WSDOT NPDES Municipal Stormwater Permit BMP Effectiveness Monitoring Report (S7.C and S7.D) Water Year 2013

October 2014

Prepared by

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Stormwater Monitoring Report

BMP Effectiveness Evaluation
Water Year 2013

Approved by:

I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations.

Signature: ______________________________ Date: ______________

Megan White, Director, WSDOT Environmental Services Office

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WSDOT = Washington State Department of Transportation

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1 Introduction

1.1 Permit Overview

On March 6, 2014, the Washington State Department of Ecology (Ecology) reissued a *National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Municipal Stormwater General Permit* (permit) (Ecology 2014) to the Washington State Department of Transportation (WSDOT), effective April 5, 2014 to April 5, 2019. Under Special Condition S7 of the permit, WSDOT must continue a monitoring program to evaluate the effectiveness of highway vegetated filter strip (VFS) and modified VFS best management practices (BMPs), and develop a monitoring program to evaluate BMP effectiveness at three facilities (rest areas, maintenance facilities, or ferry terminals). In addition, WSDOT must continue a monitoring program to establish baseline stormwater discharge information from its existing highway runoff characterization sites.

Under Special Conditions S7.B–D of the permit, monitoring reports are required for information collected at the department's stormwater BMP effectiveness and highway runoff monitoring sites. The following report helps satisfy these requirements and provides a summary of monitoring activities completed at VFS and modified VFS BMP effectiveness monitoring sites from October 1, 2012, through September 30, 2013 (water year 2013). This report also provides status on preparations to develop and implement BMP effectiveness monitoring programs at future highway and facility sites. A separate report covers ongoing monitoring activities completed at WSDOT highway runoff characterization sites.

1.2 Monitoring Requirements (S7.C and S7.D)

In accordance with the permit, WSDOT must continue to evaluate the effectiveness of its highway VFS and modified VFS stormwater treatment and hydrologic management BMPs. Monitoring must continue until statistical goals in the *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE)* (Ecology 2011) are met. If the statistical goals in TAPE cannot be met, the 2014 permit requires a maximum sampling effort of 35 sampling events.

In addition, WSDOT must develop and implement a monitoring program to evaluate the effectiveness of stormwater treatment and hydrologic management BMPs at three facilities (rest areas, maintenance facilities, or ferry terminals).

Under the previous 2009 WSDOT NPDES municipal stormwater permit (Ecology 2009a), seasonal first flush toxicity sampling was required from three BMP effluent locations in water year 2013 (WY13). Although toxicity testing is not a requirement under the current 2014 permit, this report includes a description of toxicity sampling requirements under the 2009-issued permit.

In accordance with the 2009-issued permit, toxicity samples were collected from the effluent of VFS and modified VFS BMPs based on the following annul average daily traffic (AADT):

- One highly urbanized site (≥ 100,000 AADT)
- One urbanized site (≤ 100,000 and ≥ 30,000 AADT)
- One rural site (≤ 30,000 AADT)

Results from toxicity sampling conducted in WY13 are summarized in the *WSDOT NPDES Municipal Stormwater Permit Highway Runoff Characterization Report (S7.B) Water Year 2013* (WSDOT 2014a).

1.3 Monitoring Schedule

WSDOT submitted a *Quality Assurance Project Plan (QAPP) for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* (WSDOT 2011a) to Ecology for approval on September 2, 2011.[1] Ecology sent WSDOT a QAPP approval letter on September 16, 2011. This QAPP describes the objectives of the VFS and modified VFS effectiveness monitoring programs and the procedures to be used to ensure the quality and integrity of collected data. The QAPP also identifies the project timelines and schedule.

Under the 2009 permit, WSDOT was required to fully implement the stormwater BMP effectiveness monitoring program no later than September 6, 2011. However, unanticipated challenges, including government hiring and equipment purchase freezes in effect through early summer 2011, delayed implementation of the monitoring program.

On October 20, 2011, as required under the 2009 permit, WSDOT notified Ecology that it would be unable to fully comply with monitoring program implementation timelines and that toxicity sampling would be deferred until August 2012.

In a letter to Ecology on January 13, 2012, WSDOT proposed a revised schedule and phased approach for initiating the BMP effectiveness monitoring component of its program. The phased approach provided time for the iterative learning and adaptation necessary to fully and successfully implement the program. The letter proposed sampling at one BMP monitoring site beginning May 1, 2012, with the remainder of the sites operational by June 15, 2012. Ecology concurred, and WSDOT successfully met the revised timelines and schedule.

In October 2013 and March 2014, WSDOT submitted its first BMP effectiveness monitoring reports (WSDOT 2013a and 2014c). Those reports describe the development and status of the program through the first two years of monitoring. This report updates information from the previous reports. Appendix A summarizes BMP stormwater sampling data from WY13.

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[1] The *QAPP for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* was recently revised and updated (WSDOT 2014b).

2 Monitoring Program Implementation

2.1 Site Selection Strategy

The first step in selecting BMP effectiveness evaluation sites was a thorough review of the monitoring program's objectives and permit requirements. WSDOT used the program's objectives and permit requirements to establish the number and types of sites needed for monitoring.

Guidance from the California Department of Transportation (Caltrans 2003) and the following evaluation criteria helped ensure WSDOT selected the most appropriate sites:

- Property ownership
- Site representativeness
- Personnel safety
- Site accessibility
- Equipment security
- Discharge measurement capability
- Site design limitations

2.1.1 Property Ownership

Only properties owned and operated by WSDOT were considered during the site evaluation and selection process.

2.1.2 Site Representativeness

Monitoring was required from two treatment BMPs, at no less than two sites per BMP. Screening criteria for representativeness meant study sites had to be minimally influenced by unique contributing sources of pollution. The following factors were important in assessing BMP effectiveness site locations:

- Long-Term Location – Based on information available during the site selection process, sites that had the potential to be developed or redeveloped in the near future were avoided.
- Uniform Flow – Runoff flows need to be well mixed, but not turbulent. Sites with slopes greater than 33 percent or slopes with abrupt grade changes were not selected.
- Erosion Potential – Extremely steep slopes or cut and fill areas where the land surface had not been stabilized were avoided.
- Tidal and Backwater Influences – Backwater or tidally-influenced sites were not selected.

- High Groundwater Table – A high groundwater table sometimes influences stormwater runoff if the groundwater reaches the surface and mixes with runoff. Therefore, sites where groundwater influence was suspected or confirmed were avoided.
- Illegal Discharges – Sites where there were signs of illegal discharges or dumping of wastes were not considered.
- Surrounding Land Uses – Sites where the surrounding land use heavily influenced the quality of runoff through aerial deposition were avoided.

2.1.3 Personnel Safety

For any WSDOT highway project, staff safety is a high priority. Hazards from traffic, explosive or toxic gasses, poor footing on slopes, slippery conditions, and poor visibility due to adverse weather or night work were minimized or avoided whenever possible.

The following site attributes expose monitoring field teams to potentially unsafe conditions:

- Sites located along a highway shoulder
- Sites that require traffic diversions
- Sites with poor access
- Sites close to waterways

To minimize the effect(s) of these hazards, members of the field team had to be capable of performing all tasks required for sample collection and be familiar with WSDOT's *Safety Procedures and Guidelines Manual* (WSDOT 2013b) and *Work Zone Traffic Control Guidelines* (WSDOT 2012). Site-specific Pre-Activity Safety Plans were developed for each monitoring site to further minimize the effect of these hazards.

2.1.4 Site Accessibility

Monitoring sites were selected to provide safe and feasible access. Highway shoulder width and site visibility from the roadway had to be sufficient to allow safe access for vehicles leaving and reentering the highway.

Due to the nature of highway BMP effectiveness monitoring, locating sites away from the highway shoulder was not an option. To improve fieldwork safety, staff sought access to freeway sites from frontage roads or other off-site locations. When sample timing or site retrofit needs made off-site access impracticable, field teams followed WSDOT safety guidelines and minimized time spent working along the highway.

To make sure personnel could quickly locate and access monitoring sites, site-specific Health and Safety Plans were developed to include a description of parking and work zone safety procedures. Information in the Health and Safety Plans included lists of physical and biological hazards, standard emergency procedures, site maps, and directions.

2.1.5 Equipment Security

Selected sites had to provide adequate level space for monitoring station installation in areas that did not stand out visually. Data collection equipment was installed in locked metal enclosures on level ground or concrete platforms to reduce the risk of tampering.

Locked metal enclosures provided a secure location as well as protection from wind, rain, and snowfall. Signs applied to the outside of the enclosures identified the monitoring stations as WSDOT property, and they appear to have deterred site vandalism.

2.1.6 Discharge Measurement Capability

Monitoring sites were selected in locations that allowed accurate discharge measurement and automatic sample collection. In order to effectively monitor sheet flow runoff from WSDOT highways, conveyance systems were constructed to collect, direct, and measure stormwater runoff from sections of the roadway. Stormwater monitoring conveyance systems had to provide suitable water depth for measuring discharge and collecting representative stormwater samples during storm events.

2.1.7 Site Design Limitations

To meet permit requirements, BMP monitoring stations had to be established to enable collection of water quality and quantity data from influent and effluent sampling locations. The following site design limitations were considered when establishing monitoring stations for BMP effectiveness evaluation:

- The physical space needed for monitoring infrastructure and data collection platform (DCP) establishment.
- The monitoring site design needs that would provide easy access for BMP influent and effluent sampling.
- Monitoring equipment and site infrastructure that would need to be installed to enable accurate flow measurements, and reduce the amount of maintenance required.

2.2 Addressing Resource and Logistical Constraints

To maximize resources and address logistical challenges in implementing the stormwater BMP effectiveness monitoring program, WSDOT staff developed a strategy to optimize the number of monitoring locations needed to meet permit requirements. To address logistical challenges and reduce team mobilization costs, monitoring study sites were localized to reduce staff travel time and associated costs. Whenever possible, staff co-located BMP effectiveness and highway runoff characterization sites to further reduce the number of locations and total number of sites required for monitoring.

Figure 1 shows the location of the highway runoff characterization and BMP effectiveness monitoring sites across the state.

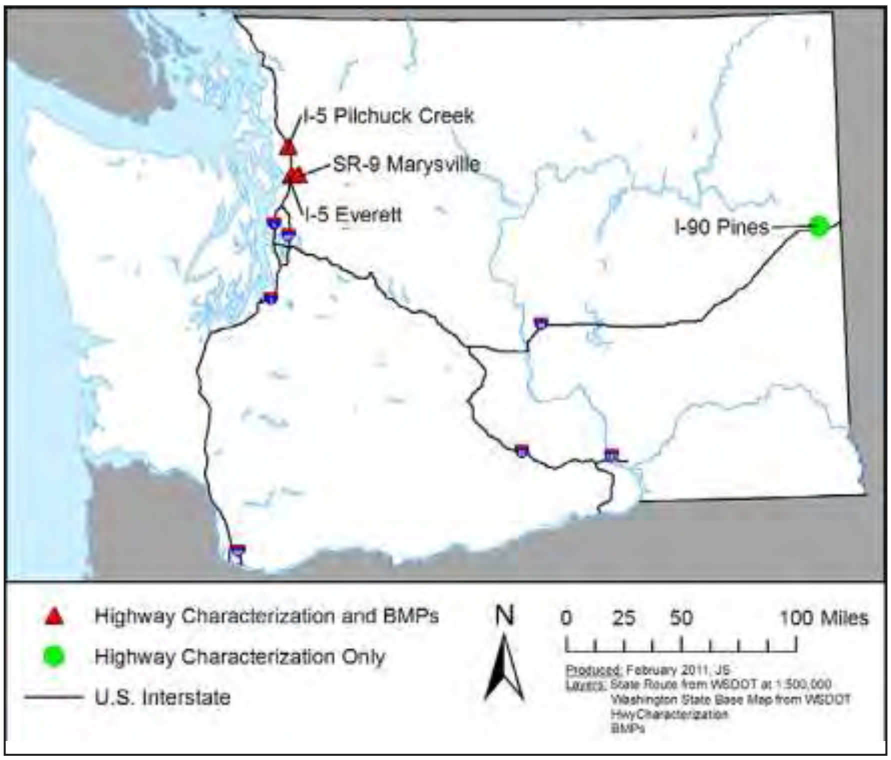


Figure 1 Highway runoff and BMP effectiveness monitoring sites.

2.3 BMP Effectiveness Monitoring Sites

WSDOT combined permit-required highway runoff characterization and BMP effectiveness monitoring sites at two locations along Interstate 5 (I-5). The following types of biofiltration BMPs were selected for monitoring:

- Vegetated filter strips (VFS)
- A compost-amended vegetated filter strip (CAVFS)
- Experimental or modified vegetated filter strips (modified VFS)

Vegetated filter strips (VFS) are sloping land areas with planted vegetation and amended soils used to treat stormwater sheet flow from roads and highways. These BMPs function by slowing runoff velocities, filtering sediment and other pollutants, and providing some biologic uptake and infiltration into underlying soils (WSDOT 2014d).

A *basic vegetated filter strip (VFS)* is a compacted roadside embankment that is hydroseeded with an established grass seed mix. A *compost-amended vegetated filter strip* (CAVFS) is a variation of the basic VFS that incorporates soil amendments (compost) into the top 12 inches of soil to enhance infiltration characteristics, increase surface roughness, and improve plant growth and cover (WSDOT 2014d). Basic VFSs and CAVFSs are preferred filter strip designs. Both BMPs are also approved for use by the Washington State Department of Ecology (Ecology) and described in detail in the *Highway Runoff Manual* (WSDOT 2014d).

The *modified vegetated filter strip* (modified *VFS*) is an experimental BMP that has not yet received approval from Ecology. The modified VFS includes a 3-inch compost blanket that is applied to the surface of the soil. In comparison to CAVFS, the modified VFS does not require heavy equipment to till compost into the top 12 inches of the soil, making the cost of installation less expensive.

Modified VFS designs reduce costs for construction because compost blanket applications require minimal ground disturbance, fewer traffic impacts, and less traffic control. In addition, compost blankets may be applied on steeper slopes, over broader areas, and as erosion control earlier in the construction process. Modified VFSs can also be applied in confined spaces, such as urban areas, where CAVFS installations are usually not possible.

The department's VFS effectiveness study sites were established along roadside embankments adjacent to the northbound lanes of I-5 (MPs 197.27 and 197.35) and southbound lanes of I-5 (MPs 210.71 and 210.85). These sites provide a paired study for comparison of a low-impact development (LID) treatment approach, as required by the permit. A CAVFS was installed along the southbound lanes of I-5 at MP 210.78 for additional comparison.

The SR 9 study site is different in that it addresses only one permit requirement—it provides a "rural" sampling location for BMP effluent toxicity testing. Highway runoff characterization is also collected from the edge of pavement at the SR 9 study site, but this data is not included in the VFS effectiveness evaluation.

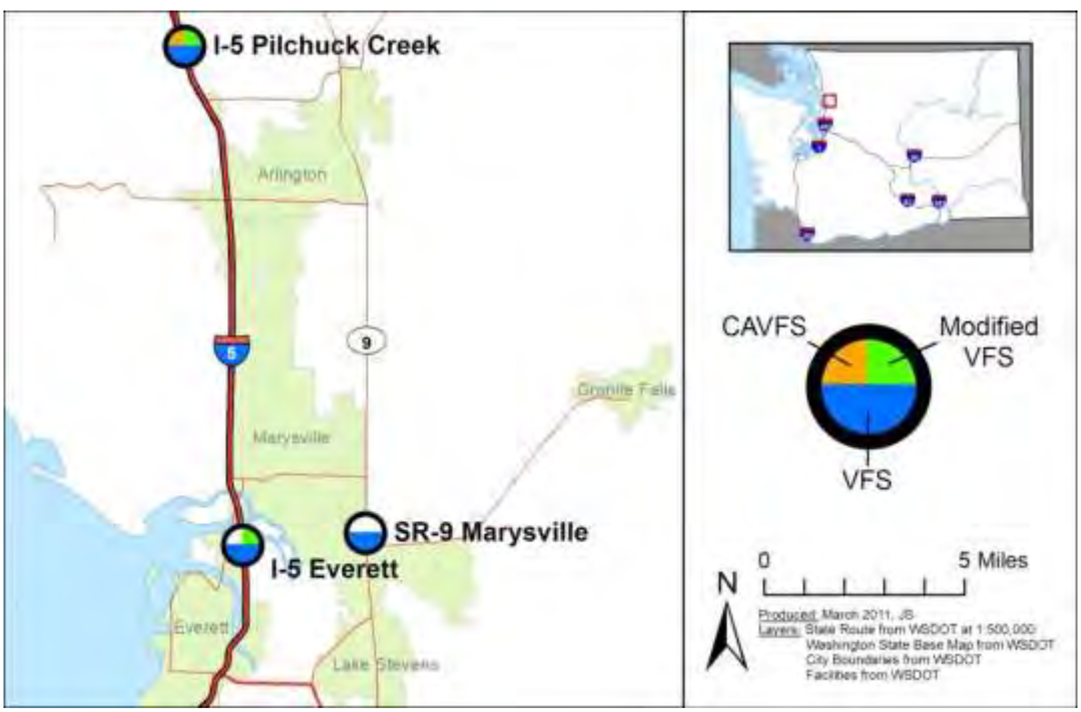
Table 1 provides a list of the BMPs, with their locations, average slopes, and average grades. Figure 2 shows the BMP effectiveness study site locations.

Table 1 Highway characterization monitoring sites.

BMP Study	Location	BMP Type	Traffic Designation[1]	Average Slope (H:V)[2]	Average % Grade
I-5 VFS Study	I-5, Everett MP197.27	Basic VFS	Highly urbanized 126,000 AADT	3.70:1	27
	I-5, Everett MP 197.35[3]	Modified VFS		3.85:1	26
	I-5 Pilchuck MP 210.71	Basic VFS	Urbanized 76,000 AADT	4.00:1	25
	1-5 Pilchuck MP 210.78	CAVFS		3.85:1[4]	26
	I-5 Pilchuck MP 210.85[3]	Modified VFS		3.70:1	26
SR 9 Rural VFS Study	SR9 Marysville MP 17.92[3]	VFS	Rural 20,000 AADT	4.00:1	25

[1] Annual average daily traffic (AADT). AADT values were obtained from the WSDOT "Annual Traffic Report" (WSDOT 2013c).
[2] Horizontal: Vertical (H:V)
[3] Toxicity samples collected from influent and effluent sampling points.
[4] Estimated slope.

Figure 2



BMP locations and types for stormwater monitoring.

2.4 Highway Runoff Characterization and BMP Effectiveness Study Design

The I-5 BMP effectiveness studies evaluate and compare highway treatment performance of basic VFS, modified compost-blanket VFS, and CAVFS designs. Stormwater collectors (4-inch-diameter high-density polyethylene pipes) are positioned along each VFS at the edge of pavement, and at 6.6 feet (2 meters) and 13.1 feet (4 meters) downslope from the pavement edge. Each collector is notched along its length to allow free flow of surface water into the pipes, but prevent rainfall from contributing to discharge volumes. WSDOT staff will evaluate and compare treatment performance from the pavement edge (influent samples) and downslope collection points (effluent samples).

As part of the study's sampling design, WSDOT staff established effluent sample collection points 6.6 feet downslope, because highways in highly urbanized areas often have limited space to locate stormwater treatment along the road shoulder. Some studies suggest much of the flow reduction and water quality treatment performance of VFSs may occur close to the edge of pavement (Ebihara et al., 2009; Kaighn and Yu 1996).

The effluent collection points located 13.1 feet downslope are included in this study to further evaluate the treatment performance of the BMPs on the road shoulder embankment. Sampling from the 6.6- and 13.1-foot locations provides an opportunity to assess to what extent, if any, performance is enhanced by increasing the distance.

Aerial views of the I-5 Everett and I-5 Pilchuck Creek BMP effectiveness monitoring study sites are shown in Figures 3 and 4.

Figure 5 shows an aerial view of the SR 9 Marysville monitoring study site. This site provides a monitoring location for rural highway runoff and BMP effluent toxicity sampling. Thus, this site is not part of the BMP effectiveness evaluation.

Figure 3 I-5 Everett BMP effectiveness monitoring study sites.

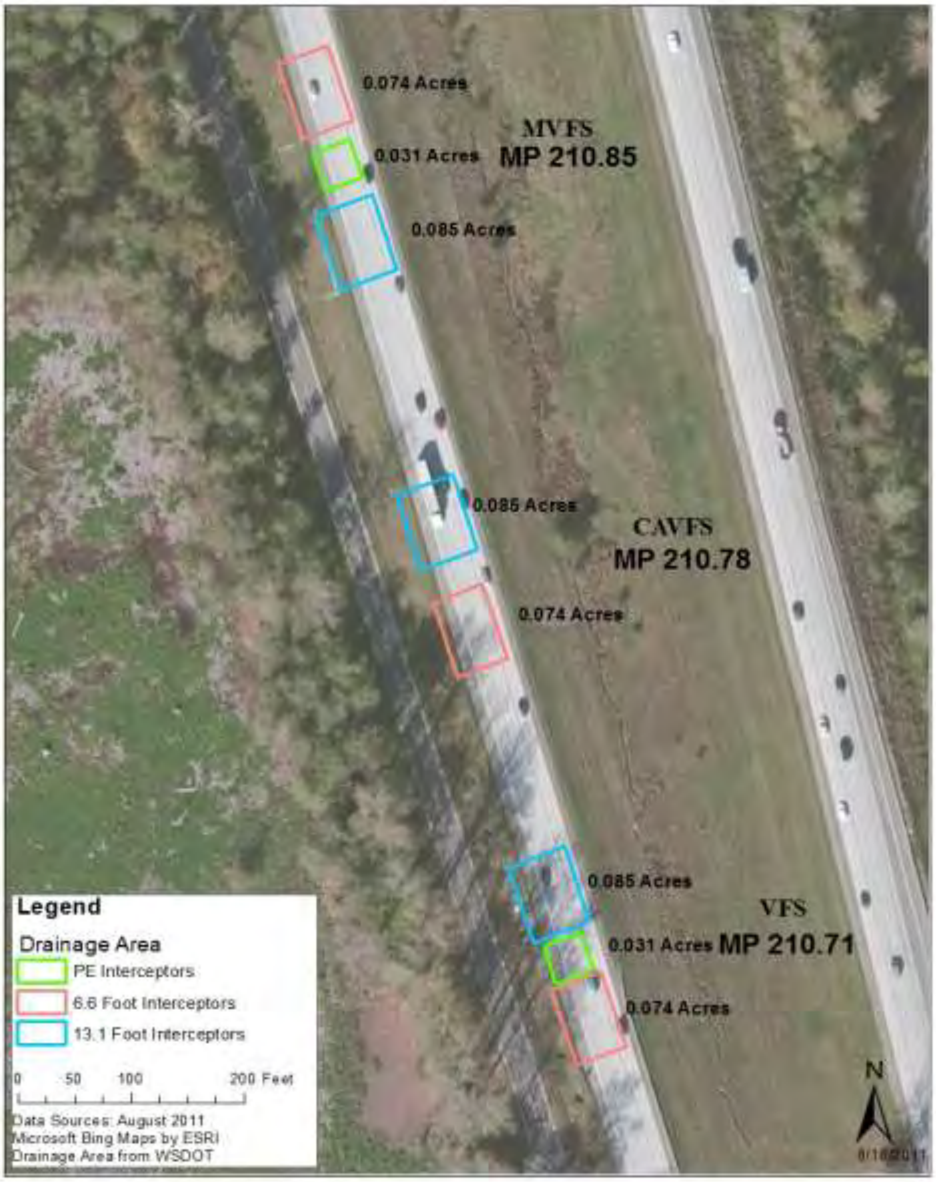


Figure 4 I-5 Pilchuck Creek BMP effectiveness monitoring study sites.

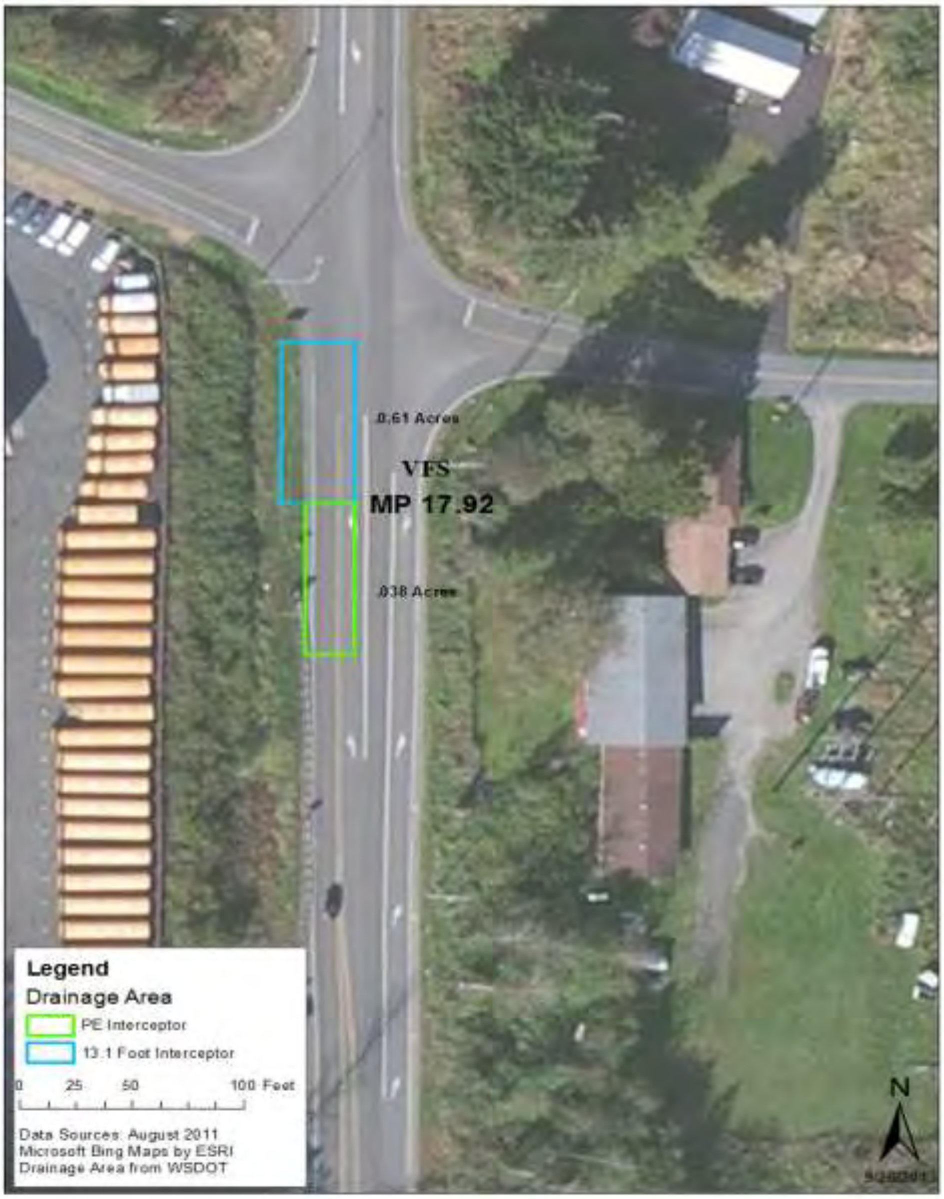


Figure 5 SR 9 Marysville highway and BMP effluent monitoring site.

2.4.1 Time of Concentration

WSDOT staff programmed automatic flow-weighted composite samplers to begin sampling as early in a storm runoff event as feasible, and to continue sampling past the longest estimated time of concentration. For highway runoff characterization and BMP effectiveness monitoring sites, time of concentration is the time necessary for surface runoff to reach the edge of pavement collector from the hydraulically most distant point of each drainage area. Time of concentration estimates provide a baseline to ensure pacing of the monitoring equipment is set to obtain a representative sample and to evaluate whether contributions from the entire basin are represented.

Each monitoring site's times of concentration were based on a range of rainfall depths typical in Washington State. Flow lengths were estimated from hydraulics reports, field estimates, as-built drawings, aerial photography, or WSDOT's GIS Workbench (WSDOT 2011b). Drainage areas were calculated by multiplying the flow length by the length of the pavement edge collectors.

For further information regarding each site's time of concentration, refer to the March 2014 revision of the *Quality Assurance Project Plan for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* (WSDOT 2014b).

2.4.2 Monitoring Site Set-Up and Sampling Design Details

WSDOT staff installed high-density polyethylene (HDPE) pipe collectors along the pavement at the I-5 Everett, I-5 Pilchuck Creek, and SR 9 Marysville highway runoff characterization and BMP effectiveness monitoring sites. Each collector is notched along its length to allow free flow of surface water into the pipes, but prevent rainfall from contributing to discharge volumes.

Staff buried pipes and mortared them to the edge of the pavement. Collector pipes slope slightly downhill to promote directional flow for measurement. Figure 6 shows the pavement edge collector pipe and highway shoulder in cross section.

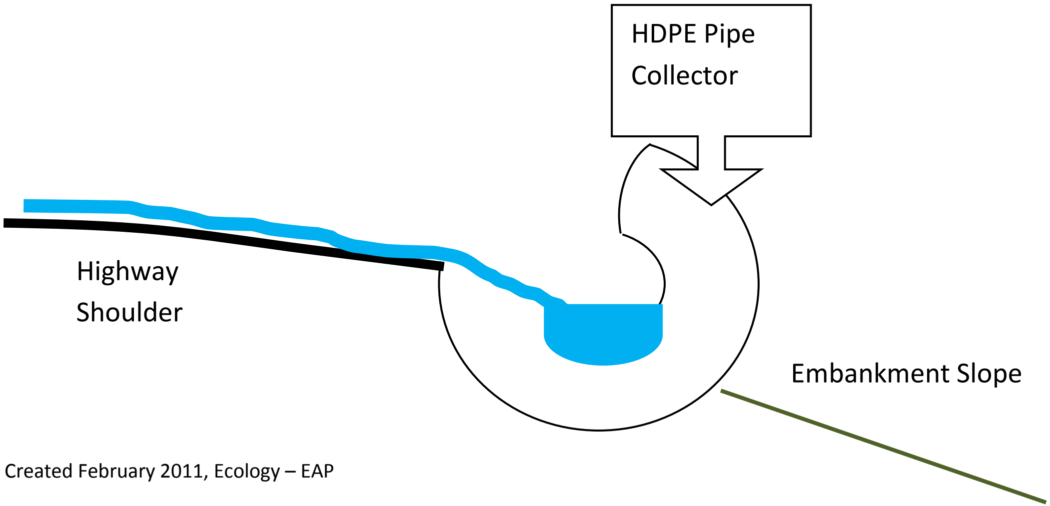


Figure 6 Cross section of the pavement edge collector.

Collector pipes installed at 6.6 feet and 13.1 feet along the VFS embankments were recessed into the surface of the soil and positioned to collect surface runoff flowing through the BMP from the edge of pavement. Similar to the pavement edge collector, the 6.6- and 13.1-foot collectors were sloped slightly to promote directional flow for measurement. Figure 7 shows the downslope collector in cross section.

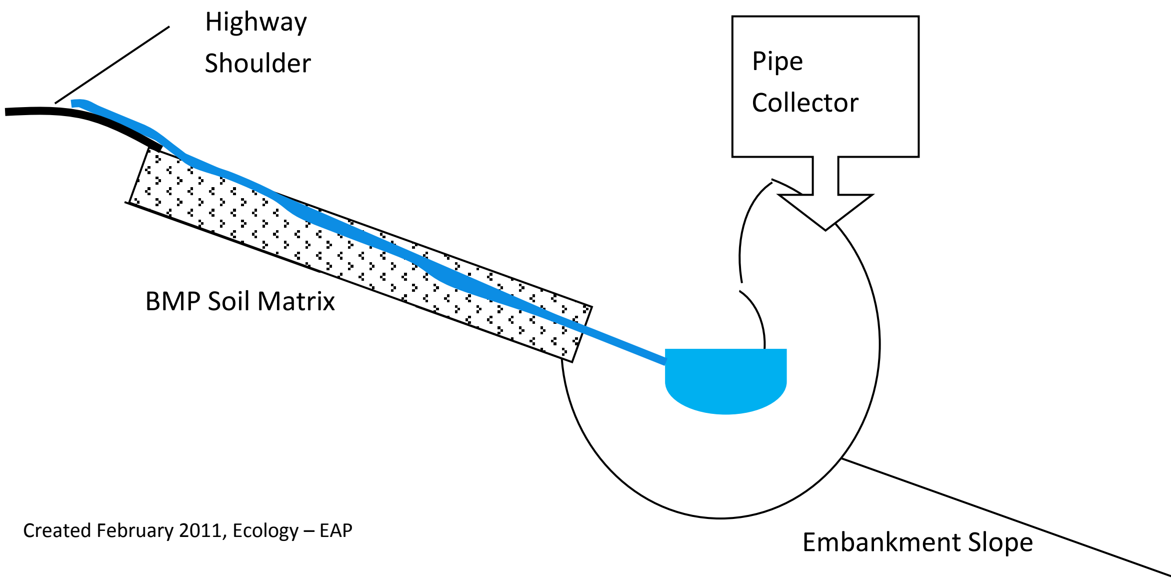


Figure 7 Cross section of the downslope collector.

Figure 8 shows a generalized drawing of a combined highway runoff and BMP effectiveness monitoring site. The diagram illustrates how collectors were positioned to collect sheet flow runoff from the surface of the highway and downslope through the VFS. The data collection platform (DCP) with rain gage, solar panel, transmitting antennae, and enclosures was installed at the lower end of the roadside embankment.

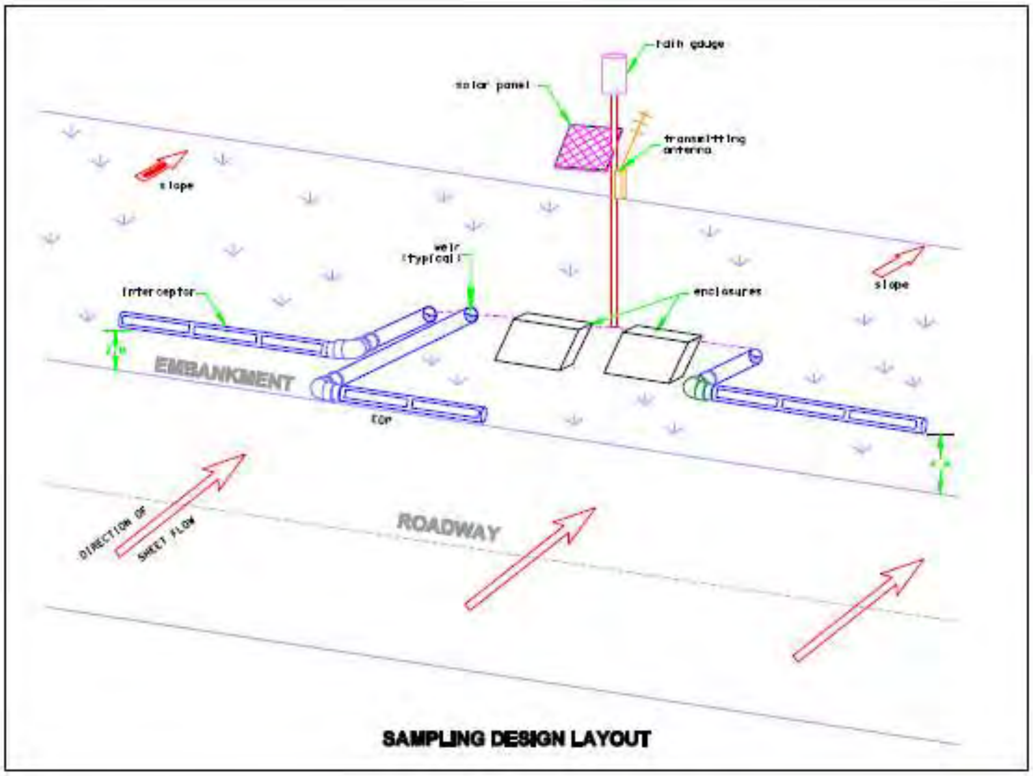


Figure 8

Generalized sampling design.

Figures 9, 10, and 11 depict the I-5 Everett, I-5 Pilchuck Creek, and SR 9 Marysville monitoring sites. Since the SR 9 Marysville monitoring site is not part of the BMP effectiveness evaluation, only one collector was installed along the slope of the VFS embankment.

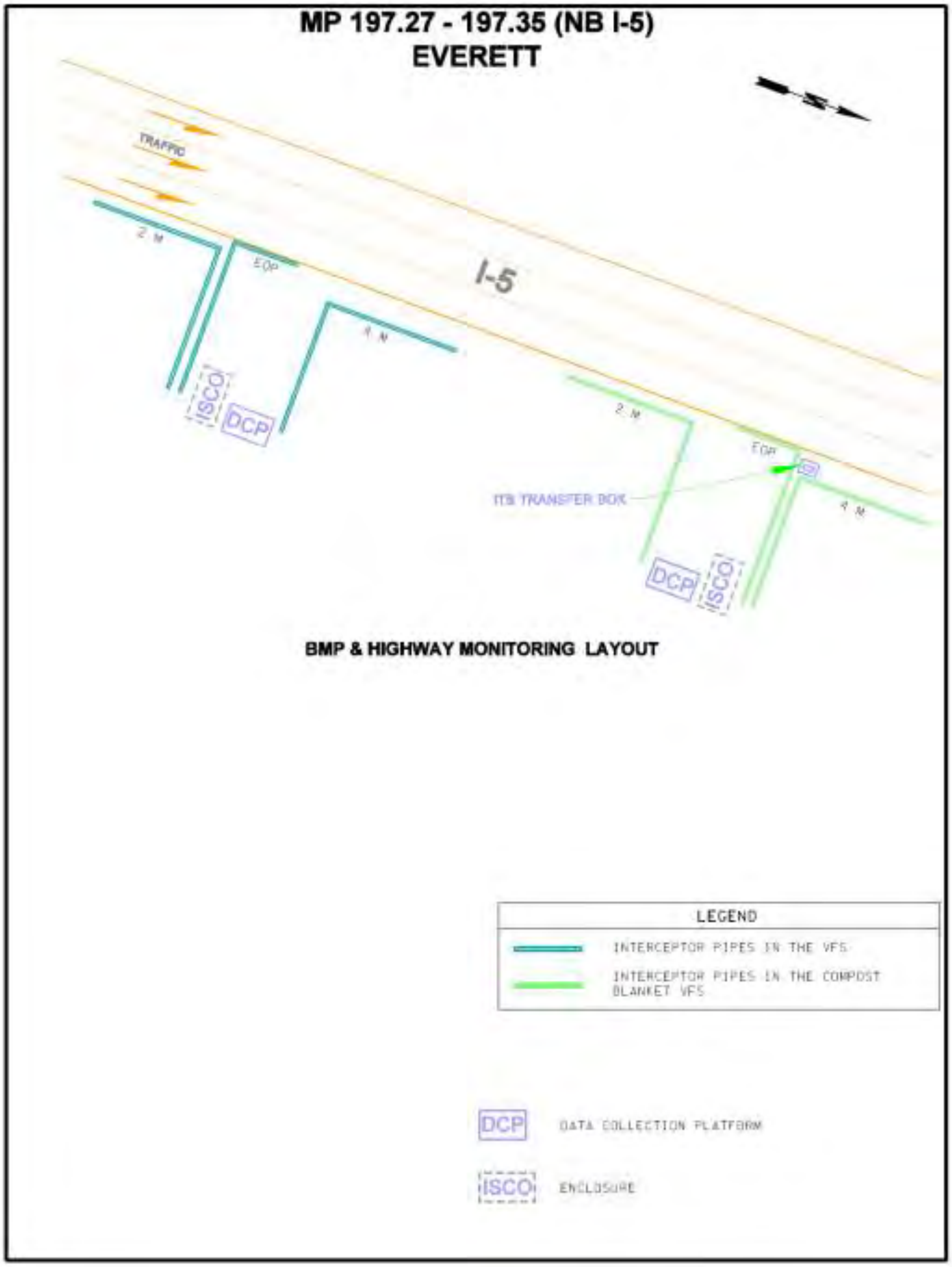


Figure 9 I-5 Everett Highway and BMP effectiveness monitoring site.

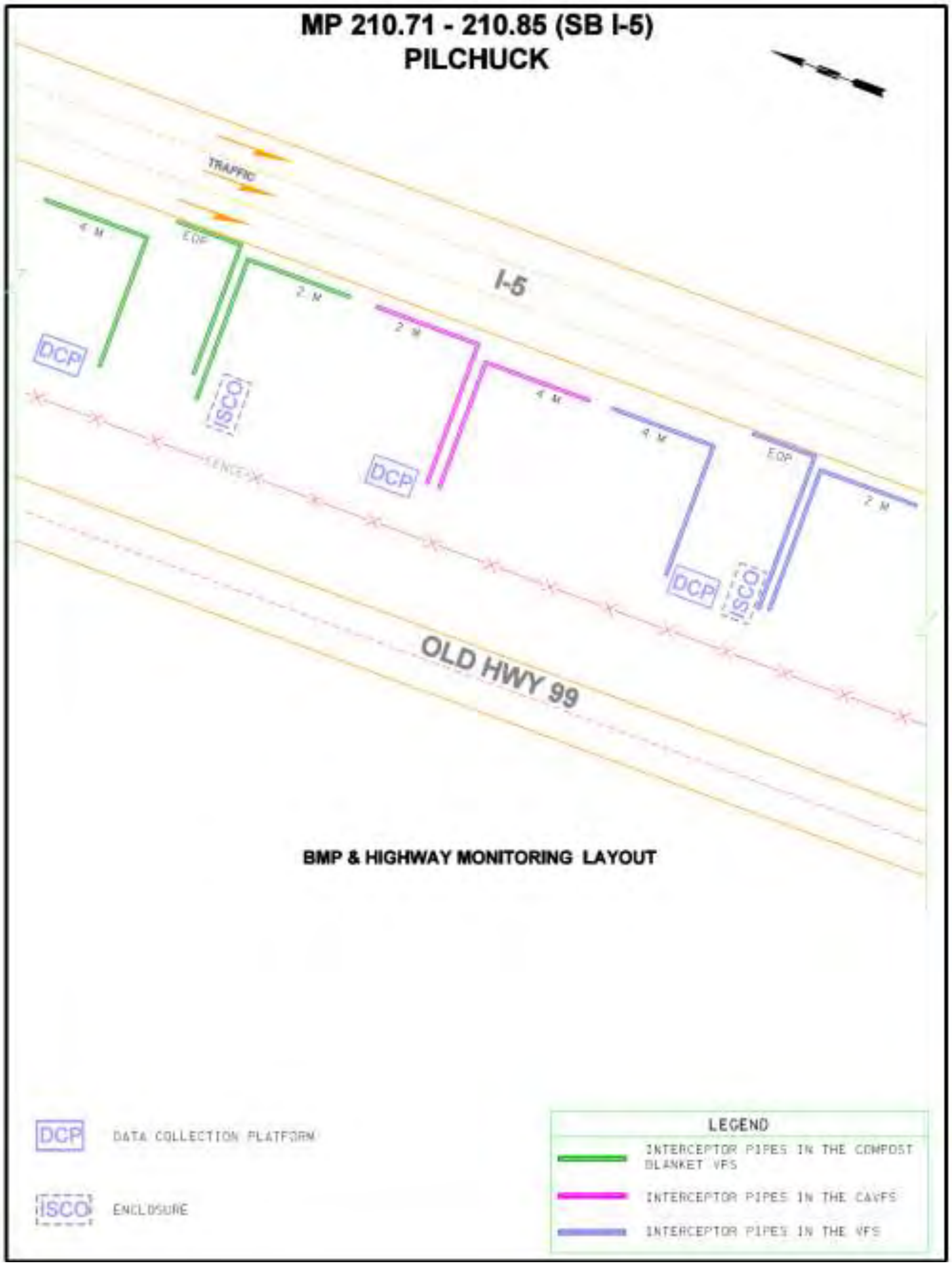


Figure 10 I-5 Pilchuck Creek Highway and BMP effectiveness monitoring site.

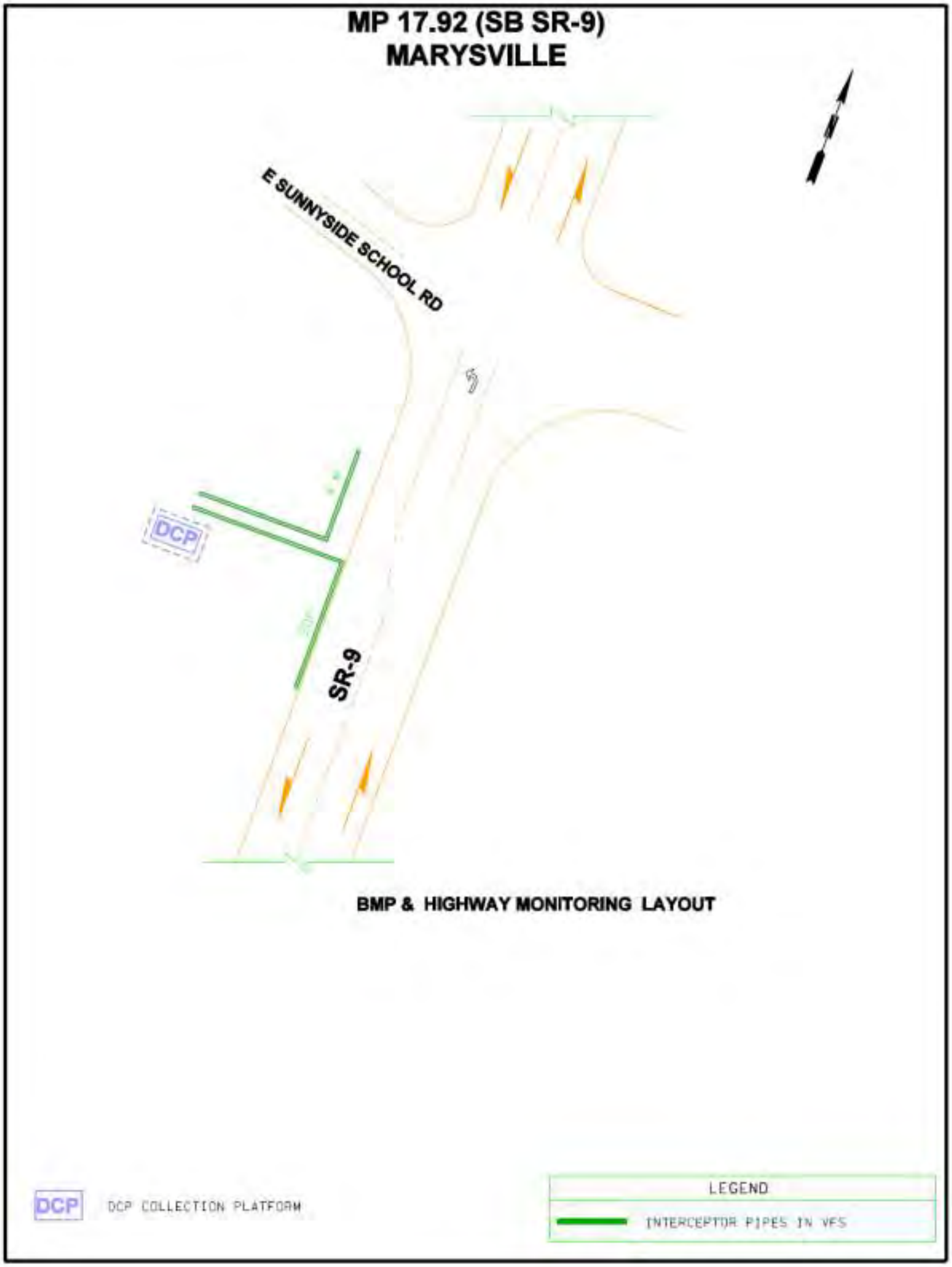


Figure 11 SR 9 Marysville monitoring site.

3 Sampling and Monitoring Procedures

3.1 Monitoring Stations

Monitoring stations at best management practice (BMP) effectiveness monitoring sites typically include an equipment enclosure with lock, Global Positioning System (GPS), antenna, solar panel, and rain gage. The antenna, solar panel, and rain gage are attached to a mounting pole that is installed along the side of the equipment enclosure.

The equipment enclosure houses a data logger; refrigerated automatic sampler; sample tubing; an analog module to run a thermistor (temperature sensor); stage measuring devices, including a depth pressure transducer (PT) and compact bubble sensor (CBS); and a 12-volt battery. Sample tubing runs from the automatic sampler through protective conduit located outside the enclosure to the designated sampling point. The thermistor and PT wires as well as the CBS line run through conduit to a stilling well where stage and temperature are recorded. The locked enclosure provides a secure location for equipment as well as protection from wind, rain, and snowfall.

3.1.1 Precipitation Measurement

At each monitoring station, WSDOT installed a pole-mounted tipping bucket rain gage to accurately capture on-site rainfall measurements. Rain gages were leveled and installed in a secure location where no trees, buildings, overpasses, or other objects obstructed or diverted precipitation prior to entering the rain gage. WSDOT used National Weather Service criteria as guidance for rain gage installation (NWS 2010).

WSDOT collected rain gage data every 15 minutes and stored it in the data logger's memory. WSDOT used these data, transmitted telemetrically to a WSDOT database, to track and record site-specific precipitation measurements.

3.1.2 Temperature Measurement

Water temperature measurements are recorded to fulfill permit requirements and monitor freezing conditions at each of the BMP effectiveness monitoring sites. Sensors were installed at each of the sampling points for every station to record temperature measurements continuously. These data are recorded by the data logger every 15 minutes and transmitted hourly to WSDOT's database. If temperatures approach freezing, the data logger discontinues sample collection.

Sample event tables in Appendix B provide minimum and maximum temperature values recorded during sampling events.

3.2 Weather Tracking

WSDOT uses weather information—from satellite imagery, prediction models, the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS), and private forecasters—to forecast potentially qualifying storm events on a daily basis. As candidate storms approach, radar observations and hourly reports from land-based weather stations help track and evaluate storm potential. Staff use telemetered data transmitted from individual monitoring stations to track the progress of a storm event and the beginning of runoff. The stormwater monitoring team uses this information to direct field team deployments for sample collection.

To qualify, storms have to meet rainfall depth and antecedent dry period criteria. Table 2 lists storm event criteria in effect for BMP effectiveness monitoring sites through WY13.

Table 2 Storm event criteria for BMP effectiveness monitoring.

Criteria	BMP Effectiveness Monitoring	BMP Effluent First-Flush Toxicity Monitoring
Monitoring Period	Year round	Annual (Aug 1 – Oct 31)
Rainfall Depth	0.15” minimum; no fixed maximum	Not specified
Rainfall Duration	1-hour minimum; no fixed maximum	Not specified
Antecedent Dry Period	< 0.04” rain in the previous 6 hours	< 0.04” rain in the previous week (168 hours)
Inter-Event Dry Period	Not specified	Not specified
Minimum Intensity	Lowest intensity that qualifies as a rainfall event[1]	Not specified

[1] Average intensities should exceed 0.03 inches per hour for at least half the sampled storms.

A one-week antecedent dry period was required prior to seasonal first flush toxicity sampling at the three BMP effluent monitoring locations in western Washington. The first flush sampling event had to occur in August or September. If unsuccessful in August or September, a first flush toxicity sample was collected in October, irrespective of the antecedent dry period.

To make the best use of limited resources, WSDOT combined western Washington highway runoff characterization and BMP effectiveness monitoring sites. Where storm criteria for highway characterization and BMP effectiveness monitoring differed, the most inclusive storm criteria were followed. For example, the antecedent dry period criteria for highway monitoring required more time between storms. In this case, antecedent dry period criteria for highways were followed for both highway runoff characterization and BMP effectiveness monitoring sites.

3.3 Sampling Parameters

Sampling requirements listed in S7.C.4 and S7.E.5 of the 2009 permit specify parameters for seasonal first flush toxicity testing and BMP effectiveness monitoring, respectively. These parameters are listed in Table 3, in the priority order of analysis. If insufficient sample volume existed, the department processed samples for the highest priority pollutants in accordance with laboratory volume requirements.

Table 3 Sampling water quality parameters listed in order of priority.

BMPs	Toxicity
TSS	Cu, Zn, Cd, Pb (total)
PSD	Cu, Zn, Cd, Pb (dissolved)
pH	triclopyr (not applied)[1]
total phosphorus	2, 4-D (not applied)
orthophosphate	clopyralid (not applied)
hardness	diuron (not applied)
Cu, Zn (total)	dichlobenil (not applied)
Cu, Zn (dissolved)	picloram (not applied)
	glyphosate
	TSS
	chlorides
	Hardness[2]
	MBAS
	PAHs
	phthalates
	TPH-Dx and TPH-Gx

[1] Herbicides were only required for monitoring if applied in the site drainage area.

[2] Hardness was not a permit-required parameter. It is included in this list by Ecology recommendation and because of the effect of hardness on the bioavailability of metals in solution.

WSDOT was required to sample and analyze herbicides at toxicity monitoring sites where listed herbicides were applied in the monitoring site vicinity. The stormwater monitoring team annually checked herbicide applications for all monitoring site drainage areas.

WSDOT staff used these annual reviews to update the list of herbicides monitored at each site. On the west side of the state, only glyphosate was applied in or near the monitoring study sites.

The permit also required sediment sampling for BMP effectiveness monitoring sites. However, the BMPs the department selected for monitoring (i.e., basic VFS, CAVFS, and modified VFS) are infiltration-type BMPs that use grass and soil, or compost, grass, and soil, as filtration media. Sediment samples from these BMPs were not collected since there is no technique to ensure collected sediment would represent only stormwater-carried sediments and not components of the soil or compost. Ecology approved this deviation from permit requirements during the QAPP approval process.

3.4 Sampling Methods

BMP effectiveness monitoring sites were established to measure stormwater quality and quantity. Table 4 lists parameter categories, sampling frequency, and methods.

Table 4 Sampling methods overview.

Parameter Category	Sampling Frequency	Sampling Method	Telemetered Data?
Rainfall	Continuous, year round	Rain gage	yes
Stage (flow)	Continuous, year round	Stage measuring device	yes
Temperature	Continuous, year round	In situ probe	yes
Chemical, except TPH	Discrete storm events	Autosampler	no
TPH	Discrete storm events	Grab sample	no

For further information regarding field work activities, sample processing details, and analytical requirements for BMP effectiveness evaluation and toxicity water quality sampling, see the March 2014 revision of the *Quality Assurance Project Plan for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* (WSDOT 2014b).

3.5 Station Maintenance

In water year 2013 (WY13), WSDOT staff provided regular station maintenance every six to eight weeks or after sampled storm events. Monitoring staff performed a visual inspection of the monitoring site to identify possible damage to equipment and any new or unsafe conditions. Staff checked equipment enclosures for signs of tampering or forced entry. Unusual odors and the presence of water or debris were noted for the record and addressed through further investigation and site retrofit or rehabilitation, when necessary.

Staff inspected and cleaned outlet pipes, sampling basins, and the conveyance system to ensure the monitoring station was in good condition prior to a sampled storm event. Field staff followed this inspection and cleaning procedure to ensure representative data collected from the system was unaffected by accumulated debris and sensor drift.

Following the *Standard Operating Procedure for Equipment Maintenance and Cleaning* (WSDOT 2011c), field staff conducted station checks that included equipment inventory, inspections, testing, and replacement of worn or missing parts. Monitoring staff inspected internal wires and cables to evaluate wear and ensure cable connections to the data logger were in good condition. Station antennae declinations and bearings were checked, and solar panels were cleaned to remove accumulated debris. When servicing or calibration of scientific equipment at monitoring stations was required, trained technicians followed manufacturers' specifications and conducted servicing and calibration of equipment on site or in a controlled environment, as appropriate.

3.6 Equipment Decontamination

Unless certified as precleaned from the equipment source, WSDOT staff or a contract lab decontaminated pump tubing, churners, sample containers, filters, or other materials that came into contact with sampled stormwater prior to each use. Intake tubing was cleaned prior to installation and changed once each year.

For more detailed descriptions of decontamination procedures, see the March 2014 revision of the *Quality Assurance Project Plan for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* (WSDOT 2014b).

3.7 Staff Roles and Responsibilities

WSDOT used Stormwater and Watersheds Program staff in the Headquarters (HQ) Environmental Services Office (ESO) and staff from the department's region offices to implement its monitoring program. In WY13, seven staff from the HQ ESO played key roles in the stormwater monitoring strategy. Staff from a field office in Mount Vernon supported ESO efforts on a part-time basis and participated in stormwater monitoring at different levels.

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4 Quality Assurance and Quality Control

The *Quality Assurance Project Plan for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices* (WSDOT 2014b) includes a comprehensive description of quality assurance and quality control activities.

During the water year 2013 (WY13) sampling season, WSDOT implemented quality control (QC) procedures through all phases of data collection and analyses. Quality control procedures included field collection and laboratory processing for all permit-required samples. Additionally, verification and validation of both field- and laboratory-generated data occurred as part of data management activities. The quality of raw, unprocessed, and processed data was subject to review and management using established protocols, including the following areas of work:

1. Field quality control
    - Implementation of standard operating procedures
    - Field instrument inspection, calibration, and maintenance
    - Site water conveyance systems inspection and maintenance
    - Collection of field notes and maintenance documentation
    - Collection of composite field duplicate/grab field replicate samples
    - Collection of field equipment blanks
    - Field audits of monitoring staff
2. Laboratory quality control
    - Laboratory instrument maintenance and calibration
    - Analysis of laboratory duplicate/split samples
    - Analysis of laboratory matrix spike and matrix spike duplicate samples
    - Analysis of laboratory blanks and standards
3. Data management
    - Hydrology and precipitation data review and verification
    - Field data review and verification
    - Reviewing and adjusting for data gaps, data anomalies, and data qualifiers in precipitation and hydrology data
    - Laboratory data review and validation
    - Self-assessment and audit of project processes

As part of data management and in addition to implementing field and laboratory quality control activities, WSDOT utilized third-party data validators to perform validation on the analytical data.

WSDOT's data quality consultant prepared an analytical data quality assessment report (Appendix C) for WSDOT. This report provides an overview of the analytical scheme, data verification and validation procedures, and the quality of analytical data collected. The quality of data was assessed and discussed in terms of measurement quality objectives (MQOs) (i.e., precision, accuracy, representativeness, comparability, sensitivity, and completeness). The analytical data quality assessment report includes data collected from all WSDOT monitoring sites, including the department's highway runoff characterization and best management practice (BMP) effectiveness monitoring sites.

5 Monitoring Results

5.1 WY13 BMP Monitoring

WSDOT collected water quality, hydrological, and meteorological data at vegetated filter strip (VFS) best management practice (BMP) effectiveness monitoring sites in water year 2013 (WY13). Appendix A summarizes BMP stormwater sampling data, and Appendix B presents monitoring storm reports. Appendix C provides the data quality assessment report.

5.2 Sampling Logistics and Challenges

WSDOT field staff used storm event criteria and guidelines detailed in WSDOT's NPDES municipal stormwater permit and Ecology's Technical Assessment Protocol (TAPE) (Ecology 2011) to deploy for forecast qualifying storm events. Collecting BMP stormwater data was challenging due to the dynamic and unpredictable nature of storm forecasts and rainfall. Section 3.2 details the storm event criteria used to determine team deployments.

Sample collection requirements included a minimum of 10 equal-volume samples (aliquots)[2] collected during each sampled storm event and combined to create a single composite sample. For storm events lasting less than 24 hours, samples had to be collected for 75 percent of the storm hydrograph (by volume). For storm events lasting more than 24 hours, samples had to be collected for at least 75 percent of the first 24 hours of the storm (Ecology 2011).

Frequently, storm event patterns that meet one permit requirement contribute to not meeting another requirement. For example:

- WSDOT uses industry standard remote autosamplers that collect sample aliquots based on the amount of stormwater volume flowing out of the respective BMPs. WSDOT autosamplers can only hold a certain amount of stormwater, 9.4 liters (2.5 gallons), which limits the number of aliquots that can be collected during a storm. Autosamplers are programmed based on forecast rainfall amounts and predicted volume of stormwater runoff. However, actual storm event rainfall and volume often differ from forecast amounts. With an event that produces greater than predicted amounts of runoff, autosamplers may fill prematurely, limiting their ability to capture 75 percent of a storm. Conversely, events that produce less than the predicted amount may fail to meet the 10 aliquot requirement set by TAPE and the permit.

[2] Seven to nine aliquots may be accepted; however, the Technical Evaluation Report (TER) must include an explanation and justification as to why less than 10 aliquots were collected.

- Rain-to-runoff patterns often differ based on many contributing variables. A storm event that occurs in close proximity to another event may display different surface runoff characteristics than a storm event occurring after weeks of no precipitation. In addition, a high-intensity, short-duration rain event will display different stormwater runoff dynamics than a low-intensity storm occurring over a long duration.

Despite the challenges in collecting qualified storm event samples, WSDOT successfully collected multiple events at all of the BMP sites in WY13. Field observations and data regarding site hydrology and soils (e.g., soil saturation levels, structure, and composition) conducted during the year improved sampling success by improving the predictability of runoff occurring from a forecast storm event. WSDOT anticipates using these site feedback loops, paired with consistent improvements in the understanding of the science of stormwater, to further improve sampling efficacy.

5.3 Stormwater Sample Collection

WSDOT is in the process of collecting enough stormwater samples to meet permit and Ecology's Technology Assessment Protocol (TAPE) requirements. TAPE guidelines specify the number of samples, sampling procedures, and type of data assessment needed to meet the required statistical goals for BMP approval. When sampling and statistical goals are met, a Technical Evaluation Report (TER) will be compiled and submitted to Ecology. The TER will present the results and discussion of WSDOT's VFS BMP performance.

Appendix B details all storm event sampling dates and parameter sample values. The numbers of storm events sampled in WY13 at WSDOT's 14 BMP sample collection points are presented below:

I-5 Everett, MP 197.27, VFS:

- Five events collected at site pavement edge (PE) (Everett 01)
- Three events collected 6.6 feet (2 meters) from PE (Everett 02)
- Four events collected 13.1 feet (4 meters) from PE (Everett 03)

I-5 Everett, MP 197.35, Modified VFS

- Seven events collected at site PE (Everett 04)
- Four events collected 6.6 feet from PE (Everett 05)
- Three events collected 13.1 feet from PE (Everett 06)

I-5 Pilchuck, MP 210.71, VFS

- Nine events collected at site PE (Pilchuck 01)
- Four events collected 6.6 feet from PE (Pilchuck 02)
- Seven events collected 13.1 feet from PE (Pilchuck 03)

I-5 Pilchuck, MP 210.78, Compost-Amended VFS (CAVFS)

- Two events collected 6.6 feet from PE (Pilchuck 04)
- Seven events collected 13.1 feet from PE (Pilchuck 05)

I-5 Pilchuck, MP 210.85, Modified VFS

- Nine events collected at site PE (Pilchuck 06)
- Two events collected 6.6 feet from PE (Pilchuck 07)
- Four events collected 13.1 feet from PE (Pilchuck 08)

5.4 Monitoring Trends

A primary goal of WSDOT's BMP effectiveness monitoring is to compare sample parameter and surface runoff values between influent and effluent points of each VFS BMP. TAPE currently requires a minimum of 12 paired influent and effluent samples. A minimum two years of monitoring is generally recommended. WSDOT did not successfully collect 12 paired influent and effluent samples in WY13. Therefore, the data collected at WSDOT's BMP monitoring sites in WY13 has not yet been analyzed for statistical relevance, though a general trend of flow reduction has been noticed at most of WSDOT's VFS BMPs. Once 12 paired samples have been collected, the statistical analysis will be conducted.

5.5 Toxicity Sampling

WSDOT field staff collected toxicity monitoring stormwater samples in September and October in WY12 and WY13. Toxicity monitoring requirements involved both highway runoff characterization and BMP effectiveness monitoring sites. Results from both years show no significant toxic effect and a high survival rate for *Hyalella azteca*, a small aquatic crustacean and the target species for toxicity testing. Data summaries are presented in the *WSDOT NPDES Municipal Stormwater Permit Highway Runoff Monitoring Reports* (WSDOT 2013a and 2014a). Some VFS storm event data were collected during toxicity monitoring and will be added to the data presentation and analyses in the final VFS BMP effectiveness monitoring report.

5.6 Changes to the Monitoring Program

WSDOT staff evaluated the effectiveness of monitoring practices in WY13 and recorded their observations. These observations helped refine existing monitoring methods and procedures. These changes should improve the accuracy and efficiency of data collection, and make more effective use of limited staff time and resources.

The following changes were made in WY13:

1. **Frequency of site storm event preparation:** Staff originally prepared sites for sampling immediately before storm events, with the intention of calibrating the systems as close to the start of the sampling events as possible. Unfortunately, short notice prior to many sampled storm events created rushed and potentially inaccurate site configurations, occasionally resulting in missed or rejected storm data. Switching storm preparation to a two-week cycle allowed for more thorough sampling conveyance system cleanout and equipment calibration, and better data quality.

2. **Monitoring station maintenance staff:** In WY12 and WY13, the field team lacked sufficient staff to manage the significant site maintenance workload. Most field team time was devoted to obtaining samples, with little time left for maintaining and improving the structural components of the sampling conveyance systems and equipment. Late in WY13, WSDOT hired a staff member whose primary duty was site maintenance. This staff member was able to implement many infrastructure efficiencies in addition to maintaining system operations on a tighter schedule.

3. **WSDOT region staff support:** Staff support from region maintenance and environmental offices was critically important during the initial phase of stormwater BMP effectiveness monitoring. However, with recent reductions in work force, these region staff have limited availability for stormwater monitoring due to other work priorities. Shifting the majority of region staff responsibilities to stormwater monitoring staff at WSDOT Headquarters helped focus team efforts, eliminated reliance on region staff with limited availability, and improved consistency of work.

4. **Sample naming and labeling:** The original naming and labeling conventions for laboratory samples were complex and non-intuitive, creating problems in often-challenging field conditions. These sample names were replaced by a simple date-based naming convention that staff could easily generate and follow in the field. This change drastically reduced time in the field and improved sample labeling accuracy.

5. **New forecasting tool:** In WY13, staff deployed a WSDOT Storm Event Reporting and Forecasting (SERF) tool. This tool provided a direct link to NOAA regional forecasts and created a communication email chain to alert staff when a qualifying storm approached. The SERF tool significantly shortened the time needed to generate a daily forecast, making faster and more efficient deployments for storm event sampling possible. To meet permit requirements, SERF also saved a record of all forecasts and deployment decisions.

5.7 Lessons Learned

WSDOT found that developing the VFS BMP effectiveness monitoring program was a complex endeavor. Following are some of the lessons learned from implementing the monitoring program:

1. **Sample conveyance system cleaning:** Clogging of stormwater sampling infrastructure by debris was found to be more significant than expected. Changes in cleanout routines, re-design of sampling systems for easy cleanout, and development of special tools for cleanout were all employed as adaptive strategies to solve this problem.
2. **Storm forecasting:** A decision matrix is needed to guide and manage storm deployments for the monitoring field team. The decision matrix must be developed using permit storm criteria, but details need to be included to effectively manage the daily decision-making process and ensure consistency.
3. **Storm deployments:** Sampling teams need to be available to respond to storms with short notice. In case individuals from the monitoring field team are unavailable, alternate staff should be available to sample, if they are needed. Forecasts need to be rechecked immediately prior to sampling events and team deployments. The SERF tool should be used to track sampling attempts more frequently.
4. **Standard operating procedures (SOPs):** SOPs ensure reliable and representative monitoring data are collected. Reliable monitoring data facilitates early problem detection. SOPs are needed to document all steps in the monitoring process, from sample collection in the field to data management and validation in the office.

5.8 Projected Work and Future Monitoring Projects

WSDOT's VFS effectiveness monitoring continues, with the goal of obtaining enough samples to satisfy permit requirements and produce useful data for decision making. WSDOT will analyze WY14 data to assess whether statistical goals in TAPE have been met. If statistical goals are met, WSDOT will produce a final BMP effectiveness report in October 2015.

Within one year following submittal of the VFS BMP effectiveness studies final report or no later than October 2017, WSDOT in consultation with Ecology must begin implementation of new highway BMP effectiveness studies. The selection of highway BMP effectiveness studies must be based on WSDOT's stormwater research priorities and the stormwater treatment needs of the agencies, and must be at approximately the same level of monitoring effort and cost as the current VFS BMP effectiveness studies.

The 2014 WSDOT NPDES municipal stormwater permit also requires implementation of a monitoring program to evaluate the effectiveness of stormwater treatment and hydrologic management BMPs at rest areas, maintenance facilities, or ferry terminals. The stormwater BMPs (operational or structural) selected for monitoring should address concerns identified from WY12 and WY13 baseline facilities monitoring data. WSDOT must evaluate BMPs at two facilities in western Washington, and one facility east of the Cascades. Monitoring staff are currently involved in a site-selection process.

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Glossary

analyte – An element, ion, compound, or chemical moiety (pH, alkalinity) that is to be determined. The definition can be expanded to include organisms, such as fecal coliform (Kammin 2010).

annual average daily traffic (AADT) – The average, over a year, of the number of vehicles passing a point on a highway in both directions each day (Mohamad et al., 1998). Counts are estimated using Trip Generation, published by the Institute of Transportation Engineers, or using a traffic study prepared by a professional engineer or transportation specialist with expertise in traffic volume estimation (WSDOT 2014d).

best management practices (BMPs) – The structural devices, maintenance procedures, managerial practices, prohibitions of practices, and schedules of activities that are used singly or in combination to prevent or reduce the detrimental impacts of stormwater, such as pollution of water, degradation of channels, damage to structures, and flooding (WSDOT 2014d).

Clean Water Act (CWA) – A federal act passed in 1972, formerly referred to as the Federal Water Pollution Control Act, which contains provisions to restore and maintain the quality of the nation's waters. Major amendments to the CWA in 1987 addressed stormwater pollution by extending the National Pollutant Discharge Elimination System (NPDES) permit program to include stormwater discharges. Section 402 of the CWA governs the NPDES permit program.

data collection platform (DCP) – A collection of instruments or sensors that operate and report to a central data logger. A DCP is collectively housed in a central location or "platform" at the monitoring site.

first flush – Typically, the first 30 to 60 minutes of runoff from a rainfall event (Caltrans 2003). A first-flush rain event for toxicity is defined in Special Condition S7.C.1 of the 2009 WSDOT NPDES municipal stormwater permit as the first qualifying rain event that occurs after July 31, with a one-week antecedent dry period (or October, irrespective of the antecedent dry period, if unsuccessful in August and September) (Ecology 2009a).

flow-weighted compositing – Samples of equal volume are taken at equal increments of flow volume and composited (Ecology 2009b)

Global Positioning System (GPS) – A satellite navigation system used to determine ground position and velocity (location, speed, and direction).

hydrograph – A graph of flow versus time for a given point (Caltrans 2003).

hyetograph – A graph of rainfall to a monitoring station versus time (Caltrans 2003).

Jersey barrier – A tapered concrete structure installed in the median or along the roadside shoulder to prevent vehicle crossovers.

low-impact development (LID) – An evolving approach to land development and stormwater management that uses a site's natural features and specially designed BMPs to manage stormwater; it involves assessing and understanding the site, protecting native vegetation and soils, and minimizing and managing stormwater at the source. Low-impact development practices are appropriate for a variety of development types (WSDOT 2014d).

National Pollutant Discharge and Elimination System (NPDES) – The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the state from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington State Department of Ecology (Ecology 2014).

parameter – A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene, nitrate+nitrite, and anions are all parameters (Kammin 2010; Ecology 2004).

pavement edge (PE) collector – A 6-inch high-density polyethylene pipe or similar device that is installed to collect runoff from an impervious roadway. PE collectors also act as conveyance systems for stormwater from the road surface to pass through a flow measurement device and allow for composite sample collection.

pH – A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Quality Assurance Project Plan (QAPP) – A document that describes the objectives of a monitoring project and the procedures necessary to ensure the quality and integrity of the collected data (Ecology 2004).

representativeness – The state or quality of being accurately representative of something. Expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point, or an environmental condition (USEPA 2006).

stormwater – That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a stormwater drainage system into a defined surface water body or a constructed infiltration facility (WSDOT 2014d).

thermistor – A temperature-sensing probe that displays large changes in resistance in proportion to small changes in temperature.

stilling well – A well or chamber that is connected to the main flow channel by a small inlet.

time of concentration – The time necessary for surface runoff to reach the edge of pavement collector from the hydraulically most remote point of the drainage area (WSDOT 2014d). Time of concentration provides a measure to ensure time pacing of the monitoring equipment is set to obtain a representative sample and to evaluate whether contributions from the entire basin are represented.

water year (WY) – The 12-month period beginning October 1 for any given year through September 30 of the following year. The water year is designated by the calendar year in which it ends. For example, the water year ending September 30, 2012, is called the “2012” water year (USGS 2013).

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Acronyms, Abbreviations, and Units of Measurement

Acronyms and Abbreviations

AADT	annual average daily traffic
BMP	best management practice
CAVFS	compost-amended vegetated filter strip
Cd	cadmium
CBS	compact bubble sensor
COC	chain of custody
Cu	copper
CWA	Clean Water Act
DCP	data collection platform
Ecology	Washington State Department of Ecology
ESO	Environmental Services Office
GIS	geographical information system
GPS	Global Positioning System
HDPE	high-density polyethylene
HQ	WSDOT Headquarters
I-5	Interstate 5
LID	low-impact development
MBAS	methylene blue active substances
MEL	Manchester Environmental Laboratory
MP	milepost
MQO	measurement quality objective
NB	northbound
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Association
NWS	National Weather Service
OP	orthophosphate
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PE	pavement edge
pH	measure of alkalinity or acidity
PSD	particle size distribution
PT	pressure transducer
QAPP	Quality Assurance Project Plan

QA	quality assurance
QC	quality control
SB	southbound
SERF	Storm Event Reporting and Forecasting tool
SOP	standard operating procedure
SR	state route
TAPE	Technology Assessment Protocol – Ecology (TAPE)
TC	time of concentration
TP	total phosphorus
TPH	total petroleum hydrocarbon
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
VFS	vegetated filter strip
WSDOT	Washington State Department of Transportation
WY	water year
Zn	zinc

Units of Measurement

ac	acre
°C	degrees centigrade
°F	degrees Fahrenheit
ft	feet
g	gram, a unit of mass
in	inch
gal/min	gallons per minute
L/min	liters per minute
mg	milligrams
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mL	milliliters
Qp	gallons/minute
Tc	time of concentration
µg/Kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
µm	micrometer
oz	ounce

Appendix A:
Analytical Data

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Appendix A – Analytical Data

EVERETT 01		STORM EVENT													
PARAMETER	**UNITS**	**11/7/2012**		**12/11/2012**		**2/11/2013**		**2/22/2013**		**3/2/2013**		**3/6/2013**		**3/20/2013**	
Conventionals															
TSS	mg/L	29		--		--		--		132		--		--	
Chloride	mg/L	3.51		--		--		--		--		--		5.84	
Hardness as $CaCO_3$	mg/L	11.5		--		--		--		--		--		16.5	
Bacteria															
Fecal coliform	cfu/100ml	--		800		4400		--		--		--		--	
Nutrients															
Total Phosphorous	mg/L	0.0423		--		--		--		--		--		0.121	
Orthophosphate	mg/L	0.01	U	--		--		--		--		--		--	
Total Kjeldahl Nitrogen	mg/L	0.91	U	--		--		--		--		--		0.85	J
Nitrate-Nitrite	mg/L	0.335		--		--		--		--		--		0.224	
Metals															
Total Recoverable Copper	ug/L	21.7		--		--		--		--		--		--	
Dissolved Copper	ug/L	6.05	J	--		--		--		--		--		--	
Total Recoverable Lead	ug/L	--		--		--		--		--		--		--	
Dissolved Lead	ug/L	--		--		--		--		--		--		--	
Total Recoverable Cadmium	ug/L	--		--		--		--		--		--		--	
Dissolved Cadmium	ug/L	--		--		--		--		--		--		--	
Total Recoverable Zinc	ug/L	64.5		--		--		--		--		--		--	
Dissolved Zinc	ug/L	27.7	J	--		--		--		--		--		--	
PAH Compounds															
Acenaphthene	ug/L	0.0099	U	--		--		--		--		--		--	
Acenaphthylene	ug/L	0.0099	U	--		--		--		--		--		--	
Anthracene	ug/L	0.0099	U	--		--		--		--		--		--	
Benzo(a)anthracene	ug/L	0.014		--		--		--		--		--		--	
Benzo(b)fluoranthene	ug/L	0.04		--		--		--		--		--		--	
Benzo(k)fluoranthene	ug/L	0.015		--		--		--		--		--		--	
Benzo(ghi)perylene	ug/L	0.061		--		--		--		--		--		--	
Benzo(a)pyrene	ug/L	0.025		--		--		--		--		--		--	
Chrysene	ug/L	0.033		--		--		--		--		--		--	

Dibenzo(a,h)anthracene	ug/L	0.0099	U	--		--		--		--		--		--	
Fluoranthene	ug/L	0.04		--		--		--		--		--		--	
Fluorene	ug/L	0.0099	U	--		--		--		--		--		--	
Indeno(1,2,3-cd)pyrene	ug/L	0.041	J	--		--		--		--		--		--	
Naphthalene	ug/L	0.016	J	--		--		--		--		--		--	
Phenanthrene	ug/L	0.024		--		--		--		--		--		--	
Pyrene	ug/L	0.069		--		--		--		--		--		--	
Phthalates															
bis(2-Ethylhexyl)phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Butyl benzyl phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Di-n-butyl phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Diethyl phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Dimethyl phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Di-n-octyl phthalate	ug/L	0.2	U	--		--		--		--		--		--	
Herbicides															
Dichlobenil	ug/L	--		--		--		--		--		--		--	
Diuron	ug/L	--		--		--		--		--		--		--	
2,4-D	ug/L	--		--		--		--		--		--		--	
Clopyralid	ug/L	--		--		--		--		--		--		--	
Picloram	ug/L	--		--		--		--		--		--		--	
Triclopyr	ug/L	--		--		--		--		--		--		--	
Glyphosate	ug/L	25	U	--		--		--		--		--		--	
TPH															
TPH-Diesel (NWTPH-Dx)	mg/L	--		12.15		21.15		4.35		--		4.75		--	
Diesel	mg/L	--		0.15	U	0.15	UJ	0.15	U	--		0.15	UJ	--	
Lube Oil	mg/L	--		12		21	J	4.2		--		4.6	J	--	
TPH-Gas (NWTPH-Gx)	mg/L	--		0.07	U	0.07	U	0.05	U	--		0.05	U	--	
Particle Size Distribution															
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	0.11		--		--		--		--		--		9.82	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	17.11		--		--		--		--		--		10.76	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.22		--		--		--		--		--		8.25	
Particle/Grain Size, Phi	mg/L	0.01	U	--		--		--		--		--		0.01	U

Scale 2 to 3 (125-250 um)															
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	--		--		--		--		--		0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	4.94		--		--		--		--		--		57.94	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	8.27		--		--		--		--		--		12.3	

EVERETT 01		**STORM EVENT**					
PARAMETER	**UNITS**	**4/12/2013**		**5/12/2013**		**5/21/2013**	
Conventionals							
TSS	mg/L	--		38	--		38
Chloride	mg/L	--		--	--		--
Hardness as $CaCO_3$	mg/L	--		--	--		--
Bacteria							
Fecal coliform	cfu/100ml	--		--	--		--
Nutrients							
Total Phosphorous	mg/L	--		--	--		--
Orthophosphate	mg/L	--		1.12	--		1.12
Total Kjeldahl Nitrogen	mg/L	--		3.8	--		3.8
Nitrate-Nitrite	mg/L	--		0.513	--		0.513
Metals							
Total Recoverable Copper	ug/L	--		37.4	--		37.4
Dissolved Copper	ug/L	--		28.4	--		28.4
Total Recoverable Lead	ug/L	--		--	--		--
Dissolved Lead	ug/L	--		--	--		--
Total Recoverable Cadmium	ug/L	--		--	--		--
Dissolved Cadmium	ug/L	--		--	--		--
Total Recoverable Zinc	ug/L	--		89.3	--		89.3
Dissolved Zinc	ug/L	--		73.2	--		73.2

PAH Compounds							
Acenaphthene	ug/L	0.01	U	--	0.01	U	--
Acenaphthylene	ug/L	0.01	U	--	0.01	U	--
Anthracene	ug/L	0.01	U	--	0.01	U	--
Benzo(a)anthracene	ug/L	0.029	J	--	0.029	J	--
Benzo(b)fluoranthene	ug/L	0.035		--	0.035		--
Benzo(k)fluoranthene	ug/L	0.029		--	0.029		--
Benzo(ghi)perylene	ug/L	0.082		--	0.082		--
Benzo(a)pyrene	ug/L	0.027	J	--	0.027	J	--
Chrysene	ug/L	0.075		--	0.075		--
Dibenzo(a,h)anthracene	ug/L	0.011	U	--	0.011	U	--
Fluoranthene	ug/L	0.11	J	--	0.11	J	--
Fluorene	ug/L	0.01	U	--	0.01	U	--
Indeno(1,2,3-cd)pyrene	ug/L	0.024		--	0.024		--
Naphthalene	ug/L	0.021		--	0.021		--
Phenanthrene	ug/L	0.064		--	0.064		--
Pyrene	ug/L	0.16		--	0.16		--
Phthalates							
bis(2-Ethylhexyl)phthalate	ug/L	6.5		--	6.5		--
Butyl benzyl phthalate	ug/L	0.39	U	--	0.39	U	--
Di-n-butyl phthalate	ug/L	0.62	U	--	0.62	U	--
Diethyl phthalate	ug/L	0.33	J	--	0.33	J	--
Dimethyl phthalate	ug/L	0.2	U	--	0.2	U	--
Di-n-octyl phthalate	ug/L	1.3	J	--	1.3	J	--
Herbicides							
Dichlobenil	ug/L	--		--	--		--
Diuron	ug/L	--		--	--		--
2,4-D	ug/L	--		--	--		--
Clopyralid	ug/L	--		--	--		--
Picloram	ug/L	--		--	--		--
Triclopyr	ug/L	--		--	--		--
Glyphosate	ug/L	--		25	--		25
TPH							
TPH-Diesel (NWTPH-Dx)	mg/L	--		--	--		--
Diesel	mg/L	--		--	--		--

Lube Oil	mg/L	--		--	--		--
TPH-Gas (NWTPH-Gx)	mg/L	--		--	--		--
Particle Size Distribution							
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		--	--		--
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		--	--		--

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate
TPH-Diesel (NWTPH-Dx) values are calculated as the sum of the Diesel and Lube Oil concentrations

EVERETT-02		STORM EVENT					
PARAMETER	UNITS	3/2/2013		3/20/2013		5/21/2013	
Conventionals							
TSS	mg/L	66		--		31	
Hardness as $CaCO_3$	mg/L	17.4		10.9		25.3	
Nutrients							
Total Phosphorous	mg/L	0.112		0.0971		0.309	
Orthophosphate	mg/L	--		--		0.146	
Total Kjeldahl Nitrogen	mg/L	0.9	J	--		2.4	J
Nitrate-Nitrite	mg/L	0.277		0.12		0.901	
Metals							
Total Recoverable Copper	ug/L	--		--		28.1	
Dissolved Copper	ug/L	--		--		14.8	
Total Recoverable Zinc	ug/L	--		--		76	
Dissolved Zinc	ug/L	--		--		32.8	
Particle Size Distribution							
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	1.67		19.91		9.72	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	16.05		8.89		24.85	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.01	U	8.61		8.63	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	30.36		36.37		0.01	U
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	20.18		11.74		10.25	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

EVERETT-03		STORM EVENT							
PARAMETER	UNITS	11/7/2012		12/12/2012		3/2/2013		3/20/2013	
Conventionals									
TSS	mg/L	49		10		11		--	
Hardness as $CaCO_3$	mg/L	39.6		26.5		24.9		22.5	
Nutrients									
Total Phosphorous	mg/L	2.1		0.189		0.197		0.253	
Orthophosphate	mg/L	1.69		0.107		--		--	
Total Kjeldahl Nitrogen	mg/L	1.9		1.2	J	1.4		0.86	J
Nitrate-Nitrite	mg/L	--		0.472		0.472		0.395	
Metals									
Total Recoverable Copper	ug/L	12		6.8		--		--	
Dissolved Copper	ug/L	9.86	J	4.85		--		--	
Total Recoverable Zinc	ug/L	155		40.1		--		--	
Dissolved Zinc	ug/L	145	J	38.3		--		--	
Particle Size Distribution									
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	6.88		1.89		10.75		8.83	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	3.65		0.6		3.89		9.09	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	2.78		1.22		0.13		5.38	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	1.82		0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	23.49		0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	28.74		9.47		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	1.29		1.28		2.18		5.16	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

EVERETT 04		STORM EVENT											
PARAMETER	UNITS	11/7/2012		12/11/2012		2/17/2013		2/22/2013		3/2/2013		3/6/2013	
Conventionals													
TSS	mg/L	51	J	--		74		--		100		--	
Chloride	mg/L	3.91		--		25.9		--		10.1		--	
Hardness as $CaCO_3$	mg/L	13.5		--		29.2		--		17.3		--	
Bacteria													
Fecal coliform	cfu/100ml	--		400		--		--		--		--	
Nutrients													
Total Phosphorous	mg/L	0.0817		--		0.129		--		0.107		--	
Orthophosphate	mg/L	0.01	U	--		--		--		--		--	
Total Kjeldahl Nitrogen	mg/L	1.1		--		1.5	J	--		1.1		--	
Nitrate-Nitrite	mg/L	0.373		--		0.739		--		0.246		--	
Metals													
Total Recoverable Copper	ug/L	19.6		--		--		--		--		--	
Dissolved Copper	ug/L	5.93	J	--		--		--		--		--	
Total Recoverable Lead	ug/L	--		--		--		--		--		--	
Dissolved Lead	ug/L	--		--		--		--		--		--	
Total Recoverable Cadmium	ug/L	--		--		--		--		--		--	
Dissolved Cadmium	ug/L	--		--		--		--		--		--	
Total Recoverable Zinc	ug/L	109		--		--		--		--		--	
Dissolved Zinc	ug/L	73.5	J	--		--		--		--		--	
PAH Compounds													
Acenaphthene	ug/L	0.01	U	--		0.01	U	--		--		--	
Acenaphthylene	ug/L	0.01	U	--		0.01	U	--		--		--	
Anthracene	ug/L	0.01	U	--		0.018		--		--		--	
Benzo(a)anthracene	ug/L	0.01	U	--		0.047		--		--		--	
Benzo(b)fluoranthene	ug/L	0.053		--		0.097		--		--		--	
Benzo(k)fluoranthene	ug/L	0.019		--		0.029		--		--		--	
Benzo(ghi)perylene	ug/L	0.092		--		0.029		--		--		--	
Benzo(a)pyrene	ug/L	0.028		--		0.046		--		--		--	
Chrysene	ug/L	0.047		--		0.1		--		--		--	
Dibenzo(a,h)anthracene	ug/L	0.028	UJ	--		0.01	U	--		--		--	
Fluoranthene	ug/L	0.056		--		0.14		--		--		--	
Fluorene	ug/L	0.01	U	--		0.013		--		--		--	

Indeno(1,2,3-cd)pyrene	ug/L	0.066	J	--		0.025		--		--		--	
Naphthalene	ug/L	0.014	UJ	--		0.034		--		--		--	
Phenanthrene	ug/L	0.029		--		0.078		--		--		--	
Pyrene	ug/L	0.094		--		0.23		--		--		--	
Phthalates													
bis(2-Ethylhexyl)phthalate	ug/L	0.2	U	--		6.9	J	--		--		--	
Butyl benzyl phthalate	ug/L	0.2	U	--		0.36	UJ	--		--		--	
Di-n-butyl phthalate	ug/L	0.2	U	--		0.46	UJ	--		--		--	
Diethyl phthalate	ug/L	0.2	U	--		0.42		--		--		--	
Dimethyl phthalate	ug/L	0.2	U	--		0.11	J	--		--		--	
Di-n-octyl phthalate	ug/L	0.2	U	--		1.7	J	--		--		--	
Herbicides													
Dichlobenil	ug/L	--		--		--		--		--		--	
Diuron	ug/L	--		--		--		--		--		--	
2,4-D	ug/L	--		--		--		--		--		--	
Clopyralid	ug/L	--		--		--		--		--		--	
Picloram	ug/L	--		--		--		--		--		--	
Triclopyr	ug/L	--		--		--		--		--		--	
Glyphosate	ug/L	25	U	--		25	U	--		25	U	--	
TPH													
TPH-Diesel (NWTPH-Dx)	mg/L	--		6.55		--		5.75		--		7.05	
Diesel	mg/L	--		0.15	U	--		0.15	U	--		0.15	UJ
Lube Oil	mg/L	--		6.4		--		5.6		--		6.9	J
TPH-Gas (NWTPH-Gx)	mg/L	--		0.07	U	--		0.05	U	--		0.05	U
Particle Size Distribution													
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	1.96		--		0.6		--		--		--	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	4		--		12.45		--		--		--	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	2.82		--		0.69		--		--		--	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	--		0.01	U	--		--		--	
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	--		0.01	U	--		--		--	
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	30.07		--		42.59		--		--		--	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	4.78		--		16.91		--		--		--	

EVERETT 04		STORM EVENT									
PARAMETER	UNITS	3/20/2013		4/12/2013		4/19/2013		5/21/2013		9/15/13	
Conventionals											
TSS	mg/L	88		72		46		55		81	
Chloride	mg/L	--		--		6.39		3.69		4.57	
Hardness as $CaCO_3$	mg/L	14.1		17.6		18.2		16.8			
Bacteria											
Fecal coliform	cfu/100ml	--		--		--		2600			
Nutrients											
Total Phosphorous	mg/L	0.13		0.138	J	0.0928		0.142			
Orthophosphate	mg/L	--		--		--		0.0183			
Total Kjeldahl Nitrogen	mg/L	--		0.46	J	--		1.5	J		
Nitrate-Nitrite	mg/L	0.198		0.455		0.531		0.676			
Metals											
Total Recoverable Copper	ug/L	--		--		--		34.6		64.8	
Dissolved Copper	ug/L	--		--		--		13.8		28	
Total Recoverable Lead	ug/L	--		--		--		--			
Dissolved Lead	ug/L	--		--		--		--			
Total Recoverable Cadmium	ug/L	--		--		--		--			
Dissolved Cadmium	ug/L	--		--		--		--			
Total Recoverable Zinc	ug/L	--		--		--		157		257	
Dissolved Zinc	ug/L	--		--		--		74.2		16	
PAH Compounds											
Acenaphthene	ug/L	0.011	U	--		0.01	U	--			
Acenaphthylene	ug/L	0.011	U	--		0.01	U	--			
Anthracene	ug/L	0.011	J	--		0.01	U	--			
Benzo(a)anthracene	ug/L	0.042		--		0.021		--			
Benzo(b)fluoranthene	ug/L	0.078		--		0.035		--			
Benzo(k)fluoranthene	ug/L	0.049		--		0.024		--			
Benzo(ghi)perylene	ug/L	0.11		--		0.053		--			
Benzo(a)pyrene	ug/L	0.045		--		0.025		--			
Chrysene	ug/L	0.12		--		0.064		--			
Dibenzo(a,h)anthracene	ug/L	0.016	U	--		0.0089	J	--			

Fluoranthene	ug/L	0.15		--		0.075		--			
Fluorene	ug/L	0.011	U	--		0.01	U	--			
Indeno(1,2,3-cd)pyrene	ug/L	0.043		--		0.016		--			
Naphthalene	ug/L	0.016		--		0.014		--			
Phenanthrene	ug/L	0.067		--		0.041		--			
Pyrene	ug/L	0.22		--		0.12		--			
Phthalates											
bis(2-Ethylhexyl)phthalate	ug/L	6.8		--		7.1		--			
Butyl benzyl phthalate	ug/L	0.31	UJ	--		0.32	UJ	--			
Di-n-butyl phthalate	ug/L	0.41	U	--		0.44	U	--			
Diethyl phthalate	ug/L	0.51		--		0.46		--			
Dimethyl phthalate	ug/L	0.21	UJ	--		0.21	UJ	--			
Di-n-octyl phthalate	ug/L	0.73		--		1.1	J	--			
Herbicides											
Dichlobenil	ug/L	--		--		--		--			
Diuron	ug/L	--		--		--		--			
2,4-D	ug/L	--		--		--		--			
Clopyralid	ug/L	--		--		--		--			
Picloram	ug/L	--		--		--		--			
Triclopyr	ug/L	--		--		--		--			
Glyphosate	ug/L	25	U	--		18	J	25	U		
TPH											
TPH-Diesel (NWTPH-Dx)	mg/L	--		--		--		3.35			
Diesel	mg/L	--		--		--		0.15	UJ		
Lube Oil	mg/L	--		--		--		3.2	J		
TPH-Gas (NWTPH-Gx)	mg/L	--		--		--		0.07	U		
Particle Size Distribution											
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		9.04		11.17		12.76			
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		17.83		5.66		32.66			
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		8.74		8.55		10.98			

Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.01	U	0.01	U	0.01	U		
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		0.01	U	0.01	U	0.01	U		
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		18.71		41.01		0.01	U		
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		22.11		0.12		21.86			

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate
TPH-Diesel (NWTPH-Dx) values are calculated as the sum of the Diesel and Lube Oil concentrations

EVERETT-05		**STORM EVENT**							
PARAMETER	**UNITS**	**11/7/2012**		**3/2/2013**		**4/12/2013**		**5/21/2013**	
Conventionals									
TSS	mg/L	51		8		33		19	
Hardness as $CaCO_3$	mg/L	41.8		24		34.9		75.3	
Nutrients									
Total Phosphorous	mg/L	0.464		0.512		2.13	J	9.01	
Orthophosphate	mg/L	0.181		--		--		8.91	
Total Kjeldahl Nitrogen	mg/L	--		2.3		10		20	J
Nitrate-Nitrite	mg/L	--		0.725		0.109		1.11	
Metals									
Total Recoverable Copper	ug/L	13.5		--		--		32.6	
Dissolved Copper	ug/L	10.5	J	--		--		25	
Total Recoverable Zinc	ug/L	55.7		--		--		129	
Dissolved Zinc	ug/L	49.1	J	--		--		82.6	

Particle Size Distribution									
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		1.34		0.6		3.47	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		0.46		3.49		0.88	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		0.01	U	1.11		2.66	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.01	U	0.01	U	0.4	
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		0.01	U	0.01	U	14.16	
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		4.23		2.66		5.76	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		0.67		11.14		0.22	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

EVERETT-06		STORM EVENT					
PARAMETER	UNITS	12/12/2012		3/2/2013		3/20/2013	
Conventionals							
TSS	mg/L	26		10		8	
Hardness as $CaCO_3$	mg/L	22.1		21.1		22.3	
Nutrients							
Total Phosphorous	mg/L	0.8		0.469		0.548	
Orthophosphate	mg/L	0.485		--		--	
Total Kjeldahl Nitrogen	mg/L	--		1.9		2.4	
Nitrate-Nitrite	mg/L	0.461		0.943		0.581	
Metals							
Total Recoverable Copper	ug/L	7.39		--		--	
Dissolved Copper	ug/L	3.6		--		--	

Total Recoverable Zinc	ug/L	34.2		--		--	
Dissolved Zinc	ug/L	13.6		--		--	
Particle Size Distribution							
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		0.01	U	5.66	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		3.75		0.41	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		0.01	U	1.52	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		0.01	U	5.06	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		2.28		0.84	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK 01		**STORM EVENT**											
PARAMETER	**UNITS**	**10/18/12**		**11/7/2012**		**12/11/2012**		**2/11/2013**		**2/16/2013**		**2/21/2013**	
Conventionals													
TSS	mg/L	31		21		--		--		50		--	
Chloride	mg/L	0.92		2.77		--		--		13.7		27.6	
Hardness as $CaCO_3$	mg/L	17		17.4		--		--		31.4		--	
Bacteria													
Fecal coliform	cfu/100ml	18		--		110000		2000		--		1200	
Nutrients													
Total Phosphorous	mg/L	0.0687		0.0562		--		--		0.0886		0.115	
Orthophosphate	mg/L	0.0163	J	0.0142		--		--		--		0.01	U
Total Kjeldahl Nitrogen	mg/L	--		--		--		--		0.84	U	0.99	U
Nitrate-Nitrite	mg/L	--		--		--		--		0.566		0.351	

Metals													
Total Recoverable Copper	ug/L	16		11.4		--		--		--		28.1	
Dissolved Copper	ug/L	3.99		4.51	J	--		--		--		9.9	
Total Recoverable Lead	ug/L	--		--		--		--		--		--	
Dissolved Lead	ug/L	--		--		--		--		--		--	
Total Recoverable Cadmium	ug/L	--		--		--		--		--		--	
Dissolved Cadmium	ug/L	--		--		--		--		--		--	
Total Recoverable Zinc	ug/L	62.8		56	J	--		--		--		128	
Dissolved Zinc	ug/L	16.8		26	J	--		--		--		32.1	
PAH Compounds													
Acenaphthene	ug/L	0.011	U	--		--		--		0.0098	U	--	
Acenaphthylene	ug/L	0.011	U	--		--		--		0.0098	U	--	
Anthracene	ug/L	0.055		--		--		--		0.0098	U	--	
Benzo(a)anthracene	ug/L	0.011	U	--		--		--		0.021		--	
Benzo(b)fluoranthene	ug/L	0.011	U	--		--		--		0.05		--	
Benzo(k)fluoranthene	ug/L	0.011	U	--		--		--		0.019		--	
Benzo(ghi)perylene	ug/L	0.043		--		--		--		0.021		--	
Benzo(a)pyrene	ug/L	0.033	J	--		--		--		0.024		--	
Chrysene	ug/L	0.011	U	--		--		--		0.052		--	
Dibenzo(a,h)anthracene	ug/L	0.011	U	--		--		--		0.0098	U	--	
Fluoranthene	ug/L	0.062		--		--		--		0.073		--	
Fluorene	ug/L	0.015	J	--		--		--		0.0098	U	--	
Indeno(1,2,3-cd)pyrene	ug/L	0.011	U	--		--		--		0.018		--	
Naphthalene	ug/L	0.018		--		--		--		0.022		--	
Phenanthrene	ug/L	0.041		--		--		--		0.048		--	
Pyrene	ug/L	0.063		--		--		--		0.12		--	
Phthalates													
bis(2-Ethylhexyl)phthalate	ug/L	4.1	J	--		--		--		4	J	--	
Butyl benzyl phthalate	ug/L	0.22	J	--		--		--		0.2	U	--	
Di-n-butyl phthalate	ug/L	0.25	UJ	--		--		--		0.34	UJ	--	
Diethyl phthalate	ug/L	0.22	U	--		--		--		0.2	UJ	--	
Dimethyl phthalate	ug/L	0.22	U	--		--		--		0.2	UJ	--	
Di-n-octyl phthalate	ug/L	0.75	J	--		--		--		0.89	J	--	

Herbicides													
Dichlobenil	ug/L	--		--		--		--		--		--	
Diuron	ug/L	--		--		--		--		--		--	
2,4-D	ug/L	--		--		--		--		--		--	
Clopyralid	ug/L	--		--		--		--		--		--	
Picloram	ug/L	--		--		--		--		--		--	
Triclopyr	ug/L	--		--		--		--		--		--	
Glyphosate	ug/L	--		25	U	--		--		25	U	25	U
TPH													
TPH-Diesel (NWTPH-Dx)	mg/L	1.05		--		8.65		3.95		--		2.55	
Diesel	mg/L	0.05	U	--		0.15	U	0.15	UJ	--		0.15	U
Lube Oil	mg/L	1		--		8.5		3.8	J	--		2.4	
TPH-Gas (NWTPH-Gx)	mg/L	0.07	U	--		0.07	U	0.07	U	--		0.05	U
Particle Size Distribution													
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	0.01	U	--		--		--		0.49		--	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	4.04		--		--		--		8.12		--	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.01	U	--		--		--		1.19		--	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	--		--		--		0.01	U	--	
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	--		--		--		0.01	U	--	
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	21.85		--		--		--		18.01		--	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	5.96		--		--		--		12.18		--	

PILCHUCK 01		STORM EVENT											
PARAMETER	UNITS	2/25/2013		2/28/2013		3/2/2013		3/6/2013		3/20/2013		4/12/2013	
Conventionals													
TSS	mg/L	32		66		77		--		53		54	
Chloride	mg/L	19.5		--		5.39		--		7.09		4.66	
Hardness as $CaCO_3$	mg/L	46.5		29.7		22.8		--		36		31.3	
Bacteria													
Fecal coliform	cfu/100ml	--		--		--		--		--		--	
Nutrients													
Total Phosphorous	mg/L	0.0659		0.104		0.0947		--		--		0.132	J
Orthophosphate	mg/L	--		0.01	U	--		--		0.01	U	--	
Total Kjeldahl Nitrogen	mg/L	--		1.1	J	0.57	J	--		0.66	J	0.78	J
Nitrate-Nitrite	mg/L	--		0.089		0.078		--		0.115		0.144	
Metals													
Total Recoverable Copper	ug/L	--		30.7		--		--		22.3		--	
Dissolved Copper	ug/L	--		6.3		--		--		6.75		--	
Total Recoverable Lead	ug/L	--		--		--		--		--		--	
Dissolved Lead	ug/L	--		--		--		--		--		--	
Total Recoverable Cadmium	ug/L	--		--		--		--		--		--	
Dissolved Cadmium	ug/L	--		--		--		--		--		--	
Total Recoverable Zinc	ug/L	--		130		--		--		87.9		--	
Dissolved Zinc	ug/L	--		15.6		--		--		16.2		--	
PAH Compounds													
Acenaphthene	ug/L	--		0.01	U	--		--		0.01	U	0.01	U
Acenaphthylene	ug/L	--		0.01	U	--		--		0.01	U	0.01	U
Anthracene	ug/L	--		0.015		--		--		0.0078	J	0.01	U
Benzo(a)anthracene	ug/L	--		0.047		--		--		0.015		0.023	J
Benzo(b)fluoranthene	ug/L	--		0.051		--		--		0.027		0.036	
Benzo(k)fluoranthene	ug/L	--		0.037		--		--		0.02		0.024	
Benzo(ghi)perylene	ug/L	--		0.091		--		--		0.06		0.084	
Benzo(a)pyrene	ug/L	--		0.033		--		--		0.021		0.026	J
Chrysene	ug/L	--		0.068		--		--		0.047		0.06	
Dibenzo(a,h)anthracene	ug/L	--		0.011		--		--		0.01	U	0.01	U
Fluoranthene	ug/L	--		0.17		--		--		0.065		0.081	J

Fluorene	ug/L	--		0.012		--		--		0.01	UJ	0.01	U
Indeno(1,2,3-cd)pyrene	ug/L	--		0.031		--		--		0.016		0.024	
Naphthalene	ug/L	--		0.014		--		--		0.013	U	0.02	
Phenanthrene	ug/L	--		0.078		--		--		0.033		0.047	
Pyrene	ug/L	--		0.2		--		--		0.099		0.12	
Phthalates													
bis(2-Ethylhexyl)phthalate	ug/L	--		3.8	J	--		--		3.9		4.6	
Butyl benzyl phthalate	ug/L	--		0.2	U	--		--		0.24	UJ	0.39	U
Di-n-butyl phthalate	ug/L	--		0.24	UJ	--		--		0.31	U	0.5	U
Diethyl phthalate	ug/L	--		0.2	UJ	--		--		0.2	U	0.2	U
Dimethyl phthalate	ug/L	--		0.2	UJ	--		--		0.2	UJ	0.2	U
Di-n-octyl phthalate	ug/L	--		0.61	J	--		--		0.62		0.84	U
Herbicides													
Dichlobenil	ug/L	--		--		--		--		--		--	
Diuron	ug/L	--		--		--		--		--		--	
2,4-D	ug/L	--		--		--		--		--		--	
Clopyralid	ug/L	--		--		--		--		--		--	
Picloram	ug/L	--		--		--		--		--		--	
Triclopyr	ug/L	--		--		--		--		--		--	
Glyphosate	ug/L	25	U	--		25		--		25	U	25	U
TPH													
TPH-Diesel (NWTPH-Dx)	mg/L	1.75		--		--		4.05		--		--	
Diesel	mg/L	0.15	U	--		--		0.15	UJ	--		--	
Lube Oil	mg/L	1.6		--		--		3.9	J	--		--	
TPH-Gas (NWTPH-Gx)	mg/L	0.05	UJ	--		--		0.05	U	--		--	
Particle Size Distribution													
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		0.7		--		--		1		0.6	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		12.3		--		--		8.21		15.19	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		0.56		--		--		6.68		7.34	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.01	U	--		--		0.01	U	0.01	U

Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		0.01	U	--		--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		30.69		--		--		36.06		24.29	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		16.14		--		--		10.12		15.35	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate
TPH-Diesel (NWTPH-Dx) values are calculated as the sum of the Diesel and Lube Oil concentrations

PILCHUCK-02		**STORM EVENT**							
PARAMETER	**UNITS**	**10/18/2012**		**2/28/2013**		**3/2/2013**		**3/20/2013**	
Conventionals									
TSS	mg/L	35	J	--		11		23	
Hardness as $CaCO_3$	mg/L	13.6		25.2		22.2		34.2	
Nutrients									
Total Phosphorous	mg/L	0.181		0.0674		0.0952		0.219	
Orthophosphate	mg/L	0.0851	J	0.0199		--		0.0949	
Total Kjeldahl Nitrogen	mg/L	--		0.94	U	0.64	J	0.95	J
Nitrate-Nitrite	mg/L	0.106		0.128		0.096		0.133	
Metals									
Total Recoverable Copper	ug/L	16.7		10.7		--		10	
Dissolved Copper	ug/L	8.94		6.37		--		6.32	
Total Recoverable Zinc	ug/L	50.8		28		--		52.7	
Dissolved Zinc	ug/L	10.3		11.6		--		18.8	
Particle Size Distribution									
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	2.68		--		0.01	U	4.67	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	2.6		--		7.03		1.29	

Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.38		--		0.01	U	16.07	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	25.63		--		0.01	U	18.11	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	3.6		--		3.87		1.55	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK-03		STORM EVENT													
PARAMETER	**UNITS**	**10/18/2012**		**11/7/2012**		**12/12/2012**		**2/21/2013**		**2/25/2013**		**2/28/2013**		**3/20/2013**	
Conventionals															
TSS	mg/L	37		62	J	19	J	8		2		--		19	
Hardness as $CaCO_3$	mg/L	13.7		42.8		22		--		30.8		20.5		30	
Nutrients															
Total Phosphorous	mg/L	0.27		0.583		0.111		--		0.175		0.0978		0.334	
Orthophosphate	mg/L	0.158	J	--		0.0479		0.208		0.114		0.0694		0.162	
Total Kjeldahl Nitrogen	mg/L	--		0.79	U	0.37	J	--		1.5	J	0.56	U	1.6	
Nitrate-Nitrite	mg/L	0.079		0.314		0.147		--		0.292		0.156		0.262	
Metals															
Total Recoverable Copper	ug/L	18		12.5		8.18		9.16		5.48		6.67		9.45	

Dissolved Copper	ug/L	11.9		4.23	J	4.76		7.1		5.03		6.22		5.54	
Total Recoverable Zinc	ug/L	38.1		228		24.6		64.3		30.9		20		39.8	
Dissolved Zinc	ug/L	12.8		166	J	14		54.2		30.9		15.9		26.3	
Particle Size Distribution															
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	6.99		--		3.56		--		--		0.8		20.81	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	3.83		--		11.2		--		--		0.42		1.42	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.01	U	--		3.95		--		--		0.13		16.56	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	--		0.01	U	--		--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	2.88		--		0.01	U	--		--		0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	26.38		--		0.01	U	--		--		0.01	U	14.17	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	0.81		--		7.31		--		--		0.39		1.57	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK-04		STORM EVENT			
PARAMETER	UNITS	2/21/2013		2/28/2013	
Conventionals					
TSS	mg/L	27		16	
Hardness as $CaCO_3$	mg/L	49.7		--	
Nutrients					
Total Phosphorous	mg/L	0.898		0.603	
Orthophosphate	mg/L	0.685		0.518	
Total Kjeldahl Nitrogen	mg/L	4.1		--	
Nitrate-Nitrite	mg/L	0.764		--	
Metals					
Total Recoverable Copper	ug/L	9.65		6.79	
Dissolved Copper	ug/L	6.64		3.43	
Total Recoverable Zinc	ug/L	35.8		28.7	
Dissolved Zinc	ug/L	19.2		14.9	
Particle Size Distribution					
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	0.01	U	1.02	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	0.8		8.1	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	1.02		0.38	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	21.59		0.01	U
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	1.51		4.9	

Notes:

-- parameter not analyzed

U - Analyte not detected above reported result

J - estimated value

UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK-05		STORM EVENT													
PARAMETER	UNITS	10/18/2012		2/21/2013		2/25/2013		2/28/2013		3/13/2013		3/20/2013		4/13/2013	
Conventionals															
TSS	mg/L	28		6		11		14		15		9		16	
Hardness as $CaCO_3$	mg/L	35.7		34.6		42.7		36.7		36.6		34.7		45.9	
Nutrients															
Total Phosphorous	mg/L	1.06		0.836		0.518		0.374		--		0.468		0.585	J
Orthophosphate	mg/L	0.887	J	0.765		0.438		0.368		--		--		--	
Total Kjeldahl Nitrogen	mg/L	2		2	J	1.9	J	1.6		2.4		2		1	U
Nitrate-Nitrite	mg/L	0.263		1.22		0.703		0.513		0.461		0.353		0.098	
Metals															
Total Recoverable Copper	ug/L	25.1		6.39		9.51		11.1		--		--		--	
Dissolved Copper	ug/L	21.7		4.07		7.54		9.26		--		--		--	
Total Recoverable Zinc	ug/L	29.6		61.9		21.1		28.4		--		--		--	
Dissolved Zinc	ug/L	27.5		49		12.2		21.2		--		--		--	
Particle Size Distribution															
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	14.51		0.01	U	0.11		2.37		19.03		14.95		11.78	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	2.16		3.4		9.36		10.3		0.01	U	0.7		10.58	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	0.65		0.01	U	0.01	U	2.23		16.71		18.77		9.11	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U

Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	24.15		0.01	U	0.01	U	0.01	U	0.01	U	7.29		0.01	U
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	2.79		1.56		4.74		4.52		0.01	U	1.37		5.43	

Notes:
-- parameter not analyzed
U - Analyte not detected above reported result
J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK-06		**STORM EVENT**									
PARAMETER	**UNITS**	**11/7/2012**		**2/16/2013**		**2/22/2013**		**2/25/2013**		**2/28/2013**	
Conventionals											
TSS	mg/L	77	J	125		47		24		67	
Hardness as $CaCO_3$	mg/L	23.8		38.4		55.6		48.3		31.9	
pH		--		--		--		--		--	
Temperature	degrees C	--		--		--		--		--	
Nutrients											
Total Phosphorous	mg/L	0.304		0.185		0.108		0.0849		0.0949	
Orthophosphate	mg/L	0.0242		--		0.01	U	0.01	U	0.01	U
Total Kjeldahl Nitrogen	mg/L	--		1.3	J	1.1	J	0.87	UJ	1	U
Nitrate-Nitrite	mg/L	--		0.518		0.373		0.11		0.094	

Metals										
Total Recoverable Copper	ug/L	17.2		--		24.7		15.7		29.2	
Dissolved Copper	ug/L	5.29	J	--		8.3		6.78		6.37	
Total Recoverable Zinc	ug/L	86		--		96.5		53.9		138	
Dissolved Zinc	ug/L	18.7	J	--		24.9		16.6		17	
Particle Size Distribution											
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	9		41.33		0.01	U	0.01	U	0.99	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	9.46		13.65		16.32		21.38		12.29	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	10.8		15.39		5.26		0.01	U	1.1	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.02		0.01	U	0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	41.74		0.01	U	0.01	U	0.01	U	0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	65.48		71.11		50.86		0.01	U	31.73	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	5.76		17.96		19.62		8.78		17.06	

PILCHUCK-06		STORM EVENT							
PARAMETER	UNITS	3/12/2013		3/20/2013		4/4/2013		4/12/2013	
Conventionals									
TSS	mg/L	46		49		53		52	
Hardness as $CaCO_3$	mg/L	32.8		33.8		45.3		30.5	
pH		--		--		--		--	
Temperature	degrees C	--		--		--		--	
Nutrients									
Total Phosphorous	mg/L	0.116		0.101		0.222		0.11	J
Orthophosphate	mg/L	--		--		--		--	
Total Kjeldahl Nitrogen	mg/L	0.91	J	0.56	J	2.7		0.88	J
Nitrate-Nitrite	mg/L	0.12		0.092		0.345		0.16	
Metals									
Total Recoverable Copper	ug/L	--		--		--		--	
Dissolved Copper	ug/L	--		--		--		--	
Total Recoverable Zinc	ug/L	--		--		--		--	
Dissolved Zinc	ug/L	--		--		--		--	
Particle Size Distribution									
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		5.49		--		4.56	

Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		8.51		--		40.27	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		10.68		--		9.88	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.01	U	--		0.01	U
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		0.01	U	--		0.01	U
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		40.15		--		0.01	U
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		11.33		--		19.2	

Notes:
-- parameter not analyzed
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PILCHUCK-07		STORM EVENT			
PARAMETER	UNITS	3/12/2013		4/4/2013	
Conventionals					
TSS	mg/L	37		29	
Hardness as $CaCO_3$	mg/L	29.1		55.3	
Nutrients					
Total Phosphorous	mg/L	0.992		3.35	
Orthophosphate	mg/L	--		--	
Total Kjeldahl Nitrogen	mg/L	--		11	J
Nitrate-Nitrite	mg/L	0.766		0.164	
Metals					
Total Recoverable Copper	ug/L	--		--	
Dissolved Copper	ug/L	--		--	
Total Recoverable Zinc	ug/L	--		--	
Dissolved Zinc	ug/L	--		--	
Particle Size Distribution					
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	--		14.86	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	--		0.88	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	--		6.47	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	--		0.09	
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	--		17.81	
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	--		7.19	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	--		0.35	

Notes:
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J - estimated value
UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

PILCHUCK-08		STORM EVENT							
PARAMETER	UNITS	3/12/2013		3/20/2013		4/4/2013		4/10/2013	
Conventionals									
TSS	mg/L	--		75		120		42	
Hardness as $CaCO_3$	mg/L	24.9		31.8		56.5		34	
Nutrients									
Total Phosphorous	mg/L	1.38		2.06		8.77		5.16	
Orthophosphate	mg/L	--		--		--		--	
Total Kjeldahl Nitrogen	mg/L	--		6.2		39		--	
Nitrate-Nitrite	mg/L	0.209		0.037		0.042		0.022	
Metals									
Total Recoverable Copper	ug/L	--		--		--		--	
Dissolved Copper	ug/L	--		--		--		--	
Total Recoverable Zinc	ug/L	--		--		--		--	
Dissolved Zinc	ug/L	--		--		--		--	
Particle Size Distribution									
Particle/Grain Size, Phi Scale <1 (>500 um)	mg/L	14.03		3.79		13.84		--	
Particle/Grain Size, Phi Scale >10 (<1.0 um)	mg/L	2.5		3.09		3.51		--	
Particle/Grain Size, Phi Scale 1-2 (250-500 um)	mg/L	11.17		6.15		12.83		--	
Particle/Grain Size, Phi Scale 2 to 3 (125-250 um)	mg/L	0.01	U	0.01	U	11.47		--	
Particle/Grain Size, Phi Scale 3 to 4 (62.5-125 um)	mg/L	0.01	U	1.59		43.93		--	
Particle/Grain Size, Phi Scale 4-8 (3.9-62.5 um)	mg/L	35.85		48.18		17.87		--	
Particle/Grain Size, Phi Scale 8-10 (1.0-3.9 um)	mg/L	3.76		5.55		1.2		--	

Notes:
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UJ - Analyte not detected above reported result, reported reporting limit may inaccurate

Appendix B:
WY13 Storm Reports

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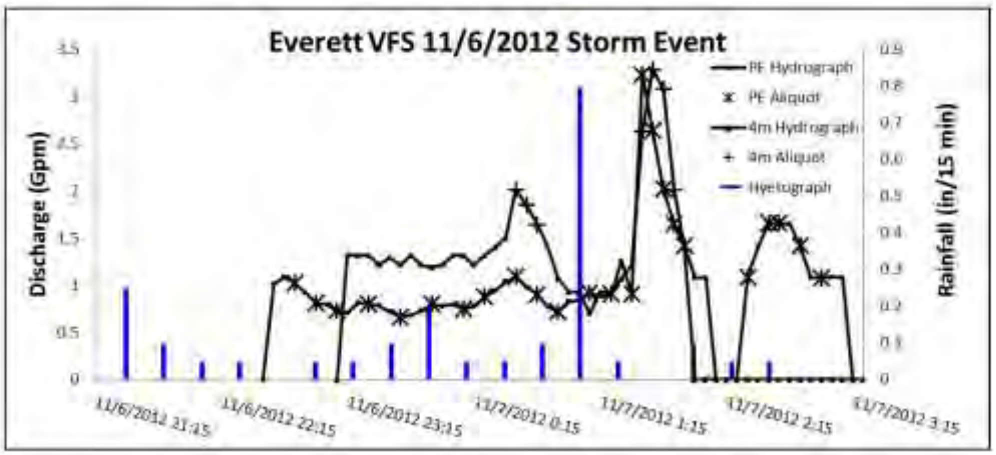
Everett VFS

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.47	11/6/2012 22:35	11/7/2012 11:15	12.67	47.74	0.04	0.16

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	24	11/6/2012 22:50	11/07/2012 1300	4.17	250	6,000	8.98	10.65	J
4	7	11/7/2012 0:35	11/7/2012 1:50	1.25	250	1,750	9.44	10.01	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	11/6/2012 22:40	11/7/2012 3:10	4.50	281.24	62.50	281.24	270.44	96.16	3.24	0.66	1.08	0.500
4	11/6/2012 23:15	11/7/2012 1:55	2.67	61.38	22.99	61.38	59.56	97.05	0.84	0.18	0.37	0.053

J=Estimate of Hydrology information



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.51	12/11/2012 13:45	12/12/2012 7:00	17.25	78	0.03	0.06

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	N/A	N/A	N/A	N/A	N/A	N/A	5.34	5.97	
4	12	12/11/2012 15:25	12/12/2012 3:40	12.25	250	4,000	5.35	6.50	

RUNOFF / DISCHARGE	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	12/11/2012 16:40	12/12/2012 7:25	14.75	525.19	35.61	525.19	N/A	N/A	1.02	0.18	0.66	0.087
4	12/11/2012 15:20	12/12/2012 5:10	13.83	179.68	12.99	179.68	158.55	88.24	0.46	0.18	0.32	0.011

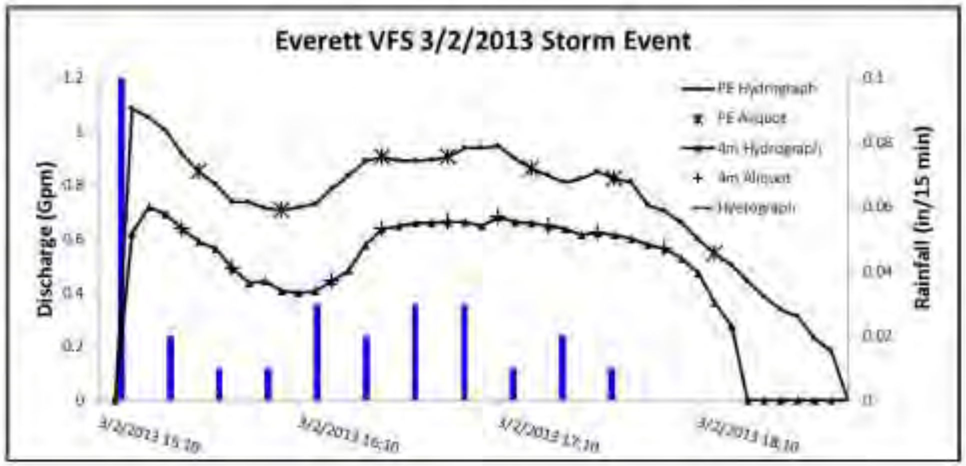
Only grab samples collected at influent.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.30	3/2/2013 15:15	3/2/2013 20:30	5.25	45	0.05	0.11

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	7	3/2/2013 15:40	3/2/2013 18:15	2.58	250	1,750	7.10	9.12	
2	28	3/2/2013 15:25	3/2/2013 18:50	3.42	250	7,000	6.79	9.36	R
4	9	3/2/2013 15:35	3/2/2013 18:00	2.42	250	2,250	7.29	9.12	

RUNOFF / DISCHARGE	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point0 (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/2/2013 15:20	3/2/2013 18:50	3.50	160.90	45.97	160.90	148.92	92.55	1.08	0.18	0.75	0.101
2	3/2/2013 15:20	3/2/2013 22:25	7.08	204.62	28.90	204.62	148.28	72.46	1.04	0.18	0.51	0.090
4	3/2/2013 15:20	3/23/2013 18:20	3.00	105.36	35.12	105.36	97.13	92.19	0.72	0.28	0.57	0.035

Rejected because less than 75% of the hydrograph was sampled.

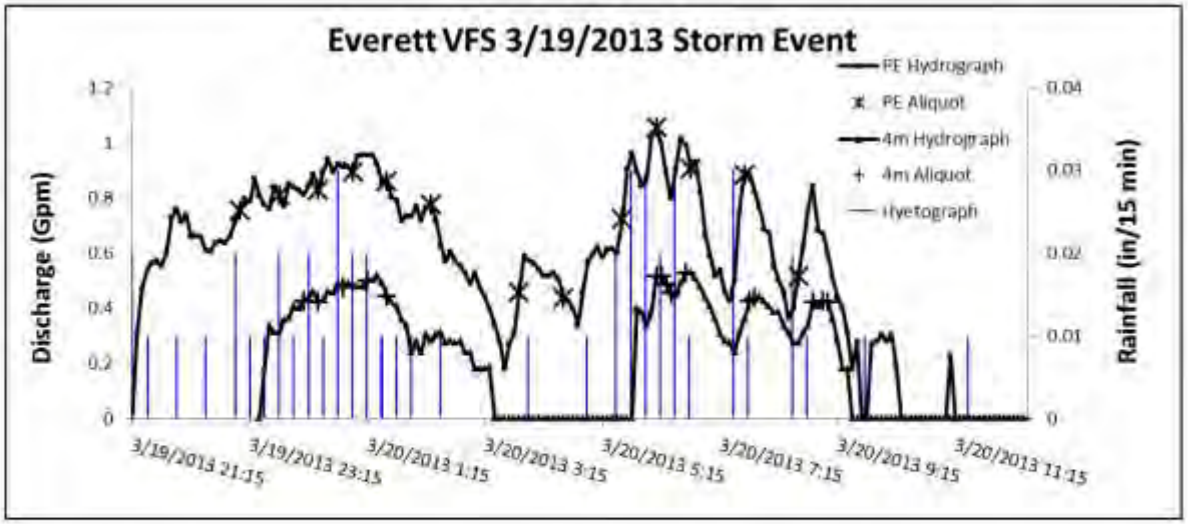


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.51	3/19/2013 21:15	3/20/2013 11:40	14.42	38.25	0.03	0.09

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	13	3/19/2013 22:15	3/20/2013 8:35	10.33	250	3,500	6.31	7.63	J
2	13	3/19/2013 23:55	3/20/2013 10:15	10.33	250	3,250	6.42	9.31	R
4	15	3/20/2013 0:10	3/20/2013 9:05	8.92	250	3,750	6.46	7.99	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/19/2013 21:20	3/20/2013 11:10	13.83	506.35	36.61	506.35	465.53	86.3	1.06	0.18	0.65	0.095
2	3/19/2013 23:25	3/20/2013 12:15	12.83	309.15	24.10	309.15	290.07	N/A	0.86	0.18	0.49	0.056
4	3/19/2013 23:30	3/20/2013 9:25	9.92	169.00	17.04	169.00	163.99	97.04	0.53	0.18	0.37	0.016

J=Estimate of Hydrology information – Rejected because less than 75% of the hydrograph was sampled.



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.72	5/21/2013 3:15	5/22/2013 2:45	23.50	43.75	0.03	0.19

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	29	5/21/2013 3:55	5/22/2013 4:30	24.58	250	7,250	8.43	16.25	
2	19	5/21/2013 3:50	5/22/2013 0:30	20.67	250	7,000	10.36	16.25	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	5/21/2013 3:25	5/22/2013 6:15	26.83	922.20	34.37	849.49	849.49	100.00	1.24	0.18	0.53	0.143
2	5/21/2013 3:40	5/22/2013 2:00	22.33	251.48	11.26	251.48	222.55	66.70	0.83	0.18	0.39	0.051

Rejected because less than 75% of the hydrograph was sampled.

Everett MVFS

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.48	11/6/2012 22:25	11/7/2012 10:15	11.83	48.25	0.04	0.19

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	29	11/6/2012 22:45	11/7/2012 10:35	11.83	250	7,250	6.73	11.54	
2	10	11/7/2012 0:25	11/7/2012 2:05	1.67	250	4,750	9.62	10.45	R

RUNOFF / DISCHARGE	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	11/6/2012 22:30	11/7/2012 10:55	12.42	312.99	25.20	312.99	307.18	98.14	1.63	0.18	0.66	0.291
2	11/6/2012 23:05	11/7/2012 11:20	12.25	121.84	9.95	121.84	77.51	63.62	0.75	0.18	0.36	0.039

Rejected because less than 75% of the hydrograph was sampled.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.53	12/11/2012 13:45	12/12/2012 6:55	17.17	42.24	0.03	0.07

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	N/A	N/A	N/A	N/A	N/A	N/A	5.29	6.50	
4	12	12/11/2012 22:25	12/12/2012 5:00	6.58	250	3,000	5.33	5.64	

RUNOFF / DISCHARGE	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	12/11/2012 14:00	12/11/2012 13:45	0.25	595.68	2382.73	519.47	N/A	N/A	1.01	0.18	-0.09	0.085
4	12/11/2012 15:20	12/12/2012 7:20	16.00	208.17	13.01	208.17	191.87	92.17	0.45	0.01	0.11	0.010

Only grab samples collected at influent.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.27	3/2/2013 15:15	3/2/2013 17:50	2.58	51.49	0.09	0.1

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	3/2/2013 15:35	3/2/2013 18:45	3.17	250	2,250	6.72	9.70	R
2	10	3/2/2013 15:40	3/2/2013 18:25	2.75	250	2,500	6.99	9.70	
4	13	3/2/2013 16:40	3/2/2013 18:40	2.00	250	3,250	6.85	8.01	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/2/2013 15:15	3/2/2013 22:00	6.75	310.27	45.97	310.27	222.58	71.74	1.25	0.00	0.75	0.146
2	3/2/2013 15:25	3/2/2013 19:15	3.83	124.11	32.40	124.11	106.88	86.12	0.68	0.18	0.53	0.030
4	3/2/2013 16:30	3/2/2013 20:00	3.50	92.75	26.50	92.75	68.90	74.28	0.59	0.10	0.43	0.021

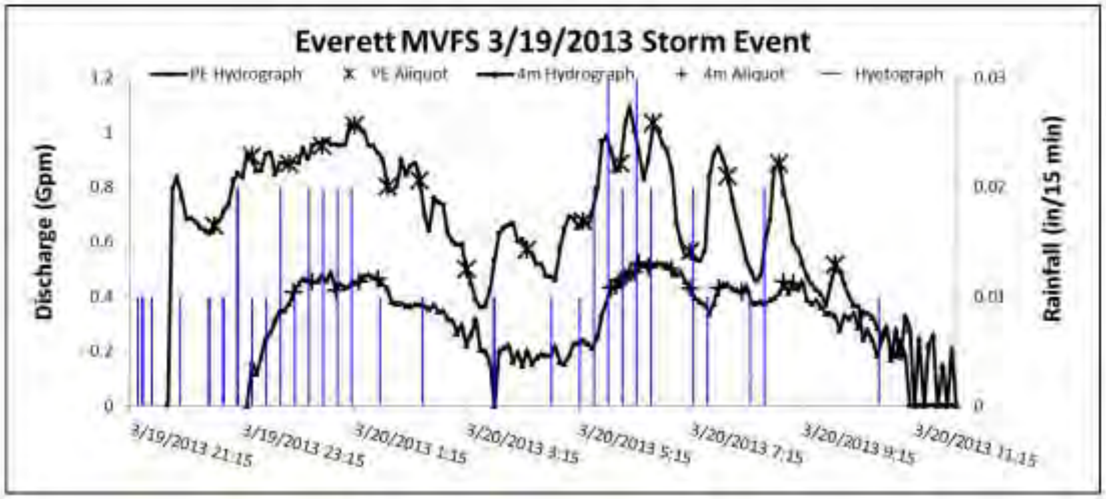
Rejected because less than 75% of the hydrograph was sampled.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.45	3/19/2013 21:30	03/20/2013 17:40	13.17	38.74	0.03	0.1

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	16	3/19/2013 22:45	3/20/2013 9:50	11.08	250	4,000	5.77	8.18	
4	19	3/20/2013 0:10	3/20/2013 9:05	8.92	250	4,750	5.77	7.57	J

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/19/2013 22:00	3/20/2013 11:05	13.08	550.09	42.06	550.09	528.63	96.10	1.09	0.18	0.49	0.103
4	3/19/2013 23:25	3/20/2013 13:55	14.50	255.06	17.59	255.06	207.59	81.39	0.52	0.05	0.33	0.016

J=Estimate of Hydrology information



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.17	4/12/2013 13:45	4/12/2013 16:20	2.58	32.5	0.06	0.07

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	14	4/12/2013 14:05	4/12/2013 16:20	2.25	250	3,500	6.14	7.62	
2	17	4/12/2013 14:45	4/12/2013 18:05	3.33	250	5,750	6.01	7.02	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	4/12/2013 13:55	4/12/2013 16:50	2.92	122.52	41.96	122.52	111.11	90.69	1.00	0.18	0.38	0.082
2	4/12/2013 14:30	4/12/2013 18:55	4.42	137.08	31.01	137.08	122.68	66.00	0.72	0.18	0.22	0.035

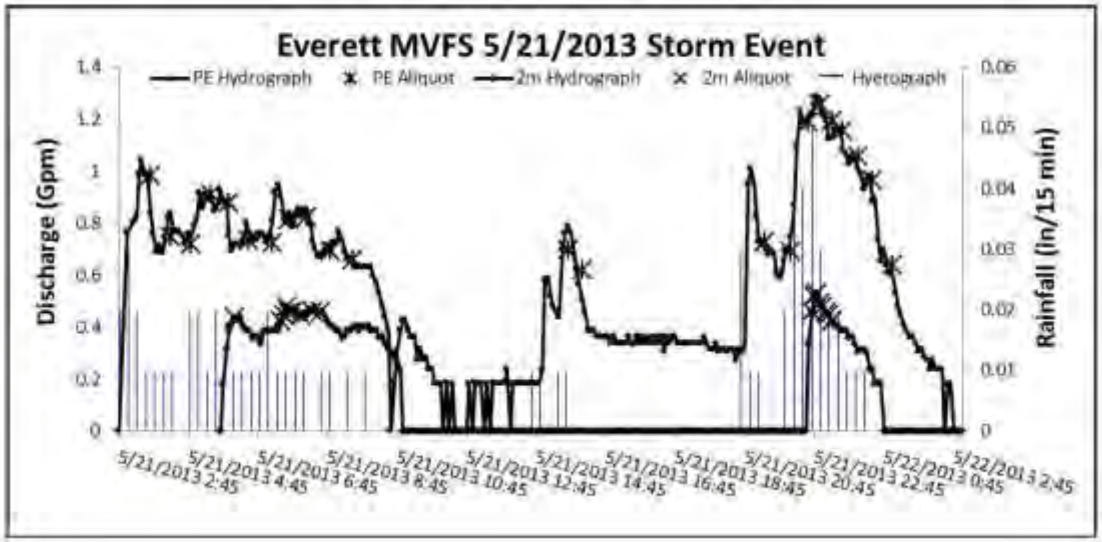
Rejected because less than 75% of the hydrograph was sampled.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.66	5/21/2013 3:10	5/22/2013 0:25	21.25	44.75	0.03	0.16

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	22	5/21/2013 3:40	5/22/2013 1:00	21.33	250	5,500	8.83	12.09	J
2	17	5/21/2013 6:05	5/21/2013 23:15	17.17	250	4,250	8.83	12.09	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	5/21/2013 3:15	5/22/2013 5:55	26.67	801.61	30.06	797.08	797.08	100.00	1.29	0.18	0.58	0.157
2	5/21/2013 5:45	5/22/2013 0:40	18.92	168.67	8.92	168.67	142.23	84.32	0.53	0.18	0.38	0.016

J=Estimate of Hydrology information

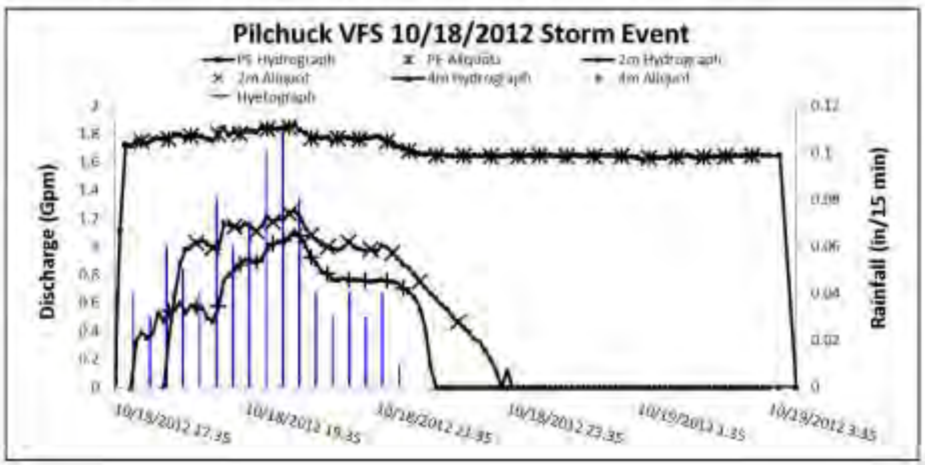


Pilchuck VFS

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.95	10/18/2012 17:35	10/18/2012 21:50	4.25	62.74	0.19	0.34

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	25	10/18/2012 18:00	10/19/2012 3:20	9.33	250	6,250	11.25	12.98	
2	13	10/18/2012 18:50	10/19/2012 22:50	4.00	250	3,250	11.25	11.79	
4	14	10/18/2012 18:25	10/18/2012 22:00	3.58	250	3,500	11.31	11.79	

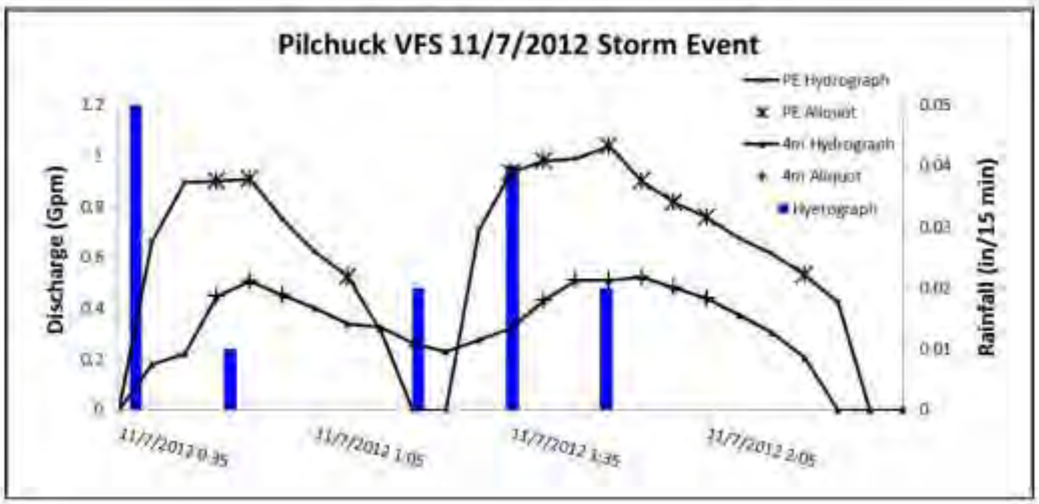
RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	10/18/2012 17:40	10/19/2012 3:45	10.08	1,025.60	101.75	1,025.60	992.71	96.79	1.85	1.11	1.70	0.119
2	10/18/2012 18:25	10/18/2012 23:35	5.17	270.51	52.32	270.51	259.65	95.99	1.25	0.12	0.55	0.147
4	10/18/2012 17:55	10/18/2012 22:25	4.50	198.34	44.08	198.34	186.16	93.86	1.11	0.15	0.46	0.107



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.15	11/7/2012 0:35	11/7/2012 3:25	2.83	49.5	0.04	0.06

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	9	11/7/2012 0:55	11/7/2012 2:25	1.50	250	2,250	9.18	10.56	
4	9	11/7/2012 0:50	11/7/2012 2:05	1.25	250	2,250	9.24	10.56	

RUNOFF / DISCHARGE													
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	11/7/2012 0:45	11/7/2012 2:30	1.75	74.84	42.77	74.84	72.73	97.18	1.04	0.31	0.75	0.091
4	11/7/2012 0:40	11/7/2012 2:20	1.67	38.81	23.24	38.81	34.37	88.56	0.52	0.18	0.37	0.015



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.62	12/11/2012 9:35	12/12/2012 11:30	25.92	37.25	0.02	0.08

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	N/A	N/A	N/A	N/A	N/A	N/A	5.18	6.54	
4	37	12/11/2012 13:55	12/12/2012 11:35	21.67	250	9,250	4.40	6.34	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	12/11/2012 9:45	12/12/2012 12:40	26.92	779.94	28.97	708.09	N/A	N/A	0.97	0.08	0.52	0.076
4	12/11/2012 10:15	12/12/2012 15:20	29.08	472.34	16.24	417.87	417.87	100.00	0.76	0.07	0.33	0.040

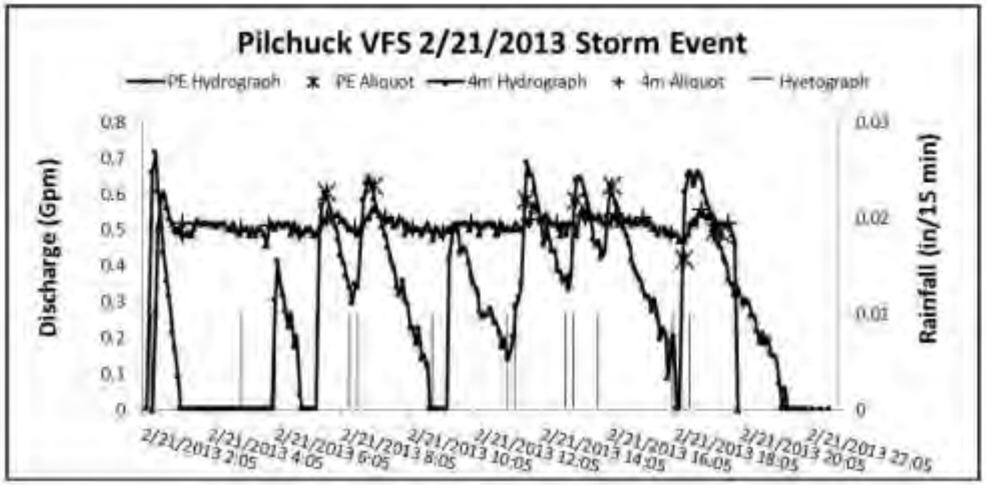
Only grab samples collected at influent.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.16	2/21/2013 2:25	2/21/2013 18:50	16.42	37.99	0.01	0.02

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	2/21/2013 7:40	2/21/2013 19:20	11.67	250	2,000	3.72	5.88	
4	22	02/21/2013 11:20	02/22/2013 05:30	18.17	250	5,500	3.43	5.88	J

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	2/21/2013 2:30	2/21/2013 21:30	19.00	351.43	18.50	351.43	317.09	90.23	0.71	0.04	0.39	0.035
4	02/21/2013 10:30	02/22/2013 05:15	18.75	348.94	18.61	348.94	348.94	100.00	0.72	0.18	0.41	0.022

J=Estimate of Hydrology information

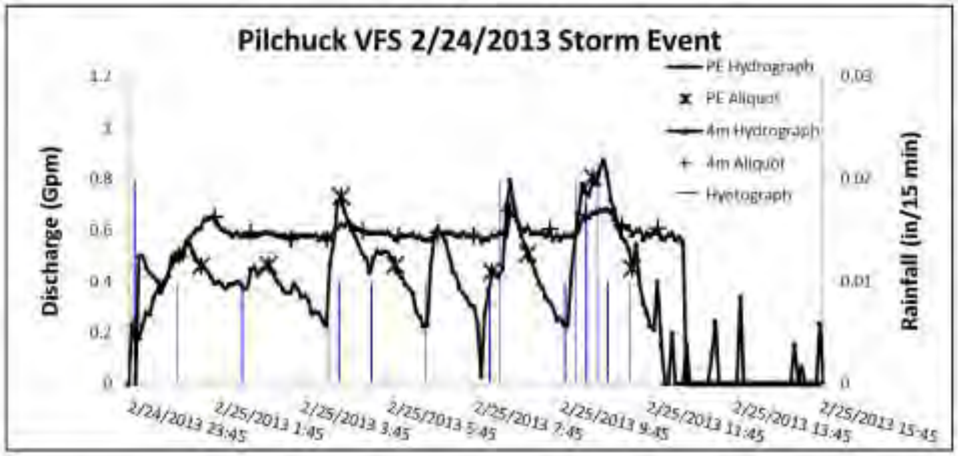


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.20	2/24/2013 23:50	2/25/2013 11:25	11.58	38	0.02	0.08

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	2/25/2013 1:25	2/25/2013 11:25	10.00	250	2,000	4.74	5.21	J
4	19	2/25/2013 0:55	2/25/2013 16:20	15.42	250	4,750	4.74	8.57	J

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	2/25/2013 0:00	2/25/2013 15:45	15.75	337.45	21.43	337.45	317.53	94.10	0.87	0.03	0.44	0.057
4	2/24/2013 23:55	2/25/2013 16:45	16.83	774.13	46.00	774.13	755.29	97.57	0.84	0.60	0.76	0.052

J=Estimate of Hydrology Information



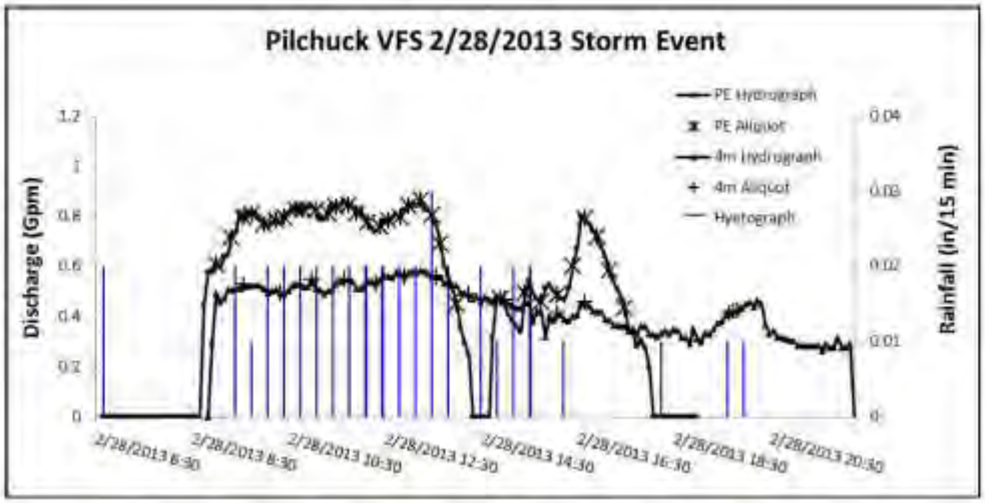
PRECIPITATION

Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.41	2/28/2013 6:40	2/28/2013 16:35	9.92	67.75	0.04	0.09

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	32	2/28/2013 9:00	2/28/2013 17:30	8.50	250	8,000	5.46	7.77	
2	9	2/28/2013 11:45	2/28/2013 13:30	1.75	250	2,250	7.01	7.71	R
4	14	2/28/2013 9:35	2/28/2013 19:50	10.25	250	3,500	5.87	8.22	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	02/28/2013 16:45	2/28/2013 18:00	9.25	347.12	37.53	347.12	338.51	97.52	0.87	0.20	0.65	0.057
2	2/28/2013 11:00	2/28/2013 22:15	11.25	55.08	4.90	55.08	43.51	78.99	0.50	0.07	0.35	0.014
4	2/28/2013 8:55	2/28/2013 22:15	13.33	348.26	26.13	348.26	301.82	86.66	0.59	0.26	0.44	0.021

Rejected because hydrology information is unreliable.



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.33	3/2/2013 14:40	3/2/2013 18:30	3.83	46.24	0.07	0.12

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	10	3/2/2013 15:05	3/2/2013 17:55	2.83	250	2,500	6.85	9.20	
2	19	3/2/2013 15:35	3/2/2013 17:05	1.50	250	4,750	7.17	8.65	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/2/2013 14:45	3/2/2013 18:20	3.58	182.60	51.00	182.60	171.92	94.16	0.98	0.20	0.83	0.079
2	3/2/2013 14:45	3/2/2013 17:10	2.42	57.09	23.59	57.09	55.87	97.87	0.63	0.18	0.50	0.025

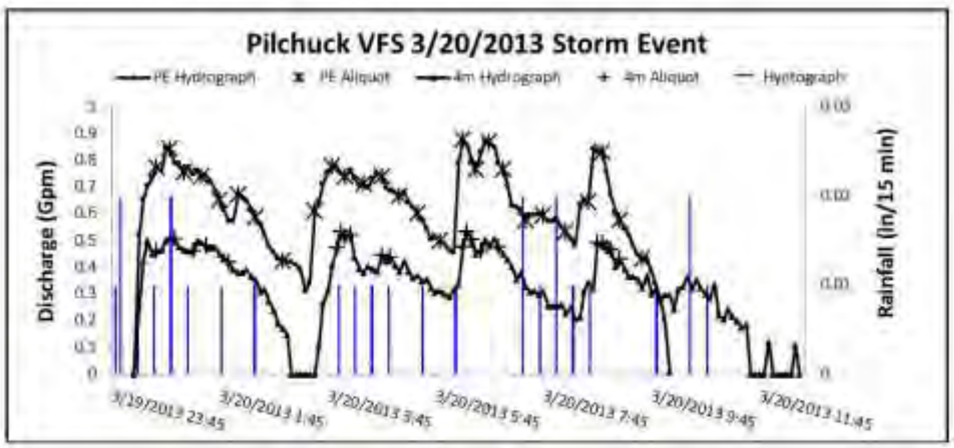
Rejected because hydrology information is unreliable.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.27	3/20/2013 0:10	3/20/2013 8:50	8.83	41.74	0.03	0.05

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	27	3/20/2013 0:35	3/20/2013 9:35	9.00	250	6,750	6.64	8.99	
2	37	3/20/2013 6:30	3/20/2013 12:30	6.00	250	9,250	7.98	11.68	R
4	21	3/20/2013 0:35	3/20/2013 9:10	8.58	250	5,250	6.64	8.72	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/20/2013 0:15	3/20/2013 10:10	9.92	373.70	37.67	373.70	363.84	97.36	0.88	0.15	0.62	0.059
2	3/20/2013 4:55	3/20/2013 14:30	9.58	368.12	38.43	368.12	256.72	69.74	1.04	0.14	0.73	0.090
4	3/20/2013 0:15	3/20/2013 12:25	12.17	238.34	19.58	238.34	195.88	82.19	0.53	0.11	0.30	0.016

Rejected because less than 75% of the hydrograph was sampled.



Pilchuck CAVS

PRECIPITATION

Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.93	10/18/2012 17:25	10/18/2012 21:50	4.42	63.25	0.19	0.35

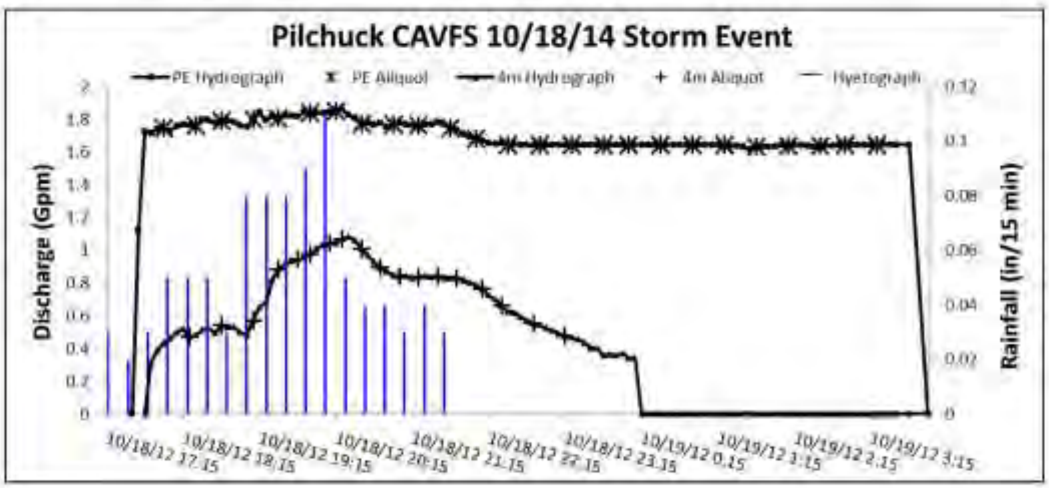
ALIQUOTS

Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	WATER TEMP Min (C°)	WATER TEMP Max (C°)	VALIDATION CODE
0	25	10/18/2012 18:00	10/19/2012 3:20	9.33	250	6,250	11.25	12.98	
4	18	10/18/2012 18:20	10/18/2012 23:15	4.92	250	4,500	11.07	11.58	J

RUNOFF / DISCHARGE

	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	10/18/2012 17:40	10/19/2012 3:45	10.08	1,025.60	101.75	1,025.60	992.71	96.79	1.85	1.11	1.70	0.119
4	10/18/2012 17:50	10/19/2012 0:15	6.42	266.92	41.58	266.92	239.50	89.73	1.21	0.32	0.68	0.099

J=Estimate of Hydrology information

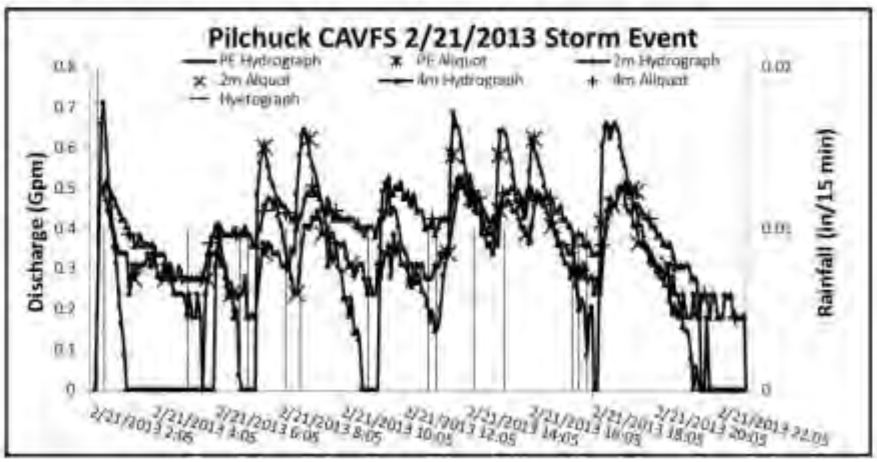


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.16	2/21/2013 2:30	2/21/2013 18:55	16.42	37.5	0.01	0.02

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	2/21/2013 7:40	2/21/2013 19:20	11.67	250	2,000	3.72	5.88	
2	19	2/21/2013 3:30	2/21/2013 20:30	17.00	250	4,750	3.32	6.01	J
4	26	2/21/2013 3:20	2/21/2013 23:40	20.33	250	6,500	3.32	6.01	J

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	2/21/2013 2:30	2/21/2013 21:30	19.00	351.43	18.50	351.43	317.09	90.23	0.71	0.04	0.39	0.035
2	2/21/2013 2:35	2/22/2013 0:30	21.92	589.05	26.87	589.05	502.35	85.28	0.59	0.32	0.45	0.021
4	2/21/2013 2:35	2/22/2013 0:30	21.92	709.22	32.36	709.22	688.06	97.02	0.63	0.41	0.54	0.025

J=Estimate of Hydrology information

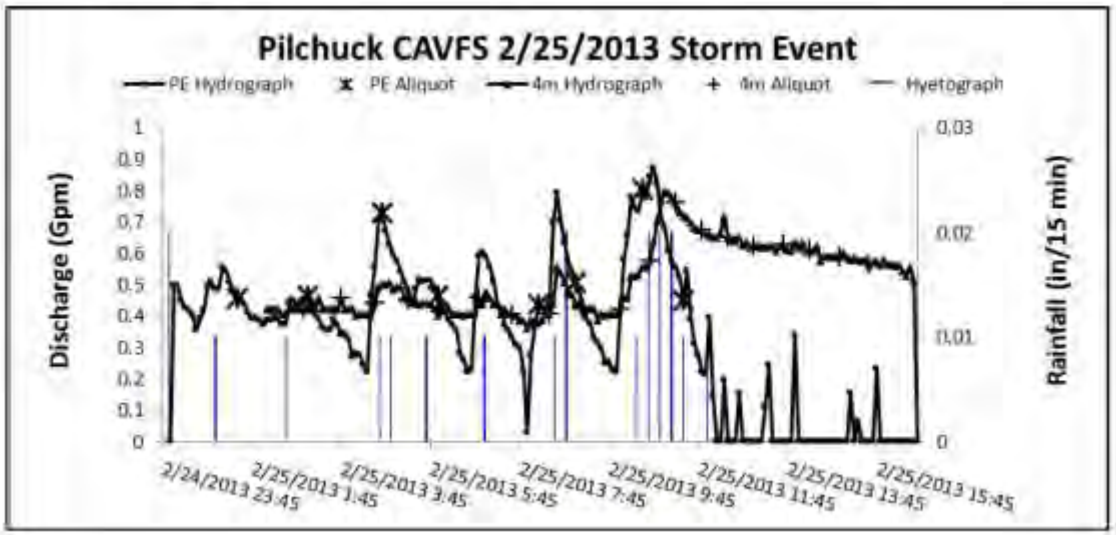


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.18	2/25/2013 2:05	2/25/2013 10:55	8.83	40.25	0.02	0.07

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	2/25/2013 1:25	2/25/2013 11:25	10.00	250	2,000	4.74	5.21	J
4	21	2/25/2013 2:55	2/25/2013 16:15	13.33	250	5,000	4.69	10.49	J

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	2/25/2013 0:00	2/25/2013 15:45	15.75	337.45	21.43	337.45	317.53	94.10	0.87	0.03	0.44	0.057
4	2/25/2013 2:10	2/25/2013 16:45	14.58	546.44	37.48	546.44	530.54	97.09	0.86	0.52	0.62	0.055

J=Estimate of Hydrology information

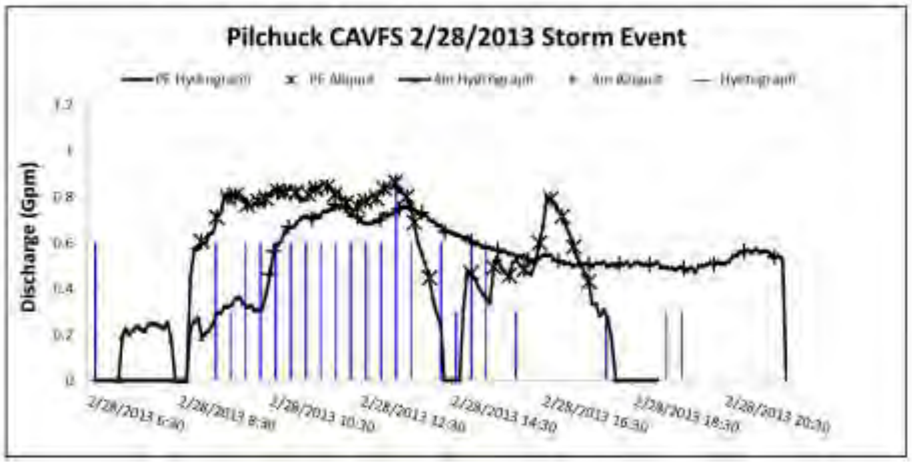


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.39	2/28/2013 7:10	2/28/2013 17:10	10.00	68.25	0.04	0.08

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	32	2/28/2013 9:00	2/28/2013 17:30	8.50	250	8,000	5.46	7.77	
2	17	2/28/2013 8:45	2/28/2013 18:25	9.67	250	4,250	5.10	7.94	R
4	21	2/28/2013 10:30	2/28/2013 21:35	11.08	250	5,250	5.83	9.45	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	02/28/2013 16:45	2/28/2013 18:00	9.25	347.12	37.53	347.12	338.51	97.52	0.87	0.20	0.65	0.057
2	2/28/2013 7:15	2/28/2013 21:45	14.50	439.48	30.31	439.48	359.99	72	0.70	0.26	0.50	0.033
4	2/28/2013 7:15	2/28/2013 21:45	14.50	451.15	31.11	451.15	445.76	98.81	0.77	0.17	0.53	0.041

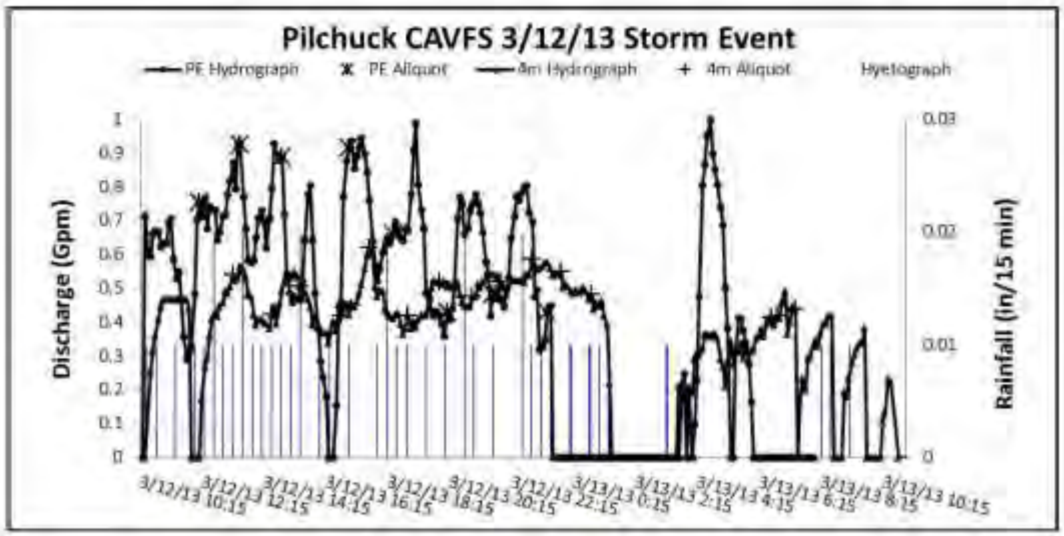
Rejected because less than 75% of the hydrograph was sampled.



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.48	3/12/2013 10:15	3/13/2013 5:05	18.83	117.24	0.02	0.05

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	3/12/2013 12:10	3/12/2013 23:25	11.25	250	2,000	9.85	10.54	
4	15	3/12/2013 11:40	3/13/2013 7:25	19.75	250	4,000	9.91	10.75	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/12/2013 10:25	3/13/2013 6:00	19.58	549.61	28.07	549.61	486.31	88.48	1.00	0.10	0.61	0.082
4	3/12/2013 10:30	3/13/2013 10:30	24.00	524.06	21.84	520.58	486.68	93.49	0.62	0.11	0.42	0.024



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.26	3/20/2013 0:15	3/20/2013 9:15	9.00	42	0.03	0.04

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	27	3/20/2013 0:35	3/20/2013 9:35	9.00	250	6,750	6.64	8.99	
4	21	3/20/2013 0:50	3/20/2013 14:25	13.58	250	7,000	6.42	14.74	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/20/2013 0:15	3/20/2013 10:10	9.92	373.70	37.67	373.70	363.84	97.36	0.88	0.15	0.62	0.059
4	3/20/2013 0:20	3/20/2013 14:45	14.42	598.85	41.53	598.85	591.80	73.8	0.88	0.46	0.70	0.059

Rejected because less than 75% of the hydrograph was sampled.

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.33	4/12/2013 14:05	4/12/2013 22:40	8.58	48.25	0.04	0.07

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	17	04/12/2013 14:25	04/12/2013 22:55	8.50	250	4,250	5.81	7.24	
4	29	4/12/2013 15:55	4/12/2013 23:40	7.75	250	9,250	5.27	6.59	R

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	04/12/2013 14:00	04/12/2013 23:20	9.33	279.63	29.97	279.63	270.04	96.57	1.00	0.14	0.62	0.081
4	4/12/2013 14:15	4/13/2013 1:10	10.92	339.99	31.13	339.99	295.58	68.3	0.76	0.09	0.54	0.041

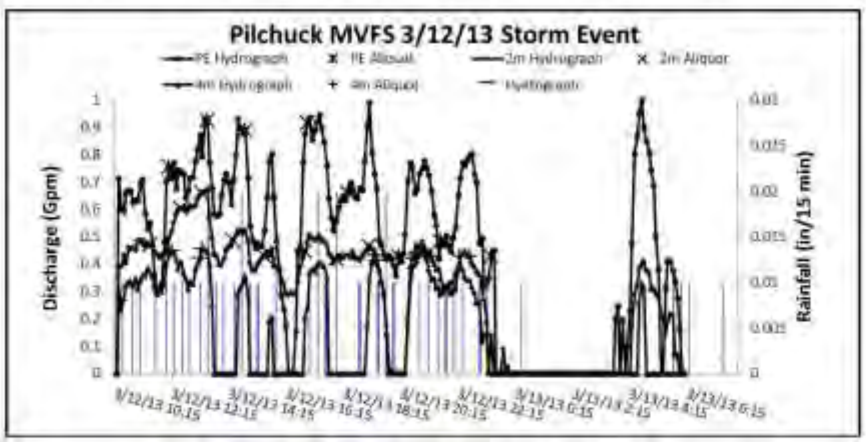
Rejected because less than 75% of the hydrograph was sampled.

Pilchuck MVFS

PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.49	3/12/2013 10:20	3/13/2013 5:45	19.42	117.49	0.02	0.05

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	8	3/12/2013 12:10	3/12/2013 23:25	11.25	250	2,000	9.85	10.54	
2	8	3/12/2013 11:30	3/12/2013 19:10	7.67	250	2,000	9.85	10.54	
4	11	3/12/2013 12:10	3/12/2013 22:40	10.50	250	2,750	9.85	10.54	

RUNOFF / DISCHARGE													
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/12/2013 10:25	3/13/2013 6:00	19.58	549.61	28.07	549.61	486.31	88.48	1.00	0.10	0.61	0.082
2	3/12/2013 10:25	3/13/2013 5:55	19.50	339.62	17.42	339.62	244.15	77.90	0.67	0.02	0.40	0.029
4	3/12/2013 10:25	3/13/2013 4:45	18.33	182.54	9.96	182.54	166.40	91.16	0.47	0.15	0.35	0.012

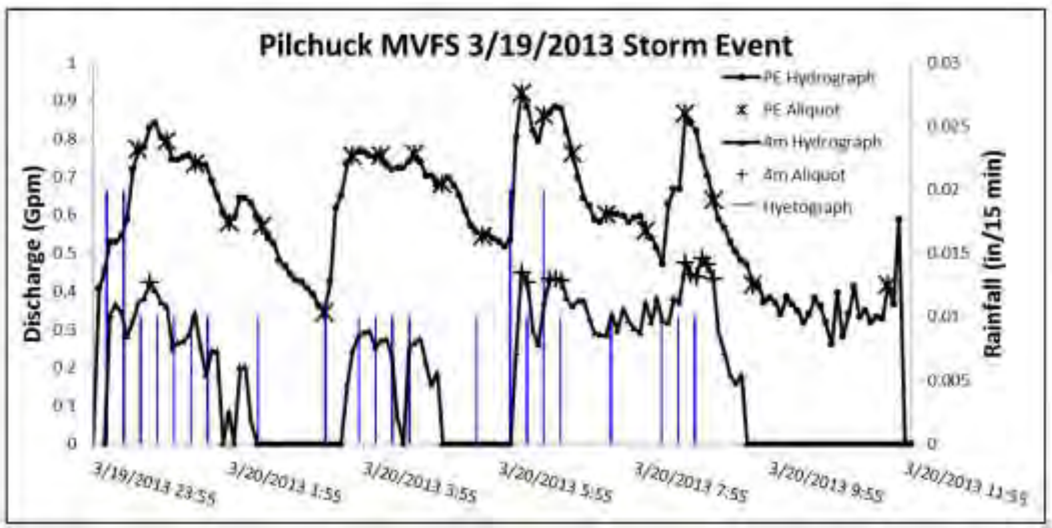


PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.26	3/19/2013 23:55	3/20/2013 8:55	9.00	41.74	0.03	0.06

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	20	3/20/2013 0:35	3/20/2013 11:40	11.08	250	5,000	6.83	14.03	J
4	12	3/20/2013 0:45	3/20/2013 9:05	8.33	250	3,000	6.83	8.87	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	3/20/2013 0:00	3/20/2013 11:50	11.83	424.08	35.85	424.08	419.32	98.88	0.92	0.26	0.59	0.066
4	3/20/2013 0:10	3/20/2013 9:30	9.33	123.42	13.23	123.42	118.19	95.76	0.49	0.06	0.30	0.013

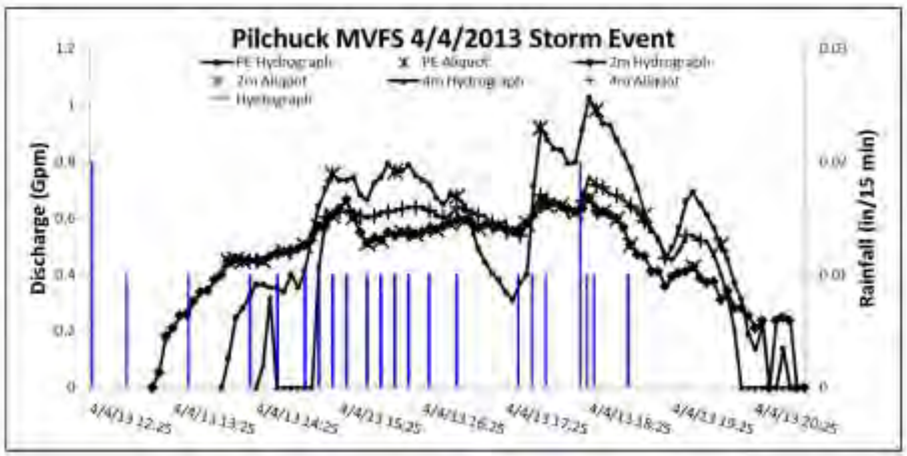
J=Estimate of Hydrology information



PRECIPITATION						
Total (in)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Antecedent (hrs)	Avg Hourly Rainfall Intensity	Max Hourly Rainfall Intensity
0.24	4/4/2013 12:25	4/4/2013 18:55	6.50	321	0.03	0.06

ALIQUOTS							WATER TEMP		VALIDATION CODE
Sample Point (m)	Aliquots Collected	First Aliquot Time (UTC)	Last Aliquot Time (UTC)	Sampling Duration (hrs)	Volume (mL)	Total Sample Volume (mL)	Min (C°)	Max (C°)	
0	7	4/4/2013 15:20	4/4/2013 20:00	4.67	250	1,750	12.25	12.65	
2	28	4/4/2013 14:05	4/4/2013 19:40	5.58	250	7,000	12.25	12.69	
4	26	4/4/2013 15:15	4/4/2013 19:45	4.50	250	6,500	12.25	12.65	

RUNOFF / DISCHARGE												
	Runoff Time			Volume			Sampled		Flow			Stage
Sample Point (m)	Start Time (UTC)	End Time (UTC)	Duration (hrs)	Total (gal)	Intensity (gal/hr)	First 24Hrs (gal)	Discharge Total Volume Sampled (gal)	% Hydrograph Sampled	Peak (gpm)	Min (gpm)	Mean (gpm)	Max (ft)
0	4/4/2013 19:50	4/4/2013 12:25	7.42	424.08	57.15	232.13	223.04	96.09	0.57	0.14	-3.84	0.088
2	4/4/2013 13:15	4/4/2013 20:50	7.58	216.36	28.54	216.36	197.50	91.28	0.67	0.05	0.48	0.029
4	4/4/2013 14:30	4/4/2013 20:10	5.67	182.04	32.11	182.04	172.43	94.72	0.74	0.08	0.58	0.038



Appendix C:
Analytical Data Quality Assessment Report

Analytical Data Quality Assessment Report

Washington State Department of Transportation
NPDES Stormwater Monitoring Program

Roadway Stormwater Treatment Evaluation: Best Management Practices

Data Collected during October 18, 2012 through July 10, 2013

Prepared for:

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September 16, 2014

Executive Summary

This Data Quality Assessment Report (DQAR) presents an overview of the analytical scheme, data verification and validation procedures, and the quality of analytical data collected during the stormwater monitoring year 2013 (October 18, 2012 through July 10, 2013) under the Washington State Department of Transportation's (WSDOT) National Pollution Discharge Elimination System (NPDES) Stormwater Monitoring Program (Program), Roadway Stormwater Treatment Evaluation for Best Management Practices (BMP). The quality of data was assessed and discussed in terms of Measurement Quality Objectives (MQOs), *i.e.*, precision, accuracy, representativeness, comparability, sensitivity, and completeness.

A total of 94 stormwater samples were collected during this monitoring year. Sample analyses were primarily performed by the Washington State Department of Ecology (Ecology) Manchester Environmental Laboratory (MEL) with specialty analyses performed by TestAmerica Laboratories, Inc. (total Kjeldahl nitrogen [TKN]) and Analytical Resources, Inc. (particle size distribution [PSD] in water).

A Stage 2b data validation was performed on 100 percent of the analytical data. Based on the on-going oversight of the laboratory performance and the outcome of the data validation, completeness of the data collection effort was calculated as 100 percent. This achieves the monitoring goal of 95%. Significant observations and results of the analytical data quality assessment are summarized as follows:

1. The sample filtration for dissolved metals and *ortho*-phosphate was to be conducted within 15 minutes of collection, according to 40CFR, Part 136. Due to field technical difficulty, most of the samples were filtered outside the 15-minute window, yet within 24 hours of collection. The delay in filtration was not expected to result in significant effects on data usability. Dissolved metals and *ortho*-phosphate results were footnoted in the Annual Report for these cases.

2. TKN results for 22 out of the 54 samples were affected by detections of the analyte in method blanks and/or initial calibration, and/or out-of-control-limit matrix spike recovery. As a result, either the reporting limits were raised or the reported values qualified as estimated for the affected results.

Table of Contents

Acronyms and Abbreviations

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
ARI	Analytical Resources, Inc. – Tukwila, Washington
ASTM	American Society of Testing and Materials
CCB	continuing calibration blank
CCV	continuing calibration verification
CLP	U.S. EPA Contract Laboratory Program
COC	chain of custody
CS1	first (lowest) initial calibration standard
DQAR	data quality assessment report
DQO	data quality objective
DVR	data validation report
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ICAL	initial calibration
ICB	initial calibration blank
ICP	Inductively coupled plasma
ICV	initial calibration verification
LCL	lower control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
mg/L	milligram per liter
MDL	method detection limit
MEL	Washington State Department of Ecology Manchester Environmental Laboratory
MQO	measurement quality objective
MS	matrix spike
MSD	matrix spike duplicate
NPDES	National Pollution Discharge Elimination System
OP	*ortho*-phosphate
PQL	practical quantitation limit

Permit	WSDOT NPDES and State Waste Discharge Permit for Municipal Stormwater
Program	NPDES Stormwater Monitoring Program
PSD	particle size distribution
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
SVOCs	semivolatile organic compounds
TAL	TestAmerica Laboratories, Inc.
TAPE	Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (Publication No. 02-10-037)
TKN	total Kjeldahl nitrogen
TP	total phosphorus
TSS	total suspended solids
WSDOT	Washington State Department of Transportation

1.0 SAMPLE COLLECTION AND ANALYTICAL PROGRAM

1.1 Field Sampling Program

Sample collection for the Washington State Department of Transportation (WSDOT) National Pollution Discharge Elimination System (NPDES) Stormwater Monitoring Program (Program) was conducted during October 18, 2012 through July 10, 2013 by WSDOT personnel, following the *Quality Assurance Project Plan* (QAPP; WSDOT 2011). A total of 94 stormwater and seven sediment samples were collected during this period of monitoring.

1.2 Laboratory Analysis Program

Sample analyses were primarily performed by the Washington State Department of Ecology (Ecology) Manchester Environmental Laboratory (MEL) for metals (total and dissolved copper and zinc), and inorganic parameters (total suspended solids, hardness, nitrate/nitrite, *ortho*-phosphate [OP], and total phosphorus [TP]). Selected specialty analyses were performed by TestAmerica Laboratories, Inc. (total Kjeldahl nitrogen [TKN]), and Analytical Resources, Inc. (particle size distribution [PSD] in water).

Sample analysis schedule is summarized in **Table 1-1**.

2.0 DATA VERIFICATION AND VALIDATION

2.1 Data Quality Objectives

Data quality objectives (DQOs) for the Program were defined to meet the WSDOT NPDES and State Waste Discharge Permit for Municipal Stormwater (Permit), which was issued by Ecology on February 4, 2009 (Permit No. WAR043000A). Specific data quality goals (i.e., measurement quality objectives [MQOs] commonly presented as precision, accuracy, representativeness, comparability, sensitivity, and completeness) are defined in the QAPP (WSDOT 2011).

2.2 Data Verification Procedures

Data verification was performed to ensure completeness of the hardcopy and electronic analytical data reported and archived. A complete cross-checking of laboratory identification numbers with field identification numbers was performed to ensure that analyses had been performed as specified by the chain of custody (COC) documentation.

Hardcopy laboratory reports were inventory checked for sample result forms, instrument run logs, instrument initial calibration and continuing calibration verifications, associated quality control (QC) analyses, and supporting documents.

2.3 Data Validation Procedures

A Stage 2b data validation was performed on 100 percent of the data. The validation followed the procedures specified in U.S. Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) National Functional Guidelines for Data Review (USEPA 2010), with modifications to accommodate program and analytical method requirements as specified in the WSDOT *Stormwater Monitoring Chemical Data Validation Guidance and Criteria, Version 1.2* (WSDOT 2013).

2.4 Data Assessment Results

As a result of the data validation, data qualifiers were appended to the affected data as:

- J - The result is an estimated quantity. The associated numerical value is approximate concentration of the analyte in the sample.
- **U** - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method reporting limit (RL).

- **UJ** - The analyte was analyzed for, but not detected. The method detection limit (MDL) and practical quantitation limit (PQL) are estimated values.

Detailed scope of the data validation, validation findings, and data qualification were presented in the data validation reports (DVRs).

3.0 DATA QUALITY AND USABILITY ASSESSMENT

Based on the outcomes of the validation, the following sections present a data quality overview for analytical data collected during the stormwater monitoring year 2013. The following sections address accuracy, precision, representativeness, comparability, sensitivity, and completeness. QC parameters applied to evaluating each of the MQOs are summarized in **Table 3-1**.

3.1 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random and systematic errors. It is quantified as the degree of agreement between a measurement with a known reference. Analytical accuracy is evaluated via the percent recovery (%R), percent difference (%D), or percent drift ($\%D_f$) values of initial and continuing calibration, internal standards, surrogate spikes, matrix spike (MS)/matrix spike duplicate (MSD), laboratory control sample (LCS)/ laboratory control sample duplicate (LCSD), in conjunction with results of method blanks, calibration blanks, and trip blanks. Results of blanks assist in identifying the type and magnitude of effects on system errors introduced via field and/or laboratory procedures.

Quality control anomalies affecting data accuracy were identified as follows:

3.1.1 Sample Preservation and Holding Times

The OP analyses were performed one to two days past the method recommended holding time for three samples. These results were qualified as estimated values, according to the data validation. Data qualified as a result of holding time and sample preservation violations are summarized in **Table 3-2**.

3.1.2 Calibration Verification

Initial and continuing calibration verification (ICV and CCV) analyses verify accuracy of the initial calibration (ICAL) and current instrument condition prior to sample analyses. The recovery of the first (lowest concentration) ICAL standard (CS1) was evaluated to verify the ICAL validity at the RL level. ICV, CCV, and CS1 results are presented as %D or $\%D_f$ values. Excessive bias of a %D or $\%D_f$ value indicates a potential bias of the analytical results associated with these verification analyses.

No data were affected as a result of anomalies related to calibration verification.

3.1.3 Blanks

Presence of target analytes in blanks indicated potential effects on results for samples prepared/analyzed with these blanks, and the accuracy of the results might have been skewed.

TKN was detected in selected method blanks and/or calibration blanks at a level less than the method RL. Sample results less than 10 times the level found in their associated blank were considered affected. TKN results for eight samples were affected. Results less than the quantitation limits were qualified as non-detects at the quantitation limits. Results greater than the RL but less than 10 times the detection in the blank were qualified as estimated at the reported values. Data qualified in this manner are summarized in **Table 3-3**.

3.1.4 Matrix Spike (MS) and MS Duplicate (MSD) Recovery

The %R values for MS and MSD analyses indicate levels of potential effects on a given analytical system resulting from the nature of a sample.

The %R values for TKN in the MS and/or MSD analyses performed on multiple program samples were outside the control limit (75-125%). TKN results for 14 samples were affected and qualified as estimated values.

The %R values for TP in the MS and/or MSD analyses performed on multiple program samples were outside the control limit (75-125%). TP results for four samples were affected and qualified as estimated values.

Sample results affected by outlying MS recovery are summarized in **Table 3-2**.

3.2 Precision

Precision is defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is evaluated via the relative percent difference (RPD) values of LCS/LCSD analyses, MS/MSD analyses, and concentrations obtained from the two analytical columns for dual column methodologies. In addition, the RPD values of field duplicate analyses represent the combined precision of sample collection and analysis procedures, as well as sample homogeneity.

No data usability was affected by outliers related to precision measures.

3.3 Representativeness

Representativeness is the level of confidence that the analytical data reflect the actual field condition. Representativeness is ensured by maintaining sample integrity during collection, preparation, and analysis. The evaluation of associated method and field blanks also assists in identifying artifacts that may skew the representativeness of the samples.

No anomalies were identified in sample preservation, handling, preparation, and analysis that affected data representativeness, except for the QC anomalies affecting accuracy (Section 3.1) and precision (Section 3.2) as discussed above. The data quality potentially resulting from these anomalies were evaluated and determined to have no significant effects on the data representativeness.

3.4 Comparability

Comparability is the confidence with which one data set can be compared to another data set. Using standard methods throughout the data generation processes ensures the comparability of data generated in separate sampling days or events.

All samples collected during monitoring year 2013 were analyzed using standardized analytical methodologies. Data generated during this monitoring event are expected to be comparable to data generated in 2012 and upcoming stormwater monitoring events within this program.

3.5 Sensitivity

Sensitivity depicts the level of ability for an analytical system (*i.e.*, sample preparation and instrumental analysis) to detect a target component in a given sample matrix with a defined level of confidence. Factors affecting the sensitivity of an analytical system include: analytical system background (*e.g.*, laboratory artifact or method blank contamination), sample matrix (*e.g.*, mass spectrometry ion ratio change, co-elution of peaks, or baseline elevation), and instrument instability.

To evaluate if the analytical sensitivity achieved the project expectation, sample-specific PQLs were compared against the RL goals set forth in the QAPPs. In addition, sample results were compared to detections of target analytes in method blanks to identify potential effects of laboratory background on sensitivity.

The blank-related effects are discussed above in Section 3.1. Sample results affected by detections in the blanks were qualified as non-detects at the standard PQLs, which sufficed the project PQL goals.

3.5.1 Sample Matrix Interference

The presence of target or non-target chemicals or subjects in samples may affect the ability of an analytical system to accurately quantitate the target analyte at the expected sensitivity.

Sandy materials were observed in sample PIL-02-V2M-A001 interfering with the Total Suspended Solids (TSS) quantitation. The TSS result for sample PIL-02-V2M-A001 was qualified as estimated, as presented in **Table 3-2**.

3.6 Completeness and Data Usability

Completeness is defined as the percentage of usable data divided by the total amount of data collected. Data qualified (R)[1] and target analytes that were not analyzed or reported by the laboratory were counted as unusable data and factored in the completeness determination.

3.6.1 Overall Data Completeness

A total of 927 data points were collected, with none of the data points rejected. Overall analytical data completeness for the WSDOT's NPDES Stormwater Monitoring Program's BMP study during monitoring year 2013 was calculated at 100 percent, achieving the project goal of 95 percent.

REFERENCES

USEPA 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technology Innovation,* U.S. Environmental Protection Agency, June 2008, EPA-540-R-08-01.

USEPA 2010. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, Office of Superfund Remediation and Technical Innovation,* U.S. Environmental Protection Agency, January 2010, USEPA 540/R-10/011.

Washington Department of Transportation (WSDOT) 2013. *Stormwater Monitoring: Chemical Data Validation Guidance and Criteria, Version 1.2.* Pyron Environmental, Inc., April 24, 2013.

WSDOT 2011. *Quality Assurance Project Plan for WSDOT Roadway Stormwater Treatment Evaluation: Best Management Practices.* Working draft, March 2011.

TABLES

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Table 1-1 Sample Analysis Schedule

Stormwater			
Parameter	Analytical Method	Number of Samples	Analytical Laboratory
Total Suspended Solids (TSS)	SM 2540D	63	Washington State Department of Ecology, Manchester Environmental Laboratory (MEL), Manchester, WA
Nitrate/Nitrite	SM 4500 NO_3 I	61	
Ortho-phosphate (OP)	SM 4500 P G	41	
Total Phosphorus (TP)	SM 4500 P F	36	
Total Metals (Cu, Zn)	EPA 200.8	42	
Dissolved Metals (Cu, Zn)	EPA 200.8	42	
Hardness	SM 2340B	67	
Particle Size Distribution (PSD)	ASTM D3977-97/TAPE	58	Analytical Resources, Inc. (ARI) – Tukwila, WA
Total Kjeldahl Nitrogen (TKN)	USEPA 351.2	54	TestAmerica Laboratories, Inc. (TAL) – Denver, CO

Notes:

1. SM – *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 20[TH] Edition, 1995
2. EPA Methods - *USEPA Methods for Chemical Analysis of Water and Wastes*, EPA–600/4-79-020, March 1983 Revision
3. ASTM – American Society of Testing and Materials
4. TAPE - Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology, 2008

Table 3-1 Quality Control Parameters Corresponding to Measurement Quality Objectives

MQOs	QC Parameters
Precision	**RPD or Concentration Difference Values of:** LCS/LCSD MS/MSD (or Laboratory Duplicate) Dual Column Confirmation
Accuracy	Holding Time **%RSD, %R, %D, or %D_f Values of:** Calibration Verification (CS1, ICV, CCV) Surrogate Spikes Internal Standards LCS and LCSD MS and MSD Interference Check Sample for Metals Analyzed with ICP Methodologies Serial Dilution for Metals Analyzed with ICP Methodologies **Results of:** Instrument and Calibration Blanks (ICB/CCB) Method (Preparation) Blanks Trip Blanks
Representativeness	Results of All Blanks Sample Integrity Holding Times
Comparability	Sample-specific PQLs Sample Collection Methodologies Sample Preparation and Analytical Methodologies
Completeness	Data Qualifiers Laboratory Deliverables and Analyte Lists Requested/Reported Valid Results Number of Rejected Results
Sensitivity	Sample-specific MDLs and PQLs

Notes:

%RSD – Percent relative standard deviation
%R – Percent recovery
%D – Percent difference
%D_f – Percent drift
%RPD – Percent relative percent difference
CCB – Continuing calibration blank
CCV – Continuing calibration verification
CS1 – First (lowest) initial calibration standard
ICB – Initial calibration blank
ICP – Inductively coupled plasma
ICV – Initial calibration verification
LCS – Laboratory control sample
LCSD – Laboratory control sample duplicate
MDL – Method detection limit
MQOs – Measurement quality objectives
MS – Matrix spike
MSD – Matrix spike duplicate
PQL – Practical quantitation limit
RPD – Relative percent difference

Table 3-2 Data Affected by Holding Time and Quality Control Criterion Violations

Field Sample ID	Lab Sample ID	Analyte	Qualifier	Reason
PIL-02-V2M-A001	1210072-05	*ortho*-Phosphate	J	Holding time
PIL-03-V4M-A001	1210072-11	*ortho*-Phosphate	J	Holding time
PIL-05-C4M-A001	1210072-06	*ortho*-Phosphate	J	Holding time
EV-03-V4M-A004	580-36358-3	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-03-V4M-A014	580-36358-4	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-03-V4M-A013	580-37288-2	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-05-C4M-A013	580-37288-3	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
EV-02-V2M-A013	580-38618-6	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
EV-02-V2M-A015	580-38618-5	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
EV-05-M2M-A016	580-38618-1	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-02-V2M-A002	580-39221-4	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-03-V4M-A002	580-39221-2	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-04-C2M-A002	580-39221-3	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-05-C4M-A002	580-39221-6	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-06-MEP-A002	580-39221-5	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-08-M4M-A002	580-39221-1	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was <LCL
PIL-07-M2M-A010	580-37935-6	Nitrogen, Total Kjeldahl	J	Matrix spike %R value was >UCL
EV-05-M2M-A013	1304068-09	Total Phosphorus	J	Matrix spike %R value was <LCL
PIL-05-C4M-A022	1304068-04	Total Phosphorus	J	Matrix spike %R value was <LCL
PIL-06-MEP-A031	1304068-11	Total Phosphorus	J	Matrix spike %R value was <LCL
EV-03-V4M-A002	1307055-07	Total Phosphorus	J	Matrix spike %R value was <LCL
PIL-02-V2M-A001	1210072-05	Total Suspended Solids	J	Matrix interference

Notes:

Holding Time – Analysis of the sample was performed past the method required holding time.
Matrix interference – Sandy material was observed in the sample that affected the accuracy of the measurement.
%R – Percent recovery
LCL – Lower control limit
UCL – Upper control limit

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Table 3-3 Data Affected by Detections in Blanks

Field Sample ID	Laboratory Sample ID	Analyte	Original Result	Qualified Result	Unit	Comment
PIL-03-V4M-A007	580-35871-3	Nitrogen, Total Kjeldahl	0.79 J	1.0 U	mg/L	MB,CB
PIL-06-MEP-A010	580-37130-2	Nitrogen, Total Kjeldahl	1.3	1.3 J	mg/L	MB,CB
PIL-05-C4M-A007	580-37270-3	Nitrogen, Total Kjeldahl	2.0	2.0 J	mg/L	MB,CB
PIL-06-MEP-A013	580-37270-4	Nitrogen, Total Kjeldahl	1.1	1.1 J	mg/L	MB,CB
PIL-06-MEP-A016	580-37288-4	Nitrogen, Total Kjeldahl	0.87 J	1.0 U	mg/L	MB
PIL-02-V2M-A010	580-37300-5	Nitrogen, Total Kjeldahl	0.94 J	1.0 U	mg/L	MB
PIL-03-V4M-A019	580-37300-4	Nitrogen, Total Kjeldahl	0.56 J	1.0 U	mg/L	MB
PIL-06-MEP-A021	580-37300-2	Nitrogen, Total Kjeldahl	1.1	1.1 J	mg/L	MB

Notes:

CB – Analyte was detected in initial and/or continuing calibration blanks and the sample result was affected.

J – The value was qualified as estimated.

MB – Analyte was detected in method blank and the sample result was affected.

mg/L – milligram per liter

U – Analyte was not detected at or above the adjusted reporting limit.

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