Quality Assurance Project Plan for Baseline Stormwater Monitoring of WSDOT Maintenance Facilities, Rest Areas, and Ferry Terminals

September 2011

Prepared by

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WSDOT = Washington State Department of Transportation

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1 Abstract

The Washington State Department of Ecology's (Ecology) Environmental Assessment Program (EAP) was contracted by the Washington State Department of Transportation's (WSDOT) Stormwater and Watersheds Program to prepare a Quality Assurance Project Plan (QAPP) for stormwater monitoring under the 2009 WSDOT National Pollutant Discharge and Elimination System (NPDES) and State Waste Discharge Permit for Municipal Stormwater (hereinafter "permit") (Ecology, 2009a).

Studies conducted or designed by Ecology on behalf of WSDOT must have an approved QAPP. A QAPP describes the objectives of the study and the procedures to be followed to ensure the quality and integrity of collected data and ensure the results are representative, accurate, and complete.

This QAPP is specifically written for monitoring activities required under S7.D of the permit, which requires WSDOT to conduct stormwater monitoring at six maintenance facilities, two rest areas, and one ferry terminal for baseline water quality data. The QAPP was created to implement a monitoring program that will meet the requirements of the permit.

2 Background

WSDOT is responsible for stormwater runoff from its facilities, properties, and managed operations, including maintenance facilities, ferry terminals, and rest areas. Stormwater generated by impervious surfaces is regulated by the U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge and Elimination System (NPDES) program. EPA delegated NPDES permit development and issuance authority to the Washington State Department of Ecology (Ecology). Ecology oversees implementation at the state level.

Three Quality Assurance Project Plans (QAPPs) were prepared by Ecology's Environmental Assessment Program (EAP) for WSDOT to meet the WSDOT NPDES and State Waste Discharge Permit for Municipal Stormwater (Ecology, 2009a). This QAPP describes a monitoring plan to conduct baseline assessment of stormwater characteristics at WSDOT facilities. The facilities assessed under this QAPP include maintenance facilities, rest areas, and a ferry terminal. Other QAPPs describe stormwater characterization monitoring from WSDOT highways and effectiveness monitoring for WSDOT stormwater best management practices (BMPs).

Stormwater monitoring will provide feedback to WSDOT for inclusion in its Stormwater Management Program and Stormwater Pollution Prevention Plans (SWPPPs). This QAPP is designed to ensure the quality and integrity of the collected samples and to describe monitoring stations, field sampling procedures, and the quality assurance and quality control (QA/QC) procedures used to support representative, accurate, and complete results. Appendix A provides a glossary of terms and acronyms used herein.

2-1 WSDOT NPDES Permit History

Stormwater discharges are regulated through the NPDES program, which was established by the federal government in Section 402 of the Clean Water Act (CWA). In the state of Washington, the EPA delegated authority to Ecology to implement all provisions of the CWA, including the NPDES program. Municipal stormwater permits are one component of the NPDES program. Phase I of the NPDES stormwater permitting program was promulgated in 1990 and applies to all municipalities with populations greater than 100,000. Phase I permittees in Washington were required to conduct monitoring under their NPDES permits. In 1999 federal Phase II stormwater requirements were published, which later led to expanding coverage to smaller urbanized areas.

In 1995 Ecology issued an NPDES municipal separate stormwater permit that requires WSDOT to prepare and implement a stormwater program to treat highway runoff before it is released into receiving water bodies. The following water quality management areas in Washington State were designated as Phase I areas and covered by the 1995 permit: Cedar/Green, Island/Snohomish, and South Puget Sound. In those permits, WSDOT was identified as a co-permittee with other Phase I jurisdictions (King, Pierce, and Snohomish Counties, and the cities of Seattle and Tacoma). In 1999, Ecology issued a Phase I stormwater permit covering Clark County. Those permits were originally scheduled to expire on July 5, 2000. However, Ecology granted the permittees, including WSDOT, an administrative extension until the permits were updated and reissued.

In January 2007 Ecology reissued the Phase I municipal stormwater permit, with the Port of Seattle and Port of Tacoma identified as Phase I secondary permittees. Concurrently, Ecology issued the Phase II municipal stormwater permits. The Phase II permits apply to more than 100 cities statewide and parts of 13 counties, covering areas that generally have a population density of more than 1,000 people per square mile.

WSDOT's permit coverage continued under the original 1995 permit, until it was issued its own municipal stormwater permit (number WAR043000A) on February 4, 2009. WSDOT's current permit covers discharges from municipal separate storm sewer systems (MS4s) owned or operated by the department. MS4s are conveyances or a system of conveyances, which include roads with drainage systems, municipal streets, curbs, gutters, catch basins, ditches, constructed channels, and storm drains. Discharges covered in the WSDOT permit include stormwater runoff from state highways, rest areas, park and ride lots, ferry terminals, and maintenance facilities. The geographic area of coverage includes Phase I and Phase II permitted areas, as shown in Figure 1.

The permit was most recently modified on May 5, 2010, in response to a settlement agreement with Puget Soundkeeper Alliance, an environmental advocacy organization. WSDOT's permit is effective through March 6, 2014.

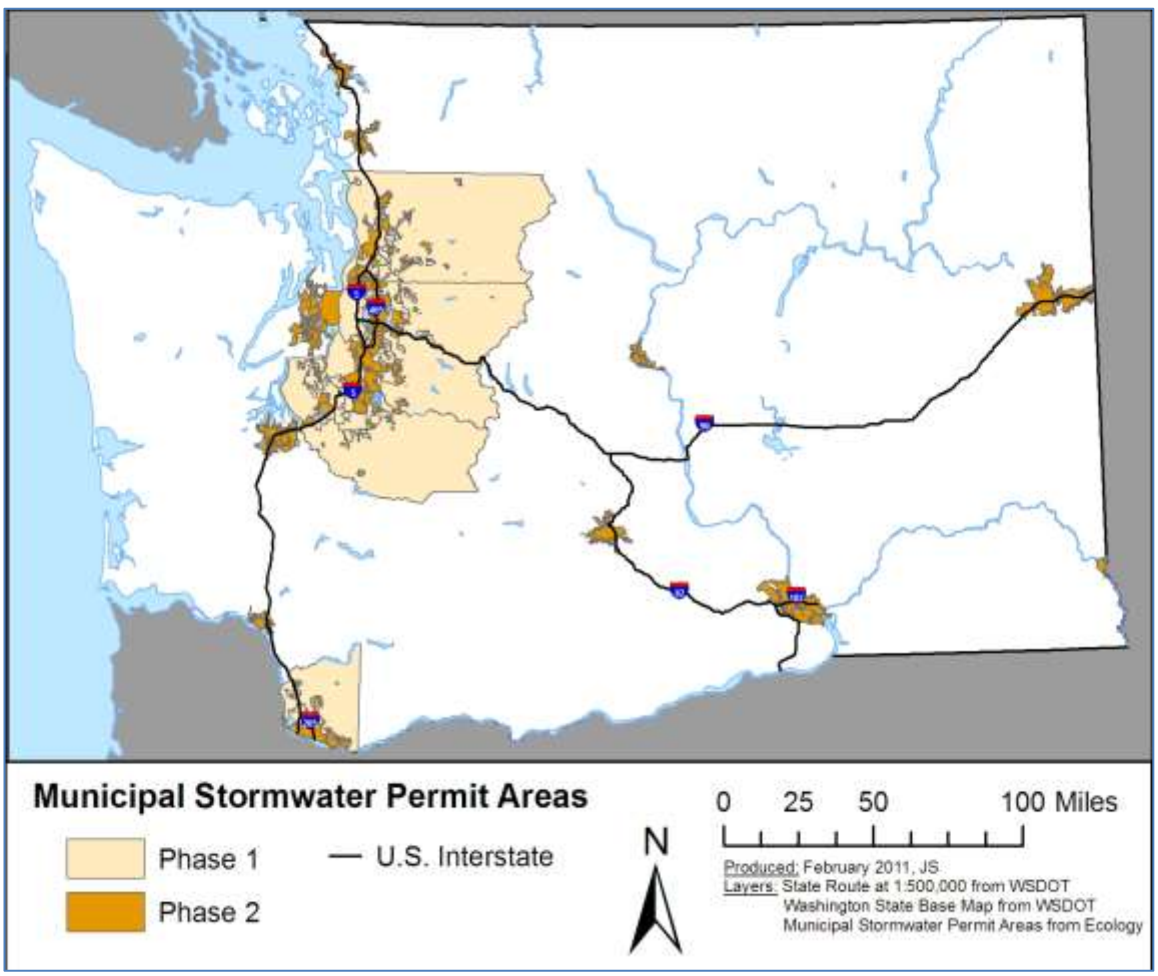

Figure 1 WSDOT municipal stormwater permit area.

2-1.1 *Permit Monitoring Requirements*

S7 of the permit (see Appendix B) requires WSDOT to develop and implement a stormwater monitoring program. The permit identifies three WSDOT land uses, each with specific monitoring requirements:

- Highways: Baseline stormwater and sediment characterization monitoring (S7.B) and seasonal first flush toxicity testing (S7.C).
- Maintenance facilities, rest areas, and ferry terminals: Baseline stormwater characterization (S7.D).
- Best management practices (BMPs): Stormwater treatment and hydrologic management evaluation monitoring (S7.E) and seasonal first flush toxicity testing (S7.C).

A separate QAPP was submitted to Ecology's Water Quality Program for each land use to meet the S7 monitoring requirements in the permit. Each QAPP addresses the specific monitoring requirements for the land use designated in the permit. This QAPP addresses the requirements in S7.D of the permit related to maintenance facilities, rest areas, and ferry terminals. It also describes how monitoring will be conducted to gather stormwater data from facilities. Sampling will include collecting year-round stormwater with hand grabs and composite autosampling.

This QAPP describes the process to:

- Target storm events
- Monitor rainfall
- Collect samples
- Evaluate results to ensure quality data
- Locate sampling points
- Set up monitoring stations
- Verify and summarize data

2-2 Previous Facility Monitoring Studies

Previous studies of stormwater characteristics for WSDOT maintenance facilities, ferry terminals, and rest areas are lacking. Monitoring required at facilities under the 2009 permit will provide valuable information to the agency.

Several site features and functions common to WSDOT's facilities may contribute to stormwater pollution. These features and functions include:

- Vehicle and equipment cleaning, parking, fueling, and repair
- Storage of sand, salt, herbicides, fertilizers, building materials, signs, and guardrails
- Transfer of stored materials to vehicles

Impervious surfaces at maintenance facilities, rest areas, and ferry terminals have very few barriers to the transport of runoff, such as grass or soil, and do not facilitate infiltration. Therefore, they have a higher potential to generate more stormwater runoff and pollutant loads than other types of land use (Rushton, 2001). These impervious surfaces provide a place for traffic-generated residues and airborne pollutants to accumulate and run off during storm events.

Throughout the United States, heavy metals (namely chromium, copper, lead, nickel, and zinc), oil and grease, nutrients, and solvents have been associated with runoff from vehicle service or maintenance activities. In addition, eroded soils, the primary source of suspended particulates in stormwater, may be a site-specific concern at some maintenance yards (Caltrans, 2003).

Rest areas are well-used short-term parking areas for passenger cars, recreational vehicles, and commercial vehicles. Oil and grease from vehicles, fecal coliform bacteria from pets and sewage holding tanks, and soils from the landscape may be sources of pollutants in stormwater at rest areas.

Ferries are used by thousands of commuters on a daily basis in Washington. Parking lots and holding lanes associated with ferry terminals are essentially short-term parking areas that may be associated with vehicle-related pollutants.

California Studies

The California Department of Transportation (Caltrans) conducted a three-year stormwater study that included maintenance facilities, park and ride lots, and rest areas. The Caltrans Statewide Stormwater Runoff Characterization Study (2000–2003) monitored over 50 locations across the state (Caltrans, 2003). Interestingly, pollutant concentrations in stormwater at park and ride lots, rest areas, and maintenance facilities were similar to each other. The Caltrans study did not monitor ferry terminals; however, park and ride lots may provide a similar point of reference.

Table 1 lists a few select parameters from the Caltrans monitoring efforts for park and ride lots, rest areas, and maintenance facilities (Caltrans, 2003). The table includes parameters required for sampling under the WSDOT permit. Although the number of commuters, daily use, and climatic variables between California and Washington are considerably different, these data are valuable in designing a WSDOT stormwater monitoring program. California's population is larger and its climate is generally drier and warmer than western Washington, which probably allows more pollutants to build up over longer intervals between rain events. Therefore, the data in Table 1 should be considered the higher end of anticipated concentrations.

Total suspended solids (TSS), all metals, and nutrient concentrations varied from year to year, which illustrates the high variability of stormwater. It is unknown whether Caltrans has collected runoff information or formulated BMPs for each land use since the 2003 study. Without runoff information, it is difficult to compare relative pollutant contributions.

Table 1 Summary of Caltrans facility stormwater runoff monitoring and whole storm event mean concentration data for 2000–2003 (Appendix A – Caltrans, 2003).

Parameter	Data	Maintenance Facility			Rest Areas			Park and Ride Lots[1]		
		2000	2001	2002	2000	2001	2002	2000	2001	2002
pH	n	82	32	30	22	17	14	92	60	53
	Mean	7.0	6.8	6.49	6.9	6.8	6.78	6.9	6.7	6.66
	SD	0.6	0.4	0.77	0.5	0.5	0.23	0.6	0.6	0.71
TSS (mg/L)	n	81	32	30	22	17	14	92	60	53
	Mean	110.3	73.7	63.03	58.9	68.4	63.89	64.6	52.8	76.58
	SD	95.8	91.1	43.97	58.0	50.7	62.31	63.9	41.9	60.29
Hardness (mg/L)	n	81	32	30	22	17	14	92	60	53
	Mean	28.3	26.5	20.62	18.3	35.3	53.43	33.2	18.2	18.32
	SD	20.5	44.9	16.06	8.4	56.4	172.43	60.7	17.3	21.55
Nitrate as N (mg/L)	n	82	32	30	22	17	14	92	60	53
	Mean	0.76	0.56	0.72	0.89	0.93	1.09	0.7	0.6	0.28
	SD	0.99	1.09	1.77	0.87	0.93	1.02	1.0	0.9	0.26
TKN (mg/L)	n	81	32	29	22	17	14	92	60	50
	Mean	1.97	1.76	1.01	2.51	8.62	2.12	2.6	2.4	1.43
	SD	1.69	2.40	0.86	1.82	24.38	1.59	2.1	2.5	1.29
Phos., Total (mg/L)	n	81	32	30	22	17	14	92	60	53
	Mean	0.29	0.20	0.14	0.40	0.55	0.46	0.4	0.3	0.23
	SD	0.29	0.15	0.17	0.36	0.69	0.70	0.6	0.2	0.21
As, Dissolved (ug/L)	n	81	32	30	22	17	14	92	60	53
	Mean	12.72	1.95	1.68	1.35	1.24	1.93	0.70	0.67	IDD
	SD	18.86	1.82	1.10	1.71	1.10	7.42	0.71	0.53	IDD
As, Total (ug/L)	n	82	32	30	22	17	14	92	60	53
	Mean	17.02	2.65	2.07	1.79	1.69	8.73	1.20	0.94	1.88
	SD	25.11	2.04	1.31	2.08	1.63	21.24	1.18	0.89	11.61
Cd, Dissolved (ug/L)	n	81	32	30	22	17	14	92	60	53
	Mean	0.33	0.21	0.21	IDD	IDD	IDD	0.13	0.15	IDD
	SD	0.36	0.14	0.16	IDD	IDD	IDD	0.30	0.17	IDD
Cd, Total (ug/L)	n	82	32	30	22	17	14	92	60	53
	Mean	0.86	0.47	0.47	0.30	0.44	0.24	0.34	0.26	0.30
	SD	0.75	0.46	0.46	0.57	0.78	0.08	0.47	0.22	0.40
Cu, Dissolved (ug/L)	n	81	32	30	22	17	14	92	60	53
	Mean	18.2	9.1	6.59	7.5	14.2	7.43	8.5	10.3	6.32
	SD	21.3	8.8	6.38	5.1	20.4	2.48	7.1	12.0	5.81
Cu, Total (ug/L)	n	82	32	30	22	17	14	92	60	53
	Mean	38.0	16.3	13.52	12.5	22.5	13.64	16.8	16	15.33
	SD	45.0	13.9	11.05	9.9	22.0	4.15	16.7	14.1	12.59
Pb, Dissolved (ug/L)	n	81	32	30	22	17	14	92	60	53
	Mean	3.4	1.0	1.34	0.9	2.0	1.05	1.3	1.2	1.52
	SD	7.4	1.1	2.60	0.6	2.6	0.84	1.7	1.5	4.42
Pb, Total (ug/L)	n	82	32	30	22	17	14	92	60	53
	Mean	34.1	13.3	12.96	6.0	11.2	6.09	9.1	7.6	12.39
	SD	48.6	11.1	21.09	7.4	10.4	3.69	9.6	10.4	14.21
Zn, Dissolved (ug/L)	n	81	32	30	22	17	14	92	60	53
	Mean	143.0	65.8	72.31	49.2	153.8	48.00	77.4	86.8	42.70
	SD	121.5	40.5	55.40	37.3	465.0	33.81	95.8	125.8	47.94
Zn, Total (ug/L)	n	82	32	30	22	17	14	92	60	53
	Mean	307.6	131.0	134.58	96.9	232.1	105.14	165.4	141.2	130.53
	SD	297.2	82.6	100.82	86.5	526.1	63.15	177.2	143.8	123.47

[1] Park and ride data were included to serve as a point of reference for ferry terminals.

n = Number of samples
SD = Standard deviation
IDD = Indicates insufficient detected data

3 Project Description

3-1 Project Goals

The goal of this QAPP is to describe a monitoring program intended to collect high-quality data that characterizes baseline stormwater runoff quality from WSDOT facilities in accordance with requirements in S7.D of the permit. Specifically, this QAPP addresses early stormwater runoff quality characterization at WSDOT-operated maintenance facilities, rest areas, and ferry terminals. The purpose of this monitoring is as follows:

1. Produce scientifically credible data that represent discharges from WSDOT's maintenance facility, ferry terminal, and rest area land uses.
2. Provide information that can be used by WSDOT for designing and implementing effective stormwater management strategies for WSDOT facilities.

WSDOT references the *Highway Runoff Manual* (HRM) and utilizes Stormwater Pollution Prevention Plans (SWPPPs) at maintenance facilities and rest areas to implement stormwater treatment technologies and evaluate stormwater management practices. SWPPPs for ferry terminals are currently being developed.

Because little information exists on pollutants in stormwater runoff from WSDOT facilities, information gathered as part of this permit monitoring effort will be used to inform the HRM and SWPPPs.

3-2 Section S7.D Permit Monitoring Requirements

The primary objective of the stormwater characterization monitoring required under S7.D is to gather monitoring data from WSDOT's nonhighway facilities (maintenance facilities, rest areas, and ferry terminals). The data requirements in accordance with S7.D are summarized in Table 2.

Table 2 Stormwater sampling data requirements (Ecology, 2009a).

Type	Description
Number of Sites	S7.D of the permit requires WSDOT to collect baseline water quality data at: • Two high-use rest areas • Six maintenance facilities (one in each region) • One high-use ferry terminal
Location	Rest areas and ferry terminals along highly traveled routes were selected. One maintenance facility must be located in each WSDOT region: six total.
Sampling Method	Most parameters will be collected using automatic composite samplers to collect time-weighted samples that consist of a minimum of five individual stormwater grab samples, equally spaced in time and collected within the first hour of runoff. Additionally, fecal coliform and TPH will be collected by hand grab sample methods.
Sample Timing and Frequency	WSDOT will conduct sampling as early in the runoff event as feasible, but not later than 20 minutes after the onset of runoff. WSDOT will collect samples from a minimum of seven storm events throughout the calendar year. WSDOT will sample: (1) At least five qualifying storm events during the wet season. Wet season samples will be collected over a time frame exceeding 28 consecutive days. (2) At least one qualifying storm event during the dry season. (3) A seasonal first flush event no earlier than August 1 annually. The seasonal first flush sample must have a one-week antecedent dry period.
Wet Season Storm Event Criteria (western Washington October 1–April 30; eastern Washington October 1–June 30)	The wet season will meet the following conditions: (1) Rainfall depth: 0.20-inch minimum, no fixed maximum (2) Rainfall duration: No fixed minimum or maximum (3) Antecedent dry period: Less than 0.02-inch rain or no surface runoff in the previous 24 hours (4) Inter-event dry period: 6 hours
Dry Season Storm Event Criteria (western Washington May 1–September 30; eastern Washington July 1–September 30)	The dry season will meet the following conditions: (1) Rainfall depth: 0.20-inch minimum, no fixed maximum (2) Rainfall duration: No fixed minimum or maximum (3) Antecedent dry period: Less than 0.02-inch rain in the previous 72 hours (4) Inter-event dry period: 6 hours
Parameters	Permit-specified parameters vary for each facility type: maintenance facility, ferry terminal, and rest area. These parameters are shown by facility type in Table 9.

3-3 Data Collection

According to the permit, monitoring implementation begins on September 6, 2011. However, the permit only requires the 2012 Annual Stormwater Monitoring Report to cover monitored events that occur after October 1, 2011. During the three-week interim period, the following will apply:

1. Sampling for dry season storms from September 6 to September 30 will not be conducted because the entire dry season will not be captured.
2. Because only one seasonal first flush storm event is required after August 1, this sample will still be attempted and reported regardless of whether the sampling occurs before or after October 1, 2011.
3. Missed storms will be documented.

The facilities monitoring program will continue through the three-year permit cycle. Information to meet the permit objectives includes:

- Identification of facility pollutant-generating activity areas and drainage area maps of the selected characterization locations.
- Continuous annual records of rainfall data.
- Concentrations of contaminants in samples collected.

To accomplish monitoring at all field sites, a data collection platform (DCP) consisting of composite autosamplers, a data logger, and associated equipment will be installed at each monitoring site. Automated samplers provide a mechanism to start collecting samples within the first 20 minutes of runoff (as required in the permit) without field staff present.

Autosamplers will be programmed to begin time-weighted composite sampling once enough runoff has accumulated to enable sample collection during a storm event. Time-weighted compositing is defined by S7.D.3 of the permit as five equally spaced stormwater aliquots within the first hour of runoff.

Grab samples will be collected by hand directly into sample jars during the first 20 minutes of a qualifying runoff event for total petroleum hydrocarbons (TPH) and fecal coliform. If it is not possible to collect a manual grab sample during the same storm event as a composite sample, a grab sample will be collected from a separate qualifying event.

Rainfall data will be collected continuously to characterize the antecedent dry period, total rainfall distribution, inter-event dry period, and rainfall intensity during the sampled storm events.

Data loggers at each site will record measurement data from the autosampler and all other associated monitoring equipment, such as the rain gage, liquid level actuator, and temperature meter. Data from the logger will be manually downloaded as well as telemetered to WSDOT. Telemetered data will be restricted to the information most valuable for timing the deployment of the sampling teams. Manual download by field staff will retrieve a more detailed data set and fill in data gaps. More sampling and data collection information is presented in Section 7, Sampling Process Design.

3-3.1 Target Population and Sampling Frequency

For stormwater monitoring under this permit, target stormwater populations are characterized by the following:

- Continuous rainfall monitoring through all sampled storm events
- Composite sampling for chemical analysis
- Grab sampling for chemical analysis
- Wet and dry season storm criteria

Seven qualifying storm event samples are required each year. The seven sampling events will be distributed throughout the year as follows: five wet season storms, one dry season storm, and one seasonal first flush sample.

3-4 Practical Constraints for Monitoring

Practical constraints for a successful permit monitoring program include:

- Study boundaries.
- Geographic limitations and climactic challenges.
- Study design requirements.
- Physical challenges of the study design.
- Logistical challenges regarding weather forecasting, verification of storm quality, and synchronization of sampling equipment.

WSDOT will put forth good faith efforts to collect and meet permit requirements. The phrase, "good faith efforts" is used in the permits for other Phase I permittees. It is believed to apply to WSDOT as well, although it may have been inadvertently deleted. The following text is from the Phase I: Municipal Stormwater NPDES and State Waste Discharge General Permit in S8.D.2.a of the permit (Ecology, 2007a):

> *Each stormwater monitoring site shall be sampled according to the following frequency unless good faith efforts with good professional practice by the Permittee do not result in collecting a successful sample for the full number of storms.*

3-4.1 Study Boundaries

The study area boundaries include WSDOT-owned maintenance facilities, rest areas, and ferry terminals. Several limiting factors for site selection were encountered while screening potential sites. Most of these limiting factors related to study boundaries and facility usage requirements.

Sites with shared ownership or commingled stormwater were not considered for permit monitoring. For example, more than one rest area was found to be nonrepresentative due to co-ownership with the Washington State Patrol. These sites commingle the stormwater runoff from rest areas and weigh stations, making it difficult to differentiate between source contributions. Another constraint for monitoring involved finding one ferry terminal and two rest areas that were not only high use but also were present within the permit coverage area. In addition, these sites required existing stormwater control systems that could be readily retrofitted with monitoring equipment.

3-4.2 Geographic Limitations and Climatic Challenges

During the winter, western Washington storms are typically long in duration (multiple days) and frequent. In eastern Washington, storms are shorter in duration and less frequent, and conditions are drier. Therefore, a reduced number of qualifying storm events is expected in eastern Washington. Additionally, precipitation east of the Cascades is more likely to be snow. The combination of fewer storms and more snow at eastern Washington monitoring sites may influence the number of successful sampling events. Another challenge is the ambiguity of forecasting rain, particularly in western Washington.

A challenge specific to eastern Washington is that several facilities partition their drainage areas to multiple discharge points in order to reduce the size of their drainage areas. These smaller drainage areas, while acting to control flashier runoff patterns and reduce flood potential, are anticipated to produce lower runoff volumes. This may pose a potential challenge for sampling at some sites east of the Cascades.

3-4.3 Study Design Requirements

Site selection requirements of the permit created several difficulties in finding representative facilities. Finding representative rest areas and ferry terminals within the permit boundaries and a maintenance facility in each WSDOT region was a challenge. A major factor for site selection was determining the suitability of a particular facility for routine monitoring. For instance, at several locations, the complexity of the drainage system precluded collecting samples that represented all site activities.

3-4.4 Physical Challenges of the Study Design

Baseline monitoring of stormwater from each facility presents some physical design limitations. In some cases, the drainage areas selected for sampling at the facilities are relatively small; therefore, runoff may not provide enough volume for sample collection. Other challenges include choosing sites for monitoring that are representative of typical WSDOT activities for that region, while ensuring the monitoring does not impede regular facility operations.

To overcome physical and climatic challenges, technology will be used to minimize unsuccessful sampling trips. Automatic samplers, a rain gage, a temperature probe, and telemetry equipment will be installed at each site. Rainfall data will be collected continuously to characterize the antecedent dry period, total rainfall distribution, inter-event dry period, and rainfall intensity during sampled storm events. Since the runoff from a small paved area can be flashy in nature, autosamplers will be set to sample as early as the first runoff.

Maintenance facilities and rest areas are not staffed 24 hours a day. Because storms may start at odd hours, this may limit the availability of WSDOT staff assistance. For this reason, automatic equipment will be used to start sampling within the first 20 minutes of a qualified event and to collect samples in the autosampler for the first hour of runoff. WSDOT staff will collect grab samples, perform necessary sample preservation, and ship samples to the laboratory.

If region WSDOT staff are unavailable, stormwater monitoring field teams will be used to collect samples. Permission and keys will be required to gain access to the facilities after hours.

3-4.5 Logistical Challenges

Some of the logistical challenges associated with this project include: monitoring small, flashy drainage areas; complexity and variability of stormwater discharge; requirements to sample within the first hour of runoff; the large geographic scale of the monitoring site locations; and holding times.

Geographic and Climatic Logistical Challenges

Logistical complications are anticipated to reduce sampling success. Four of the six maintenance facilities, both rest areas, and the ferry terminal are located at least 90 miles or more from where the WSDOT sampling team will be based in Tumwater. Samples could be missed due to the amount of driving time necessary to reach the facilities, even if the field sampling teams stay in hotels near the sites. In particular, travel times may limit successful grab sample collection. The geographic scope of the monitoring locations requires advanced warning of qualifying storm events to allow travel time; however, the variability of Washington's precipitation patterns increases the difficulty of predicting storms.

Successful sampling and monitoring will require a well-developed, automated field data collection system and supporting monitoring team. WSDOT will train staff and maintain a field crew that will likely deploy to the field location or a local hotel when a promising forecast occurs during the work week. Telemetered data reporting and automated sample collection will be utilized to accomplish the monitoring goals by improving the successful rate of storm event sampling. Nonetheless, travel times and storm dynamics will likely be major factors contributing to missing some of the holding times for fecal coliform, as well as filtration of dissolved metals and orthophosphate.

Automatic samplers will be programmed to collect composite samples for water quality monitoring as soon as the sampling thresholds programmed in the logger are met.

Grab samples may be missed due to the flashy nature of storms and the potential for limited availability of representative runoff. Timing of the sampling will be difficult because the samples must be collected by hand, and they require staff to be on-site within the first hour of runoff. WSDOT staff nearby or located at the facilities will be encouraged to participate in grab sampling efforts.

In several cases, grab samples will be collected within a catch basin. A pole sampler is believed to be sufficient for grab sample collection.

Laboratory Logistical Challenges

Several of the sample parameters have short holding times that will require laboratories to process samples possibly within 8 hours of sample collection. Many laboratories, including Ecology's Manchester Environmental Laboratory (MEL), do not maintain 24-hour and 7-day-a-week staffing levels. Some labs have limited working hours on weekends. As a result, the days and times of the sampling program may be limited to the following proposed schedule:

- Sample during weekdays until noon on Fridays.
- Do not sample on Saturdays or on Sunday mornings.
- Sampling late (after 3 pm) Sundays is a possibility.

Programmed Equipment Errors Logistical Challenges

The potential for human programming errors is a possibility when operating any monitoring equipment. While some testing will be conducted prior to sampling, there will likely be a continuous need to monitor and adjust programming to meet permit requirements given site conditions. Care must be taken to follow standard operating procedures (SOPs) in an effort to minimize errors. Field staff will be prompted to notify the Field Lead or check the National Oceanic and Atmospheric Administration (NOAA) Emergency Data Distribution Network website to verify station transmissions after any alterations to programming.

A loss of power to any of these stations may inhibit monitoring by turning the data logger and automatic sampler off. To avoid power loss, field staff will visit each station on at least a six-week rotational maintenance schedule, or more frequently for storm event sampling. During scheduled maintenance trips, batteries and solar panels will be maintained according to standard operating procedures.

Environmental/Remote Location Logistical Challenges

Damage from storm events (such as washouts or flooding) or the immediate environment (such as trees falling or traffic accidents) may present limitations for stormwater monitoring. Site equipment design and implementation will identify, remove, or prevent equipment damage or safety hazards. By utilizing telemetry, WSDOT will be able to identify malfunctions, errors, and damaged equipment from the hourly transmissions at each monitoring station. Field staff will be dispatched as soon as feasible to repair or replace damaged equipment.

4 Organization and Schedule

The following section describes the roles and responsibilities of the key team participants, including internal members of WSDOT's Stormwater and Watersheds Program and external participants. The organizational structure was designed to provide project control and proper quality assurance and quality control (QA/QC) for the field investigations.

4-1 Organization

The roles of key individuals involved in the study are provided in Table 3. A detailed description of the lines of authority and reporting between those individuals and organizations is presented. WSDOT staff may delegate their responsibilities to other staff when they are not present or are busy with other tasks. This allows adaptive management of monitoring program responsibilities and may be necessary to meet permit requirements. If responsibilities are delegated, staff will be responsible for ensuring their responsibilities are carried out properly in their absence.

4-1.1 Training

Field personnel will receive training in proper sampling and field analysis for each standard operating procedure they will be using. They will demonstrate to the Field Lead their ability to properly operate the automatic samplers and retrieve the samples. The Field Lead will sign off on each field staff member.

A field audit will be performed at least annually to verify proper methods and techniques. In addition, a follow-up meeting at the end of the water year will be organized to discuss methods and procedures. Stormwater monitoring crews will receive training for working in wet, cold, and poor-visibility conditions. Monitoring personnel and workers installing or maintaining equipment may be exposed to traffic hazards, confined spaces, and slippery conditions. Workers and staff who install or maintain the equipment may need confined space entry training.

Monitoring crews will be trained on the traffic control plan for sites that expose them to traffic hazards. A traffic safety plan and safety guidelines for use while conducting monitoring or maintenance activities at the field sites are presented in Appendix D. These traffic controls were adapted from WSDOT's *Work Zone Traffic Control Guidelines* (WSDOT, 2009b). The safety plans specify personal protective gear and include a Pre-Activity Safety Plan for Stormwater Field Work form to be filled out on each site visit.

Table 3 Organization of project staff and responsibilities.

Name	Roles	Responsibilities
WSDOT Stormwater and Watersheds Program Staff		
Fred Bergdolt	NPDES Stormwater Monitoring Project Manager	Manages overall WSDOT compliance activities; verifies whether or not the QAPP is followed and the project is producing data of known and acceptable quality; ensures adequate field training and supervision of all monitoring staff; complies with corrective action requirements.
Sarah Burdick	Quality Assurance Officer	Develops a quality management system for stormwater monitoring; oversees all operations, identifying whether QA/QC goals are met; validates and aids in verifying data collected; assists with the monitoring reports to Ecology.
Janice Sloan	Data Steward	Acquires data from telemetered systems and contract laboratories; verifies and transfers data collected into databases; manages laboratory contracts; analyzes and interprets data; assists with reports to Ecology.
Zackary Holt	Field Lead	Manages and oversees stormwater monitoring activities, sampling decisions, and equipment maintenance; manages internal and external field teams. Served as co-author during QAPP development and site design.
Brad Archbold	Logistics Lead	Coordinates with laboratories and field staff to ensure sampling equipment and bottles are tracked and distributed; cleans, calibrates, and organizes monitoring equipment.
Field Crew x 2	Field Sampling	Assist in collecting and processing of field composite and grab samples.
WSDOT staff	Field Sampling/ Project Reporting	WSDOT region staff assist in collecting and processing field composite and grab samples. WSDOT HQ staff assist with storm forecasting activities and in writing the draft and final reports.
ECOLOGY Staff		
Foroozan Labib, Water Quality Program	Permit Coordinator	Reviews and approves QAPPs and project deliverables from WSDOT to Ecology for NPDES Municipal Stormwater Permit implementation.
Julie Lowe, Water Quality Program	Permit Monitoring Coordinator	Reviewed monitoring elements and provided advice/comments for QAPP development during the period of Feb. 2009 to June 2011.
Brandi Lubliner, Toxic Studies Unit, EAP	Project Manager (WSDOT Contractor)	Lead author for QAPP development and site design; assisted in site setup; coordinated technical lead duties and analytical contracts during the period of Aug. 2009 to April 2011.

EAP = Environmental Assessment Program, within Ecology

QAPP = Quality Assurance Project Plan

4-2 Schedule

Listed in Table 4 are key deadlines for WSDOT under the permit. This schedule reflects the extension in time due to the exceedance of the 90-day review time frame by Ecology's Water Quality Program's (WQP).

Table 4 Key Deadlines for QAPPs and reports.

Due	Description
September 6, 2010	Draft QAPPs due from WSDOT to Ecology's WQP (submitted September 2, 2010).
October 31, 2010	SWMP Progress Report and First Stormwater Monitoring Report on status of preparations to meet S7.A through S7.E.
December 1, 2010	Ecology WQP reviews the QAPP within 90 days and responds with comments to WSDOT. Since Ecology's WQP did not meet the 90-day review period, the QAPP approval deadline is extended by the equivalent number of days (7 days) per permit condition S7.G.
March 13, 2011	The deadline for Ecology approval of the revised QAPP. Deadline was extended from March 6 to March 13, 2011.
September 6, 2011	Final QAPPs due to Ecology WQP program with all revisions complete.
September 6, 2011	Full implementation of the monitoring program begins.
October 1, 2011	Collection of monitoring data for reporting begins.
October 31, 2011	Second Stormwater Monitoring Report on status of preparations to meet S7.A through S7.E.
October 31, 2012	Third Stormwater Monitoring Report on status of preparations to meet S7.A through S7.E.
October 31, 2013	Fourth Stormwater Monitoring Report will be prepared and submitted with the Annual SWMP Progress Report, covering data collected from October 1, 2011 – September 30, 2012, as described in S8.F. This will be the first time a detailed monitoring report will be submitted with the annual report.
February 6, 2014	A Final Water Quality Monitoring Report for each program outlined in S7 is due to Ecology's WQP.

5 Quality Objectives

A primary purpose of this QAPP is to ensure data collected for the WSDOT stormwater permit are scientifically and legally defensible and meet the requirements of WSDOT's permit. This section discusses the chemical quality assurance (QA) topics for stormwater.

5-1 Data Quality Objectives (DQOs)

DQOs are qualitative and quantitative statements developed using the data quality objectives process. This process clarifies study objectives and defines the appropriate type(s) of data and tolerable levels of potential error. The DQOs for WSDOT's stormwater monitoring projects are as follows:

1. The data will be generated according to set criteria and procedures for field sampling, sample handling and processing, laboratory analysis, and recordkeeping.
2. The data will be representative of the monitoring site and be of a known precision, bias, and accuracy.
3. Data reporting and analytical sensitivity will be clearly established and adequate for stormwater management program decisions and endpoints.

Once established, DQOs become the basis for measurement quality objectives. MQOs are discussed for data under each heading in this section.

5-2 Measurement Quality Objectives (MQOs)

MQOs are the acceptance thresholds for data, based on the data quality indicators, and are used specifically to address instrument and analytical performance.

Quality control (QC) is often confused with quality assurance (QA). QC refers to data collection, management, and analysis. It is a set of standard operating procedures for the field and laboratory that are used to evaluate and control the accuracy of measurement data. (See Section 10 for more information.) QA is a decision-making process, based on all available information, that determines whether the data are usable for all intended purposes (Ecology, 2004).

The QA decision-making process relies upon measurable values, such as MQOs that specify how good the data must be in order to meet the objectives of the study. MQOs established for WSDOT stormwater permit monitoring are based on guidance from multiple sources, which include EPA, Ecology, laboratory experience, and best professional judgment. The hierarchy of guidelines to be followed, in descending order, is:

1. Permit (Ecology, 2009a)
2. 40 CFR 136
3. Guidance documents referred to in the permit

4. Other guidance documents from:
    - Ecology, such as standard operating procedures, and
    - EPA, such as *Methods and Functional Guidelines* (USEPA, 2008 and 2010), and 2002 EPA guidance on Environmental Data Verification and Data Validation (USEPA, 2002a)
5. Best professional judgment

MQOs are the performance or acceptance thresholds or goals for the study's data, based primarily on the data quality indicators (DQIs). DQI performance measures are expressed in terms of:

- Sensitivity
- Bias
- Representativeness
- Precision
- Accuracy
- Completeness
- Comparability

Measurements to address these DQIs are provided in Table 5, which represents how the data will be verified by contracted laboratories for WSDOT to assess sensitivity, accuracy, precision, and comparability. Failure to meet the MQOs may result in data being qualified or rejected. Further descriptions are discussed in the following sections.

Refer to Section 9, Measurement Procedures, for a thorough discussion of laboratory-specific MQOs.

Table 5 Measurement quality objectives for chemical analysis of stormwater (Ecology, 2009a and 2011; USEPA, 2010 and 2008).

Parameter	Lowest Concentration of Interest (Reporting Limit)	Lab Duplicate[1] (RPD)	Matrix Spike[2] (% Rec*)	Matrix Spike Duplicate[1] (RPD)	Control Standard (LCS)/ Surrogate Standard[5] (% Rec*)
MQO	**Sensitivity**	**Bias and Precision**	**Bias and Accuracy**	**Bias and Precision**	**Bias and Accuracy**
Conventionals					
TSS	1 mg/L	≤20%	n/a	n/a	80–120
Chloride	0.2 mg/L	≤20%	75–125	≤20%	90–110
Hardness as $CaCO_3$[4]	1 mg/L	≤20%	75–125	≤20%	70–130
Temperature	0.1°C	n/a	n/a	n/a	n/a
Bacteria					
Fecal coliform	2 min, 2 x 10^6 max/100 mL	≤20%	n/a	n/a	n/a
Nutrients					
Total phosphorus (TP)	0.01 mg/L	≤20%	75–125	≤20%	80–120
Orthophosphate (OP)	0.01 mg/L	≤20%	75–125	≤20%	80–120
Total Kjeldahl Nitrogen (TKN)	0.5 mg/L	≤20%	90–110	n/a	90–110
Nitrate-nitrite	0.01 mg/L	≤20%	75–125	≤20%	80–120
Metals					
Total Recoverable (Cu, Pb, Cd, Zn)[4]	(0.1, 0.1, 0.2, 5.0) µg/L	≤20%	75–125	≤20%	70–130
Dissolved (Cu, Pb, Cd, Zn)[4]	(0.1, 0.1, 0.1, 1) µg/L	≤20%	75–125	≤20%	70–130
Organics					
PAH Compounds:					
acenaphthene	0.1 µg/L	≤40%	55–97	≤40%	40–112
acenaphthylene	0.1 µg/L	≤40%	48–103	≤40%	10–126
anthracene	0.1 µg/L	≤40%	51–113	≤40%	24–127
benzo[a]anthracene	0.1 µg/L	≤40%	59–137	≤40%	38–147
benzo[b]fluoranthene	0.1 µg/L	≤40%	53–99	≤40%	42–116
benzo[k]fluoranthene	0.1 µg/L	≤40%	33–122	≤40%	38–131
benzo[ghi]perylene	0.1 µg/L	≤40%	38–110	≤40%	12–122
benzo[a]pyrene	0.1 µg/L	≤40%	42–110	≤40%	14–129
chrysene	0.1 µg/L	≤40%	51–116	≤40%	37–128
dibenzo[a,h]anthracene	0.1 µg/L	≤40%	27–129	≤40%	10–134
fluoranthene	0.1 µg/L	≤40%	60–107	≤40%	42–123
fluorene	0.1 µg/L	≤40%	50–134	≤40%	50–134
indeno[1,2,3-cd]pyrene	0.1 µg/L	≤40%	37–135	≤40%	29–129
naphthalene	0.1 µg/L	≤40%	41–97	≤40%	41–105
phenanthrene	0.1 µg/L	≤40%	18–105	≤40%	18–105
pyrene	0.1 µg/L	≤40%	61–118	≤40%	43–131
PAH Surrogates:					
Terphenyl-D_{14}	n/a	n/a	n/a	n/a	34–148
2-Fluorobiphenyl	n/a	n/a	n/a	n/a	28–136
Acenaphthylene-D_8	n/a	n/a	n/a	n/a	50–150
Fluorene-D_{10}	n/a	n/a	n/a	n/a	50–150
Anthracene-D_{10}	n/a	n/a	n/a	n/a	50–150
Pyrene-D_{10}	n/a	n/a	n/a	n/a	48–143
Benzo(a)pyrene-D_{12}	n/a	n/a	n/a	n/a	50–150
Phthalates:					
bis(2-Ethylhexyl)phthalate	1.0 µg/L	≤40%	61–131	≤40%	80–128
Butyl benzyl phthalate	1.0 µg/L	≤40%	80–150	≤40%	23–183

Table 5 (continued) Measurement quality objectives for chemical analysis of stormwater (Ecology, 2009 and 2011; USEPA, 2010 and 2008).

Parameter	Lowest Concentration of Interest (Reporting Limit)	Lab Duplicate[1] (RPD)	Matrix Spike[2] (% Rec*)	Matrix Spike Duplicate[1] (RPD)	Control Standard (LCS)/ Surrogate Standard[5] (% Rec*)
MQO	**Sensitivity**	**Bias and Precision**	**Bias and Accuracy**	**Bias and Precision**	**Bias and Accuracy**
Di-n-butyl phthalate	1.0 µg/L	≤40%	73–148	≤40%	70–156
Diethyl phthalate	1.0 µg/L	≤40%	79–117	≤40%	77–123
Dimethyl phthalate	1.0 µg/L	≤40%	73–126	≤40%	74–122
Di-n-octyl phthalate	1.0 µg/L	≤40%	61–148	≤40%	75–135
Phthalate Surrogates:					
Dimethylphthalate-D_6	n/a	n/a	n/a	n/a	50-150
Herbicides:[3]					
Dichlobenil	0.033 µg/L	≤40%	50–150	≤40%	50–140
Diuron	0.05 µg/L	≤40%	50–150	≤40%	50–140
2, 4-D	0.0625 µg/L	≤40%	20–150	≤40%	25–140
Clopyralid	0.0625 µg/L	≤40%	20–150	≤40%	21–140
Picloram	0.0625 µg/L	≤40%	10–100	≤40%	10–100
Triclopyr	0.0625 µg/L	≤40%	50–150	≤40%	50–140
Glyphosate	25 µg/L[7]	≤40%	50–150	≤40%	50–140
Herbicide Surrogates:					
2,4,6-Tribromophenol	n/a	n/a	n/a	n/a	33–99
2,4-Dichlorophenylacetic acid	n/a	n/a	n/a	n/a	37–91
1,3-Dimethyl-2-nitrobenzene	n/a	n/a	n/a	n/a	41–135
TPH:					
TPH-Diesel (NWTPH-Dx)	0.25-0.5 mg/L[6]	≤40%	70–130	≤40%	70–130
TPH-Gas (NWTPH-Gx)	0.25 mg/L	≤40%	70–130	≤40%	70–130
TPH Surrogates:					
Pentacosane	n/a	n/a	n/a	n/a	50–150
1,4-Difluorobenzne	n/a	n/a	n/a	n/a	70–130
Benzene, 1,4-dibromo-2-methyl-	n/a	n/a	n/a	n/a	70–130
Surfactants:					
Methylene blue active substances (MBAS)	0.025 mg/L	Meet all performance criteria in lab method relative to sample replication and reference toxicant.			

[1] The relative percent difference must be less than or equal to the indicated percentage for values that are greater than 5 times the reporting limit. Relative percent difference (RPD) must be ± 2 times the reporting limit for values that are less than or equal to 5 times the reporting limit.

[2] For inorganics, the *Contract Laboratory Program Functional Guidelines* states that the spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of four or more (USEPA, 2010).

[3] Limited to the herbicides as listed in the permit and used within the drainage area by WSDOT. This list may increase or decrease based on usage records from WSDOT. This list will be updated annually.

[4] Method Quality Objectives (matrix spike & LCS values) are based on *Contract Laboratory Program Functional Guidelines* for inorganic data review (USEPA, 2010) and organic data review (USEPA, 2008). All other values were obtained from Manchester Environmental Laboratory performance criteria (Ecology, 2011).

[5] For PAHs and phthalates, both deuterated and nondeuterated monitoring compounds are the surrogate standards.

[6] The reporting limit depends on the hydrocarbons detected. The lighter the hydrocarbons, the lower the limit; therefore, a range is used for the acceptable reporting limit.

[7] Results for glyphosate analysis between the RL of 25 ug/L and MDL of 2.5 ug/L will be reported. These results will be qualified as estimates.

* Recovery

5-2.1 Sensitivity

Sensitivity is the measure of the concentration at which an analytical method can positively identify and report analytical results. The sensitivity of a method is commonly called the "detection limit." In fact, there are multiple and different limits in analytical analysis and reporting:

- Instrument detection limit (IDL)
- Method detection limit (MDL)
- Practical quantitation limit = reporting limit (RL)

The "reporting limit" expressed in the permit refers to the practical quantification limit established by the laboratory, not the method detection limit.

Ecology specified the reporting limits and analytical methods in the permit's Appendix 5, and they are restated in Table 5. MQOs that were not stated in the permit's Appendix 5 were gathered from other sources, such as the Manchester Environmental Laboratory's *Lab Users Manual,* 9th Edition (MEL, 2008), and the EPA's published guidelines for the Contract Laboratory Protocols (CLP) for inorganic and organic data (USEPA, 2010 and 2008).

5-2.2 Bias and Blanks

Bias represents systematic error and can be used to describe a tendency or preference in one direction. Bias in water quality samples will be assessed based on the analyses of method blanks, field blanks, transport blanks, matrix spikes, and laboratory control samples (LCS).

Field Sample Bias and Blanks

Field or transport blank results greater than the reporting limit (RL) will be flagged as blank contamination (*B*). The associated project samples collected with that blank sample will be scrutinized by the Quality Assurance Officer upon receipt of the laboratory report. Depending on the type of blank collected (trip, travel, or equipment), the Field Lead should be notified as soon as possible to re-run the blank and reclean the equipment that may have contaminated the field blank. Typically, associated project samples within five times the blank concentration will be flagged as an estimate (*J*).

Laboratory Bias and Blanks

The following sections describe the differences between method blanks and matrix spikes, both of which are used to identify potential biases affecting results.

Blanks

Laboratory method blanks should not exceed the reporting limit. If this occurs, the associated blank concentration is defined as the new reporting limit. Sample concentrations within five times de facto reporting limit will be flagged by the laboratory as *B,* associated project data reviewed and qualified as *U* or *J*, per Table 16, and the WSDOT Data Steward will be alerted to the contamination. Common laboratory contaminants within ten times the de facto reporting limit will be flagged as *B*, per CLP guidance. WSDOT will determine how many samples are affected and if corrective actions are necessary.

Matrix spikes

The targeted range for percent recovery of matrix spikes and matrix spike duplicates (ms/msd) varies according to the parameter (see Table 5). Percent recovery for matrix spikes will be calculated using Equation 1 (Ecology, 2004).

Equation 1: Percent Recovery for MS/MSD

$$\%R = \frac{(X_S - X_O)}{C_S} \times 100\%$$

Where:

$\%R$ = percent recovery
X_s = spike sample result
X_o = original sample amount
C_s = concentration of spike

Laboratory Control Sample

The laboratory control sample (LCS) serves as a monitor of the overall performance of each step during the analysis, including the sample preparation (USEPA, 2010). The goals for percent recovery of LCS vary for each parameter. Percent recovery for LCS will be calculated using Equation 2 (USEPA, 2010).

Equation 2: Percent Recovery for LCS

$$\%\mathrm{R} = \frac{M}{T} \times 100\%$$

Where:

%R = percent recovery
M = measured value
T = true value

5-2.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data represent characteristic environmental conditions or, more specifically, site conditions. Representativeness of the hydrologic data will be ensured by proper site selection and proper selection and installation of all associated monitoring equipment. Rainfall patterns, stormwater conveyance features, and surrounding land uses were elements considered in the identification of monitoring locations and sampling frequencies. Rainfall and temperature monitoring will be conducted over a sufficient length of time (three years) to ensure data are collected during representative climatic conditions for the region.

Representativeness of the water quality data from WSDOT facilities will be ensured by targeting the sampling criteria set forth in S7.D.4 of the permit, which is listed in Table 2. It is understood that these data will systematically not include very low-volume storms or the long, intermittent storms typical of the northwest. Runoff data for facilities monitoring will only characterize water quality within the first hour of runoff from targeted storm events.

Representativeness of the samples can also be evaluated by analysis of field replicates. Field variability found using composite techniques may be different from the field variability found between replicate grab samples. Any sample data may be deemed “nonrepresentative” and rejected by the Quality Assurance Officer or Data Steward if any of these criteria are not met.

5-2.4 Precision

Precision is the measure of nearness of repeated measurements to the same value over time. Precision of samples and data collected will be evaluated using field and laboratory replicate sample analyses. Poor precision of field replicates may be due to heterogeneity of the stormwater, which has been a fairly common problem in stormwater characterization studies. Field replicates may be evaluated at the targeted relative percent difference (RPD) or relative standard deviation (RSD) listed in Table 5. Other reasons for poor precision may include contamination, problems with sampling, or poor sensitivity of the analytical methods. Bias and blanks will assist with determining a reason for poor precision.

Analytical precision is measured using laboratory duplicate (split) samples for inorganic analyses and matrix spike/matrix spike duplicate (ms/msd) samples for organic analyses. Poor laboratory precision may indicate:

- Poor sample homogenization
- High sample heterogeneity
- Matrix interferences
- Poor sample handling in the laboratory
- Contamination of laboratory chemicals or equipment
- Poor sensitivity of the analytical methods

Laboratory duplicates are generally performed by splitting one sample into two and performing the analysis separately on each split. The ms/msd are prepared by adding a known concentration of a compound to the sample and determining the concentration of that spike in the sample matrix. The matrix spike and matrix spike duplicate are compared to provide an estimate of the precision of the laboratory method.

Often in stormwater samples, the poor recovery of the ms/msd data will help quantify the interference that may be a part of the original (native) sample.

Precision of a duplicate pair is calculated as the relative percent difference (RPD), which is usually expressed as a percentage (shown in Equation 3) (Ecology, 2004).

Equation 3: Relative Percent Difference

$$\text{RPD} = \frac{|C_1 - C_2|}{\bar{x}} \times 100\%$$

Where:

RPD = relative percent difference
C_1 = concentration of original sample
C_2 = concentration of duplicate
$\bar{x}$ = mean of samples

Precision of more than three sample replicates is calculated as the relative standard deviation, which is expressed as a percentage (shown in Equation 4) (Ecology, 2004).

Equation 4: Relative Standard Deviation

$$\mathrm{RSD} = \frac{S}{\bar{x}} \times 100\%$$

Where:

RSD = percent relative standard deviation
S = standard deviation
$\bar{x}$ = mean of samples

5-2.5 Accuracy

Accuracy is the measure of agreement between a measurement's result and the true or known value. Analytical accuracy can be found by analyzing known reference materials or known standards (LCS, ms/msd, and/or surrogates). A common metric is the percent recovery of a spike. Factors that influence analytical accuracy include laboratory calibration procedures, sample preparation (field and laboratory) procedures, and laboratory equipment or deionized water contamination.

Accuracy is calculated as the percent recovery, which is usually expressed as a percentage (see Equation 1).

5-2.6 Completeness

Completeness is the percentage of measurements judged to be valid over the total number of measurements compared to the amount of data deemed necessary to meet monitoring objectives. Completeness goals in terms of number of storm events sampled are set to the number of storm events required by the permit. Completeness of data gathered will be maximized in the field by telemetry, composite autosamplers, refrigerated samplers, packaging samples for transport to avoid breakage, and timely sample processing.

Laboratories can improve completeness by processing samples within their holding times. Completeness for telemetered data is anticipated to be high; however, the grab sample data completeness is expected to be much lower. For data analysis, valid sample data may include all unflagged data and *J* flagged data reviewed by the Data Steward.

5-2.7 Comparability

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Standard sampling procedures, analytical methods, units of measurement, standard reporting rules, and reporting limits will be applied to meet the goal of data comparability. Comparability is limited by other MQOs because data sets can be compared with confidence only when precision and accuracy are known.

6 Site Descriptions

This section addresses the experimental design, monitoring methodologies, site descriptions, and site development for data collection. In addition, this section describes the locations of the facilities and the monitoring sites at each facility. Detailed figures showing the drainage areas, sampling points, and equipment installations are available in Appendices D and E.

Approximately fifteen maintenance facilities, six ferry terminals, and six rest areas were evaluated as potential monitoring locations. At some of the locations, selecting an appropriate monitoring site was relatively straightforward. In other cases, monitoring locations were identified by minimizing complicating factors. For example, an evaluation of stormwater drainage areas was typically the first step in identifying suitable locations for monitoring.

At most facilities, the largest drainage area was the preferred and most appropriate location. However, in many cases, multiple discharge points and the orientation of activities at some facilities made monitoring from the largest drainage areas not representative of activities. In those situations, sampling from smaller drainage areas with runoff that was isolated and representative of typical activities became the alternative strategy.

Six representative maintenance facilities, one in each WSDOT region statewide, as well as two rest areas and one ferry terminal selected for monitoring, are listed in Table 6 and shown in Figure 2.

Table 6 Selected maintenance facilities, rest areas, and ferry terminals.

WSDOT Region	Facility Name	Facility Location
Maintenance Facilities		
Northwest	Ballinger	City of Shoreline
Olympic	Lakeview	City of Lakewood
South Central	Clarkston	City of Clarkston
Southwest	Vancouver	City of Vancouver
North Central	Euclid	City of Wenatchee
Eastern	Geiger	City of Spokane
Rest Areas		
Northwest	Smokey Point Northbound	North of Marysville
Northwest	Smokey Point Southbound	North of Marysville
Ferry Terminal		
Olympic	Bainbridge Island Terminal	Winslow, Bainbridge Island

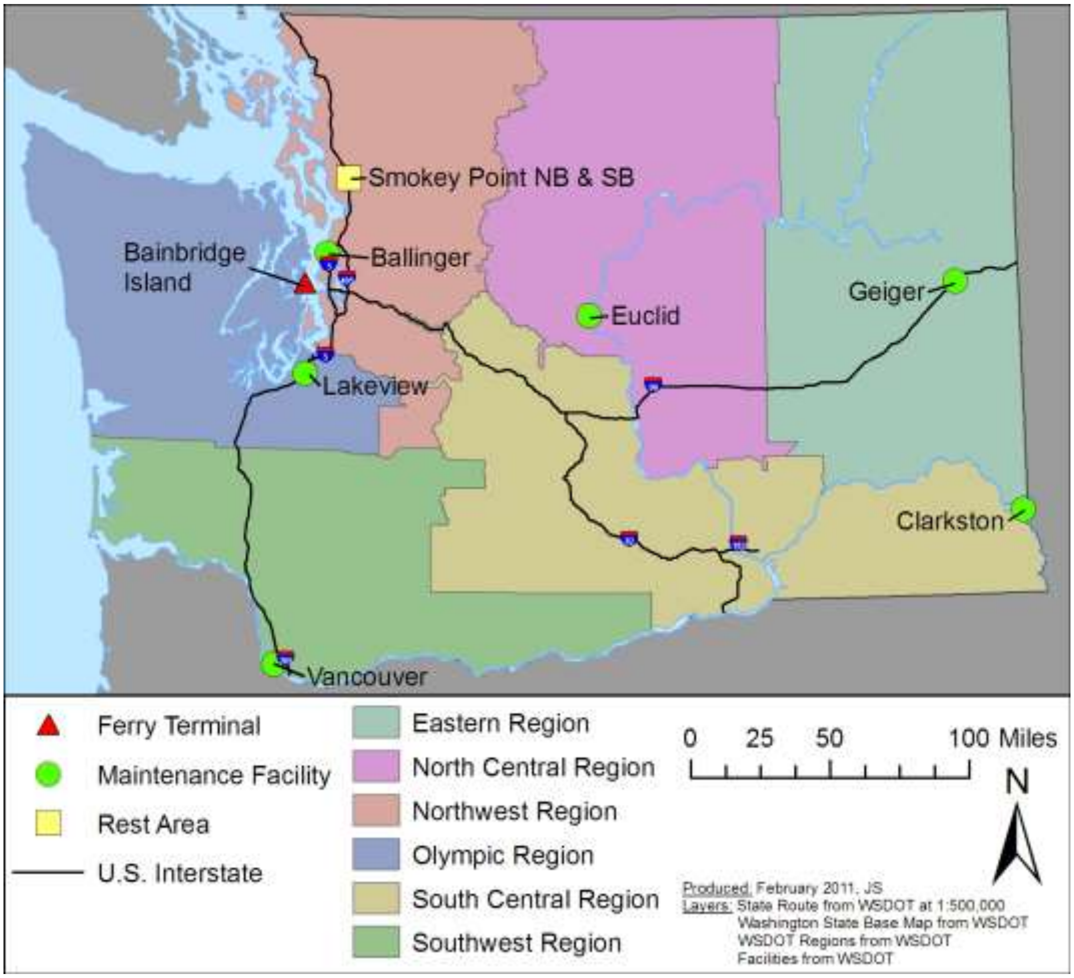

Figure 2 WSDOT regions and selected facilities for stormwater monitoring.

6-1 Maintenance Facilities

According to the permit, water quality data must be collected from six maintenance facilities, one in each WSDOT region. For each facility, monitoring locations should be established to capture runoff from most of the site and down-gradient from potential pollutant-generating activities.

The site-selection process for maintenance facilities includes an assessment of activities at each site and the following key selection criteria:

- Permit coverage area
- Adequate drainage area
- Representativeness
- Site topography
- Hydraulic characteristics
- No off-site runoff
- Easy access for sampling
- Adequate space for monitoring equipment
- Sampling will not affect normal maintenance activities

6-1.1 Site Descriptions

In this section, brief physical descriptions of the selected facilities are provided. Site visits were made to each maintenance facility, rest area, and ferry terminal to document the layout, stormwater drainage areas, catchment basins, and possible pollutant-source activities.

During the site visit, the most representative and suitable locations for stormwater characterization were identified. The activities and structures identified at facilities that may generate polluted stormwater varied from location to location, but in general there was a fairly consistent representation among the sites. Table 7 lists the identified maintenance facility activities that occur within the drainage area of the selected monitoring site. These identified activities may be considered pollutant-generating sources if they are poorly managed or are exposed to rainfall or stormwater runoff.

Activities at ferry terminals and rest areas are not listed in Table 7. Maps of the drainage areas at each facility can be found in Appendix D.

Table 7 Maintenance facility sampling location and activities matrix.

Region	Facility	Activities														
		Galvanized Metals	Treated Lumber	Prewash Pad	Sand	Salt	Deicer	Sweepings	Landscaping	Truck Parking	Storage Buildings	Maintenance Buildings	Transportation Equipment Fund Shop	Offices	Fuel Island	Herbicide/Fertilizer[2]
Northwest	Ballinger			x[1]	x	x		x	x	x		x	x	x	x	x[1]
Olympic	Lakeview	x	x	x[1]			x		x	x	x	x	x	x		x[1]
South Central	Clarkston			x			x					x		x	x[1]	
Southwest	Vancouver								x	x	x	x	x	x	x	x[1]
North Central	Euclid	x				x				x	x		x			x[1]
Eastern	Geiger		x	x[1]	x					x	x	x	x	x	x	x[1]

[1] Possible vehicle track-out of contaminants only. It is possible to collect some, but not all, of the runoff from this activity.

[2] Herbicides and nutrients (those listed in S7.B.4) are stored, used, or in trucks parked within the drainage area of the monitoring station.

Ballinger (Northwest Region)

The Ballinger Maintenance Facility is located at 1621 North 205th Street in Shoreline. Residential areas border the facility to the south and east, and a shopping center is located to the west. Ballinger is a small facility with a consolidated stormwater control system that collects stormwater runoff from most of the facility. Runoff discharges to a two-stage detention pond treatment system.

Monitoring will be conducted before stormwater discharges to the pond. Figure D-1 shows the catch basin and the outline of the approximately 0.79 acres that drain to the stormwater ponds. Discharge to the stormwater ponds is currently impacted with sediments, resulting in a slight backup of water into the catch basin. This pipe run and the catch basin will be cleared and pumped out before monitoring begins.

Lakeview (Olympic Region)

The Lakeview Maintenance Facility is in the city of Lakewood at 11211 41st Avenue Southwest. The facility is bordered by I-5 to the east and surrounded by side streets and commercial properties in all other directions. Lakeview is a midsized maintenance facility with a stormwater system that collects runoff from nearly the entire facility.

The chosen monitoring point is the outlet of a large Type 2 catch basin. This catch basin is incorporated at the end of a conveyance system and discharges to an on-site swale and retention pond combination treatment system. Figure D-2 shows the catch basin and drainage area of approximately 4 acres.

Clarkston (South Central Region)

The Clarkston Maintenance Facility is near the west edge of the city at 1501 Bridge Street. The facility is bordered to the west by the Clarkston Golf and Country Club, and to the south and east by residential housing and small, commercial properties. Monitoring will take place in the northeast corner of the facility, where the majority of runoff is conveyed to the edge of an asphalt parking area and collected in a shallow paved depression (see Figure D-3). The drainage area is approximately 5.48 acres.

Vancouver (Southwest Region)

The Vancouver Maintenance Facility is located at 4200 Main Street. The facility is bordered by Main Street to the east and is surrounded by high-density housing in all other directions. A small groundwater rehabilitation center for trichloroethane (TCE) contamination is located at the northwest corner of the facility. It is not anticipated that the TCE contamination will influence stormwater chemistry or study design.

Figure D-4 shows the chosen catch basin for monitoring located near the main entrance from the southern drainage area. This location drains the majority of the facility: approximately 5.5 acres. Monitoring will be conducted in Catch Basin 4 (CB 4), located near the entrance to the facility. Runoff from this facility drains to a city of Vancouver stormwater conveyance.

Euclid (North Central Region)

The Euclid Maintenance Facility is located in Wenatchee at 2830 Euclid Avenue. An undeveloped property borders the facility to the west, and the Wenatchee Apple Commission building and its adjoining property borders the site to the east.

The catch basin chosen for monitoring (CB 30) drains the upper tier of the facility where Building D is located, then discharges runoff to a retention pond. Building D contains materials storage, offices, a carpenter shop, materials lab, and Transportation Equipment Fund (TEF) vehicle maintenance shop. This location represents typical maintenance facility activities and will adequately facilitate collection of samples. Figure D-5 shows the catch basin and approximately 3.2 acres that will contribute runoff to this monitoring location.

Geiger (Eastern Region)

The Geiger Maintenance Facility is located near the airport at 7211 West Westbow Boulevard in Spokane. Geiger is representative of an Eastern Region maintenance facility that meets permit monitoring needs.

The chosen monitoring location is a concrete inlet structure or sump built to discharge to the existing stormwater pond northwest of the fuel station. Figure D-6 shows the monitoring location, which captures approximately 1 acre of stormwater runoff from three building roofs, a fueling station, vehicle storage, and incidental runoff from material storage areas.

6-2 Rest Areas

WSDOT is required to monitor two high-use rest areas in accordance with S7.D.2.a of the permit. Stormwater pollutant sources at rest areas may include vehicle traffic, sewage holding tanks, buildings, and landscaping. Landscaping pollutant-source activities may include pet waste, fertilizers, and soils washed off the landscape.

The selected rest area should be located within the permit coverage area, coincide with higher annual average daily traffic (AADT), and represent typical activities at WSDOT rest areas. Key selection criteria for rest areas include:

- Permit coverage area
- High use as defined by 81,000 AADT
- Representativeness
- Site topography
- Hydraulic characteristics
- Adequate drainage area
- Absence of a high groundwater table
- Lack of runoff from off-site locations
- Easy access for sampling

Although rest areas are established along highways across the state, only sites west of the Cascades were within the permit coverage area and met AADT criteria. Six rest areas meeting the permit conditions were evaluated along I-5. The Smokey Point Northbound and Southbound rest area sites near Marysville were selected for stormwater characterization monitoring.

Sampling site access, larger drainage areas, and close proximity to other sampling stations make both sites good choices for monitoring. Drainage area activities include vehicle parking, truck parking, and grounds keeping at both sites. Rainfall variability between sites will be minimal since both sites are so close to each other.

An AADT of 81,000 in both directions at these rest areas on I-5 satisfies the high-use requirements for both sites. The rest areas are bordered by a combination greenbelt/housing plot and I-5 lanes. The Smokey Point facilities provide restrooms, truck parking, recreational vehicle (RV) parking, and dumping stations.

Smokey Point Rest Area (Northbound I-5)

The Smokey Point Northbound (NB) Rest Area is located along I-5 near Marysville, approximately half a mile north of Exit 206. Drainage is divided four ways for this facility: entrance route drainage, main rest area drainage, RV dump collection, and exit route drainage. The main rest area and exit route drainage are collected in a retention pond located near the exit for the facility.

The main rest area drainage was selected for sampling at this rest area. The drainage system includes catch basins that collect water from paved parking, some landscaped areas, and discharge runoff through a pipe to an oil and water separator (OWS) that drains to a pond. Monitoring will be conducted in the oil water separator tee before the pond. Figure D-7 shows the monitoring location and the drainage area that will collect stormwater from approximately 4.89 acres.

Smokey Point Rest Area (Southbound I-5)

The Smokey Point Southbound (SB) Rest Area is located along I-5 just north of Marysville, approximately 1 mile south of Exit 208. There are several catch basins and an OWS attached to this drainage conveyance before it discharges.

Drainage is divided into two distinct catchment systems: one for the restrooms, truck, and car parking, and the other for RV parking and the dump station. The selected drainage for monitoring is the drainage area that captures the restroom, truck, and car-parking areas. Runoff from the drainage area is routed through an OWS and off-site to a local creek. Stormwater will be sampled in the conveyance system prior to discharging to the creek. Figure D-8 shows the monitoring location at the pipe outlet and the drainage area that collects stormwater from approximately 6.7 acres.

6-3 Ferry Terminals

WSDOT is required to monitor one high-use ferry terminal in accordance with S7.D.1.c of the permit. High use was not described in the permit; therefore, WSDOT determined that high use would be defined using ridership values from the 2009 Washington State Ferries Traffic Statistics Rider Segment reports. Key selection criteria for stormwater monitoring sites at ferry terminals include:

- Permit coverage area
- High use as defined by ridership levels
- Representativeness
- Site topography
- Hydraulic characteristics
- Adequate drainage area
- Lack of runoff from off-site locations
- Easy access for sampling

- Adequate space for monitoring equipment
- Equipment security
- Sampling will not affect normal activities at the ferry terminal

Sites Considered

Six ferry terminals were considered, and site visits were made to assess representativeness and suitability for monitoring. All of the ferry terminals considered for monitoring were similar in function but had very different spatial orientations and site plans. Most of the ferry docks and surrounding areas were unsuitable for stormwater monitoring without expensive reconfiguration of the site or stormwater system; for example, disconnecting the local city system from the ferry terminal stormwater system. Several common characteristics pose distinct challenges to stormwater monitoring, including extremely steep or flat slopes; parking lots with multiple drainage locations; ferry terminal piers built with flow-through drains; and on-site flows from adjacent commercial areas, city streets, or residential areas.

Bainbridge Island Ferry Terminal

The most suitable monitoring location is the Bainbridge Island Ferry Terminal, which is located at the southwestern end of Bainbridge Island. The ferry terminal is located in Eagle Harbor in the town of Winslow and is bordered to the north and northeast by high-occupancy parking, to the south and southeast by Puget Sound, and to the west by residential condominiums.

The selected monitoring location will capture stormwater from the vehicle waiting area, located just before the pier. Approximately 1.8 acres drain to the selected drainage system. Figure D-9 shows the drainage area and catch basin that will collect stormwater from vehicle holding lanes. The conveyance system is routed through three catch basins and discharges to Puget Sound. The stormwater runoff will be sampled at the pipe discharge point.

This site has a moderate slope with some runoff from surrounding areas at higher flows. Stormwater runoff during larger storm events may run onto this site from the road (SR 305) and parking lots near the ferry terminal.

7 Sampling Process Design (Experimental)

The sampling process design was developed based on monitoring requirements identified in the permit. This section addresses sampling experimental design to ensure the data collection and monitoring methodologies satisfy the requirements of the permit, and data of known quality are generated from this monitoring effort.

Detailed individual site design layouts depicting drainage area are available in Appendix D. The monitoring design and equipment installation for each facility type are available in Appendix E.

7-1 Monitoring Overview

Monitoring to characterize stormwater will involve establishing monitoring stations at the selected facilities to measure stormwater quality. Table 8 lists the parameter categories, sampling frequency, and methods of sampling. Actual parameters are discussed below.

Table 8 Overview of monitoring at WSDOT facilities.

Parameter Category	Sampling Frequency	Sampling Method	Permit Required?	Telemetered Data
Rainfall	Continuous, year round	Rain gage	No	Yes
Temperature	Continuous, year round	In situ probe	Yes for temperature, but continuous monitoring not required	Yes
Chemical, except grab samples	Discrete storm events	Autosampler	Yes	No
TPH and/or fecal coliform	Discrete storm events	Grab sample	Yes	No

7-1.1 Method of Sampling

Grab Samples

Grab samples are typically those collected manually in jars or measured in situ by a probe. Stormwater characterization at WSDOT facilities requires grab samples to be collected for fecal coliform and TPH within the first 20 minutes of runoff. The method of grab collection may vary due to access to the discharged stormwater; a jar may be held by hand or fixed to a pole sampler. Ecology's SOP for Collecting Grab Samples from Stormwater Discharges will be followed (Ecology, 2009c).

To clarify grab sample collection in the permit for facilities, Ecology recommends using the language from S7.B.4.b of the highway runoff section in the permit.

> *Grab samples shall be collected as early in the runoff event as practical. If grab samples are not collected during qualifying storm events, non-qualifying sized storm events may be sampled.*

Continuous Samples

Rainfall and temperature will be continuously monitored at the station locations. A data collection platform (DCP) will be located at each monitoring location. The DCP will consist of the data logger, autosampler, and attached peripheral probes. Each of the data loggers will be configured to collect data from the autosampler and attached peripheral probes for water temperature and rain. Data loggers will be programmed to record measurements every 15 minutes. Each data logger will be equipped with a satellite antenna to telemeter data. These 15-minute data blocks will be saved to the internal logger memory and transmitted at one-hour intervals year round to establish a site-specific characterization. Field crews will also manually download data from the data loggers.

Composited Samples

The permit specifies that stormwater runoff must be collected by "…a minimum of five individual stormwater grab samples, equally spaced in time and collected within the first hour of runoff." These samples are required by S7.D.4 "…to begin as early in the runoff as practical but not later than 20 minutes after the onset of runoff at the monitoring locations."

Refrigerated autosamplers such as an ISCO Avalanche or a similar product will be used to collect stormwater samples during a qualifying storm event. Autosamplers will be programmed to begin sampling at the predetermined rates required for analysis. Sample collection into autosampler bottles will be triggered by a three-step threshold system. The three thresholds are:

- Rainfall, to ensure a storm event is occurring.
- Presence of runoff, to ensure water is flowing through the conveyance system.
- Water temperature, to avoid sampling during freezing conditions.

Water temperature, rainfall, and stage will be measured using external probes connected to the data logger. If these three thresholds do not meet the programming criteria, samples will not be collected.

Each monitoring station will support different bottle configurations, depending on sample volume requirements, planned replicates, or storm size. Each monitoring station will be equipped with a refrigerated compositor and a glass bottle for sample containment. Ecology's Automatic Sampling for Stormwater Monitoring SOP and WSDOT's Field Sampling with Autosamplers SOP will be followed (Ecology, 2009b; WSDOT, in draft 2011).

7-1.2 Parameters

S7.D.2. of the permit specifies parameters to be monitored at each land use type (maintenance facility, rest area, and ferry terminal).These parameters are listed in Table 9 in order of priority. If an insufficient sample quantity is collected, WSDOT is advised to process the sample for the next-highest priority pollutants in accordance with volume requirements.

Conditions limiting the volume of water collected and the reason for not sampling specific parameters will be documented in the field notes. Stormwater samples will be collected by either grab or composited techniques, as required by the permit. S7.D.2 of the permit also states:

> *Chemicals below method detection limits after two years of data analysis may be dropped from the list of parameters.*

Table 9 Parameters to be monitored at each WSDOT facility in order of priority (Ecology, 2009a).

Rest Areas	Maintenance Facilities	Ferry Terminal
TPH: NWTPH-Dx and NWTPH-Gx (grab)	TSS	PAHs
Total recoverable and dissolved metals (copper, zinc, cadmium, and lead)	TPH: NWTPH-Dx and NWTPH-Gx (grab)	TPH: NWTPH-Dx and NWTPH-Gx (grab sample)
PAHs	PAHs	Total and dissolved metals (copper, zinc, cadmium, and lead)
TSS	Herbicides (listed in S7.B.4 for only those that WSDOT applies on-site, stores on-site, or applies by vehicles parked on-site)	Methylene blue active substances (MBAS)
Herbicides (listed in S7.B.4 for only those that WSDOT applies on-site, stores on-site, or applies by vehicles parked on-site)	Nutrients: Total phosphorus, ortho-phosphate, nitrate/nitrite, and total Kjeldahl nitrogen (where fertilizers are applied on-site, stored on-site, or applied by vehicles parked on-site)	TSS
Nutrients: Total phosphorus, nitrate/nitrite, orthophosphate, and total Kjeldahl nitrogen	Total and dissolved metals: copper, zinc, cadmium, and lead	Fecal coliform (grab)
Chlorides	Methylene blue activated substances (MBAS)	Temperature[1] (collected from runoff in situ)
Phthalates	Chlorides	Hardness[2]
Fecal coliform (grab)	Temperature[1][2] (collected from runoff in situ)	
Temperature[1] (collected from runoff in situ)	Hardness[2]	
Hardness[2]		

[1] Temperature is measured by in situ probe and is also used as a threshold for triggering of autosamplers.

[2] Not permit-required, but included by EAP recommendation. The Project Manager will decide whether the data will be reported in official documents.

Herbicides and Nutrients

The permit requires herbicide and nutrient monitoring at rest areas and maintenance facilities for only those parameters where "WSDOT applies on-site, stores on-site, or applies by vehicles parked on-site." On-site is interpreted as meaning in the monitoring site drainage area.

WSDOT will communicate with staff annually to stay up to date on the storage, use, and transport of herbicides and nutrients in monitoring site drainage areas. These yearly reviews of storage, use, and transport of herbicides and nutrients by WSDOT will be used to update the list of herbicides and nutrients to be monitored at each site. Modifications to the list of herbicides and nutrients to be monitored will be made using an addendum to this QAPP.

Based on WSDOT's current and historical records of usage from 2008 to the present, the herbicides listed in the permit that were used at the selected maintenance facilities and rest area sites are:

- All maintenance facility sites: Triclopyr (ester formula only)
- All maintenance facility sites: 2,4-D
- All maintenance facility sites: Clopyralid
- All maintenance facility sites: Diuron
- All maintenance facility sites: Dichlobenil
- All maintenance facility sites: Picloram
- All maintenance facility sites, Smokey Point Northbound Rest Area, and Smokey Point Southbound Rest Area: Glyphosate (nonaquatic formula only)

From this list, anytime the herbicide Triclopyr is mentioned later in the permit, it is assumed that Triclopyr (ester formula only) is implied.

S7.D.2 of the permit provides the following list of nutrients that WSDOT will monitor at rest areas and maintenance facilities:

- Total phosphorus
- Orthophosphorus
- Nitrate/Nitrite
- Total Kjeldahl nitrogen

7-2 Seasonal First Flush Monitoring

7-2.1 Target Population

S7.D.4 of the permit requires one of the seven storm events sampled throughout the calendar year to represent the seasonal first flush. Seasonal first flush is defined by the permit as a sampling event with a one-week antecedent dry period that occurs after August 1. Therefore, WSDOT will annually characterize the first storm event of the summer/fall season. WSDOT will use "good faith" efforts to collect the seasonal first flush sample. Conditions limiting the volume of water collected and the reason for not sampling specific parameters will be documented in the field notes.

7-2.2 Monitoring

Monitoring for the annual seasonal first flush storm will follow the same sample program and procedures as other year-round monitoring. An autosampler will be used at each sampling location to collect stormwater during a qualifying event. Autosamplers will be controlled by a data logger and prompted to collect composite samples (five equally spaced subsamples) over the duration of an hour. If a qualifying event is missed or if the sample is corrupted, sample collection will be attempted during the next qualifying event.

8 Sampling Procedures

The following sections describe the methods and procedures for identifying, organizing, collecting, maintaining, and processing samples, equipment, and data in the field. Any field sampling for this project will follow these specific guidelines.

8-1 Storm Event Targeting Procedures

Satellite imagery and model predictions will be used as a basis for weather information provided by the National Oceanic and Atmospheric Administration, the National Weather Service, and/or private forecasters. These predictions will be evaluated by the Field Lead to determine potential qualifying storm events. As candidate storms approach, radar observations and hourly reports from land-based weather stations will be used to track and evaluate storm progress. These land-based weather stations include universities, news organizations, or state and national agencies, and they will be accessed through the Internet.

The minimum rainfall criterion is a rainfall depth of 0.20 inch. Whether or not this rainfall amount will generate runoff at each monitored facility will be observed once monitoring begins. Snowmelt alone will not be considered a qualifying event. Snowmelt accompanied by rainfall (typically called sleet) and a rain-on-snow event are considered qualifying events that will be monitored. Once a storm is determined to be a candidate for measurement, the Field Lead will notify the appropriate personnel, including laboratory staff, and initiate mobilization for stormwater sampling as soon as feasible.

These decisions and further explanations regarding staff training are documented in the Decision Matrix for Targeting Storm Events SOP (WSDOT, in draft 2011). This SOP describes the decision process for identifying and mobilizing for qualifying storm events.

The estimated duration and estimated rainfall used in the decision (the "*Go*" decision) to initiate sampling procedures will be logged on storm-tracking forms (see an example form in Appendix F) and stored in WSDOT central files, along with a printed or electronic copy of the forecast. A diagram of the series of decisions and events for sampling is shown in Figure 3.

The Field Lead will notify the sampling field crew to begin pre-event preparation for stormwater sampling. Given the logistical difficulties in getting to the sampling sites, the Field Lead may make the decision based on storm size (for example, if the storm is predicted to be small) not to deploy the sampling team for a grab sample.

8-2 Pre-Event Preparation Procedures

Figure 3 is a simplified flow diagram of the decisions and actions needed for successful sampling.

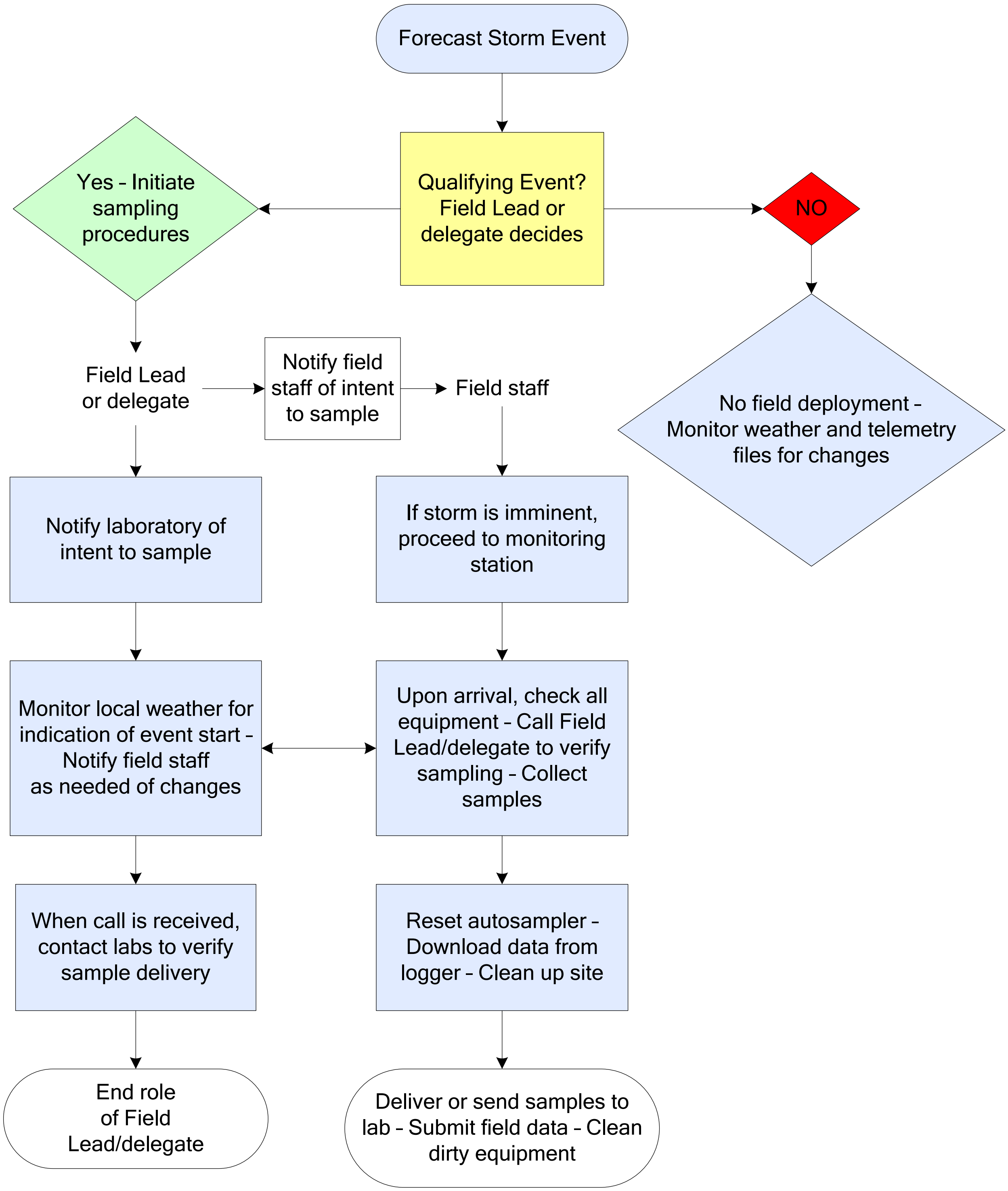

Figure 3 WSDOT sampling procedures flow diagram.

8-2.1 Trip Preparation

When a storm has been categorized as "qualified" by the Field Lead, it may be necessary to travel to the site before the rain begins in order to be ready for grab sampling. This may require significant time allocations for commutes or for hotel arrangements prior to storm events in certain areas. Packing lists and trip checklists with detailed instructions will be followed. Example lists are included in Appendix G. Field technicians are responsible for packing all necessary equipment for site maintenance, sampling, and sample shipping supplies prior to deployment. Due to the potential for short-notice storm events, the travel vehicles should be staged and ready.

Monitoring the telemetered data from a mobile Internet-capable device will assist in the timing of field deployment, whether from the office or the hotel. Deployment timing will depend on the predicted level of rainfall and runoff, and whether grab samples can be made within the first 20 minutes. After each sampling event, autosamplers will be reset for the next sampling event; therefore, crews will be prepared to clean the sampler and exchange bottles and equipment as necessary.

8-2.2 Lab Notification

Once samples are collected, the field technicians must notify the laboratories whether sampling was successful and whether they need to prepare for the reception of samples.

8-2.3 Site Preparation

Upon arrival at the monitoring site, field technicians will visually inspect sampling equipment activity in progress. Any necessary alterations will be catalogued and reset to ensure sampling precision. If field crews arrive before sampling begins, they will:

- Check the data logger program to verify sampling will take place when the step triggers have been satisfied.
- Inspect autosamplers to verify bottles are appropriately set and tubing is attached properly at the sampling point.
- Check the measuring devices and remove any obstructions and sediment that could impede the flow of stormwater.
- Prepare for grab sampling.

8-3 Monitoring and Maintenance Procedures

8-3.1 Precipitation Measurement

At each monitoring site, pole-mounted tipping bucket rain gages will be installed to accurately represent on-site rainfall characteristics. Rain gages should be installed in a secure, level fashion in a location where no buildings, trees, overpasses, or other objects obstruct or divert rainfall prior to entering the rain gage. Rain gage placement will, to the best of WSDOT's ability, follow the Northwest Weather Service specifications (🖰 http://www.weather.gov/om/coop/standard.htm).

Rain gages will be calibrated prior to the onset of permit monitoring and will be maintained in accordance with the manufacturers' specifications.

Rain gage data will be collected every 15 minutes and stored in the data logger's memory. In addition, the rain gage data will be broadcast hourly via telemetry to a WSDOT database in order to remotely identify on-site weather characteristics. During each station visit, the rain gages will be inspected, cleared of debris, and maintained in accordance with the manufacturers' specifications. Rain gage data will be downloaded from the logger for each storm event or during the maintenance schedule.

8-3.2 Grab Sampling

Manual collection of grab samples for TPH and fecal coliform will begin as early in the runoff event as feasible. If the drainage area is very small, field staff may need to be on-site before the storm begins in order to prepare for grab sampling. Grab samples will be collected either by using an appropriate pole sampler with a bucket or claw for holding the sample jar or by hand into the sample jars, following the SOP for Collecting Grab Samples from Stormwater Discharges (Ecology, 2009c).

Hand-held portable meters and visible sheen observations may sometimes be used to enhance stormwater characterization by measuring water quality parameters, although this is not required for permit compliance. Field grab sampling efforts and other activities will be documented on a field sampling form (see example in Appendix H).

8-3.3 Composited Sample Retrieval

Each monitoring location will support different bottle configurations, depending on sample volume requirements, planned replicates, or storm size, as listed in Table 10 for each type of facility.

Table 10 Minimum targeted volumes for composite sample collection (Ecology, 2009a; MEL, 2008; 40 CFR 136.3).

Recommendations	Rest Areas	Maintenance Facilities	Ferry Terminals
Minimum volume of sample needed to analyze all parameters except herbicides*[1]	4.3 liters	3.7 liters	3.2 liters
Minimum volume of sample needed to analyze all parameters including herbicides[1]*	7.4 liters	6.8 liters	N/A
Maximum additional sample volume needed for quality control analyses	Dependent on QC samples and parameters of interest up to 7.4 liters	Dependent on QC samples and parameters of interest up to 6.8 liters	Dependent on QC samples and parameters of interest up to 3.2 liters
Recommended compositor bottle size (glass)	9.4 liters	9.4 liters	9.4 or 3.8 liters

[1] Herbicides are only required if used, stored, or in trucks parked at the facility. Therefore, some facilities may not require collection of these parameters.

* Estimates do not include needed volumes for QC samples.

Upon completion of sampling, the data logger and autosampler will return to normal operating modes. The autosampler will be ready for the field technicians to recover the sample bottles. Field personnel will wear nitrile gloves at all times during sample collection and follow standard health and safety procedures. Preservation and filtration of samples (if needed) will occur immediately after composited samples have been collected.

Upon completion of sampling, prefabricated labels will be verified and samples will be placed in coolers with bubble wrap and blue ice packs for transport. Chain of custody (COC) forms will be filled out completely and sent with the coolers. Appendix I contains the Manchester Environmental Laboratory (MEL) COC as an example form.

Collection of blanks will occur as scheduled and will be included in the transport of coolers.

The autosampler will then be inspected, cleaned, and restocked according to the Field Sampling with Autosamplers SOP specific to WSDOT's program for field crew training (WSDOT, in draft 2011). Ecology's SOP for Automatic Sampling for Stormwater Monitoring will serve as a guide (Ecology, 2009b). An important aspect of cleaning and restocking the autosampler will be switching the tubing on an as-needed basis.

8-3.4 Field Filtration

Orthophosphate and dissolved metals will be filtered in the field within 15 minutes of final aliquot collection. If filtering occurs between 15 minutes and 24 hours, the sample will be *J* qualified. If field filtering occurs after 24 hours for both orthophosphate and the dissolved metals, then the sample will be rejected and labeled with an *R* on the field forms. Field sampling efforts, including filtration and other activities, will be documented on a field sampling form (see example in Appendix H).

Metals Sample Collection/Handling

A modified version of EPA's "clean hands/dirty hands" protocol for low-level detection of metals (USEPA, 1996) will be used as a guideline during sample collection. A modified version of the protocol will allow sampling to be performed by one field technician as opposed to two. Accordingly, the laboratory will preclean laboratory bottles for metals, as required for the analytical method. The laboratory will then place the metals bottles into two separate Ziploc® or comparable sealed plastic bags for transport to the site. Prior to sample collection, the field technician will put on a new set of gloves (i.e., clean and powder free) for each sequence of clean or dirty hands sampling that is required for proper implementation of the protocol. The sequence of clean and dirty hands operations to be used during sampling is described in detail as follows:

Dirty Hands (two sets of new gloves):

- Open the cooler with sample bottles
- Remove double-bagged sample bottle from cooler
- Unseal outer bag

Clean Hands (remove outer set of gloves):

- Unseal inner bag containing sample bottle
- Remove bottle and unscrew cap
- Rinse bottle three times in water to be sampled (if sample contains no preservative)
- Fill sample bottle
- Return sample bottle to inner bag
- Reseal inner bag
- Reseal outer bag
- Return double-bagged sample to cooler

8-3.5 Field Sample Verification

Before sending the coolers to the laboratory, field staff must fill out field sampling forms (see example form in Appendix H). Additionally, field staff may need to verify that the storm event met the permit requirements for storm sampling (antecedent dry period and rainfall quantity). However, if in doubt, the technician should always send the cooler as soon as possible. The technician should follow up with a call to the laboratory to cancel the analysis if the Field Lead or delegate determines the storm event did not meet permit criteria or should not be used as one of the three nonqualifying events. Communication between the field crew and the Field Lead or delegate is critical and will require cellular phones.

The field technician will be able to determine the final volume of the captured sample and divide samples into aliquots and place them in sample jars according to the priority list of parameters to be measured. If insufficient sample volume was collected for all parameters to be analyzed, the highest-priority parameters will be sent to the lab for analysis. Upon shipment of samples to the laboratory, field technicians will return to headquarters (or the field station) and submit their field notes and copies of COC forms to the Field Lead for review.

The Field Lead will review the collected storm reports, field notes, COC forms, and maintenance forms to determine whether any data quality errors were made. If errors are found, notice will be given to the laboratory regarding the type of error, which sample was collected erroneously, and whether the sample should be disqualified for analysis based on the error.

8-3.6 Telemetered Data Collection

Each station's telemetered data logger is preprogrammed to continuously collect temperature and rainfall data, as well as composite samples when threshold requirements are met. The data loggers are programmed with a step-triggering system designed to minimize falsely triggered sampling. The step-triggering system uses environmental data (such as rainfall and water temperature) collected by the data logger to determine whether a storm event is qualified and whether or not to initiate a sample collection. When programmed thresholds are met, the logger will wake up the autosampler and initiate its sample collection program. The autosampler will collect preprogrammed amounts in accordance with the permit requirements and analytical needs.

Temperature and rainfall data will be collected and logged every 15 minutes and transmitted every hour to the WSDOT database. Upon receipt of transmission in the central database, data will be qualified, tabulated, manipulated, and stored until it is able to be reviewed and finalized by the Data Steward.

Field technicians must download the internal memory of the data logger to a specified storage drive (thumb drive) after final stormwater samples have been collected. This data will supplement the telemetered data and be used to fill any transmission gaps that may have occurred.

8-3.7 Equipment Maintenance and Cleaning

Servicing of scientific instrumentation will follow manufacturers' methods or will be conducted as needed by trained technicians in a controlled environment. Routine site visits will occur every six weeks or after a sampled storm event. Refer to the Equipment Maintenance and Cleaning SOP for the specifics on instrument cleaning, station visits, and maintenance (WSDOT, in draft 2011). For specific equipment maintenance, refer to operators' manuals.

Generally, maintenance will consist of equipment inventories, inspections, testing, and replacement of worn or missing components.

Equipment Decontamination

All sampling equipment and containers will be prepared prior to the sampling event. Any portion of the autosampler (including intake screen, intake tubing, pump tubing, and sampler containers), filters, or other materials coming into contact with the sampled stormwater will be decontaminated prior to use or will be certified as precleaned from the equipment source.

The sampling equipment mentioned above that can be cleaned will be washed or rinsed with non-phosphate soap, rinsed three times with deionized water, and air dried. Clean implements will be stored in aluminum foil or polyethylene bags for transport to the field station.

Plastic or tubing will be washed or rinsed with nonphosphate soap, rinsed three times with deionized water, and air dried. Clean implements will be stored in aluminum foil or polyethylene bags for transport to the field station. Stainless steel sampling implements, including the spoons, bowls, and stirrers, will be cleaned by sequentially:

1. Washing in nonphosphate detergent and hot tap water
2. Rinsing with hot tap water
3. Rinsing with 10% nitric acid (if sampling for metals)
4. Rinsing with deionized water three times
5. Air drying in clean area free of contaminants
6. Rinsing with pesticide-grade acetone (if sampling for organics)
7. Air drying in clean area free of contaminants
8. Rinsing with pesticide-grade hexane (if sampling for organics)
9. Air drying in clean area free of contaminants

After drying, equipment will be wrapped in aluminum foil and stored in polyethylene bags until used in the field. Sampling equipment will be dedicated to the station and will only be used at subsequent stations after cleaning in accordance with the above procedures, which are based on EPA guidelines (USEPA, 1992).

8-3.8 Adaptive Management

Once experience is gained with monitoring, a process called "adaptive management" will be employed for minor or major changes. Relatively small changes to the monitoring program will not incur authoritative signature approval.

Examples of small changes include, but are not limited to:

- Sizes of bottles used in the automatic sampler
- The equipment used for field filtration
- Using a different brand of equipment but retaining functional equivalency
- Adjustments to the programming of the automatic samplers

Major changes to the sampling program are required by the permit to get signatory approval from WSDOT and Ecology prior to the changes.

Major changes may include:

- Changing the sampling location at a site
- Changes in analytical methods

9 Measurement Procedures

This section describes the laboratory selection process, sample-processing procedures, sample labeling and chain of custody, laboratory methods, and reporting limits.

9-1 Laboratory Selection

Laboratories have been selected based on their current accreditation status with Ecology (http://www.ecy.wa.gov/apps/eap/acclabs/labquery.asp) and their ability to achieve acceptable limits of detection for the parameters measured as part of this project. Due to the scale of sampling under this permit, multiple laboratories have been selected to ensure sample completeness. For example, fecal coliform samples that are collected in eastern Washington will be sent to a nearby laboratory that can successfully analyze the samples. This is necessary to meet the 8-hour holding time (6 hours transit and 2 hours at the laboratory).

The laboratory will report the analytical results to WSDOT in a timely manner. The laboratory will provide all sample and quality control data in standardized laboratory reports suitable for evaluating the project data. Laboratory reporting of reviewed and qualified data, will include, but not be limited to:

- Case narratives and data summaries discussing laboratory QA/QC.
- Reported result values, including those between the method detection limit and the laboratory reporting limit.
- The method detection limits and laboratory reporting limits for all analytes for each batch.
- QA/QC results such as field replicates, laboratory duplicates, surrogates, method blanks, and matrix spikes.
- A PDF or equivalent copy of the case narrative and data.
- An electronic deliverable datum developed by WSDOT specifying the format in which laboratories are to report data.

The laboratory reports will also include any problems encountered in the analyses. Raw data will be kept at the laboratory for a minimum of five years.

9-1.1 Laboratories

Laboratories selected by WSDOT are accredited and capable of meeting reporting limits and holding times set forth by the method or permit, unless noted in this QAPP. Table 11 lists the selected laboratories for sample processing. A complete list of accredited laboratories and parameters analyzed can be found at: http://www.ecy.wa.gov/programs/eap/labs/search.html

Table 11 Selected laboratories for sample processing.

Laboratory Name	Analytical Purpose	Address	Contact/Phone
Manchester Environmental Laboratory	All parameters in Table 13, except glyphosate, MBAS, and total Kjeldahl nitrogen	Washington State Dept of Ecology Manchester Environmental Laboratory 7411 Beach Drive East Port Orchard, WA 98366 Work Hours: 8:00 to 4:30 Weekdays	Stuart Magoon 360-871-8800
TestAmerica Laboratories, Inc.	Glyphosate, ortho-phosphate,[1] total Kjeldahl nitrogen	Labs nationally – GA contract: TestAmerica: Seattle, Tacoma, Spokane, Portland	Katie Downie 253-922-2310
Anatek Labs, Inc.	Fecal coliforms[1]	504 E. Sprague, Suite D Spokane, WA 99202	Kathy Sattler 509-838-3999
AmTest Laboratory	Fecal coliforms,[1] MBAS	13600 NE 126th Pl., Suite C Kirkland, WA 98034	Aaron Young 425-885-1664

[1] Additional laboratories beyond Manchester Environmental Laboratory are needed to meet holding times for this analysis.

9-2 Sample Processing Procedure

This section presents the post-storm event sample-processing procedures for water samples. At the end of a successful sampling event, a final composite sample may be required at sites where more than one bottle was filled. Post-storm event sample processing for routine samples will take place after the storm event is completed and all runoff samples are taken.

9-2.1 Sample Amounts and Containers

The collected samples will be analyzed for the listed chemical parameters required by S7.D of the permit. Parameter-specific sample volumes, holding times, container specifications, and preservation are described in Table 12 for each target parameter. Table 12 was created from the *Laboratory Users Manual* (MEL, 2008), Table II of 40 CFR 136.3, and specified methods within the permit.

Table 12 Sample containers, amounts, preservation, and holding times for stormwater samples (MEL, 2008; 40 CFR 136.3; Ecology, 2009a).

Analysis	Quantity Needed for Analysis	Quantity Needed for QC Samples	Container	Holding Time	Preservative[1]
Chloride	100 mL	MS, MSD, and Dup = 100 mL each	125 mL w/m poly bottle	28 days	Cool to ≤6°C
Fecal coliform (grab)	250 mL	Dup = 250 mL	250 mL glass/polypropylene bottle	6 hours + 2 at Lab	Fill the bottle to the shoulder; cool to ≤ 10°C[2]
Hardness as $CaCO_3$	100 mL	Dup = 100 mL	125 mL w/m poly bottle	6 months	H_2SO_4 to pH<2; cool to ≤6°C
Herbicides – Dichlobenil, diuron	1 liter	MS & MSD = 1 liter each	1 liter amber glass bottle with Teflon® lid	7 days to extraction, 40 days after extraction	Cool to ≤6°C
Herbicides – 2,4-D, clopyralid, picloram, triclopyr (ester formula)	1 liter	MS & MSD =1 liter each	1 liter amber glass bottle with Teflon® lid	7 days to extraction, 40 days after extraction	Cool to ≤6°C
Herbicides – Glyphosate* (nonaquatic formula)	60 mL	60 mL	60 mL screw cap bottles with a Teflon® faced silicone septa	14 days	Cool to ≤4°C[2]
Methylene blue active substances (MBAS)	400 mL	400 mL	1 liter amber glass bottle	48 hours	Cool to 4°C
Metals – dissolved (Cu, Cd, Zn, Pb)	100 mL	MS, MSD, and Dup = 100 mL each	500 mL HDPE bottle[4] with Teflon® lid	6 months	Filter within 15 minutes of collection[4]; then add HNO_3 to pH <2[5]; cool to ≤6°C
Metals – total recoverable (Cu, Cd, Zn, Pb)	100 mL	MS, MSD, and Dup = 100 mL each	500 mL HDPE bottle[4] with Teflon® lid	6 months	HNO_3 to pH <2
Nitrate/Nitrite	125 mL	125 mL	125 mL clear w/m poly bottle	28 days	H_2SO_4 to pH<2; cool to≤6°C
Orthophosphate (OP)	30 mL	MS, MSD, and Dup = 125 mL each	125 mL amber w/m poly bottle	48 hours	Filter within 15 minutes of collection[4]; cool to ≤6°C
PAH compounds	1 liter	MS and MSD = 1 liter each	1 liter amber glass bottle with Teflon® lid	7 days to extraction, 40 days after extraction	Store in dark, Cool to ≤6°C[2]
Phthalates	1 liter	MS and MSD = 1 liter each	1 liter amber glass bottle with Teflon® lid	7 days to extraction, 40 days after extraction	Store in dark; cool to ≤6°C[2]

Table 12 (continued) Sample containers, amounts, preservation, and holding times for stormwater samples (MEL, 2008; 40 CFR 136.3; Ecology, 2009a).

Analysis	Quantity Needed for Analysis	Quantity Needed for QC Samples	Container	Holding Time	Preservative[1]
Total Kjeldahl nitrogen (TKN)	125 mL	125 mL	125 mL clear w/m poly bottle (do not combine with other nutrients)	28 days	H_2SO_4 to pH<2; cool to ≤6°C
TSS	1 liter	Dup = 1 liter for clear water, less to none if dirty	1 liter w/m poly bottle	7 days	Cool to ≤6°C
Total phosphorus (TP)	50 mL	MS, MSD, and Dup = 50 mL	60 mL clear w/m poly bottle	28 days	HCl to pH<2; cool to 4°C $\underline{+}$ 2°C
TPH-Diesel (NWTPH-Dx) (grab)	1 liter	Dup = 1 liter	1 liter n/m glass jar, organic free with Teflon® lined lids	7 days for unpreserved, 14 days for preserved**	HCl to pH<2; cool to 4°C ±2°C
TPH-Gas (NWTPH-Gx) (grab)	120 mL (fill vial full)	Dup = 120 mL	(3) 40 mL glass VOA vials with Teflon® coated septum-lined screw tops	7 days for unpreserved, 14 days for preserved	HCl to pH<2; cool to 4°C ±2°C

w/m = wide mouth
n/m = narrow mouth
MS = matrix spike
MSD = matrix spike duplicate
Dup = Laboratory duplicate

[1] Preservation needs to be done in the field unless otherwise noted. Ice will be used in cool samples to approximately 4°C.
[2] At the lab a reducing agent may be added as a preservative if an oxidant such as chlorine is present.
[3] Containers cleaned in accordance with OSWER Cleaning Protocol #9240.0-05 (MEL, 2008).
[4] 0.45 micron pore size filters.
[5] Preserved in lab within 24 hours of arrival.

* EPA Method 547
** ECY 97-602

Sample Volumes

For the purpose of ensuring the highest possible quality of data and to ensure fulfillment of permit-required parameter sampling, an excess amount of sample will be collected (if available) for each composited sample. Each autosampler will hold glass carboys to collect composited stormwater for facility runoff samples unless otherwise specified. Sample amounts listed in Tables 10 and 12 are based on the needed quantity for a single laboratory analysis for each analyte and the excess volume for lab QC samples. This volume has been determined by the laboratory to be satisfactory for its minimum requirements. Field replicates will be collected according to the established schedule.

Sample Containers

For all samples, commercially available precleaned sample containers will be used and the record of certification from the suppliers will be maintained. The sample container shipment documentation will record batch numbers for the containers. With this documentation, containers can be traced to the supplier and container wash analysis results can be reviewed.

Laboratories are able to clean and reuse many containers. Containers will be cleaned to EPA QA/QC specifications (USEPA, 1992). Precleaned sample containers (bottles and carboys) will be used for sampling.

A glass carboy (volume dependent upon parameters required per site) will be used primarily to collect composited samples directly from the autosampler in the field. Tubing lined with fluorinated ethylene propylene (FEP) or a similar product will be inserted into the opening of the carboy and sealed with an appropriate stopper, or it will be wrapped in Parafilm® to form a seal. Several parameters can be analyzed from the same composite sample; therefore, sample splitting is required. Sample splitting will take place in the field unless contamination is a concern; then it will be done at the laboratory. Unpredicted conditions or circumstances may require the use of rosettes containing individual bottles, instead of one large bottle.

Sample Splitting

Parameters that require preservatives or field filtration from the master composite and/or grab samples will be processed in the field. Processing in the field for automatically composited samples will consist of homogenizing the bottle's contents and placing aliquots of the composite into appropriate precleaned laboratory containers for subsequent analysis. Sample splitting will be performed using the automatic sampler head and tubing used to collect the sample. This process will involve replacing the inlet tubing with a precleaned shorter section of tubing and reversing the autosampler pump to fill lab bottles. The tubing and top of the carboy will be wrapped with Parafilm® to prevent sample contamination. The carboy will be agitated during the reverse pumping timeframe. Agitation will be done by placing the carboy on a prefabricated stool with only one central leg that can be held by a field crew member and swirled back and forth and side to side. Vortex swirling will be avoided to prevent entrapment of heavier particles in the middle of the carboy. If this method of sample splitting is inadequate in practice, the widely available churn splitter will be employed.

Post-storm event sample handling is described below and will be developed into training for field crews. Contents of this training will be based on the following section.

9-2.2 Post-Event Processing, Preservation, and Holding Times

After the storm event, data collected during the storm will be assessed to determine whether the storm qualified according to the permit specifications. If the storm event did not qualify, the samples may be discarded and the associated bottles sent to the laboratory for cleaning in preparation for the next storm event. If the criteria have been met, field crews will remove the chilled carboys and bottles for sample splitting, filtration (if necessary), and preservation. The Field Lead and Data Steward will decide whether a nonqualifying storm event will be sampled to meet permit requirements.

Sample Preservation

Some of the parameters to be analyzed (TP, TPH, TKN, Nitrate/Nitrite, total metals, and hardness) will require chemical preservation to maintain the integrity of the samples and prevent them from degrading prior to laboratory analysis. Filtration is required as well for orthophosphate and dissolved metals and will be conducted immediately after composited sample collection is completed.

Samples for orthophosphate and dissolved metals will be filtered using a filtering set-up that pulls the sample through a filter using vacuum pressure created by a peristaltic (or hand) pump. Prior to filtering the sample, an aliquot of deionized water will be passed through the filter to rinse the filter and container. After rinsing, the filtered sample will be collected and distributed into the laboratory sample bottles. Disposable filter set-ups will be used for each sample.

Sample cooling to 4º – 6ºC or less, but not freezing, is necessary for preservation of most of the parameters to be analyzed. Collected samples must be transferred from the field station to the lab in an ice-filled or blue ice-filled cooler to maintain temperature requirements.

Sample Holding Times

Holding times are the maximum allowable length of time between sample collection and laboratory manipulation. The holding time for parameters collected by the autosampler will be calculated from the time the autosampler's final aliquot is collected. Holding times are different for each analyte and are in place to maximize analytical accuracy and representativeness. Each sample collected will be packaged in a container, labeled, and shipped according to holding time limitations. If holding times cannot be met, the Field Lead will process and label the sample for the next appropriate parameter.

The holding time for fecal coliforms is 6 hours plus 2 hours at the laboratory. Given the inherent logistical difficulties of meeting this holding time, samples analyzed between 8 and 24 hours will be acceptable but flagged as an estimate with a *J* qualifier: samples held longer than 24 hours will be rejected, indicated by an *R* qualifier.

If necessary, the Field Lead will coordinate with the analytical laboratory to ensure samples can be transported, received, and processed during nonbusiness hours. Sample containers will be transported or sent by the field team to the analytical laboratory, following established sample handling and chain of custody procedures. At the laboratory, samples may be further divided for analysis or storage.

9-3 Sample Labeling and Chain of Custody

9-3.1 Labeling

Labeling is used to identify each sample's location and the analyte(s) in that sample to be analyzed. Laboratory-prepared bottles will be labeled to identify the cleanliness and/or preservative contents for each bottle. Labels will be premade. Bottles will be either numbered or prelabeled to ensure proper handling. Labels will be filled out in pencil or permanent pen, placed on sample containers, and taped with packing tape to reduce water damage to the label. Labels for samples will contain the following information, which will also be written on the chain of custody forms (see below):

1. Station name/identification
2. Analysis to be performed
3. Date and time of sampling
4. Sample ID or coding information
5. Sample numbers (1 of 3, 2 of 3, and so on)
6. Name/initials of field tech performing the sampling

9-3.2 Chain of Custody (COC)

Chain of custody can be defined as a systematic procedure for tracking a sample or datum from its origin to its final use. COC procedures are necessary to ensure thorough documentation of handling for each sample, from field collection to laboratory analysis. The purpose of this procedure is to minimize errors, maintain sample integrity, and protect the quality of data collected. A COC form (see Appendix I) will accompany each cooler of samples. After completing the form and packaging the samples for shipping, the sampler should retain a copy of the form for the record. Individuals who manipulate or handle the samples are required to log their activities on the form. Definitions of custody from the *Lab Users Manual* (MEL, 2008) are described below:

> *A sample is considered to be under a person's custody if it is:*
> *In the individual's physical possession*
> *In the individual's sight*
> *Secured in a tamper-proof way by that person, or*
> *Secured by the person in an area that is restricted to authorized personnel*
>
> *Elements of chain-of-custody include:*
> *Sample identification*
> *Security seals and locks*
> *Security procedures*
> *Chain-of-custody record*
> *Field log book*

When the laboratory receives the cooler, it will assume responsibility for samples and maintenance of the COC forms. The laboratory will then conduct its procedures for sample log-ins, storage, holding times, tracking, and submittal of final data to the responsible parties.

9-4 Laboratory Methods, Instruments, Reporting Limits

9-4.1 Laboratory Methods and Analytical Reporting Limits

The selected parameters, analytical methods, and reporting limits are shown in Table 13.

9-4.2 Laboratory Instrumentation

Maintenance of laboratory equipment will be conducted in a manner specified by the manufacturer or by the quality assurance guidelines established by the chosen laboratory. The instrumentation in service records will either meet or exceed manufacturers’ specifications for use.

Table 13 Methods and reporting limits for water samples.

Parameter	Method in Water (SM=Standard Method, EPA=EPA Method, ASTM= American Society of Testing and Materials Method)*	Reporting Limit
Chloride	EPA 300.0	0.2 mg/L
Dissolved (Cd, Cu, Pb)	EPA 200.8 (ICP/MS)	0.1 ug/L
Dissolved (Zn)	EPA 200.8 (ICP/MS)	1.0 ug/L
Fecal coliform[3]	SM 9221E or SM 9222D	2 min., 2E6 max
Hardness as $CaCO_3$[4]	SM 2340B (ICP)	1.0 mg/L
Herbicides – 2,4-D, clopyralid, picloram, triclopyr (ester formula only)	EPA 8270D GC/MS	0.01 – 1.0 ug/L
Herbicides – Diuron	EPA 8270/8321 LC/MS	
Herbicides – Dichlobenil	EPA 8270D different extraction from other herbicides	
Herbicides – Glyphosate[5] (nonaquatic formula)	EPA 547 drinking water method, HPLC or LC/MS, readily breaks down	25 ug/L
Methylene blue active substances (MBAS)	SM 5540C	0.025 mg/L
Nitrate/Nitrite	SM 4500-NO3 I	0.01 mg/L
Orthophosphate (OP)	SM 4500-P G	0.01 mg P/L
PAH compounds[1]	EPA 8270D	0.1 ug/L
Phthalates[2]	EPA 8270D	1.0 ug/L
Total Kjeldahl nitrogen (TKN)	EPA 351.2	0.5 mg/L
Total phosphorus (TP)	SM 4500-P F	0.01 mg P/L
Total recoverable (Cd)	EPA 200.8 (ICP/MS)	0.2 ug/L
Total recoverable (Cu)	EPA 200.8 (ICP/MS)	0.1 ug/L
Total recoverable (Pb)	EPA 200.8 (ICP/MS)	0.1 ug/L
Total recoverable (Zn)	EPA 200.8 (ICP/MS)	5.0 ug/L
TSS	SM 2540D (TAPE requires TSS samples not to exceed 500 microns – A US Standard sieve [#35] or equivalent device may be used for sieving at the lab)	1.0 mg/L
TPH-Diesel	NWTPH-Dx – Ecology, 1997 (Publication No. 97-602)	0.25 – 0.50 mg/L
TPH-Gas	NWTPH-Gx – Ecology, 1997 (Publication No. 97-602)	0.25 mg/L

[1] PAHs of interest: acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene fluorine, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene.

[2] Phthalates of interest: bis(2-Ethylhexyl)phthalate, Butyl benzyl phthalate, Di-n-butyl phthalate, Diethyl phthalate, Dimethyl phthalate, and Di-n-octyl phthalate.

[3] Each laboratory analyzing for fecal coliforms is accredited for both methods. Laboratories were allowed to select their preferred method. MEL and AmTest selected SM 9222D and Anatek selected SM9221E. However, laboratories may use the non-preferred method if sample or condition specific issues arise.

[4] Not permit-required, but included by EAP recommendation. The Project Manager will decide whether to collect this data and include data in official documents.

[5] Results for glyphosate analysis between the RL of 25 ug/L and MDL of 2.5 ug/L will be reported. These results will be qualified as estimates.

* SM: http://www.standardmethods.org/
EPA: http://water.epa.gov/scitech/methods/cwa/methods_index.cfm
EPA: http://www.epa.gov/osw/hazard/testmethods/sw846/online/index.htm
ASTM: http://www.astm.org/SITEMAP/index.html

10 Quality Control Procedures

This section discusses the quality control (QC) procedures that will be implemented in order to provide high-quality data that meet the requirements of the WSDOT permit. Quality control procedures will encompass field collection and laboratory processing of all samples, and will be monitored throughout the duration of the study. The quality of raw, unprocessed, and processed data is then subject to review via the established protocols in Section 5-2, Measurement Quality Objectives.

10-1 Field Quality Control Procedures

10-1.1 Standard Operating Procedures (SOPs)

Quality control in the field will refer to SOPs (listed in Table 14) for field sampling; equipment maintenance; documentation; sample collection; blank or replicate sample collection; and appropriate action for correcting and documenting potential field errors. The field quality control schedule for monitoring efforts is shown in Table 15. To ensure the quality and consistency of sample collections, equipment maintenance and sample collection SOPs will be followed.

Table 14 List of standard operating procedures.

SOPs Published by Ecology[1]
ECY001 – Collecting Grab Samples from Stormwater Discharges
ECY002 – Automatic Sampling for Stormwater Monitoring
ECY004 – Calculating Pollutant Loads for Stormwater Discharges
EAP029 – Metals Sampling
EAP030 – Fecal Coliform Sampling
EAP015 – Manually Obtaining Surface Water Samples
SOPs Developed by WSDOT (in draft)[2]
Equipment Maintenance and Cleaning
Decision Matrix for Targeting Storm Events
Field Sampling with Autosamplers
Using Portable Meters

[1] Ecology 2006, 2007, 2009b, 2009c, 2009d, 2010b.

[2] WSDOT, in draft 2011.

These SOPs will describe the following elements in detail:

- Regular maintenance of monitoring stations to ensure data relevance.
- Collection of continuous temperature and rainfall, for reference.
- Collection of automated, refrigerated, composited samples to characterize storm events.
- Use of certified, contaminant-free, or decontaminated sample containers.
- Storage of unused sampling bottles in clean sealed containers prior to use.
- Implementation of modified "clean hands/dirty hands" techniques (for example, one person collects samples, while the other person opens the manhole covers and changes batteries) for sample collection and site maintenance.

- Replacement of sampler tubing with its surrogate tube (two tubes for each sampler, one always clean and stored away while the other is in use; switch when dirty, clean, and repeat as needed).
- Storage of collected samples on ice in a labeled cooler designated for transport.
- Delivery of samples to the laboratory, with completed COC forms and within proper holding times.

10-1.2 Field Instrument Quality Control

In order to maintain the highest degree of data quality, field equipment will undergo routine cleaning, calibrations, and maintenance at the recommended frequency specified by each manufacturer. Battery maintenance and data downloads from the data loggers will occur for each storm event or at least every six weeks, whichever comes first.

10-1.3 Documentation

Field data sheets will be printed on Rite-in-the-Rain® water-resistant forms or waterproofed tablet PCs to allow ease of use during storm events. When completed, these field sheets will be submitted to the Data Steward and stored in an organized central filing location. Forms and documentation will include station visit/maintenance sheet, COC forms, and weather qualification report (see Appendices F, G, and H for examples of field forms). All entries on field documents will be made in pencil or permanent pen and will list the field technician's name(s). Any errors or typos will be crossed out and rewritten by the technician who recorded the data. All corrections will be initialed and dated when made.

If field sampling or procedural errors are discovered, action will be taken to manage and correct those errors. Corrections may occur via corrective editing, relabeling, or, if warranted, flagging, discarding, and resampling. If a consistent error persists, an amendment to the sampling procedures may be required.

10-1.4 Composite/Grab Field Replicate Samples

Composited field replicate samples will be collected at a rate of 10 percent of the total samples collected for monitoring under the permit. Field replicates will be collected by splitting composited samples or by setting up an additional auto-compositor to collect additional sample volume as equipment is available. Excess volume will be programmed into loggers to provide enough sample volume for field replicates collected by splitting composite samples (if the storm event is large enough). A schedule will be maintained by site to facilitate field crews knowing when to collect field replicate samples at each site. Parameters measured in the field sample will also be measured in the replicate sample for a particular storm event.

Grab field replicates will be collected following a similar schedule to the composited field replicates, but they may not be collected during the same storm event at the same site. Staggering the grab samples and composite samples may be necessary to increase the volume of sample available for collection. Grab field replicates will also be collected at a rate of 10 percent of the total samples.

All field replicates will be labeled the same as other samples, so that the sample has its own unique number. These replicate samples will be submitted blind to the laboratory with all other field samples.

The sampling schedule may be adjusted to meet the field replicate frequencies early in the fall/winter sampling season to prepare for a dry spring/summer season. The Field Lead and Data Steward should continuously manage the field replicate collections to achieve the 10% goal and communicate with the field crews so they know what samples, which storms, and to which monitoring sites field replicates should be taken for the monitoring program.

10-1.5 Field Blanks

The term "field blanks" includes equipment rinsate blanks, transport blanks, transfer blanks, and specific equipment blanks such as tubing. An initial effort to collect equipment rinsate blanks at representative sites will be conducted early in the monitoring program. After this initial effort, sampling process blanks will be collected at the remaining monitoring sites within the first year of monitoring. Equipment rinsate blanks will be collected at least once a year at each site.

The equipment rinsate blanks will consist of laboratory-supplied contaminant-free water that is run through the autosampler system into a clean sample bottle. The goal is mimic the sampling process to determine whether contamination is present from any part of sampling such as equipment, sample filtration, sample handling, or transport.

Additional field blanks will be collected if sample procedures or site conditions change. They may also be used as part of field audits to ensure procedures to reduce contamination are being followed. All field blank samples will be labeled with unique numbers and will accompany field samples sent to the laboratory.

If field blank contamination is discovered, additional field blank samples will be used to determine the source of the contamination. Field blank samples collected to determine the contamination source may include:

- A tubing equipment blank collected after an autosampler's Teflon® tubing is replaced, to determine whether contamination is from the tubing.
- A field equipment blank collected from the filtration apparatus used to filter metals and orthophosphate.
- A field transfer blank collected by pouring lab-provided deionized water into a clean sample bottle to determine whether field contamination is present, unrelated to the equipment.
- A field transport blank collected by transporting unopened bottles containing organic and metal-free certified clean water from the laboratory into the field, and then returning it to the laboratory (bottles are not opened in the field). Transport blanks are used to determine whether any contamination occurs while traveling from field to laboratory.

Any field blank contamination will be reviewed by the QA Officer or Data Steward to determine whether samples associated with the field blanks should be qualified based on the contamination. Sample results will be flagged with a *J* if they are less than or equal to 5 times the field blank concentration.

A schedule of storm events with planned field replicate, blank, or other QC samples will be maintained and followed as part of the stormwater sampling program.

Table 15 Field quality control schedule.*

Field Sample Collected	Frequency [2]	Control Limit	Corrective Action
Composited Field Replicate	10% of total samples or 1 per batch[1]	Qualitative control – Assess representativeness, comparability, and field variability	Review procedures; alter if needed
Grab Field Replicate	10% of total samples or 1 per batch[1]		Review procedures; alter if needed
Equipment Rinsate Blank	At least once a year at each site (the first year; BMP sites will be sampled twice early in the program, per TAPE guidance)	Blank analyte concentration should be below the reporting limit	Compare blanks for analyte to determine whether the sampling process is the source of contamination; re-evaluate decontamination procedures; evaluate results greater than 5x blank concentrations
Blank Samples for Determining a Contamination Source	As needed	Blank analyte concentration should be below the reporting limit	Compare results from separated blanks to isolate the source of contamination; evaluate results greater than 5x blank concentrations

[1] Total samples are for the entire monitoring program under S7 of the permit.

[2] Frequencies will be maintained for the monitoring program in its entirety.

* The table is based in part on an EPA QA and SOP website (Appendix B-3: Field QC and Laboratory QC Sample Collection and Documentation Requirements) accessed January 2011:
http://www.epa.gov/earth1r6/6pd/qa/qadevtools/mod5_sops/sample_handling_preservation/appendix_b3.pdf

10-2 Laboratory Quality Control Procedures

This section discusses the quality control (QC) procedures that will be implemented by the contracted analytical laboratory in order to provide high-quality chemical and physical analyses that meet the requirements of the WSDOT permit. Contract laboratories will make every effort to meet sample holding times and target reporting limits for all parameters.

Laboratory quality control procedures and results will be closely monitored throughout the duration of the permit-mandated sampling. The quality of laboratory data is subject to review via the established protocols in Section 5-2, Measurement Quality Objectives. A typical schedule for laboratory QC samples is shown in Table 16 and at a minimum includes:

- Laboratory duplicates
- Matrix spikes
- Matrix spike duplicates
- Method/instrument blanks
- References (standards/surrogate standards/internal standards)

10-2.1 Laboratory Instrument Calibration

The instrumentation utilized by the chosen laboratories will meet or exceed manufacturers' specifications for use and maintenance. Maintenance of this equipment will be conducted in a manner specified by the manufacturer or by the quality assurance guidelines established by the chosen laboratory. Use of this equipment will follow the chosen laboratory's standard operating procedures or the methods established by the manufacturer.

10-2.2 Laboratory Duplicate/Splits

Laboratory duplicate samples will be analyzed regularly to verify that the laboratory's analytical methods are maintaining their precision. The contracted laboratory should perform "random" duplicate selection on submitted samples that meet volume requirements. After a sample is randomly selected, the laboratory should homogenize the sample and divide it into two identical "split" samples. To verify method precision, identical analyses of these lab splits should be performed and reported. Some parameters may require a double volume for the parameter to be analyzed as the laboratory duplicate. Matrix spike duplicates may be used to satisfy frequencies for laboratory duplicates.

10-2.3 Laboratory Matrix Spikes and Matrix Spike Duplicates

Matrix spike samples are triple-volume field samples (per parameter tested) that are spiked in the laboratory with method-specific target analytes, and then analyzed under the same conditions as the field samples. A matrix spike provides a measure of the recovery efficiency and accuracy for the analytical methods being used. Matrix spikes are typically analyzed in duplicate (matrix spike/matrix spike duplicate [ms/msd]) to determine method accuracy and precision. Matrix spikes will be prepared and analyzed at a rate of 1pair/20 (five percent) samples collected or one pair for each analytical batch, whichever is most frequent. (Batch matrix spikes may be performed on other samples not related to this monitoring effort.) The ms/msd samples should be collected in the first shipment of organics samples.

Use of ms/msd at the frequency of five percent of the total number of samples is common practice. For the purposes of permit monitoring, these frequencies meet the expectations. However, WSDOT may consider a more frequent use of ms/msd samples early in the monitoring program, then taper off to five percent or one pair for each analytical batch later in the program. Laboratory duplicates may be used to satisfy frequencies for matrix spike duplicates.

10-2.4 Laboratory Blanks and Standards

Laboratory blanks are useful for instrument calibrations and method verifications, as well as to determine whether any contamination is present in laboratory handling and processing of samples.

Laboratory Standards

Laboratory standards (reference standards) are objects or substances that can be used as a measurement base for similar objects or substances. In many instances, laboratories using digital or optical equipment will purchase, from an outside accredited source, a solid, powdered, or liquid standard to determine high- or low-level quantities of a specific analyte. These standards are accompanied with acceptance criteria and are used to test the accuracy of the laboratory's methods. Laboratory standards are typically used after calibration of an instrument and prior to sample analysis.

Surrogate and Internal Standards

Surrogate standards are used for processing and analysis of extractable organic compounds (TPH, PAHs, phthalates, and herbicides). A surrogate standard is added before extraction, and it monitors the efficiency of the extraction methods. Internal standards are added to organic compounds and metal digestates to verify instrument operation when using inductively coupled plasma-mass spectrometry (ICP-MS) analysis.

Method Blanks

Method blanks are designed to determine whether contamination sources may be associated with laboratory processing and analysis. Method blanks are prepared in the laboratory using the same reagents, solvents, glassware, and equipment as the field samples, and they will accompany the field samples through analysis.

Instrument Blank

An instrument blank is used to "zero" analytical equipment used in the laboratory's methods. Instrument blanks usually consist of laboratory-pure water and any other method-appropriate reagents, and they are used to zero instrumentation.

Table 16 Example of laboratory quality control schedule for monitoring effort.

Quality Control Sample[1]	Analysis Type	Frequency[2]	Control Limit	Corrective Action
Laboratory Duplicates[3]	inorganic	5% of total samples or 1 per batch (method-specific)	RPD[4] >20%	Evaluate procedure; ID contaminant source; reanalyze or qualify affected data
	conventional		Analyte/matrix-specific: usually RPD >20%	
	organics		RPD >40%	
Matrix Spikes	inorganic	For metals at least 2 samples per year; otherwise, 5% of total samples or 1 per batch[1]	Analyte/matrix-specific: usually Recovery <75% or >125%	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
	conventional	5% of total samples or 1 per batch[1]	Analyte/matrix-specific: usually Recovery <75% or >125%	
	organics	5% of total samples or 1 per batch[1]	Analyte/matrix-specific: ranges from Recovery <10% or >150%	Evaluate lab dups/standards recoveries and assess matrix effects; evaluate or qualify affected data
Matrix Spike Duplicates[3]	inorganic	For metals at least 2 samples per year; otherwise, 5% of total samples or 1 per batch	RPD >20%	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
	conventional	5% of total samples or 1 per batch	Analyte/matrix-specific: usually RPD >20%	
	organics	5% of total samples or 1 per batch	Analyte/matrix-specific: usually RPD >40% (water); RPD >20% (soil)	
Method / Instrument Blanks	inorganic	5% of total samples or 1 per batch (method-specific)	Blank analyte/matrix concentration ≤ reporting limit	Blank concentration is defined as the new reporting limit – Evaluate procedure; ID contaminant source; reanalyze blanks or qualify sample data (<5-10x blank concentration)
	conventional			
	organics			
References (lab control sample, surrogate, and internal standards)	inorganic	5% of total samples or 1 per batch (method-specific)	Analyte/matrix-specific: ranges from Recovery <70% or >130%	Evaluate lab duplicates and matrix spike recoveries, and assess efficiency of extraction method; evaluate or qualify affected data
	conventional		Analyte/matrix-specific: ranges from Recovery <70% or >130%	
	organics		Analyte/matrix-specific: ranges from Recovery <10% or >183%	

[1] Quality control samples may be from different projects for frequencies on a per batch basis.

[2] Frequencies will be maintained for the monitoring program in its entirety.

[3] Laboratory and matrix spike duplicates both measure precision and accuracy; a combination of these two quality control samples may be used to satisfy frequencies.

[4] RPD: relative percent difference.

11 Data Management Procedures

WSDOT's stormwater monitoring program will be collecting and managing data from three sources: telemetered field stations, field observations/measurements, and laboratory analysis of field samples. All data will be managed and stored by WSDOT. Post-processed data will be finalized and incorporated into annual reports and electronic reports. Reports and data will be submitted to Ecology in the format required by the permit.

11-1 Telemetered Data Management

Telemetered data will be transmitted from each station hourly throughout the year and will be managed by WSDOT and stored in a WSDOT database. Telemetered data will be augmented with data downloaded from the data logger to fill any potential data gaps.

11-2 Field Data Management

Field checklists and forms will be completed in the field during sampling and maintenance visits. All field documentation will be reviewed by the field technicians for completeness and identification of potential errors while in the field. Documents will be organized and stored in the appropriate central storage, which will be determined by the WSDOT Data Steward.

Data downloaded from the field data loggers will be uploaded to a centralized dedicated location at WSDOT. After uploading data, field staff will send the responsible senior staff an e-mail notifying them that the data have been moved to the storage folder for processing. Senior staff will then import, verify, and process those data via WSDOT's database.

11-3 Laboratory Data

Finalized laboratory data will be sent to WSDOT from each laboratory. Following analysis, the laboratories will be allowed to batch samples based on holding times to provide cost savings. Reporting will vary depending on holding time, but should not exceed six months from the documented sampling date. Data will be submitted as an electronic data deliverable and a hard copy or PDF report. Hard copies or PDFs will be mailed or e-mailed to the Data Steward at WSDOT. Laboratory reports will be reviewed by the Data Steward/Quality Assurance Officer. Any errors or missing data will be reported to the responsible laboratory for amendment or correction. Finalized electronic laboratory data will be incorporated into WSDOT's database, while hard copy data sheets will be filed in WSDOT's central data storage

11-4 Audits

Routine audits will be conducted by senior staff to ensure this QAPP is being implemented correctly and the quality of the data is acceptable. A review of field procedures will be conducted once annually for each crew. If QA issues are identified during an audit, assessment and response actions will be implemented as necessary. The sections below describe in detail the steps to be carried out in connection with each of these activities.

During an audit review, the auditor may check that:

- Sampling locations were correctly sampled.
- SOPs were followed.
- There is documentation of the visit, with chain of custody or maintenance forms.
- There is proper identification and resolution of nonconformances.
- Correction of identified deficiencies has been made.
- Assessment has been made and corrective action taken.

The need for an audit can be determined by any participating member in the stormwater monitoring program. An audit may include procedural reviews, field visits, technical oversight, inspection, data quality assessment, or management system review. Audits of the analytical laboratories are limited to the subcontract agreements made with those laboratories.

11-5 Deficiencies, Nonconformances, and Corrective Action

Deficiencies are defined as unauthorized deviations from those procedures documented in the QAPP or SOPs. Nonconformances are deficiencies that severely affect the data quality and render them unacceptable or indeterminate. Deficiencies related to field and laboratory measurement systems include, but are not limited to, missed field visit forms, instrument malfunctions, blanks contamination, and quality control sample failures.

Routine audits will be performed to detect potential deficiencies in the automated water quality, temperature, and rainfall data collected for this project. In connection with those audits, the downloaded data will be compared with telemetered data to identify potential quality assurance (QA) issues. This audit will specifically include an examination of the data record for gaps, anomalies, or inconsistencies among the precipitation data from the automated monitoring stations.

Any data generated from calibration checks that were performed at a particular monitoring station will also be entered into control charts and reviewed to detect potential instrument drift or other operational problems. If QA issues are identified on the basis of these audits, a site visit will be performed immediately to troubleshoot the problem and to implement corrective actions if possible. Any QA issues detected through these audits will be documented in the electronic data record.

Audits performed for water quality data will occur according to WSDOT's Stormwater Monitoring Quality Management Plan. This review will be performed to ensure all data are consistent, correct, and complete, and all required quality control information has been provided. Results from these audits will be documented in QA worksheets that will be prepared for each batch of samples. If a potential QA issue is identified through these audits, the Data Steward or Quality Assurance Officer will review the data to determine whether any response actions are required. Response actions in this case might include the collection of additional samples or the reanalysis of existing samples. If reanalysis is not an option, corrective actions may include the qualification of the data as estimated (*J*) or rejected (*R*) values. All deficiencies, nonconformances, and corrective actions will be documented in annual data reports for the project.

Deficiencies detected through routine audits will be documented in accordance with the procedures identified above. The Quality Assurance Officer, in consultation with the Project Manager, will determine whether the deficiency constitutes a nonconformance. If it is determined that a nonconformance exists, the Quality Assurance Officer will decide the disposition of the nonconforming data and any necessary corrective action(s). Corrective actions may include the qualification of the data as estimated (*J*) or rejected (*R*) values. All deficiencies, nonconformances, and corrective actions will be documented in annual status reports for the project. Status reports may include:

- Graphical and tabular summaries of the collected data.
- Results from comparisons in hydrology and water quality between the monitoring sites.
- Conclusions.
- Appendices: quality assurance memoranda, raw data tables, field datasheets, and chain of custody documentation.

12 Data Verification, Validation, and Usability

12-1 Data Verification

Data verification refers to the process of data review that occurs at the end of a data collection effort, such as at the end of the wet season or year. Data verification is defined as:

> *Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set.* (Kammin, 2010)

The Quality Assurance Officer or the Data Steward will implement the data verification process. Field data inputs, the completed chain of custody (COC), and laboratory reports, bench sheets, certifications, and process documentation will be reviewed to see whether they met requirements. If poor data quality trends or significant problems are identified, corrective action(s) will be implemented to improve the data quality.

The data verification procedures are being developed by a consultant for WSDOT to complement the QAPPs. As a result, verification procedure documentation will provide WSDOT a data assessment toolbox and programmatic approach to ensure quality goals. The verification procedures will be a stand-alone document. Initial data verification will focus on reviewing the data records, laboratory reports, field reports, and COCs. This review will look at qualified or flagged data and evaluate their impact on the overall data quality objectives. If the data do not meet the statistical data review criteria, then the data point will be removed from the overall data set. The preliminary review may incorporate statistical review methods described later in this section. Issues that could affect the usability of the data may include: apparent anomalies in recorded data, missing values, deviations from standard operating procedures, and the use of nonstandard data collection methodologies (USEPA, 2002a).

Any changes to the results as originally reported by the laboratory should either be accompanied by a note of explanation from the data verifier or the laboratory, or reflected in a revised laboratory data report.

Data verification records include certification statements, which certify the data have been verified and signed by appropriate personnel. Data verification records can also include a narrative that identifies technical noncompliance issues or shortcomings of the data produced during the field or laboratory activities.

12-1.1 Statistical Data Review

A statistical data review will be conducted to identify outliers and other abnormalities in the data. Statistical analysis will calculate the mean, median, mode, sample range, sample variance, standard deviation, standardized mean difference, and the coefficient of variation. Outliers or data that are anomalous with the entire data set will be reviewed for the origin of the error in data collection, laboratory analysis, data input and recording, QA/QC, and data verification.

The data will be plotted to identify additional outliers or confirm outliers and abnormal data. Outlying data will be compared against the statistical and preliminary data review to confirm that the point is an outlier or anomaly.

If the data are unable to conform, do not meet the data quality objectives, or it is uncertain whether the data are able to conform to the project data set and goals, then the data will be removed.

12-1.2 Nondetects

Nondetected data will be addressed through use of statistical methods commonly agreed upon by the group of Phase I permittees. An SOP for evaluating nondetects (currently in draft form) provides a summary and comparison of the following methods: Substitution Half-U, Maximum Likelihood Estimation, Regression on Order Statistics, Robust Regression on Order Statistics, or Kaplan Meier (Non-parametric).

12-2 Data Validation

Data validation goes beyond data verification to examine the data for usability. WSDOT may seek data validation on all or parts of the stormwater monitoring program for its own purposes; however, data validation is not required by the permit. Validation is defined as:

> *An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability and integrity, as these criteria relate to the usability of the data set.* (Kammin, 2010)

Ecology considers the following three key criteria to determine whether data validation has actually occurred:

- Use of raw or instrument data for evaluation
- Use of third-party assessors
- Use of EPA's *National Functional Guidelines* or the equivalent for review

12-3 Usability Statement

If the data verification process finds that the data quality objectives (DQOs) stated in this QAPP are met, then the data will be useable for project objectives. This statement of usability pertains to the data being acceptable for the purposes under which it was collected, but does not cover uses outside of the original intent. If the DQOs are not met, a determination will be made to either quantify and qualify the offending data and proceed with project goals or to consider elimination of the offending data completely. Anomalies in the data will be identified and their impacts on the data assessed in each annual Stormwater Monitoring Report.

Two main aspects of the Usability Statement include:

1. Determining the stormwater runoff is representative.
2. Ensuring sample results met the storm and sample criteria.

13 Reports

In accordance with the schedule presented in Section 4, Organization and Schedule, four types of reports will be generated in relation to the Stormwater Monitoring Program activities covered in this QAPP. These report types are:

1. Sample Field Notes
2. Sample Event Records
3. Stormwater Monitoring Report
4. Final Water Quality Monitoring Report

13-1 Field Notes and Event Records

13-1.1 Field Notes

Notes recorded in the field will be kept in an organized filing system and may include the following (paper or electronic) information:

- Field sampler name, date, and time of sampling
- Filtration and preservation of samples
- Volume of water collected
- Measurements made by multi-meter probes
- Visual observations
- Rainfall and runoff observations
- Records of number of grab samples taken
- Maintenance activity logs
- Maintenance inspection field sheets

13-1.2 Event Records

Records of the storm event will be kept in an organized filing system and may include the following (paper or electronic) information or components:

- Website print-outs of predicted rainfall
- Sampling time frame for the storm event
- Data quality analysis indicating how the sampled event met criteria
- Chain of custody forms
- Support documents such as calculations or problems encountered

13-1.3 Annual Stormwater Monitoring Report

The annual Stormwater Monitoring Report is required by S8.F of the permit to provide a summary of the previous water year's monitoring results. Detailed stormwater monitoring data reports are due to Ecology by October 31, beginning in 2013 and annually thereafter. The complete Annual Stormwater Monitoring Report will include, at a minimum, the information specified by the permit in S7 and S8.

For the reports submitted in 2010, 2011, and 2012, reporting requirements include the status of preparations to meet requirements in S7.A through S7.E of the permit and will be included in the annual Stormwater Management Plan (SWMP) Progress Report. In October 2013, a complete and separate Stormwater Monitoring Report is due, to accompany the annual SWMP Progress Report (Table 17).

Table 17 outlines the monitoring requirements as stated in the permit for each report. Data sets required to be submitted to Ecology will be in Excel format and included in the reports as tables or data summaries. All required reports will be submitted to Ecology in both paper and electronic formats.

Table 17 Reporting requirements for the Annual Stormwater Monitoring Reports starting in 2013 (Ecology, 2009a).

Category	Reporting Requirement
Sampled Storm Event	Sample event identification (date, time, location)
	Tabular water quality data and summary results for each monitored parameter
	Antecedent dry period, inter-event period, and total precipitation depth
	Time period of sample collection
Report	Any proposed changes to the monitoring program that could affect future data results for each site

13-1.4 Final Water Quality Monitoring Report

A Final Water Quality Monitoring Report is due February 6, 2014. It will include a complete discussion of each monitoring program outlined in S7 and S8.F of the permit. The report must include the following items:

- An estimated cost for each monitoring program component.
- Stormwater management actions taken or planned to reduce pollutants from WSDOT land uses.
- A description of the monitoring programs still in progress.
- A cumulative water quality results summary for each site.
- An estimated water quality loading from highway runoff sites for each pollutant, based on precipitation and runoff volume.
- Evaluation of monitoring sites.
- A cumulative analysis of parameters of concern from each of WSDOT's land use monitoring sites.

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15 Appendices

Appendix A Glossary, Acronyms, Abbreviations, and Units of Measurement

Glossary

accreditation – A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data" (WAC 173-50-040) (Kammin, 2010).

accuracy – The degree to which a measured value agrees with the true value of the measured property. EPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USGS, 1998).

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 or Klebsiella (Kammin, 2010).

best management practices (BMPs) – The schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices approved by Ecology that, when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington State (Ecology, 2009a).

bias – The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

blank – A sample prepared to contain none (or as little as possible) of the analyte of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

calibration – The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. The most important aspect of any calibration method is its ability to obtain accurate results with a high degree of certainty and repeatability (Kammin, 2010; Ecology, 2004).

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. Section 303(d) of the CWA establishes the Total Maximum Daily Load (TMDL) program. Pub.L.92-500, as amended Pub. L.95-217, Pub. L.95-576, Pub. L. (6-483 and Pub.L.97-117, 33 USC 1251et.seq).

comparability – The degree to which different methods, data sets, and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

completeness – The amount of valid data obtained from a data collection project compared to the planned amount. Completeness is usually expressed as a percentage; a data quality indicator (USEPA, 1997).

control chart – A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology, 2004).

control limit – Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean—action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

data integrity – A qualitative DQI that evaluates the extent to which a data set contains data that are misrepresented, falsified, or deliberately misleading (Kammin, 2010).

data quality indicators (DQI) – Data quality indicators are commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

data quality objectives (DQO) – Data quality objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

data set – A grouping of samples, usually organized by date, time, and/or analyte (Kammin, 2010).

data validation – An analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set (Ecology, 2004). Data validation criteria are based upon the measurement quality objectives developed in the QA Project Plan or similar planning document, or presented in the sampling or analytical method. Data validation includes a determination, where possible, of the reasons for any failure to meet method, procedural, or contractual requirements, and an evaluation of the impact of such failure on the overall data set. Data validation applies to activities in the field as well as in the analytical laboratory (USEPA, 2002a). Data validation follows data verification (USEPA, 2006). Ecology considers four key criteria to determine whether data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation
- Use of third-party assessors
- Data set is complex
- Use of EPA *Functional Guidelines* or equivalent for review

Examples of data types commonly validated would be:

- Gas Chromatography (GC)
- Gas Chromatography-Mass Spectrometry (GC-MS)
- Inductively Coupled Plasma (ICP)

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier, data is usable for intended purposes
- *J*, data is estimated, may be usable, may be biased high or low
- *R*, data is rejected, cannot be used for intended purposes (Kammin, 2010; Ecology, 2004)

data verification – The process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. Again, the goal of data verification is to ensure and document that the data are what they purport to be, that is, that the reported results reflect what was actually done. When deficiencies in the data are identified, then those deficiencies should be documented for the data user's review and, where possible, resolved by corrective action. Data verification applies to activities in the field as well as in the laboratory (USEPA, 2002a). Data verification precedes data validation (USEPA, 2006).

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.

detection limit (limit of detection) – The concentration or amount of an analyte that can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

duplicate samples – Two samples taken from and representative of the same population, and carried through the steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess the variability of all method activities, including sampling and analysis (USEPA, 1997).

EC_{50} (effective concentration, fifty percent) means the effluent concentration estimated to cause an adverse effect in fifty percent of the test organisms in a toxicity test involving a series of dilutions of effluent (WAC 173-205-020).

edge of pavement (EOP) interceptor – A 6-inch HDPE pipe or similar device that is set up to collect runoff from an impervious roadway. EOP interceptors also act as conveyance systems for stormwater from the road surface to pass through a flow measurement device and allow for composite sample collection.

fecal coliform – That portion of the coliform group which is present in the intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within twenty-four hours at 44.5 plus or minus 0.2 degrees Celsius (WAC 173-201A-020).

field blank – Blanks that are analyzed to determine whether there is contamination during sampling. For water sampling, these consist of pure (e.g., deionized, micro-filtered) water that is subjected to all aspects of sample collection, field processing, preservation, transportation, and laboratory handling as an environmental sample. The pure water must be obtained from the laboratory or other reliable supplier (Ecology, 2004). Field blanks include the following types:

> ***equipment rinsate blank*** – Pure (deionized, micro-filtered) water that is run through the sample pickup, tubing, and collection apparatus of the automated sampler, and is otherwise subjected to all subsequent aspects of sample collection, field processing, preservation, transportation, and laboratory handling as an environmental sample. If the equipment is not cleaned or rinsed with pure water before each environmental sample is drawn, then the equipment should not be cleaned or rinsed with pure water before collecting the rinsate blank.
>
> ***filter blank*** – A special case of a rinsate blank prepared by filtering pure water through the filtration apparatus after routine cleaning. The filter blank may detect contamination from the filter or other part of the filtration apparatus (Ecology, 2004). This is only applicable if filtration is done in the field.

transport blank – A container of pure water that is prepared at the lab and carried unopened to the field and back with the other sample containers to check for possible contamination in the containers or for cross-contamination during transportation, storage of the samples (Ecology, 2004).

transfer blank – Prepared by filling a sample container with pure water during routine sample collection to check for possible contamination from the surroundings. The transfer blank will also detect contamination from the containers or from cross-contamination during transportation and storage of the samples (Ecology, 2004).

laboratory control sample (LCS) – A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

matrix spike – A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology, 2004).

measurement quality objectives (MQOs) **–** A subset of data quality objectives (DQOs) that specify how good the data must be in order to meet the objectives of a project (Ecology, 2004). The acceptance thresholds or goals for a project's data, usually based on the individual data quality indicators (DQIs) for each matrix and analyte group or analyte. These include bias, precision, accuracy, representativeness, comparability, completeness, and sensitivity (USEPA, 2006).

measurement result – A value obtained by performing the procedure described in a method. (Ecology 2004).

method – A formalized group of procedures and techniques for performing an activity e.g., sampling, chemical analysis, or data analysis), systematically presented in the order in which they are to be executed (USEPA, 1997).

method blank – A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Kammin, 2010; Ecology, 2004).

method detection limit (MDL) – The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99 percent probability of being identified and reported to be greater than zero (40 CFR 136).

National Pollutant Discharge 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, 2009a).

nonpoint source – The term nonpoint source is used to identify sources of pollution that are diffuse and do not have a point of origin or that are not introduced into a receiving stream from a specific outlet. Common non-point sources are rainwater and runoff from agricultural lands, industrial sites, parking lots, and timber operations, as well as escaping gases from pipes and fittings (EPA Waste and Cleanup Risk Assessment Glossary).

nutrient – A substance such as carbon, nitrogen, or phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

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).

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.

point source – Any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation (CAFO), landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff (NPDES Glossary).

pollution – Contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life (WAC 173-200-020).

precision – The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998). Usually expressed as relative percent difference (RPD) or relative standard deviation (RSD) (Ecology, 2004).

quality assurance (QA) – A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP) – A document that describes the objectives of a project and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

quality control (QC) – The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

replicate samples – Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

reporting limit – (1) The minimum value below which data are documented as nondetects. (2) The minimum value of the calibration range. Analyte detections between the detection limit and the reporting limit are reported as having estimated concentrations (EPA Environmental Measurement Glossary 2010).

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).

sample (field) – A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

sample (statistical) – A finite part or subset of a statistical population (USEPA, 1997).

sensitivity – In general, denotes the rate at which the analytical response (e.g., absorbance, volume, or meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

spiked blank – A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 1997).

spiked sample – A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 1997).

split sample – This term denotes when a discrete sample is further subdivided into portions, usually duplicates (Kammin, 2010).

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, 2010).

surrogate – For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

systematic planning – A step-wise process that develops a clear description of the goals and objectives of a project and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The data quality objectives (DQO) process is a specialized type of systematic planning (USEPA, 2006).

Technology Assessment Protocol – Ecology (TAPE) – A Washington State Department of Ecology process for reviewing and approving new stormwater treatment technologies (Ecology, 2008a).

Total Maximum Daily Load (TMDL) – TMDL means a water cleanup plan. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure the water body can be used for the purposes the state has designated. The calculation must also account for seasonable variation in water quality. Water quality standards are set by states, territories, and tribes. They identify the uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. The Clean Water Act, section 303, establishes the water quality standards and TMDL programs (Ecology, 2009a).

Acronyms and Abbreviations

40 CFR	Title 40 of the Code of Federal Regulations
AADT	annual average daily traffic
BMP	best management practice
CB	catch basin
CFR	Code of Federal Regulations
CLP	contract laboratory protocols
COC	chain of custody
CWA	Clean Water Act
DCP	data collection platform
DQI	data quality indicator
DQO	data quality objective
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
et al.	and others
HRM	*Highway Runoff Manual*
ICP-MS	inductively coupled plasma-mass spectrometry
IDL	instrument detection limit
LCS	laboratory control sample
LID	low-impact development
MBAS	methylene blue active substances
MDL	method detection limit
MEL	Manchester Environmental Laboratory
MQO	measurement quality objective
MS4	municipal separate storm sewer system
MS/MSD	matrix spike/matrix spike duplicate
NB	northbound
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OP	orthophosphate
OWS	oil and water separator
PAH	polycyclic aromatic hydrocarbons
PASP	pre-activity safety plan
PPE	personal protective equipment
PSD	particle size distribution
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
RSD	relative standard deviation

RV	recreational vehicle
SB	southbound
SOP	standard operating procedure
SRM	standard reference materials
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TAPE	Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (TAPE)
TCE	trichloroethane
TEF	Technology Equipment Fund
TIE	toxicity identification evaluation
TI/RE	toxicity identification/reduction evaluation
TKN	total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TP	total phosphorus
TPH	total petroleum hydrocarbons
TRE	toxicity reduction evaluation
TSS	total suspended solids
USGS	United States Geological Survey
WAC	Washington Administrative Code
WQP	Water Quality Program
WSDOT	Washington State Department of Transportation

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
ft	feet
g	gram, a unit of mass
in	inch
L/min	liters per minute
mg	milligram
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mL	milliliters
ug/Kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
µm	micrometer
oz	ounce

Appendix B Section 7 of 2009 WSDOT NPDES Municipal Stormwater Permit

S7. MONITORING

A. Monitoring Objectives

WSDOT shall develop and implement a monitoring program to establish baseline stormwater discharge information from its highway conveyances, rest areas, maintenance facilities, and ferry terminals and develop and implement a monitoring program to evaluate Best Management Practice (BMP) effectiveness. Annual monitoring report data requirements shall be submitted as described in S8.F Stormwater Monitoring Report. WSDOT shall design the monitoring strategy to:

1. Produce scientifically credible data that represents discharges from WSDOT's various land uses;
2. Provide information that can be used by WSDOT for designing and implementing effective stormwater management strategies for WSDOT facilities; and
3. Determine the long-term effectiveness of individual facility Stormwater Pollution Prevention Plans.

B. Baseline Monitoring of WSDOT Highways

1. WSDOT shall obtain stormwater discharge quality and quantity data from the edge of pavement at highway sites. WSDOT shall collect data to allow analysis of pollutant loads and prioritize parameters of concern. WSDOT shall collect samples at each site, at the frequencies and durations, and for the parameters specified in this section.

2. Continuous flow recording of all storm events (not just sampled storm events) is necessary for at least one year to establish a baseline rainfall/runoff relationship.

3. Baseline Monitoring Site Selection

   Baseline monitoring sites shall have the conveyance system and drainage area mapped, and be suitable for permanent installation and operation of flow-weighted composite sampling equipment. WSDOT shall document the time of concentration for each selected drainage area using rainfall durations for typical seasonal storms.

   WSDOT shall establish monitoring sites at locations with the following annual average daily traffic (AADT):

   a. Two highly urbanized Western Washington sites (≥100,000 AADT)
   b. One urbanized Western Washington site (≤100,000 and ≥30,000 AADT)
   c. One rural Western Washington site (≤30,000 AADT)
   d. One urbanized Eastern Washington site (≤100,000 and ≥30,000 AADT)

4. Parameters To Be Sampled and Analyzed

   a. WSDOT shall sample, analyze, and report the following parameters as indicated in order of priority if insufficient volume exists. Chemicals below method detection limits after two years of data analysis may be dropped from the list of parameters. Parameter details, analytical methods and reporting limits are included in Appendix 5.
      i. Total and dissolved metals: copper, zinc, cadmium and lead
      ii. Polycyclic Aromatic Hydrocarbons (PAHs)

iii. Total suspended solids (TSS)
iv. Chlorides
v. Phthalates
vi. Herbicides: Triclopyr (Ester formula only), 2,4-D, Clopyralid, Diuron, Dichlobenil, Picloram , and Glyphosate (only if NON aquatic formula is used). Herbicides shall be sampled and analyzed only if applied near the monitoring site vicinity.
vii. Nutrients: Total phosphorus, orthophosphate

b. Grab samples shall be collected as early in the runoff event as practical. If grab samples are not collected during *qualifying* storm events, non-qualifying sized storm events may be sampled. Grab samples shall be collected, analyzed and reported for the parameters listed below. The total number of grab samples collected shall be equal to the total number of storm events collected to meet the conditions in S7.B.6.a. Parameter details, analytical methods and reporting limits are included in Appendix 5.
   i. Total Petroleum Hydrocarbons (TPH): NWTPH-Dx and NWTPH-Gx
   ii. Fecal coliform
   iii. Temperature (collected from runoff in-situ or as a grab sample)
   iv. Visible sheen observation

5. Sampling method

WSDOT shall use flow-weighted composite samplers to sample qualifying storm events, except where this permit specifies grab samples or other sampling methods. The automated sampler shall be programmed to begin sampling as early in the runoff event as practical. Each composite sample must consist of at least 10 aliquots. Composite samples with 7 to 9 aliquots are acceptable if they meet the other sampling criteria and help achieve a representative balance of storm events and storm sizes. WSDOT shall obtain samples from the edge of the pavement or from a location within a pipe conveyance system as long as in the latter case, the stormwater has not passed through a treatment BMP, a vegetated area, or the soil column.

6. Sample timing and frequency

WSDOT shall sample storm events as early in the storm event as practical and continue sampling past the longest estimated time of concentration for the contributing drainage area. For storm events lasting less than 24 hours, samples shall be collected for at least seventy-five percent of the storm event hydrograph. For storm events lasting longer than 24 hours, samples shall be collected for at least seventy-five percent of the hydrograph of the first 24 hours of the storm.

a. WSDOT shall sample each stormwater monitoring site at the following frequency:
   i. Sixty-seven percent of the forecasted qualifying storms, which result in actual *qualifying* storm events up to a maximum of 14 storm events per water year. 11 of the 14 storm events must meet the qualifying storm event criteria defined in Section S7.B.6.b.
   ii. WSDOT may collect and report data from up to 3 storm events that were forecasted qualifying storms but which did not meet the qualifying storm

event criteria for rainfall depth (0.2-inch minimum). These 3 non qualifying storms events may be collected and counted as part of the 14 required storm events.

iii. WSDOT shall ensure that storm samples are distributed throughout the year and approximately reflecting the distribution of rainfall between the wet and dry seasons. The goal for western Washington sites is to collect 60-80% of the samples during the wet season and 20-40% during the dry season. For eastern Washington, the goal is to collect 80-90% of the samples in the wet season and 10-20% of the samples in the dry season.

b. Storm Event Criteria
   i. A qualifying storm event during the wet season in Western Washington (October 1 through April 30) and in Eastern Washington (October 1 through June 30) shall meet the following conditions:
      1) Rainfall depth: 0.20-inch minimum, no fixed maximum
      2) Rainfall duration: No fixed minimum or maximum
      3) Antecedent dry period: less than 0.02-inch rain or no surface runoff in the previous 24 hours
      4) Inter-event dry period: 6 hours
   ii. A qualifying storm event during the dry season in Western Washington (May 1 through September 30) and in Eastern Washington July 1 through September 30) shall meet the following conditions:
      1) Rainfall depth: 0.20-inch minimum, no fixed maximum
      2) Rainfall duration: No fixed minimum or maximum
      3) Antecedent dry period: less than 0.02-inch rain in previous 72 hours
      4) Inter-event dry period: 6 hours

7. Baseline Sediment Testing

WSDOT shall trap and analyze sediments at each highway sampling site or at the vicinity of each stormwater monitoring site at least annually. WSDOT shall collect sediment samples using in-line sediment traps. Similar methods or sampling of receiving water sediment deposits shall be approved by Ecology at the time of QAPP submittal.

a. WSDOT shall sample, analyze, and report the following parameters in sediments, as indicated in order of priority if insufficient volume exists. Chemicals below method detection limits after two years of data analysis may be dropped from the list of parameters. Parameter details, analytical methods and reporting limits are listed in Appendix 5.
   i. Particle size (grain size)
   ii. Total organic carbon
   iii. Total metals: copper, zinc, cadmium and lead
   iv. PAHs
   v. TPH – NWTPH-Dx Phenolics
   vi. Herbicides: Dichlobenil, Triclopyr, Pircloram, and Clopyralid. Herbicides shall be sampled and analyzed only if applied in the monitoring site drainage area.
   vii. Phthalates
   viii. Total solids

8. Reporting for Baseline Monitoring of Highways
    a. The Annual Stormwater Monitoring Report shall include the following information for each sampled storm event:
        i. Sample event identification (date, time, location);
        ii. Tabular water quality data and summary results for each monitored parameter including sediments;
        iii. Antecedent dry period, inter-event period and total precipitation depth; and
        iv. A graphical representation of the storm's hyetograph and hydrograph, with aliquot collection points spatially located throughout the hydrograph; the sampled time period (% of hydrograph sampled), total runoff time period and total runoff volume.
    b. WSDOT shall include in each Annual Stormwater Monitoring Report the following information for each site once sampling begins:
        i. Rainfall/runoff relationship established using continuous flow records and precipitation data;
        ii. For the 2013 Annual Stormwater Monitoring Report, submit the following for each parameter:
            1) Mean and median Event Mean Concentrations (EMCs) only from sampled storm events; and
            2) Total annual pollutant load and the seasonal pollutant load for the wet and dry seasons only from sampled storm events.
        iii. For all other Annual Stormwater Monitoring Reports, WSDOT shall submit the following for each parameter:
            3) Mean and median EMCs only from sampled storm events;
            4) Total annual pollutant load and the seasonal pollutant load for the wet and dry seasons for both sampled and estimated unsampled storm events.
            5) The method used to estimate loads for unsampled events shall be applied to previously submitted data and continue for remaining years of the permit cycle.
            6) Any proposed changes to the monitoring program that could affect future data results.
    c. WSDOT shall express the loadings as total pounds and as pounds per acre.

C. Seasonal First Flush Toxicity Testing

WSDOT shall test the seasonal first flush for toxicity in accordance with the criteria and procedures described in this section. This toxicity testing is for screening purposes only and is not effluent characterization or compliance monitoring under WAC 173-205.

1. Toxicity Storm Event Criteria
    WSDOT shall collect six toxicity screening samples and associated chemical analysis at least once per monitoring year in August or September. Samples shall be collected with at least a one-week antecedent dry period (or October, irrespective of antecedent dry period, if unsuccessful in August or September).

2. Toxicity Sample Collection Criteria
   WSDOT shall collect adequate sample volume to perform both the toxicity test and the chemical analysis test described below. If sample volume for the toxicity test is equal to or less than 2 liters, do not attempt a toxicity test. Priority parameters are listed in S7.C.4 and volume requirements are listed in Appendix 6.

3. Toxicity Site Selection

   a. Once each year WSDOT shall test the seasonal first flush for toxicity from 3 untreated highway runoff monitoring locations. Samples shall be collected from the edge of the pavement or from a location within a pipe conveyance system as long as in the latter case the stormwater has not passed through a treatment BMP, a vegetated area, or the soil column. The following test sites shall be sampled:
      i. One highly urbanized site (≥100,000 AADT)
      ii. One urbanized site (≤100,000 and ≥30,000 AADT)
      iii. One rural site (≤30,000 AADT)
   b. Once each year WSDOT shall test the seasonal first flush for toxicity from 3 BMP effluent locations. BMPs shall be selected and designed in accordance with the HRM. One BMP site shall be categorized as an enhanced treatment BMP for metals removal. The BMPs shall be tested at the following sites:
      i. One highly urbanized site (≥100,000 AADT)
      ii. One urbanized site (≤100,000 and ≥30,000 AADT)
      iii. One rural site (≤30,000 AADT)

4. Parameters to be Sampled and Analyzed
   At each monitoring site, WSDOT shall collect a sample for chemical analysis and a sample for the toxicity test using the same sampling methods, at the same time and location. Parameter details, analytical methods and reporting limits are presented in Appendix 5. Chemicals below reporting limits after two years of data analysis may be dropped from the list of parameters. The following parameters shall be collected and analyzed, as indicated in order of priority if insufficient volume exists:
   a. Total and dissolved metals: copper, zinc, cadmium and lead
   b. Herbicides (listed in S7.B.4 and if only applied in the monitoring site drainage area).
   c. Total suspended solids
   d. Chlorides
   e. Hardness
   f. Methylene blue activated substances (MBAS)
   g. PAHs
   h. Phthalates
   i. TPH: NWTPH-Gx and NWTPH-Dx (collected as a grab sample)

5. Sampling Method

   WSDOT shall collect time or flow-weighted composite samples. If WSDOT is unsuccessful in completing a toxicity test despite documented, good faith efforts or due to an invalid or anomalous test result, WSDOT shall make a second sampling attempt if sufficient time remains to meet the toxicity storm event criteria. If the second attempt is also unsuccessful, WSDOT shall document its efforts in its annual stormwater monitoring report and shall not be required to conduct further sampling and analysis efforts under S7.C for that calendar year.

6. Laboratory Testing Procedures

   WSDOT shall follow toxicity testing procedures for *Hyalella azteca* 24-hour test per ASTM E1192-97. Toxicity tests must meet quality assurance criteria in the most recent versions of ASTM E1192-97 and the Department of Ecology Publication #WQ-R-95-80, Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria. The laboratory must conduct water quality measurements on all samples and test solutions for toxicity testing as specified in the most recent version of Department of Ecology publication #WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.* Sample volume, replicates, control and concentrations and required test conditions for the 24-hour survival test (ASTM E1192-97) are included in Appendix 6.

7. Follow up Actions

   If the EC_{50} from any valid and non-anomalous test is 100% stormwater or less, WSDOT shall conduct follow-up actions. WSDOT shall prepare a study design to further refine the knowledge of toxicant concentrations in stormwater discharged to receiving waters from WSDOT's roads and highways. WSDOT shall use the findings from this study to determine which highway site(s) warrant further investigation. The study design shall include a mapping of site-specific MS4s, any installed or planned structural BMPs, proposed sampling and analysis and a description of the toxicity pathways to receiving water. If necessary to produce knowledge from the study useful in source control or BMP improvement, WSDOT shall include a toxicity identification/reduction evaluation (TI/RE) in the study design. The TI/RE shall be based upon instructions in WAC 173-205-100.

8. Reporting for Annual First Flush Toxicity Testing

   WSDOT shall submit the following information for each sampling event at each site:

   a. WSDOT shall report an EC_{50} for each test. WSDOT shall submit all reports for toxicity testing in accordance with the most recent version of Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.* Toxicity reports shall be included in each Annual Stormwater Monitoring Report beginning in 2013 with the following information:
      i. Reports shall contain bench sheets, and reference toxicant results if required for the protocol, for test methods.

ii. WSDOT shall submit toxicity test reports, bench sheets, and reference toxicity results in electronic format for entry into Ecology's database and shall submit a hardcopy.

iii. WSDOT shall calculate the EC_{50} by the trimmed Spearman-Karber procedure. WSDOT may apply Abbott's correction to the data before deriving this point estimate.

D. Baseline Monitoring of Rest Areas, Maintenance Facilities and Ferry Terminals

1. Monitoring Site Selection

WSDOT shall conduct stormwater discharge monitoring to collect baseline water quality data. Monitoring locations shall be located to capture runoff from most of the site and down gradient of the major pollutant generating activities for each facility. WSDOT shall sample the following land uses:

a. Two High-Use Rest Areas
b. Six Maintenance Facilities, one in each WSDOT region;
c. One High-Use Ferry Terminal

2. Parameters Sampled and Analyzed in Stormwater

The following parameters shall be sampled, analyzed and reported in untreated water. Chemicals below method detection limits after two years of data analysis may be dropped from the list of parameters. Parameter details, analytical methods and reporting limits are presented in Appendix 5.

a. Rest areas (as indicated in order of priority if insufficient volume exists):
   i. TPH: NWTPH-Dx and NWTPH-Gx (grab)
   ii. Total and dissolved metals: copper, zinc, cadmium and lead
   iii. PAHs
   iv. TSS
   v. Herbicides (listed in S7.B.4 only for those that WSDOT applies on-site, stores on-site, or applies by vehicles parked on-site)
   vi. Nutrients: Total phosphorus, nitrate/nitrite, ortho-phosphorus, and total Kjeldahl nitrogen
   vii. Chlorides
   viii. Phthalates
   ix. Fecal coliform (grab)
   x. Temperature (collected from runoff in-situ or as a grab sample)
b. Maintenance facilities (as indicated in order of priority if insufficient volume exists):
   i. Total suspended solids
   ii. TPH: NWTPH-Dx and NWTPH-Gx (grab)
   iii. PAHs
   iv. Herbicides (listed in S7.B.4 only for those that WSDOT applies on-site, stores on-site, or applies by vehicles parked on-site)
   v. Nutrients: Total phosphorus, ortho-phosphorus, nitrate/nitrite and total Kjedahl nitrogen (where fertilizers are applied on-site, stored on-site or applied by vehicles parked on-site)
   vi. Total and dissolved metals: copper, zinc, cadmium and lead

vii. Methylene blue activated substances (MBAS)
viii. Chlorides

c. Ferry Terminal (as indicated in order of priority if insufficient volume exists):
   i. PAHs
   ii. TPH: NWTPH-Dx and NWTPH-Gx (collected as a grab sample)
   iii. Total and dissolved metals: copper, zinc, cadmium and lead
   iv. MBAS
   v. Total suspended solids
   vi. Fecal coliform (grab)
   vii. Temperature (collected from runoff in-situ)

3. Sampling Method

   WSDOT shall collect samples using composite samplers or by manual compositing grab samples. A composite sample shall consist of a minimum of five individual stormwater grab samples equally spaced in time and collected within the first hour of runoff.

4. Sample Timing and Frequency

   WSDOT shall conduct sampling as early in the runoff event as practical but not later than 20 minutes after the onset of runoff at the monitoring location.

   a. WSDOT shall collect samples from a minimum of seven storm events throughout the calendar year.
      i. WSDOT shall sample at least five qualifying storm events during the wet season. Wet season samples shall be collected over a time frame exceeding 28 consecutive days.
      ii. WSDOT shall sample at least one qualifying storm event during the dry season
      iii. Additionally, WSDOT shall collect a sample that represents the seasonal first-flush event no earlier than August 1. The seasonal first-flush sample must have a one-week antecedent dry period.
   b. Storm Event Criteria

      A qualifying storm event during the wet season in Western Washington (October 1 through April 30) and wet season in Eastern Washington (October 1 through June 30) shall meet the following conditions:
      i. Rainfall depth: 0.20-inch minimum, no fixed maximum
      ii. Rainfall duration: No fixed minimum or maximum
      iii. Antecedent dry period: less than 0.02-inch rain or no surface runoff in the previous 24 hours
      iv. Inter-event dry period: 6 hours

      A qualifying storm event during the dry season in Western Washington (May 1 through September 30) and dry season in Eastern Washington (July 1 through September 30) shall meet the following conditions:

      v. Rainfall depth: 0.20-inch minimum, no fixed maximum
      vi. Rainfall duration: No fixed minimum or maximum
      vii. Antecedent dry period: less than 0.02-inch rain in previous 72 hours
      viii. Inter-event dry period: 6 hours

5. Reporting requirements for Baseline Monitoring of Rest Areas, Maintenance Facilities and Ferry Terminals

   a. WSDOT shall submit an Annual Stormwater Monitoring Report with the following information for each sampled storm event beginning in 2013:
      i. Sample event identification (date, time, location)
      ii. Tabular water quality data and summary results for each monitored parameter;
      iii. Antecedent dry period, inter-event period and total precipitation depth; and
      iv. The time period of sample collection.

   b. WSDOT shall include in each Annual Stormwater Monitoring Report any proposed changes to the monitoring program that could affect future data results for each *site.*

E. Monitoring the Effectiveness of Stormwater Treatment and Hydrologic Management Best Management Practices (BMPs)

1. WSDOT shall conduct a full-scale monitoring program to evaluate the effectiveness and operation and maintenance requirements of stormwater treatment and hydrologic management BMPs. Any BMPs listed in its Highway Runoff Manual (HRM) may be selected. Stormwater treatment and hydrologic BMPs not listed in the HRM, require engineering designs, specifications, and approval from a professional engineer.

2. WSDOT shall monitor at least two treatment BMPs, at no less than two sites per BMP. Monitoring shall continue until statistical goals are met (defined by Ecology's publication, "Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol" (TAPE). If the statistical goals are not achieved within the term of this permit, Ecology will consider continuing the monitoring effort in the next permit cycle.

   a. WSDOT may choose BMPs it has already started evaluating prior to issuance of this permit, provided the study meets the guidelines outlined below. WSDOT shall complete the evaluation during this permit cycle.
   b. WSDOT shall obtain written approval from Ecology for the BMPs WSDOT proposes to evaluate.
   c. WSDOT shall select BMPs from the following categories:
      i. Basic Treatment
      ii. Enhanced Treatment
      iii. Metals/Phosphorus Treatment
      iv. Oil Control
   d. WSDOT shall also select one flow reduction strategy BMP (such as LID) that is in use or planned for installation. Monitoring of a flow reduction strategy shall include continuous rainfall and surface runoff monitoring. Flow reduction strategies shall be monitored through either a paired study or against a predicted outcome.

3. For BMPs monitored under this section, WSDOT shall test BMPs that have been designed and installed in accordance with HRM unless Ecology approves of an alternate design in the QAPP review.

4. WSDOT shall use appropriate sections of Ecology's TAPE (available on Ecology's website) for preparing, implementing, and reporting the results of the BMP evaluation program.
   a. WSDOT shall use USEPA publication number 821-B-02-001, "Urban Stormwater BMP Performance Monitoring," as additional guidance for preparing the BMP evaluation monitoring and shall collect information pertinent to fulfilling the "National Stormwater BMP Data Base Requirements" in section 3.4.3. of that document.
   b. WSDOT shall determine mean and median effluent concentrations, and shall determine percent removals for each BMP type with a statistical goal of 90-95% confidence and 75-80% power for the parameters for which the facility is approved in the HRM. The initial QAPP shall commit to a monitoring program designed to achieve the statistical goal, but shall target collection of at least 12 influent and 12 effluent samples per year.
5. WSDOT shall monitor the following parameters at each test site:
   a. For Basic, Enhanced, or Phosphorus Treatment BMPs: total suspended solids, particle size distribution, pH, total phosphorus, ortho-phosphate, hardness, and total and dissolved copper and zinc.
   b. For Oil Control BMPs: pH, NWTPH-Dx and –Gx, and visible oil sheen
6. WSDOT shall sample the accumulated sediment at each test site for Basic, Enhanced, Phosphorus treatment, or Oil Control BMPs for the following parameters: total solids, particle size (grain size), total volatile solids, NWTPH-Dx, total phosphorous, and total cadmium, copper, lead, and zinc.
7. Reporting requirements for Stormwater Treatment and Hydrologic Management Best Management Practice (BMP) Evaluation Monitoring beginning with the 2013 Stormwater Monitoring Report WSDOT shall include the following information for *each sampling event from each site*:
   a. Sample event identification (date, time, location)
   b. Tabular water quality data and summary results for each monitored parameter;
   c. Antecedent dry period, enter-event period and total precipitation depth;
   d. A graphical representation of storm hyetograph and hydrograph for both the influent and effluent, with each aliquot collection point spatially located throughout the hydrograph; the sampled time period (% of hydrograph sampled), total runoff time period and total runoff volume.
8. Beginning with the 2013 monitoring annual report and annually thereafter until statistical goals are met, WSDOT shall include in each Annual Report for BMP Evaluation Monitoring the following information for each *site*:
   a. Status of implementing the monitoring program and a description of Stormwater Treatment and Hydrologic Management BMP Evaluation Monitoring programs that are still in progress at the end of the reporting year
   b. WSDOT shall compute and report cumulative (including previous years) performance data for each treatment BMP test site, and for both sites of the same treatment BMP type, consistent with the guidelines in appropriate sections of Ecology's guidance for "Evaluation of Emerging Stormwater

Treatment Technologies" and USEPA publication number 821-B-02-001, "Urban Stormwater BMP Performance Monitoring," including information pertinent to fulfilling the "National Stormwater BMP Data Base Requirements" in section 3.4.3. of that document.

   c. Status of cumulative (including previous years) performance data in terms of statistical goals for each test site and for both test sites of the same treatment BMP type;
   d. Status of performance data concerning flow reduction performance for the hydrologic reduction BMP; and
   e. Any proposed changes to the monitoring program that could affect future data results.

9. A final report on each BMP monitored shall be submitted once the monitoring statistical goals are met. The final report shall include an analysis of the performance data collected on the BMPs as described in the appropriate sections of Ecology's TAPE (available on Ecology's website).

Appendix C Traffic Control Safety Guidelines

Safety Guidelines

All WSDOT personnel and contracted individuals will follow the guidelines set forth in the WSDOT publication *Work Zone Traffic Control Guidelines* (WSDOT, September 2009b). Personnel sampling stormwater runoff near roadways will be trained in the following safety guidelines and requirements.

Personal Protective Equipment (PPE)

All personnel will wear and maintain the appropriate PPE as specified by WSDOT. This includes an ANSI or MUTCD-approved type II or better retroreflective safety vest and hard hat. Weather and work-appropriate clothing will be worn for the work zone. Hearing and eye protection may be advised, depending on site conditions.

Personal Attributes

All personnel will remain alert, keep a positive and safety-conscious attitude, and be responsible for their own safety as well as that of their co-workers. It is imperative to be mindful of what is happening around the work zone.

Pre-Activity Safety Plan (PASP)

All personnel will be involved with completing and reviewing the detailed pre-activity safety plan for stormwater field work before setting up the work zone. An example PASP is displayed on the following page as a guidance document for field work.

Short-Duration Work Zones

Short-duration work zones can be described as any activity where work duration lasts less than or up to 60 minutes. Most of the stormwater sampling or equipment-checking operations will be short duration. Any work that may take longer (such as station installation) will require WSDOT to develop a tailored work plan to best suit the operation. Refer to TCP-5, TCD-16, and the "Short Duration Don'ts and Do's" from Section 3-8 in the *Work Zone Traffic Control Guidelines,* for short-duration site setup specifications on and near shoulders of multilane highways.

Safety Equipment Needed

1 – Road Work Ahead sign

1 – Shoulder Work sign

8 – 24-inch retroreflective cones

1 – Traffic Warning Light (vehicle mounted) visible from 1,000 feet away

WSDOT vehicle used to provide space for personnel

PRE-ACTIVITY SAFETY PLAN

STORMWATER FIELD WORK

Date:_________ Employee:___________________ PASP#____

1. Complete pre-travel checklist prior to travel.
2. Upon reaching the field site, team lead: evaluates work area, completes site description (below), and completes hazard assessment checklist (on back).
3. Team lead assembles field crew and reviews / discusses the Pre-activity Safety Plan controls for each safety hazard identified on the completed hazard assessment checklist.
4. Team lead maintains completed safety hazard checklist until all have returned to work station and/or have check in with their supervisor. Save document for the next person that might visit.

Site Information	Purpose of Site Visit	PPE's
Site Name: ______________________________ Field Contact:_____________________________ Phone #: (____) _____ - _________ Location: SR_____MP_____ County ______________ Nearest Medical Facility: ____________________ Map Attached Traffic Control Needed Check-in Person :________________________ Remote Location? Cell Phone Service Phone Available Scan Calling Card First Aid planning*** Known conditions/allergy medication available? Action planned _______________________	 **Pre-Travel Checklist** □ Environmental Safety Hazard Assessment and Mitigation Booklet □ Washington State Hospital List □ Pre-Trip Vehicle Inspection and Familiarization □ 1st Aid Kit □ Flares/Triangles/Signs □ Emergency Contact Phone List □ Beacons/signage/traffic cones available in vehicle □ Check SR View for parking possibilities (http://www.srview.wsdot.wa.gov/home.htm)	☐ Vest ☐ Hard Hat ☐ Eye Protection ☐ Gloves ☐ Work Boots ☐ Hearing Protection ☐ Hip Boots or waders ☐ PFD ☐ Throw rope bag ☐ Sun block ☐ Insect repellent ☐ Other:_________

PARKING ISSUES

Park in areas that provide safe entrance and exit of the work area, do not create potential conflicts with other vehicles and equipment or fire hazard on tall grass.

1. Parking on roadside or near traffic. **(<2 ft. from fog line more than 15 minutes)** □ **Yes** □ **No**	**1. When stopped on shoulder or roadway use beacon lights per WAC 204-38* requirements.** **2. Follow the signage and work provisions in the M54-44* for short/long duration work zones.** **3. When backing in a vehicle larger than a sedan, you must honk twice before backing (Work Zone Safety)**	**Parking on roadside or near traffic.** **(<15 ft. from fog line more than 15 minutes)** □ **Yes** □ **No**	**1. Position cones behind vehicle if there is limited visibility or curves in road** **2. Field vehicles should be equipped with appropriate signage for a shoulder closure.** **3. Lane closures will need to be coordinated through Traffic Control.**

* *Details pending*. WAC 204-38 is available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=204-38

** *Details pending*. M54-44 is available at http://www.wsdot.wa.gov/Publications/Manuals/M54-44.htm

*** The PASP's shouldn't include medical information, but hazards like bee stings or poison oak should be identified. If employees elect to volunteer medical information to their supervisor and/or crew, that's allowed, but the supervisor and/or crew shouldn't be soliciting that information and it **should not be recorded on this form**. If a worker who is diabetic volunteers that information to co-workers or their supervisor, you can discuss options when a blood sugar episode happens, but if they choose not to let anybody know, it's their prerogative.

Task/Hazard	Control	Site-Specific Comments	Requirements
1. Machete	1. Wear PPE (gloves, boots, heavy clothing, and eye protection); keep hands dry, rest as needed.		□ Gloves, boots, heavy clothing, eye protection
2. Working near moving traffic □ Yes □ No	1. Face oncoming traffic while on foot. 2. Be aware of or develop emergency escape routes. 3. Always wear appropriate high visibility apparel, minimum is ANSI class II vest. 4. Avoid working alone.		□ Vest needed □ Hard Hat
3. Walking over uneven terrain. □ Yes □ No	1. Be aware of loose material, unstable slopes, excavation drop-offs, tripping hazards (ruts, holes, etc.), uneven ground and other obstructions. 2. Move carefully in areas with the potential for slips, trips, or falls. 3. Wear appropriate footwear with adequate traction and support.		□ Work boots □ Leather gloves (Optional but recommended in areas where blackberries are dominant)
4. Working on or around rip-rap □ Yes □ No	1. Evaluate rip-rap for loose, rolling, or unstable rocks. 2. Wear hard hat and evaluate need for leather gloves when loose or unstable rock conditions exist or when there is potential for falling rocks.		□ Work boots and gloves
5. Working in or around areas of shallow or slowly moving water □ Yes □ No	1. Evaluate water depth hazard. 2. Evaluate slippery/steep/hidden water edge conditions and need for avoidance or uphill partner. 3. Evaluate large woody debris hazard at the work site and downstream of it. 4. Assess depth of mud and evaluate safe exit. 5. Evaluate potential rescue options that are safe for the rescuer. When warranted, establish person with throw rope bag down slope of work area and between work area and any downstream hazard.		□ Hip boots or waders
6. Working around bridges, signs, light fixtures, power lines □ Yes □ No	1. Continuously assess potential for falling rock or other overhead hazards, especially in windy weather. 2. When possible, avoid, restrict time in, or work during times of least activity in hazard areas. 3. When in hazard area, wear hard hat, gloves, and safety glasses along with approved vest and footwear.		□ Hard hat, gloves, boots
7. Harmful / poisonous plants □ Yes □ No	1. Be aware of what poison ivy/oak/Giant Hogweed/Cow Parsnip/Water Hemlock/Wild Parsnip looks like (http://poisonivy.aesir.com/ has many images and information). 2. Be aware of potential for injury from vegetation around you, such as thorns from blackberries or the sharp edges of reed canary grass. 3. Bring hand-pruners and glasses to prevent injury in thick brush and briers.		□ Hand pruners □ Eye protection □ Gloves
8. Potential for transients or human biohazards □ Yes □ No	1. Avoid confrontations with transients. 2. Avoid contact with human waste, needles, or other drug paraphernalia. 3. Request assistance from maintenance to remove hazard, when necessary.		

9. Poisonous snake or large carnivore hazard □ Yes □ No	1. When working in a snake or large carnivore area, consider two or more people for site visits. 2. When in carnivore habitat, make your presence known by talking, whistling, etc. 3. Stay in sight of partner or in radio contact.		□ Two people on site □ Radios
10. Isolated sites/ bad neighborhoods □ Yes □ No	1. Consider whether location warrants two people or a team to minimize exposure time. 2. Have cell phone or check-in plan in case of emergency.		□ Two people on site □ Cell phone
11. Risk of insect/ invertebrate problems □ Yes □ No	1. Determine if field staff are allergic to bees or yellow jackets. Bring appropriate first aid. Confirm location of nearest hospital. 2. Listen and look for bees frequently in the air and on the surface. When spotted, inform others in the field of the location. Evaluate carefully flagging location for future visits.		□ Person with allergy?
12. Working around natural overhead hazards. □ Yes □ No	1. Assess potential for falling rock, snags or other overhead hazards. 2. When possible, avoid or restrict time in the hazard area. 3. When in hazard area, wear hard hat, gloves, and safety glasses along with approved vest and footwear. 4. Request assistance from maintenance to remove hazard, if possible.		□ Hard hat, gloves, boots
13. Working around fall hazards □ Yes □ No	1. Do not work in the fall hazard area without appropriate safety equipment and training. 2. Observe fall protection rules in WAC 296-155 Part C-1.* Prepare a fall protection plan, WSDOT form 750-001, prior to performing the work		□ Fall protection plan needed
14a. Inclement weather (Hot)** □ Yes □ No	**1. In very warm conditions, consider field partner.** 2. Wear weather-appropriate clothing. **3. Rest as needed; take off hat and vests on breaks.** **4. Replenish fluids – drink one quart per hour.** 5. Bring sunscreen and hat for sun protection. 6. Stay in sight of partner or in radio contact. **7. Evaluate team for heat-related illness and monitor for need of medical attention.**	**Temperature thresholds where 1, 3, 4, & 7 apply:** $\geq 89^0$ for light clothing; $\geq 77^0$ for heavier clothes (jacket, sweatshirt, coveralls, etc.); and $\geq 52^0$ for non-breathing clothes (vapor barrier clothing or chemical resistant suits)	□ Two people on site □ Radios □ Hat, sunscreen
14b. Inclement weather (Cold) □ Yes □ No	1. In very cold/snow/stormy conditions, consider field partner. 2. Wear appropriate clothing – gloves, hat, thermal underwear, heavy jacket. 3. Stay in sight of partner or in radio contact 4. Is the vehicle equipped with chains/traction tires?		□ Two people on site □ Appropriate attire □ Vehicle equipped with appropriate cold weather gear
15. Bridge Work □ Yes □ No	1. Reference controls for: -Walking over uneven terrain -Working around a stream -Working around natural/manmade overhead hazards		□ Hard hat

	-Working around fall hazards 2. Coordinate with Maintenance personnel when working from bridge structures. Follow site specific PASP as required. 3. Box girder bridges may have confined spaces requiring training.		
16. Working on a site with confined spaces. □ Yes □ No	1. Avoid all confined spaces (*Has limited or restricted entry or exit. Examples of spaces with limited or restricted entry are tanks, vessels, silos, storage bins, hoppers, vaults, excavations, and pits.)* without specialized equipment and training. 2. Observe confined space rules in WAC 296-809		
17. Construction equipment and activities □ Yes □ No	1. PPE's required as necessary (Hearing protection, eye protection, hardhat for overhead work, etc) 2. Coordinate with PEO and/or Contractor to ensure compliance with their safety plans as applicable.		□ Hearing and/or eye protection, hard hat
18. Working around a stream defined as a water hazard (currents greater than 10cfs or deeper than 1-ft) □ Yes □ No	1. Evaluate potential rescue options that are safe for the rescuer. 2. Evaluate need for additional support from maintenance, bridge boat, or dive crews. 3. When appropriate, establish person with throw rope bag down slope of work area and any downstream in-channel hazard. 4. Evaluate the potential for loose material and unstable stream banks, and slippery/steep/hidden water edge conditions.		□ Throw rope bag □ Hip boots or waders □ PFD
19. Working in a stream defined as a water hazard □ Yes □ No	1. No wading under hazard conditions without safety equipment and training or specialized crews. 2. For in-water work, wear hip waders, tight-fitting neoprene chest wader, or equivalent. In rocky areas, boots with slip resistant felt-like material soles are recommended. 3. Wear personal flotation device in swift/deep water conditions. 4. Be aware of unstable/loose surfaces/hidden holes or objects under water.		□ Hip boots or waders

* WAC 296-155 is available at: Fall Restraint and Fall Arrest-Chapter 296-155-Part C-1

** http://www.lni.wa.gov/Safety/Rules/Policies/PDFs/WRD1015.pdf

*** WAC 296-809 is available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=296-809

Excerpt from the *Work Zone Traffic Control Guidelines*, Section 3.8, (WSDOT, 2009b)

Short Duration Don'ts and Do's:

Don't –

- Take "short cuts" or hurry to accomplish work. Determination of all work zone hazards is a must.
- Run across or "dodge" traffic in live lanes.
- Work in a live lane under adverse traffic conditions or without proper traffic control in place . . . even if it is only for a few minutes or a few seconds.
- Assume that shoulder areas are automatically safe. Distracted, aggressive or impaired drivers may encroach. Also, oversize loads may present a hazard.
- Turn your back to oncoming traffic if possible.
- Put yourself in an unexpected location that may surprise a driver.

Do –

- Use the work vehicle as protection and warning whenever possible.
- Take advantage of any resources providing protection and warning without causing additional exposure. (TMAs, buffer/shadow vehicles, PCMSs, etc.)
- Plan ahead. Poor planning is not a valid excuse for lack of equipment, devices or awareness of traffic conditions.
- Find the safest available location to park or unload equipment.
- Avoid high traffic volume hours and locations. Plan ahead for better traffic conditions or consider alternate work operations.
- Work on the same side of the road as the work vehicle and warning beacon whenever possible.

Appendix D Detailed Monitoring Location Descriptions

Figure D-1 Ballinger sampling location and contributing drainage area.

Figure D-2 Lakeview sampling location and contributing drainage area.

Figure D-3 Clarkston sampling location and contributing drainage area.

Figure D-4 Vancouver sampling location and contributing drainage area.

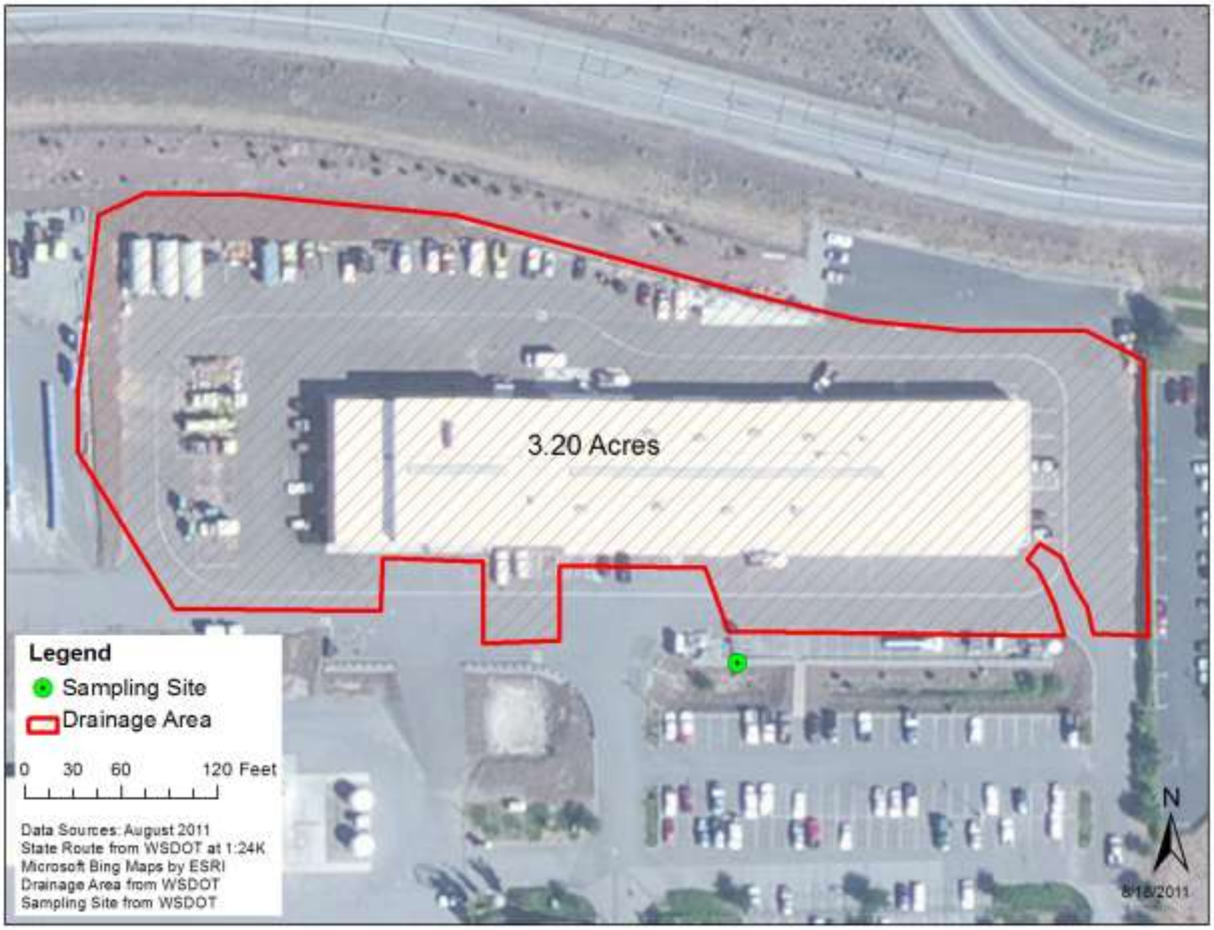

Figure D-5 Euclid sampling location and contributing drainage area.

Figure D-6 Geiger sampling location and contributing drainage area.

Figure D-7 Smokey Point (NB) Rest Area sampling location and contributing drainage area.

Figure D-8 Smokey Point (SB) Rest Area sampling location and contributing drainage area.

Figure D-9 Bainbridge Island Ferry Terminal sampling location and contributing drainage area.

Appendix E Sampling Design Layouts for WSDOT Facilities

Note: These figures are subject to minor changes once construction of monitoring stations is completed.

Standard Data Collection Platform (DCP) Setup for Facilities

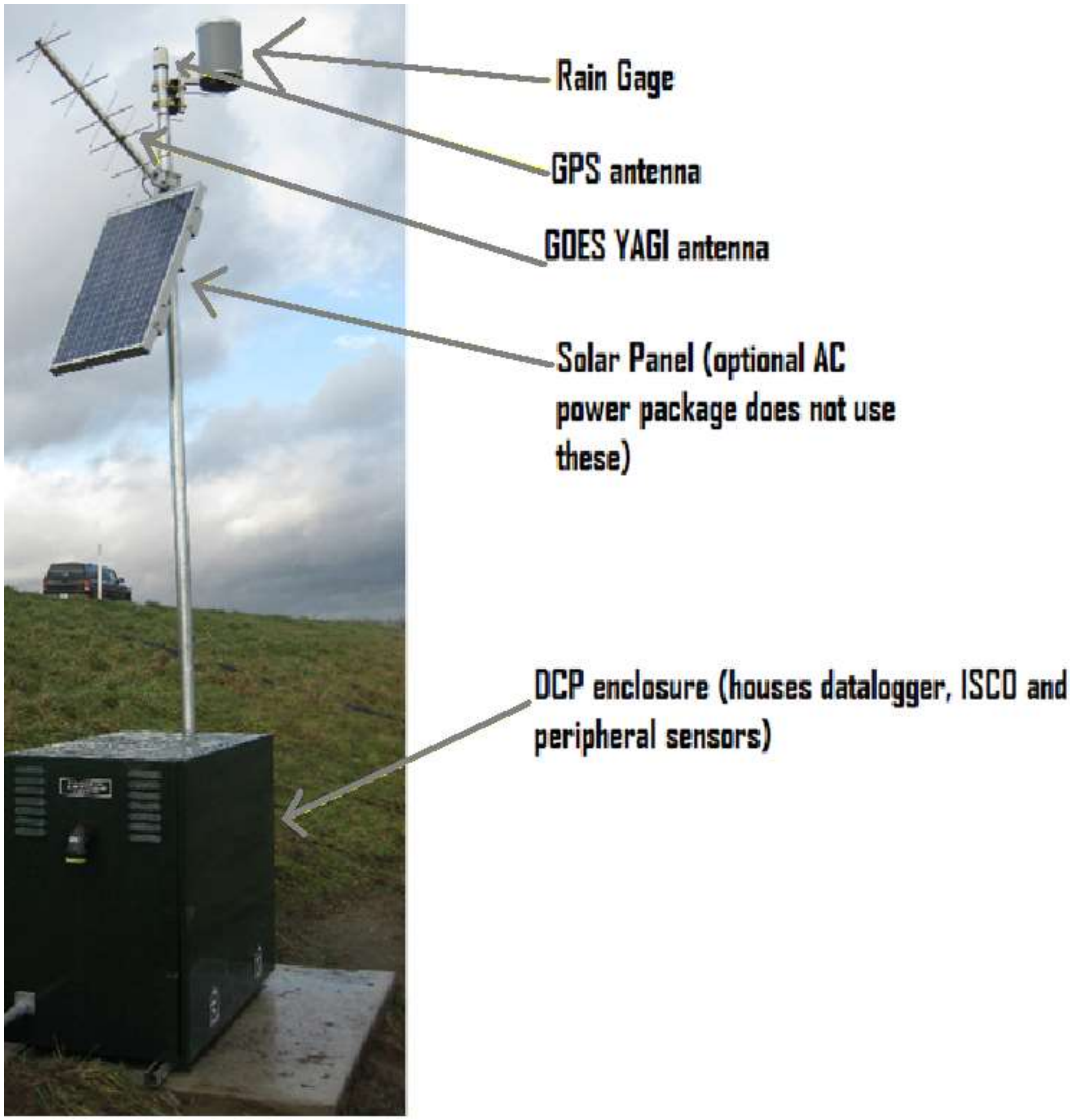

Figure E-1 A typical DCP with solar option.

Several locations have an AC power option available, which is preferential to using the solar panel.

Clarkston Maintenance Facility

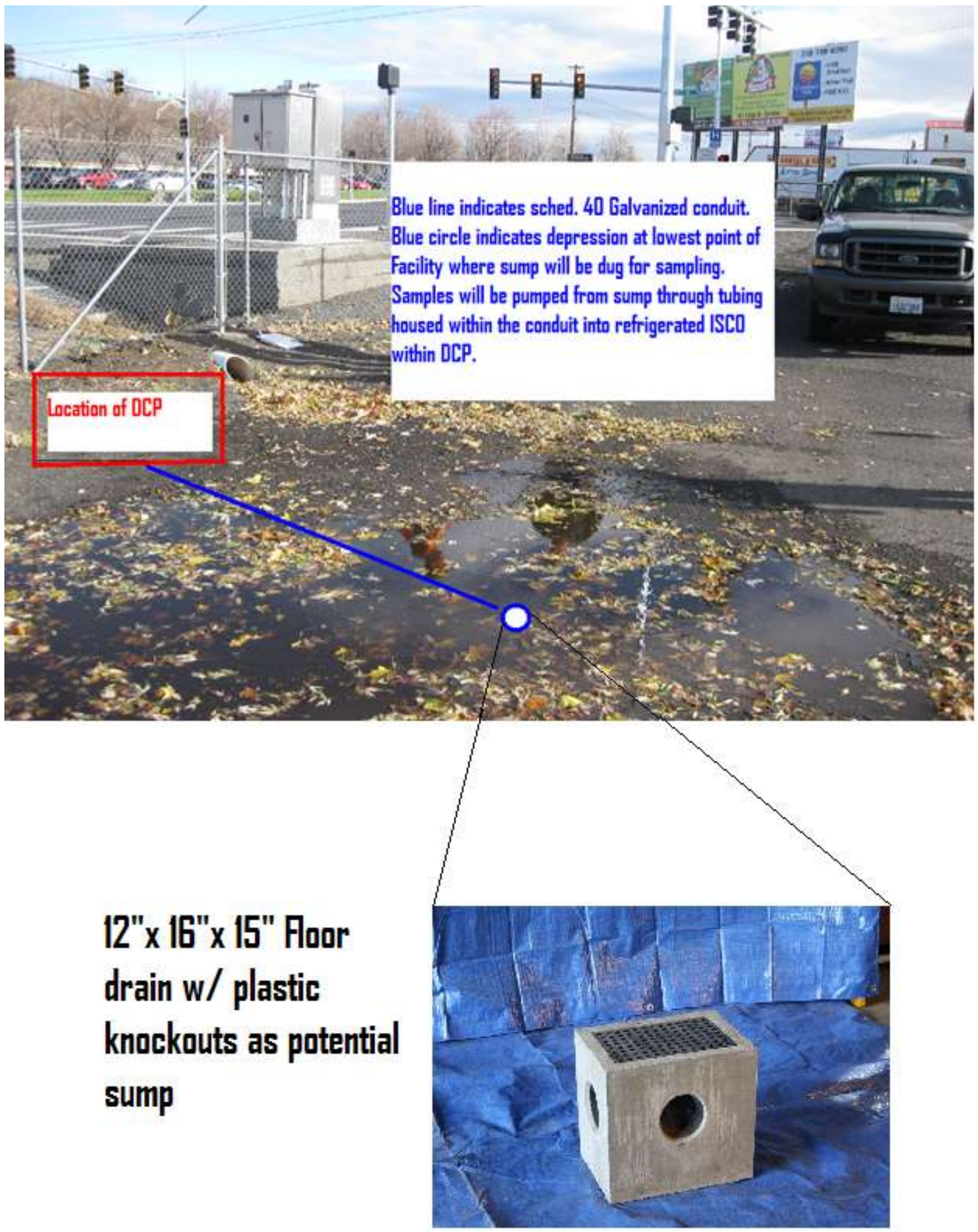

Figure E-2 Clarkston Maintenance Facility Sampling Location.

A concrete sump will be placed at the lowest point in this corner of the maintenance yard. Conduit and the DCP locations relative to the location of the sump are shown.

Geiger Maintenance Facility

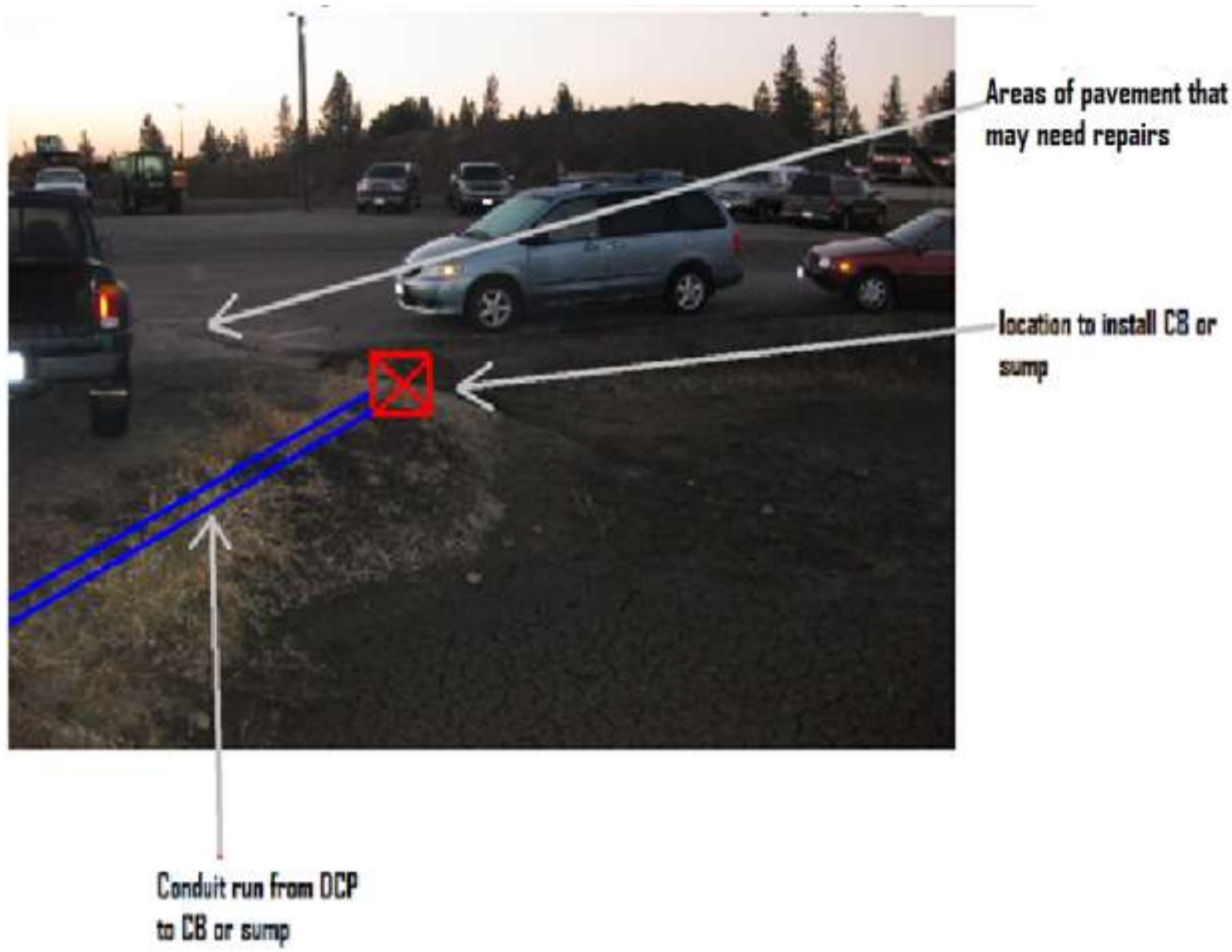

Figure E-3 Monitoring Station at the uppermost corner of the evaporative pond at the Geiger Maintenance Facility.

Another view of the evaporative pond is shown in the next photograph.

Figure E-4 Alternate view of the evaporative pond at the Geiger Maintenance Facility.

The DCP will be placed behind the power pole to avoid vehicle collisions and to potentially facilitate the use of AC power.

Euclid Maintenance Facility

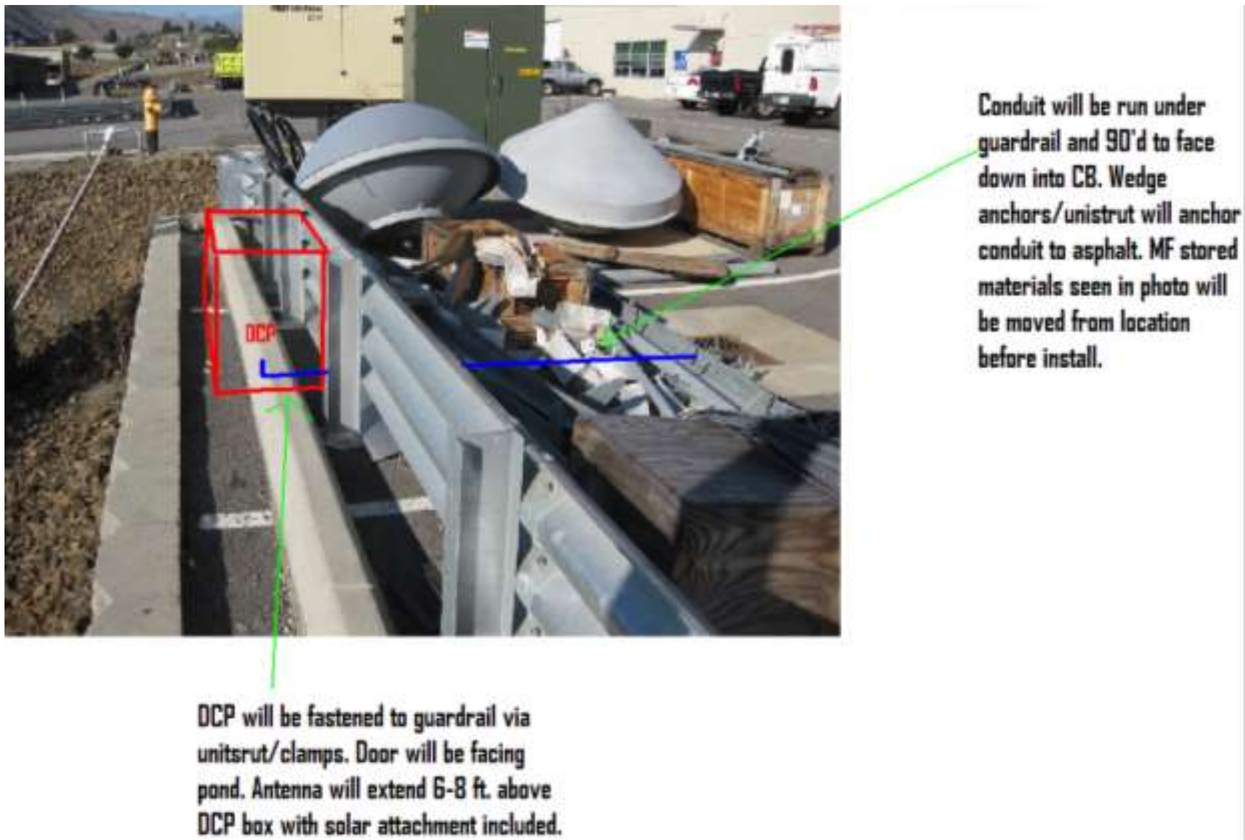

Figure E-5 Monitoring station location above catch basin #30 at the Euclid Maintenance Facility.

Ballinger Maintenance Facility

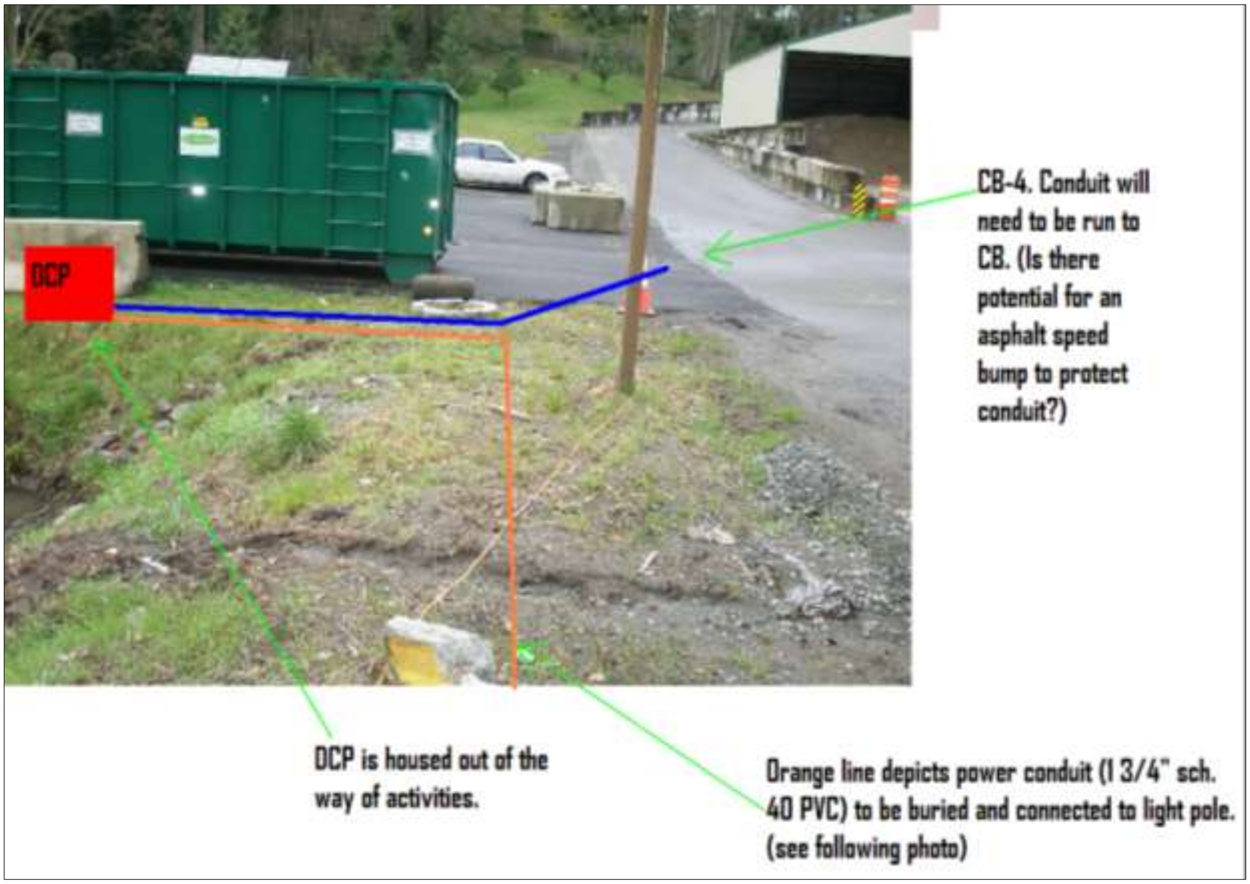

Figure E-6 Monitoring of stormwater at catch basin #4 and layout for DCP and conduit at the Ballinger Maintenance Facility.

The following Figures (E-7 and E-8) show the light pole and pond.

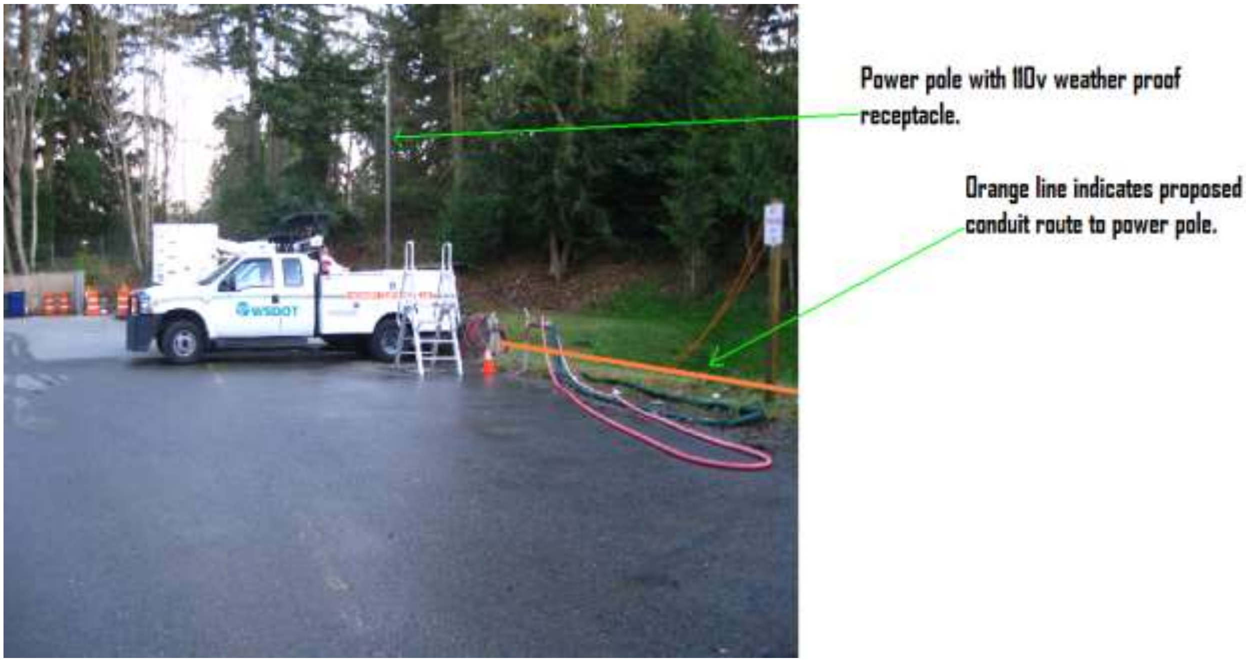

Figure E-7 Light pole and proposed route for conduit at the Ballinger Maintenance Facility.

Figure E-8 Stormwater retention pond at Ballinger.

Vancouver Maintenance Facility

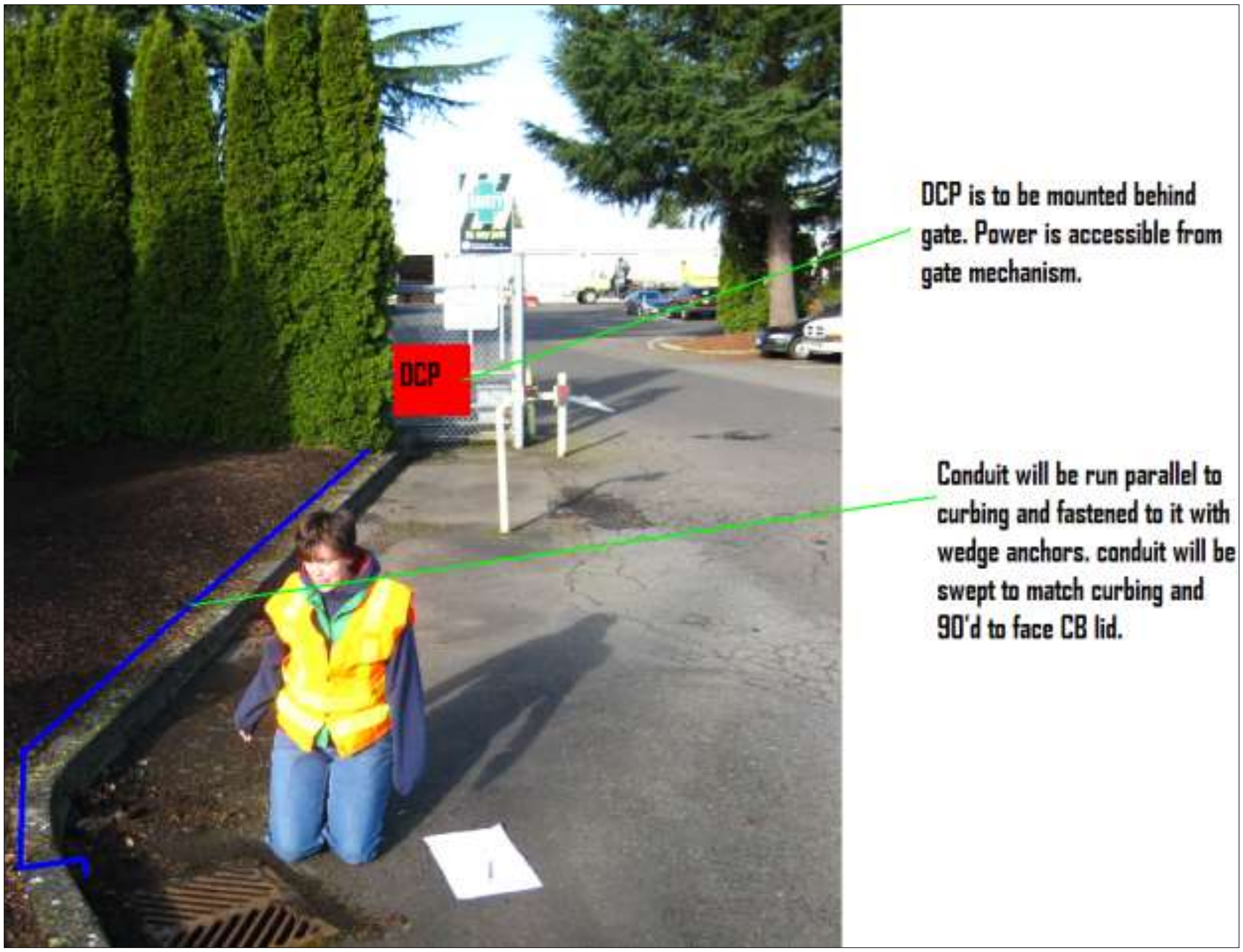

Figure E-9 Monitoring at catch basin #4 at the Vancouver Maintenance Facility.

Lakeview Maintenance Facility

Figure E-10 Monitoring from conveyance system outlet at the Lakeview Maintenance Facility.

Smokey Point Rest Area (Southbound)

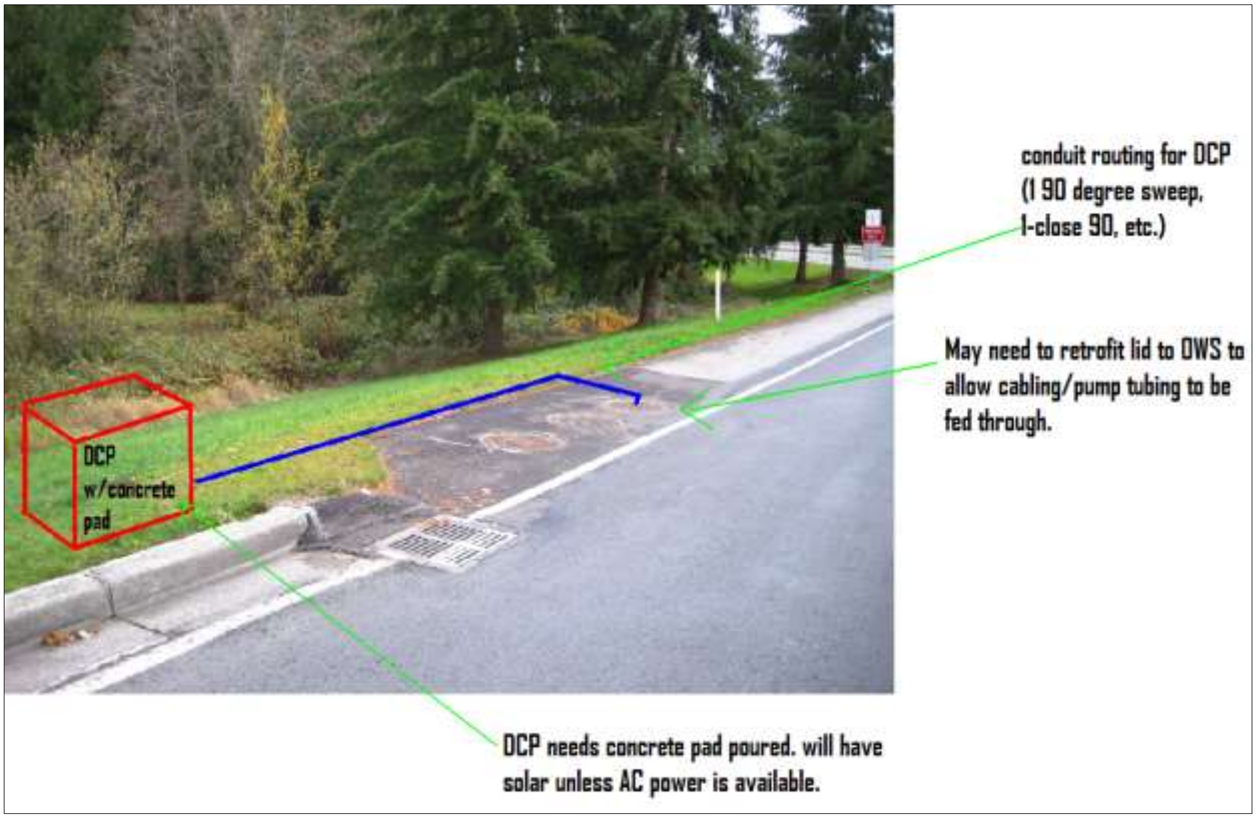

Figure E-11 Location of DCP and monitoring from pipe leaving the oil/water separator at the Smokey Point (SB) Rest Area.

Smokey Point Rest Area (Northbound)

Figure E-12 Location of DCP and monitoring from pipe leaving the oil/water separator at the Smokey Point (NB) Rest Area.

Bainbridge Island Ferry Terminal

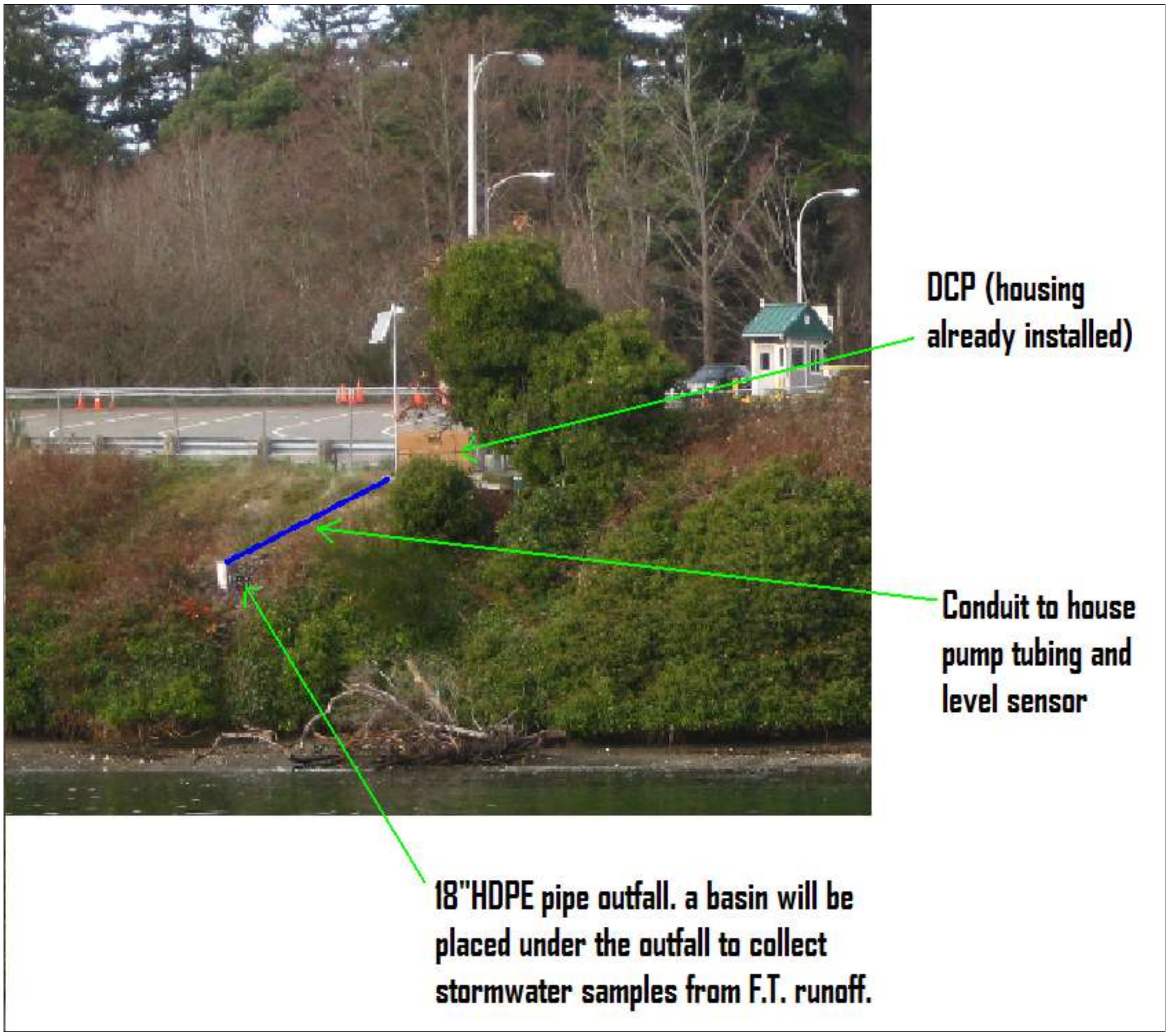

Figure E-13 Bainbridge Island Ferry Terminal monitoring station and conduit.

The DCP shown in this photo is equipped with an alternative form of enclosure. Some of these stations may be set up within a brown box instead of green due to availability.

Appendix F Storm Tracking Forms

Storm Tracking Sheet

Pre-Storm

Date:

Time:

Source of Forecast (web, news, etc.):

Location of Forecasted Storm (region):

Monitoring Sites in Area of Anticipated Storm:

Predicted Rainfall:

Predicted Storm Duration:

Seasonal First Flush or Toxicity Sample Planned? **Y / N**

1. Attach a copy of the forecast to this sheet. If initial observation was from television news, access their website and print a copy of their forecast.

2. Contact the Field Lead for the "*Go*" decision.

3. If deployment is OK'd, contact field staff and inform them of the storm characteristics and duration.

4. Contact laboratories and notify of intent to sample.

5. Monitor the telemetry files for stations in the region of the storm event. Notify field staff of storm status and if rain begins to fall on-site.

Mid-Storm

Time of first rainfall on site:

Field teams on-site for first rainfall? **Y / N**

Grab/composite samples collected? **Y / N**

6. Upon successful sample collection, notify labs of sample delivery.
If no successful samples collected notify labs.

Post-Storm

Time of last rainfall on-site:

Samples processed and sent to lab? **Y / N**

Verify reset of station parameters via telemetry files? **Y / N**

COMMENTS:

Appendix G Packing Lists and Trip Checklists

PRE/POST FIELD TRIP CHECKLIST

Before Embarking in the Field

All Staff Must –

1. Arrange for lodging (if necessary).
2. Update outlook calendar indicating location and duration of trip.
3. Notify Field Lead or contacts (if necessary).
4. Prepare field plan form with emergency contact information for specific trip location and duration.
5. Be sure to check vehicle and equipment checklists and perform a pre-trip vehicle inspection before embarking.

Pre-Trip Vehicle Inspection

1. Inspect tires for wear/damage on both sides of sidewall. Be sure to check tire pressure as well.
2. Check fluid levels (oil, transmission, windshield washer, radiator) before embarking in order to minimize possible breakdowns. Refer to the vehicle log to check and see if maintenance is due before embarking.
3. Make sure that the vehicle safety equipment is packed and that a spare tire, jack, and lug wrench are in the vehicle and in working order.
4. If any of these listed items are not in satisfactory working order, please notify the Field Lead as soon as possible. Do not embark with a vehicle that is in need of service or may be damaged.
5. Be sure to pack plenty of water and be sure that the standard first aid/emergency gear is packed.

Pre-Trip Equipment Prep

1. Assemble the required amount of precleaned autosampler tubing (amount varies per site and per trip).
2. Assemble the right size and required amount of precleaned autosampler bottles for site visit.
3. Pack sample bottles, filters, sample tags, forms, and coolers (with ice packs) needed for trip.
4. Pack extra gloves and plastic bags for equipment storage and handling.
5. Pack pole sampler (if needed) and all necessary grab sampling equipment.

<u>Proceed with Field Excursion as Planned</u>

Upon Return from the Field

End of Day –

1. If staying at a hotel, notify your contact person each evening that you are finished with field sampling so they do not initiate the rescue protocol. If your trip is only a day trip, refer to end of trip protocol.

End of Trip –

1. Pack and send samples to lab (if samples have been taken).
2. Upon return from the field, please unload your gear and equipment.
3. Don't forget to download DCP files to your laptop or desktop.
4. Unload spent batteries from vehicle and inspect for damage/leaks.
5. Place spent batteries on appropriate chargers after servicing them.
6. Hang any wet gear in their designated locations to dry.
7. Clean and store tubing and bottles in their designated locations to prevent contamination/damage.
8. Clean the interior of the vehicle (if needed).
9. Close field plan and notify contact person that your trip is over.

Vehicle and Equipment Checklist

Vehicle Equipment

This equipment should be present any time the vehicle is used.

- Cell Phone and charger

Vehicle Folder

- Mileage logs
- Emergency information
- Fuel card
- Maps

Safety Equipment

- First aid kit
- MUTCD-compliant type II or better Safety Vests (2)
- Road Cones (28" retro refl.)
- Signs (RWA, shoulder work)
- MUTCD-compliant Hard Hats (2)
- Orange Strobe (1,000 ft. visibility)

Tools / Other

- Mechanic's toolbox
- Shovel
- Loppers/clippers/machete
- Tire chains
- Spare keys
- Jack, jack handle, adequate spare tire
- Flashlight
- Lighter (for shrink tubing)
- Electrical tool box
- Pens
- Pencils
- Notepaper
- Flagging tape
- Orange spray paint
- Spare bucket
- Bubble level for weirs
- Tool for clearing sediment from interceptors

Field Gear

Field Equipment Box

- Survey pins and hammer
- Laser level
- Stadia rod and bubble level
- Thermistor
- Spare batteries for thermistor and laser
- Multi-meter (for batteries)
- Logger Menu Flow Chart
- Station/site keys
- Other keys as needed
- Appropriate DCP batteries

Station Visit Folder

- Station Visit Sheets (storm, servicing, COC)
- Station Visit Thumb Drive
- Autosampler forms
- Sample tags
- Maps/station directions
- SOPs

Autosampler Gear

- Replacement tubing
- Replacement bottles
- Replacement batteries
- DI water
- Filters for samples
- Pump for filtering samples

Personal Equipment

- Water
- Food
- Spare dry clothes
- Rain gear
- Sunscreen
- Gloves
- Boots
- Notebook w/extra Station Visit Sheets

Appendix H Field Sampling Form

Field staff name	Date
Station name/ID Number	Time
Storm Event Number	Weather observation
Qualified storm ☐ Yes ☐ No	
First Flush sampling ☐ Yes ☐ No	
Flow conditions	
Number of composite samples collected	
Number of grab samples collected	

Composite Sample			
Pre-Sample Collection		**Post-Sample Collection**	
Equipment inspected		Sampler working correctly	☐ Yes ☐ No
Tubing damaged/clogged	☐ Yes ☐ No	Sample bottles inspected	☐ Yes ☐ No
Tubing replaced*	☐ Yes ☐ No	Sample bottle problems	☐ Empty ☐ Low
Equipment sample blank added	☐ Yes ☐ No		☐ Damaged ☐ Spillage
Volume calibrated	☐ Yes ☐ No	*Sample bottles*	
Gas bubbler checked	☐ Yes ☐ No	Labeled	☐ Yes ☐ No
O-line connection checked	☐ Yes ☐ No	Preservation added	☐ Yes ☐ No
Data logger program checked	☐ Yes ☐ No	Readied for transportation	☐ Yes ☐ No
Clean bottles placed in sampler	☐ Yes ☐ No	COC form filled out	☐ Yes ☐ No
Autosampler program started	☐ Yes ☐ No	Sample line rinsed	☐ Yes ☐ No
		Clean bottles inserted	☐ Yes ☐ No
		Autosampler program reset	☐ Yes ☐ No

Grab Sample	
Sample type	☐ Hand ☐ Pole
Labeled	☐ Yes ☐ No
Preservation added	☐ Yes ☐ No
Placed in correct transportation container	☐ Yes ☐ No
COC documents filled out	☐ Yes ☐ No

Rain Gage	
Inspected	☐ Yes ☐ No
Debris removed	☐ Yes ☐ No
Data downloaded	☐ Yes ☐ No
Cleared	☐ Yes ☐ No
Reset	☐ Yes ☐ No

One sample per wet season and dry season	Wet / Dry
Composite field duplicate	
Grab field duplicate	
Field blank (autosampler containers)	
Field blank (sample containers)	
Equipment blank (autosampler samples)	
Equipment blank (grab samples)	
Transport blank	

Battery	
Voltage	
Weir/Flume	
Inspected for debris	
Debris removed	
Level checked	

Stage	
Logger (ft)	
Staff plate or weir (ft)	

Appendix I Chain of Custody Form

Laboratory Analyses Required

Page ____ of ____

Project Name: ______________________________

SIC: ___ ___ ___ ___ ___ Program: ______________________________

Send Results to: ____________________ Mail Stop: ____________________

☐ Preliminary Investigation ☐ For HW Designation

☐ Monitoring ☐ For NPDES

Date Results needed by: ______________

Name/Reference # of QAPP for this project: ______________________

Sampling		Field Station Identification	Manchester Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Micro	Metals	Organic Chemistry
Date Year: ☐ Mo Day	Time (Military) 0001 - 2400 Hr Mn						Alkalinity; Conductivity; pH; Turbidity; ☐ Chloride ☐ Sulfate; Fluoride; Total Suspended Solids; Total Dissolved Solids; ☐ Total Solids ☐ % Sol ☐ % Vol Sol; TOC; DOC; BOD5; Oil & Grease (HEM); Ammonia; Nitrite/Nitrate; Total Phosphorus; Orthophosphate; TPN; Chlorophyll ☐ filters	Fecal Coliform ☐ MF ☐ MPN; Total Coliform ☐ MF ☐ MPN; E. Coli ☐ MF ☐ MPN; % Klebsiella; Enterococcus	PP Metals; Mercury (Hg) ☐ low level; Hardness; Individual Elements (please list); ☐ Total ☐ Dissolved	VOA; BTEX; TPHG; TPHD; HCID Only (Hydrocarbon ID); PCB aroclors; ☐ Pest 1 ☐ w/PCB aroclors; ☐ Pest 2 ☐ w/PCB aroclors; ☐ Pest 3 ☐ w/PCB aroclors; Carbamates; PESTMS; Herbicides; PBDE; BNA; PAH

Project Officer: ____________________

Phone Number: ____________________

Cell Number: ____________________

Samplers: ____________________

Recorder: ____________________

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments (Temperature, Preserv., etc.)

Comments: ______________________________

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