option of developing up to three scenarios with each scenario including up to seven land use and sweeping condition mixes. This approach provides the ability to perform a sensitivity analysis to determine where program modifications will provide the greatest increase in pollutant removal efficiency at the lowest cost.

The model can assist in optimizing sweeping operations by answering questions such as:

- What is the optimum average length of a sweeping route given the equipment capacity, labor constraints, and route design?
- How does the route design (e.g., a loop vs. a wheel spoke path) impact performance?
- What is the trade-off between upgrading the sweeper fleet with new sweepers that have higher mechanical availability and using the existing fleet?
- What is the pollutant removal benefit for different schedules (e.g., night vs. day, eight vs. ten hour shifts, four vs. seven days per week, etc.)?
- What are the resources needed to sweep a certain percentage of the street inventory (e.g., capital costs, annual O&M budget, operators, equipment, signs, etc.)?
- What is the trade-off between voluntary and mandatory parking compliance for different geographical areas (e.g., depending on the willingness of residents to park elsewhere, is voluntary parking compliance [with no signs] more cost-effective than mandatory parking compliance [with signs])?

And further, once operations are optimized, to increase pollutant removal cost-effectiveness by answering such questions as:

- What sweeping velocity provides the highest pollutant removal at the lowest cost (e.g., increasing sweeping velocity reduces pickup efficiency and cost per mile therefore increasing the cost of pollutants removed per mile; what velocity provides the optimum cost per kg pollutant removed)? Note that the sweeping velocity impacts the route length and there is likely a maximum velocity that is practical on congested streets.

- What land uses types and traffic volume based street class should be prioritized to be swept first?
- What is the optimum sweeping frequency for different land uses and traffic volumes considering the season, street condition, and sweeping velocity (e.g., what frequency balances the sediment load build up with wash-off)?
- Should the sweeping plan change depending on the season (e.g., more or less frequent during the wet season, does the objective change from pollutant removal to flood prevention in the fall season, less frequent with more routes in the dry season)?

The model output for each scenario includes a set of outcomes which can be used to determine the resources needed to achieve a specific targeted environmental outcome, and how efficient the sweeping program is at achieving that outcome:

- **Service delivery outcomes** include capital and annual operating and maintenance budget, percent of the street inventory swept, and annual curb miles swept.
- **Environmental outcomes** include annual sediment removed and annual pollutant load (using fines less than 250 µm as a surrogate for total suspended solids [TSS]) removed.
- **Efficiency outcomes** include unit costs on a curb mile swept, sediment removed, and TSS removed basis.

Recommended future actions based on the findings include:

- 2013 O&M budget and schedule for the Street Sweeping for Water Quality Program
- Cost and benefit of adding voluntary parking compliance to the existing program in 2013.
- Evaluation of whether additional sweepers are needed or the regularly scheduled replacement sweepers (due in July) will suffice to meet the 2013 program objectives.
- Resource needs for future expansion into residential areas.

The model does not currently consider the social costs and benefits of a street sweeping program nor any revenue generated from parking fines.

3.3 Program Effectiveness Deliverables

The program effectiveness study is now complete and two deliverables will be submitted to satisfy the Permit requirements for Section S8.E: 1) the targeted action work is documented in a report titled “Program Effectiveness Report - Sweet Sweeping for Water Quality” dated March 2012 which is submitted under separate cover concurrently with this report; and 2) the targeted outcome work's deliverable is a spreadsheet model named "Sweeping to Reduce Contaminants" (STORC) which will be submitted to Ecology on compact disk.

4 S8.F Stormwater Treatment and Hydrologic Management BMP Evaluation

4.1 Overview

The Permit requires full scale field monitoring to evaluate the effectiveness and operation and maintenance requirements of stormwater treatment and hydrologic management best management practice (BMPs) applied in Permittee's jurisdiction. Specifically, the Permit requires that each Phase I Permittee select two treatment types that are standard technologies in their stormwater manuals, for detailed performance monitoring. Two BMP units per each BMP treatment type are required to be monitored. In addition, one hydrologic management (or "flow reduction") BMP is also required to be monitored.

4.1.1 Treatment BMP Number One Overview

One of the two selected treatment types that the City has monitored is the Stormwater Management StormFilter® (StormFilter) manufactured by Contech Construction Products Inc. (Contech) which is a proprietary stormwater treatment BMP. The specific configuration evaluated by the City was the CatchBasin StormFilter™ (CBSF).

The CBSF is a frequently installed BMP by the Seattle Department of Transportation (SDOT) to treat roadway stormwater runoff. The City was interested in monitoring the effectiveness of this BMP because the cartridge technology has received a basic treatment General Use Level Designation (GULD) by Ecology based on testing within a vault configuration not a catch basin device.

The City's CBSF monitoring was started during WY2009 and was completed during the current water year.

4.1.2 Treatment BMP Number Two Overview

The second BMP project that the City proposed to monitor consisted of two bioretention swales located in the High Point redevelopment project of West Seattle. The final QAPP for the High Point bioretention swales project was submitted to Ecology on February 12, 2009. The City began implementation of monitoring the bioretention swales prior to February 2009, with the intent to collect the first water quality samples with the start of the partial water year on February 16, 2009. However, factors such as the complexity of this monitoring project coupled with concerns over the numerous assumptions and models required to make performance estimates, and the lack of transferability of findings from the project, resulted in the City changing its approach to the second BMP.

The City was still interested in evaluating the performance of bioretention systems and soils and pursued an opportunity to partner with the Washington State University (WSU) Puyallup Research and Extension Center to have WSU conduct BMP evaluation monitoring on the City's behalf by using Special Condition S8.B of the Permit. WSU, with the City of Puyallup, is constructing a Low Impact Development (LID) research center at the WSU Puyallup Research and Extension Center. The LID center will contain many full-scale BMPs including bioretention cells, water gardens and porous pavements.

The City will use monitoring and results from four bioretention cells, referred to as mesocosms, to meet Special Condition S8.F.2.b for monitoring a metals/phosphorus treatment BMP. The four mesocosms are identical (essentially one primary and three replicates) and all contain a 60/40 mix of aggregate/compost. The mix and configuration of the mesocosms is similar to the City's bioretention design standard. Stormwater will flow into each mesocosm and the water quality samples and flow data will be collected at the influent and effluent of each mesocosm to calculate pollutant reduction.

The City notified Ecology of its plan to replace the High Point BMP project with the WSU collaboration verbally and followed with a letter dated September 15, 2009. Ecology gave the City approval to proceed with this plan. The City signed a Memorandum of Agreement (MOA) with WSU on November 12, 2009. The WSU mesocosm final QAPP was completed in September 2010 and Ecology approved the QAPP in a letter dated October 27, 2010. Construction of the research facility was completed in the fall of 2010 and the monitoring was started in the late fall of 2011.

A brief summary of information provided in the QAPP and the results of the WY2010 work on this project are presented below.

4.1.3 Hydrologic Management BMP Overview

The Permit requires the City to monitor a flow reduction strategy that is in use in the city or planned for installation within the city in a paired study or against a predicted outcome. To meet this requirement, the City has monitored one bioretention swale located in the High Point community in West Seattle. Flow was monitored in the swale continuously for two years and reported in the WY2009 annual report.

4.2 CatchBasin StormFilter™ Monitoring (Treatment BMP One)

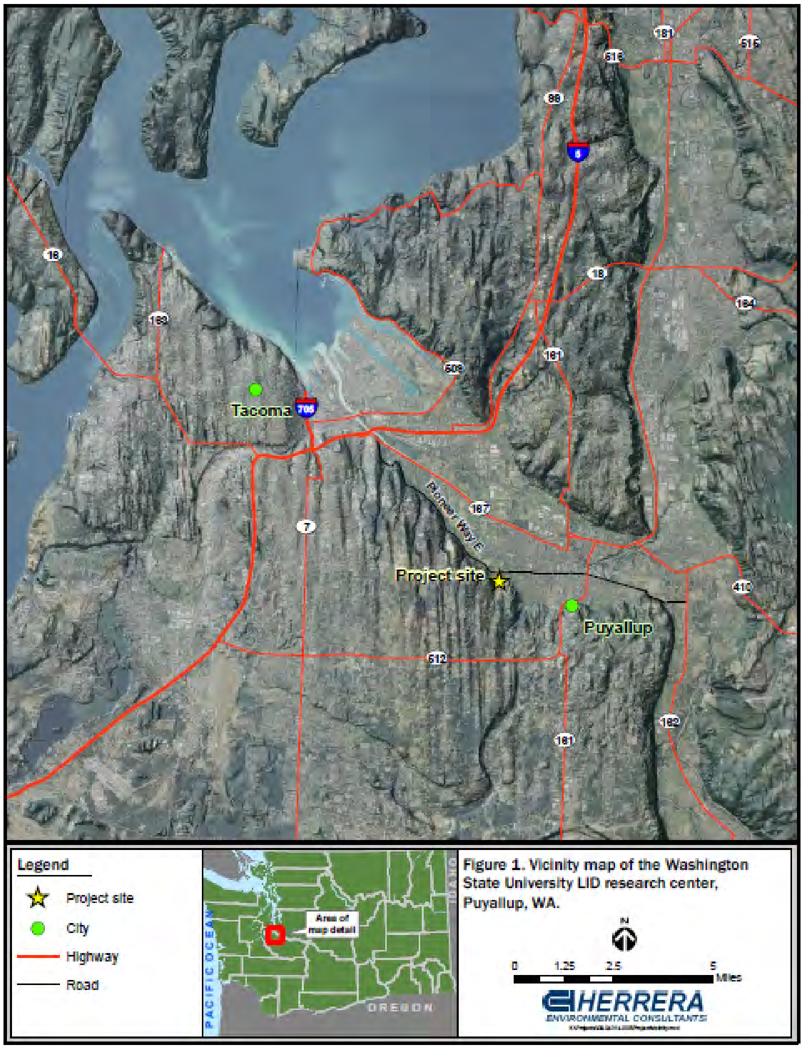
The CatchBasin StormFilter monitoring work was performed from February 2009 through September 2011. The performance of the units was evaluated based on analyses of water quality, rainfall and flow data. A total of 37 stormwater events were sampled between both of the monitored CBSF units, which exceeded the required maximum storm event number of 35 required pursuant to the Permit. Because the maximum sample number has been achieved, this study is considered complete and SPU has fulfilled its monitoring obligation pursuant to Permit.

The complete results of this study, which spanned three water years, are presented in a separate report titled "CatchBasin StormFilter Performance Evaluation Report" dated March 5, 2012 and submitted to Ecology concurrently with this report.

4.3 WSU Mesocosm Monitoring (Treatment BMP Two)

The City and Washington State University (WSU) have partnered to study bioretention stormwater facilities as the second treatment BMP that the City will monitor to meet Permit requirements. During WY2010, this partnership produced a QAPP for the mesocosm monitoring portion of the new LID research center which is located at WSU's Puyallup campus (see Figure 4.10). The QAPP was prepared by Herrera Environmental Consultants on the behalf of WSU and the City. A final QAPP was submitted to Ecology in September 2010. The following summarizes the monitoring plan detailed in the QAPP.

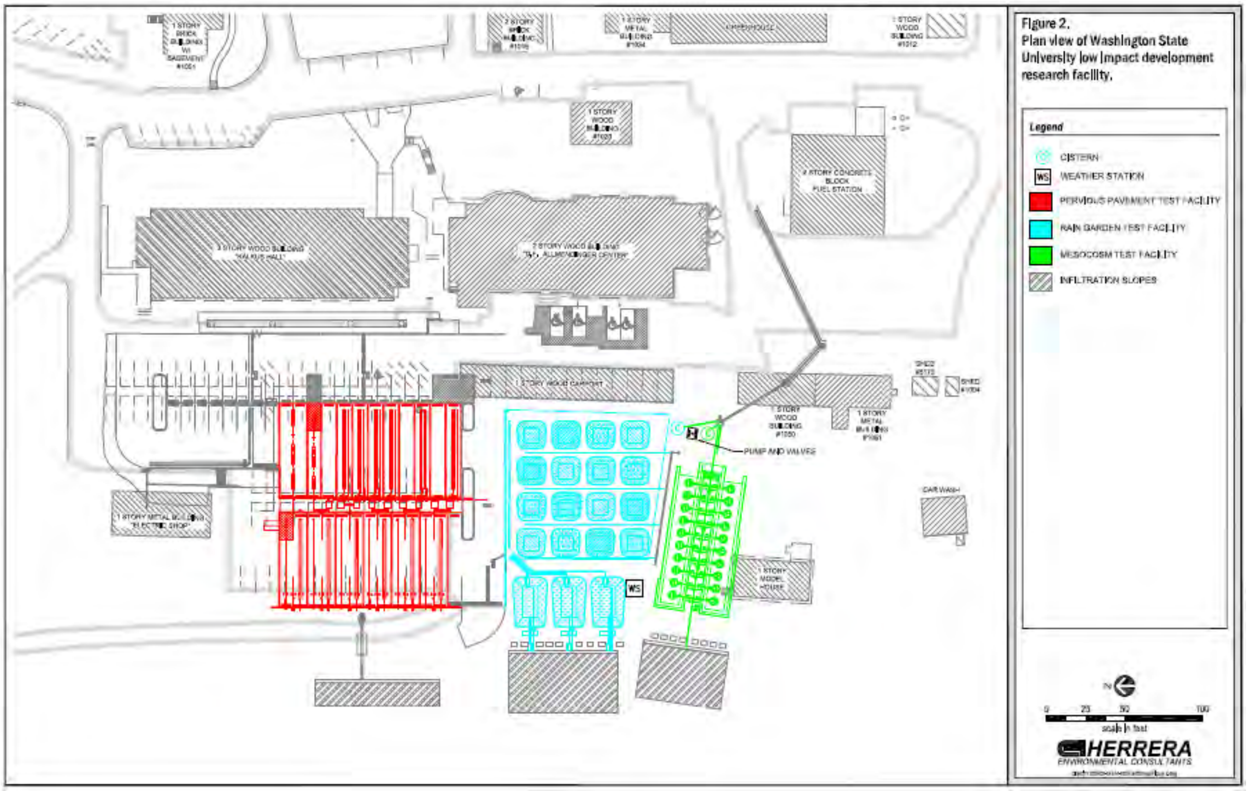
Figure 4.3. Vicinty Map – WSU LID Research Center



4.3.1 WSU Mesocosm Monitoring Design Summary

The LID research center contains many full-scale, structural stormwater BMPs including bioretention cells, water gardens and porous pavements. Figure 4.3.1a displays the plan view of the entire LID research center, which includes the mesocosms (shown in green) along with other LID elements not studied by the City.

Figure 4.3.1a. Site Map – WSU LID Research Center



The City will analyze data from a subset (four) of the twenty bioretention cells, referred to as mesocosms, to evaluate bioretention soils as metals/phosphorus treatment BMPs. The four mesocosms of the City's study are identical (essentially one primary and three replicates) and all contain a soil mixture of 60 percent aggregate and 40 percent compost. The mix, configuration and sizing of the mesocosms are similar to the bioretention design standard in the City's stormwater code. The monitoring plan for this subset of mesocosms will conform to requirements identified in the Permit and be very similar to those used for Treatment BMP Number One.

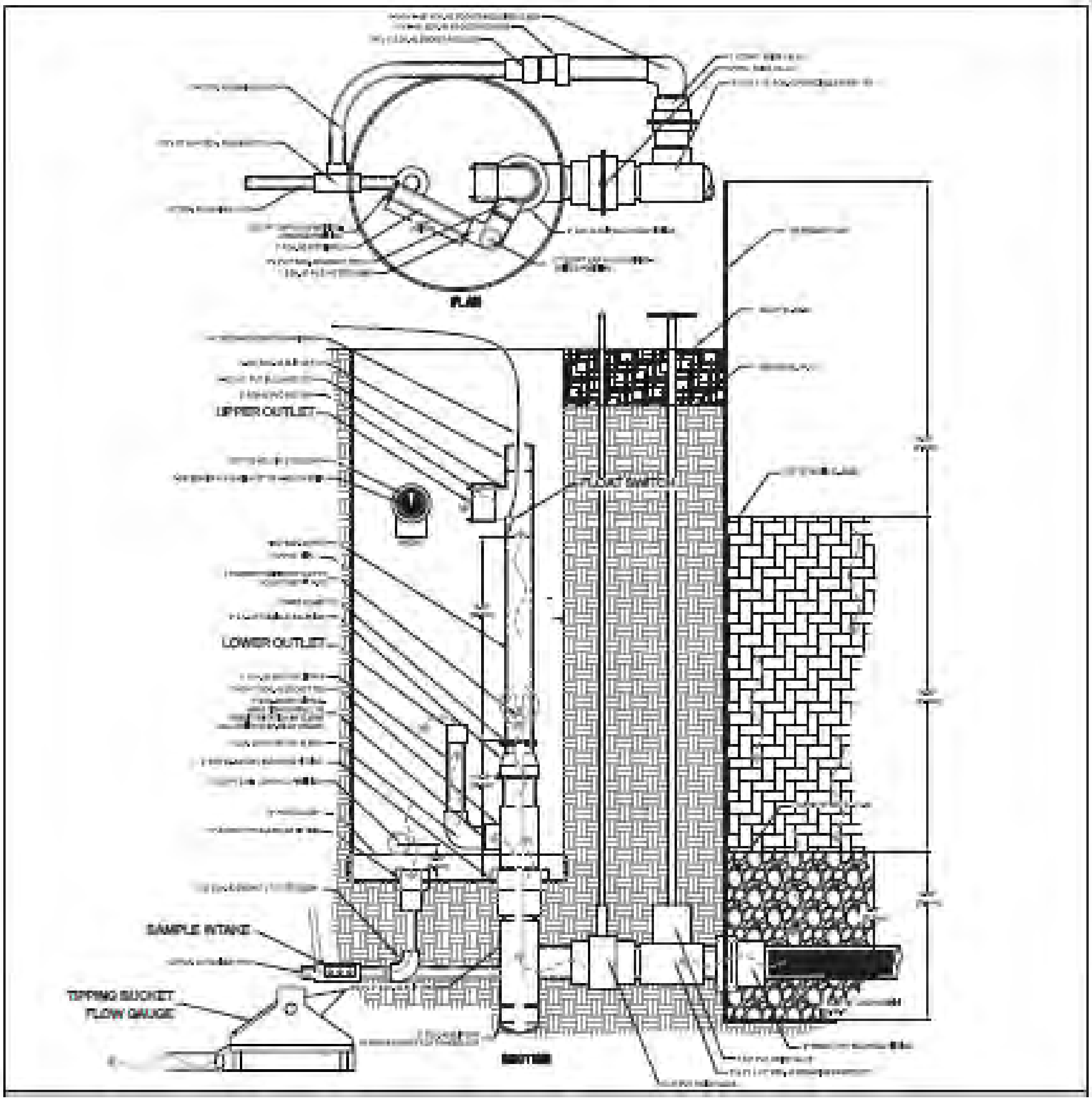
Runoff from an 18,021 square foot (SF) drainage area will be routed via gravity flow to all 20 mesocosms and one influent monitoring station. The runoff will be routed to an 11,370 liter (L) (3,000 gallon) cistern for storage and delivery to the mesocosms. Stormwater from the cistern will be routed via gravity flow to the mesocosms to assess treatment performance during natural storms. Weir boxes constructed at the water surface elevation inside the cistern will distribute flows evenly to each mesocosm, with one distribution line bypassing the mesocosms and terminating at a separate Influent Monitoring Station. Influent flows and chemistry for all the mesocosms will be generalized based on data that are collected at this station.

Eductors (jet pump ejectors) installed inside the cistern will be activated during sampled storm events to attempt to keep particulate bound pollutants from settling out in the cistern prior to reaching the mesocosms. The educators were installed to minimize pretreatment that might occur in the cistern that would bias the results from the mesocosm monitoring. If settling of solids does occur within the cistern (essentially performing pretreatment), the result will be to lower the influent concentration of stormwater distributed to all the mesocosms and the Influent Monitoring Station. The influent versus effluent comparison will not be compromised by the effect of pretreatment, but the calculated performance efficiency of the mesocosms may be more conservative compared to using “untreated” or higher concentration influent stormwater.

Each mesocosm is constructed with a 152.4 centimeter (cm) (60 inches) diameter by 132 cm (52 inches) deep media tank to hold the bioretention soil mix. The bottom of each media tank is filled with coarse sand to a depth of 30.5 cm (12 inches) thick. Next, 61 cm (24 inches) of the bioretention soil mix was placed over the sand layer and hand packed before water is introduced to the system. A slotted underdrain pipe within the sand layer serves as the drain for the mesocosm. Flow enters the tanks through a manifold constructed of plastic piping perforated with drilled holes that distributes water across the surface of the bioretention soil mix. The following figure shows a cross-section and plan view of a typical mesocosm with related components.

Each mesocosm has a surface area of 19.63 SF. Given flows from the impervious drainage area will be distributed equally to the 20 mesocosms and the Influent Monitoring Station, the ratio of contributing basin area to surface area for the mesocosm is 2.3 percent ([19.63 SF $\times$ 21]/18,021 SF = 0.023 = 2.3 percent). For reference, SPU sizing criteria for water quality treatment using bioretention require the bottom area of the treatment system to represent 2.6 percent of the contributing area for 6 inches of ponding, and 2.0 percent of the contributing area for 12 inches of ponding. Pursuant to SPU design criteria, the maximum ponding depth for bioretention cells is 12 inches and in high density right-of-way applications the ponding depth shall be no greater than 6 inches. In general, these data indicate the mesocosms are appropriately sized for assessing the performance of systems that were constructed to meet SPU’s sizing criteria for water quality treatment (larger sizing is required for facilities used for flow control).

Figure 4.3.1b. Mesocosm Cross-Section and Plan View



Stormwater inflows and outflows to the four mesocosms monitored by WSU for fulfillment of the City's Permit requirements will be measured continuously. Although the mesocosms are sized for water quality only, the flow data will then be analyzed to evaluate the flow reduction effects of the bioretention soil mix, including its effects on reducing and/or delaying flow peaks, volume and duration. In conjunction with the water quality monitoring described below, these data will also facilitate event-based pollutant loading analyses for characterizing water quality treatment performance.

Volume-proportional composite effluent samples will be collected from each mesocosm and used to characterize effluent chemistry. Similarly, one volume-proportional composite sample will be collected from the Influent Monitoring Station and used to generalize influent chemistry across all the mesocosms.

Storm criteria, analytical parameters, sample numbers and data and analysis goals will all be the same as used for the Catch Basin StormFilter BMP (Treatment BMP Number One) monitoring discussed previously in this report.

4.3.2 Monitoring Status

Construction of the facility was completed during the fall of 2010. Monitoring equipment was purchased, installed, programmed and tested beginning early 2011 and finished during the summer of 2011. The first mesocosm storms were not sampled until November 2011 so monitoring results will be included in the WY2012 annual report.

4.4 Hydrologic Management BMP Monitoring

SPU completed the hydrologic management BMP assessment during WY2009. For a discussion of this work, refer to the WY2009 Annual Report.

Appendix C.1: Stormwater Characterization - Quality Assurance/Quality Control Report

City of Seattle

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This Quality Assurance/Quality Control (QA/QC) report presents results of the QA/QC review of flow monitoring and analytical data generated for the Stormwater Characterization project (Permit Section S8.D) for Water Year (WY) 2011. The following discussion includes QA/QC practices and results for flow monitoring, laboratory analytical testing and field sample analysis.

Flow Monitoring QA/QC Results

Flow data were reviewed and edited according to the procedures outlined in Section 2.3.8.2 of the body of the main report. The following is a summary of any inconsistencies noted during data review at each of the three monitoring locations:

Residential Monitoring Station (R1): During each routine monthly maintenance visit, the pressure transducer in the R1 flume was removed, cleaned and reinstalled. This cleaning was necessary due to the accumulation of fine sediment within the flume's stilling well where the sensor is positioned that can foul the sensitive diaphragm of the transducer. A water level check was performed each time prior to sensor removal to provide a point of reference for correcting the level data. The water level checks indicated that the pressure transducer readings were drifting up to 0.03 feet over each month. The drift pattern was observed for transducers from multiple manufacturers so the drift is attributed to site conditions. As part of the troubleshooting and sensor testing, the R1 transducer was removed from the flume and placed in a bucket of water from August 8 to August 12, 2011. No rain fell during this testing period so the flow was estimated to be zero. All other level and flow data were routinely corrected for drift during the data QC process.

Commercial Monitoring Station (C1): The storm pipe at C1 has a slope of 7 percent which results in very high velocities, often exceeding 10 feet per second [(fps) - velocities above 10 fps are considered less than optimal] and relatively low water levels (base flow levels are less than 2 inches). Low water levels make for inaccurate velocity measurements (the velocity sensor requires approximately 3 inches of water level for accurate measurements) and during moderate to high flow conditions the high velocity can produce a turbulent "rooster tail" (flows hitting the front of sensor and ramping over the sensor in an aerated and turbulent manner) over the submerged area/velocity sensor which causes high variability in the water level measurement. To increase the accuracy of the flow data, a low flow dam was installed immediately downstream of the sensor to backup water over the sensor to enable velocity measurements at low to moderate flows and to mitigate the rooster tail effect during higher flows. The dam improves the accuracy of flow measurements during higher flow storm conditions but can cause overestimation of flow during lower, base flow conditions. This is because level is measured within the backwater zone (because the level transducer is located near the back of the submerged sensor) but the Doppler velocity sensor is obtaining measurements just upstream of the backwater zone (since the velocity sensor is located at the very front of the sensor) so velocity measurements are largely unaffected by the backwater created by the dam. The combination of the backwatered, elevated level readings and unaffected velocity readings can lead to a general overestimation of the flow rate under base flow conditions. As the flow increases, the sensor becomes more completely submerged and the check dam's influence is reduced. Increased flow leads to increased flow measurement accuracy. Since the presence of the dam is considered to provide increased flow accuracy during storm flows, the storm flow data are considered as accurate as possible given the challenging site conditions.

Debris is commonly found in this pipe and there have been numerous occurrences of debris becoming entangled in or around the area/velocity sensor and the sediment traps located downstream. This debris is removed immediately upon discovery but may result in short periods of lower accuracy flow data as the debris obstructs the sensor's ability to measure velocity.

Several data gaps occurred between January 1 and March 11, 2011. The level and/or velocity sensor data were flat-lined or non-existing during these gaps. The area velocity sensor was replaced on March 8, 2011 and a new power cord was installed on March 11, 2011 to resolve the issue. The gaps add up to about two full days of missing data.

Anomalous spikes in velocity and flow were observed in the data throughout the year. The spikes typically occurred during periods with low flow and were likely caused by inconsistent communication errors between the flow monitor and data logger (which are made by different manufacturers). These spikes were not representative of actual flow conditions and were removed from the final flow data.

Industrial Monitoring Station (I1): This site experiences a backwater condition due to the pipe's low elevation difference with the Duwamish River which can result in below optimum flow velocities for the Doppler velocity sensor [velocities less than one foot per second (fps) are difficult for the sensor to measure accurately]. The standing water level in the pipe created by the backwater is always greater than 1 foot but averages around 2 feet during most of the year. Runoff from smaller storms enters the pipe and is slowed by the standing water. The diminished velocities are primarily a concern during small or low intensity events where the slow velocities may be undetected by the sensor which results in the flow being calculated as zero. During larger events, the backwater effect is less of a problem as the increased runoff creates higher velocities. Therefore, the confidence in the velocity and flow data is lower for small events than for the larger events where higher flow velocities and rates occur.

The velocity sensor was obstructed by sediment between October 13 and October 26, 2010 and between December 14 and December 30, 2011. Velocity was recorded as zero during these periods despite several large storm events, so the dependent flow value was calculated as zero during these periods. The velocity sensor was restored each time by cleaning and was later relocated to a position well out of any pipe sediment on January 17, 2011. Velocity and flow data during these two periods are not considered valid and were not included in the finalized data set. The flow data were not recreated from level data during these periods since the level data varies based on the tides and backwater conditions so a simple level to flow relationship cannot be generated for this site.

Anomalous spikes in level and flow were observed in the data throughout the year. The spikes typically occurred during periods with zero flow and were likely caused by inconsistent communication between the flow monitor and data logger (which are made by different manufacturers) and were not representative of actual flow conditions. These spikes were removed from the final flow data.

There was data gap on January 19-21, 2011 during which no data were collected.

Analytical QA/QC Results

This analytical data quality QA/QC report addresses analytical data collected for the Stormwater Characterization project during WY2011.

Analytical Data QA/QC Procedures

All laboratory data packages were received with a hardcopy report and an electronic data deliverable (EDD). For each data package, laboratory case narratives were reviewed for quality control issues and corrective action(s) taken. Data were evaluated for required methods, holding times, reporting limits, accuracy, precision and blank contamination.

Each EDD was imported into a review template spreadsheet where deviations from the measurement quality objectives (MQOs) were identified and associated samples were qualified accordingly.

One result value per sample per analyte is reported. Where the laboratory performed dilutions or re-analyses that resulted in multiple valid values, the result with the lowest detection limit is reported.

Data qualifiers were applied to sample chemistry data based on the results of validation. Four data qualifier codes were used; U, J, UJ and R.

Data Qualifier Definitions

Data Qualifier	Definition
U	Analyte was analyzed for, but not detected above reported result.
J	Reported result is an estimated quantity.
UJ	Analyte was analyzed for, but not detected above reported estimate.

Data Qualifier	Definition
R	Result value was rejected. Result should not be used in analyses.

Analytical Methods and Reporting Limits

The following table is used to describe the methods and reporting limits (RL) used by the laboratory. Reporting limits represents the minimum concentration of an analyte in a specific matrix that can be identified and quantified above the method detection limit and within specified limits of precision and bias during routine analytical operating conditions. Reporting limits can vary by individual samples, particularly for sediments where the quantity and dilution analyzed affect the minimum detectable value.

Stormwater Samples - Analytes, Methods and Reporting Limits

Analyte Group	Analyte	Reporting Limit	Units	Lab Method
Bacteria	Fecal Coliform	2	CFU/ 100 mL	SM9222D
Conventional	BOD	2	mg/L	SM5210B
	Conductivity	1	µmhos/cm	EPA120.1
	Hardness	0.33	mg/L $CaCO_3$	SM2340B
	pH	0.01	std units	SM4500H
	Solids, Total Suspended	1	mg/L	SM2540B
	Surfactants	0.025	mg/L	SM5540C
	Turbidity	0.05	NTU	EPA180.1
Metals	Cadmium - Dissolved	0.1 [a]	µg/L	EPA200.8
	Cadmium - Total	0.1 [a]	µg/L	EPA200.8
	Copper - Dissolved	0.5	µg/L	EPA200.8
	Copper - Total	0.5	µg/L	EPA200.8
	Lead - Dissolved	0.1 [a]	µg/L	EPA200.8
	Lead - Total	0.1 [a]	µg/L	EPA200.8
	Mercury - Dissolved	0.02	µg/L	SW7470A
	Mercury - Total	0.02	µg/L	SW7470A
	Zinc - Dissolved	4	µg/L	EPA200.8
	Zinc - Total	4	µg/L	EPA200.8
Nutrients	Chloride	0.1	mg/L	EPA300.0

Analyte Group	Analyte	Reporting Limit	Units	Lab Method
	Nitrate + Nitrite	0.01	mg-N/L	EPA353.2
	Nitrogen, Total Kjeldahl	0.3	mg-N/L	EPA351.2
	Orthophosphate	0.004	mg-P/L	SM4500-PE
	Phosphorus, Total	0.008	mg-P/L	SM4500-PE
SVOC	2,4-D	0.08 [b]	µg/L	EPA8321B
	Diazinon	0.2	µg/L	SW8270DSIM
	Dichlobenil	0.024	µg/L	SW8270DSIM
	Malathion	0.2	µg/L	SW8270DSIM
	MCPP	0.08 [b]	µg/L	EPA8321B
	Prometon	0.024	µg/L	SW8270DSIM
	Triclopyr	0.08	µg/L	EPA8321B
	Chlorpyrifos	0.2	µg/L	SW8270DSIM
	Dibenzofuran	0.1	µg/L	SW8270DSIM
	PAHs	0.1	µg/L	SW8270DSIM
	Phthalates	1	µg/L	SW8270D
	Pentachlorophenol	0.5	µg/L	SW8270DSIM
TPH	Diesel Range	0.1	mg/L	NWTPH-DX
	Gasoline Range Hydrocarbons	0.25	mg/L	NWTPH-GX
	Motor Oil	0.2	mg/L	NWTPH-DX

Notes:

a. Corrective action was taken to reduce to the reporting limit to 0.1 µg/L.

b. Corrective action was taken to lower the reporting limit to 0.08 µg/L by using analytical method EPA8321B.

Sediment Samples- Analytes, Methods and Reporting Limits

Analyte Group	Analyte	Reporting Limit	Units	Lab Method
Conventionals	Solids, Total	0.01	%	SM2540B
	Grain Size	0.1	%	PSEP-PS
	Total Organic Carbon	0.02	%	EPA9060
Metals	Cadmium	0.1	mg/kg	EPA200.8
	Copper	0.5	mg/kg	EPA200.8
	Lead	0.1	mg/kg	EPA200.8
	Mercury	0.02	mg/kg	SW7471

Analyte Group	Analyte	Reporting Limit	Units	Lab Method
	Zinc	0.2	mg/kg	EPA200.8
PCB	Aroclors	32	µg/kg	SW8082
Pesticides	Chlorpyrifos	10	µg/kg	SW8270DSIM
	Diazinon	10	µg/kg	SW8270DSIM
	Malathion	13	µg/kg	SW8270DSIM
PAHs	PAHs	5	µg/kg	SW8270DSIM
Phenolics[1]	2,4,5-Trichlorophenol	1	µg/kg	SW8270DSIM
	2,4,6-Trichlorophenol	1	µg/kg	SW8270DSIM
	2,4-Dichlorophenol	1	µg/kg	SW8270DSIM
	2,4-Dimethylphenol	1	µg/kg	SW8270DSIM
	2,4-Dinitrophenol	1	µg/kg	SW8270DSIM
	2-Chlorophenol	1	µg/kg	SW8270DSIM
	2-Methylphenol	1	µg/kg	SW8270DSIM
	2-Nitrophenol	1	µg/kg	SW8270DSIM
	4,6-Dinitro-2-methylphenol	1	µg/kg	SW8270DSIM
	4-Chloro-3-methylphenol	1	µg/kg	SW8270DSIM
	4-Methylphenol	1	µg/kg	SW8270DSIM
	4-Nitrophenol	1	µg/kg	SW8270DSIM
	Pentachlorophenol	1	µg/kg	SW8270DSIM
	Phenol	1	µg/kg	SW8270DSIM
Phthalates	bis(2-Ethylhexyl)phthalate	25	µg/kg	SW8270D
	Butylbenzylphthalate	20	µg/kg	SW8270D
	Diethylphthalate	50	µg/kg	SW8270D
	Dimethylphthalate	20	µg/kg	SW8270D
	Di-n-Butylphthalate	20	µg/kg	SW8270D
	Di-n-Octyl phthalate	20	µg/kg	SW8270D

Notes:

1. In order to achieve lower reporting limits, phenolic analysis was subcontracted to Spectra Laboratories. The laboratory was instructed to performed pentachlorophenol by SW8270D-SIM and all other phenolics by SW8270D. The laboratory, in an effort to reach the lowest possible limits, mistakenly analyzed for all the phenolic compounds using SW8270D-SIM. This resulted in achieving much lower than required reporting limits for phenolics. However, due to the difficulty in analyzing these sediments using SW8270D-SIM, Spectra Laboratories has refused to attempt this low level phenolics analysis again and will perform SW8270D in the future.

Laboratory Data QA/QC Evaluation Results

Holding Time

All sample results were assessed for holding time compliance in accordance with 40 Code of Federal Regulations (CFR) Part 136. For composite samples, the sample time used was the last aliquot in each composite.

Analytical results obtained outside of holding time, but within 2x the holding time have been qualified as estimated (J). Qualification based on holding time is only applied to the specific results described herein.

Holding times were met for all stormwater samples. The following sediment sample results were obtained outside of holding time:

All sediment results for phenolics and pentachlorophenol, were analyzed 13 days past hold time. The laboratory reported that though the samples were extracted within the hold time, matrix issues required the analysis to be stopped multiple times for instrument clean-up, sample dilutions and re-runs. SPU will notify laboratories in the future of potential matrix issues with these samples that could prolong the analysis time. No further action was taken.

All sediment results for total solids were analyzed 6 days past hold time. The laboratory had inadvertently assumed a 14 day hold time. SPU has addressed corrective action with the lab to ensure samples are analyzed within hold times. Analytical results obtained outside of holding time have been qualified as estimated (J/UJ).

Laboratory Blanks

Laboratory method blanks were generated and analyzed by the laboratories in association with primary environmental samples. The following table lists the qualification actions resulting from the blank results.

Blank Validation Criteria

Blank Result	Blank Compared to Sample	Action
Blank > RL	Sample < RL	Qualify sample result as non-detect (U) at the Reporting Limit.
	RL < Sample < Blank	Qualify sample result as non-detect (U) at the reported concentration.
	Blank < Sample < 10x Blank	Qualify sample result as estimated (J).
	10x Blank < Sample	No qualification needed.
Blank < (-RL)	Sample < RL	Qualify sample result as estimated non-detect (UJ) at Reporting Limit.

Blank Result	Blank Compared to Sample	Action
	RL < Sample < 10x Blank	Qualify sample result as estimated (J).
	10x Blank < Sample	No qualification needed.
(-RL) < Blank < RL	Sample < RL	Qualify sample result as non-detect (U) at Reporting Limit.
	RL < Sample	No qualification needed.

RL – reporting limit

The following table illustrates the application of qualifiers to sample results based on the blank QC sample type.

Association of Blank QC Qualifiers to Results

Blank Sample Type	Associated Results
Method Blank	All results in prep batch
Filter Blank	All results from same sample delivery group
Trip Blank	All results from same sample delivery group
Tubing Blank	All composite results from project water year and
Bottle Blank/Splitter Blank/Bailer Blank	All composite results from project water year
Grab Sampler Equipment Blank	All grab results from project water year

All laboratory method blank results were within control limits with the exception of those listed below. For the method blanks exceedances below, corrective action has been taken and associated sample results were qualified accordingly.

Method Blank Exceedances for Water Samples

Analyte	Reported Result	Units	Action
bis(2-Ethylhexyl)phthalate	7.3	µg/L	Sample result less than the 7.3 qualified U
Orthophosphate	0.007	mg-P/L	Sample results between 0.007 and 0.07 qualified J

Field and equipment blanks were collected and analyzed in addition to laboratory method blanks. The results of these additional blanks can be found in the *Field Sample QC/QC Results* section later in this report.

No method blank exceedances were observed for blank samples associated with sediment samples.

Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy was demonstrated by analysis of matrix spikes (MS), laboratory control samples (LCS), reference materials (RM) and surrogate compounds (SUR). Laboratory control limits were used when provided. The following table lists the qualification actions resulting from the accuracy analysis.

Accuracy Validation Criteria

Percent Recovery*	Sample Compared to RL	Action
%R < LowLimit	Sample ≤ RL	Qualify sample result as estimated non-detect (UJ).
	RL < Sample	Qualify sample result as estimated (J).
	Parent† > 4x spike added	No qualification needed.
UppLimit < %R	Sample ≤ RL	No qualification needed.
	RL < Sample	Qualify sample result as estimated (J).
	Parent > 4x spike added	No qualification needed.

RL – reporting limit

† Parent - The sample from which an aliquot is used to make the spiked QC sample.

* The percent recovery of the spiked compound and is calculated as:

$$\%R = \frac{(Spiked\ QC\ Sample\ Result - Parent\ Sample\ Result)}{Spike\ amount}$$

The following table illustrates the application of qualifiers to sample results based on the accuracy of QC sample types.

Association of Accuracy QC to Sample Results

QC Type	Associated Results
LCS/LCSD/RM	All results in prep batch
MS/MSD	All results in prep batch
Surrogate	Results for associated analyte in current sample only

All accuracy QC results were within control limits except as noted below. Sample results associated with QC exceedances have been qualified as appropriate.

Accuracy Exceedances for Water Samples

Analyte	Type	Analysis Date	Out	Action
Anthracene	LCS	8/12/2011	Low	Associated Sample Qualified J
Benzo(a)anthracene	LCS	2/8/2011	Low	Associated Sample Qualified UJ
Benzo(a)anthracene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Benzo(a)pyrene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Benzo(g,h,i)perylene	MS/MSD	12/17/2010	Low	Associated Samples Qualified J
Benzo(g,h,i)perylene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Benzo(g,h,i)perylene	LCS	9/28/2011	Low	Associated Samples Qualified UJ
Biochemical Oxygen Demand	LCS	8/3/2011	Low	Associated Sample Qualified J
Calcium	MS	12/13/2010	Low	Associated Sample Qualified J

Analyte	Type	Analysis Date	Out	Action
Chrysene	LCS	2/8/2011	Low	Associated Sample Qualified J
Dibenzofuran	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Diesel Range Hydrocarbons	LCS/LCSD	11/4/2010	High	Associated Samples Qualified J
Fluoranthene	LCS	2/8/2011	Low	Associated Sample Qualified UJ
Fluoranthene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Fluoranthene	LCS	9/28/2011	Low	Associated Samples Qualified J/UJ
Indeno(1,2,3-cd)pyrene	MS/MSD	12/17/2010	Low	Associated Sample Qualified J
Indeno(1,2,3-cd)pyrene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Indeno(1,2,3-cd)pyrene	LCS	9/28/2011	Low	Associated Samples Qualified UJ
Phenanthrene	LCS	2/8/2011	Low	Associated Sample Qualified UJ
Phenanthrene	LCS	8/12/2011	Low	Associated Sample Qualified UJ
Pyrene	MS	12/17/2010	Low	Associated Samples Qualified J

Accuracy Exceedances for Sediment Samples

Analyte	Type	Analysis Date	Out	Action
2-Methylphenol	MS/MSD	11/22/2011	High	Associated positive results qualified J
4,6-Dinitro-2-methylphenol	LCS	11/22/2011	Low	Associated results qualified J/UJ
Pentachlorophenol	LCS	11/22/2011	Low	Associated results qualified J/UJ
Pentachlorophenol	MS	11/22/2011	High	Associated positive results qualified J

The Laboratory Control Sample (LCS) recoveries for the above compounds did not meet the control limits established by the project. However, the limits, with the exception of biochemical oxygen demand (BOD), were considered in control by the laboratory. For this reason, the associated samples were qualified as estimated. For BOD, it is presumed from the laboratory log books that weak BOD seed material resulted in the low LCS recovery. As the BOD analysis cannot be reanalyzed, the associated samples were qualified as estimated (J) and no further action was taken.

Precision

Precision is the degree observed reproducibility of measurement results. Precision was demonstrated by analysis of laboratory sample duplicates (LD), field sample duplicates (FD), laboratory control sample duplicates (LCSD) and matrix spike duplicates (MSD). The following table lists the qualification actions resulting from the precision analysis.

Precision Validation Criteria

<table>
<tr><th rowspan="2">Matrix</th><th colspan="2">Original & Duplicate</th><th rowspan="2">Associated Sample</th><th rowspan="2">Action</th></tr>
<tr><th>Criteria 1</th><th>Criteria 2</th></tr>
<tr><td rowspan="3">Water</td><td rowspan="6">Both Original and Dup Results < 5x RL</td><td rowspan="2">|original - duplicate| > RL</td><td>Result < RL</td><td>Qualify sample results as estimated non-detect (UJ).</td></tr>
<tr><td>Result > RL</td><td>Qualify sample results as estimated (J).</td></tr>
<tr><td>|original - duplicate|≤ RL</td><td>All</td><td>No qualification needed.</td></tr>
<tr><td rowspan="3">Sed</td><td rowspan="2">|original - duplicate| > 2x RL</td><td>Result < RL</td><td>Qualify sample results as estimated non-detect (UJ).</td></tr>
<tr><td>Result > RL</td><td>Qualify sample results as estimated non-detect (UJ).</td></tr>
<tr><td>|original - duplicate|≤ 2x RL</td><td>All</td><td>No qualification needed.</td></tr>
<tr><td rowspan="3">Water</td><td rowspan="6">Either Original or Dup Results > 5x RL</td><td rowspan="2">RPD† > 20*%</td><td>Result < RL</td><td>Qualify sample results as estimated non-detect (UJ).</td></tr>
<tr><td>Result > RL</td><td>Qualify sample results as estimated (J).</td></tr>
<tr><td>RPD ≤ 20*%</td><td>All</td><td>No qualification needed.</td></tr>
<tr><td rowspan="3">Sed</td><td rowspan="2">RPD > 35%</td><td>Result < RL</td><td>Qualify sample results as estimated non-detect (UJ). Note in report.</td></tr>
<tr><td>Result > RL</td><td>Qualify sample results as estimated (J).</td></tr>
<tr><td>RPD ≤ 35%</td><td>All</td><td>No qualification needed.</td></tr>
</table>

RL – Reporting Limit

- † RPD – Relative Percent Difference between the original and the duplicate, calculated as follows:
- $RPD = 100 \times \left|\frac{(original - duplicate)}{Mean\ (original, duplicate)}\right|$
- *An RPD control limit of 25% was used when assessing field duplicate water samples.

The following table illustrates the application of qualifiers to sample results based on the precision QC sample types.

Association of Precision QC to Sample Results

QC Type	Associated Results
Lab Duplicate	All results in prep batch
Laboratory Control Sample Duplicate	All results in prep batch
Matrix Spike Duplicate	Parent sample results[1]
Field Dupicate/ Field Split	Parent sample results only[2]

- Notes:
- 1. In cases where the only associated precision QC was the MSD, the MSD was used to evaluate all results in the prep batch.
- 2. In cases where the laboratory was deficient in providing laboratory precision QC, Field precision QC was used to evaluate all results in each prep batch.

All laboratory precision QC results were within control parameters except as noted below. Associated sample results have been qualified accordingly.

Laboratory Precision Exceedances for Water Samples

Analyte	Type	Analysis Date	Result	Units	RL	RPD	Action
1-Methylnaphthalene	LCS/LCSD	6/6/2011	2.11	µg/L	0.1	26	Assoc. Samples Qualified UJ
1-Methylnaphthalene	MS/MSD	12/17/2010	2.26	µg/L	0.1	34	Assoc. Samples Qualified J/UJ
2,4-D	LCS/LCSD	2/8/2011	0.7	µg/L	0.08	26	Assoc. Sample Qualified UJ
2,4-D	LCS/LCSD	2/9/2011	0.17	µg/L	0.08	115	Assoc. Samples Qualified UJ
2-Methylnaphthalene	LCS/LCSD	6/6/2011	2.02	µg/L	0.1	25.1	Assoc. Samples Qualified UJ
Acenaphthene	LCS/LCSD	6/6/2011	1.83	µg/L	0.1	27.4	Assoc. Samples Qualified UJ
Acenaphthylene	LCS/LCSD	10/19/2010	1.51	µg/L	0.1	40.2	Assoc. Samples Qualified J/UJ
Acenaphthylene	LCS/LCSD	11/17/2010	1.73	µg/L	0.1	39.8	Assoc. Samples Qualified UJ
Acenaphthylene	LCS/LCSD	6/6/2011	1.77	µg/L	0.1	31	Assoc. Samples Qualified UJ
Anthracene	LCS/LCSD	11/17/2010	1.98	µg/L	0.1	24.4	Assoc. Samples Qualified UJ
Anthracene	LCS/LCSD	6/6/2011	1.81	µg/L	0.1	23.4	Assoc. Samples Qualified UJ
Benzo(a)pyrene	LCS/LCSD	10/19/2010	1.21	µg/L	0.1	56	Assoc. Samples Qualified J/UJ
Benzo(a)pyrene	LCS/LCSD	11/17/2010	1.46	µg/L	0.1	43	Assoc. Samples Qualified J/UJ
Dibenzofuran	LCS/LCSD	6/6/2011	2.05	µg/L	0.1	24.8	Assoc. Samples Qualified UJ
Dichlobenil	LCS/LCSD	10/18/2010	0.86	µg/L	0.024	29	Assoc. Samples Qualified J/UJ
Dichlobenil	LCS/LCSD	11/11/2010	0.57	µg/L	0.024	52	Assoc. Samples Qualified J/UJ
Dichlobenil	LCS/LCSD	11/18/2010	0.46	µg/L	0.024	107	Assoc. Sample Qualified J
Dichlobenil	LCS/LCSD	11/22/2010	0.65	µg/L	0.02	21	Assoc. Samples Qualified

Analyte	Type	Analysis Date	Result	Units	RL	RPD	Action
					4		UJ
Diesel Range Hydrocarbons	LCS/LCSD	3/30/2011	1.76	mg/L	0.1	42.9	Assoc. Sample Qualified J
Fluorene	LCS/LCSD	6/6/2011	2.12	µg/L	0.1	25.2	Assoc. Samples Qualified UJ
MCPP	LCS/LCSD	2/8/2011	0.65	µg/L	0.08	20	Assoc. Sample Qualified UJ
MCPP	LCS/LCSD	2/9/2011	0.29	µg/L	0.08	73	Assoc. Samples Qualified UJ
Naphthalene	LCS/LCSD	6/6/2011	2.01	µg/L	0.1	20.9	Assoc. Samples Qualified J/UJ
Naphthalene	MS/MSD	12/17/2010	2.06	µg/L	0.1	37	Assoc. Samples Qualified J/UJ
Nitrate + Nitrite	Lab Dup	12/10/2010	0.132	mg-N/L	0.01	41.1	Assoc. Sample Qualified J
Triclopyr	LCS/LCSD	10/19/2010	0.41	µg/L	0.08	44	Assoc. Samples Qualified UJ
Triclopyr	LCS/LCSD	2/8/2011	0.75	µg/L	0.08	27	Assoc. Sample Qualified UJ
Triclopyr	LCS/LCSD	2/9/2011	0.42	µg/L	0.08	41	Assoc. Samples Qualified J/UJ
Triclopyr	LCS/LCSD	12/17/2010	0.6	µg/L	0.08	20	Assoc. Samples Qualified UJ

Laboratory Precision Exceedances for Sediment Samples

Analyte	Type	AnalysisDate	RPD	Action
4-Nitrophenol	MS/MSD	11/22/2011	84.6	Associated results qualified UJ
Pentachlorophenol	MS/MSD	11/22/2011	56	Associated results qualified J/UJ

-
- RPD – Relative percent difference

The Laboratory Control Sample and Duplicate (LCS/LCSD) RPDs for the above compounds did not meet the control limits established by the project. However, the limits were considered in control by the laboratory. For this reason, the associated samples were qualified as estimated.

Field duplicates were collected and analyzed in addition to laboratory duplicates. The results of these additional blanks can be found in the *Field Results Sample QA/QC* results section below.

Laboratory Calibration

Spectra Laboratories, the lab subcontracted to perform analysis of phenolics on sediment samples, did not dilute and reanalyze results which exceeded the calibration range. These results have been qualified as estimated (J), and are listed below.

Laboratory Results Exceeding Calibration Range – Sediment Samples

Analyte	Site	Reported Result	Units
4-Methylphenol	R1	1560	µg/kg
4-Methylphenol	C1	169	µg/kg
Phenol	R1	636	µg/kg

Data Completeness

Approximately 2600 analytical results were required for the Stormwater Characterization project during WY2011. All samples were received by the laboratory and all required parameters were analyzed with the exception of one result for prometon. This parameter was inadvertently overlooked by the laboratory for one sample. Upon final QA/QC review, the amount of useable data reported for the project year exceeded the MQO of 90 percent.

Field Sample QA/QC Sample Results

The following section discusses the results of QA/QC samples generated in the field or laboratory by field staff.

Field Blank QC Samples

Trip Blanks

Trip blanks accompanied all sample bottles used for Gasoline Range Hydrocarbon (TPH-G) analyses from the time the empty sample bottles left the laboratory until the filled bottles were relinquished to the laboratory. Trip blanks were analyzed for TPH-G, and no contamination was found above the reporting limit. No TPH-G was detected in any of the trip blanks submitted. Trip blank dates and analytical results are shown in the table below.

Water Trip Blank Data

Sample Date	Reported Result	Qualifier	Units
11/9/2010	0.25	U	mg/L
1/6/2011	0.25	U	mg/L
1/21/2011	0.25	U	mg/L
2/1/2011	0.25	U	mg/L
2/10/2011	0.25	U	mg/L
5/25/2011	0.25	U	mg/L
6/22/2011	0.25	U	mg/L
8/2/2011	0.25	U	mg/L
10/9/2010	0.25	U	mg/L

Sample Date	Reported Result	Qualifier	Units
10/30/2010	0.25	U	mg/L
11/17/2010	0.25	U	mg/L
12/7/2010	0.25	U	mg/L
1/12/2011	0.25	U	mg/L
10/23/2010	0.25	U	mg/L
11/30/2010	0.25	U	mg/L
2/12/2011	0.25	U	mg/L
3/1/2011	0.25	U	mg/L
3/24/2011	0.25	U	mg/L
3/28/2011	0.25	U	mg/L
4/1/2011	0.25	U	mg/L
5/15/2011	0.25	U	mg/L
9/17/2011	0.25	U	mg/L

Water Sampling Equipment Blanks

To test the cleanliness of all the sampling and processing equipment that comes in contact the sampled stormwater, a blank sample was collected from following equipment:

- 2.5 Gallon Glass Bottle – composite bottle used in auto samplers
- Cone and Churn Splitters – used to process samples
- Sampler Tubing – used to pump samples from channel to composite bottle

The results of water sampling equipment blank samples are summarized in the table on the following page.

Equipment blanks were analyzed for all applicable analytes (i.e., composite sampling equipment analyzed for composite sample analytes and grab sample equipment analyze for grab sample analytes).

All results were non-detect with the exception of Nitrate + Nitrite and Total Kjeldahl Nitrogen (TKN) in the autosampler tubing blanks collected in December. SPU observed the nitrogen contamination during data screening and requested that the field and laboratory staff investigate. The source of contamination was determined to be the nitrile gloves being used by some laboratory staff during sample bottle cleaning procedures. Corrective action was taken by the lab in January 2011. A second set of tubing blanks was collected in April 2011 and tested for Nitrate + Nitrite and TKN to confirm that corrective action had resolved the contamination issue. The corrective action is considered to have resolved the issue with the exception of one TKN result for the second R1 tubing blank. The laboratory is continuing to investigate and address laboratory contamination sources.

Nitrate + Nitrite results prior to February 2011 were assessed based on a blank contamination level of 0.016 µg/L. Nine sample results between 0.016 µg/L and 0.16 µg/L have been qualified "J". No qualification was needed for the other Nitrate + Nitrite results due to the field blank results.

TKN sample results were assessed based on a blank contamination level of 0.53 µg/L. Sample results between 0.53 and 5.3 µg/L were qualified "J".

No other equipment blank results required sample result qualification.

Stormwater Split Samples

During WY2011, four duplicate grab samples four composite split samples were analyzed as field precision QC samples. The duplicate and split sample results are summarized in the tables below.

The assigned qualifier for each of the QC sample results appears adjacent to the reported value. The qualifier applied to the associated sample results, based on rules listed above, is displayed after the RPD or absolute difference column.

Water Sampling Equipment Blank Data

Analyte	Reporting Limit	Units	Bottle Blank	Splitter Blank	Tubing Blanks: R1 Tubing Blank		Tubing Blanks: C1 Tubing Blank		Tubing Blanks: I1 Tubing Blank	
			12/28/2010	12/28/2010	12/3/2010	4/8/2011	12/3/2010	4/8/2011	12/3/2010	4/8/2011
Cadmium, Dissolved	0.2	µg/L	0.2 U	0.2 U	0.2 U		0.2 U		0.2 U	
Cadmium, Total	0.2	µg/L	0.2 U	0.2 U	0.2 U		0.2 U		0.2 U	
Copper, Dissolved	0.5	µg/L	0.5 U	0.5 U	0.5 U		0.5 U		0.5 U	
Copper, Total	0.5	µg/L	0.5 U	0.5 U	0.5 U		0.5 U		0.5 U	
Lead, Dissolved	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Lead, Total	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Zinc, Dissolved	4	µg/L	4 U	4 U	4 U		4 U		4 U	
Zinc, Total	4	µg/L	4 U	4 U	4 U		4 U		4 U	
Nitrogen, Total Kjeldahl (TKN)	0.3	mg-N/L	0.3 U	0.3 U	**0.36**	**0.53**	**0.37**	0.3 U	**0.48**	0.3 U
Nitrate + Nitrite	0.01	mg-N/L	0.01 U	0.01 U	**0.016**	0.1 U	**0.01**	0.01 U	**0.013**	0.01 U
Orthophosphate	0.004	mg-P/L	0.004 U	0.004 U	0.004 U		0.004 U		0.004 U	
Phosphorus, Total	0.008	mg-P/L	0.008 U	0.008 U	0.008 U		0.008 U		0.008 U	
bis(2-Ethylhexyl)phthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Butylbenzylphthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Diethylphthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Dimethylphthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Di-n-Butylphthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
Di-n-Octyl phthalate	1	µg/L	1 U	1 U	1 U		1 U		1 U	
1-Methylnaphthalene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
2-Methylnaphthalene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Acenaphthene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Acenaphthylene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Anthracene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Benzo(a)anthracene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Benzo(a)pyrene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Benzo(g,h,i)perylene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Benzofluoranthenes, Total	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Chrysene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Dibenz(a,h)anthracene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Dibenzofuran	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Fluoranthene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Fluorene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Indeno(1,2,3-cd)pyrene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Naphthalene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	

					Tubing Blanks					
Analyte	Reporting Limit	Units	Bottle Blank	Splitter Blank	R1 Tubing Blank		C1 Tubing Blank		I1 Tubing Blank	
			12/28/2010	12/28/2010	12/3/2010	4/8/2011	12/3/2010	4/8/2011	12/3/2010	4/8/2011
Pentachlorophenol	0.5	µg/L	0.5 U	0.5 U	0.5 U		0.5 U		0.5 U	
Phenanthrene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	
Pyrene	0.1	µg/L	0.1 U	0.1 U	0.1 U		0.1 U		0.1 U	

Water Sample Grab Duplicate Data

Analyte	RL	Units	C1 Grab – 11/17/2010				R1 Grab - 11/17/2010				R1 Grab – 1/6/2011				I1 Grab – 5/15/2011			
			Parent	Dup	RPD or |Δ|	Qualifier	Parent	Dup	RPD or |Δ|	Qualifier	Parent	Dup	RPD or |Δ|	Qualifier	Parent	Dup	RPD or |Δ|	Qualifier
Diesel Range Hydrocarbons	0.1	mg/L	0.93	0.88	5.52		0.39	0.33	|0.06|		0.32	0.31	|0.01|		0.23	0.25	|0.02|	
Gasoline Range Hydrocarbons	0.25	mg/L	0.25 U	0.25 U	0		0.25 U	0.25 U	0		0.25 U	0.25 U	0		0.25 U	0.25 U	0	
Fecal Coliform	40	CFU/100 mL	3480	2960	16.1		1480	1080	**31.3**	J	300	250	|50|		2000	1700	16.2	

Water Sample Composite Split Data

Analyte	RL	Units	C1 Composite – 11/30/2010				R1 Composite – 1/7/2011				I1 Composite – 1/12/2011				I1 Composite – 1/21/2011			
			Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier
Conductivity	1	umhos/cm	191	182	4.8		52.2	52	0.38		144	145	0.69		158	158	0	
pH	0.01	std units	6.92	7.28	|0.36|		6.76	6.86	|0.1|		7.21	7.36	|0.15|		7.46	7.57	|0.11|	
Solids, Total Suspended	1	mg/L	92.4	93.3	1.0		38.5	39.3	2.1		63.2	63.8	0.95		63.7	60.7	4.8	
Turbidity	0.05	NTU	82.5	85	3.0		52	50	3.9		38	29	**26.9**	J	46.2	48.8	5.5	
Cadmium, Dissolved	0.2	µg/L	0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0	
Cadmium, Total	0.2	µg/L	0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0	
Copper, Dissolved	0.5	µg/L	17	15.8	7.3		4.8	4.8	0		4.1	4.3	4.8		3.7	3.7	0	
Copper, Total	0.5	µg/L	59.6	60.8	2.0		14.6	14.6	0		15.2	14.6	4.0		13	12.3	5.5	
Lead, Dissolved	1	µg/L	1	1	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
Lead, Total	1	µg/L	21	22	4.7		16	15	6.5		6	6	0		5	5	0	
Zinc, Dissolved	4	µg/L	37	34	8.5		16	17	|1|		32	33	3.1		40	40	0	
Zinc, Total	4	µg/L	142	143	0.7		52	56	7.4		94	94	0		99	95	4.1	
Chloride	0.1	mg/L	33.8	32.1	5.2		5.7	5.7	0		11.1	11.2	0.90		4.6	4.6	0	
Nitrogen, Total Kjeldahl	0.3	mg-N/L	1.62	1.59	1.9		0.95	1.1	|0.15|		1.07	1.09	|0.02|		0.91	1.1	|0.19|	
Nitrate + Nitrite	0.01	mg-N/L	0.175	0.23	**27.2**	J	0.314	0.304	3.2		0.332	0.316	4.9		0.3	0.334	11	
Ortho-Phosphate	0.004	mg-P/L	0.028	0.028	0		0.01	0.01	0		0.074	0.074	0		0.083	0.084	1	
Phosphorus, Total	0.008	mg-P/L	0.31	0.302	2.6		0.142	0.218	**42.2**	J	0.224	0.214	4.6		0.278	0.27	2.9	
Biological Oxygen Demand	1	mg/L	7.5	8.8	16		2.4	2.3	|0.1|		2 U	2 U	0		2.3	2.3	0	
Triclopyr	0.08	µg/L	0.08 U	0.08 U	0		0.08 U	0.08 U	0		0.08 U	0.08 U	0		0.08 U	0.08 U	0	
Surfactants	0.025	mg/L	0.025 U	0.025 U	0		0.025 U	0.025 U	0		0.025 U	0.025 U	0		0.025 U	0.025 U	0	
Hardness	0.33	mg/L CaCO3	31	31	0		16	16	0		58	56	3.5		72	72	0	
Mercury, Dissolved	20	ng/L	20 U	20 U	0		20 U	20 U	0		20 U	20 U	0		20 U	20 U	0	
Mercury, Total	20	ng/L	20 U	20.9	|0.9|		20 U	20 U	0		20 U	20 U	0		20 U	20 U	0	
2,4-D	1	µg/L	1 U	1 U	0		0.08 U	0.08 U	0		0.08 U	0.08 U	0		0.08 UJ	0.08 UJ	0	
MCPP	250	µg/L	250 U	250 U	0		0.08 U	0.08 U	0		0.08 U	0.08 U	0		0.08 UJ	0.08 UJ	0	
bis(2-Ethylhexyl)phthalate	1	µg/L	5.1	3.5	**|1.6|**	J	1.2	1.6	|0.4|		1.4	1.2	|0.2|		1.2	1.1	|0.1|	
Butylbenzylphthalate	1	µg/L	1 U	1 U	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
Diethylphthalate	1	µg/L	1 U	1 U	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
Dimethylphthalate	1	µg/L	1 U	1 U	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
Di-n-Butylphthalate	1	µg/L	1 U	1 U	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
Di-n-Octyl phthalate	1	µg/L	1 U	1 U	0		1 U	1 U	0		1 U	1 U	0		1 U	1 U	0	
1-Methylnaphthalene	0.1	µg/L	0.1 U	0.1	0		0.1 U	0.1 U	0		0.91	0.82	10		0.1 U	0.1 U	0	
2-Methylnaphthalene	0.1	µg/L	0.15	0.13	|0.02|		0.1 U	0.1 U	0		1.9	1.7	11		0.1 U	0.1 U	0	

Analyte	RL	Units	C1 Composite – 11/30/2010				R1 Composite – 1/7/2011				I1 Composite – 1/12/2011				I1 Composite – 1/21/2011			
			Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier	Parent	Split	RPD or |Δ|	Qualifier
Acenaphthene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Acenaphthylene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Anthracene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Benzo(a)anthracene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Benzo(a)pyrene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Benzo(g,h,i)perylene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Benzofluoranthenes, Total	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.11	0.1 U	0		0.1 U	0.1 U	0	
Chlorpyrifos	0.2	µg/L	0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0	
Chrysene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Diazinon	0.2	µg/L	0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0	
Dibenz(a,h)anthracene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Dibenzofuran	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Dichlobenil	0.1	µg/L	0.025 U	0.024 U	0		0.16	0.18	|0.02|		0.024 U	0.024 U	0		0.024 U	0.024 U	0	
Fluoranthene	0.1	µg/L	0.1	0.13	|0.03|		0.15	0.15	0		0.13	0.11	|0.02|		0.1 U	0.1 U	0	
Fluorene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Indeno(1,2,3-cd)pyrene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.1 U	0.1 U	0	
Malathion	0.2	µg/L	0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0		0.2 U	0.2 U	0	
Naphthalene	0.1	µg/L	0.31	0.26	|0.05|		0.1 U	0.1 U	0		2.1	1.9	10		0.1 U	0.1 U	0	
Pentachlorophenol	0.5	µg/L	0.5 U	0.5 U	0		0.5 U	0.5 U	0		0.5 U	0.5 U	0		0.5 U	0.5 U	0	
Phenanthrene	0.1	µg/L	0.1 U	0.1 U	0		0.1 U	0.1 U	0		0.13	0.12	|0.01|		0.1 U	0.1 U	0	
Prometon	0.1	µg/L	0.025 U	0.024 U	0		0.024 U	0.024 U	0		0.024 U	0.024 U	0		0.024 U	0.024 U	0	
Pyrene	0.1	µg/L	0.16	0.16	0		0.11	0.14	|0.03|		0.11	0.1	|0.01|		0.1 U	0.1 U	0	

- Notes:
- **U** - Analyte was not detected above the reported result.
- **J**- Analyte was positively identified. The reported result is an estimate.
- **UJ**- Analyte was not detected above the reported estimate.
- **RPD –** Relative percent difference, |Δ| - Absolute difference. RPD may be calculated based on results with more significant figures than those shown in this table.

Appendix C.2: Stormwater Characterization - Annual, Storm And Base Flow Event Hydrographs

City of Seattle

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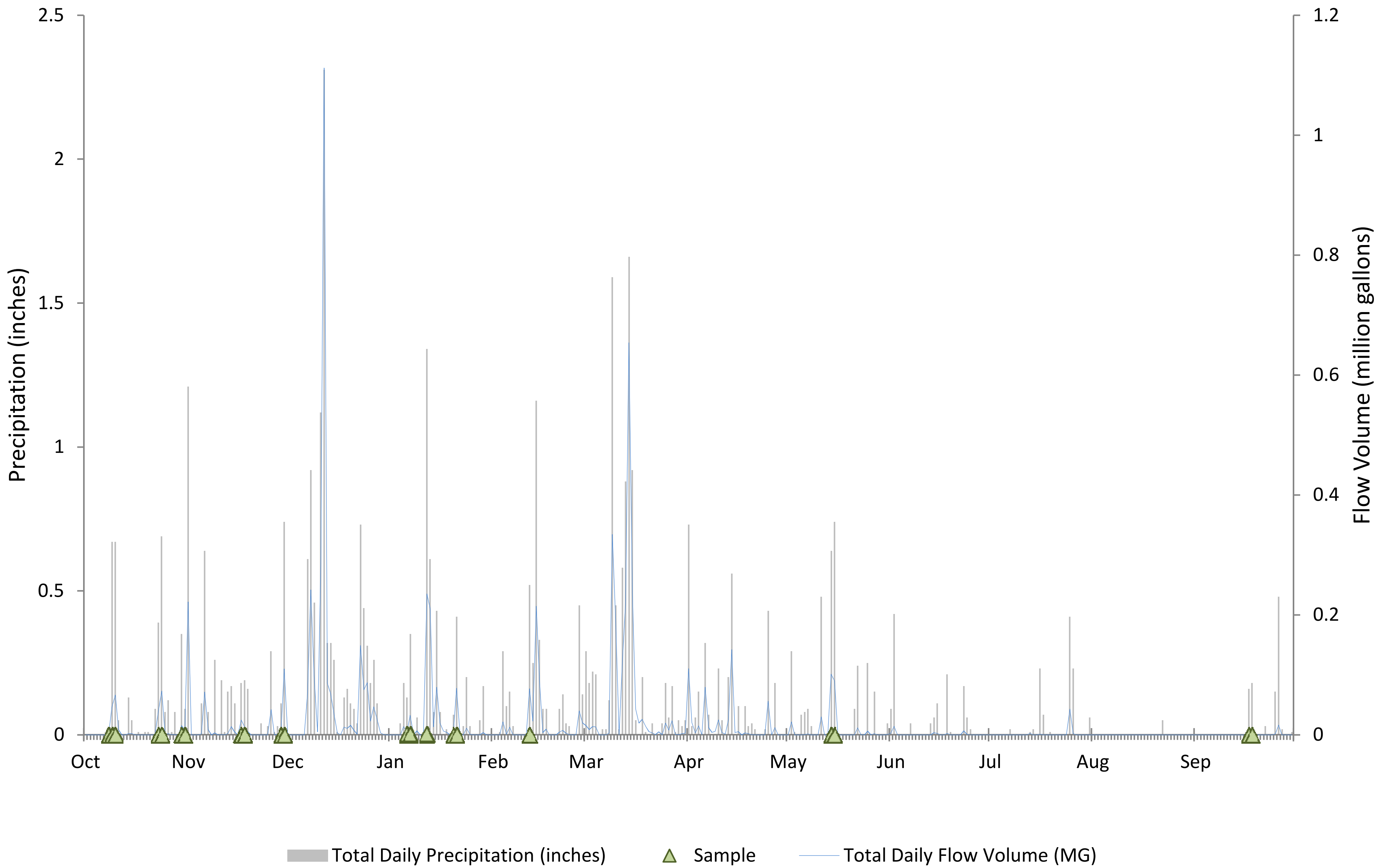
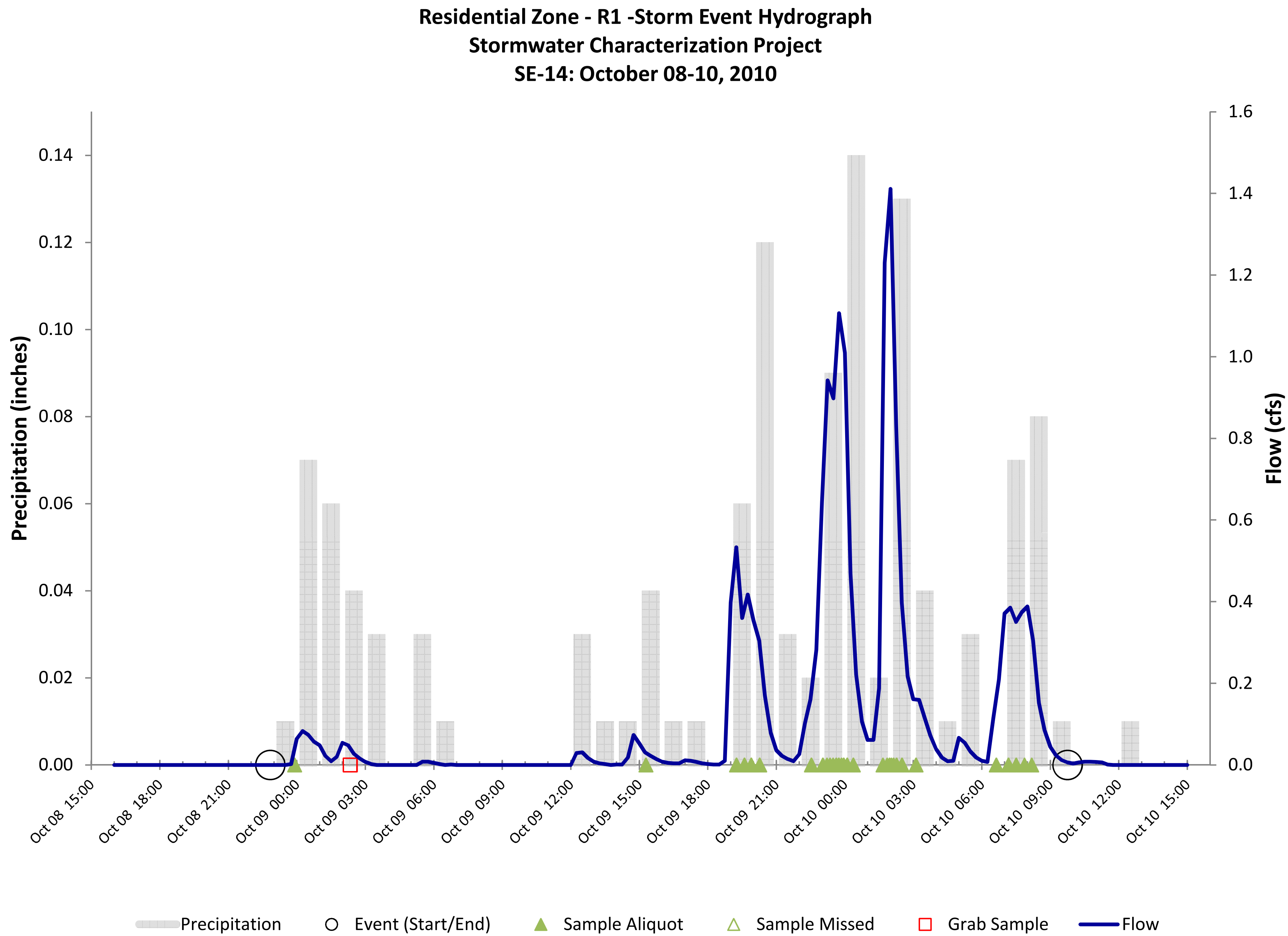
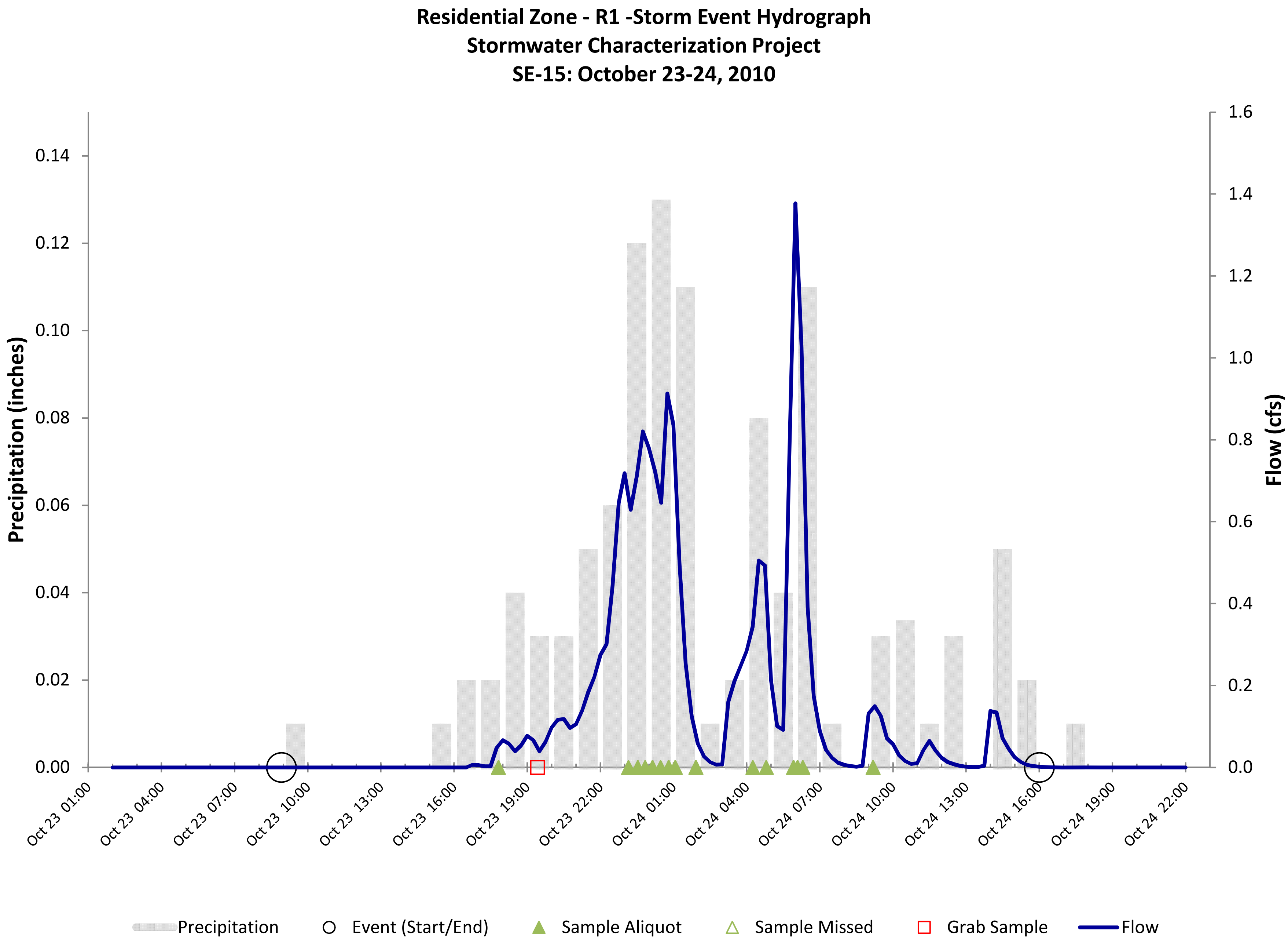
Residential Site - R1
Annual Hydrograph
Water Year: 2011

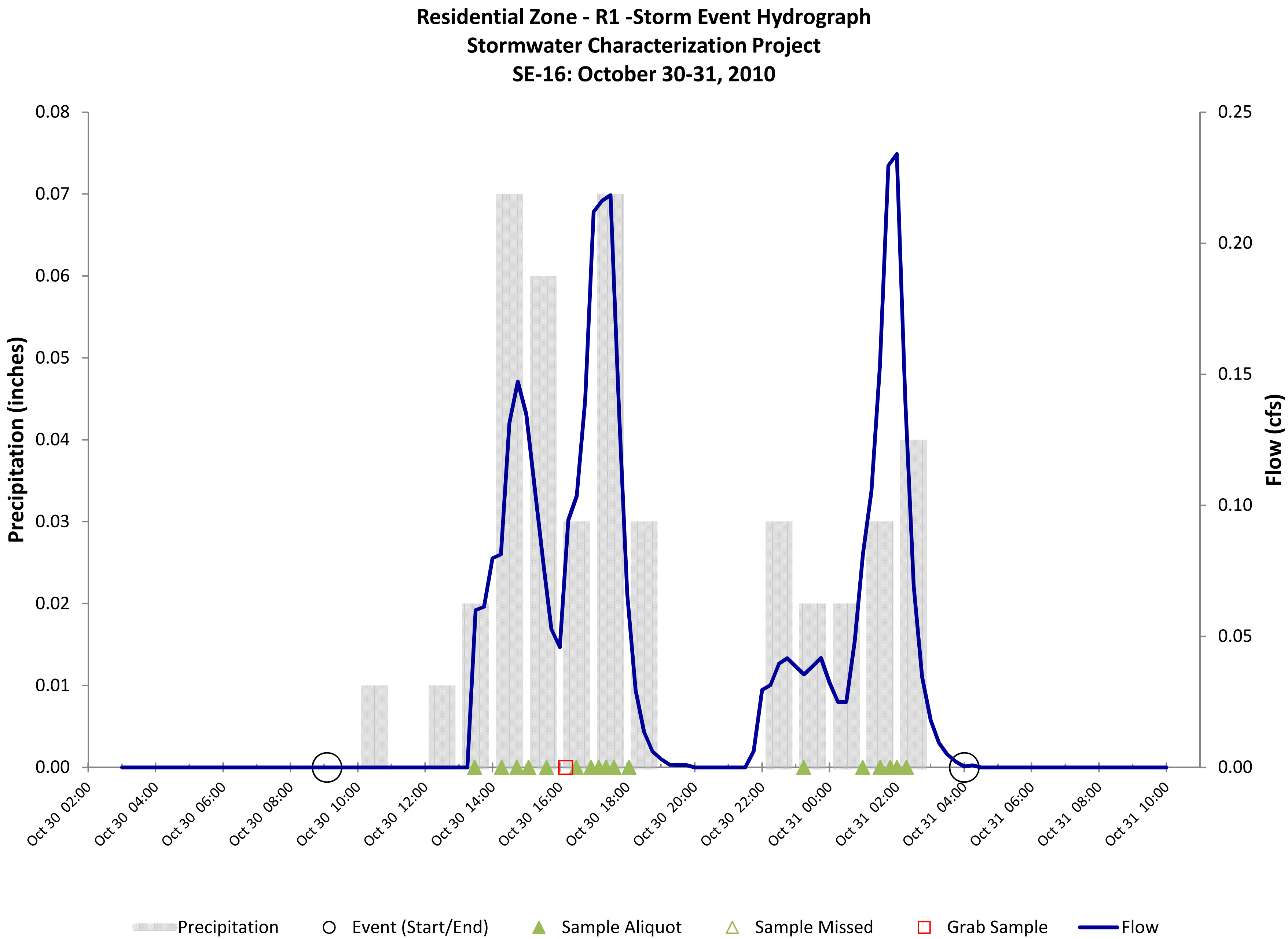




Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-14: October 08-10, 2010
Precipitation (inches)
Flow (cfs)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Oct 08 15:00
Oct 08 18:00
Oct 08 21:00
Oct 09 00:00
Oct 09 03:00
Oct 09 06:00
Oct 09 09:00
Oct 09 12:00
Oct 09 15:00
Oct 09 18:00
Oct 09 21:00
Oct 10 00:00
Oct 10 03:00
Oct 10 06:00
Oct 10 09:00
Oct 10 12:00
Oct 10 15:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

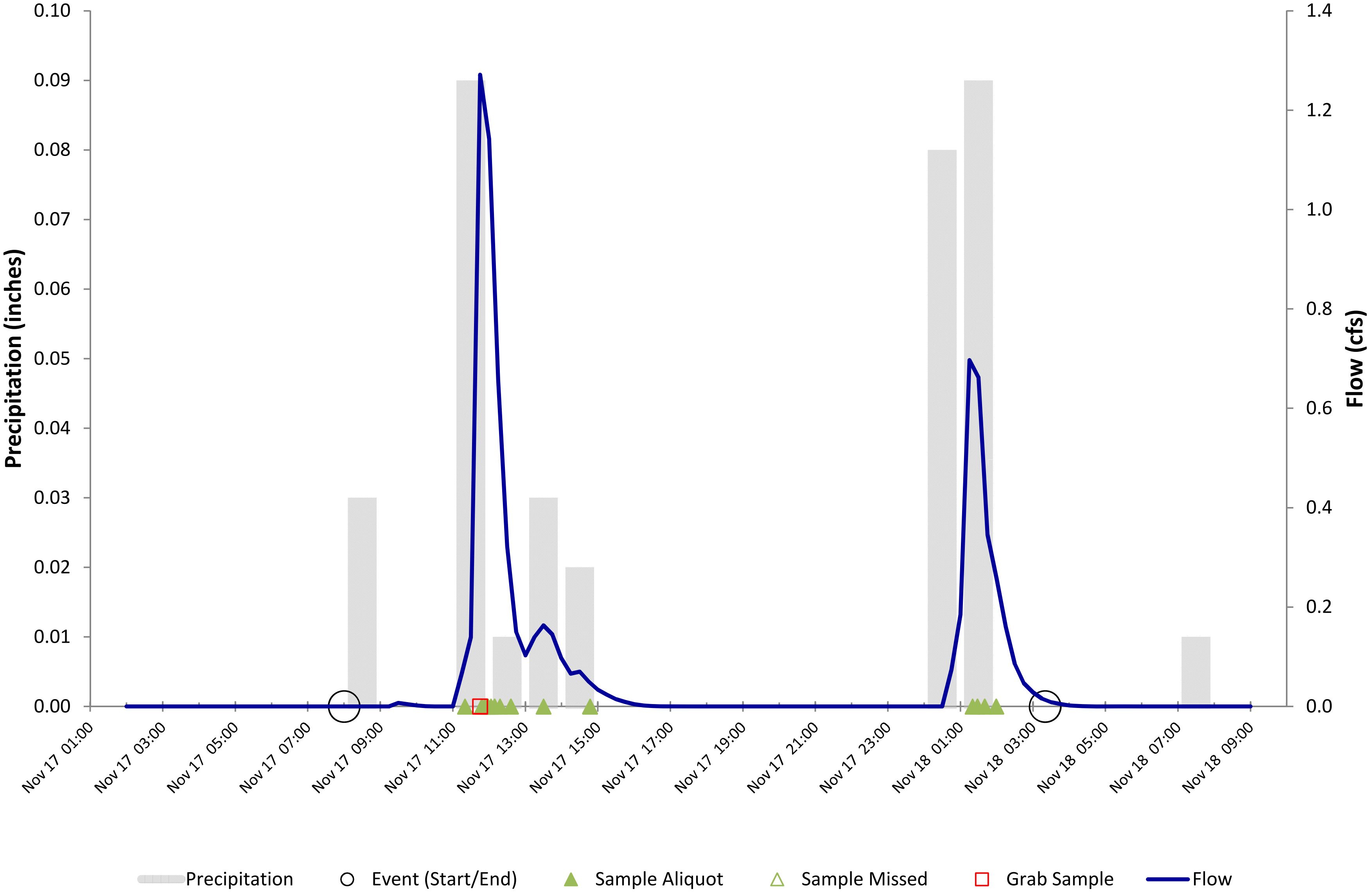


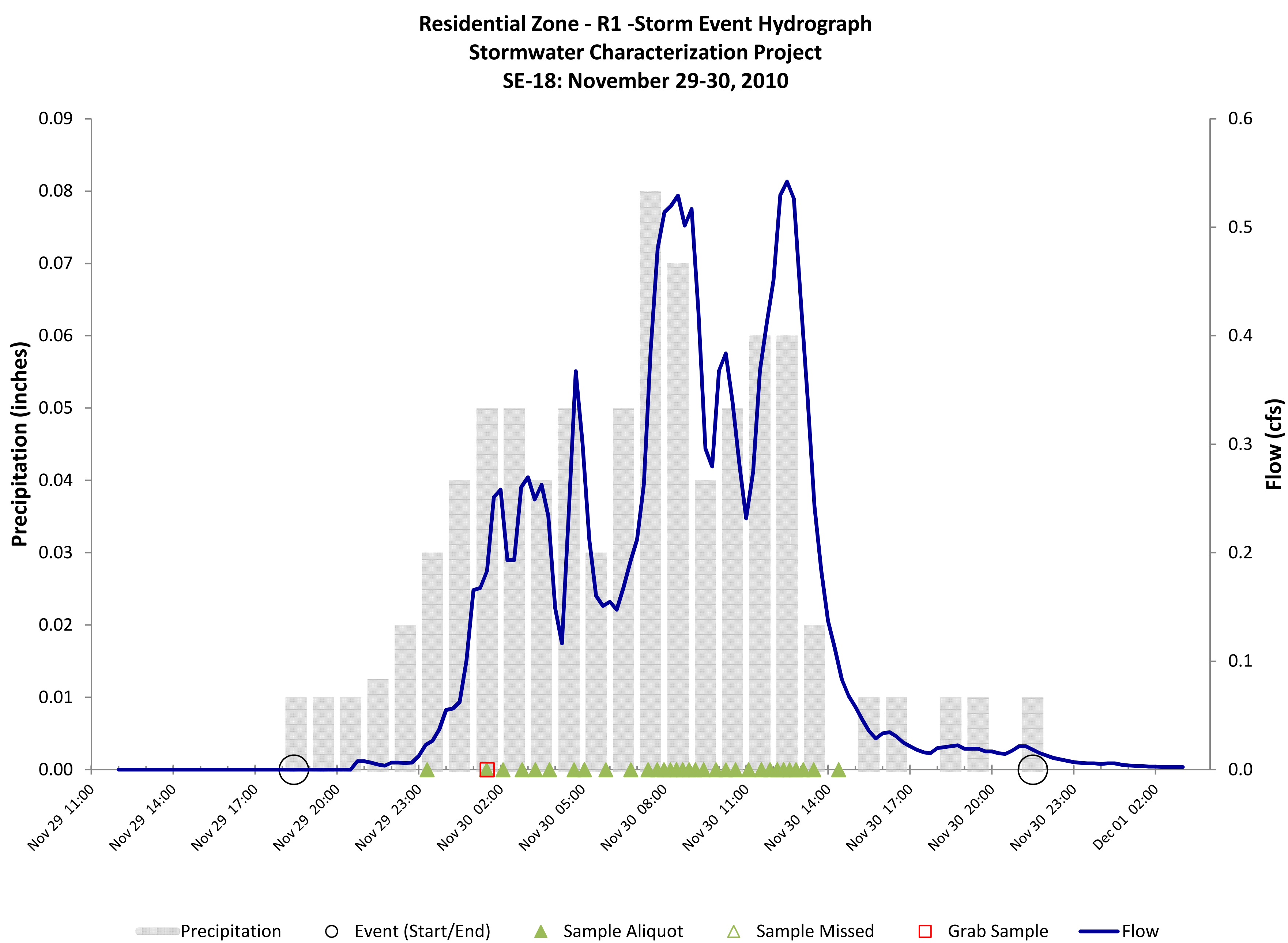
Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-15: October 23-24, 2010
Precipitation (inches)
Flow (cfs)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Oct 23 01:00
Oct 23 04:00
Oct 23 07:00
Oct 23 10:00
Oct 23 13:00
Oct 23 16:00
Oct 23 19:00
Oct 23 22:00
Oct 24 01:00
Oct 24 04:00
Oct 24 07:00
Oct 24 10:00
Oct 24 13:00
Oct 24 16:00
Oct 24 19:00
Oct 24 22:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-16: October 30-31, 2010
Precipitation (inches)
Flow (cfs)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.25
0.20
0.15
0.10
0.05
0.00
Oct 30 02:00
Oct 30 04:00
Oct 30 06:00
Oct 30 08:00
Oct 30 10:00
Oct 30 12:00
Oct 30 14:00
Oct 30 16:00
Oct 30 18:00
Oct 30 20:00
Oct 30 22:00
Oct 31 00:00
Oct 31 02:00
Oct 31 04:00
Oct 31 06:00
Oct 31 08:00
Oct 31 10:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

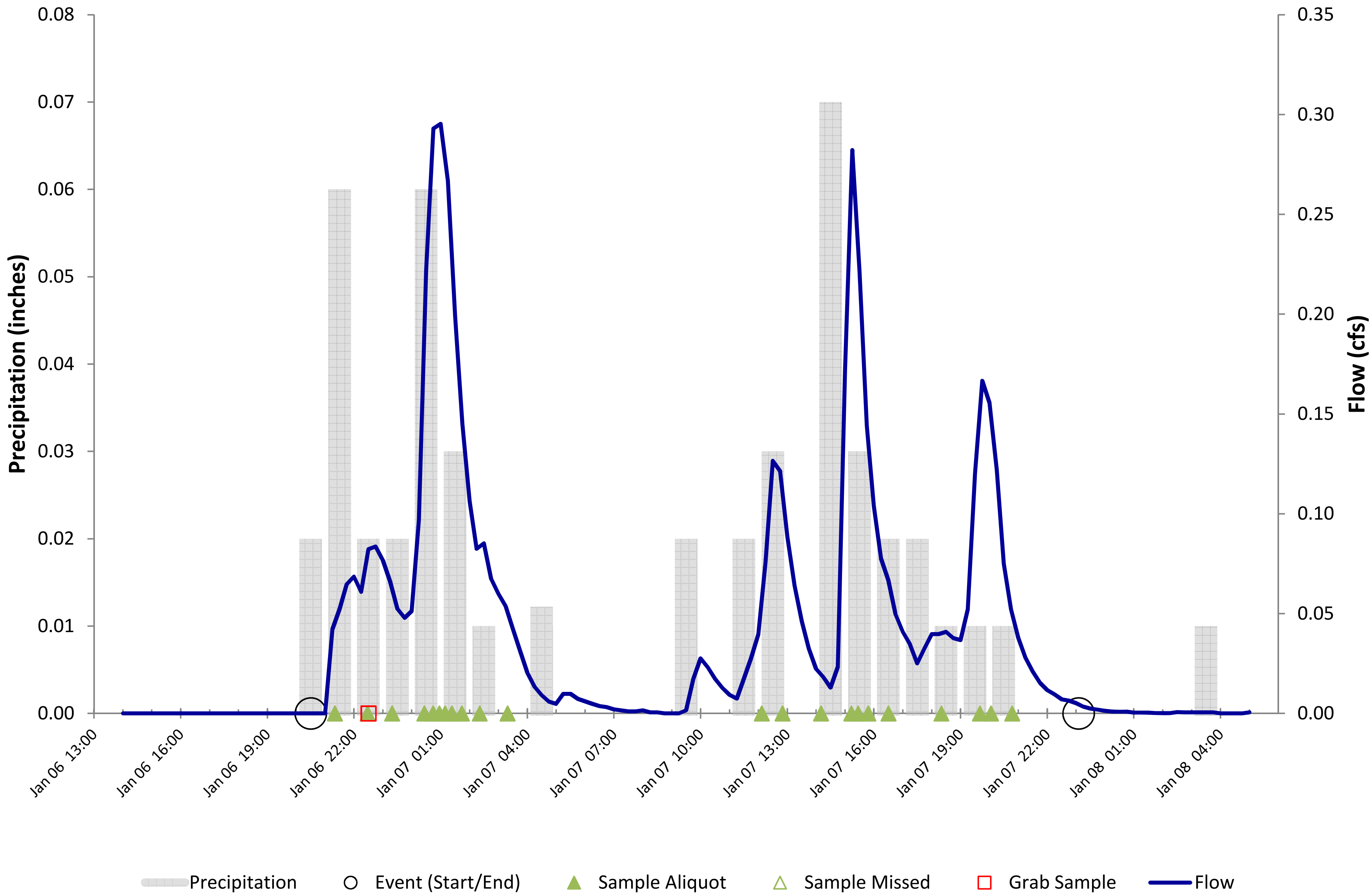
Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-17: November 17-18, 2010

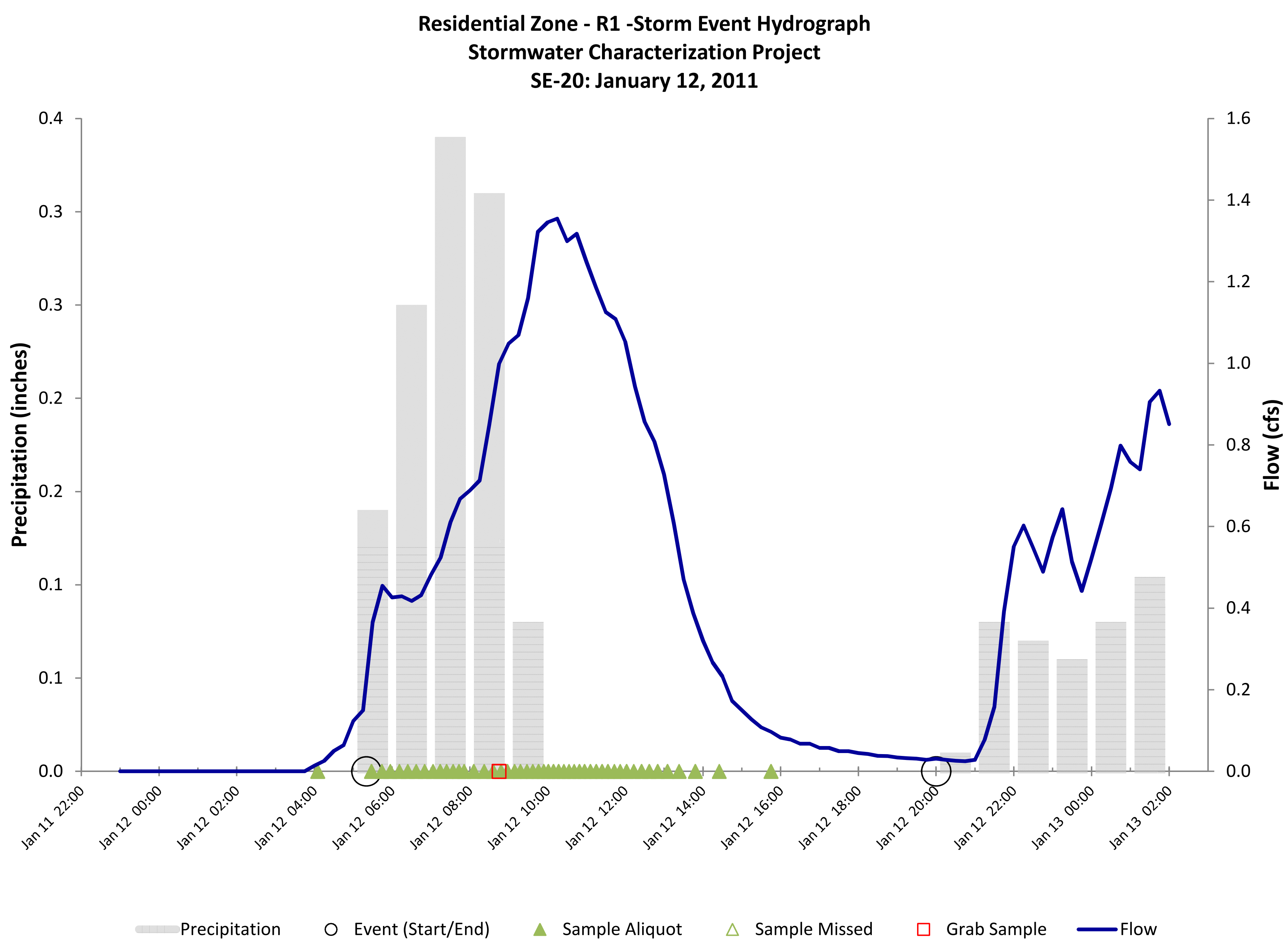


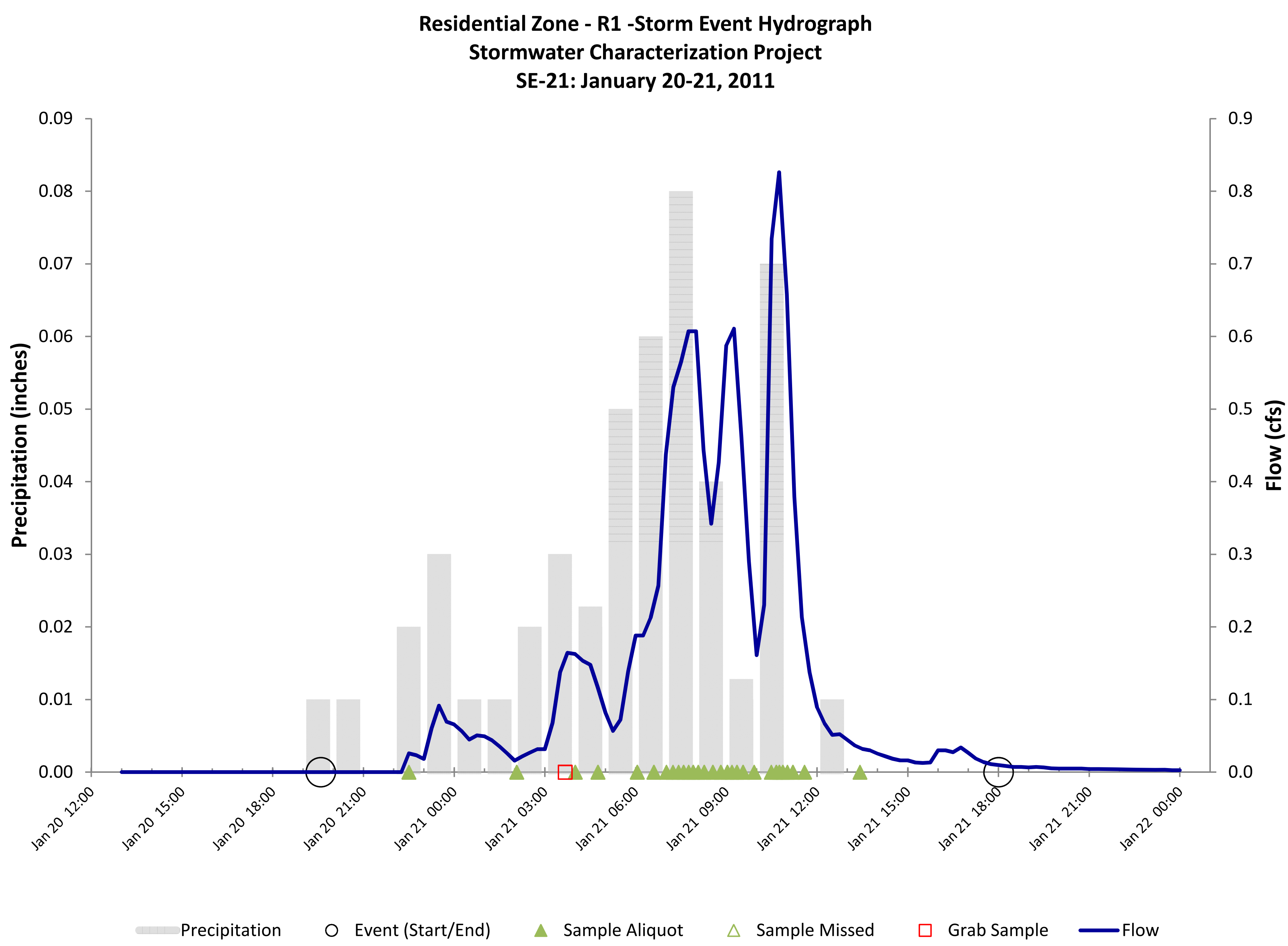


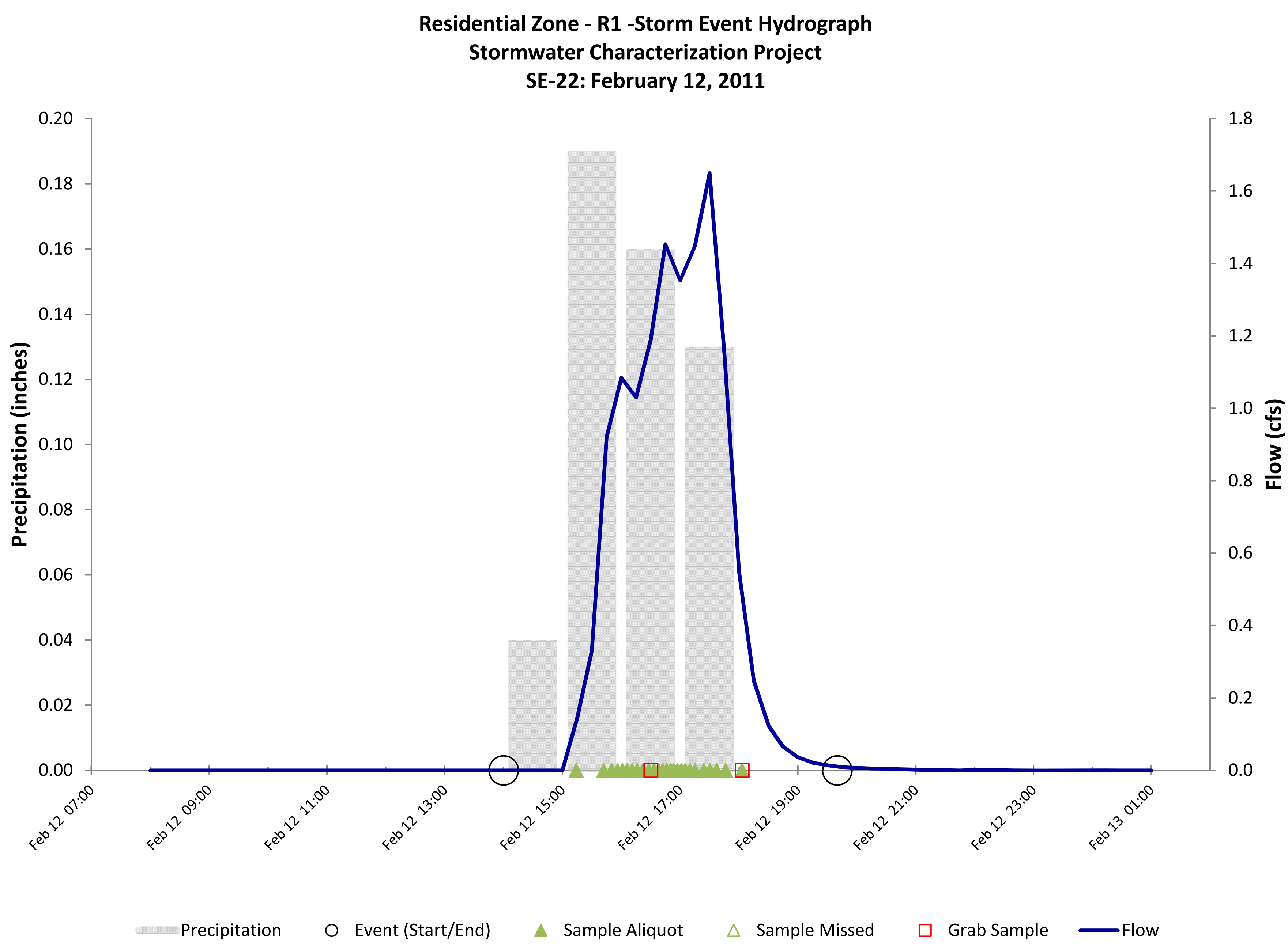
Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-18: November 29-30, 2010
Precipitation (inches)
Flow (cfs)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Nov 29 11:00
Nov 29 14:00
Nov 29 17:00
Nov 29 20:00
Nov 29 23:00
Nov 30 02:00
Nov 30 05:00
Nov 30 08:00
Nov 30 11:00
Nov 30 14:00
Nov 30 17:00
Nov 30 20:00
Nov 30 23:00
Dec 01 02:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

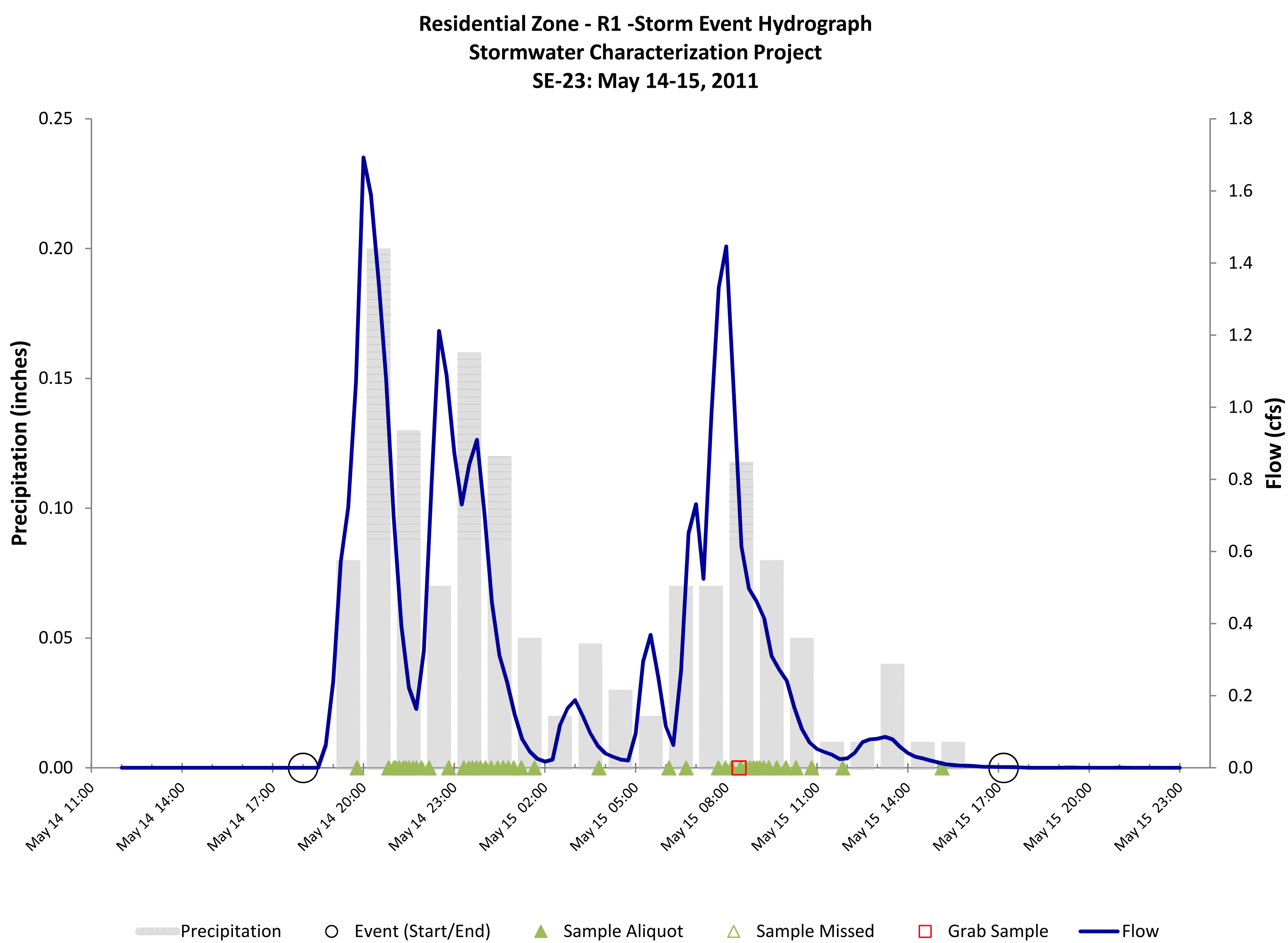
Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-19: January 06-07, 2011

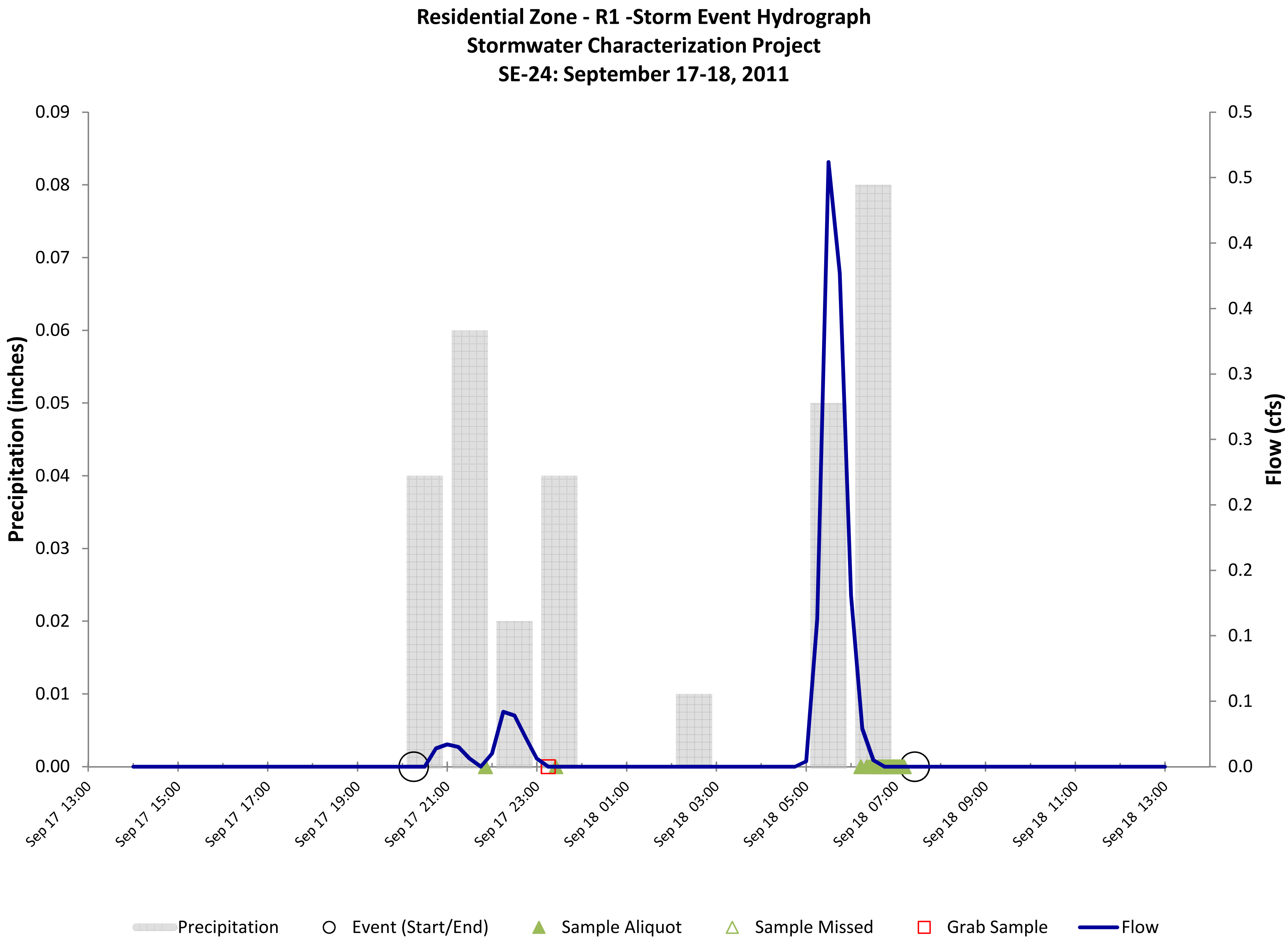



Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-20: January 12, 2011
Precipitation (inches)
Flow (cfs)
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jan 11 22:00
Jan 12 00:00
Jan 12 02:00
Jan 12 04:00
Jan 12 06:00
Jan 12 08:00
Jan 12 10:00
Jan 12 12:00
Jan 12 14:00
Jan 12 16:00
Jan 12 18:00
Jan 12 20:00
Jan 12 22:00
Jan 13 00:00
Jan 13 02:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

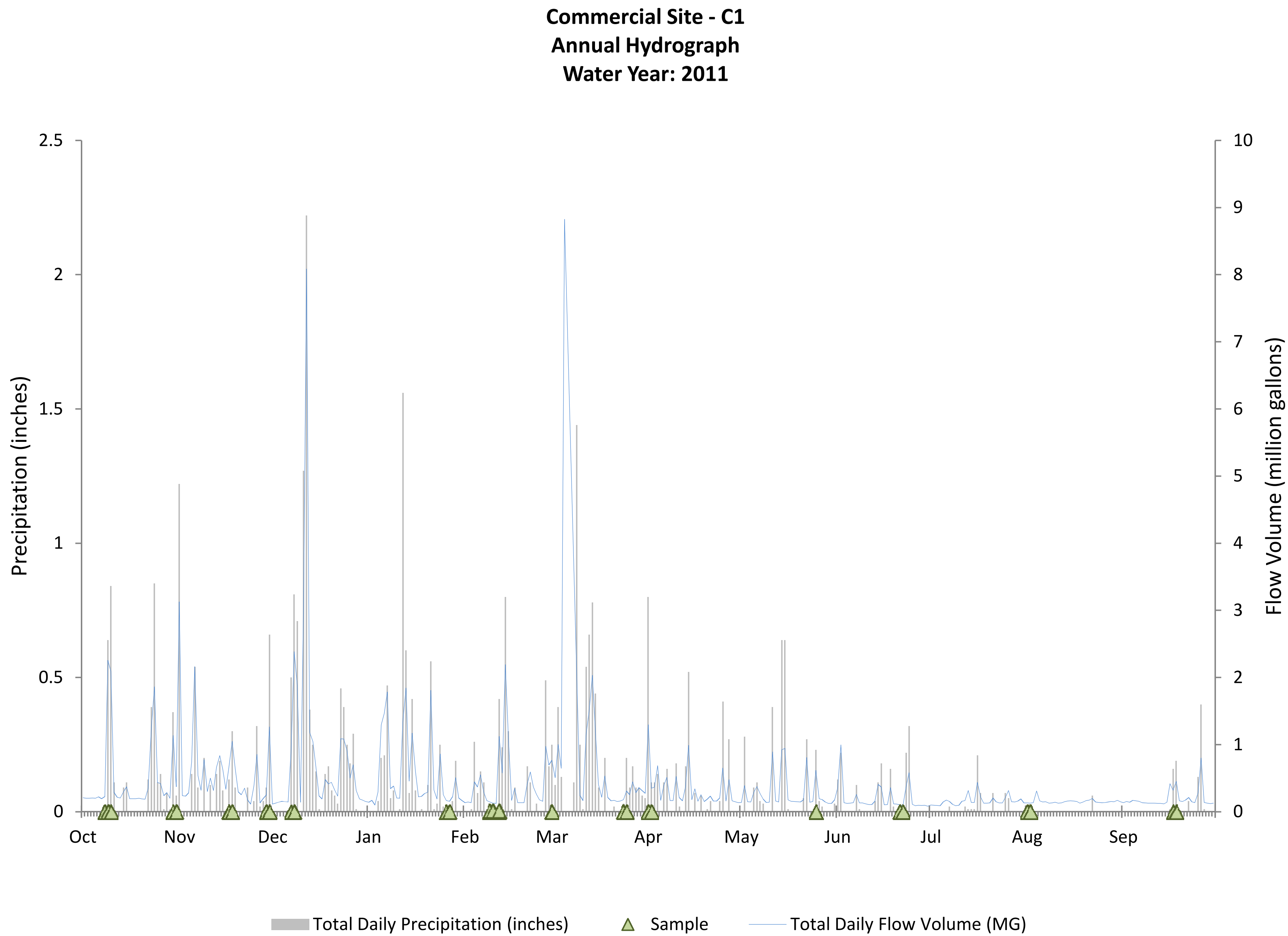

Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-21: January 20-21, 2011
Precipitation (inches)
Flow (cfs)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan 20 12:00
Jan 20 15:00
Jan 20 18:00
Jan 20 21:00
Jan 21 00:00
Jan 21 03:00
Jan 21 06:00
Jan 21 09:00
Jan 21 12:00
Jan 21 15:00
Jan 21 18:00
Jan 21 21:00
Jan 22 00:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow


Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-22: February 12, 2011
Precipitation (inches)
Flow (cfs)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Feb 12 07:00
Feb 12 09:00
Feb 12 11:00
Feb 12 13:00
Feb 12 15:00
Feb 12 17:00
Feb 12 19:00
Feb 12 21:00
Feb 12 23:00
Feb 13 01:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

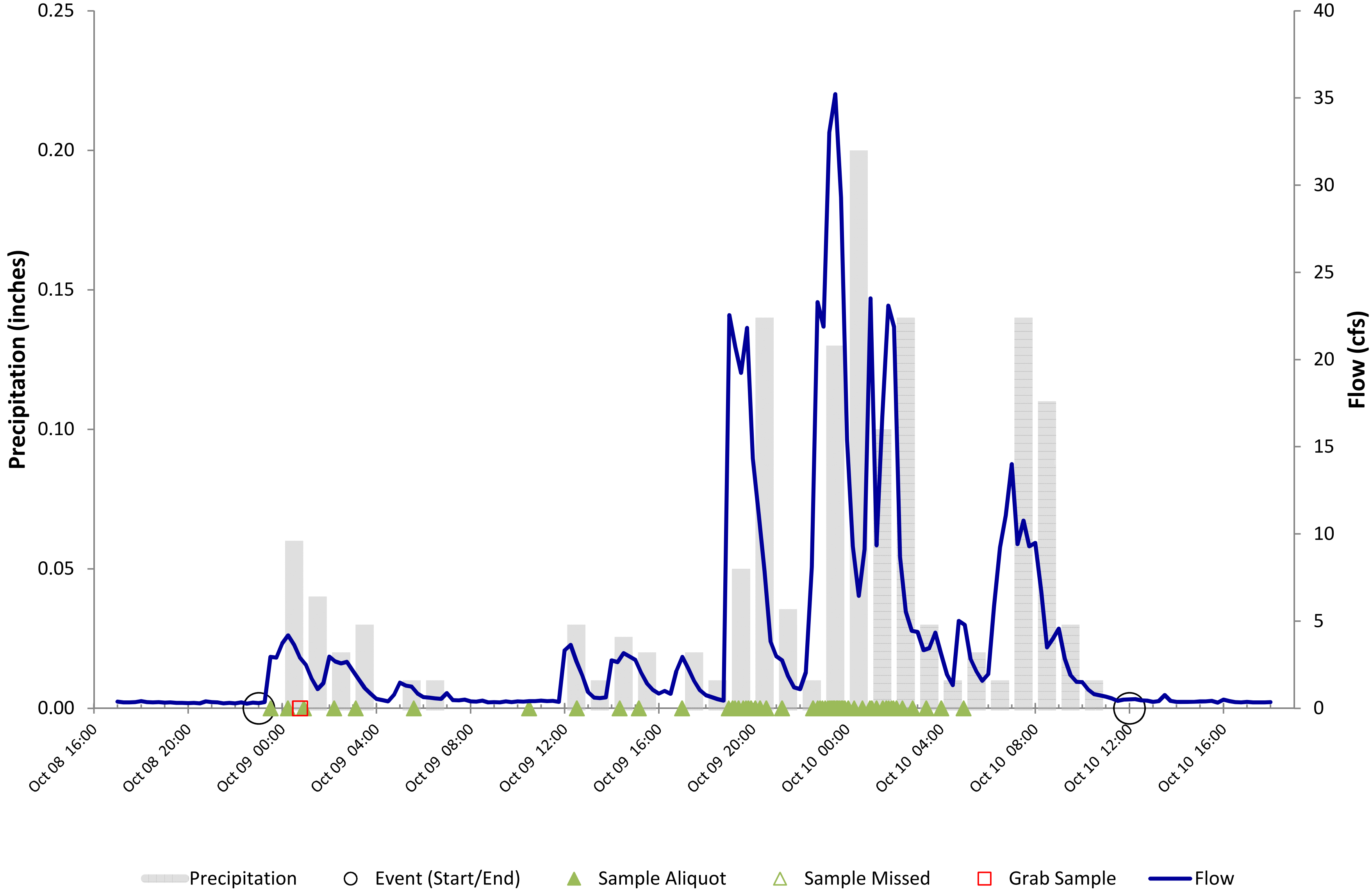

Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-23: May 14-15, 2011
Precipitation (inches)
Flow (cfs)
0.25
0.20
0.15
0.10
0.05
0.00
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
May 14 11:00
May 14 14:00
May 14 17:00
May 14 20:00
May 14 23:00
May 15 02:00
May 15 05:00
May 15 08:00
May 15 11:00
May 15 14:00
May 15 17:00
May 15 20:00
May 15 23:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



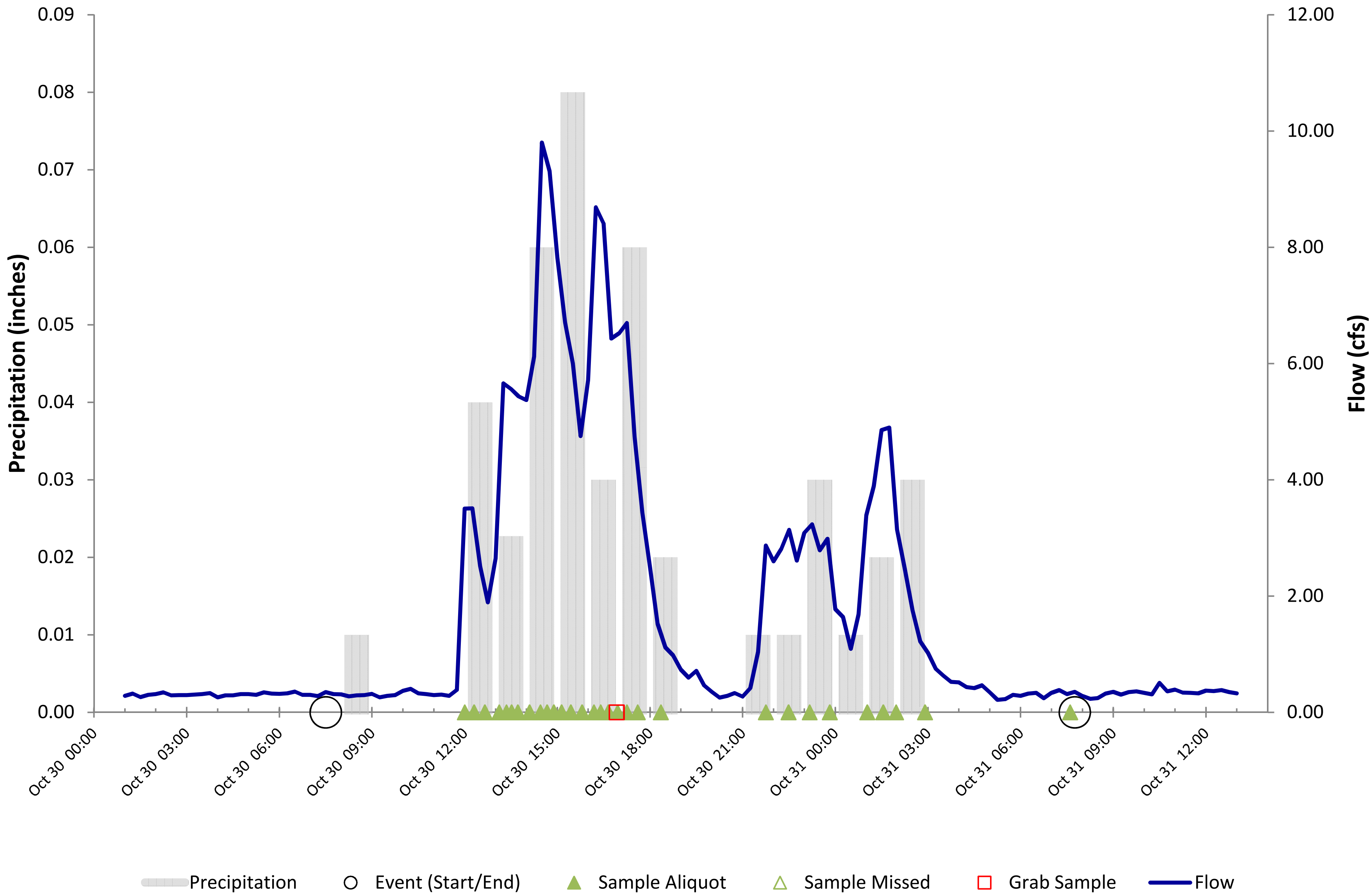
Residential Zone - R1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-24: September 17-18, 2011
Precipitation (inches)
Flow (cfs)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.5
0.5
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Sep 17 13:00
Sep 17 15:00
Sep 17 17:00
Sep 17 19:00
Sep 17 21:00
Sep 17 23:00
Sep 18 01:00
Sep 18 03:00
Sep 18 05:00
Sep 18 07:00
Sep 18 09:00
Sep 18 11:00
Sep 18 13:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow


Commercial Site - C1
Annual Hydrograph
Water Year: 2011
Precipitation (inches)
Flow Volume (million gallons)
0
0.5
1
1.5
2
2.5
0
1
2
3
4
5
6
7
8
9
10
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Total Daily Precipitation (inches)
Sample
Total Daily Flow Volume (MG)

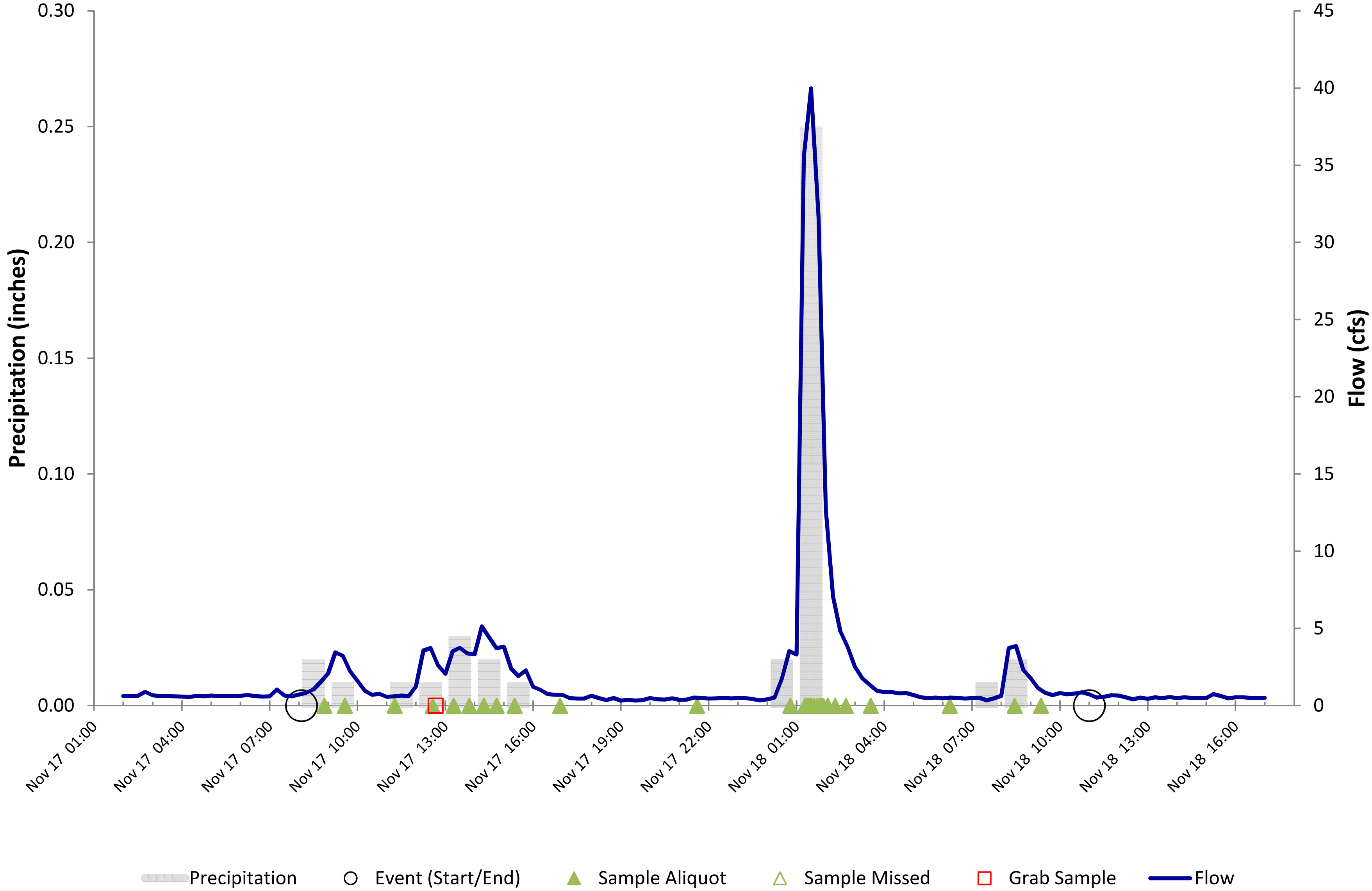
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-13: October 08-10, 2010

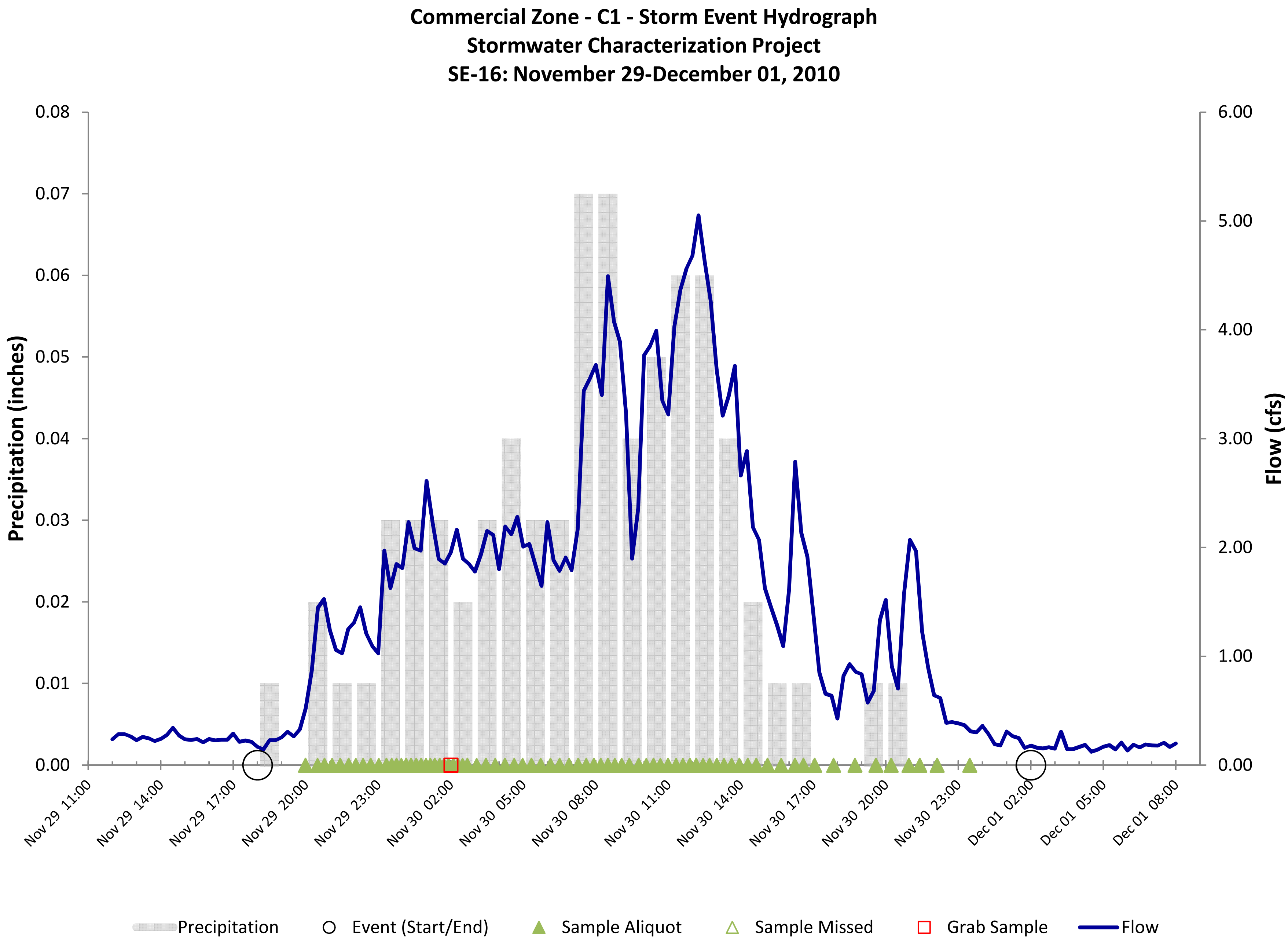


Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-14: October 30-31, 2010

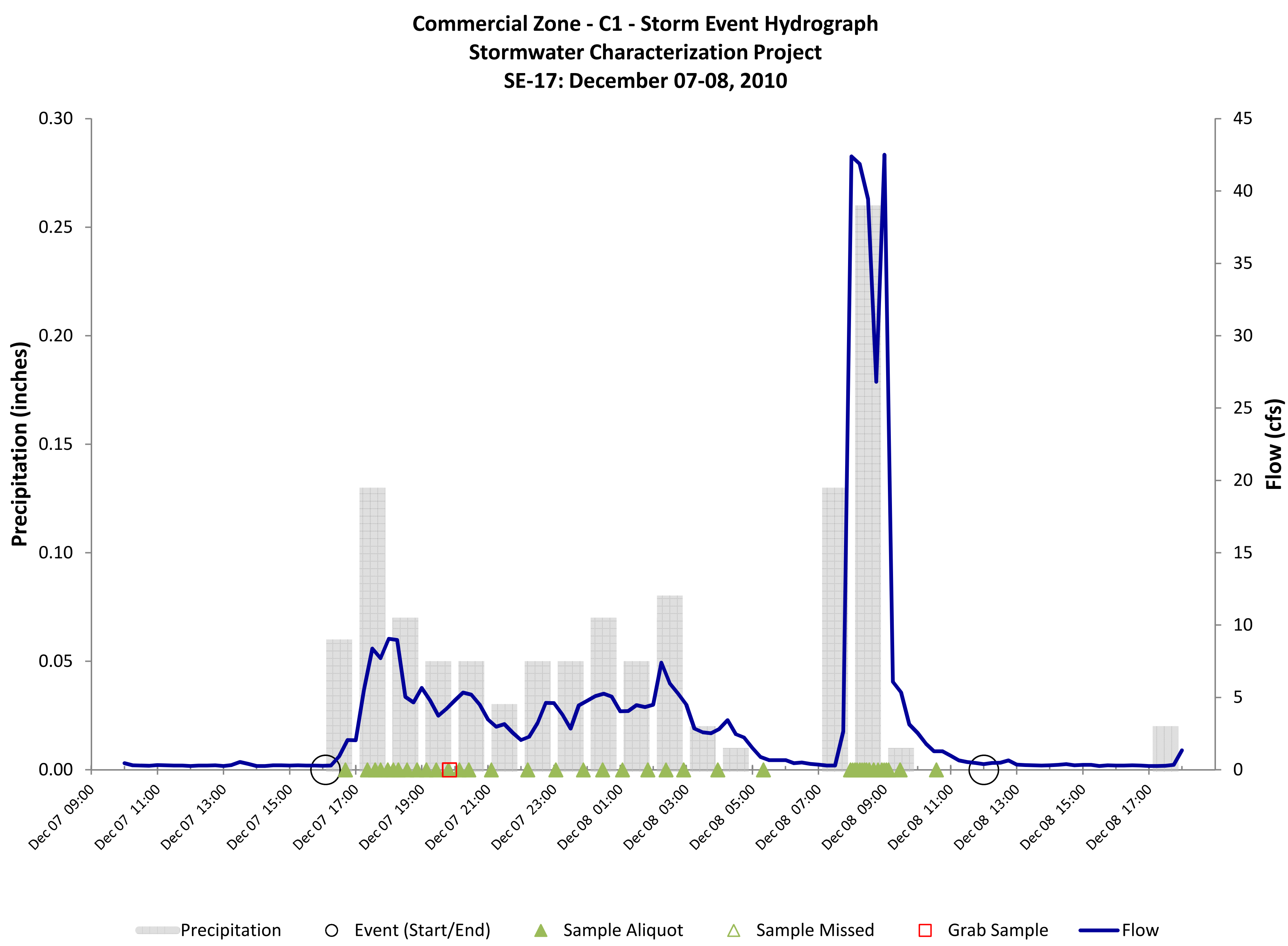


Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-15: November 17-18, 2010



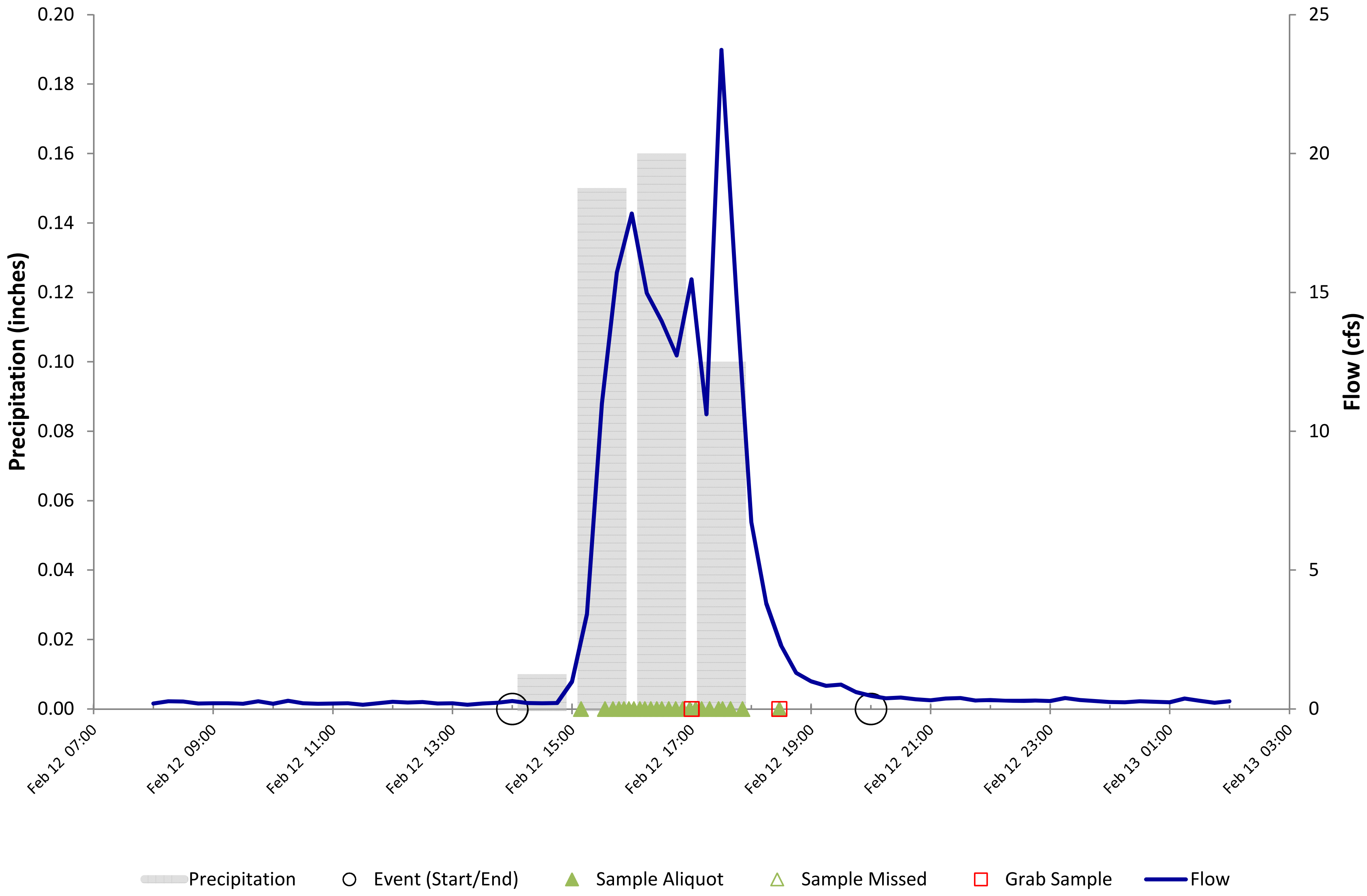


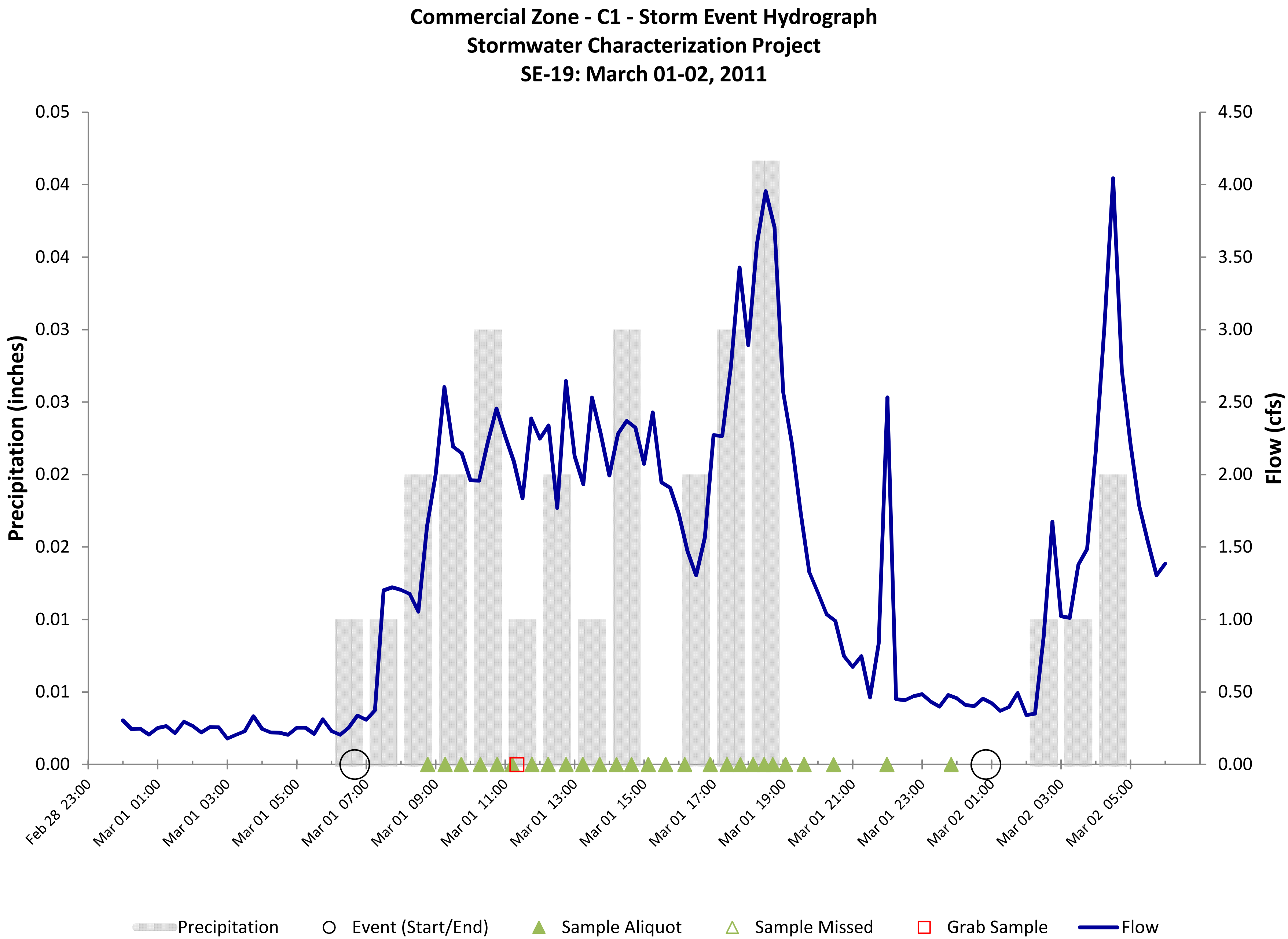
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-16: November 29-December 01, 2010
Precipitation (inches)
Flow (cfs)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Nov 29 11:00
Nov 29 14:00
Nov 29 17:00
Nov 29 20:00
Nov 29 23:00
Nov 30 02:00
Nov 30 05:00
Nov 30 08:00
Nov 30 11:00
Nov 30 14:00
Nov 30 17:00
Nov 30 20:00
Nov 30 23:00
Dec 01 02:00
Dec 01 05:00
Dec 01 08:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-17: December 07-08, 2010
Precipitation (inches)
Flow (cfs)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
45
40
35
30
25
20
15
10
5
0
Dec 07 09:00
Dec 07 11:00
Dec 07 13:00
Dec 07 15:00
Dec 07 17:00
Dec 07 19:00
Dec 07 21:00
Dec 07 23:00
Dec 08 01:00
Dec 08 03:00
Dec 08 05:00
Dec 08 07:00
Dec 08 09:00
Dec 08 11:00
Dec 08 13:00
Dec 08 15:00
Dec 08 17:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

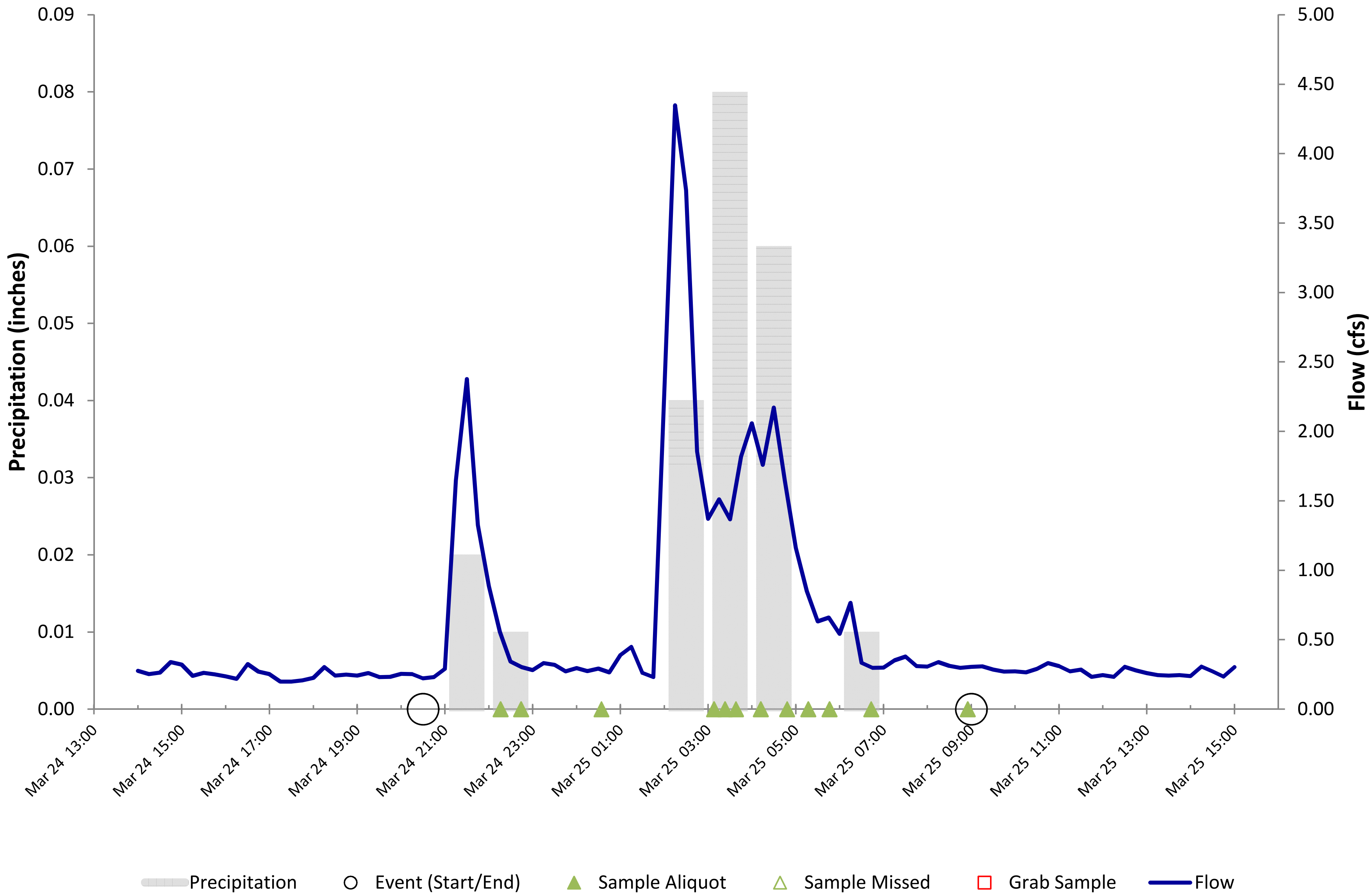
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-18: February 12, 2011



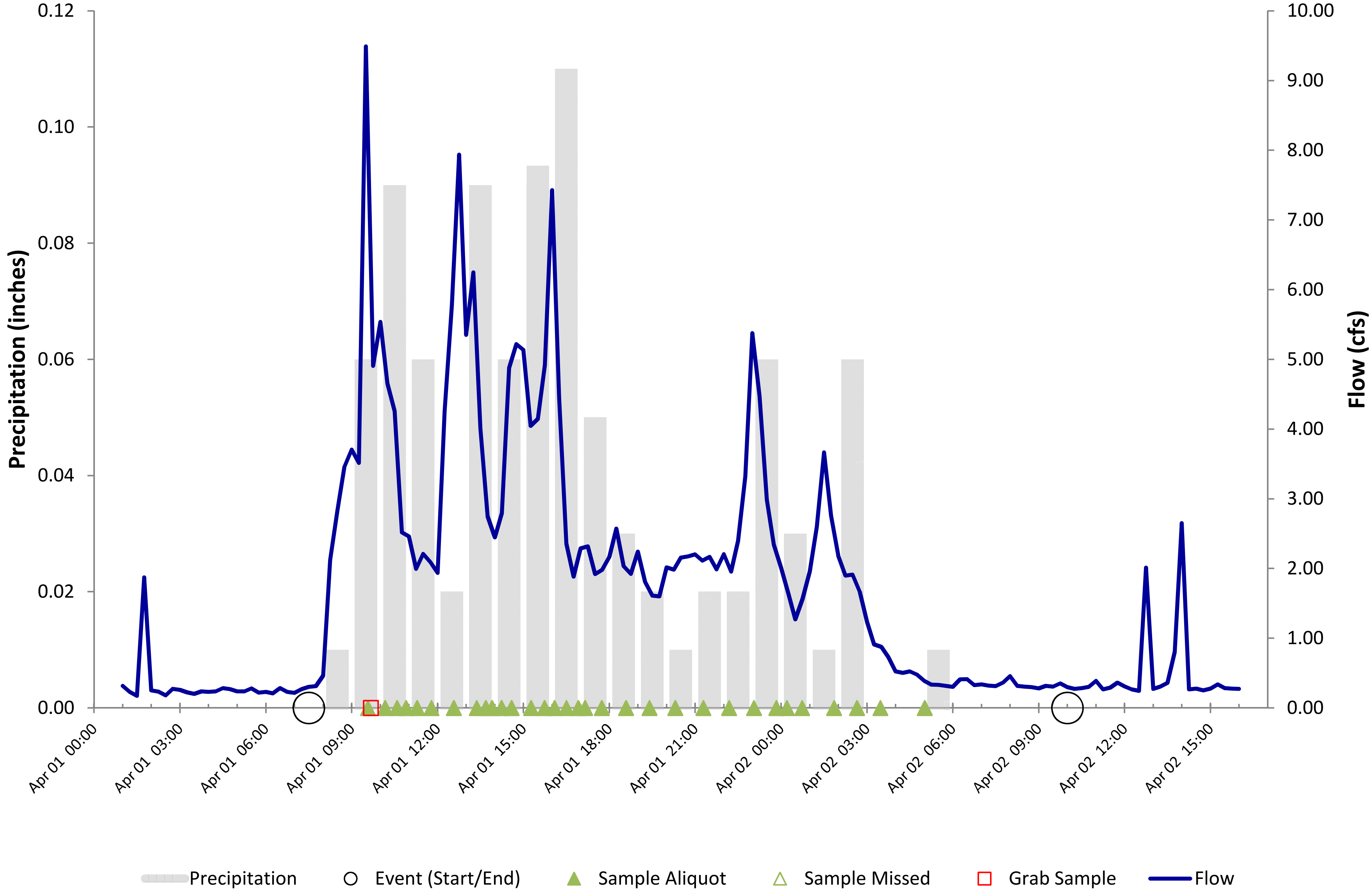


Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-19: March 01-02, 2011
Precipitation (inches)
Flow (cfs)
0.05
0.04
0.04
0.03
0.03
0.02
0.02
0.01
0.01
0.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Feb 28 23:00
Mar 01 01:00
Mar 01 03:00
Mar 01 05:00
Mar 01 07:00
Mar 01 09:00
Mar 01 11:00
Mar 01 13:00
Mar 01 15:00
Mar 01 17:00
Mar 01 19:00
Mar 01 21:00
Mar 01 23:00
Mar 02 01:00
Mar 02 03:00
Mar 02 05:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

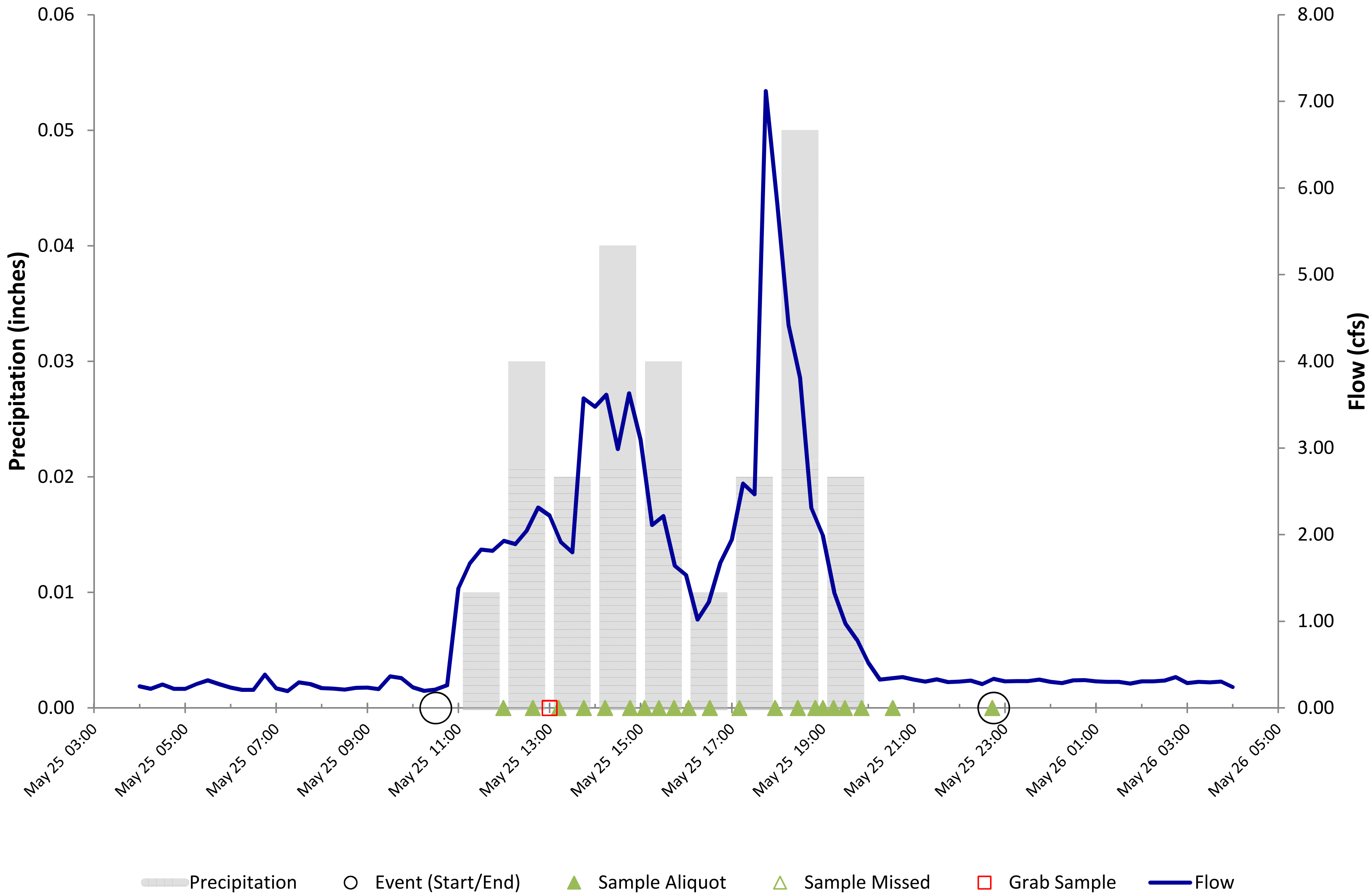
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-20: March 24-25, 2011

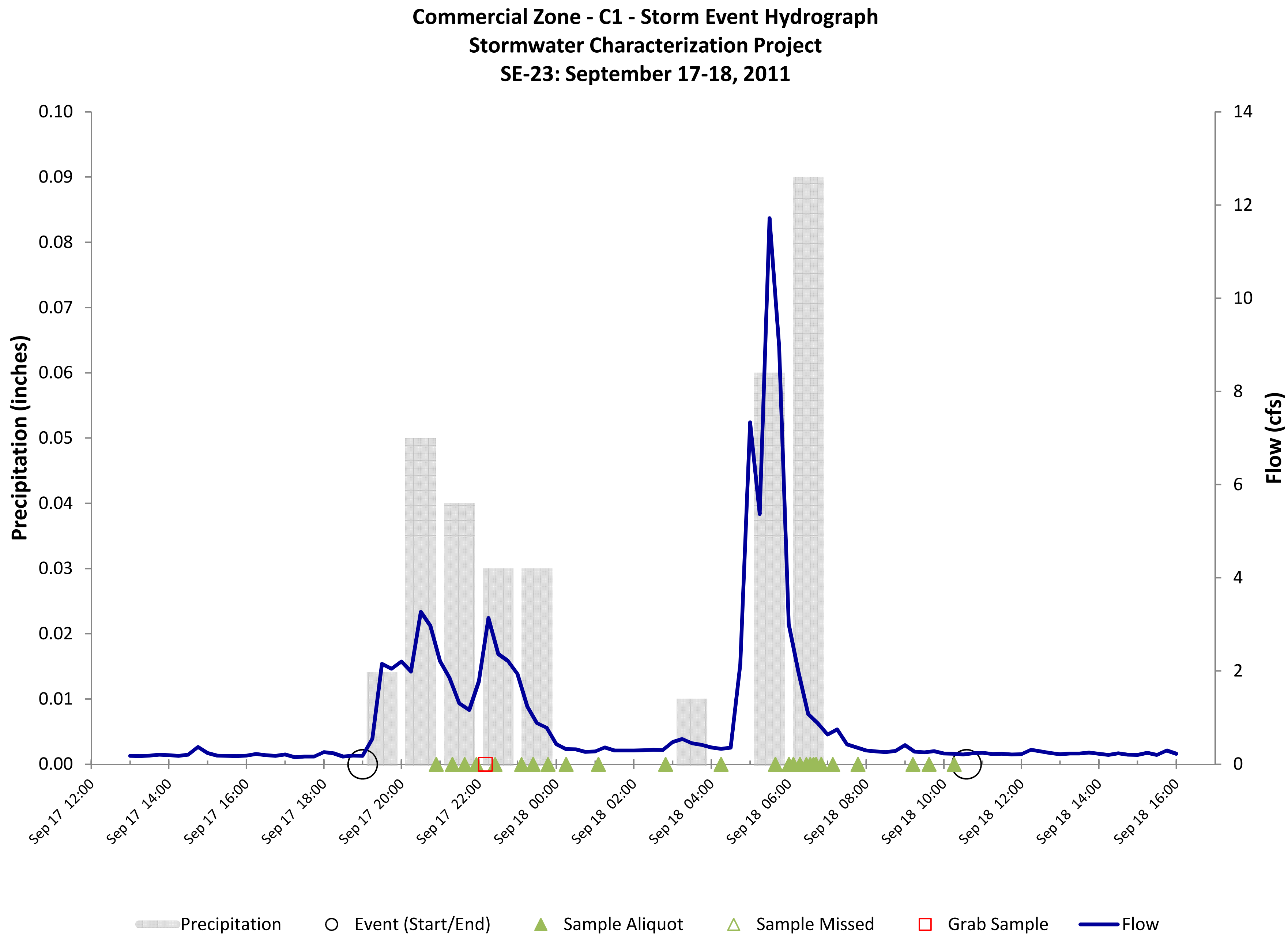


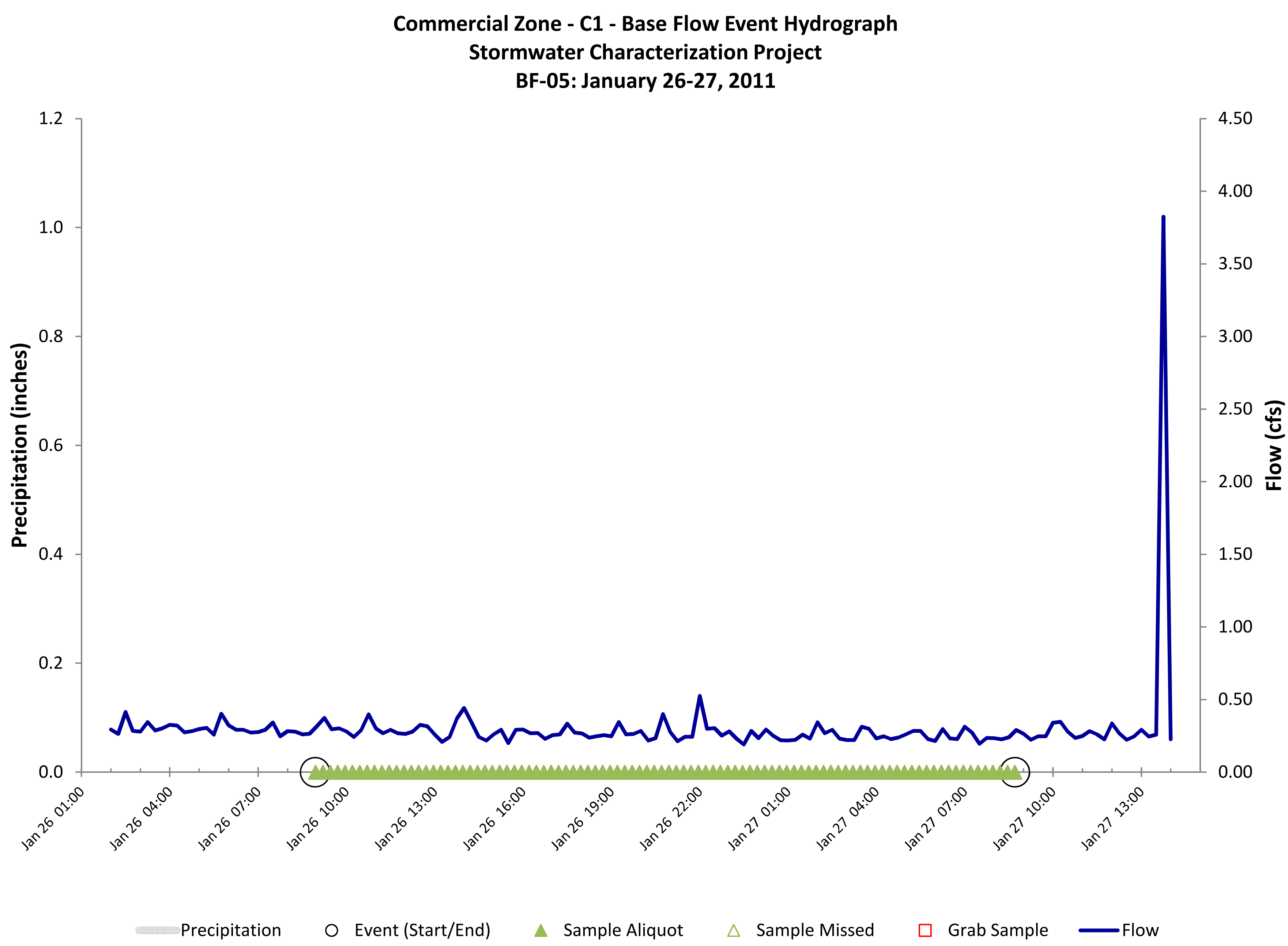
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-21: April 01-02, 2011



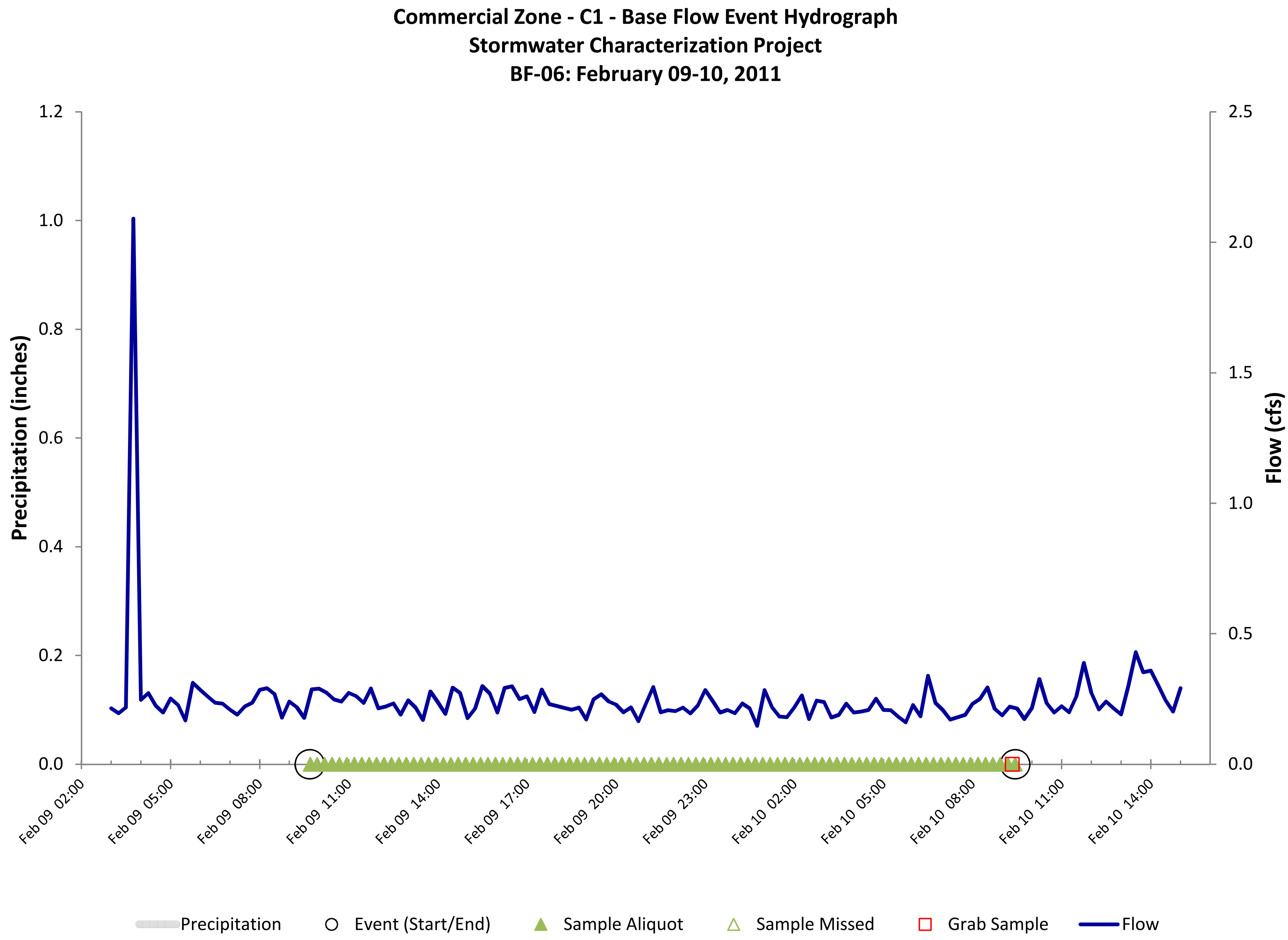
Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-22: May 25, 2011




Commercial Zone - C1 - Storm Event Hydrograph
Stormwater Characterization Project
SE-23: September 17-18, 2011
Precipitation (inches)
Flow (cfs)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
14
12
10
8
6
4
2
0
Sep 17 12:00
Sep 17 14:00
Sep 17 16:00
Sep 17 18:00
Sep 17 20:00
Sep 17 22:00
Sep 18 00:00
Sep 18 02:00
Sep 18 04:00
Sep 18 06:00
Sep 18 08:00
Sep 18 10:00
Sep 18 12:00
Sep 18 14:00
Sep 18 16:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

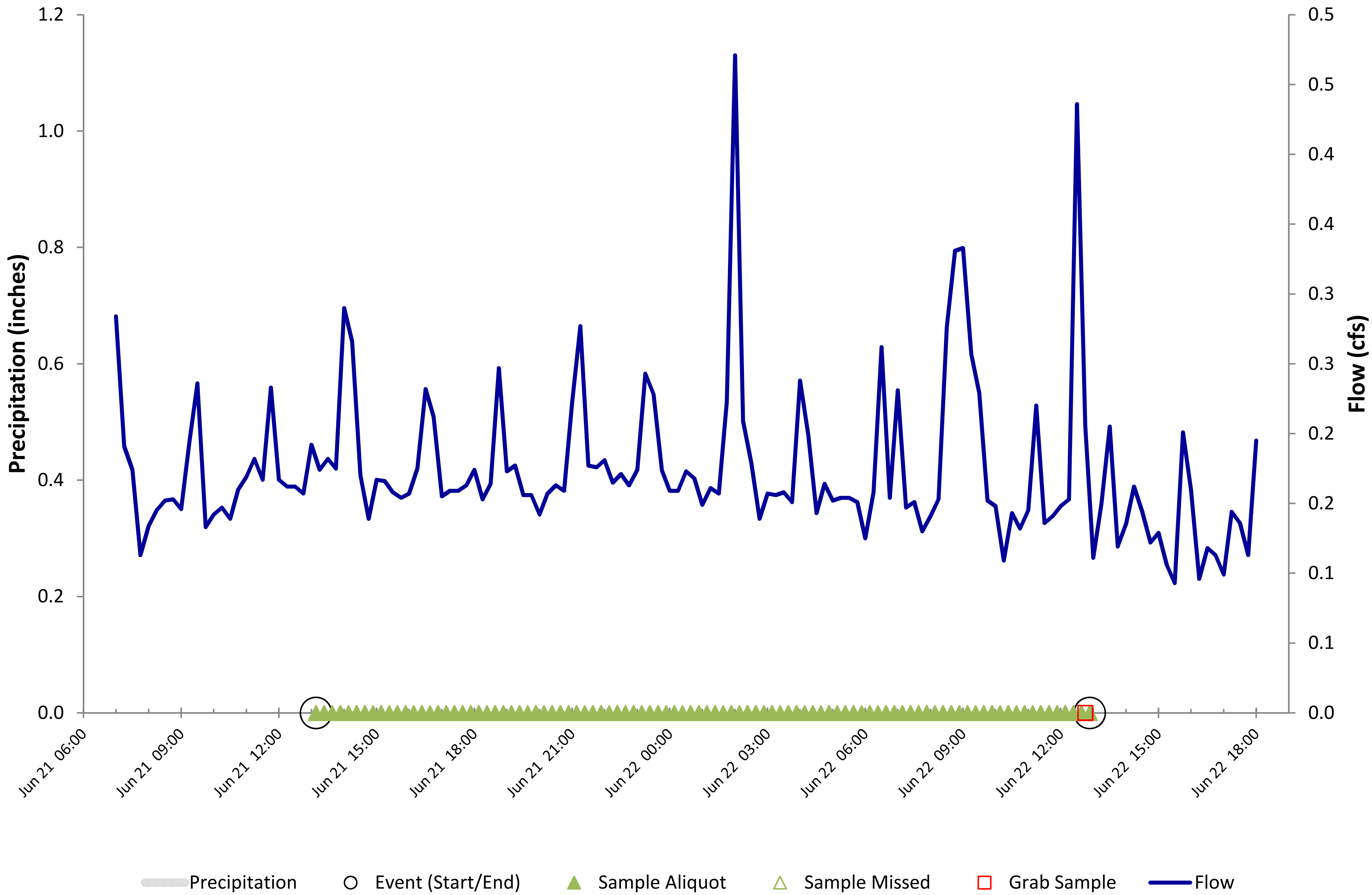


Commercial Zone - C1 - Base Flow Event Hydrograph
Stormwater Characterization Project
BF-05: January 26-27, 2011
Precipitation (inches)
Flow (cfs)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jan 26 01:00
Jan 26 04:00
Jan 26 07:00
Jan 26 10:00
Jan 26 13:00
Jan 26 16:00
Jan 26 19:00
Jan 26 22:00
Jan 27 01:00
Jan 27 04:00
Jan 27 07:00
Jan 27 10:00
Jan 27 13:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

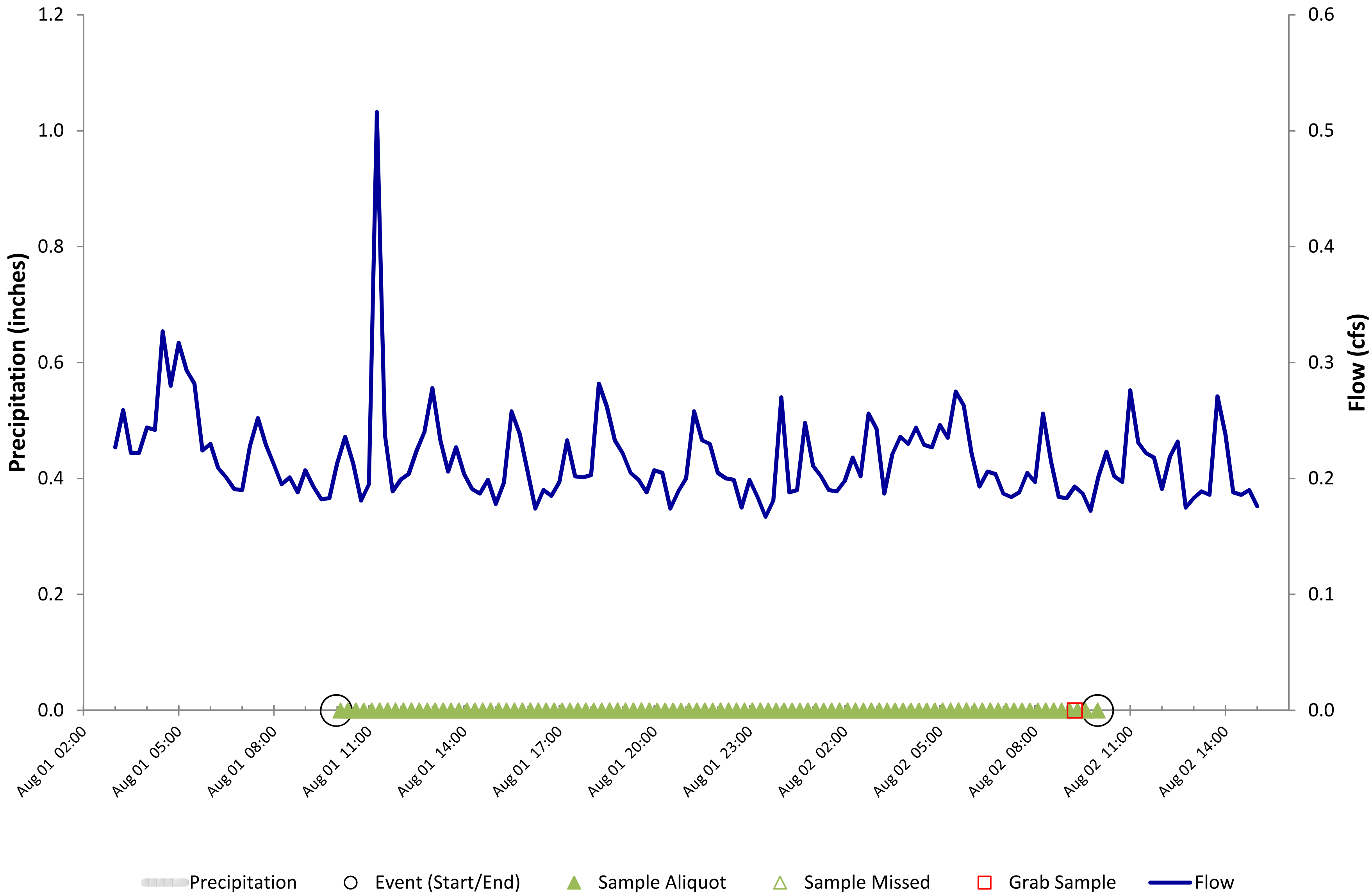


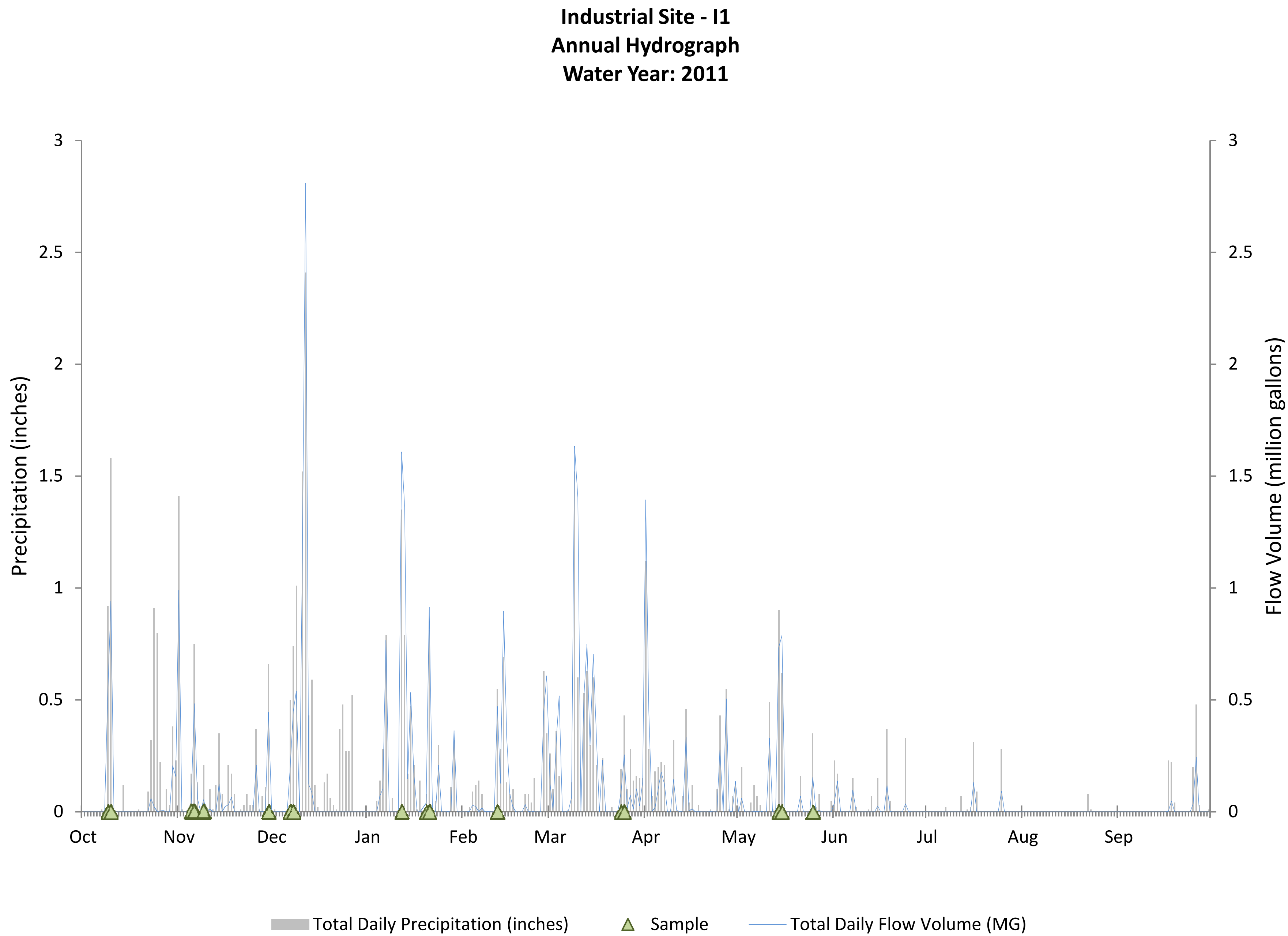
Commercial Zone - C1 - Base Flow Event Hydrograph
Stormwater Characterization Project
BF-06: February 09-10, 2011
Precipitation (inches)
Flow (cfs)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb 09 02:00
Feb 09 05:00
Feb 09 08:00
Feb 09 11:00
Feb 09 14:00
Feb 09 17:00
Feb 09 20:00
Feb 09 23:00
Feb 10 02:00
Feb 10 05:00
Feb 10 08:00
Feb 10 11:00
Feb 10 14:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

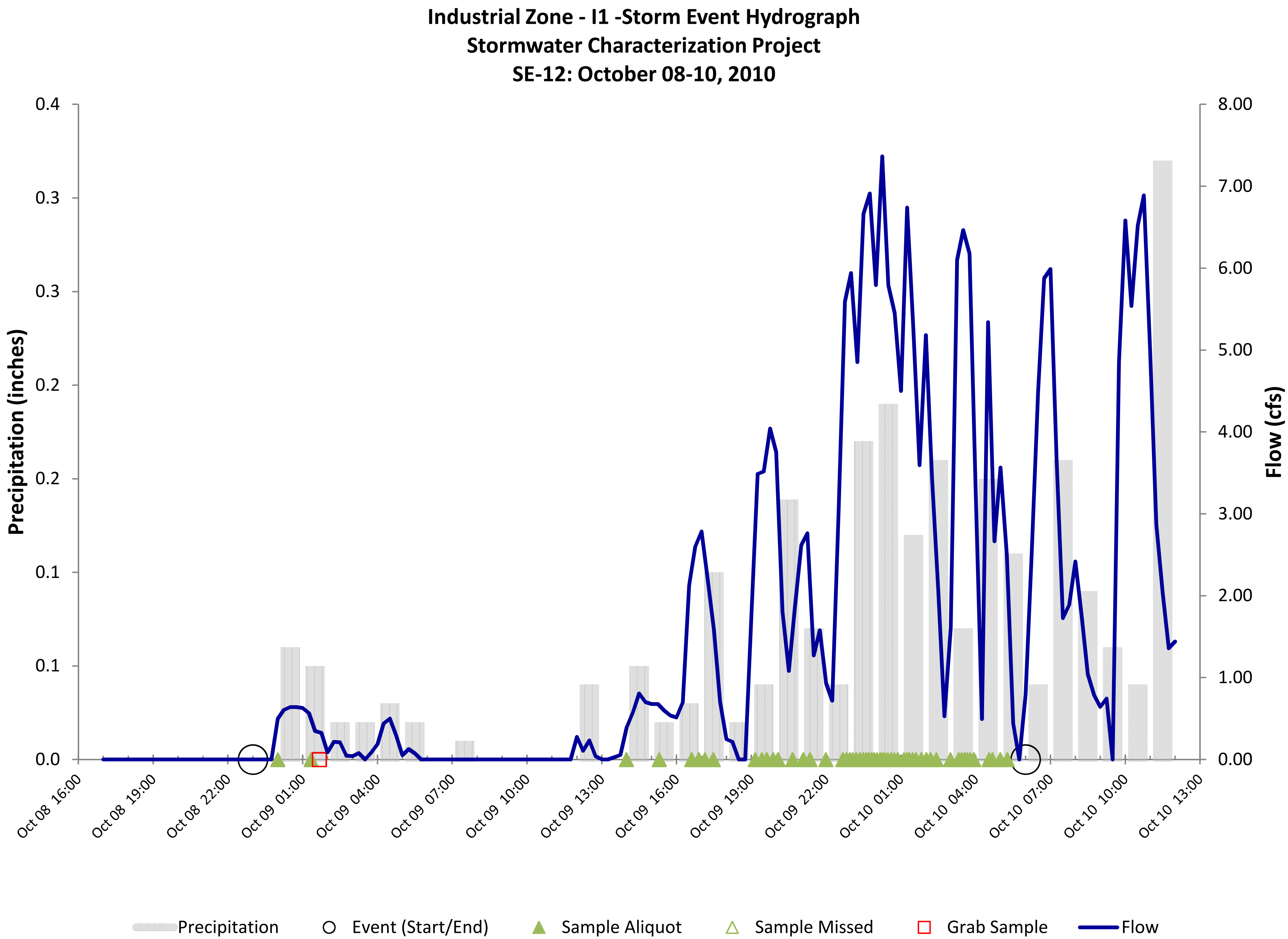
Commercial Zone - C1 - Base Flow Event Hydrograph
Stormwater Characterization Project
BF-07: June 21-22, 2011



Commercial Zone - C1 - Base Flow Event Hydrograph
Stormwater Characterization Project
BF-08: August 01-02, 2011

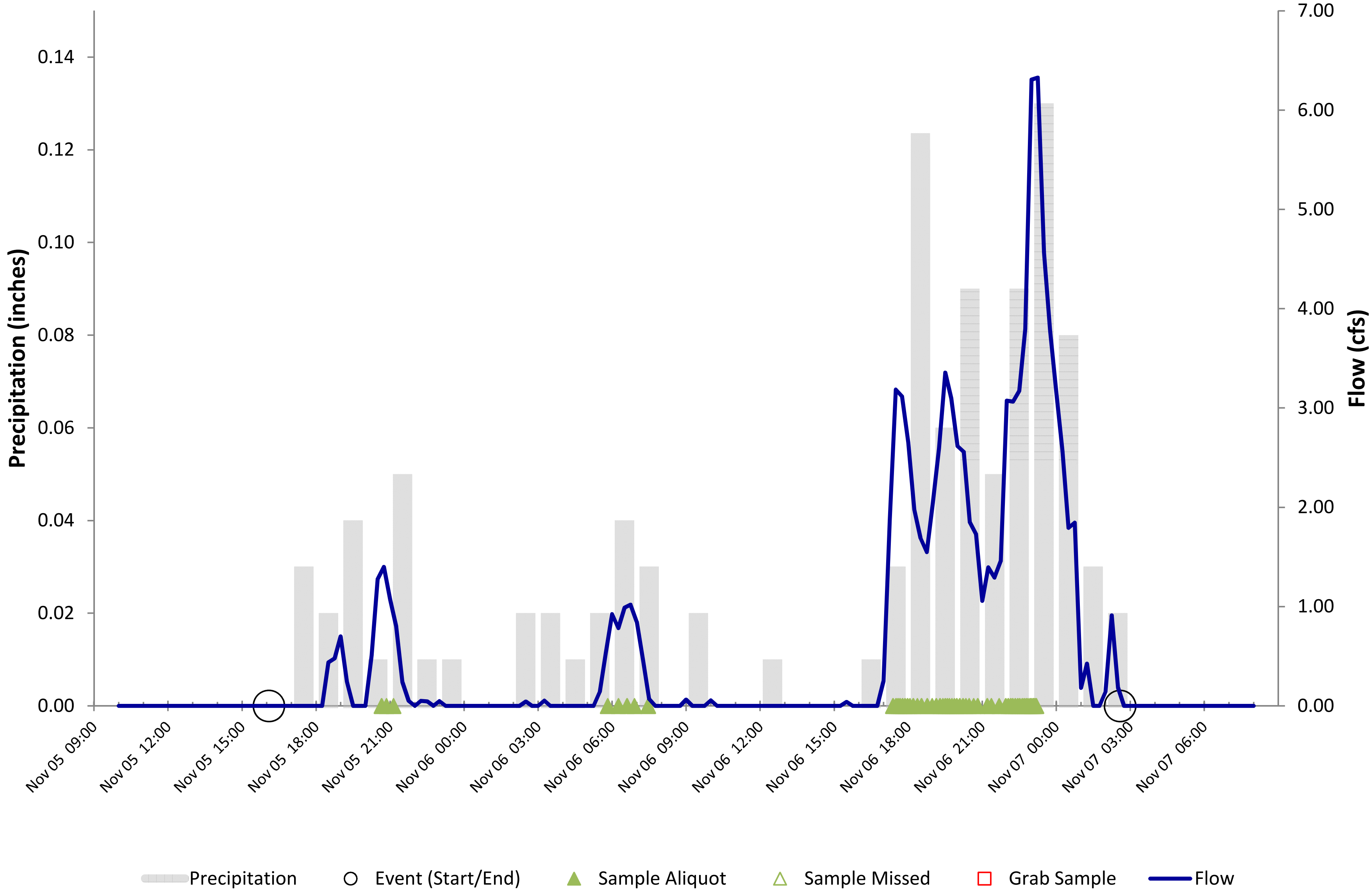



Industrial Site - I1
Annual Hydrograph
Water Year: 2011
Precipitation (inches)
Flow Volume (million gallons)
0
0.5
1
1.5
2
2.5
3
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Total Daily Precipitation (inches)
Sample
Total Daily Flow Volume (MG)

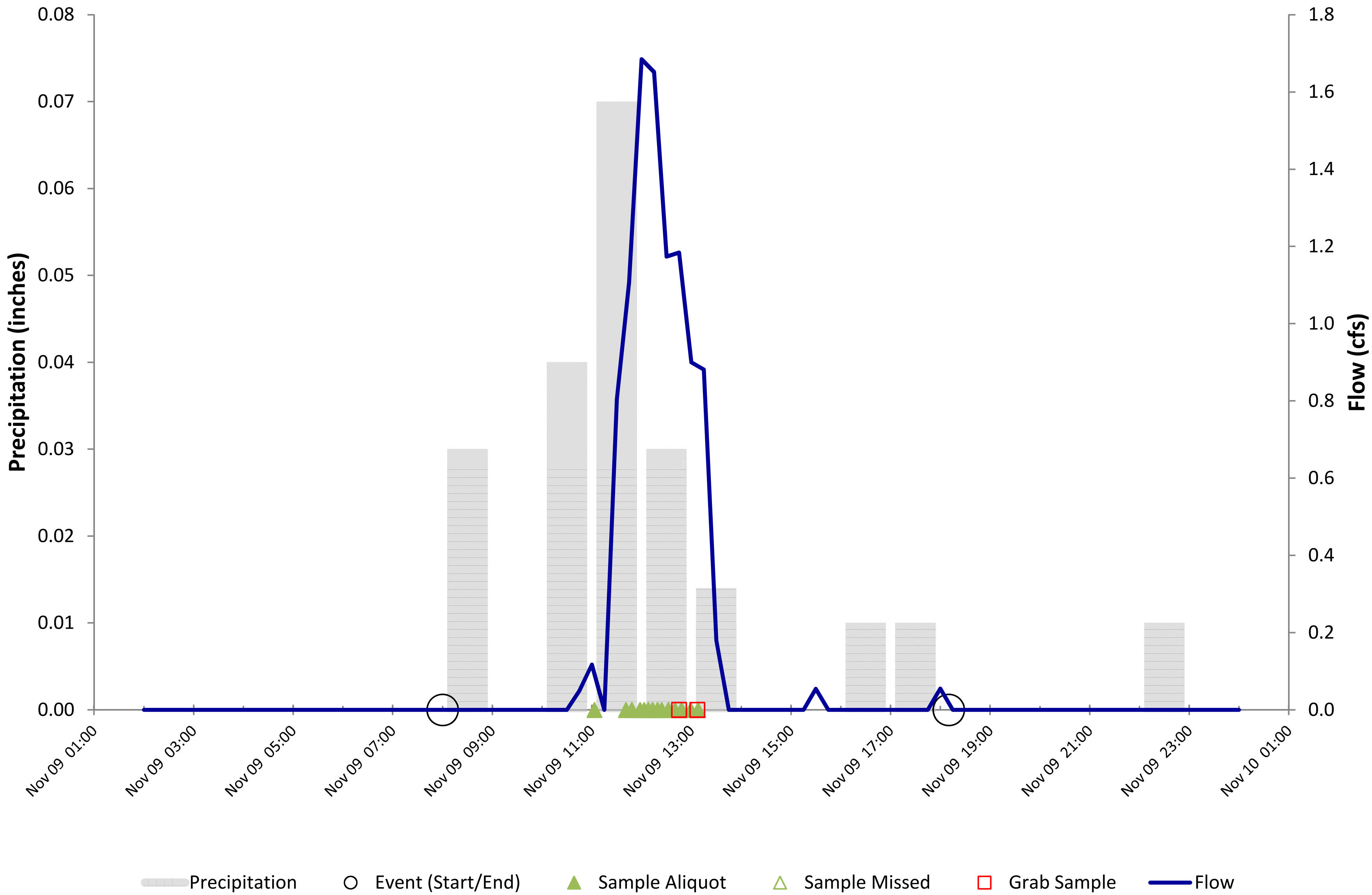


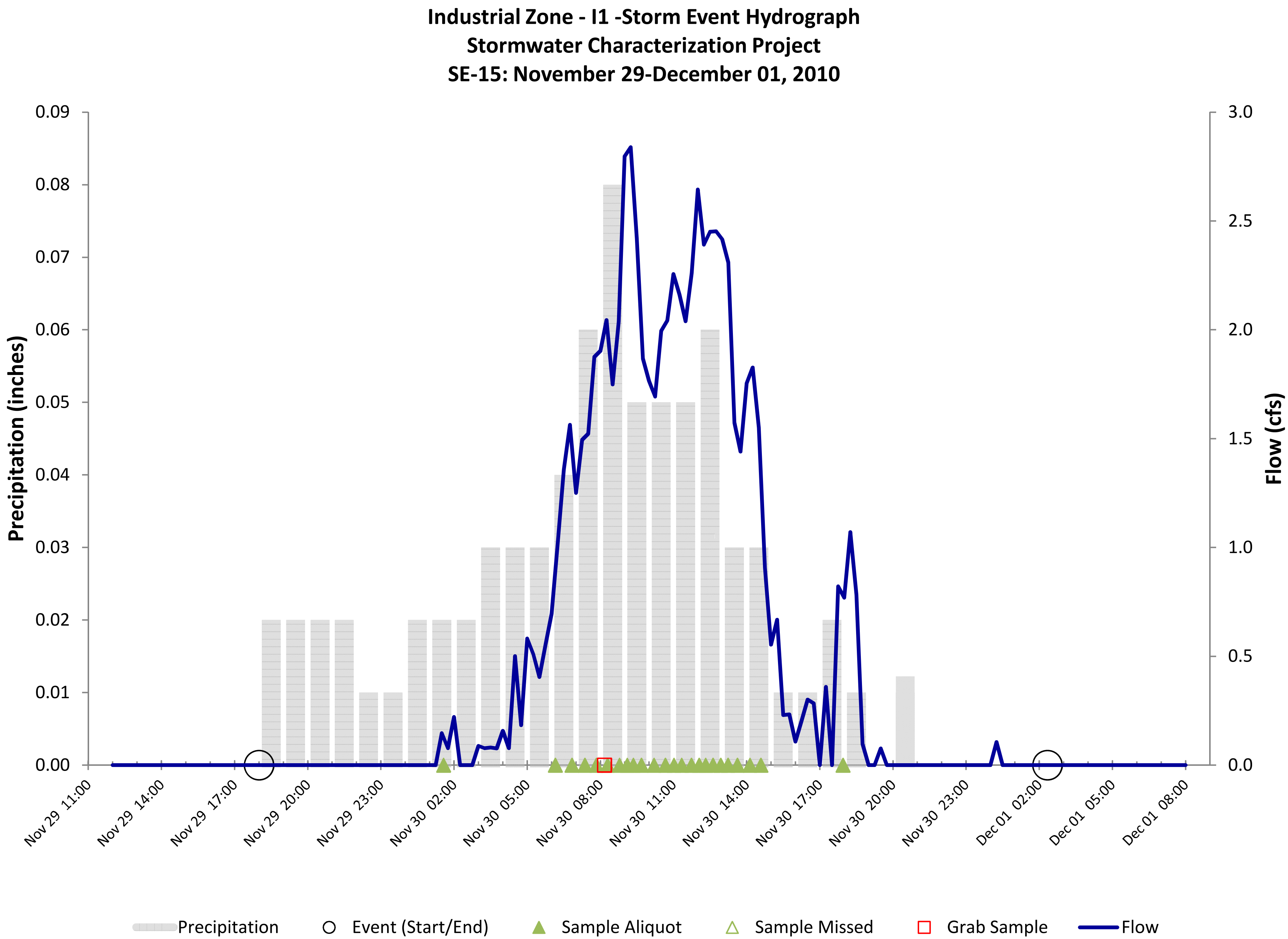
Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-12: October 08-10, 2010
Precipitation (inches)
Flow (cfs)
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Oct 08 16:00
Oct 08 19:00
Oct 08 22:00
Oct 09 01:00
Oct 09 04:00
Oct 09 07:00
Oct 09 10:00
Oct 09 13:00
Oct 09 16:00
Oct 09 19:00
Oct 09 22:00
Oct 10 01:00
Oct 10 04:00
Oct 10 07:00
Oct 10 10:00
Oct 10 13:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-13: November 05-07, 2010



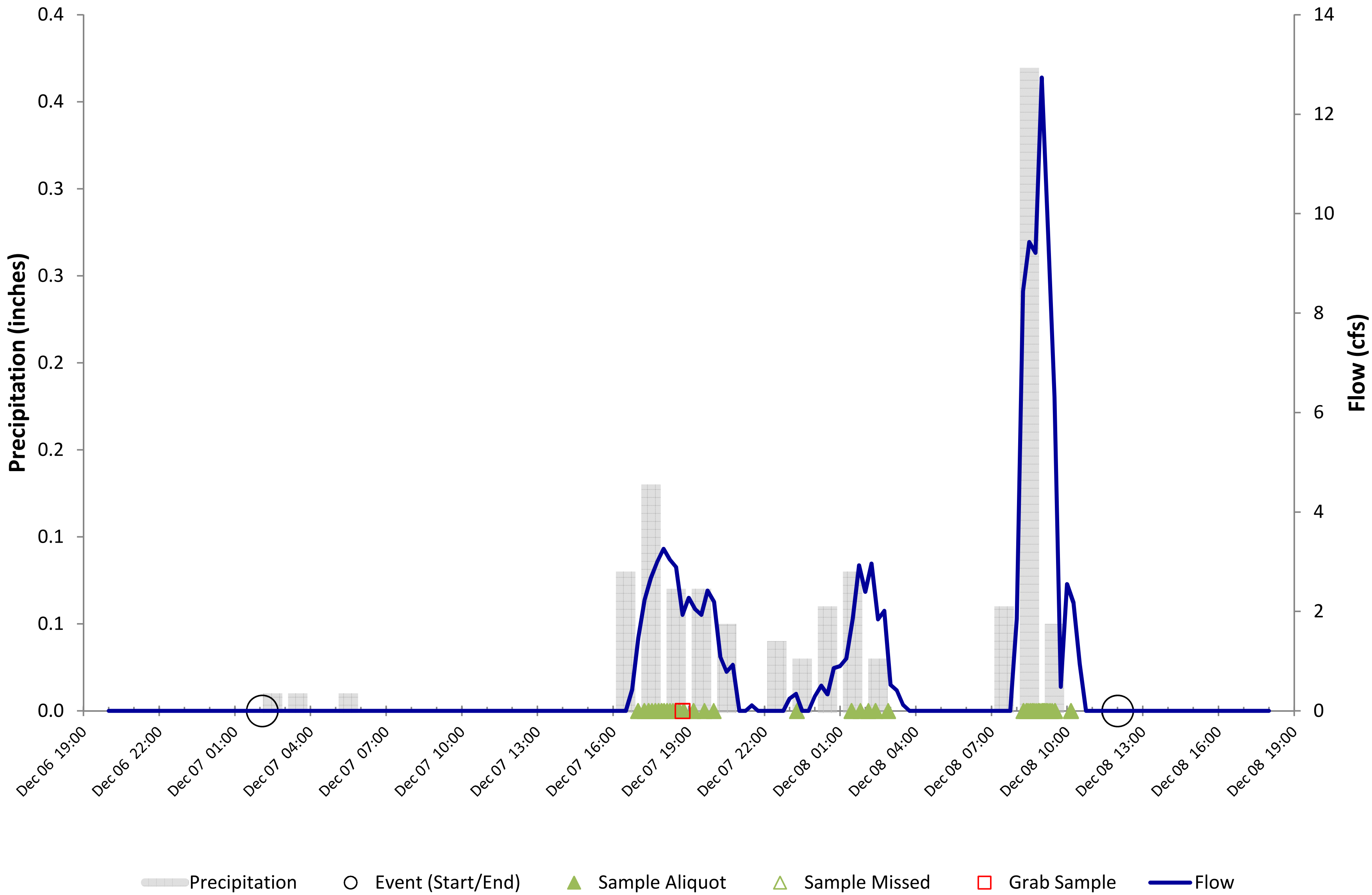
Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-14: November 09, 2010

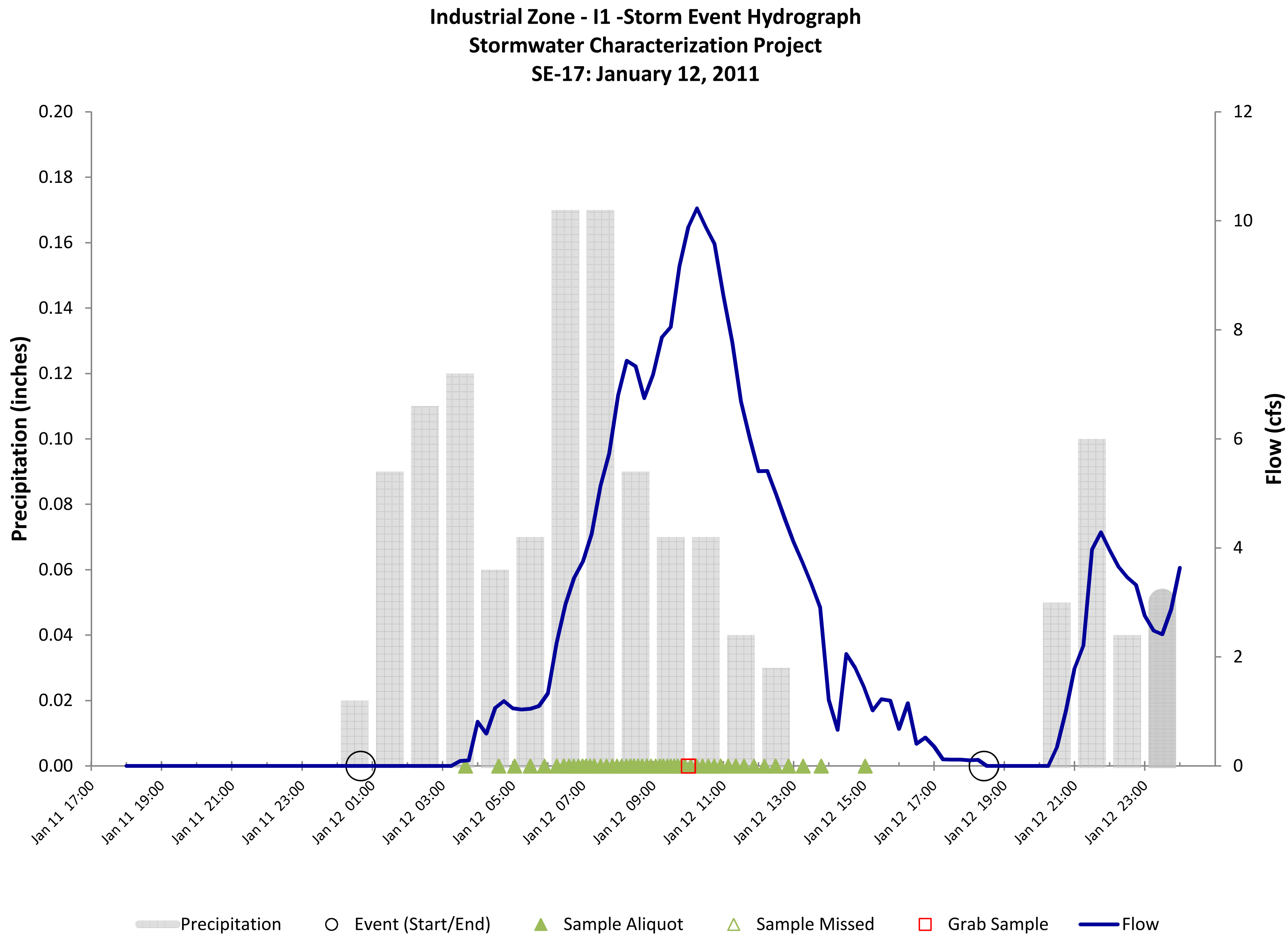




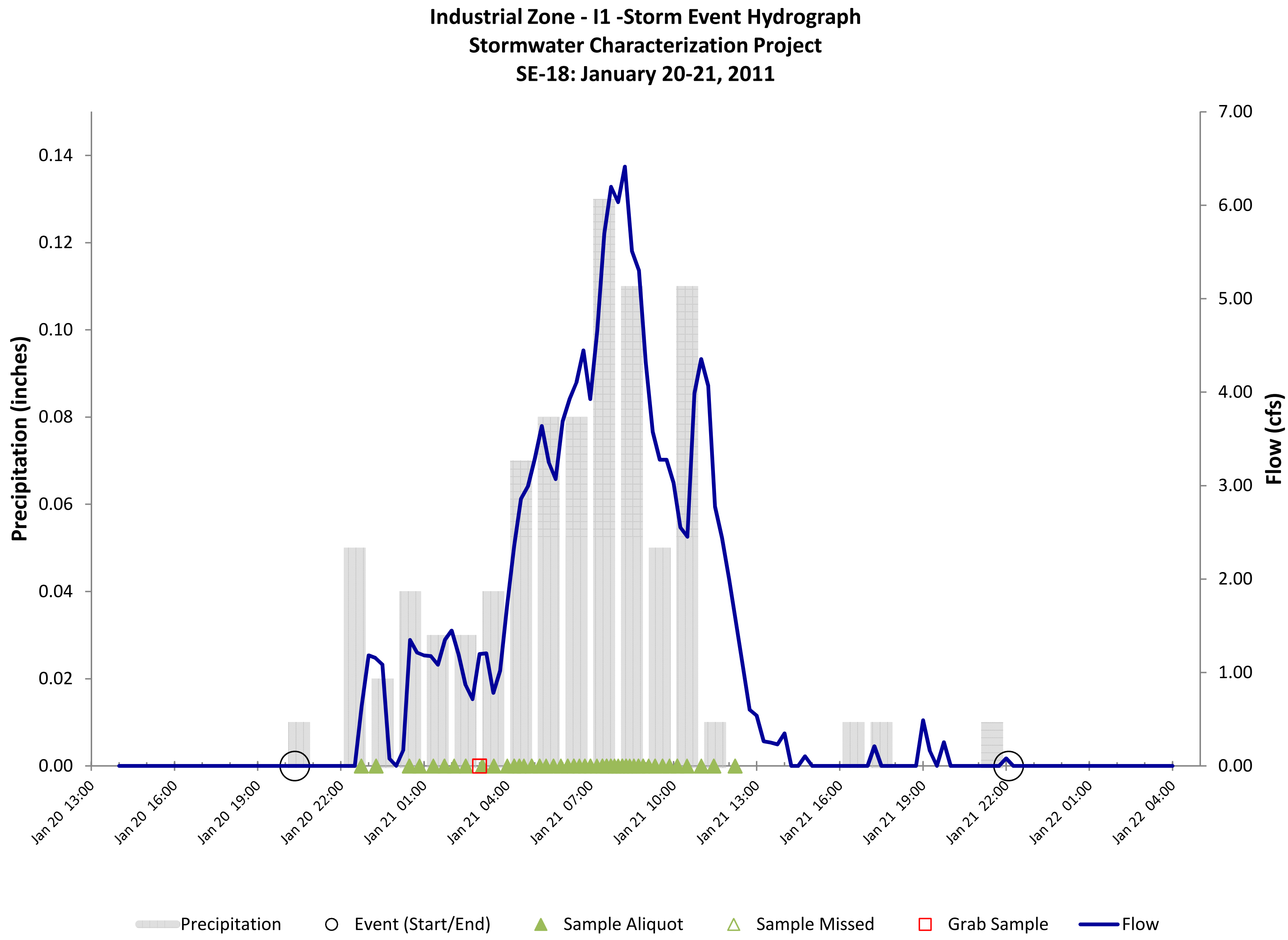
Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-15: November 29-December 01, 2010
Precipitation (inches)
Flow (cfs)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Nov 29 11:00
Nov 29 14:00
Nov 29 17:00
Nov 29 20:00
Nov 29 23:00
Nov 30 02:00
Nov 30 05:00
Nov 30 08:00
Nov 30 11:00
Nov 30 14:00
Nov 30 17:00
Nov 30 20:00
Nov 30 23:00
Dec 01 02:00
Dec 01 05:00
Dec 01 08:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

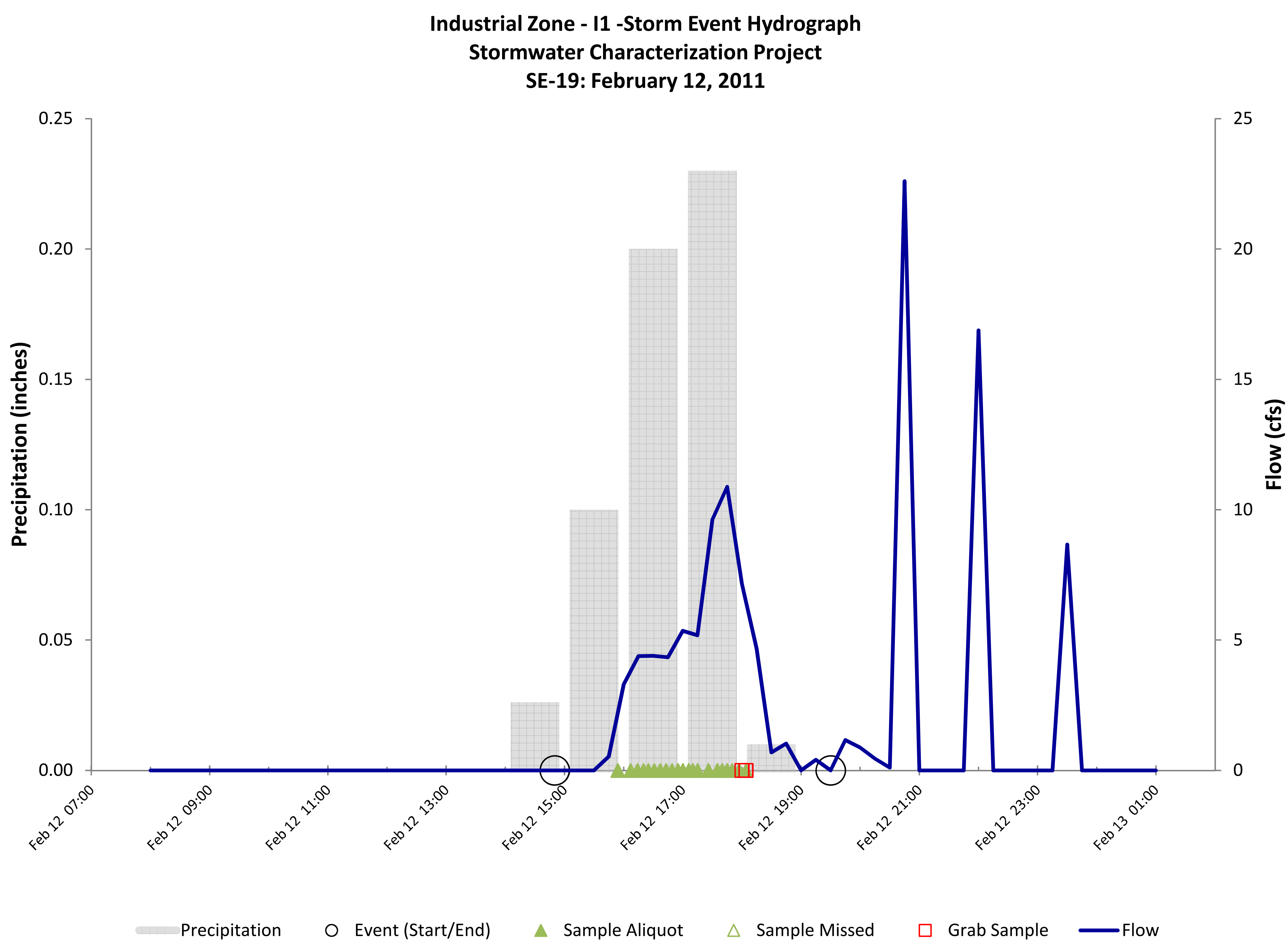
Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-16: December 07-08, 2010



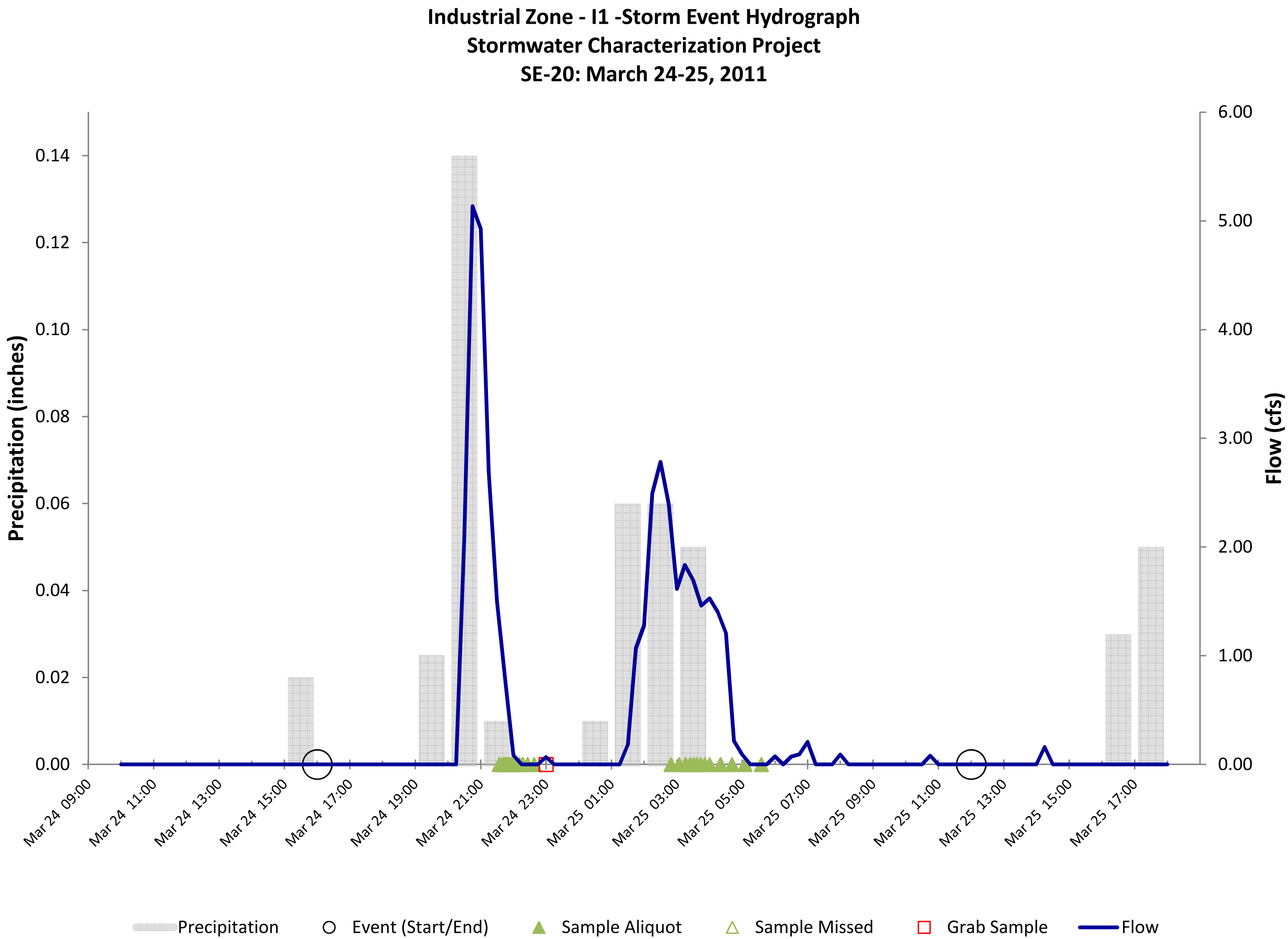


Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-17: January 12, 2011
Precipitation (inches)
Flow (cfs)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
12
10
8
6
4
2
0
Jan 11 17:00
Jan 11 19:00
Jan 11 21:00
Jan 11 23:00
Jan 12 01:00
Jan 12 03:00
Jan 12 05:00
Jan 12 07:00
Jan 12 09:00
Jan 12 11:00
Jan 12 13:00
Jan 12 15:00
Jan 12 17:00
Jan 12 19:00
Jan 12 21:00
Jan 12 23:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow

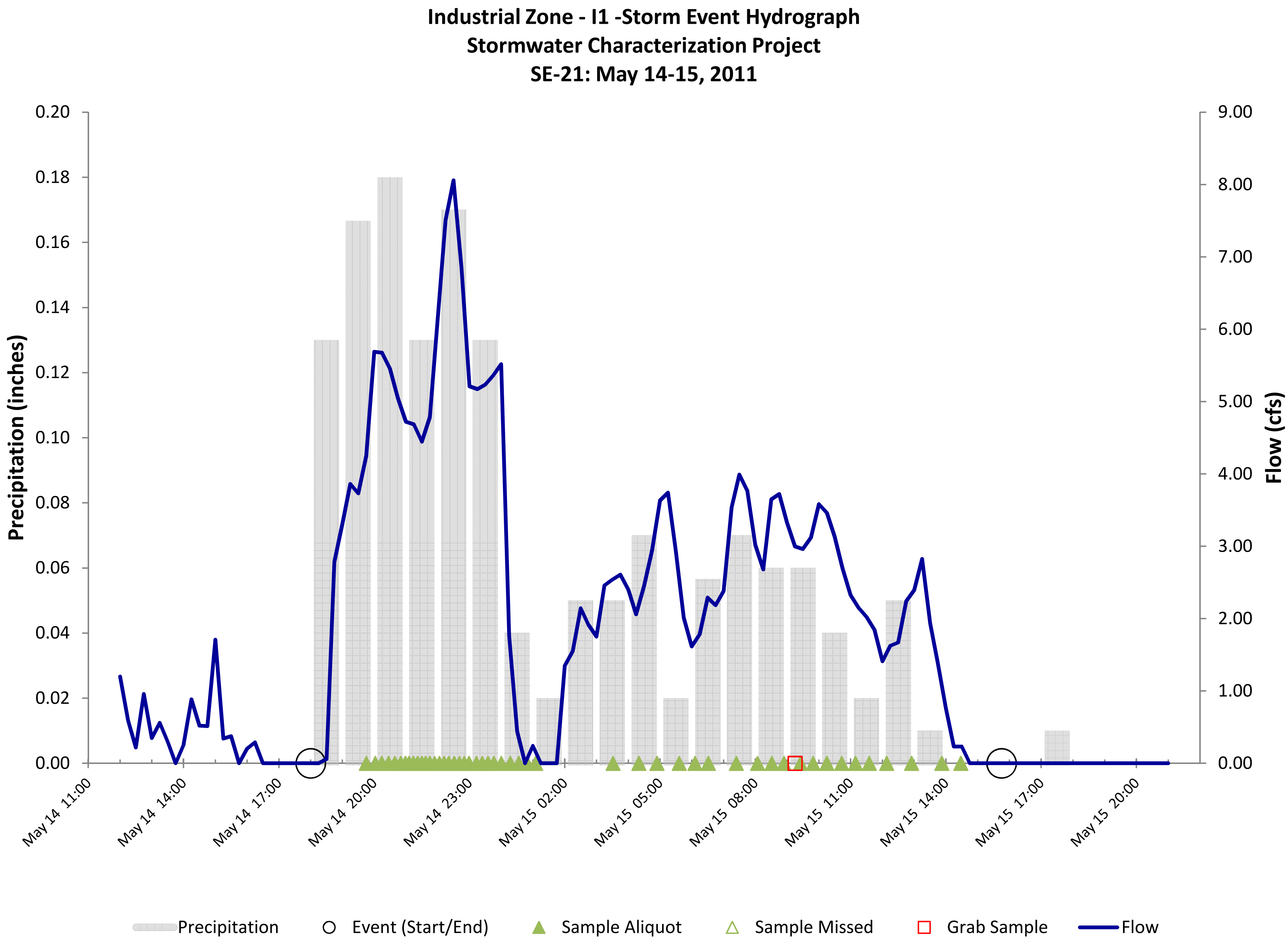

Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-18: January 20-21, 2011
Precipitation (inches)
Flow (cfs)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Jan 20 13:00
Jan 20 16:00
Jan 20 19:00
Jan 20 22:00
Jan 21 01:00
Jan 21 04:00
Jan 21 07:00
Jan 21 10:00
Jan 21 13:00
Jan 21 16:00
Jan 21 19:00
Jan 21 22:00
Jan 22 01:00
Jan 22 04:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



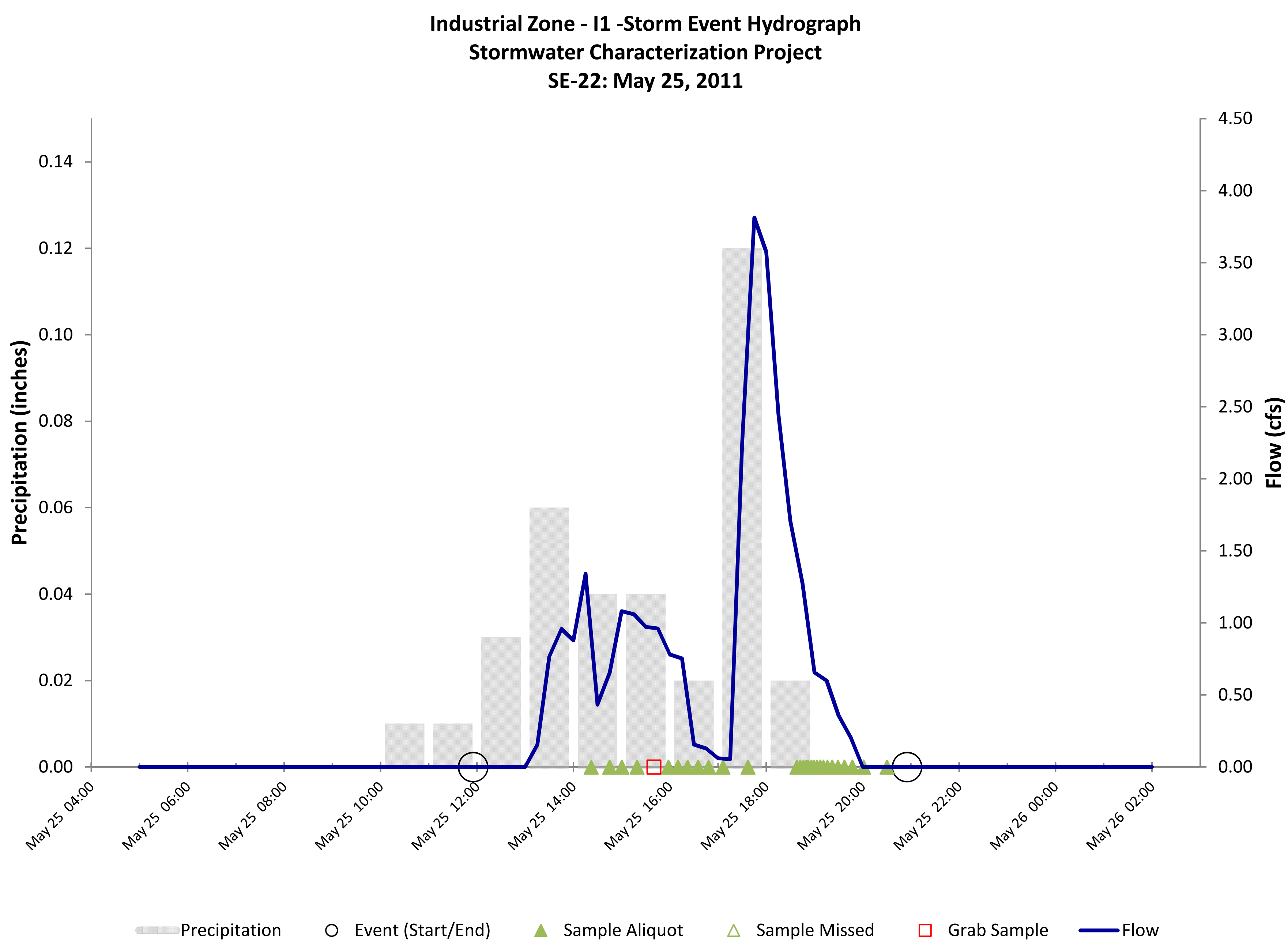
Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-19: February 12, 2011
Precipitation (inches)
Flow (cfs)
0.25
0.20
0.15
0.10
0.05
0.00
25
20
15
10
5
0
Feb 12 07:00
Feb 12 09:00
Feb 12 11:00
Feb 12 13:00
Feb 12 15:00
Feb 12 17:00
Feb 12 19:00
Feb 12 21:00
Feb 12 23:00
Feb 13 01:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-20: March 24-25, 2011
Precipitation (inches)
Flow (cfs)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Mar 24 09:00
Mar 24 11:00
Mar 24 13:00
Mar 24 15:00
Mar 24 17:00
Mar 24 19:00
Mar 24 21:00
Mar 24 23:00
Mar 25 01:00
Mar 25 03:00
Mar 25 05:00
Mar 25 07:00
Mar 25 09:00
Mar 25 11:00
Mar 25 13:00
Mar 25 15:00
Mar 25 17:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow



Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-21: May 14-15, 2011
Precipitation (inches)
Flow (cfs)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
May 14 11:00
May 14 14:00
May 14 17:00
May 14 20:00
May 14 23:00
May 15 02:00
May 15 05:00
May 15 08:00
May 15 11:00
May 15 14:00
May 15 17:00
May 15 20:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow


Industrial Zone - I1 -Storm Event Hydrograph
Stormwater Characterization Project
SE-22: May 25, 2011
Precipitation (inches)
Flow (cfs)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
May 25 04:00
May 25 06:00
May 25 08:00
May 25 10:00
May 25 12:00
May 25 14:00
May 25 16:00
May 25 18:00
May 25 20:00
May 25 22:00
May 26 00:00
May 26 02:00
Precipitation
Event (Start/End)
Sample Aliquot
Sample Missed
Grab Sample
Flow