Stormwater Lateral Loading Study
Lower Duwamish Waterway, WA

Data Report

Prepared for

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List of Acronyms

2LAET	second lowest apparent effects threshold
ARI	Analytical Resources, Inc.
AXYS	Axys Analytical Services, Ltd
Boeing	The Boeing Company
cfs	cubic feet per second
COPC	contaminant of potential concern
CSL	Cleanup Screening Level
CSO	combined sewer overflow
DC	direct current
DOC	dissolved organic carbon
DW	dry weight
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
gpm	gallons per minute
HPAH	high molecular weight polycyclic aromatic hydrocarbon
KBFI	Boeing Field – King County International Airport (rain gauge)
KC	King County
KCIA	King County International Airport
LAET	lowest apparent effects threshold
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MHHW	mean higher high water
MLLW	mean lower low water
MTCA	Model Toxics Control Act
NBF-GTSP	North Boeing Field/Georgetown Steam Plant
NCDC	National Climatic Data Center
OCDD	octachlorodibenzo-p-dioxin
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenylether
PCB	polychlorinated biphenyl
Port	Port of Seattle
PSEP	Puget Sound Estuary Program
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/ Feasibility Study
RL	reporting limit
RPD	relative percent difference
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SD	storm drain
SIM	selected ion monitoring

SMS	Sediment Management Standards
SQS	Sediment Quality Standard
SVOC	semivolatile organic compound
TEF	toxic equivalency factor
TEQ	toxic equivalency
TOC	total organic carbon
TSS	total suspended solids
VOC	volatile organic compound
WHO	World Health Organization
WQC	Washington State Marine Water Quality Criteria

Executive Summary

Introduction

The Washington State Department of Ecology (Ecology) supports the Environmental Protection Agency (EPA) efforts on the Lower Duwamish Waterway (LDW) Remedial Investigation/ Feasibility Study (RI/FS) and is leading source control efforts in coordination with local governments. A wide range of contaminants are present in a 5.5-mile reach of the LDW, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals. High concentrations of these contaminants have made this portion of the LDW a Federal Superfund and state Model Toxics Control Act (MTCA) site.

The Stormwater Lateral Loading Study was conducted to measure contaminant concentrations associated with stormwater discharges and to estimate lateral contaminant loadings from four significant stormwater outfalls within the LDW study area. This report includes the chemical analysis results for whole water, filtered solids, and sediment trap solids collected at storm drain access locations between January and May 2011 for each of the four selected LDW outfalls. These results were then used to calculate wet season contaminant loadings to the LDW.

The specific objectives of the Stormwater Lateral Loading Study were as follows:

- Collect data necessary to assess contaminant loading from four significant municipal and industrial stormwater outfalls.
- Identify stormwater contaminants associated with the different outfalls studied.
- Estimate stormwater contaminant of potential concern (COPC) lateral loadings for the studied outfalls.
- To the extent possible, correlate the loadings from whole water, filtered solids, and sediment trap solids samples.

Sample Collection

Sampling took place at storm drain access locations (maintenance holes) located as close to the outfalls as possible. Whole water and filtered solids samples were collected during three types of flow conditions over the course of the 2010–2011 wet season at each of the four outfall sampling locations:

- Storm events — Six storm events were sampled between January and April 2011. These samples are representative of a range of precipitation amounts and conditions over the sampling period.
- Base flow — Samples collected during three base flow events were intended to be representative of water and solids that enter the storm drain system via groundwater infiltration or as a result of unidentified connections to the system.
- Tidal inundation — One sample was collected at each location during a period of both high tide and no precipitation. These samples were intended to represent LDW river water that may transport contaminants both up-line and down-line and influence solids deposited in sediment traps.

In addition to the samples collected for chemical and physical analysis, the whole water sampling equipment logged water depth, conductivity, and velocity data during sample collection and for selected periods over the course of the wet season. These data were used to assess the tidal and base flow conditions observed at each of the sampling locations.

Sediment traps deployed at each of the sampling locations were used to collect suspended solids. Sediment trap samples were composited over a period of several months to provide enough material for chemical analysis. An attempt was made to collect inline solids grab samples at each sampling location; however, most of the accessible locations did not contain enough solid material to sample.

Challenges of Stormwater Sampling

Over the course of this study many sampling challenges were encountered related to weather predictions, site conditions, and sampling equipment. Because the same challenges will likely be confronted during future LDW stormwater sampling efforts, the lessons learned from this study can be used to help increase the efficiency and sampling efficacy of future stormwater sampling projects.

Stormwater outfalls that empty into the LDW are often submerged at high tide stages allowing river water to flow up into the storm drain lines. In order to prevent the sampling of tidal water rather than stormwater, storm event sampling could only take place during low tide periods. This tidal constraint generally restricted sampling intervals to 6 hours. This small sampling window was often shorter than the duration of storm events, allowing samples to be collected over only a portion of the storm hydrograph. Additionally, the presence of up to 6 feet of tidal water in maintenance holes during high tidal periods prevented the long-term deployment of sampling equipment, as many of the equipment components could not be submerged.

Calculation of lateral loading requires an estimate of stormwater volume. This volume can be derived through measured flows, modeling, or a combination of the two. In the case of estimating flow volume from an intertidal outfall, tidal exchanges influence both water velocity and depth measured by in-line flow sensors. Unfortunately, the resulting flow data cannot easily be corrected for tidal influence. Tidal water in the storm drain lines regularly increased water depth in the maintenance hole by many feet and slowed drain line velocity to near zero. Therefore, contaminant mass loading calculations for intertidal outfalls must rely heavily on predicted stormwater flows derived through watershed modeling.

Successfully targeting a storm event for sampling requires accurate rainfall predictions. This is especially true when sampling must take place during a narrow tidal window. A storm event was generally selected for sampling when an uninterrupted interval of precipitation totaling greater than 0.2 inch was predicted in the 24-hour forecast and the precipitation was predicted to extend over a low tide window. Unfortunately, predicted storm events often did not materialize as they were forecasted. On numerous occasions, sampling equipment was installed and programmed to sample during the tidal window, but the late onset of precipitation caused the collected samples to consist mainly of base flow. Instances also occurred when storm activity shifted so far beyond the tidal window that sampling was cancelled mid-way through the equipment installation process.

Observations and Recommendations

Based on analysis of the collected samples, major observations from this study are presented below:

- The intertidal nature of LDW outfalls greatly restricts the ability to sample storm events and derive loading estimates. High tides impeded the duration of stormwater sampling, rarely allowing stormwater samples to be collected over the entire storm hydrograph. Estimation of storm flow volume is hindered when tidal water is present in the storm drain, as both velocity and depth measurements have a tidal component that is difficult to correct for. Tidal water often filled the sampling location maintenance holes to a depth of many feet, inhibiting the long-term deployment of whole water and filtered solids sampling equipment without risking damage.
- Tidal water present in storm drains had low velocity throughout the wet season and low total suspended solids (TSS) and COPC concentrations when measured at the beginning of the dry season. Therefore, tidal inflow may not significantly introduce or redistribute COPCs within a storm drain. The insignificance of tidal water may only be true for the outfalls studied and should not be dismissed in future investigations. Despite the fact that sediment traps were frequently submerged by tidal water during deployment, the low TSS of tidal water suggests that storm drain solids collected in the sediment traps may contain little contribution from particles transported in tidal water. However, future sampling may be warranted to target tidal water during the wet season, as tidal water is more likely to introduce solids into storm drains when TSS concentrations in the LDW are highest.
- Sampling during the 2010–2011 wet season resulted in a limited data set consisting of whole water and filtered solids samples from six storm events and three base flow events, as well as sediment trap samples collected over the entire season. Limited sample volume often restricted the analysis of COPCs. Wide variability of COPC concentrations were often measured in storm drain samples from the same location because of differences in sampling event conditions, sampling methodology, and inherent variability. Loading estimates generally have an associated error between ±40 and ±100 percent for both storm flow and base flow loading estimates. Both the limited amount of analytical data and uncertainty in loading estimates limit the accuracy with which chemical loadings to the LDW can be determined from the studied outfalls.
- PCBs, dioxin/furan congeners, metals, PAHs, and polybrominated diphenylethers (PBDEs) were detected in stormwater samples from all sampled outfalls. This mix of COPCs may be typical of surface runoff from urban/industrial developed properties in the LDW drainage basin.
- Whole water samples from PS2220 contained concentrations of copper and zinc that exceed the acute and chronic Washington State Marine Water Quality Criteria (WQC). Storm drain solids samples from all sampled locations contained concentrations of multiple COPCs that exceeded state sediment management standards (SMS) and the Washington State MTCA Method A cleanup standards. However, there are no regulatory standards for filtered solids, sediment trap solids, or inline solids samples. Although these standards do not apply to storm drain sediments, they are used as benchmarks in this report to provide a rough indication of storm drain sediment quality.

- Independent COPC loading estimates for the different stormwater sample types (whole water, filtered solids, and sediment trap solids) are remarkably similar given the extremely different circumstances by which each sample type was collected and its associated errors. Relative percent difference (RPD) values for commonly detected COPCs averaged 42 percent for whole water/filtered solids sample pairs, 58 percent for filtered solids/sediment trap sample pairs, and 83 percent for whole water/sediment trap sample pairs (Table 20). This finding suggests that all sample types are fairly interchangeable for estimating COPC loadings from stormwater for this study. However, it should be noted that sediment traps cannot be used to determine differences between contaminant contributions from base flow and storm flow.
- Base flow COPC loadings in these four drains are substantially lower than storm flow, suggesting that surface runoff, not infiltration, dominates the potential for sediment impacts for the outfalls in this study. This may not be the case in areas where contaminated soil or groundwater infiltrate into the storm drains.
- Many of the highest COPC concentrations and unit-area loads were found in stormwater from the smaller sub-basins of this study (PS2220 and BDC2088). Source control for outfalls that discharge less total stormwater volume may be easier to implement because of the greater potential for identifying the source.

1.0 Introduction

The Washington State Department of Ecology (Ecology) supports the Environmental Protection Agency (EPA) efforts on the Lower Duwamish Waterway (LDW) Remedial Investigation/ Feasibility Study (RI/FS) and is leading source control efforts in coordination with local governments. Ecology and EPA are currently implementing a two-phase RI/FS with a workgroup of potentially responsible parties, collectively known as the Lower Duwamish Waterway Group (LDWG). The LDWG members include the City of Seattle, The Boeing Company (Boeing), the Port of Seattle (the Port), and King County. A wide range of contaminants are present in a 5.5-mile reach of the LDW, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals. High concentrations of these contaminants have made this portion of the LDW a Federal Superfund and state Model Toxics Control Act (MTCA) site.

The LDWG has estimated contaminant loading to the LDW through a multi-step process that includes stormwater runoff modeling, sediment transport modeling, and the application of catch basin and inline solids data. Ecology tasked Science Applications International Corporation (SAIC) with collecting data to help evaluate how well these estimates correlate to actual input of contaminants to the waterway. SAIC has contracted with NewFields to assist in this effort. As part of this evaluation, a Stormwater Lateral Loading Study was conducted to measure contaminant concentrations associated with stormwater discharges and to estimate lateral contaminant loadings from four significant stormwater outfalls within the LDW study area.

This report includes the chemical analysis results for whole water, filtered solids, and sediment trap solids collected at storm drain access locations between January and May 2011 for each of the four selected LDW outfalls. These results were then used to calculate wet season contaminant loadings to the LDW.

Sampling was conducted following the study design and methods described in the *Stormwater Lateral Loading Study Combined Sampling and Analysis Plan and Quality Assurance Project Plan* (SAIC 2010). This study was performed in conjunction with the LDW *Accelerated Source Tracing Study* (SAIC and NewFields 2011a) and shares many of the same sampling methods. Appendix C describes the logistical challenges encountered in both of these studies associated with sampling of tidally influenced storm drains that discharge to the LDW.

1.1 Project Scope and Objectives

The purpose of this sampling and analysis effort was to collect whole water, filtered solids, and sediment trap solids from storm drains at four outfall locations and measure the concentrations of selected contaminants of potential concern (COPCs) in these samples. Using these data, lateral loadings were calculated for COPCs from each of the studied outfalls. This report documents the whole water, filtered solids, and sediment trap solids analytical results, as well as the assumptions used to calculate COPC lateral loadings to the LDW. The specific objectives of the Stormwater Lateral Loading Study were as follows:

- Collect data necessary to assess contaminant loading from four significant municipal and industrial stormwater outfalls.
- Identify stormwater contaminants associated with the different outfalls studied.
- Estimate stormwater COPC lateral loadings for the studied outfalls.
- To the extent possible, correlate the loadings from whole water, filtered solids, and sediment trap solids samples.

1.2 Document Organization

This Data Report summarizes and evaluates the results of the Stormwater Lateral Loading Study within the context of the project scope and study objectives. Section 2.0 of this document describes the outfalls studied, including the LDW sub-basins that drain to these outfalls and the storm drain access locations chosen for sampling. Section 3.0 explains how samples were collected as well any deviations from the Combined Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP) for the Stormwater Lateral Loading Study (SAIC 2010). Section 4.0 describes the methods for sample analysis. The data collected for this study, which include analytical results for whole water, filtered solids, sediment trap solids, and inline solids, are summarized in Section 5.0. A summary of the data validation for the chemical analyses is provided in Section 6.0. Section 7.0 presents the equations used for calculating lateral loadings from stormwater outfalls. A discussion of stormwater COPC concentrations and loadings, as well as appropriate uses for these results, is presented in Section 8.0. Section 9.0 includes conclusions drawn from this study and recommendations for conducting future stormwater lateral loading studies. References are provided in Section 10.0. The following appendices are included as part of this report:

- Appendix A. Outfall and Sampling Locations
- Appendix B. Synopsis of a Sampling Event
- Appendix C. Challenges of Stormwater Sampling
- Appendix D. Field Logs
- Appendix E. Chemistry Results Summary Tables
- Appendix F. Laboratory Reports and Chain-of-Custody Forms
- Appendix G. Data Validation Reports
- Appendix H. Recommendations for Future Lateral Loading Studies

2.0 Sampling Locations

Each of the four storm drain lines sampled for this study is owned by one of the four LDWG members: The City of Seattle, King County, the Port, or Boeing. These systems receive stormwater runoff from different drainage sub-basins of the LDW (Figure 1). Individual outfalls and their associated storm drains are identified in this report by their identification number (e.g., 2095) presented in Appendix H of the LDW Remedial Investigation Report (Windward 2010).

Field reconnaissance conducted in May and June 2009 (SAIC 2009), and again in September and October 2010 under the current work assignment, identified outfalls and access locations appropriate for sampling. SAIC (2009) provides a review of 34 LDW outfalls (with outfall pipe diameters greater than 24 inches) investigated for potential stormwater sampling. This report recommends 15 outfalls and associated SD access locations that were considered to logistically be the easiest to sample. The recommended SD access locations were chosen because they:

- Are found in close proximity to the outfall,
- Allow minimally obstructed surface access to SD lines, and
- Provide adequate conditions for the long-term installation of stormwater sampling equipment.

At the time these recommendations were made, collection of filtered solids was not part of the scope of work for lateral loading stormwater sampling. Therefore, the recommended sampling sites provided in SAIC (2009) were not assessed based on their potential for use to collect filtered solids. During additional field reconnaissance by SAIC and NewFields in autumn 2010, the 15 outfalls/access locations recommended for sampling in SAIC (2009) were revisited to assess whether or not composite whole water samples, filtered solids, and sediment trap solids could be collected simultaneously during storm events. The new set of criteria (and reasoning) used to deem outfalls/access locations capable of being sampled consisted of the following:

- Outfall elevation is above +5 feet mean lower low water (MLLW) (provides adequate sampling duration between high tides),
- Outfall pipe diameter is greater than 24 inches (allows flow depth necessary for sediment trap solids collection),
- Access location is close to the outfall and is downstream of oil-water separators (samples are representative of outfall discharge),
- Access location can be accessed 24 hours a day with little prior notice to property owner (limits restrictions on storm event sampling), and
- Maintenance holes provide a minimum of 9 feet of headspace and 17 inches of horizontal clearance (allows room for sampling equipment deployment).

Of the 15 outfalls/access locations recommended for sampling in SAIC (2009), only four met the above set of criteria. Two of these were sampled as a part of the *Stormwater Lateral Loading Study* (locations KC2062 and NF2095). Locations PS2220 and BDC2088 were not recommended for sampling in SAIC (2009) based on restricted access to private property, but they were deemed acceptable for sampling after the establishment of Site Access Agreements between Ecology and both the Port and Boeing.

Sampling took place at storm drain access locations (maintenance holes) located as close to the outfalls as possible. Table 1 lists the total area, total impervious area, and land cover classifications for each of the four sub-basins. The surface area of each outfall sub-basin was calculated using GIS software following Thiessen polygon analysis of storm drain structure shapefiles to determine probable drainage boundaries. The area of impervious surface and land cover classifications for each sub-basin was determined using the National Land Cover 2006 Percent Developed Imperviousness dataset, available at: http://www.mrlc.gov/nlcd_2006.php.

Figures 2 through 5 display the drainage sub-basins, storm drains, and sampling access locations for outfalls NF2095, KC2062, PS2220, and BDC2088, respectively. Tables A-1 and A-2 of Appendix A present specific information about the outfalls and sampling access locations including coordinates, dimensions, and elevations. A schematic of a typical LDW storm drain and outfall is presented in Figure 6. This figure shows that outfalls typically empty to the banks of the LDW at intertidal elevations, allowing tidal water to flow up the storm drain during high tidal stages. Maintenance holes provide access to the water flowing in the storm drain and a secure location to deploy sampling equipment.

2.1 Norfolk Outfall #2095

The Norfolk combined sewer overflow/emergency overflow/storm drain (CSO/EOF/SD) (outfall 2095) is owned by the City of Tukwila. Seattle Public Utilities (SPU) owns the drain lines within the City of Seattle that contribute to this outfall, and King County owns the CSO. The outfall receives runoff from the Norfolk SD and overflows from the King County combined sewer system, as well as emergency overflows from SPU's pump station #17. The 770-acre drainage basin for this outfall consists of residential and industrial properties in the Beacon Hill neighborhood and industrial properties adjacent to East Marginal Way S (Figure 2). The capacity of the combined sewer system may be exceeded during periods of heavy rainfall, resulting in the possible discharge of untreated human and industrial waste from the outfall into the LDW. To avoid the possibility of sampling wastewater during storm events, a sampling location (NF2095) up-line of the CSO junction was selected (Figure 2).

The Norfolk outfall is located near LDW river mile 5.0 at an elevation of +5.1 feet MLLW. As reported in the LDWG Draft Final Feasibility Study (AECOM 2010), the upper extent of the tidal salt wedge is near river mile 6.3 under winter flow conditions of greater than 1,000 cubic feet per second (cfs). The outfall shows a waterline indicative of frequent tidal inundation. The elevation of the storm drain bottom at sampling location NF2095 was approximately +9.1 feet MLLW. This location was expected to be influenced by high tides. However, there is a tide gate covering the outfall opening, which may restrict tidal water from entering the SD system. There was no evidence of tidal inundation in the measured parameters (Section 5.2) or observations of slack water during any of the site visits, suggesting the efficient operation of the tide gate.

2.2 KCIA Outfall #2062

The King County International Airport (KCIA) SD#2 outfall 2062 receives runoff from the central portion of KCIA with possible inputs from parts of the Boeing Thompson-Isaacson property (Figure 3). The total drainage area for this outfall is approximately 210 acres. Within this drainage system, storm drains on KCIA property initially drain to a cistern hole located at a King County (KC) lift station just east of East Marginal Way S (Figure 3). Stormwater and base flow are held within the lift station cistern until the increasing water level causes the lift station pumps to engage. The water is then pumped across the Boeing Thompson-Isaacson property located west of East Marginal Way S before discharge from the outfall (Figure 3).

If all discharge from outfall 2062 originated on KCIA property, no discharge would be observed unless the KC lift station was pumping. However, the outfall has continuous discharge even during base flow periods, suggesting a continuous source of water to the storm drain system down-line of the lift station, likely from the Boeing Thompson-Isaacson property.

The KCIA sampling location KC2062 is 135 feet up-line of the outfall on the Boeing Thompson-Isaacson property and approximately 2,000 feet down-line of the KC lift station (Figure 3). This location is tidally influenced, becoming inundated with river water when the tidal height is above approximately +8.0 feet MLLW.

2.3 Port of Seattle Outfall #2220

Outfall 2220 receives runoff from the central portion of the Port's Terminal 115 property (Figure 4). The drainage basin (26 acres) consists almost entirely of an asphalt surface used for the transport and storage of shipping containers. Sampling location PS2220 is 265 feet up-line of this outfall. This storm drain is tidally influenced, experiencing tidal inundation at approximately +5.4 feet MLLW.

2.4 Boeing Developmental Center Outfall #2088

Outfall 2088 receives runoff from a central portion of the Boeing Developmental Center (Figure 5). The drainage basin (13 acres) consists of buildings, parking lots, and a green belt, all on Boeing property. Sampling location BDC2088 is a maintenance hole 170 feet up-line of this outfall. This storm drain is tidally influenced, experiencing tidal inundation at approximately +7.5 feet MLLW.

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3.0 Data Collection

This section describes the collection of whole water and storm drain solids, as well as water flow rate and conductivity data. Storm drain solids consist of any solids in storm drains, catch basins, and maintenance hole sumps, as well as particulates in stormwater. For this study, storm drain solids were collected as filtered solids, sediment trap solids, and inline solids. The SAP/QAPP was followed for all sample collection activities (SAIC 2010), with the exceptions noted in Section 3.2. A synopsis of a typical storm-sampling event is outlined in Appendix B, describing the logistics involved with this sampling effort. Appendix B also includes information regarding the prediction of potential sampling events, mobilization of field equipment, and deployment and recovery of sampling gear. Specific challenges associated with this data collection effort are detailed in Appendix C.

3.1 Sample Collection

Whole water and filtered solids samples were collected during three types of flow conditions over the course of the 2010–2011 wet season at each of the four outfall sampling locations:

- Storm events — Six storm events were sampled between January and April 2011. These samples are representative of a range of precipitation amounts and conditions over the sampling period.
- Base flow — Samples collected during three base flow events were intended to be representative of water and solids that enter the storm drain system via groundwater infiltration or as a result of unidentified connections to the system.
- Tidal inundation — One sample was collected at each location during a period of both high tide and no precipitation. These samples were intended to represent LDW river water that may transport contaminants both up-line and down-line and influence solids deposited in sediment traps.

Figure 7 presents a timeline of field activities over the sampling season. Sampling activities for storm events, base flow, and tidal inundation events consisted of collecting whole water and filtered solids. Whole water and filtered solids samples consisted of one composite sample per individual event. In addition to the samples collected for chemical and physical analysis, the whole water sampling equipment logged water depth, conductivity, and velocity data during sample collection and for selected periods over the course of the wet season. These data were used to assess the tidal and base flow conditions observed at each of the sampling locations.

Sediment trap samples were composited over a period of several months to provide enough material for chemical analysis. An attempt was made to collect inline solids grab samples at each sampling location, as described in the SAP/QAPP; however, most of the accessible locations did not contain enough solid material to sample.

3.1.1 Equipment Installation

Certain components of the sampling systems remained installed at each sampling location for the duration of the sampling season, while other components were deployed only for an individual sampling event. All equipment, with the exception of batteries, was dedicated to a specific sampling location to minimize the possibility of cross contamination between sites.

At the beginning of the sampling season, a confined-space entry team from Clearcreek Contractors, Everett, WA, installed sediment traps, flow sensors, and suction lines for whole water sampling within the storm drains. Field notes associated with equipment installation and sampling are presented in Appendix D. The exact configuration of equipment varied among locations due to site-specific characteristics such as pipe shape, diameter, and vault depth. The stormwater suction line and flow sensor were mounted adjacent to each other on a stainless steel pipe ring installed in the storm drain just upstream of the maintenance hole (Figure 8). Sediment traps were installed just downstream of the maintenance holes, leaving the area directly underneath the maintenance hole clear for the intermittent deployment of whole water samplers and stormwater filtration systems (Figure 8).

A whole water sampler and stormwater filtration system were installed at each sampling location during sampling events only, and they were removed between sampling events. Temporary installation of this equipment also included the deployment of two 12-volt marine batteries to power the collection systems and sensors. This equipment was not left in the maintenance vaults for more than a few days, as submergence during high tidal stages had the potential to damage the electronic components of the systems. A tripod and winch were used to lower the whole water sampler and stormwater filtration system in tandem into the maintenance vault (Figure 8). The entire sampling package remained suspended from a hanger designed to fit securely below the maintenance hole cover during sampling. The sampling package was removed upon sampling completion so that whole water and filtered solids samples could be retrieved, data could be downloaded, and batteries could be recharged.

3.1.2 Flow Modules and Conductivity Measurements

Water depth, velocity, and conductivity measurements of water in the storm drains were made using Isco (Teledyne Isco; Lincoln, NE) equipment leased from Whitney Equipment, Bothell, WA. At each sampling location, an Isco 6712c automated whole water sampler was used to power, control, and record data received from a Model 750 area velocity flow module and a YSI 600 (Yellow Springs Instruments; Yellow Springs, OH) conductivity sensor. Flow sensors were attached to the pipe rings installed in the storm drains and were present for the duration of the sampling season. The conductivity sensors were deployed only during sampling events and were attached directly to the stormwater filtration pump cages (Figure 8). Because both sensors were controlled by the Isco sampler, flow and conductivity data were only collected during sampling events and other selected intervals, rather than continuously over the entire sampling season.

3.1.3 Whole Water Samples

Whole water samples were collected using the Isco 6712c units. For storm event and base flow sampling, timers on the Isco computers were programmed to collect aliquots only during low tidal windows when LDW river water was not present in the storm drains. For the tidal water collection event, Isco timers were set to collect aliquots during high tidal stages during periods of no precipitation when LDW tidal water was assumed to be present in the storm drains.

The Isco units were programmed with sampling interval start/stop times based upon the storm drain elevations, predicted daily tidal levels in the LDW, and the timing of predicted storm activity. Although an effort was made to sample as much of the storm hydrograph as possible, rising tidal levels generally restricted sampling to a maximum of 6 hours. Time-weighted whole water samples were collected by the Isco samplers over the programmed sampling interval, generally collecting a 1-liter aliquot every 15 minutes, without overfilling the carboy. The programs included rinsing and purging of the suction line before the collection of each aliquot. The composite sample was collected in a decontaminated 2.5-gallon carboy installed in the sampler base.

Immediately before sampler deployment, the Isco suction line and flow sensor cord were retrieved from the maintenance hole (where they were installed for the duration of the sampling season) and connected to the Isco sampler. The conductivity sensor, also connected to the Isco, was lowered to the bottom of the storm drain along with the stormwater filtration pump.

After the completion of sampling, the Isco sampler was removed from the maintenance hole and the carboy was delivered to the analytical laboratory. The laboratory was responsible for decontamination of the carboy as specified in the SAP/QAPP (SAIC 2010). Isco samplers were taken to the NewFields office (Edmonds, WA) where their exteriors were rinsed and where they were stored between sampling events. Flow and conductivity data were downloaded from the Isco units after each sampling event. Equipment rinse blank samples were collected and analyzed prior to the beginning of the sampling program.

3.1.4 Filtered Solids Samples

The stormwater filtration system used to collect solids samples was described in the SAP/QAPP (SAIC 2010). These filtration units were specifically designed to fit within a variety of maintenance hole sizes and configurations without the need for an external power source. The stormwater filtration systems were deployed in conjunction with the Isco whole water samplers for storm, base flow, and tidal water sampling events.

Each filtered solids sampling unit consisted of the following:

- Polyvinyl chloride (PVC) frame,
- Two 12-volt deep cycle marine batteries,
- Two filter housings,
- Two inline flow totalizers,
- Waterproof control box containing a digital timer,
- Pump cage,
- Bilge pump,
- Float switch, and
- Conductivity sensor (for connection to the Isco sampler).

The submerged portion of the filtration system consisted of a direct current (DC) powered, 2,000-gallons-per-hour submersible bilge pump and float switch connected to the pump cage. One-inch diameter tubing connected the pump to the two parallel filtration housings mounted on the PVC frame (Figure 9). When deployed, the weighted pump cage sat upright on the bottom of the storm drain maintenance hole while the filtration apparatus hung below the maintenance hole cover (Figure 8). The PVC frame also supported the two 12-volt marine batteries required to power the bilge pump, pump timer, Isco sampler, and sensors.

Depending upon the sampling location, as much as 6 feet of tidal water could be present within the maintenance hole at high tide. While the filtered solids sampling equipment was designed to be water-resistant, the digital timer, totalizers, and batteries could not be submerged. Therefore, the long-term deployment of the sampling equipment would have resulted in severe damage. This restriction required deployment, sampling, and recovery of sampling equipment during a low-tide period, generally limiting sampling intervals to 6 hours.

Immediately before sampler deployment, the DC timer on the filtration system was set with the same start/stop times as the Isco sampler (Section 3.1.3). The float switch located on the pump cage was set just above the base flow water level. It was assumed that, when the timer reached its start time and there was a sufficient depth of stormwater, the pump would activate. In reality, the float switches were often pinned down by turbulent storm flow and failed to start the pump. For all but the first storm event, the float switches were not wired into the control system and the pump was activated strictly by the timer.

Similar to the whole water samples, filtered solids samples were time-weighted rather than flow-weighted. Once the pump was activated, stormwater was pushed through the pump hose where the flow was split and forced through separate, pre-weighed, 5-micron polypropylene filter bags. Figure 10 displays the interior of three filter bags: an unused filter, one with a moderate amount of filtered solids, and one with a heavy amount of filtered solids. Flow totalizers, connected to the outflow side of each filter housing, measured the volume of water passing through each filter. These volume data were used to calculate the total suspended solids (TSS) concentration of stormwater passing through the filter. The parallel filtration system allowed for the concurrent collection of two discrete storm drain solids samples denoted as filters A and B. Each filter was assumed to be equally representative of the sampling event. Analytical options for the filter bags were limited because the whole bag was extracted for analysis of either PCB Aroclors, PAHs, or dioxin/furan congeners. Therefore, analysis of these contaminants was rotated between sampling events.

At the completion of a sampling event, the filtration systems were retrieved with the Isco samplers. The totalizer volume for each filter was recorded in the field logbook. Filter bags were removed from the filter housings, squeezed of their excess water, and placed into labeled sample bags. Collected filters were stored on ice and delivered to the analytical laboratory with the whole water samples. Between sampling events, the filtration systems were stored in the NewFields warehouse with other field gear required for sampler deployment.

3.1.5 Sediment Trap Solids Samples

Two sediment traps were installed at each location by a confined space entry crew in December 2010 and collected sediment until early May 2011. The sediment traps consisted of a stainless steel bracket, which holds a 1-liter Teflon sample bottle. The traps were mounted to the wall of the storm drain downstream of all sensors and sampling gear (Figure 8). The sediment traps were tall enough to allow the capture of stormwater solids yet prevent the capture of suspended solids in base flow when there is no tidal water present in the storm drain. However, at three of the four locations sampled (NF2095 being the possible exception), the tops of the sediment trap bottles were below the height of tidal influence. Therefore, the sediment traps may have captured particles suspended in stormwater, base flow, and tidal water when the traps were submerged at high tidal stages.

On May 5, 2011, a confined space entry crew capped the collection bottles with Teflon-lined caps and removed the bottles and brackets from the storm drains. Sediment trap samples were delivered to the laboratory where all sediments from a single location were composited and homogenized before analysis. The laboratory was also responsible for decontamination of the Teflon jars and caps.

3.1.6 Inline Solids Samples

Collection of inline solids was attempted at all locations during base flow conditions and low tidal stages. A decontaminated stainless steel scoop at the end of a long pole was used to scrape any deposited material off the floor of the storm drain. This method was only successful at collecting solids at location KC2062. Once brought to the surface, the solids were transferred from the scoop to glass sample jars.

3.2 Deviations from the Sampling Plan

As anticipated during the planning stages of this study, numerous deviations from the approved SAP/QAPP (SAIC 2010) were required during the sampling effort to collect representative samples of sufficient volume.

3.2.1 Targeted Storm Events

The storm events targeted for sampling did not always meet the criteria outlined in the SAP/QAPP. At the beginning of the sampling season, storm events targeted for sampling were evaluated relative to the following criteria (Ecology 2007):

- Wet Season: October 1 through April 30
- Rainfall volume: 0.20-inch minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: Less than or equal to 0.02 inch of rain in the previous 24 hours
- Inter-event dry period: 6 hours

It was expected that these criteria would need to be modified in order to sample a sufficient number of storm events. The SAP/QAPP also stated that an effort would be made to sample at least 75 percent of the storm hydrograph, or at least 75 percent of the first 24 hours if the storm event lasted longer than 24 hours. Early in the sampling season it was apparent that tidal inundation would restrict the number of possible sampling events and the duration of sample collection.

Table 2 presents a summary of the six sampled storm events. All storm events consisted of an uninterrupted interval of 5 hours or more with total precipitation greater than 0.2 inch, with the exception of storm event 4, which had 0.133 inch of precipitation. The antecedent dry period criterion was dismissed. Only two of the six storm sampling events captured 75 percent or more of the storm hydrograph (storm events 3 and 6) because high tides required either late initiation or early termination of a given sampling event.

3.2.2 Time-Weighted Whole Water Samples

Throughout the entire sampling season, time-weighted rather than flow-weighted whole water samples were collected at all of the sampling locations. As presented in the SAP, whole water samples were to be collected as flow-weighted composites, consisting of equal volume aliquots sampled at predetermined runoff volume intervals. Such a sampling scheme would collect aliquots more frequently at higher flow rates and less frequently at lower flow rates. Flow-weighted samples are preferred over time-weighted samples, because they better reflect the typical storm hydrograph.

In order to program the Isco units to collect flow-weighted whole water samples, the relationship between precipitation amount and stormwater runoff is required for each location. The Isco samplers were deployed with the flow meters prior to stormwater sampling in hopes of obtaining this relationship. However, high tides obscured most precipitation events, causing problems with the flow sensor's ability to accurately measure stormwater velocity and depth. Additionally, the tidally restricted sampling windows prevented the collection of a flow-weighted sample over the entire storm hydrograph. As a result, time-weighted whole water samples, rather than flow-weighted samples, were collected over the same sampling interval as the filtered solids samples.

3.2.3 Tidal Water Sampling

Sampling of tidal water in the storm drains was not included in the SAP/QAPP. It became apparent through numerous field observations that the sediment trap bottles at most locations became inundated during high tides. This is demonstrated in Figure 6, which shows the schematic of a typical LDW outfall and storm drain. Dashed lines representing the MLLW and mean higher high water (MHHW) levels show the extent of the tidal influence near the sampling gear.

It was also observed that storm flow in the storm drain did not always cover the mouths of the sediment trap bottles. In order to account for particles that may be deposited in the sediment traps during high tides, whole water and filtered solids were collected at each sampling location when tidal water was observed in the storm drain. These tidal samples were collected during a time of no precipitation so that tidal water was not being diluted by stormwater.

3.2.4 Inline Solids Sampling

Storm drain inline solids could only be collected at one of the four sampling locations (KC2062). The SAP/QAPP stated that inline solids grab samples would be collected at each of the sampling locations. If inline solids were not present, an attempt would be made to collect the sample from an alternate access location along the storm drain.

Multiple attempts were made to collect inline solids at each of the sampling locations using a stainless steel scoop at the end of an extendable pole. These sampling attempts occurred during periods when there was limited or no water flow through the storm drains. Inline solids were successfully sampled from the bottom of the KC2062 storm drain. Both PS2220 and BDC2088 had no appreciable amount of solids other than gravel present within the storm drains. While NF2095 did have a small amount of observed solids deposited in the storm drain, base flow present in the line prevented the retention of solids on the sampling scoop.

Because inline solids could not be collected at PS2220, BDC2088, or NF2095, other access locations to these storm drains were investigated for sampling. The access locations immediately up-line also did not contain adequate inline solids. Solids were observed in catch basin structures of lateral lines connected to the main storm drains. Samples from these structures were not collected because they were derived from localized drainages and would not be representative of loadings discharged by the mainline outfall.

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4.0 Analytical Methods

All analytical procedures for chemical and physical parameters were performed by subcontracted laboratories in accordance with Ecology guidelines as outlined in the SAP/QAPP (SAIC 2010). This section summarizes the analytical methods for each sample type. Specific methods used for analysis of whole water, filtered solids, sediment trap solids, and inline solids are presented in their respective data summary tables (Appendix E: Tables E-1, E-2, E-3, and E-4). The numbers of whole water and filtered solids samples analyzed for storm events, base flow, and tidal water are displayed in Table 3.

4.1 Whole Water Samples

After sampling, the 2.5-gallon carboys containing the whole water samples were delivered to Analytical Resources, Inc. (ARI), of Tukwila, WA, for sub-sampling and analysis. Twelve conventional parameters were measured including pH, total alkalinity, alkalinity as carbonate, alkalinity as bicarbonate, alkalinity as hydroxide, TSS, chloride, nitrate, sulfate, total organic carbon (TOC), dissolved organic carbon (DOC), and hardness as calcium carbonate. The methods for each of these parameters are presented in Table E-1 (Appendix E).

Whole water samples were also analyzed for low level PCB Aroclors (EPA 8082), semivolatile organic compounds (SVOCs) by EPA 8270D and 8270DSIM, pesticides (EPA 8081B), volatile organic compounds (VOCs) (EPA 8260C), and total and dissolved metals (EPA 200.8, EPA 6010B, and EPA 7470A). Dissolved metals were analyzed after an aliquot of unpreserved sample was passed through a 0.45-micron filter.

For select samples, ARI also sub-sampled an aliquot, which was sent to Axys Analytical Services, Ltd (Axys) of Sidney, BC, for polybrominated diphenylether (PBDE) analysis (EPA 1614).

4.2 Filtered Solids Samples

After sample collection, the filters were delivered to ARI for processing and analysis. Filtered solids from the A filter of the parallel filtration system were first scraped to obtain material for analysis of metals and grain size. Approximately 10 grams of material were needed for metals analysis and approximately 20 grams for grain size. If insufficient sample material was obtained to analyze for all parameters, mercury was analyzed first, then other metals, then grain size. The remainder of the filter bag was extracted in its entirety and analyzed for either PCB Aroclors or PAHs. Metals were reported as mg/kg dry weight, organics (PCB Aroclors and PAHs) were reported in units of µg per filter bag, and grain size was reported in percent size fraction.

For PCB Aroclor analysis, the filter bags were first dried to determine the dry weight of material captured during filtration. The dry filter bags were then extracted whole and analyzed for PCB Aroclors. For PAH analysis, the filter bags were not dried due to the volatility of the individual PAH compounds. Rather, the wet filter bags were extracted whole and analyzed for PAHs.

PCB Aroclors were analyzed by EPA 8082, PAHs were analyzed by EPA 8270D, and metals were analyzed by EPA 6010B and EPA 7471A. Grain size analysis was initially performed using the Sedigraph unit. Due to instrument breakdown in early April, subsequent grain size analyses were instead perfomed by a laser diffraction unit. Both instruments used Puget Sound Estuary Program (PSEP) methods and produce comparable data of acceptable quality.

Selected B filters were sent to Axys for analysis of dioxin/furan congeners. The first batch of filters sent to Axys was sent wet weight (i.e., not dried) on the assumption that sufficient solids could be scraped from the filter for analysis. Subsequent batches of filters were first dried and weighed by ARI before being shipped to Axys for dry weight, whole-bag extraction. Dioxin/furan congeners were analyzed using EPA 1613.

All filters were labeled and weighed by ARI prior to sampling. The difference between the dry weight of a filter after sampling and the dry weight of the filter before sampling represents the total mass of solids captured on the filter during sampling. This mass of solids is used to convert the laboratory reported units of µg per filter bag to µg per kg dry weight (DW). Calculating this mass for both filters per location per event is dependent on one of three analytical scenarios:

- In scenarios where the A filter was analyzed for PCB Aroclors and the B filter for PAHs, it was assumed that the mass of solids captured on both the A and B filters was equal if no grain size and/or metals subsamples were removed. If subsamples were removed from the A filter, the mass of solids captured for the B filter was adjusted with a correction factor. For example, if the grain size and metals subsamples accounted for 5 percent of the wet weight of filter A, then the dried mass of solids captured for filter B was increased by 5 percent.

- In scenarios where the A filter was analyzed for PAHs and the B filter for dioxin/furan congeners, it was assumed that the mass of solids captured on the A and B filters was equal. The mass of solids on the B filter was determined from post sampling dry weight measurements made by ARI or Axys[1] and applied to filter A. If grain size and/or metals subsamples were removed from filter A, a correction factor was used to account for their removal. For example, if the grain size and metals subsamples accounted for 5 percent of the wet weight of filter A, then the dried mass of solids captured for filter A was decreased by 5 percent.

- In scenarios where the A filter was analyzed for PCB Aroclors and the B filter for dioxin/furan congeners, the mass of solids captured was calculated separately for each filter.

There were three cases where the mass of solids captured was less than 1 gram. Although it would have been possible to normalize the data, the final result would likely have been biased high due to the small mass. These three samples were not normalized and are not part of this report. The non-normalized results of these three samples are presented in Table E-7 (Appendix E) for reference purposes.

[1] Early in the project, Axys removed subsamples from some of the filters for analysis of dioxin/furan congeners. Removing the subsamples was meant to expedite analysis, but this complicated the calculation for mass of solids captured. If a subsample was removed by Axys, total solids was also measured. Total solids multiplied by the wet weight of the subsample equals the dry weight of the subsample. This subsample dry weight was added to the difference between the dry weight after sampling and the dry weight before sampling to obtain a total mass.

The mass of solids captured on each filter is listed in the data summary tables for filtered solids in Table E-2 (Appendix E).

4.3 Sediment Trap and Inline Solids Samples

Two sediment traps were deployed at each of the four locations. The traps were collected on May 4, 2011. Sediment from the two bottles at each location were combined prior to analysis. ARI analyzed solids from NF2095, KC2062, and PS2220 for TOC, total solids, and SVOCs. Extra solids from these three locations were sent to Axys for analysis of dioxin/furan congeners and PBDEs; however, only NF2095 and KC2062 had sufficient solids for PBDE analysis. BDC2088 was analyzed for TOC and SVOCs.

KC2062 was the only location where an inline solids grab sample could be collected. This sample was analyzed for grain size, total solids, TOC, metals, and SVOCs. Methods used for the analysis of sediment trap and inline solids are the same as those used with filtered solids.

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5.0 Summary of Results

This section summarizes the physical and chemical data collected as a part of the Stormwater Lateral Loading Study. Chemistry summary tables for samples collected during six storm events, three baseflow events, and high tide conditions are presented in Appendix E, while complete analytical results are presented in Appendix F. Analytical data validation results are summarized in Section 6.0 and are presented in full in Appendix G.

In this section, whole water chemical concentrations are compared to the acute and chronic Washington State Marine Water Quality Criteria (WQC). There are no regulatory standards for filtered solids, sediment trap solids, or inline solids samples. Results for these sample types are compared to the state sediment management standards (SMS) and the Washington State Model Toxics Control Act (MTCA) Method A cleanup standards. Although these standards do not apply to storm drain solids, they are used as benchmarks in this report to provide a rough indication of storm drain sediment quality. The SMS establish two levels:

- Sediment quality standards (SQS): Concentrations below the SQS are expected to have no adverse effects on biological resources and no significant human health risk.
- Cleanup screening level (CSL): Minor effects level used to identify areas of potential concern.

Storm drain solids chemical concentrations are compared to SMS numeric criteria for chemicals that have non-TOC normalized SMS criteria. For chemicals that have TOC-normalized SMS criteria, chemical concentrations are compared to the lowest apparent effects threshold (LAET), which is functionally equivalent to the SQS, or the second lowest apparent effects threshold (2LAET), which is functionally equivalent to CSL.

Comparison of storm drain solids collected from catch basins, manholes, and sediment traps to SMS is considered conservative. If source sediment samples are below the SMS, there is little chance of sediment offshore of the outfalls becoming recontaminated to these levels. However, a concentration above the SMS does not necessarily indicate that the sediment offshore of the outfall will exceed standards, because sediment discharged from storm drain disperses in the receiving environment and mixes with sediment from other sources before depositing.

5.1 Flow Measurements and Precipitation

Conductivity and flow sensors were deployed for each sampling event and for select monitoring periods. Although it was difficult to determine stormwater and base flow volumes due to problems with the velocity data, the level and conductivity measurements show the tidal conditions present at the sampling locations.

5.1.1 Flow Measurements

Flow level/velocity meters and conductivity probes were deployed at all four locations. At locations PS2220, KC2062, and BDC2088, conductivity and level measurements matched the tidal level recorded at Elliott Bay tide station 9447130 (http://co-ops.nos.noaa.gov/geo.shtml?location=9447130).

Figure 11 presents measurements at PS2220 from a 5-day dry period in early May. Tidal levels (red) correlate to flow meter levels (blue) for all tides greater than +6 feet MLLW, a depth that roughly corresponds to the elevation of the storm drain. At tidal levels less than approximately +6 feet MLLW, water levels in the storm drain are representative of base flow or standing water conditions (Figure 11). Conductivity measurements track the tides in the storm drain but lack a perfect correlation. At a high tide, conductivity readings varied between 3,000 and 9,000 µS/cm. This variation could be due to many factors including instrumentation drift, varying base flow, and varying river conditions. KC2062 and BDC2088 had profiles similar to that of PS220 but with varying conductivity readings at high tide.

As long as precipitation fell during a low tide window, the flow meters at locations PS2220, KC2062, and BDC2088 were also capable of measuring level due to stormwater runoff. However, stormwater levels were much lower than those associated with tidal inundation. Runoff levels from even the largest storms increased water levels in the storm drain by approximately 8 inches, compared with many feet because of tidal fluctuation. This difference in magnitude often made it difficult to discern storm flow from tidal inundation.

Tidal flow interfered with the ability of the flow meter to measure velocity. As a result, most of the velocity measurements are not reliable. A typical velocity profile for a tidal cycle consisted of rapid fluctuations in velocity from positive to negative, with no correlation to the direction of tidal flow. This same interference carried over into most low tide windows, making it impossible to measure velocity of either storm flow or base flow.

While the flow meters worked with limitations at PS2220, KC2062, and BDC2088, no measurements were available for NF2095. It is not clear why measurements were not successful at this location. Even water level did not function properly, suggesting faulty equipment. From the level and velocity data, it cannot be determined if NF2095 is tidally influenced. However, low conductivity values measured during high tidal stages suggest that the outfall’s tide gate effectively prevents tidal water from entering the SD system. Tidal influence at NF2095 is further discussed in Section 5.2.1.

Because of the problems associated with the collection of level and velocity at each location, stormwater runoff estimates for the loading calculations are based solely on total and impervious surface area of the outfall sub-basins (Section 7.1). Additional flow and level data were collected to obtain estimates for base flow volumes. On June 9 and 10, 2011, field measurements of level and velocity were made using a Global Water Flow Probe (Global Water; Gold River, CA). The probe consisted of a 15-foot handle with a propeller end for measuring velocity. The probe had difficulties measuring velocity when water depths were less than 2 inches. In some cases of low water depth, velocities were estimated from the surface by timing the movement of debris carried by the flow. Base flow is variable at KC2062 due to the cycling of the lift station pumps. The pumps activate on an hourly basis. Base flow measurements were made throughout one pump cycle.

Table 4 lists the storm drain pipe diameter, minimum and maximum base flow level, and velocity measured at sampling locations, as well as referencing the source of the data as flow probe or field estimate. These values were used in conjunction with the storm drain diameter to calculate the average base flow in gallons per minute (gpm). Base flow ranged from 0.04 gpm at PS2220 to 3.2 gpm at KC2062.

5.1.2 Precipitation Data

The Boeing Field-King County International Airport (identified as "KBFI") rain gauge was chosen to be representative of precipitation for the Stormwater Lateral Loading Study. The KBFI rain gauge is located 6.1 meters (20 feet) above sea level at 7602 Perimeter Road, on the KCIA property (Figure 1). KBFI is part of a network of meteorological stations maintained by the National Climatic Data Center (NCDC). Precipitation data are logged hourly and are available for download via subscription at http://www.ncdc.noaa.gov/oa/climate/stationlocator.html. Trace amounts of precipitation are reported as "T" by NCDC. These values were replaced with 0.001 inch for data processing purposes.

Figure 12 displays tide and precipitation records for the storm events sampled in this study. The time intervals that whole water and filtered solids samplers were actively sampling stormwater are shaded (green). These six storm events encompass a variety of storm conditions, varying in intensity and duration. Figure 13 displays tide and precipitation records for base flow (yellow) and tidal water (red) sampling events. These sampling events were targeted during periods of trace or no precipitation.

5.2 Whole Water

Whole water samples collected during storm events, base flow, and high tidal stages were analyzed for conventional and chemical parameters (Table 3). Results of whole water analysis are presented in Table E-1 (Appendix E) and are summarized below. Additional events were targeted, and samples were collected and analyzed. It was later determined these events did not meet the project criteria for storm or base flow events. Results from six of these samples are presented in Table E-5 (Appendix E) but are not summarized in this report. Figures 14, 15, and 16 display whole water results for all locations and event types, including flow-weighted average concentrations for storm flow and base flow (see Section 7.2). Whole water chemical concentrations of total PCBs, some metals, and some pesticides are compared to the acute and chronic WQC. The WQC do not exist for the other compounds analyzed.

Table 5 summarizes the frequency of detection for chemicals detected in storm event whole water samples. Cells highlighted in blue indicate locations where one or more storm event whole water samples exceeded WQC. Maximum concentrations of COPCs that exceeded the WQC in whole water samples are presented in Table 6. Chemicals that were not detected in any storm event whole water samples are listed in table E-8 (Appendix E).

5.2.1 Conventionals

The different composition of base flow, stormwater, and tidal water is evident from the analysis of whole water conventional parameters. TSS concentrations were consistently the highest in stormwater samples collected at PS2220 (Figure 14). Average base flow TSS concentrations were lower than average storm event concentrations, with the exception of KC2062 where base flow had similar TSS as stormwater. Tidal water TSS concentrations were generally similar to or less than base flow concentrations.

Whole water chloride concentrations are indicative of the amount of tidal influence on samples. At locations KC2062, PS2220, and BDC2088, chloride concentrations were greatest in tidal samples compared to base flow and stormwater samples (Figure 14). Chloride concentrations in water collected from NF2095 during a high tidal stage were similar to that of base flow at NF2095 and lower than that of tidal water at other locations, suggesting that this storm drain may not experience tidal inundation as far up-line as the NF2095 sampling location.

The tidal water chloride concentration at PS2220 is an order of magnitude higher than other locations because of the location of the PS2220 outfall (Figure 1). PS2220 is located farther downstream and at a lower elevation than the other sampled outfalls, causing it to be the most affected by the LDW tidal salt wedge. Although the salt wedge extends upstream to the other sampling locations, their higher elevation restricts storm drain tidal inflow to relatively low salinity water of the surface LDW. The fact that the base flow chloride concentration at PS2220 is also an order of magnitude higher than base flow samples from other locations suggests that water infiltrating the PS2220 storm drain during base flow conditions is composed partially of tidal water.

5.2.2 PCBs

PCBs were not detected in any base flow or tidal water samples. Low levels of PCB Aroclor 1254 were detected in whole water samples from NF2095, BDC2088, and PS2220 for multiple storm events (Table 5). PCBs were not detected in any whole water samples collected at KC2062. All detected total PCB concentrations were below the WQC, ranging from 0.01 to 0.02 µg/L.

5.2.3 Total Metals

Total metals commonly detected in storm event whole water samples were also detected in base flow and tidal water samples, with the exceptions of cadmium and selenium. Cadmium was not detected in either base flow or tidal samples at any location but was commonly detected in storm event samples. Total selenium was detected in tidal water at all locations except KC2062 but was only detected in a single storm event sample. Total mercury was not detected in any whole water samples analyzed.

5.2.4 Dissolved Metals

Dissolved metals were rarely present at concentrations exceeding WQC (Tables 5 and 6). Dissolved arsenic, copper, nickel, and zinc were detected in most samples. Copper exceeded the WQC in three of four storm event samples at PS2220, with concentrations ranging from 1.6 to 9.1 µg/L. Zinc exceeded the WQC in one of the four storm event samples at PS2220, with concentrations ranging from 5 to 120 µg/L. WQC exceedances did not occur at other locations, nor in any base flow or tidal samples (Figure 15). Two metals, cadmium and lead, were detected as total metals but were rarely or never detected in the dissolved phase. Cadmium was not detected in any of the dissolved phase samples, while dissolved lead was only detected in the three stormwater samples from storm event six. Dissolved chromium was detected at half the frequency of total chromium.

As expected, concentrations of dissolved metals were less than concentrations of total metals. As evidenced by their frequency of detection, cadmium and lead are not present in the dissolved phase. Dissolved chromium concentrations averaged about 12 percent of total chromium concentrations across all samples. Dissolved arsenic, copper, and zinc all averaged about 45 percent of total concentrations, while dissolved nickel averaged 66 percent of total nickel concentrations across all samples. In general, tidal samples had a higher percentage of dissolved to total phase metals concentrations compared to base flow and stormwater.

5.2.5 Pesticides

Pesticides were not detected in any of the whole water samples analyzed.

5.2.6 Phenols

Phenolic compounds were not detected in base flow or tidal water samples at any location. Phenol, 2-methylphenol, 4-methylphenol, and 2,4-dimethylphenol were occasionally detected in storm event samples from PS2220 but no other locations (Table 5). Concentrations of individual phenols at PS2220 ranged from 1.0 to 6.6 µg/L.

5.2.7 Phthalates

Phthalates were generally not detected in base flow samples. Phthalates were occasionally detected in stormwater samples from BDC2088 (1.0 to 5.9 µg/L) but were never detected at the other sampling locations (Table 5). The only instance when a phthalate was detected at KC2062 was in the tidal water sample at a concentration of 1.8 µg/L. Phthalates were not detected in tidal water from other locations.

5.2.8 PAHs

PAHs were detected in all base flow, storm event, and tidal water samples. PAH compounds were most frequently detected at BDC2088 and PS2220 (Table 5), and these locations also had the highest stormwater concentrations of both total high molecular weight polycyclic aromatic hydrocarbons (HPAHs) and total low molecular weight polycyclic aromatic hydrocarbons (LPAHs) (Figure 16). Total HPAHs ranged from 2.7 to 19 µg/L and 1.8 to 50 µg/L in stormwater samples from locations PS2220 and BDC2088, respectively. Total LPAHS ranged from 0.32 to 7.4 µg/L and 0.23 to 6.9 µg/L in stormwater samples from locations PS2220 and BDC2088, respectively. KC2062 was the only location where base flow total HPAH and total LPAH concentrations exceeded average storm event concentrations (Figure 16).

5.2.9 Other SVOCs

Other SVOCs (not discussed previously) were not detected in any whole water samples.

5.2.10 VOCs

VOCs in whole water samples were generally not detected. Cis-1,2-dichloroethene was detected in all base flow samples at KC2062 (0.2 to 0.3 µg/L), but not in storm event or tidal water samples. Chloroform was detected in one of two base flow samples from PS2220 (1.1 µg/L) but not in storm event or tidal water samples.

5.2.11 PBDE Congeners

PBDEs were detected in all base flow and storm event samples analyzed. Tidal samples were not analyzed for PBDEs. Flow-weighted average storm event concentrations of PBDEs were greatest at NF2095 (18,000 to 54,000 pg/L) and BDC2088 (9,500 to 42,000 pg/L) (Figure 16). Higher concentrations of PBDEs were found in storm event samples than base flow at NF2095 and PS2220. The single storm event sampled for PBDEs at KC2062 had the same concentration as base flow at this location (3,200 pg/L).

The WQC do not exist for PBDEs, and these compounds have rarely been analyzed for in Washington State stormwater samples. In one study, stormwater collected from commercial/ industrial sub-basins of the Snohomish River and Puyallup River watersheds had a median total PBDE concentration of 3,300 pg/L (Herrera 2011). In comparison, all storm event samples collected from NF2095, PS2220, and BDC2088 had total PBDE concentrations greater than this median, with the highest concentration whole water samples being an order of magnitude greater[2].

5.3 Filtered Solids

Filtered solids samples collected during storm events, base flow, and high tidal stages were analyzed for the conventional and chemical parameters listed in Table 3. Results of filtered solids analysis are presented in Table E-2 (Appendix E) and are summarized below. Additional events were targeted, and samples were collected and analyzed. It was later determined these events did not meet the project criteria for storm or base flow events. Results from six of these samples are presented in Table E-6 (Appendix E) but are not summarized in this report. Figures 17 and 18 display filtered solids results for selected chemicals at all locations and event types, including flow-weighted average concentrations for storm flow and base flow. Chemicals not detected in any filtered solids samples are listed in Table E-9 (Appendix E). Table 7 shows the frequency of detection for chemicals commonly detected in storm event filtered solids.

Filtered solids chemical concentrations are not normalized to organic carbon concentrations, as TOC cannot be measured in the filtered solids due to interference from the polypropylene filter bag. Therefore, filtered solids chemical concentrations are compared to SMS criteria for chemicals that have non-TOC normalized SMS criteria. For chemicals that have TOC-normalized SMS criteria, chemical concentrations are compared to the LAET and 2LAET. Filtered solids samples with COPCs in exceedance of SMS/LAET criteria are presented in Table 8.

5.3.1 Grain Size

Filtered solids grain size was the only sediment conventional parameter analyzed. Because of the limited amount of solids collected on filters and the priority of chemical analysis, grain size was only determined for a limited number of NF2095 and KC2062 storm event filtered solids samples. Filtered solids at both locations were generally composed of silts and clays (66 to 89

[2] Total PBDEs values presented in this data report are a sum of the detected concentrations of the 46 reported PBDE congeners. There is no standard target analyte list for the various possible 209 PBDE congeners, so these "Total PBDE" values may not be directly comparable to other datasets.

percent fines [silt + clay]), with the exception of one KC2062 sample consisting dominantly of sands (22 percent fines).

5.3.2 Dioxin/Furan Congeners

Dioxin/furan congeners were detected in all base flow and storm event filtered solids samples analyzed. Tidal filtered solids samples did not undergo dioxin/furan analysis. Octachlorodibenzo-p-dioxin (OCDD) was the congener of highest concentration in all samples. For each sample, a toxic equivalency (TEQ) was calculated using the most recent mammalian toxic equivalency factor (TEF) values from the World Health Organization (WHO) (Van den Berg et al. 2006). The maximum TEQ values of 72.6 and 73.0 pg/g occurred in two storm event samples from PS2220 (Figure 17). At this location, storm event and base flow TEQ values were of similar magnitude. Average storm event TEQ values were an order of magnitude greater for storm event samples than base flow samples at locations NF2095 (53 pg/g and 6.5 pg/g, respectively) and KC2062 (25 pg/g and 4.9 pg/g, respectively).

5.3.3 PCBs

PCBs were detected in all storm event and tidal filtered solids analyzed and in base flow filtered solids from PS2220. PCB Aroclors 1254 and 1260 were the only Aroclors detected in the samples (Table 7). The maximum total PCB concentration of 0.82 mg/kg occurred in a storm event sample from BDC2088 (Figure 17). Total PCB concentrations exceeded LAET criteria for multiple storm event samples from locations NF2095, KC2062, and BDC2088 (Table 8). PCBs were either not detected or present in concentrations less than LAET criteria in storm event samples from PS2220 and all base flow and tidal samples.

5.3.4 Metals

Metals commonly detected in storm event filtered solids samples were also detected in base flow samples. Tidal filtered solids were not analyzed for metals. Arsenic was only detected in filtered solids from PS2220, while silver was only detected at BDC2088 (Table 7). Lead and mercury were detected in storm event filtered solids from all locations but only in a base flow sample from PS2220. In no instances were lead or mercury detected at concentrations that exceed SMS criteria.

The only metals detected in concentrations exceeding SMS criteria were cadmium and zinc (Table 8). Cadmium exceeded SMS criteria in multiple storm event samples collected from both NF2095 and KC2062, and also a base flow sample from NF2095 (Figure 18). Cadmium concentrations ranged from 3 to 8 mg/kg at NF2095 and 2 to 9 mg/kg at KC2062. Unlike many other COPCs, average cadmium concentrations are of similar magnitude in storm event and base flow samples from a particular location. Zinc exceeded SMS criteria in all storm event samples from all locations and in base flow from NF2095 and PS2220 (Figure 18). The maximum zinc concentration occurred in a storm event sample from KC2062 (2090 mg/kg). The concentration of zinc in base flow filtered solids from PS2220 (2040 mg/kg) exceeded that of storm event samples from this location (1340 to 1880 mg/kg). Average zinc concentrations were higher in storm event than base flow filtered solids from NF2095 and KC2062.

5.3.5 PAHs

Most LPAHs and HPAHs were detected in stormwater filtered solids samples from all four sampling locations (Table 7). PAHs were more frequently detected in storm event and tidal water samples than base flow. LAET criteria were exceeded for multiple PAH compounds in the majority of storm events from all locations (Table 8). PS2220 was the only location where a base flow sample exceeded LAET criteria for HPAHs (31 mg/kg) (Figure 17). No tidal filtered solids PAH concentrations exceeded LAET criteria. The maximum concentrations of both total HPAHs (230 mg/kg) and total LPAHs (33 mg/kg) occurred in a storm event sample from BDC2088 (Figure 17). Flow-weighted average total HPAH and total LPAH concentrations were greater for storm events than base flow.

5.4 Sediment Trap Solids

A sediment trap is capable of collecting solids whenever the bottle's mouth is submerged. When only stormwater is present in the storm drain, submergence of the trap requires approximately 0.02 inch of precipitation per hour. Less intense storm events are incapable of producing enough runoff to raise stormwater levels in storm drains above trap mouths. For all locations sampled, the trap is too tall to be submerged exclusively by base flow. When tidal water is present in the storm drain above the trap mouth, sediment traps have the ability to capture particles suspended in stormwater, base flow or the tidal water itself. Figure 19 shows the relative amount of time during the 2010–2011 wet season that the deployed sediment traps were submerged by tidal water and stormwater. Traps at lower elevation experience more frequent and longer duration tidal influence, allowing tidal water to more frequently submerge the traps than stormwater. Traps placed at elevations above +13 feet MLLW are above the level of tidal influence and therefore should only be submerged during storm flow conditions.

Results of sediment trap solids analysis are presented in Table E-3 (Appendix E) and are summarized below. Chemicals not detected in any sediment trap solids samples are listed in Table E-10 (Appendix E). Figure 20 displays sediment trap solids results for all locations. In a similar manner as Tables 5 and 7, Table 9 shows which chemicals were detected despite there being only a single sediment trap solids sample per location. Sediment trap solids were not analyzed for PCBs because of limited sample volume.

Although TOC content was determined for three of the four sediment trap samples, chemical concentrations are not normalized to TOC so that different sample types can more easily be compared. As with filtered solids, sediment trap solids chemical concentrations are compared to SMS/LAET criteria. Sediment trap solids samples with COPCs in exceedance of SMS/LAET criteria are presented in Table 10.

5.4.1 TOC

The organic carbon content of sediment trap solids ranged from 5.0 to 12 percent, with the lowest and highest TOC content measured at KC2062 and PS2220, respectively.

5.4.2 Dioxin/Furan Congeners

Dioxin/furan congeners were analyzed in sediment trap solids samples at all locations except BDC2088. All congeners were detected in all samples analyzed, with OCDD being the highest concentration in all samples. TEQ values in these samples ranged from 8.3 to 67 pg/g, with the highest TEQ measured at PS2220 (Figure 20).

5.4.3 Phenols

Phenolic compounds were detected in sediment trap solids samples from all four sampling locations. Phenol, pentachlorophenol, and 4-methylphenol were each detected in at least two of the four locations. The highest detected concentrations of phenol (0.49 mg/kg), pentachlorophenol (0.26 mg/kg), and 4-methylphenol (0.41 mg/kg) occurred at BDC2088, PS2220, and NF2095, respectively. Sediment trap solids at BDC2088 exceeded SQS criteria for phenol (Table 10).

5.4.4 Phthalates

Bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, and di-n-octyl phthalate were detected in sediment trap solids samples from all four sampling locations (Table 9). The highest concentrations of bis(2-ethylhexyl)phthalate (13 mg/kg), butyl benzyl phthalate (1.8 mg/kg), and di-n-octyl phthalate (7.3 mg/kg) were measured at PS2220, NF2095, and BDC2088, respectively. KC2062 was the only location where sediment trap solids did not exceed LAET criteria for any phthalate compound (Table 9). All other locations exceeded LAET criteria for at least two phthalates (Table 10).

5.4.5 PAHs

Most LPAHs and HPAHs were detected in sediment trap solids samples from all four sampling locations (Table 9). NF2095 was the only location where sediment trap solids did not exceed LAET criteria for any PAH compound. All other locations exceeded LAET criteria for multiple individual PAH compounds (Table 10). Sediment trap solids at PS2220 and BDC2088 exceeded LAET criteria for both total LPAHs (34 and 15 mg/kg, respectively) and total HPAHs (84 and 120 mg/kg, respectively) (Table 10, Figure 20). Despite numerous LAET exceedances for individual LPAHs, sediment trap solids at KC2062 did not exceed LAET criteria for total LPAHs.

5.4.6 Other SVOCs

Benzoic acid and benzyl alcohol were the only other SVOCs (not discussed previously) detected in sediment trap solids samples. These compounds were only detected at locations BDC2088 and NF2095 (Table 9). The BDC2088 sample exceeded LAET criteria for both benzoic acid (1.2 mg/kg) and benzyl alcohol (0.31 mg/kg), while NF2095 exceeded LAET criteria for benzyl alcohol (0.12 mg/kg) only (Table 10).

5.4.7 PBDE Congeners

Sediment trap solids samples were analyzed for PBDEs at all locations except BDC2088. The majority of PBDE congeners were detected in all samples, with BDE-209 being the congener of highest concentration. For all samples, most congener concentrations were fairly similar. However, the concentrations of hepta-BDEs (BDE-183 through BDE-208), deca-BDE (BDE-209), and total BDEs were an order of magnitude greater in the NF2095 sample (1,050 µg/kg).

SMS/AET sediment criteria do not exist for PBDEs, and these compounds have rarely been analyzed for in LDW sediment or stormwater samples. Three sediment composite samples collected in the vicinity of the LDW Turning Basin had total PBDE congener concentrations with a range of 0.57 to 11 µg/kg (SAIC and NewFields 2011b). Stormwater sediment trap solids samples had concentrations one (KC2062 and PS2220) or two (NF2095) orders of magnitude greater than the highest concentration LDW sediment sample.[3]

5.5 Inline Solids

KC2062 was the only location where an inline solids grab sample could be collected. This sample was not analyzed for PCBs because of limited sample volume. Analysis results for this sample are presented in Table E-4 (Appendix E) and are summarized below. The inline solids chemical concentrations were compared to SMS/LAET criteria, with exceedances presented in Table 11.

5.5.1 Conventionals

The TOC content of the solids sample was 3.5 percent, consisting of 71 percent fines.

5.5.2 Metals

All metals analyzed were detected with the exceptions of mercury and silver. The measured concentrations of arsenic (90 mg/kg), cadmium (6 mg/kg), and zinc (640 mg/kg) exceeded SMS criteria (Table 11).

5.5.3 Phenols

Phenol (0.15 mg/kg) and 4-methylphenol (0.057 mg/kg) were the only phenolic compounds detected in the solids sample. Concentrations of these compounds did not exceed SMS criteria.

5.5.4 Phthalates

Bis(2-ethylhexyl)phthalate (0.25 mg/kg), butyl benzyl phthalate (0.056 mg/kg), and dimethyl phthalate (0.028 mg/kg) were detected in the solids sample. Concentrations of these compounds did not exceed LAET criteria.

5.5.5 PAHs

Most LPAHs and HPAHs were detected in the solids sample. Measured concentrations of benzo(g,h,i)perylene (1.2 mg/kg), dibenzo(a,h)anthracene (0.33 mg/kg), fluoranthene (1.8 mg/kg), and indeno(1,2,3-cd)pyrene (1.1 mg/kg) exceeded LAET criteria (Table 11).

5.5.6 Other SVOCs

Benzoic acid (0.59 mg/kg) was the only other SVOC (not discussed previously) detected in the inline solids sample. The concentration of benzoic acid did not exceed LAET criteria.

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[3] Total PBDEs values presented in this data report are a sum of the detected concentrations of the 46 reported PBDE congeners. There is no standard target analyte list for the various possible 209 PBDE congeners, so these "Total PBDE" values may not be directly comparable to other datasets.

6.0 Quality Assurance/Quality Control

Analyses were conducted following the quality assurance/quality control (QA/QC) requirements specified in the project SAP/QAPP (SAIC 2010) and the referenced test methods. The QA/QC procedures ensure that the results of the investigation are defensible and usable for their intended purpose.

6.1 Equipment Rinse Blanks

Two equipment rinse blank samples were collected to determine whether target chemicals of concern would contaminate the samples during sampling. The rinse blank samples consist of reagent grade water provided by ARI rinsed across and/or through the sample collection and processing equipment. Rinse blank samples were analyzed for VOCs, SVOCs, PAHs by selected ion monitoring (SIM), PCBs, pesticides, and metals. If chemicals were detected in the rinse blank samples, the detected concentrations were compared to the associated sample results to evaluate the potential for contamination. Detected sample concentrations within the action limit set by the associated rinse blank concentrations were requalified as nondetect (U) by EcoChem during data validation. Qualified results are discussed in the data validation report in Appendix G.

6.2 Data Validation

All chemical results gathered during this investigation were independently validated by EcoChem, Inc. of Seattle, WA. A full-level, EPA Stage 3 or 4 data validation was performed on approximately 10 percent of the results; a summary-level, EPA Stage 2B data validation was performed on the remainder of results. A compliance-level screening, EPA Stage 2A data validation including a comparison of detected results to sample concentrations was performed on the rinse blank samples. All PBDE and dioxin/furan results underwent full-level data validation. Data validation was performed following EPA guidance (EPA 1994, 2004, 2005, 2008, 2009).

For VOC analysis, only vials preserved with hydrochloric acid to a pH<2 were collected. Due to the highly reactive nature of 2-chloroethyl vinyl ether in acid preserved samples, all results for this chemical were rejected by EcoChem. Rejected results should not be used for any purpose. All other results were considered acceptable, as qualified. Issues resulting in data qualification are summarized below. A full list of qualified results including the reason for data qualification is presented in the data validation report in Appendix G.

Results for various chemicals were J- or UJ-qualified as estimated because the following were outside of control limits: calibration verification, matrix spike/matrix spike duplicate, laboratory control sample/laboratory control sample duplicate, standard reference material, internal standard, surrogate, reporting limit verification and/or inductively coupled plasma check standard recoveries, or duplicate sample and/or second column confirmation results' relative percent difference (RPD). One result each for 4-methylphenol and hexachlorobutadiene were NJ-qualified as estimated with tentative identification because of low spectral match or because the dual column RPD exceeded 60 percent, respectively. One nitrate result was J-qualified as estimated because the sample was analyzed three days outside of standard holding time.

Twenty-seven results for four chemicals were re-qualified as nondetect at elevated reporting limits (RLs) because of method blank contamination, including the following: 14 results for nitrate ranging from 0.1 to 0.6 mg/L, 7 results for naphthalene ranging from 0.016 to 0.039 µg/L, 5 results for bis(2-ethylhexyl)phthalate ranging from 1.0 to 8.0 µg/L, and one result for phenanthrene at 0.02 µg/L. Twenty-five results for methylene chloride ranging from 0.8 to 4.2 µg/L, 11 results for acetone ranging from 6.0 to 21 µg/L, and 2 results for toluene with RLs of 0.2 µg/L were re-qualified as nondetect because of equipment rinse blank contamination.

Nineteen results for three individual PCB Aroclors were Y-qualified by ARI as nondetect at elevated RLs because chromatographic interferences prevented adequate resolution of the compound at the standard RL. Nine results for three dioxin/furan congeners and 125 results for 37 specific PBDE congeners were K-qualified by Axys as being estimated maximum possible concentrations because not all method required compound identification parameters were met. These results were requalified as nondetect (U-qualified) by EcoChem at the reported concentrations.

Some planned analyses (e.g., metals and/or grain size on some specific samples) could not be performed because of insufficient sample volume. Additionally, project specific laboratory QA/QC samples could not be analyzed at required frequencies because of insufficient sample volume.

7.0 Lateral Loading Calculations

A combination of outfall discharge estimates and storm event and base flow concentration data were used to estimate COPC mass loadings for the 2010–2011 wet season (October 1 through April 30). Dry season loadings were not calculated, as dry season storm events and base flow samples were not collected for this study. Although all storm event samples were collected between January and May 2011, storms sampled are assumed to also be representative of those between October and December 2010, allowing for the calculation of loadings for the entire 2010–2011 wet season. This method may underestimate wet season loading based on results from numerous studies that have measured the highest contaminant loadings during storm events early in the storm season (see Appendix H) (Lee et al. 2004; Kayhanian and Stenstrom 2005; Soller et al. 2005; Han et al. 2006; Stein et al. 2007). Loadings were calculated using the general methods presented in Ecology's *Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges* (Ecology 2009).

7.1 Stormwater Discharge Volume

Measured flow volumes for storm events were not used to directly calculate stormwater discharge volumes because of the intertidal nature of the sampled storm drains. Rising and falling tides influence both water velocity and depth measured by the flow sensor, leading to errors in stormwater volume estimates (see Section 3.2.2). Therefore, COPC mass loading calculations used predicted stormwater flows, derived from the size of the sub-basin area for each outfall as described below.

Wet season stormwater discharge volumes were calculated using Equation 1, based on the Ecology Standard Operating Procedure (Ecology 2009):

Equation 1. Predicted discharge volume

$$V = (P/12) * A * RC * CF$$

Where:

- V is the discharge volume (gal/yr)
- P is wet season precipitation total (inches/yr)
- A is the drainage sub-basin surface area (ft^2)
- RC is the runoff coefficient equal to 0.009 *(% Impervious Surface) + 0.05
- CF is a conversion factor to convert cubic feet to gallons

Precipitation data were derived from the KBFI rain gauge as discussed in Section 5.1.2. A total of 37.5 inches of precipitation fell during the period beginning in October 2010 and ending in April 2011. Determinations of sub-basin surface areas and imperviousness are discussed in Section 2.0 and are presented in Table 1. Table 12 shows the total volume of predicted discharge from the studied LDW outfalls for the 2010–2011 wet season. Table 12 also includes estimated wet season base flow discharge volumes, calculated from average measured or estimated base flow (Table 4). Base flow was never observed at BDC2088 during the sampling season and is assumed not to occur.

7.2 Loading Calculation Method

Total wet season loadings were calculated and reported separately for whole water, filtered solids, and sediment trap solids data. Whole water loadings are the product of the mean wet season COPC concentrations and wet season flow volumes for storm flow and base flow (Equation 2). Filtered solids loadings are the product of wet season mean COPC concentrations, wet season mean TSS concentrations, and wet season flow volumes for storm flow and base flow (Equation 3). Sediment trap solids loadings are similar to that of filtered solids (Equation 4), except that base flow is not included because sediment trap solids data are assumed to represent mean stormwater COPC concentrations with no contribution from base flow (Section 3.1.5).

Equation 2. Total wet season mass load for whole water

$$ML = (V_s * C_s) + (V_b * C_b) * CF$$

Equation 3. Total wet season mass load for filtered solids

$$ML = (V_s * TSS_s * C_s) + (V_b * TSS_b * C_b) * CF$$

Equation 4. Total wet season mass load for sediment trap solids

$$ML = V_s * TSS_s * C_s * CF$$

Where:

- ML is the total wet season mass load (kg/yr)
- V_s is the total wet season storm flow volume (gal/yr)
- V_b is the total wet season base flow volume (gal/yr)
- C_s is the average wet season flow-weighted stormwater whole water/filtered solids/sediment trap solids concentration (µg/L, mg/kg)
- C_b is the average wet season flow-weighted base flow whole water/filtered solids concentration (µg/L, mg/kg)
- TSS_s is the average wet season flow-weighted stormwater TSS concentration (mg/L)
- TSS_b is the average wet season flow-weighted base flow TSS concentration (mg/L)
- CF is a conversion factor to convert gallons to liters and mg or µg to kg

V_s and V_b are presented in Table 12. Methods for calculating the wet season average flow-weighted base flow concentrations (C_b) and wet season average flow-weighted stormwater concentration (C_s) for whole water and filtered solids are presented below.

Flow-Weighted Base Flow Concentrations

Wet season mean base flow concentrations were calculated using a flow-weighted mean approach.

Equation 5. Base flow wet season flow-weighted mean concentration

$$C_b = \frac{\sum (C_{bi} * BF_i)}{\sum BF_i}$$

Where:

- C_{bi} is the base flow concentration for event i (µg/L or mg/kg)
- BF_i is the volume of base flow for event i divided by the event sampling duration (gal/hr)

Flow-weighted mean concentrations for base flow are presented in Tables 13 and 14 for whole water and filtered solids, respectively. Base flow is assumed to have no contribution to sediment trap solids concentrations.

Flow-Weighted Stormwater Concentrations

Whole water or filtered solids concentrations collected from individual storm events consist partially of base flow and are influenced by base flow concentrations. Removing base flow concentrations from storm flow assumes that base flow infiltration rates observed during dry periods continue during periods of precipitation. Equation 6 is used to remove the influence of base flow.

Equation 6. Corrected storm flow concentrations for each event

$$EMC_s = \frac{EMC_{tot} - C_b * f_b}{f_s}$$

Where:

- EMC_s is the event mean concentration corrected to storm flow (base flow concentration removed) (µg/L or mg/kg)
- EMC_{tot} is the event mean concentration including storm flow and base flow concentrations (µg/L or mg/kg)
- C_b is the base flow concentration calculated from Equation 5 (µg/L or mg/kg)
- f_b is the fraction of event flow attributed to base flow
- f_s is the fraction of event flow attributed to storm flow

For all storm events at all sampled locations, base flow constituted less than one percent of the total storm event discharge volume. Therefore, removal of the base flow COPC contribution to the event mean concentration had a minimal effect on the overall calculation.

Wet season mean storm flow concentrations were calculated using a flow-weighted mean approach similar to that shown in Equation 5.

Equation 7. Storm flow wet season flow-weighted mean concentration

$$C_s = \frac{\sum \left(EMC_{s\,i} * SF_i \right)}{\sum SF_i}$$

Where:

- EMC_{si} is the storm flow concentration from Equation 6 for event i (µg/L or mg/kg)
- SF_i is the volume of storm flow for event i divided by the event sampling duration (gal/hr)

Flow-weighted mean concentrations for storm events are presented in Tables 13 and 14 for whole water and filtered solids, respectively. Unadulterated sediment trap data are assumed to represent flow-weighted mean storm flow concentrations (Table 15).

7.3 Wet Season Mass Loadings

Wet season estimated COPC mass loadings for whole water, filtered solids, and sediment trap solids are presented in Tables 16, 17, and 18, respectively. Loadings were determined for COPCs, which were frequently detected and/or found in concentrations exceeding the WQC, SMS, or LAET criteria. These loadings are discussed in detail in Section 8.0.

Propagation of error in loading estimates exist when ranges of chemical concentrations and flow estimates are used to generate a mass loading per unit of time. A summary of COPC mass loadings and associated error estimates for the different locations and sample types is presented in Table 19. Loading error was calculated based upon the standard deviation of COPC concentrations measured at each location and sample type. Error was not assessed for cases in which loading was calculated using a single sample. Limited data are available for method comparisons, and not all analytes were analyzed in every sample type.

Few loading estimates provided in this report are likely to be more accurate than ±20 percent. Typical loading error is generally between ±40 and ±100 percent for both storm flow and base flow loading estimates. Storm flow loading uncertainty is likely attributable to variability associated with the range of storm events sampled. However, equally high uncertainty in base flow loading suggests that all flow through SD systems is inherently variable. Both the limited amount of analytical data and uncertainty in loading estimates limit the accuracy with which chemical loadings to the LDW can be determined from the studied outfalls.

8.0 Discussion

This section presents a discussion of the study results in relation to the overall study objectives and use of the data. Included is a comparison of results from the different sampling methods employed, a discussion of the interpretive uses of the data collected, and an evaluation of COPC loadings from the studied outfalls.

8.1 Comparison of Sampling Methods and Sample Types

Comparison of the physical and chemical results of whole water, filtered solids, sediment trap solids, and inline solids samples can be useful in determining which sample type to use for future storm drain evaluations. The methods associated with collecting each of these sample types present different sampling biases and logistical challenges (see Appendix H). In addition to the sampling method, there are reasons to believe COPC concentrations and grain size distributions may vary between sample types, as each sample type is collected over a different time scale and contains a unique percentage of suspended versus bedload solids:

- Whole water samples represent a single storm event. This is the only sample type with chemical concentrations that include the dissolved component. Although the suction hose is positioned along the bottom of the storm drain, the pump does not preferentially sample bedload solids. Rather, the whole water sample was mainly TSS with a mix of some bedload solids.
- Filtered solids samples also represent a single storm event. The filtration pumps were also positioned along the bottom of the storm drain. These pumps likely sampled both bedload solids and TSS.
- Sediment traps represent material collected over a period of several months. These samplers target TSS but may capture coarser materials due to suspension by large storms. The height of the trap prevents collection of base flow solids when tidal water is not present in the storm drain. The traps intermittently become inundated with tidal water when deployed at low elevations, allowing the traps to collect solids suspended in the tidal water.
- Inline solids grab samples can only be collected at locations where the configuration of storm drain structures allows for deposition of solids. These samples mainly represent bedload material that has collected over a period of several months.

Grain size data for different sample types could be compared in order to assess the range of solids collected by each sampling method. Unfortunately, insufficient quantities of solids were collected for grain size analysis of whole water and sediment trap solids samples, as chemical analysis had priority. Grain size analysis of filtered solids samples collected at NF2095 (71 to 89 percent fines) and KC2062 (22 to 88 percent fines) indicate that the stormwater filtration units are capable of collecting material composed primarily of fine-grain solids. Only a single sample at KC2062 consisted primarily of sand (72 percent sand with 22 percent fines). Because filtered solids and whole water samples were collected during the same events and the inlets for their pumps were positioned relatively close to each other along the storm drain bottom, it can be assumed that these sample types contain a similar range of grain sizes.

8.1.1 Comparison of TSS by Sampling Method

Calculation of COPC loadings from filtered solids or sediment trap solids requires an estimate of an outfall's average stormwater TSS (see Equations 3 and 4). Determination of stormwater TSS requires measurements of both the mass of solids and water volume. Whole water and filtered solids are the only data types with which stormwater TSS can be calculated. Both solids and water are collected in a whole water sample for the direct measurement of stormwater TSS. An estimate of TSS from filtered solids is possible because of the presence of flow totalizers on the stormwater filtration units.

Large, inconsistent discrepancies were observed between TSS concentrations calculated for whole water and filtered solids from the same location and sampling event. As discussed in the *Expanded Stormwater Sampling Interim Data Report* for the North Boeing Field/Georgetown Steam Plant (NBF-GTSP) site (SAIC 2011), TSS measurements derived from the solids filtrations system were deemed unusable. The inability to use the filtered solids TSS data has no impact on the interpretation of filtered solids chemistry results.

Whole water TSS values were used to calculate loadings for all events and locations. The likely error associated with filtered solids TSS measurement involves the operation of the inline flow totalizer. The turbine design of the totalizers can become clogged with debris, underestimating the volume of water filtered. Overestimates of volume were also observed to occur when storm flow through the storm drain was low, allowing air to be pumped through the system and registering on the totalizer as filtered stormwater. Until totalizer issues are resolved, collection of whole water grab or composite samples is recommended at all sampling locations to make sure a valid TSS measurement is available for loading calculations. However, because TSS can fluctuate during a storm event, the use of a whole water grab sample could contribute significant uncertainty to loading calculations.

8.1.2 Comparison of Chemistry by Sample Type

Differences in how and when the various sampling systems operated resulted in a range of chemical concentrations for the samples collected and, subsequently, lateral loading estimates derived from each sample type. By comparing results between sample types, it is possible to determine how consistent the sampling methods are with each other and, therefore, whether it is worthwhile to collect all sample types in future lateral loading studies. COPC loading values, rather than concentrations, were chosen to compare sample types in order to maintain consistent units (kg/yr) for whole water, filtered solids, and sediment trap solids results. However, this comparison is incomplete, as all sample types were not analyzed for every analyte because of sample quantity limitations.

The relative percent difference (RPD) of stormwater COPC loading values were determined for sample type pairs (whole water/filtered solids, filtered solids/sediment trap, and whole water/sediment trap) for each of the sampling locations. The RPD is the difference between two average loading values (collected by different sampling methods) divided by the average of the two loadings.

Lower RPD values imply better agreement between sample types. RPD values are used by analytical laboratories to evaluate the difference between duplicate samples. ARI uses a default value of 30 percent for organics and 25 percent for inorganics when evaluating matrix spike/matrix spike duplicate pairs from the same sample. If the RPD is below this threshold, the results are considered to be in compliance with the data quality objectives. RPD values less than 30 percent were considered an excellent match between results. An RPD value of 66 percent means one result in the comparison had twice the loading as the other. An RPD value of 100 percent means one result in the comparison was three times the loading as the other. RPD values for stormwater COPC loadings are expected to be higher than laboratory duplicate compliance thresholds, as the results used to compare stormwater loadings were not from the same sample, collected on the same date, or of the same sample type.

The average and range of RPD values for the four studied outfalls are presented in Table 20. In Table 20, average RPDs less than 30 percent are highlighted rose, and less than 66 percent are highlighted orange, to provide a rough indication of comparability in COPC loadings between sample types. The lowest RPD values for stormwater loadings occur between whole water and filtered solids samples. This result was expected, as whole water and filtered solids samples were collected during the same events. The highest average RPD values imply that PAHs and PBDEs measured in sediment traps solids are in relatively poor agreement with those in whole water. However, RPD values for all sample type pairs are remarkably low given the extremely different circumstances by which each sample type is collected and their associated errors.

Although based on a very limited data set, these results suggest that whole water, filtered solids, and sediment trap solids COPC results are fairly interchangeable for determining relative COPC loadings for different outfalls. Therefore, all sample types need not be collected for future lateral loading studies. In particular, the substantial effort required to target numerous storm events for the collection of whole water and filtered solids samples may be unnecessary. Instead it appears that sediment traps satisfactorily account for the natural variability of storm events and integrate storm flow over the wet season despite complications introduced by intermittent tidal inundation. However, because of the design of the sediment traps and the intertidal nature of the SD system, sediment traps cannot be used to determine differences between contaminant contributions from base flow and storm flow.

8.2 Data Utility

The different interpretive uses for chemical concentration data collected and the lateral loading estimates calculated for the four outfalls in this study are discussed below.

8.2.1 Concentration Data

Chemical concentration data can be used in the same manner regardless of sample type (whole water, filtered solids, or sediment trap solids). Concentration data can first be used to segregate detected versus non-detected chemicals for an outfall. Detections identify which contaminants have a potential source within the sub-basin and whether they are ubiquitously present in the outfall discharge (base flow samples) or are present only in surface runoff during precipitation events (storm event samples).

Chemical concentration data can also be compared to screening criteria (WQC, SMS, LAET) to evaluate potential risk. While the screening criteria employed in this study do not specifically apply to storm drain samples, they are used as a benchmark to identify elevated concentrations that may present a potential risk to ecological receptors when discharged to the LDW. For contaminants without relevant screening criteria, chemical concentration data can be compared between locations to identify samples with elevated concentrations.

Generally, solids discharged from LDW outfalls are deposited as sediments in the immediate vicinity of the outfall (near-field) (QEA 2008). Therefore, chemical concentrations in storm drain solids can be used to assess the potential for near-field sediment contamination for individual outfalls. While a variety of factors (advection, settling, additional sediment sources, etc.) will inevitably control the chemical concentrations of sediments deposited in an outfall's near-field region, stormwater chemical concentrations generally provide a "worst-case scenario" for ongoing sources of sediment contamination from the outfall. This assumes that near-field sediments reflect bulk storm drain solids composition with no dilution, allowing the application of risk-based sediment screening criteria to storm drain solids concentrations for determining potential impacts to sediment quality.

8.2.2 Lateral Loading Estimates

Lateral loading estimates presented in this study represent the total mass of a COPC discharged to the LDW by an outfall during the 2010–2011 wet season. These loadings should not be extrapolated to determine annual loadings, as stormwater data used to calculate these estimates were collected during the wet season only. Contaminant concentrations in both dry season storm flow and base flow may be substantially different from those observed during the wet season. Additionally, because this study presents only a limited number of samples collected during a single wet season, loading estimates do not necessarily reflect typical wet season loadings.

Chemical loadings, rather than storm drain concentrations, are used to assess whether base flow is a significant contributor to total COPC discharge. For this study, base flow loadings were deemed to be relatively insignificant for all sampled outfalls compared to those of stormwater (Tables 16 and 17).

Lateral loading estimates can also be used to compare the magnitudes of contaminant inputs to the LDW from the studied outfalls. The magnitude of an outfall's load does not necessarily reflect its likelihood to contribute to LDW sediment contamination. High loading due to large discharge volume may not create sediment impacts if the discharged particles are of low chemical concentration. However, if loading is high because of high chemical concentration, sediment impacts may be significant.

8.3 Outfall Comparison

8.3.1 Outfall Similarities

Before discussing the unique aspects of COPC loadings from the individual outfalls in this study, it is important to note their similarities.

Tidal Influence on Samples Collected

All outfalls in this study are located at LDW intertidal elevations and are consequently subject to inflow of river water during high tidal stages. Tidal water in the storm drains was sampled and found to have both lower TSS and chemical concentrations than either base flow or storm flow. Tidal water TSS was generally an order of magnitude lower than that of base flow, and COPCs were generally not detected. Therefore, tidal inflow may not significantly introduce or redistribute COPCs within a storm drain. However, this conclusion is based upon limited data collected during the early dry season (May 2011). The potential for tidal water to transport COPCs may be greater during the wet season because of the higher particle load in the LDW.

Despite the fact that sediment traps were frequently submerged by tidal water during deployment (Figure 19), the low TSS of tidal water suggests that storm drain solids collected in the sediment traps likely contain little contribution from particles entrained in tidal water. During storm event and base flow sampling, whole water and filtered solids samples were only collected when tidal water was not present in the storm drains. Therefore, tidal water does not appear to impact these sample results. Further discussion of tidal water sample results are excluded from Section 8.3 as they are not required to determine outfall COPC loads, and the intertidal nature of storm drains does not appear to significantly affect any of the sample types collected. The insignificance of tidal water may only be true for the outfalls studied and should not be dismissed in future investigations.

Contribution of Base Flow to Total Loading

Base flow is continuously present in all of the studied storm drains with the exception of BDC2088, which was never observed to support base flow. In some instances, base flow TSS and COPC concentrations are similar to or exceed concentrations in storm event samples. However, because the total volume of wet season base flow is less than 1 percent of wet season storm flow for all outfalls (Table 12), the contribution of base flow to COPC loads is minimal. The small contribution of base flow to an outfall’s total contaminant load implies that storm flow loading dominates near-field and far-field impacts for the LDW outfalls studied. The small contaminant contribution from base flow may only be true for the outfalls studied and should not be dismissed in future investigations.

COPCs Detected in Stormwater

The majority of stormwater COPCs detected in whole water, filtered solids, and sediment trap solids were found at all sampling locations. There were few instances where a COPC was restricted to specific sub-basins (see Section 8.3.2). Chemical compound classes ubiquitously detected in storm flow include PCBs, dioxin/furan congeners, metals, PAHs, and PBDEs. This mix of COPCs may be typical of runoff from urban and industrial developed property, as all of the sub-basins studied consist of at least 50 percent medium to high intensity, developed land cover (Table 1).

8.3.2 Comparison of Concentration and Loading by Outfall

This section summarizes and evaluates the discharge from individual outfalls by integrating concentration and loading results for different sample types. Wide variability of COPC concentrations were often measured in storm drain samples from the same location. While this variability is in part due to specific conditions during sampling events and differences in sampling methodology, it is also because of inherent variability in the flow through a storm drain system. This variability results in loading calculation errors, which generally range between ±40 and ±100 percent for both storm flow and base flow loading estimates (Table 19). Chemical loadings summarized in this section are derived from flow-weighted mean COPC and TSS concentrations derived from a limited number of storm event and base flow samples. Both the limited amount of analytical data and uncertainty in loading estimates limit the accuracy with which chemical loadings to the LDW can be determined from the studied outfalls.

NF2095

The Norfolk outfall (NF2095) receives runoff from the largest sub-basin (770 acres) sampled for this study (Table 1). Although it consists of a smaller percentage of impervious area (54 percent) than the other studied sub-basins, the NF2095 total wet season storm flow discharge (421 Mgal) is more than twice that of the next largest sub-basin (Table 12).

Concentration

Compared to the other outfalls sampled, storm flow at NF2095 had the highest average concentrations of PBDEs (18 to 54 ng/L [whole water], 1,050 µg/kg [sediment trap solids]) and butyl benzyl phthalate (1.8 mg/kg [sediment trap solids]) (Tables 13, 14, and 15). Filtered solids samples were found to exceed SMS/LAET for total PCBs, cadmium, zinc, and multiple PAHs (Table 8), and for phthalates and benzyl alcohol in sediment trap solids (Tables 10).

Loading

Despite NF2095 having the lowest average TSS concentrations for both storm flow (26 mg/L) and base flow (9.8 mg/L) (Table 13), the large volume of stormwater flow caused this outfall to have the highest loading of many COPCs in this study. Compared to the other outfalls sampled, storm flow at NF2095 had the highest wet season loadings of TSS, total PCBs, total PBDEs, arsenic, cadmium, copper, lead, mercury, zinc, phenol, butyl benzyl phthalate, and di-n-octyl phthalate (Tables 16, 17, and 18). Filtered solids samples suggest that NF2095 also has the highest loading of dioxin/furan TEQ, while sediment trap samples imply PS2220 has the highest dioxin/furan TEQ loading.

KC2062

The King County SD#2 (KC2062) sub-basin (211 acres) is roughly a quarter the size of the NF2095 sub-basin but contains a greater percentage of impervious surface (80 percent) (Table 1). Despite its smaller size, KC2062 supports roughly ten times the base flow of NF2095 (Table 12). KC2062 was the only sampled location that had an average base flow TSS concentration (47 mg/L) greater than that of storm flow (35 mg/L) (Table 13). This high amount of base flow is sustained by either groundwater infiltration or unidentified connections, or a combination thereof, to the storm drain system. The fact that this base flow is persistent even when the KCIA lift station is not operating suggests that most base flow enters the system downstream of the lift station, from the Boeing Thompson-Isaacson property or possible E Marginal Way inputs (Figure 3).

Concentration

Compared to the other outfalls sampled, storm flow at KC2062 had the highest average concentration of cadmium (6 mg/kg), based on filtered solids samples, and no other commonly detected COPC (Tables 13, 14, and 15). Chemical concentrations in stormwater samples exceeded SMS/LAET criteria for total PCBs, cadmium, zinc, and multiple PAHs in filtered solids (Table 8); multiple PAHs in sediment trap solids (Table 10); and arsenic, cadmium, zinc, and multiple PAHs in inline solids (Tables 11).

Loading

Storm flow TSS loading for KC2062 is roughly half that of NF2095 (Table 16). Despite KC2062 having the highest base flow volume and TSS concentration, the base flow TSS load remains less than 1 percent of that from storm flow. Compared to the other outfalls sampled, storm flow at KC2062 did not have the greatest wet season loadings for any of the commonly detected COPCs (Tables 16, 17, and 18).

PS2220

The Port of Seattle T-115 (PS2220) sub-basin is roughly 1/30 the size of the NF2095 sub-basin (26 acres) and consists mostly of an impervious asphalt surface (Table 1). Base flow is continuously present in this storm drain but constitutes less than 1 percent of total wet season discharge (Table 12). The high salinity of the base flow (Figure 14) suggests that tidal water temporarily "puddles" in storm drain depressions or subsurface voids on the T-115 property as the tide recedes. This tidal water then contributes to base flow as it is flushed out of the storm drain.

The average stormwater TSS concentration at PS2220 (210 mg/L) was an order of magnitude greater than at other sampling locations (26 to 38 mg/L) (Table 13). This high solids concentration in stormwater runoff may result from unpaved portions of the drainage area or specific industrial activities on the T-115 property that lead to a relatively large amount of "dust" on the ground surface.

Concentration

Storm flow at PS2220 often had the highest concentration of COPCs compared to other outfalls sampled. PS2220 was the only location in which the compounds 2-methylphenol, 4-methylphenol, and 2,4-dimethylphenol were commonly detected in storm flow (Table 5). Storm flow at PS2220 also had the highest concentrations of dioxin/furan TEQ in filtered solids (72.6 to 73.0 pg/g) and sediment trap solids (67.0 pg/g), bis(2-ethyhexyl) phthalate in sediment trap solids (13 mg/kg), total arsenic in whole water (2.9 to 32 µg/L), total copper in whole water (21.9 to 102 µg/L), total lead in whole water (9 to 30 µg/L), total zinc in whole water (221 to 550 µg/L) and filtered solids (1,340 to 1,880 mg/kg), and total LPAHs in whole water (0.32 to 7.4 µg/L) and sediment trap solids (34 mg/kg) (Tables 13, 14, and 15). Copper and zinc were measured at concentrations exceeding chronic and acute WQC in storm event whole water samples (Table 6). Stormwater samples had chemical concentrations that exceeded SMS/LAET criteria for cadmium, zinc, and multiple PAHs in filtered solids (Table 8), and of phthalates and multiple PAHs in sediment trap solids (Tables 10).

Loading

High TSS concentrations in storm flow at PS2220 cause the outfall to have an approximately equal particulate loading as KC2062 despite the sub-basin being an eighth the size (Table 16). As with both NF2095 and KC2062, PS2220 base flow TSS loading is less than 1 percent of that from storm flow. Compared to the other outfalls sampled, storm flow at PS2220 had the highest wet season loadings of total HPAHs and total LPAH (Tables 16, 17, and 18). Sediment trap samples suggest that PS2220 also has the greatest loading of dioxin/furan TEQ, while filtered solids samples imply NF2095 has the greatest dioxin/furan TEQ loading.

BDC2088

The Boeing Developmental Center (BDC2088) sub-basin (13 acres) is the smallest of the sampled sub-basins, 1/60 the size of the NF2095 sub-basin and consisting mostly of impervious surfaces (Table 1). Base flow was never observed in this storm drain during any of the multiple visits during the wet season. The stormwater TSS concentrations at BDC2088 (5.8 to 68 mg/L) are relatively similar to that of both NF2095 (7.3 to 36 mg/L) and KC2062 (12 to 77 mg/L) (Table 13).

<u>Concentration</u>

Storm flow at BDC2088 often had the highest concentration of COPCs compared to other outfalls sampled. Storm flow at BDC2088 had the highest concentrations of phenol in sediment trap solids (0.49 mg/kg); di-n-octyl phthalate in sediment trap solids (7.3 mg/kg); total HPAH in whole water (1.8 to 50 µg/L), filtered solids (26 to 230 mg/kg), and sediment trap solids (120 mg/kg); total LPAH in whole water (0.23 to 6.9 µg/L) and filtered solids (3.3 to 33 mg/kg); total PCBs in whole water (0.013 to 0.019 µg/L) and filtered solids (0.21 to 0.82 mg/kg); lead and mercury in filtered solids (173 mg/kg and 0.21, respectively); and total cadmium in whole water (0.2 to 0.4 µg/L) (Tables 13, 14, and 15). Stormwater samples had chemical concentrations that exceeded SMS/LAET for total PCBs, zinc, and multiple PAHs in filtered solids (Table 8), and of phenol, phthalates, benzoic acid, benzyl alcohol, and multiple PAHs in sediment trap solids (Tables 10).

<u>Loading</u>

The small size of the BDC2088 sub-basin causes it to have a significantly smaller TSS loading than the other studied outfalls (Table 16). The lack of base flow at BDC2088 prevents the outfall from being a source of COPC loadings except when precipitation causes runoff within the sub-basin. Despite BDC2088 having the smallest solids loading, whole water samples suggest that this outfall has the greatest wet season loading of total HPAHs (Table 16). Loadings of other COPCs are minimal compared to the other studied outfalls (Tables 16, 17, and 18).

9.0 Observations and Recommendations

This report documents and summarizes results from the investigation of COPC lateral loadings to the LDW. The specific objectives of the study were as follows:

- Collect data necessary to assess contaminant loading from four significant municipal and industrial stormwater outfalls.
- Identify stormwater contaminants associated with the outfalls studied.
- Estimate stormwater COPC lateral loadings for the studied outfalls.
- To the extent possible, correlate the loadings from whole water, filtered solids, and sediment trap solids samples.

During the 2010–2011 wet season, whole water and filtered solids samples were collected during storm events, base flow, and a high tidal period from four storm drains that empty into the LDW. Sediment traps were deployed over the entire season in the hope of capturing solids that integrate seasonal storm flow. Using the analytical results, COPC lateral loadings were calculated for each of the studied outfalls.

9.1 Observations

Based on analysis of the collected samples, major observations from this study are presented below:

- The intertidal nature of LDW outfalls greatly restricts the ability to sample storm events and derive loading estimates. High tides impeded the duration of stormwater sampling, rarely allowing stormwater samples to be collected over the entire storm hydrograph. Estimation of storm flow volume is hindered when tidal water is present in the storm drain, as both velocity and depth measurements have a tidal component that is difficult to correct for. Tidal water often filled the sampling location maintenance holes to a depth of many feet, inhibiting the long-term deployment of whole water and filtered solids sampling equipment without risking damage.
- Tidal water present in storm drains had low velocity throughout the wet season and low TSS and COPC concentrations when measured at the beginning of the dry season. Therefore, tidal inflow may not significantly introduce or redistribute COPCs within a storm drain. The insignificance of tidal water may only be true for the outfalls studied and should not be dismissed in future investigations. Despite the fact that sediment traps were frequently submerged by tidal water during deployment, the low TSS of tidal water suggests that storm drain solids collected in the sediment traps may contain little contribution from particles transported in tidal water. However, future sampling may be warranted to target tidal water during the wet season, as tidal water is more likely to introduce solids into storm drains when TSS concentrations in the LDW are highest.
- Sampling during the 2010–2011 wet season resulted in a limited data set consisting of whole water and filtered solids samples from six storm events and three base flow events, as well as sediment trap samples collected over the entire season. Limited sample volume often restricted the analysis of COPCs. Wide variability of COPC concentrations were

often measured in storm drain samples from the same location because of differences in sampling event conditions, sampling methodology, and inherent variability. Loading estimates generally have an associated error between ±40 and ±100 percent for both storm flow and base flow loading estimates (Table 19). Both the limited amount of analytical data and uncertainty in loading estimates limit the accuracy with which chemical loadings to the LDW can be determined from the studied outfalls.

- PCBs, dioxin/furan congeners, metals, PAHs, and PBDEs were detected in stormwater samples from all sampled outfalls. This mix of COPCs may be typical of surface runoff from urban/industrial developed properties in the LDW drainage basin.
- Whole water samples from PS2220 contained concentrations of copper and zinc that exceed the acute and chronic WQC. Storm drain solids samples from all sampled locations contained COPC concentrations that exceeded SMS/LAET criteria for multiple analytes.
- Independent COPC loading estimates for the different stormwater sample types (whole water, filtered solids, and sediment trap solids) are remarkably similar given the extremely different circumstances by which each sample type was collected and its associated errors. RPD values for commonly detected COPCs averaged 42 percent for whole water/filtered solids sample pairs, 58 percent for filtered solids/sediment trap sample pairs, and 83 percent for whole water/sediment trap sample pairs (Table 20). This finding suggests that all sample types are fairly interchangeable for estimating COPC loadings from stormwater for this study. However, it should be noted that sediment traps cannot be used to determine differences between contaminant contributions from base flow and storm flow.
- Base flow COPC loadings in these four drains are substantially lower than storm flow, suggesting that surface runoff and not infiltration dominate the potential for sediment impacts for the outfalls in this study. This may not be the case in areas where contaminated soil or groundwater infiltrate into the storm drains.
- Many of the highest COPC concentrations and unit-area loads were found in stormwater from the smaller sub-basins of this study (PS2220 and BDC2088). Source control for outfalls that discharge less total stormwater volume may be easier to implement because of the greater potential for identifying the source.

9.2 Recommendations for Future Lateral Loading Studies

Lessons learned from this study can be used to refine the design of future stormwater lateral loading studies. Appendix H outlines recommendations for a lateral loading study of similar scope, including modifications to sampler design, advantages and disadvantages of each sample type, potential LDW outfall sampling locations, and suggestions on when samples should be collected.

Collection of all the sample types collected for this study may not be necessary in future lateral loading studies. Whole water, filtered solids, and sediment trap samples exhibited loadings of different magnitudes for an outfall, but relative loadings between outfalls were consistent among sample types. Although this conclusion is based on limited data, it implies that any sample type can be used equally well for determining the COPCs and relative loadings of outfalls to the LDW. Differences in chemical concentrations, and therefore loadings, among sample types reflect biases of the sampling methods. If the goal of a lateral loading study is to determine the total chemical load from an outfall, sediment traps solids are the recommended sample type for collection. Sediment traps appear to satisfactorily account for cumulative outfall discharge when deployed within intertidal storm drains. When tidal water is present in the storm drain, sediment traps have the ability to capture solids carried by storm flow and base flow. This allows the sediment traps to account for the natural variability of storm events (including those that are not able to be sampled by other methods) and integrate both storm flow and base flow over the deployment period. However, if an important objective of a study is to differentiate storm flow and base flow concentrations and loadings, sediment traps cannot be used at intertidal locations. Such data needs may be required in source tracing studies and would benefit most from the use of whole water or filtered solids samples collected during different storm drain flow conditions.

The reliance on sediment trap solids data for future lateral loading studies would greatly reduce the amount of field effort and overall cost required for sample collection, as the substantial effort required to target independent storm events would not be required. The sediment traps may be redesigned to allow a greater surface area for solids deposition and to be deployed/recovered without the need for confined space entry into the storm drain maintenance hole. These sampler modifications could allow multiple samples to be collected from a location over the course of a wet season, rather than just a single sample, as was achieved in this study.

In addition to the stormwater solids COPC data provided by the sediment traps, stormwater TSS and discharge volume data are necessary to calculate COPC loadings. TSS measurements could be made using either whole water grab or composite samples collected during a variety of storm events over the course of the wet season. Stormwater discharge volume can be modeled in a similar manner as was done for this study, as direct measurement of storm flow was hindered by the intertidal nature of LDW outfalls.

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Figures

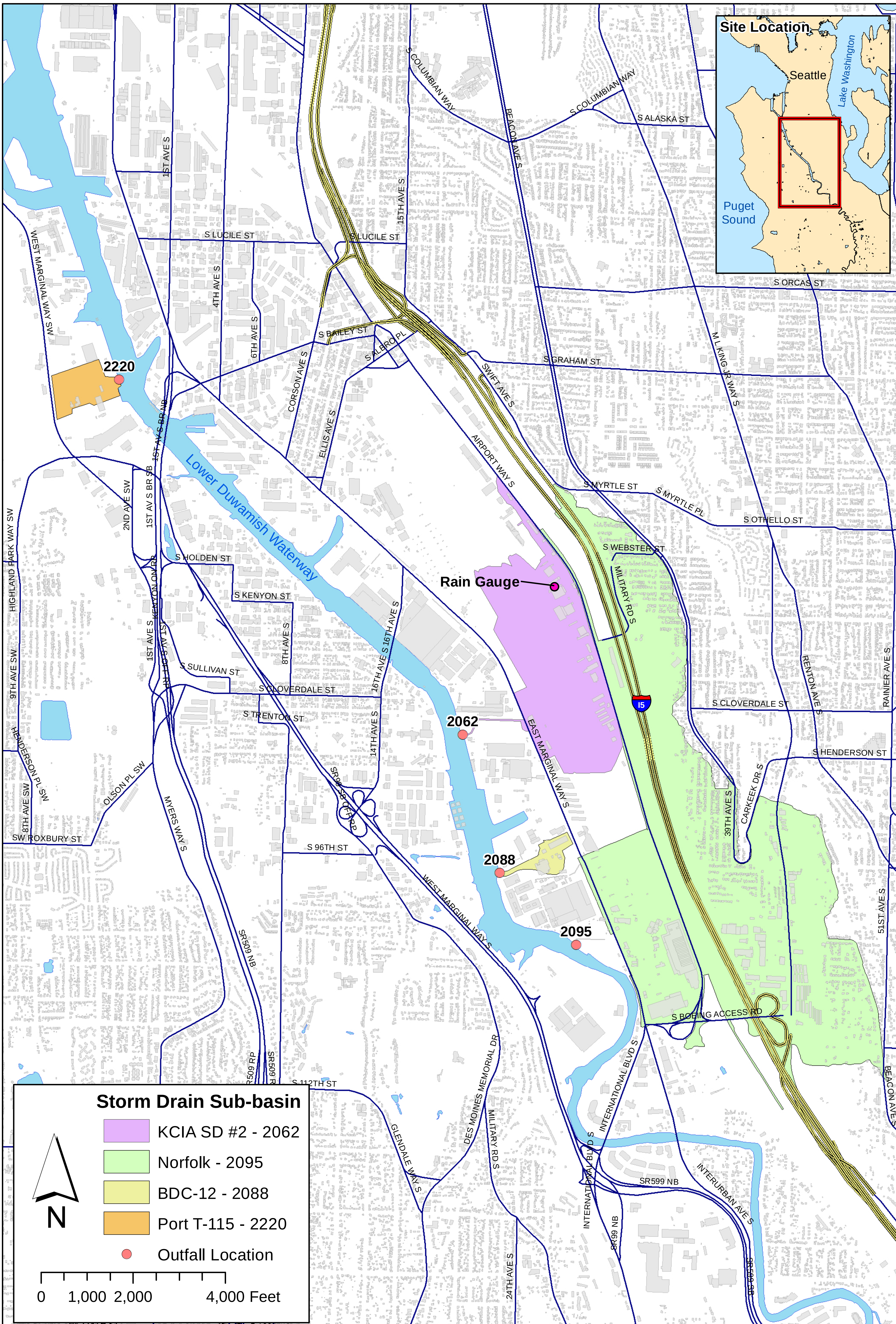

Figure 1. Drainage Sub-basins Selected for Stormwater Lateral Loading Study

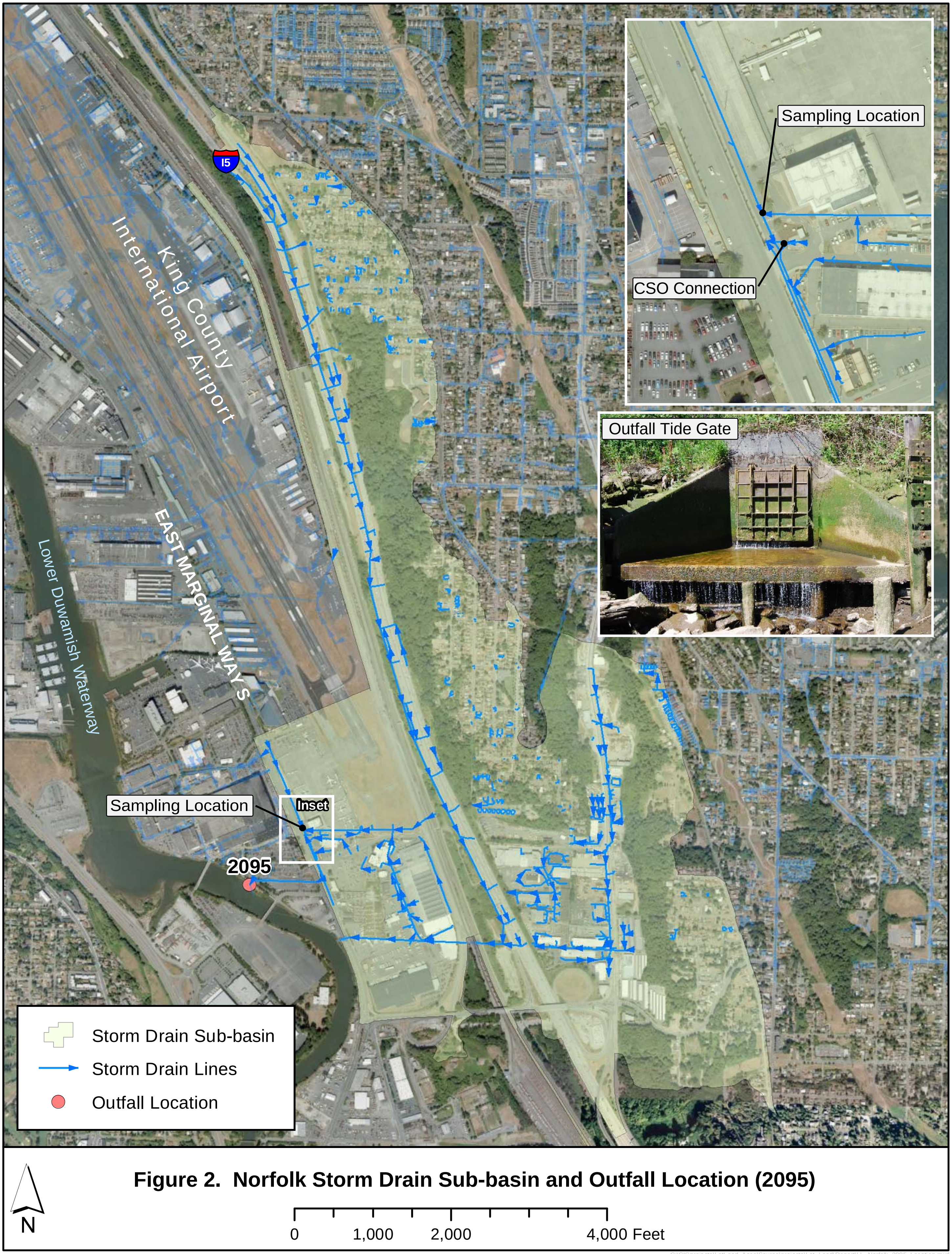

Figure 2. Norfolk Storm Drain Sub-basin and Outfall Location (2095)

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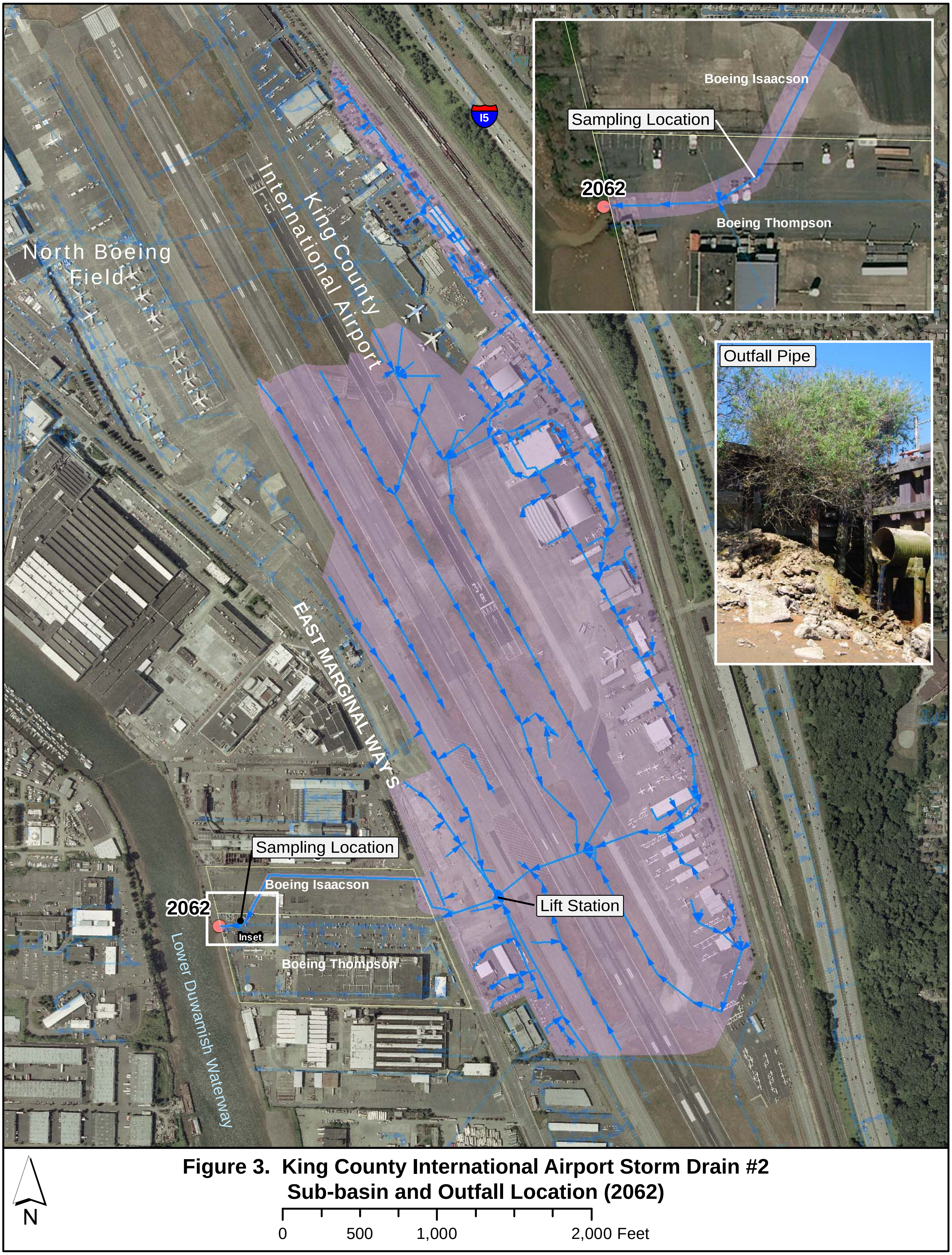

Figure 3. King County International Airport Storm Drain #2 Sub-basin and Outfall Location (2062)

Figure 4. Port of Seattle Terminal 115 Storm Drain Sub-basin and Outfall Location (2220)

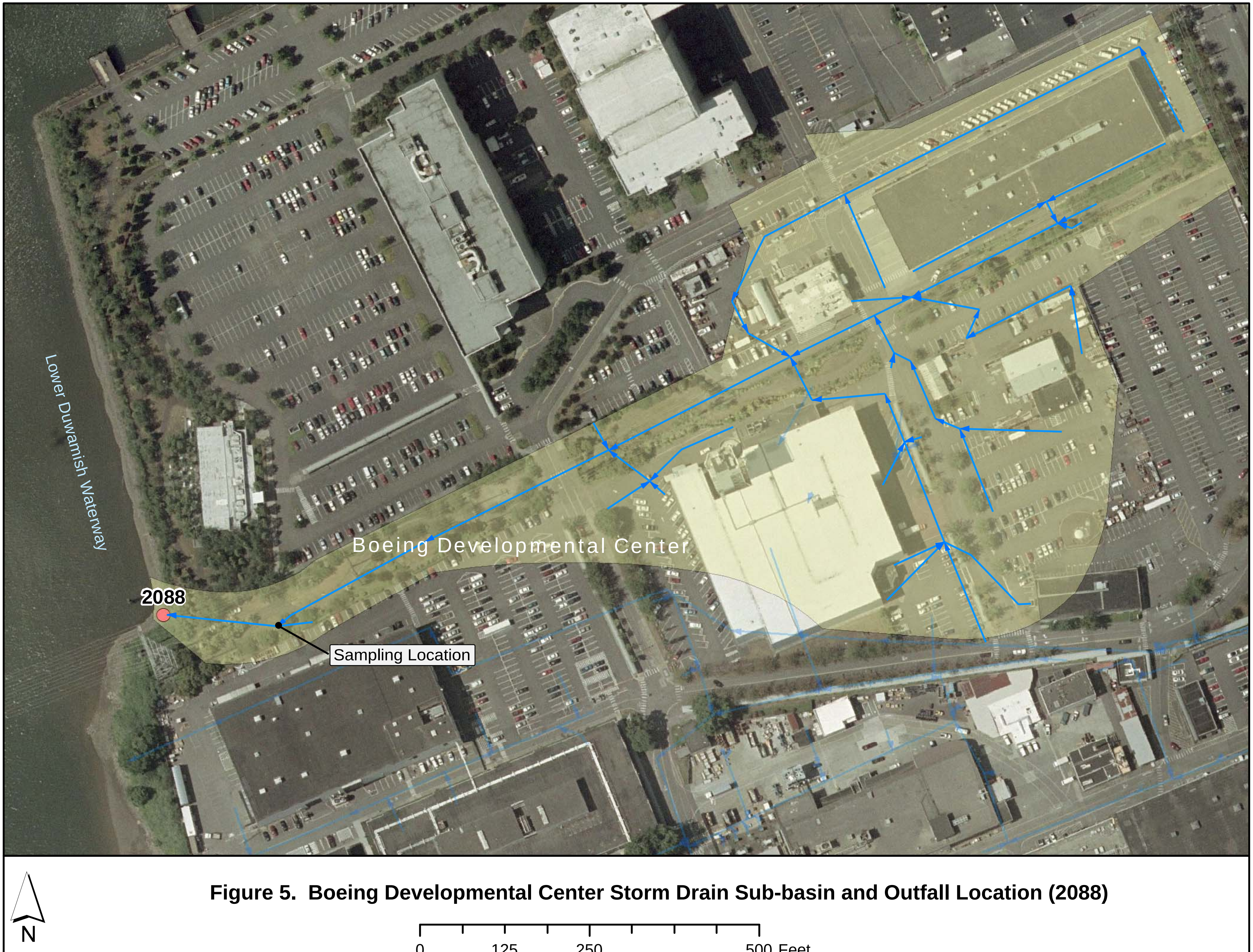

Figure 5. Boeing Developmental Center Storm Drain Sub-basin and Outfall Location (2088)

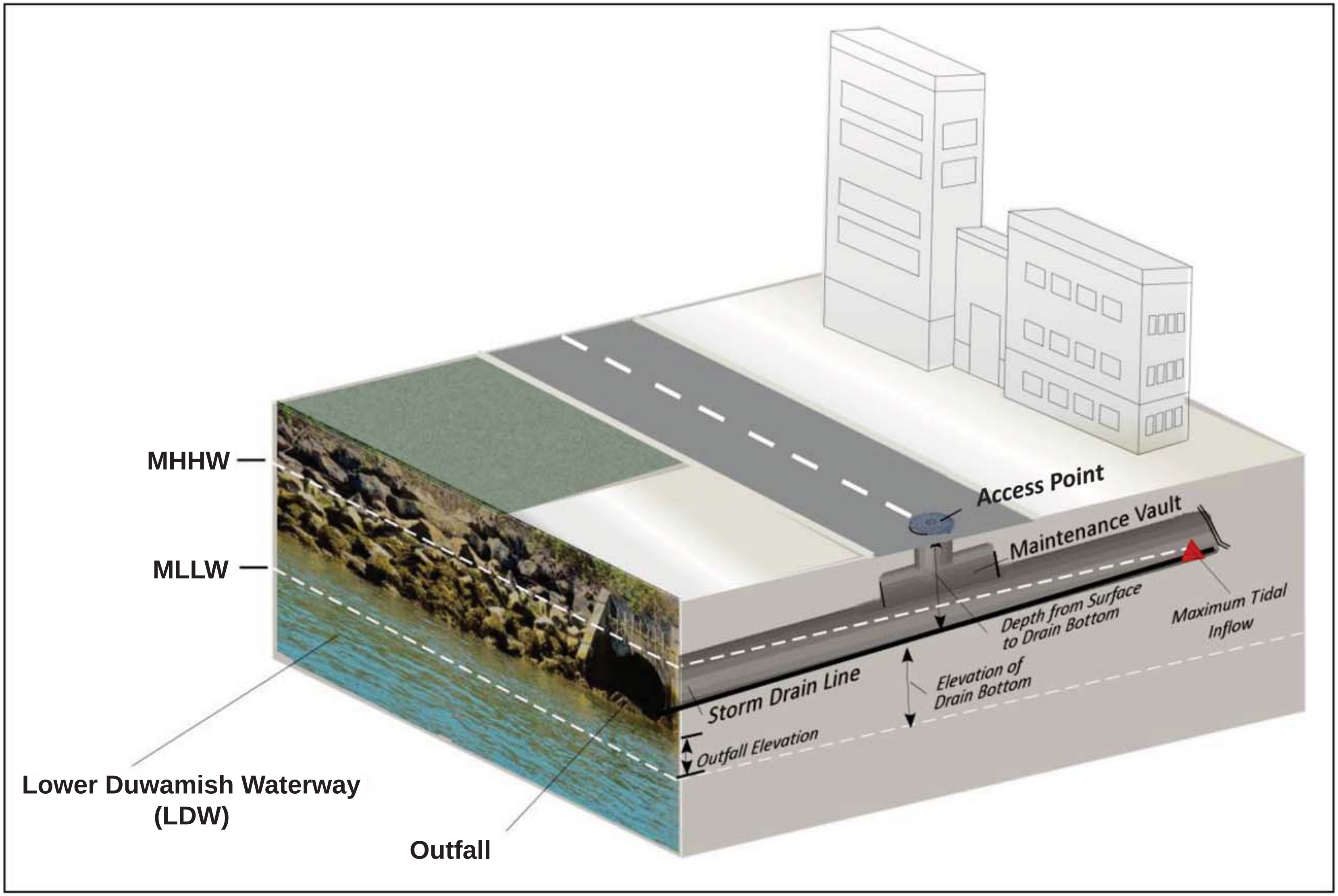

Figure 6. Schematic of a Typical LDW Storm Drain Line and Outfall

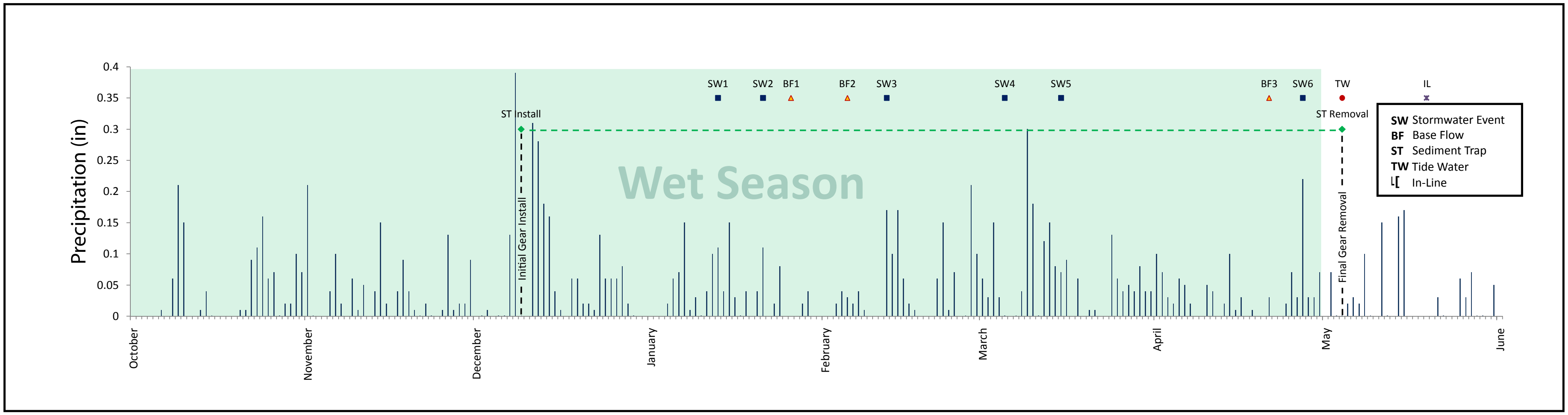

Figure 7. Timeline of Sampling Events During the 2010–2011 Wet Season

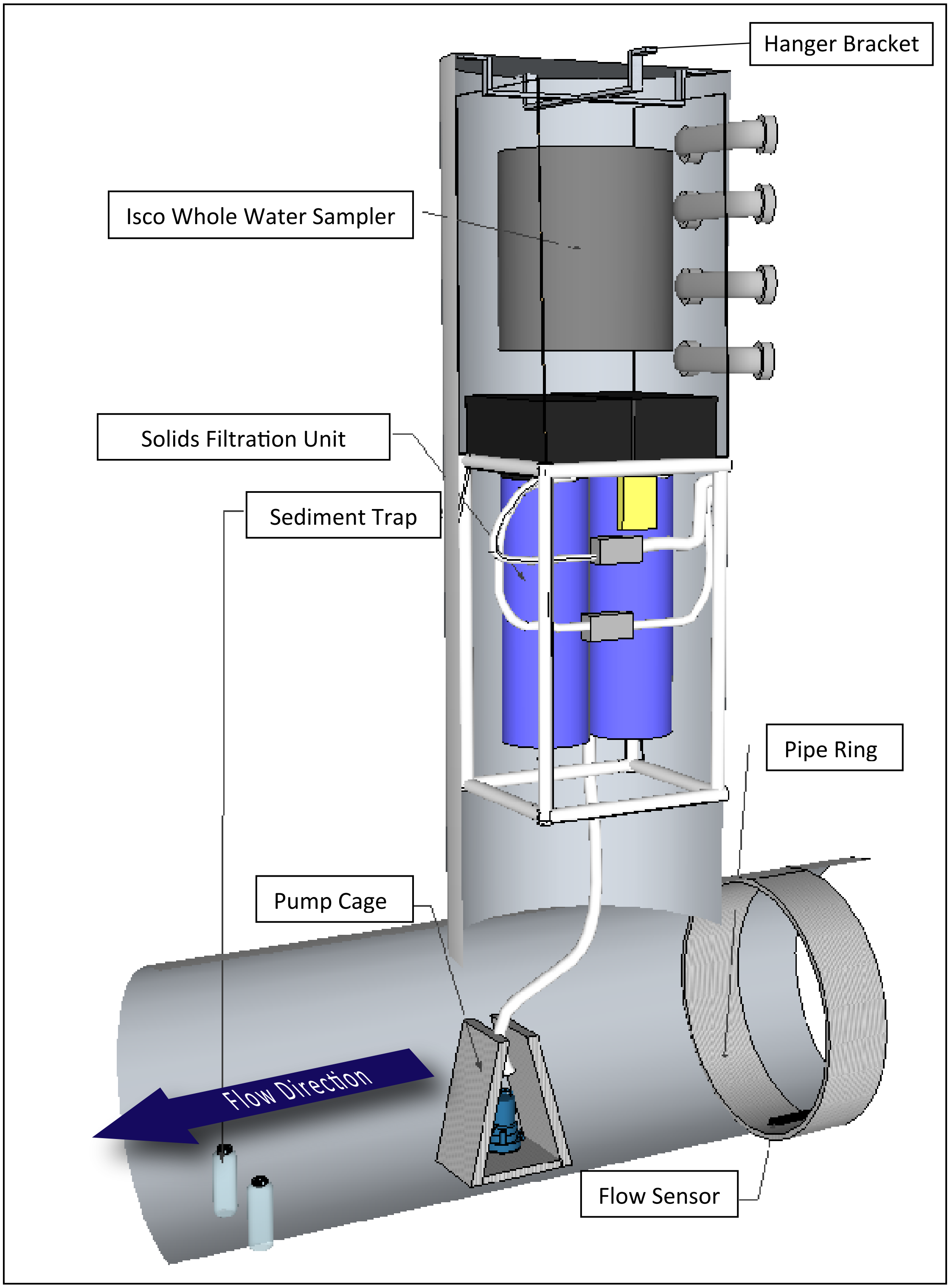

Figure 8. Schematic of Equipment Installed in a Storm Drain Maintenance Vault

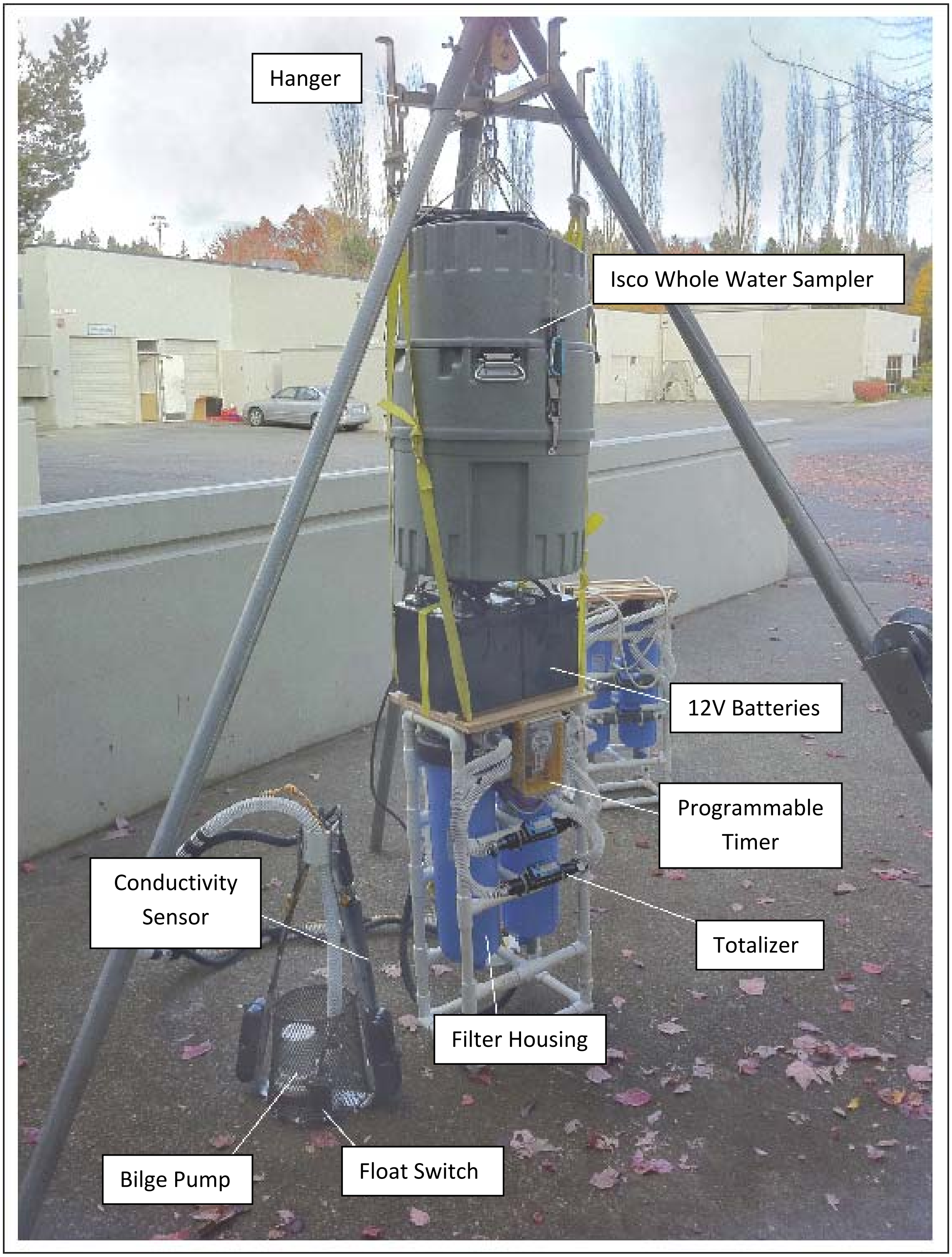

Figure 9. Stormwater Sampling Components

Figure 10. Interior of Filter Bags Used to Collect Filtered Solids

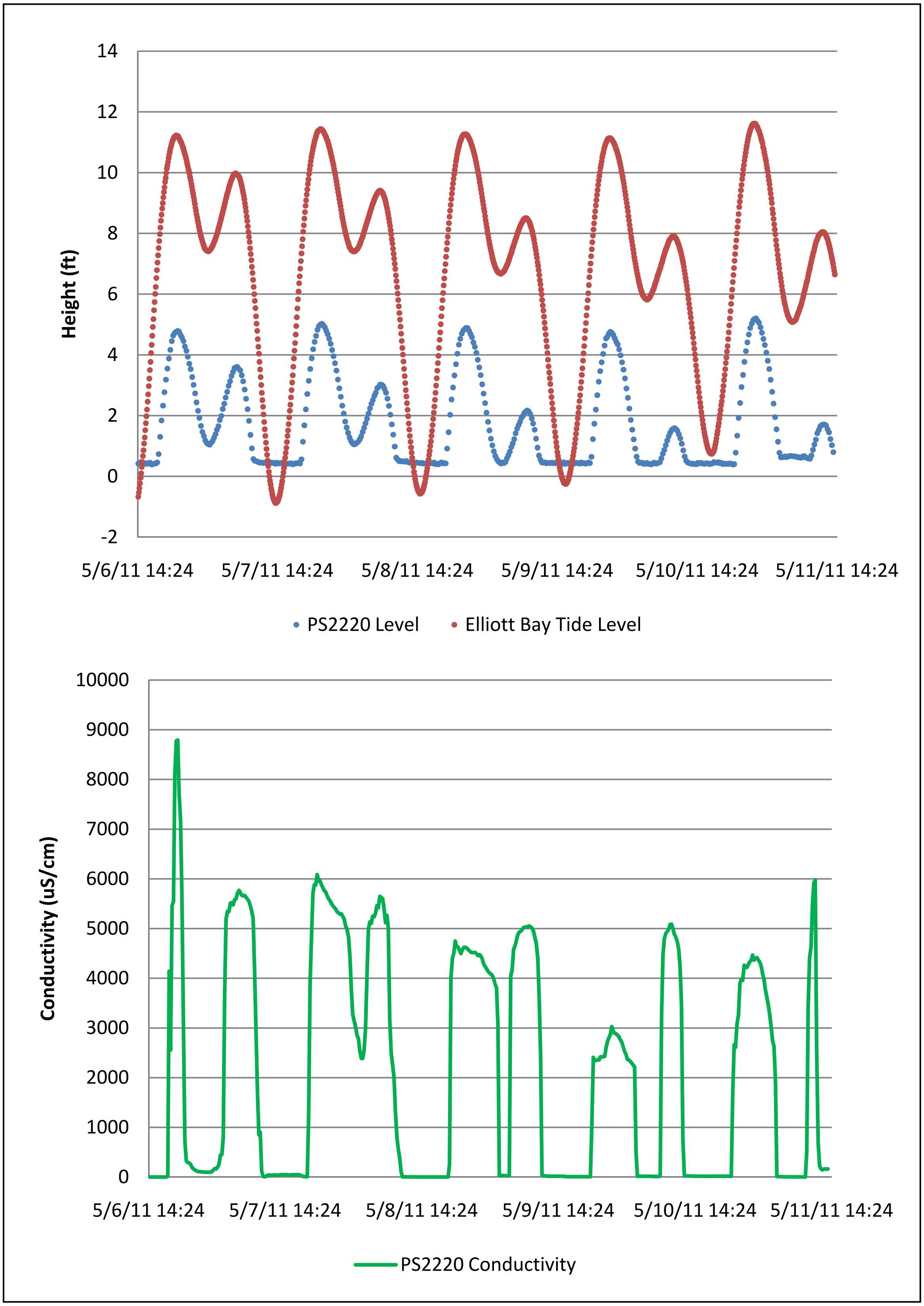

Figure 11. Water Level and Conductivity at Sampling Location PS2220

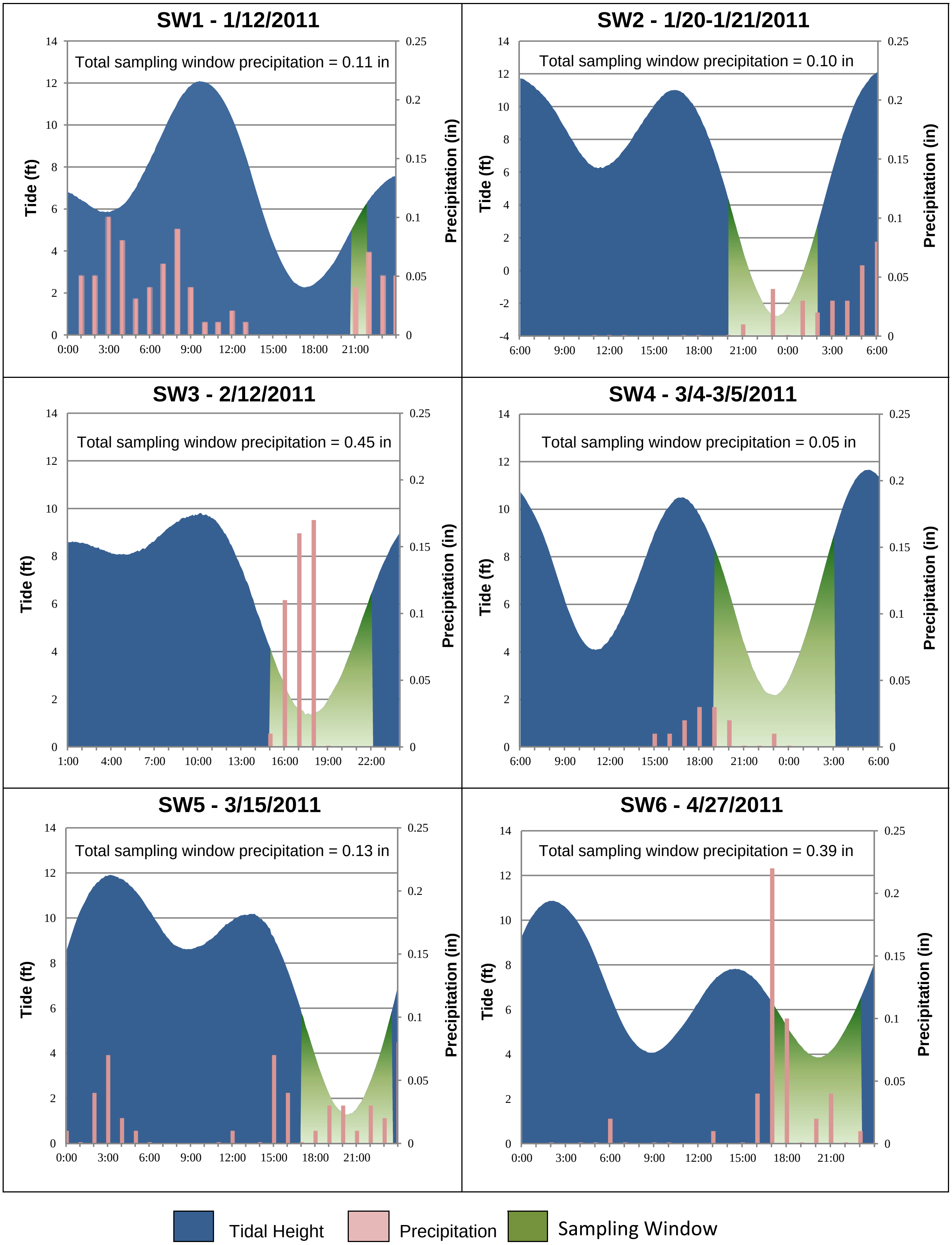

Figure 12. Storm Event Tides and Precipitation

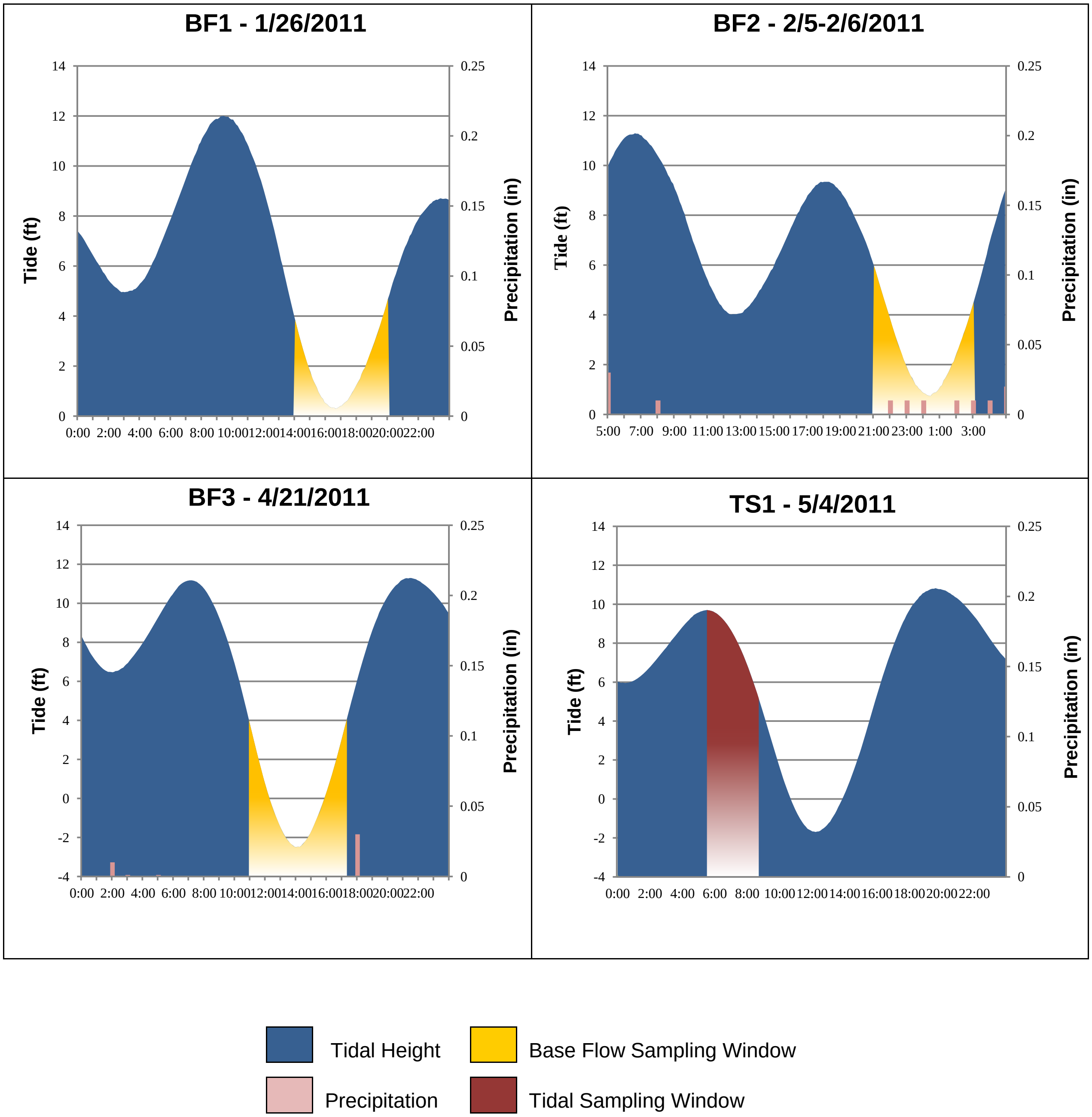

Figure 13. Base Flow and Tidal Water Sampling Tides and Precipitation

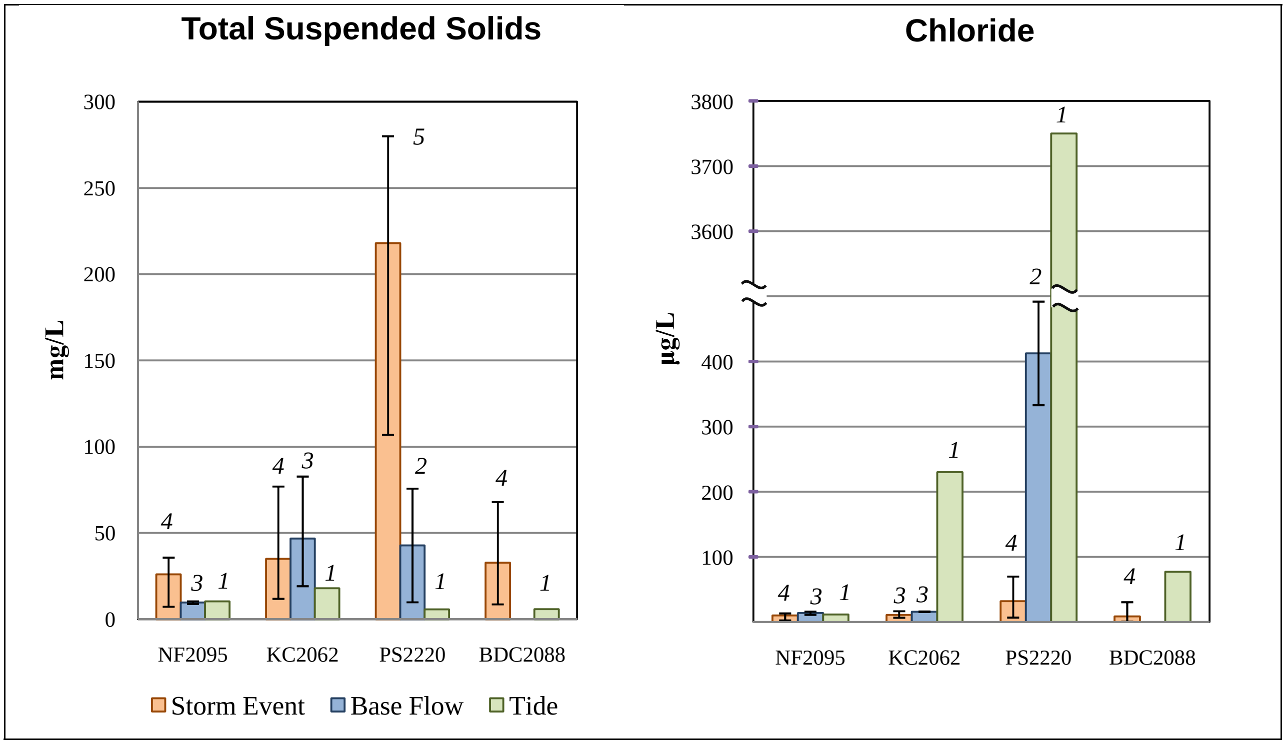

Figure 14. Flow-Weighted Mean Concentrations and Ranges of TSS and Chloride in Whole Water

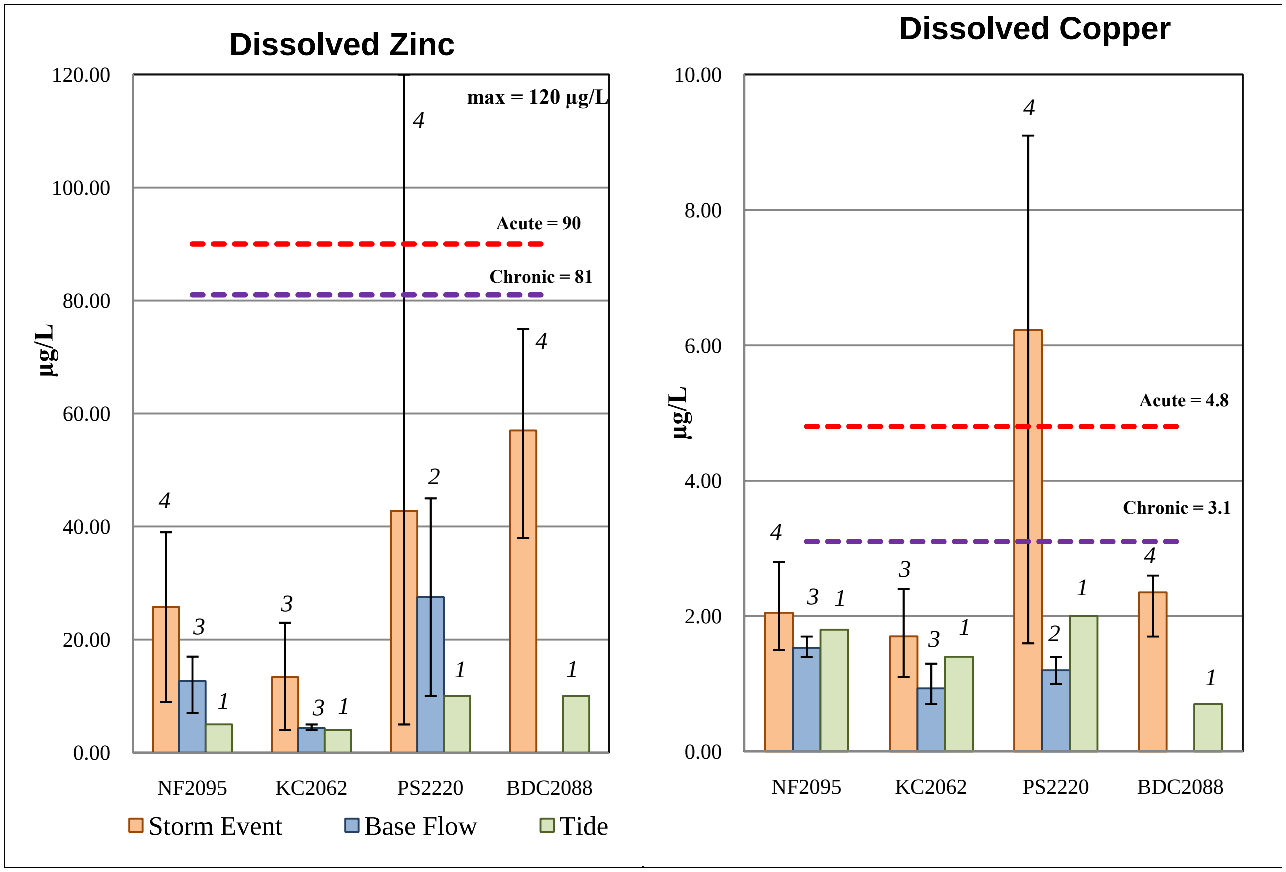

Figure 15. Flow-Weighted Mean Concentrations and Ranges of Dissolved Zinc and Copper in Whole Water

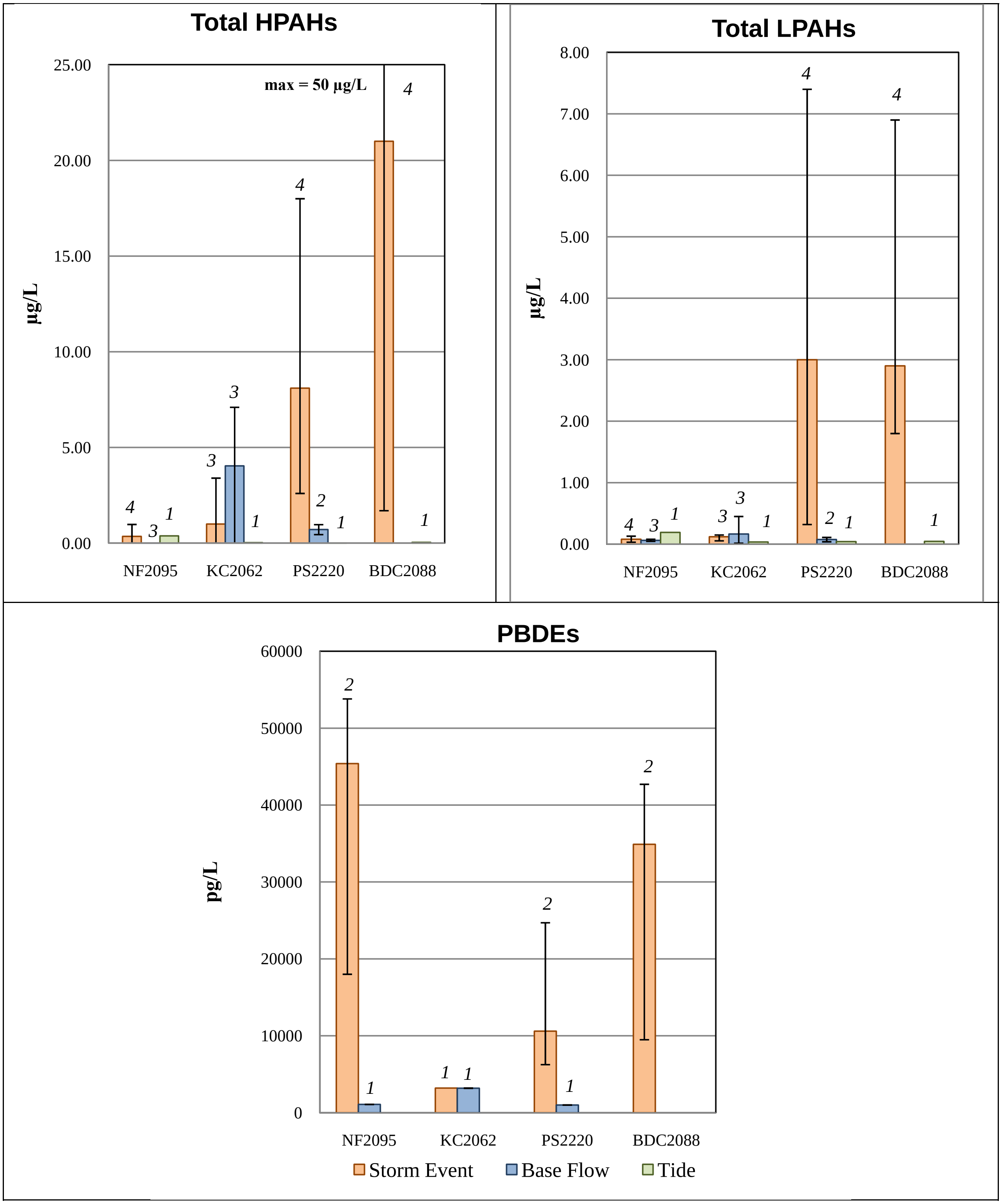

Figure 16. Flow-Weighted Mean Concentrations of HPAH, LPAH, and PBDE in Whole Water

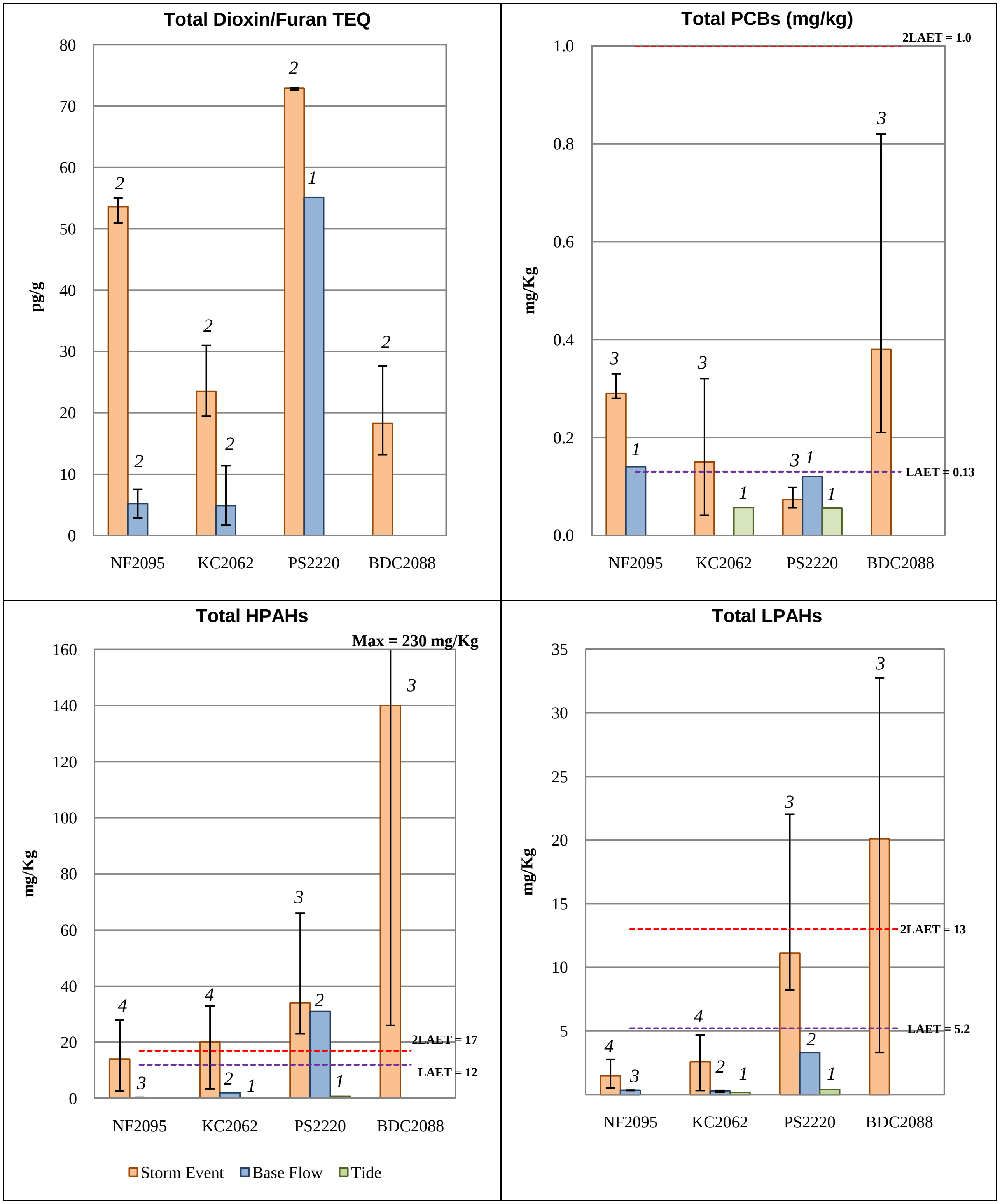

Figure 17. Flow-Weighted Mean Concentrations and Ranges of Dioxin/Furan TEQ, PCB Aroclors, HPAH, and LPAH in Filtered Solids

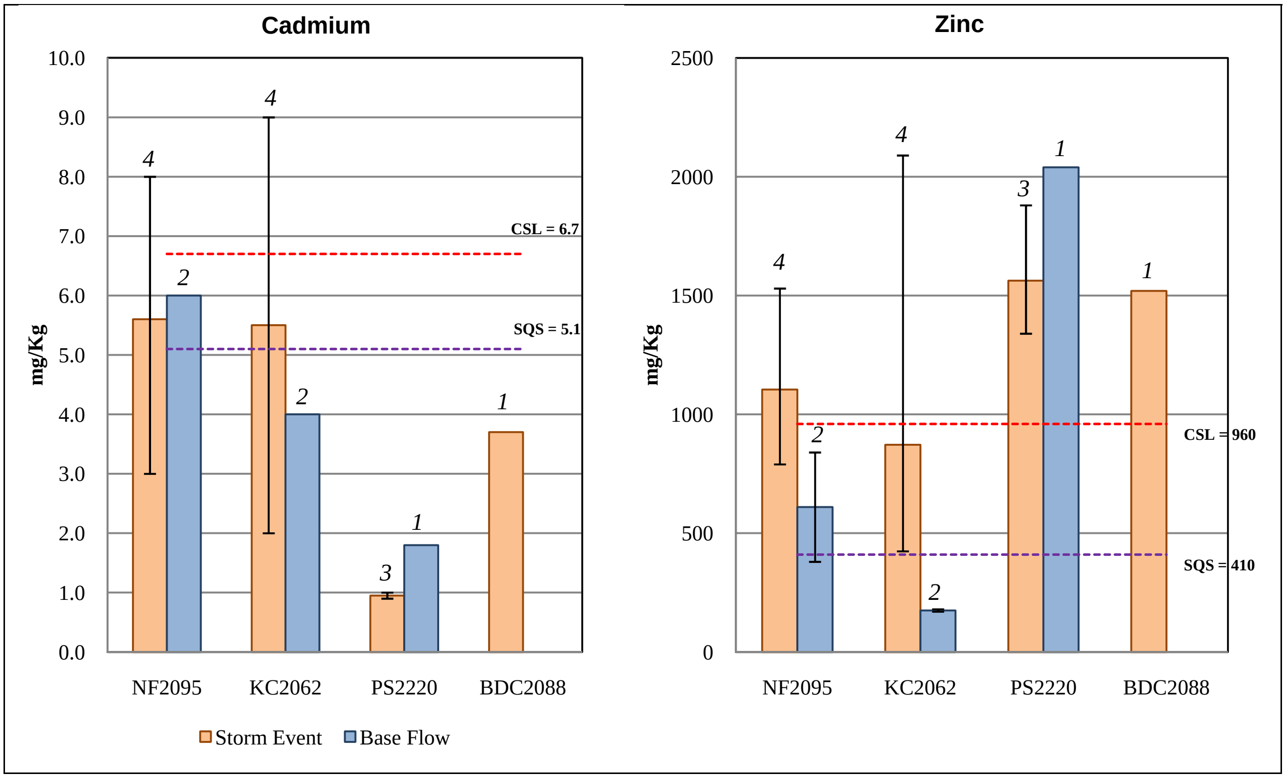

Figure 18. Flow-Weighted Mean Concentrations and Ranges of Cadmium and Zinc in Filtered Solids

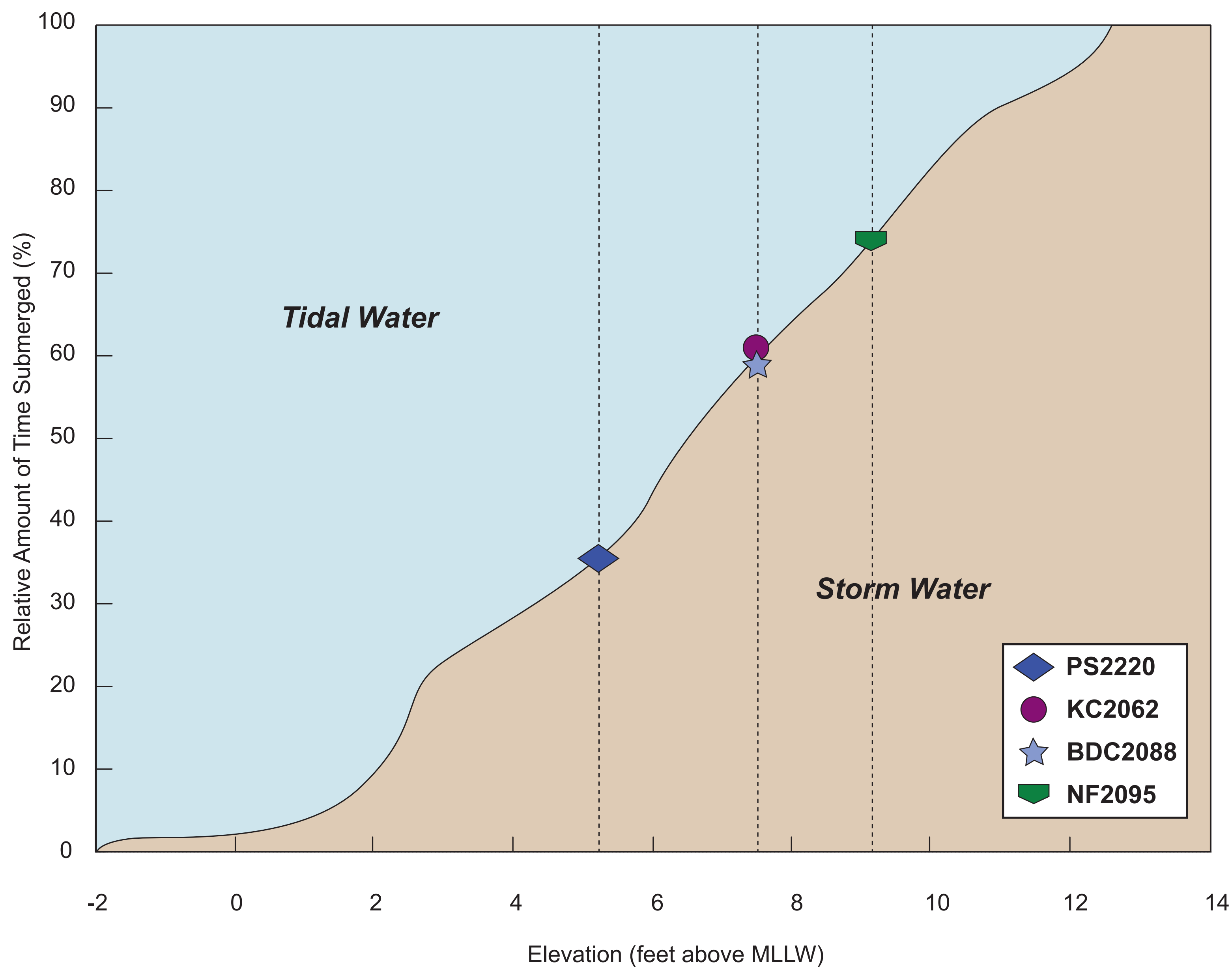

Figure 19. Types of Water Covering Sediment Traps During the 2010–2011 Wet Season

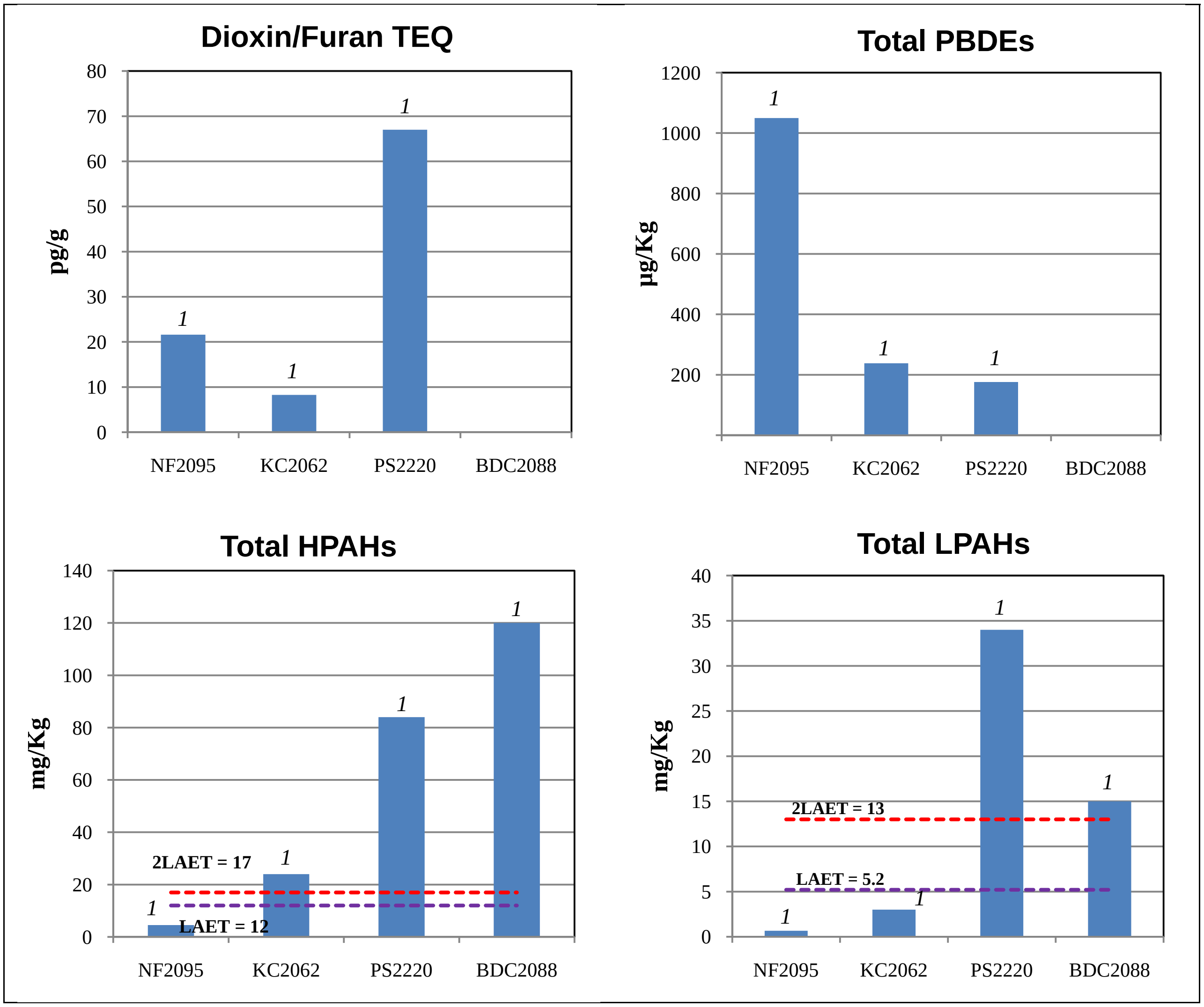

Figure 20. Sediment Trap Concentrations of Dioxin Furan TEQs, Total PBDEs, Total HPAHs, and Total LPAHs

Tables

Table 1. Characteristics of LDW Sub-basins Sampled

LDW Sub-basin	Sampling Location Abbreviation	Distance from Outfall to Sampling Location (feet)	Sub-basin Surface Area (acre)		Landcover Classification (%)			
			Total	Impervious	Developed, High Intensity	Developed, Medium Intensity	Developed, Low Intensity	Vegetation/ Open Space
City of Seattle - Norfolk	NF2095	1,665	770	417	30	26	21	23
King County SD#2	KC2062	135	211	169	75	13	10	2
Port of Seattle T-115	PS2220	265	26	24	94	6	0	0
Boeing Developmental Center	BDC2088	170	13	11	57	40	0	3

Table 2. Summary of Sampled Storm Events

Storm Event Date	Event	Total Event Precipitation (inches)	Total Event Duration (hours)	Fraction of Event Precipitation Sampled (%)	Fraction of Event Duration Sampled (%)	Section of Event Hydrograph Sampled
1/13/2011	SW1	0.21	5	52	40	rising
1/21/2011	SW2	0.301	10	34	80	rising
2/12/2011	SW3	0.451	5	100	100	entire
3/5/2011	SW4	0.133	10	47	60	falling
3/15/2011	SW5	0.242	10	54	70	falling
4/27/2011	SW6	0.433	9	91	78	falling

Table 3. Number of Storm Event, Base Flow, and Tidal Water Samples Analyzed

Location	Whole Water								Filtered Solids				
	TSS	pH, Alkalinity, Hardness, Anions, TOC, DOC	Total and Dissolved Metals (EPA 200.8/7470)	SVOCs (EPA 8270D)	PCB Aroclors (EPA 8082)	Pesticides (EPA 8081B)	VOCs (EPA 8260C)	PBDEs Congeners (EPA 1614)	Grain Size (PSEP)	Total Metals (EPA 200.8/7471)	PAHs (EPA 8270D)	PCB Aroclors (EPA 8082)	Dioxin/Furan Congeners (EPA 1614)
Base Flow													
NF2095	3	3	3	3	3	3	3	1	-	2	3	1	2
KC2062	3	3	3	3	3	3	3	1	2	2	2	-	2
PS2220	2	2	2	2	2	1	2	1	-	1	2	1	1
BDC2088	-	-	-	-	-	-	-	-	-	-	-	-	-
Storm Event													
NF2095	4	4	4	4	4	4	4	2	2	4	4	3	2
KC2062	4	3	3	3	3	3	3	1	3	4	4	3	2
PS2220	5	4	4	4	4	4	4	2	-	3	3	3	2
BDC2088	4	4	4	4	4	4	4	2	-	1	3	3	2
Tidal Water													
NF2095	1	1	1	1	1	1	1	-	-	1	1	1	-
KC2062	1	1	1	1	1	1	1	-	-	1	1	1	-
PS2220	1	1	1	1	1	1	1	-	-	1	1	1	-
BDC2088	1	1	1	1	1	1	1	-	-	1	1	1	-

Notes:

- no sample collected

Analytical methods are listed in the Appendix E data tables.

Storm events — Six storm events were sampled between January and April 2011. These samples are representative of a range of precipitation amounts and conditions over the sampling period.

Base flow — Samples collected during three base flow events were intended to be representative of water and solids that enter the storm drain system via groundwater infiltration or as a result of unidentified connections to the system.

Tidal water — One sample was collected at each location during a period of both high tide and no precipitation. These samples were intended to represent LDW river water that may transport contaminants both up-line and down-line and influence solids deposited in sediment traps.

Table 4. Base Flow Summary

Location	Pipe Diameter (in)	Baseflow Level (in)		Velocity (ft/s)		Average Flow (gpm)
		Min	Max	Min	Max	
NF2095	36	0.75	--	1	--	0.3
KC2062	48	1.75	8.5	1.2	4.6	3.2
PS2220	30	0.25	--	0.8	--	0.038
BDC2088	36	--	--	--	--	No Baseflow

KC baseflow level and velocity are weighted average of lift station cycles

Based on a field measurement using the flow probe

Based on a field estimate

Table 5. Frequency of Detection of COPCs in Storm Event Whole Water Samples

Analyte	Frequency of Detection for Storm Event Whole Water [1]			
	NF2095	KC2062	PS2220	BDC2088
PCBs				
Aroclor 1254	2/4	0/3	2/4	3/4
Total PCBs	2/4	0/3	2/4	3/4
Metals – Dissolved				
Arsenic	3/4	3/3	4/4	1/4
Chromium	0/4	0/3	4/4	3/4
Copper	4/4	3/3	4/4	4/4
Lead	0/4	0/3	1/4	1/4
Mercury	0/4	0/3	0/4	0/4
Nickel	4/4	3/3	4/4	3/4
Zinc	4/4	2/3	4/4	4/4
Phenols				
2,4-Dimethylphenol	0/4	0/3	3/4	0/4
o-Cresol	0/4	0/3	1/4	0/4
p-Cresol	0/4	0/3	1/4	0/4
Phenol	0/4	0/3	2/4	0/4
Phthalates				
Bis(2-Ethylhexyl) Phthalate	0/4	0/3	0/4	2/4
Dibutyl phthalate	0/4	0/3	0/4	1/4
Di-n-Octyl phthalate	0/4	0/3	0/4	2/4
PAHs				
1-Methylnaphthalene	0/4	1/3	3/4	1/4
2-Methylnaphthalene	1/4	2/3	3/4	3/4
Acenaphthene	1/4	0/3	4/4	3/4
Acenaphthylene	0/4	0/3	2/4	1/4
Anthracene	0/4	0/3	4/4	4/4
Benzo(a)anthracene	1/4	2/3	4/4	4/4
Benzo(a)pyrene	1/4	2/3	4/4	4/4
Benzo(ghi)perylene	2/4	2/3	4/4	4/4
Benzofluoranthene	4/4	2/3	4/4	4/4
Chrysene	2/4	2/3	4/4	4/4
Dibenzo(a,h)anthracene	1/4	2/3	4/4	4/4
Dibenzofuran	0/4	0/3	3/4	3/4
Fluoranthene	3/4	2/3	4/4	4/4
Fluorene	0/4	2/3	4/4	4/4
Indeno(1,2,3-cd)pyrene	1/4	2/3	4/4	4/4
Naphthalene	3/4	2/3	3/4	2/4
Phenanthrene	3/4	2/3	4/4	4/4
Pyrene	3/4	2/3	4/4	4/4
Total HPAHs	3/4	2/3	4/4	4/4
Total LPAHs	3/4	3/3	4/4	4/4
PBDEs				
Total BDEs	2/2	1/1	2/2	2/2

1. (Number of samples with detected concentrations)/(Total sample number)

Light blue shading - One ore more samples exceed Washington State Marine Water Quality Acute criteria

Analytical methods are listed in the Appendix E data tables.

Only chemicals detected in at least one sample are listed in this table.

Table 6. Maximum Concentration of Whole Water Samples that Exceed Washington State Marine Water Quality Criteria

Analyte	WQC Chronic	WQC Acute	Storm Event	
			PS2220	n[1]
Metals – Dissolved (µg/L)				
Copper	3.1	4.8	**9.1**	3/4
Zinc	81	90	**120**	1/4

WQC = Washington State Marine Water Quality Criteria

1. (Number of samples exceeding criteria)/(Total sample number)

Light blue shading - WQC acute criteria exceeded

Table 7. Frequency of Detection of COPCs in Storm Event Filtered Solids Samples

Analyte	Frequency of Detection for Storm Event Filtered Solids [1]			
	NF2095	KC2062	PS2220	BDC2088
Dioxins and Furans				
Dioxin/Furan Congeners	2/2	2/2	2/2	2/2
PCBs				
Aroclor 1254	3/3	3/3	3/3	3/3
Aroclor 1260	2/3	3/3	2/3	2/3
Total PCBs	3/3	3/3	3/3	3/3
Metals - total				
Arsenic	0/4	0/4	2/3	0/1
Cadmium	4/4	4/4	3/3	1/1
Chromium	4/4	4/4	3/3	1/1
Copper	4/4	4/4	3/3	1/1
Lead	4/4	4/4	3/3	1/1
Mercury	2/4	3/4	3/3	1/1
Silver	0/4	0/4	0/3	1/1
Zinc	4/4	4/4	3/3	1/1
PAHs				
1-Methylnaphthalene	3/4	3/4	1/3	2/3
2-Methylnaphthalene	3/4	4/4	3/3	3/3
Acenaphthene	0/4	2/4	3/3	2/3
Acenaphthylene	0/4	0/4	0/3	0/3
Anthracene	0/4	3/4	3/3	3/3
Benzo(a)anthracene	4/4	4/4	3/3	3/3
Benzo(a)pyrene	4/4	4/4	3/3	3/3
Benzo(ghi)perylene	4/4	4/4	3/3	3/3
Benzofluoranthene	4/4	4/4	3/3	3/3
Chrysene	4/4	4/4	3/3	3/3
Dibenzo(a,h)anthracene	0/4	1/4	0/3	1/3
Dibenzofuran	2/4	3/4	3/3	3/3
Fluoranthene	4/4	4/4	3/3	3/3
Fluorene	2/4	3/4	3/3	3/3
Indeno(1,2,3-cd)pyrene	4/4	4/4	3/3	3/3
Naphthalene	3/4	4/4	3/3	3/3
Phenanthrene	4/4	4/4	3/3	3/3
Pyrene	4/4	4/4	3/3	3/3
Total HPAHs	4/4	4/4	3/3	3/3
Total LPAHs	4/4	4/4	3/3	3/3

1. (Number of samples with detected concentrations)/(Total sample number)

Light yellow shading - SQS/LAET exceeded for one or more samples

Light blue shading - CSL/2LAET exceeded for one or more samples

Analytical methods are listed in the Appendix E data tables.

Only chemicals detected in at least one sample are listed in this table.

Table 8. Maximum Concentration of Filtered Solids Samples that Exceed SMS/LAET Criteria

Analyte	SQS/LAET	CSL/2LAET	Base Flow				Stormwater									
			NF2095	n[1]	PS2220	n[1]	NF2095	n[1]	KC2062	n[1]	PS2220	n[1]	BDC2088	n[1]
PCBs (mg/kg)														
Total PCBs	0.13	1					**0.33**	3/3	**0.32**	2/3			**0.82**	3/3
Metals – Total (mg/kg)														
Cadmium	5.1	6.7	**6**	1/2			**8**	2/4	**9**	2/4				
Zinc	410	960	**840**	1/2	**2040**	1/1	**1530**	4/4	**2090**	4/4	**1880**	3/3	**1520**	1/1
PAHs (mg/kg)														
2-Methylnaphthalene	0.67	1.4											**1.4**	1/3
Acenaphthene	0.5	0.73									**1.1**	3/3	**1.2**	1/3
Anthracene	0.96	4.4			**1.2**	1/2					**3.9**	2/3	**2.4**	1/3
Benzo(a)anthracene	1.3	1.6			**2.0**	1/2			**1.4**	1/4	**6.6**	2/3	**15**	3/3
Benzo(a)pyrene	1.6	3					**2.3**	1/4	**2.4**	2/4	**3.3**	1/3	**21**	3/3
Benzo(ghi)perylene	0.67	0.72			**1.4**	1/2	**3.2**	3/4	**2.3**	3/4	**1.6**	2/3	**19**	3/3
Benzofluoranthene	3.2	3.6			**4.3**	1/2	**6.4**	1/4	**7.8**	2/4	**9.4**	2/3	**49**	3/3
Chrysene	1.4	2.8			**4.3**	1/2	**3.7**	1/4	**4.8**	3/4	**7.4**	3/3	**28**	3/3
Dibenzofuran	0.54	0.7									**1.4**	2/3	**1.8**	2/3
Fluoranthene	1.7	2.5			**9.9**	1/2	**5.0**	2/4	**6.4**	3/4	**23**	3/3	**45**	3/3
Fluorene	0.54	1									**3.3**	3/3	**1.6**	2/3
Indeno(1,2,3-cd)pyrene	0.6	0.69					**2.5**	2/4	**2.2**	3/4	**1.5**	2/3	**16**	3/3
Naphthalene	2.1	2.4											**2.6**	1/3
Phenanthrene	1.5	5.4			**2.3**	1/2	**2.1**	1/4	**3.7**	3/4	**15**	3/3	**25**	3/3
Pyrene	2.6	3.3			**8.3**	1/2	**3.7**	1/4	**5.6**	2/4	**14**	3/3	**34**	2/3
Total HPAHs	12	17			**31**	1/2	**28**	1/4	**33**	3/4	**66**	3/3	**230**	3/3
Total LPAHs	5.2	13									**23**	3/3	**33**	2/3

1. (Number of samples exceeding criteria)/(Total sample number)

Light yellow shading - SQS/LAET criteria exceeded

Light blue shading - CSL/2LAET criteria exceeded

SQS/LAET - Sediment Quality Standards/Lowest Apparent Effects Threshold

CSL/2LAET - Cleanup Screening Level/Second Lowest Apparent Effects Threshold

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Table 9. Frequency of Detection of COPCs in Sediment Trap Solids Samples

	Frequency of Detection for Sediment Trap Solids [1]			
Analyte	**NF2095**	**KC2062**	**PS2220**	**BDC2088**
Dioxins and Furans				
Dioxin/Furan Congeners	1/1	1/1	1/1	--
Phenols				
Pentachlorophenol	0/1	0/1	1/1	1/1
Phenol	1/1	1/1	1/1	1/1
Phthalates				
Bis(2-Ethylhexyl) Phthalate	1/1	1/1	1/1	1/1
Butyl benzyl phthalate	1/1	1/1	1/1	1/1
Dibutyl phthalate	0/1	0/1	1/1	1/1
Dimethyl phthalate	1/1	0/1	0/1	0/1
Di-n-Octyl phthalate	1/1	1/1	1/1	1/1
PAHs				
1-Methylnaphthalene	0/1	0/1	1/1	0/1
2-Methylnaphthalene	1/1	0/1	1/1	0/1
Acenaphthene	0/1	1/1	1/1	1/1
Acenaphthylene	0/1	0/1	0/1	0/1
Anthracene	1/1	1/1	1/1	1/1
Benzo(a)anthracene	1/1	1/1	1/1	1/1
Benzo(a)pyrene	1/1	1/1	1/1	1/1
Benzo(ghi)perylene	1/1	1/1	1/1	1/1
Benzofluoranthene	1/1	1/1	1/1	1/1
Chrysene	1/1	1/1	1/1	1/1
Dibenzo(a,h)anthracene	1/1	1/1	1/1	1/1
Dibenzofuran	1/1	1/1	1/1	1/1
Fluoranthene	1/1	1/1	1/1	1/1
Fluorene	1/1	1/1	1/1	1/1
Indeno(1,2,3-cd)pyrene	1/1	1/1	1/1	1/1
Naphthalene	1/1	1/1	1/1	1/1
Phenanthrene	1/1	1/1	1/1	1/1
Pyrene	1/1	1/1	1/1	1/1
Total HPAHs	1/1	1/1	1/1	1/1
Total LPAHs	1/1	1/1	1/1	1/1
SVOCs				
Benzoic Acid	1/1	0/1	0/1	1/1
Benzyl Alcohol	1/1	0/1	0/1	1/1
PBDEs				
Total BDEs	1/1	1/1	1/1	--

-- Not analyzed

1. (Number of samples with detected concentrations)/(Total sample number)

Light yellow shading - SQS/LAET exceeded

Light blue shading - CSL/2LAET exceeded

Analytical methods are listed in the Appendix E data tables.

Only chemicals detected in at least one sample are listed in this table.

Table 10. Sediment Trap Solids Samples that Exceed SMS/LAET Criteria

Analyte	SQS/LAET	CSL/2LAET	NF2095	KC2062	PS2220	BDC2088
Phenols (mg/kg)						
Phenol	0.42	1.2				**0.49**
Phthalates (mg/kg)						
Bis(2-Ethylhexyl) Phthalate	1.3	1.9	**2.3**		**13**	**6.3**
Butyl benzyl phthalate	0.063	0.9	**1.8**		**1.0**	**0.38**
Di-n-Octyl phthalate	6.2					**7.3**
PAHs (mg/kg)						
Acenaphthene	0.50	0.73			**1.6**	
Anthracene	0.96	4.4			**4.3**	**1.3**
Benzo(a)anthracene	1.3	1.6		**1.6**	**5.5**	**7.8**
Benzo(a)pyrene	1.6	3.0		**1.8**	**2.5**	**9.3**
Benzo(ghi)perylene	0.67	0.72		**1.5**	**2**	**7.2**
Benzofluoranthene	3.2	3.6		**4.4**	**7**	**20**
Chrysene	1.4	2.8		**2.6**	**7.4**	**14**
Dibenzo(a,h)anthracene	0.23	0.54		**0.47**	**0.74**	**2.6**
Dibenzofuran	0.54	0.70			**2**	
Fluoranthene	1.7	2.5		**6.2**	**37**	**33**
Fluorene	0.54	1.0			**3.9**	
Indeno(1,2,3-cd)pyrene	0.60	0.69		**1.3**	**1.5**	**6.9**
Phenanthrene	1.5	5.4		**2.5**	**24**	**13**
Pyrene	2.6	3.3		**3.9**	**20**	**19**
Total HPAHs	12	17		**24**	**84**	**120**
Total LPAHs	5.2	13			**34**	**15**
SVOCs (mg/kg)						
Benzoic Acid	0.65	0.65				**1.2**
Benzyl Alcohol	0.057	0.073	**0.12**			**0.31**

Light yellow shading - SQS/LAET criteria exceeded

Light blue shading - CSL/2LAET criteria exceeded

SQS/LAET - Sediment Quality Standards/Lowest Apparent Effects Threshold

CSL/2LAET - Cleanup Screening Level/Second Lowest Apparent Effects Threshold

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Table 11. Inline Solids Samples that Exceed SMS/LAET Criteria

Analtye	SQS/LAET	CSL/2LAET	KC2062
Metals – Total (mg/kg)			
Arsenic	57	93	**90**
Cadmium	5.1	6.7	**6**
Zinc	410	960	**640**
PAHs (mg/kg)			
Benzo(ghi)perylene	0.67	0.72	**1.2**
Dibenzo(a,h)anthracene	0.23	0.54	**0.33**
Fluoranthene	1.7	2.5	**1.8**
Indeno(1,2,3-cd)pyrene	0.6	0.69	**1.1**

Light yellow shading - SQS/LAET criteria exceeded

Light blue shading - CSL/2LAET criteria exceeded

SQS/LAET - Sediment Quality Standards/Lowest Apparent Effects Threshold

CSL/2LAET - Cleanup Screening Level/Second Lowest Apparent Effects Threshold

Table 12. Estimated Storm Flow and Base Flow Volumes for the 2010–2011 Wet Season

Flow Volumes	NF2095	KC2062	PS2220	BDC2088
Total Wet Season Storm Flow Volume from Area-Based Predictions (Mgal)	421	166	23.3	10.8
Base Flow Wet Season Volume from Measured Average Flows (Mgal)	0.09	0.97	0.01	0

Table 13. Wet Season Flow-Weighted Mean Whole Water Concentrations

Analyte	NF2095	KC2062	PS2220	BDC2088
TSS (mg/L)				
Storm Flow	26	35	210	38
Base Flow	9.8	47	43	NB
Total PCBs (µg/L)				
Storm Flow	0.011	0.01 U	0.01	0.016
Base Flow	0.01 U	0.01 U	0.01 U	NB
Arsenic (µg/L)				
Storm Flow	1.1	2.6	11	0.57
Base Flow	1	3.3	1.2	NB
Cadmium (µg/L)				
Storm Flow	0.23	0.22	0.26	0.27
Base Flow	0.2 U	0.17 U	0.2 U	NB
Copper (µg/L)				
Storm Flow	4.8	2.8	53	10
Base Flow	2.3	1.6	5.2	NB
Lead (µg/L)				
Storm Flow	2.7	1.8	17	8.1
Base Flow	0.77	0.73	1.8	NB
Zinc (µg/L)				
Storm Flow	40	19	360	130
Base Flow	20	8.7	73	NB
Total HPAHs (µg/L)				
Storm Flow	0.40	1.0	9.3	22
Base Flow	0.01 U	4.0	0.71	NB
Total LPAHs (µg/L)				
Storm Flow	0.079	0.12	3.0	2.9
Base Flow	0.06	0.16	0.074	NB
Total PBDEs (ng/L)				
Storm Flow	45.4	3.2	10.6	34.9
Base Flow	1.08	3.2	0.996	NB

Colored bars indicate the relative concentration of an analyte in storm and base flow to the location with the greatest storm flow concentration.

U - Analyte was not detected

NA - Analyte was not analyzed

NB - No base flow

Table 14. Wet Season Flow-Weighted Mean Filtered Solids Concentrations

Analyte	NF2095	KC2062	PS2220	BDC2088
Dioxin/Furan TEQ, ND*0.5 (pg/g)				
Storm Flow	54	24	73	18
Base Flow	5.2	4.9	55.0	NB
Total PCBs (ug/kg)				
Storm Flow	290	150	73	380
Base Flow	150 U	NA	110	NB
Cadmium (mg/kg)				
Storm Flow	5.7	5.9	0.95	3.7
Base Flow	6.0	4.0	1.8	NB
Lead (mg/kg)				
Storm Flow	130	130	97	170
Base Flow	55 U	40 U	86	NB
Mercury (mg/kg)				
Storm Flow	0.16	0.095	0.081	0.21
Base Flow	0.6 U	0.09 U	0.12	NB
Zinc (mg/kg)				
Storm Flow	1100	940	1600	1500
Base Flow	610	180	2000	NB
Total HPAHs (mg/kg)				
Storm Flow	14	20	34	140
Base Flow	0.27	2.0	18	NB
Total LPAHs (mg/kg)				
Storm Flow	1.5	2.6	11	20
Base Flow	0.32	0.26	1.9	NB

Colored bars indicate the relative concentration of an analyte in storm and base flow to the location with the greatest storm flow concentration.

NA - Analyte was not analyzed

NB - No base flow

Table 15. Wet Season Sediment Trap Solids Concentrations

Analyte	NF2095	KC2062	PS2220	BDC2088
Dioxin/Furan TEQ, ND*0.5 (pg/g)				
Storm Flow	21.6	8.26	67	NA
Total PBDEs (µg/kg)				
Storm Flow	1050	237	176	NA
Phenol (µg/kg)				
Storm Flow	170	71	180	490
Bis(2-ethylhexyl) phthalate (µg/kg)				
Storm Flow	2300	770	13000	6300
Butyl benzyl phthalate (µg/kg)				
Storm Flow	1800	52	1000	380
Di-n-octyl phthalate (µg/kg)				
Storm Flow	730	90	290	7300
Total HPAHs (mg/kg)				
Storm Flow	4.5	24	84	120
Total LPAHs (mg/kg)				
Storm Flow	0.67	3.1	34	15

Colored bars indicate the relative concentration of an analyte to the location with the greatest concentration.

NA - Analyte was not analyzed

Table 16. Wet Season Lateral Loads based on Whole Water

Analyte	NF2095	KC2062	PS2220	BDC2088
TSS (kg/yr)				
Storm Flow	41000	22000	19000	1600
Base Flow	3.3	170	1.6	NB
Total PCBs (kg/yr)				
Storm Flow	0.018	U	8.8E-04	6.5E-04
Base Flow	U	U	U	NB
Arsenic (kg/yr)				
Storm Flow	1.80	1.60	0.97	0.02
Base Flow	3.4E-04	0.012	4.5E-05	NB
Cadmium (kg/yr)				
Storm Flow	0.370	0.140	0.023	0.011
Base Flow	U	U	U	NB
Copper (kg/yr)				
Storm Flow	7.7	1.8	4.7	0.41
Base Flow	7.8E-04	0.006	2.0E-04	NB
Lead (kg/yr)				
Storm Flow	4.3	1.1	1.5	0.33
Base Flow	2.6E-04	0.003	6.8E-05	NB
Zinc (kg/yr)				
Storm Flow	64.0	12.0	32.0	5.3
Base Flow	0.007	0.032	0.003	NB
Total HPAHs (kg/yr)				
Storm Flow	0.63	0.63	0.81	0.90
Base Flow	U	0.015	2.7E-05	NB
Total LPAHs (kg/yr)				
Storm Flow	0.13	0.08	0.26	0.12
Base Flow	2.0E-05	0.001	2.8E-06	NB
Total PBDEs (kg/yr)				
Storm Flow	0.072	0.002	0.001	0.001
Base Flow	3.7E-07	1.2E-05	3.8E-08	NB

Colored bars indicate the relative loading of an analyte in storm and base flow to the location with the greatest storm flow loading.

U - Analyte was not detected

NA - Analyte was not analyzed

NB - No base flow

Table 17. Wet Season Lateral Loads based on Filtered Solids

Analyte	NF2095	KC2062	PS2220	BDC2088
Dioxin/Furan TEQ, ND*0.5 (kg/yr)				
Storm Flow	2.2E-06	5.2E-07	1.4E-06	2.8E-08
Base Flow	1.7E-11	8.4E-10	1.6E-10	NB
Total PCBs (kg/yr)				
Storm Flow	0.012	0.003	0.001	0.001
Base Flow	U	NA	3.1E-07	NB
Cadmium (kg/yr)				
Storm Flow	0.24	0.13	0.018	0.006
Base Flow	1.9E-05	6.9E-04	5.2E-06	NB
Lead (kg/yr)				
Storm Flow	5.2	2.8	1.8	0.27
Base Flow	U	U	2.5E-04	NB
Mercury (kg/yr)				
Storm Flow	6.6E-03	2.1E-03	1.5E-03	3.3E-04
Base Flow	U	U	3.5E-07	NB
Zinc (kg/yr)				
Storm Flow	44	21	29	2.4
Base Flow	0.002	0.030	0.006	NB
Total HPAHs (kg/yr)				
Storm Flow	0.60	0.45	0.63	0.22
Base Flow	8.7E-07	3.4E-04	5.1E-05	NB
Total LPAHs (kg/yr)				
Storm Flow	0.061	0.058	0.21	0.032
Base Flow	1.0E-06	4.5E-05	5.5E-06	NB

Colored bars indicate the relative loading of an analyte in storm and base flow to the location with the greatest storm flow loading.

U - Analyte was not detected

NA - Analyte was not analyzed

NB - No base flow

Table 18. Wet Season Lateral Loads based on Sediment Trap Solids

Analyte	NF2095	KC2062	PS2220	BDC2088
Dioxin/Furan TEQ, ND*0.5 (kg/yr)				
Storm Flow	8.9E-07	1.8E-07	1.2E-06	NA
Total PBDEs (kg/yr)				
Storm Flow	0.044	0.005	0.003	NA
Phenol (kg/yr)				
Storm Flow	0.007	0.002	0.003	0.001
Bis(2-ethylhexyl) phthalate (kg/yr)				
Storm Flow	0.095	0.017	0.241	0.010
Butyl benzyl phthalate (kg/yr)				
Storm Flow	0.075	0.001	0.019	0.001
Di-n-octyl phthalate (kg/yr)				
Storm Flow	0.030	0.002	0.005	0.011
Total HPAHs (kg/yr)				
Storm Flow	0.19	0.53	1.60	0.19
Total LPAHs (kg/yr)				
Storm Flow	0.028	0.069	0.63	0.023

Colored bars indicate the relative loading of an analyte to the location with the greatest loading.

NA - Analyte was not analyzed

Table 19. Wet Season Lateral Loads and Associated Error for Different Sample Types

Analyte	NF2095						KC2062					
	Whole Water		Filtered Solids		Sediment Trap		Whole Water		Filtered Solids		Sediment Trap	
Dioxin/Furan TEQ, ND*0.5 (kg/yr)												
Storm Flow	NA		2.2E-06	±5.2%	8.9E-07	--	NA		5.2E-07	±35%	1.8E-07	--
Base Flow	NA		1.7E-11	±22%			NA		8.4E-10	±49%		
Total PCBs (kg/yr)												
Storm Flow	0.018	±18%	0.012	±52%	NA		U		0.003	±100%	NA	
Base Flow	U		U				U		NA			
Cadmium (kg/yr)												
Storm Flow	0.370	±21%	0.24	±53%	NA		0.140	±22%	0.13	±65%	NA	
Base Flow	U		1.9E-05	--			U		6.9E-04	--		
Lead (kg/yr)												
Storm Flow	4.3	±96%	5.2	±52%	NA		1.1	±45%	2.8	±57%	NA	
Base Flow	2.6E-04	±53%	U				0.003	±63%	U			
Zinc (kg/yr)												
Storm Flow	64.0	±34%	44	±53%	NA		12.0	±86%	21	±83%	NA	
Base Flow	0.007	±18%	0.002	±53%			0.032	±74%	0.030	±4%		
Total HPAHs (kg/yr)												
Storm Flow	0.63	±130%	0.60	±77%	0.19	--	0.63	±143%	0.45	±64%	0.53	--
Base Flow	U		8.7E-07	±37%			0.015	±89%	3.4E-04	±0%		
Total LPAHs (kg/yr)												
Storm Flow	0.13	±52%	0.061	±72%	0.028	--	0.08	±70%	0.058	±69%	0.069	--
Base Flow	2.0E-05	±29%	1.0E-06	±17%			0.001	±150%	4.5E-05	±37%		
Total PBDEs (kg/yr)												
Storm Flow	0.072	±56%	NA		0.044	--	0.002	--	NA		0.005	--
Base Flow	3.7E-07	--	NA				1.2E-05	--	NA			

U - Analyte was not detected

NA - Analyte was not analyzed

NB - No base flow

-- - Error is not reported when loading was calculated from a single sample.

Table 19. Wet Season Lateral Loads and Associated Error for Different Sample Types

Analyte	PS2220						BDC2088					
	Whole Water		Filtered Solids		Sediment Trap		Whole Water		Filtered Solids		Sediment Trap	
Dioxin/Furan TEQ, ND*0.5 (kg/yr)												
Storm Flow	NA		1.4E-06	±0.4	1.2E-06	--	NA		2.8E-08	±56%	NA	
Base Flow	NA		1.6E-10	--			NB		NB			
Total PCBs (kg/yr)												
Storm Flow	8.8E-04	±12%	0.001	±28%	NA		6.5E-04	±25%	0.001	±82%	NA	
Base Flow	U		3.1E-07	--			NB		NB			
Cadmium (kg/yr)												
Storm Flow	0.023	±32%	0.018	±6.1%	NA		0.011	±37%	0.006	--	NA	
Base Flow	U		5.2E-06	--			NB		NB			
Lead (kg/yr)												
Storm Flow	1.5	±49%	1.8	±35%	NA		0.33	±56%	0.27	--	NA	
Base Flow	6.8E-05	±16%	2.5E-04	--			NB		NB			
Zinc (kg/yr)												
Storm Flow	32.0	±33%	29	±18%	NA		5.3	±40%	2.4	--	NA	
Base Flow	0.003	±54%	0.006	--			NB		NB			
Total HPAHs (kg/yr)												
Storm Flow	0.81	±69%	0.63	±65%	1.60	--	0.90	±100%	0.22	±74%	0.19	--
Base Flow	2.7E-05	±52%	5.1E-05	±94%			NB		NB			
Total LPAHs (kg/yr)												
Storm Flow	0.26	±86%	0.21	±72%	0.63	--	0.12	±108%	0.032	±77%	0.023	--
Base Flow	2.8E-06	±57%	5.5E-06	±110%			NB		NB			
Total PBDEs (kg/yr)												
Storm Flow	0.001	±123%	NA		0.003	--	0.001	±67%	NA		NA	
Base Flow	3.8E-08	--	NA				NB		NB			

U - Analyte was not detected

NA - Analyte was not analyzed

NB - No base flow

-- - Error is not reported when loading was calculated from a single sample.

Table 20. Comparison of Loading Estimates for Different Sample Types

	Relative Percent Difference (%)		
Results from:	**Whole Water**	**Filtered Solids**	**Sediment Trap**
Compared to:	**Filtered Solids**	**Sediment Trap**	**Whole Water**
Dioxin/Furan TEQ			
Storm Flow Average	-	63	-
Range	-	8 - 96	-
Total PCBs			
Storm Flow Average	29	-	-
Range	11 - 45	-	-
Cadmium			
Storm Flow Average	35	-	-
Range	17 - 63	-	-
Lead			
Storm Flow Average	36	-	-
Range	18 - 85	-	-
Zinc			
Storm Flow Average	45	-	-
Range	10 - 77	-	-
Total HPAHs			
Storm Flow Average	46	55	80
Range	5 - 120	15 - 100	17 - 130
Total LPAHs			
Storm Flow Average	59	56	89
Range	21 - 120	17 - 100	9 - 130
Total PBDEs			
Storm Flow Average	-	-	81
Range	-	-	50 - 100

Notes:

--results are not available for comparison

RPD less than 30 percent

RPD less than 66 percent

Appendix A
Outfall and Storm Drain Access Locations

Table A-1. Stormwater Outfall Information

Owner	RI Outfall #	Name	Easting[1]	Northing[1]	Elevation (feet above MLLW)	Outfall Diameter (inch)	Opening Cover
City of Seattle	2095	Norfolk CSO/SD	1278630.9	190180.0	5.1	84	Tidegate
King County	2062	KCIA SD#2	1276177.3	194741.8	7.3	48	None
Port of Seattle	2220	Port T-115 SD	1268617.0	202385.0	5.4	24	None
The Boeing Company	2088	BDC SD 2088	1276974.2	191734.2	7.0	36	Flapper

Notes:

1. Washington State Plane North, NAD 83, feet

MLLW = mean lower low water

Table A-2. Storm Drain Access Location Information

Owner	Access Location Name	Easting[1]	Northing[1]	Approximate Elevation of Drain Bottom (feet above MLLW)[2]	Depth from surface to to Drain Bottom (feet)
City of Seattle	NF2095	1279329.6	190822.9	9.1	11.7
King County	KC2062	1276793.5	195076.6	8.0	8.5
Port of Seattle	PS2220	1268538.7	202443.6	5.4	12.75
The Boeing Company	BDC2088	1277630.6	191977.4	7.5	11.33

Notes:

1. Washington State Plane North, NAD 83, feet

2. The elevation for NF2095 is approximate

MLLW = mean lower low water

Appendix B
Synopsis of a Storm Sampling Event

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The purpose of this appendix is to document the sequence of events involved in targeting, mobilizing equipment for, and sampling storm events for both the LDW *Stormwater Lateral Loading Study* and *Accelerated Source Tracing Study*.

Identification of Potential Sampling Events

A forecasted storm event was selected for sampling if it met the following two criteria:

- An uninterrupted 0.2 inch of precipitation was predicted in the 24-hour forecast, and
- The event was predicted to span a minimum of 6 hours during a period when the LDW tidal elevation was less than +5 feet MLLW.

Throughout the sampling season, NewFields staff regularly tracked the short- and long-range precipitation forecast using the National Oceanic and Atmospheric Administration (NOAA) Quantitative Precipitation Forecast website: http://www.wrh.noaa.gov/forecast/wxtables/index.php?lat=47.5405059&lon=-122.3045438&table=custom&duration=7&interval=6.

The website was used to monitor predicted precipitation in 6-hour increments for the south Seattle area. This online resource is ideal for continual weather tracking, as the percent chance of precipitation, precipitation quantity estimates, and the timing of predicted rainfall are updated many times daily. These forecasts were used to identify “potential stormwater sampling events” when an uninterrupted interval of precipitation totaling greater than 0.2 inch was predicted.

After a potential stormwater sampling event had been identified, tidal elevations at the Lower Duwamish Waterway 8th Avenue S tide station were determined for the same time period using the website: http://www.protides.com/washington/776/. Simultaneous stormwater sampling at multiple locations required a tidal elevation below approximately +5 feet MLLW (for Lateral Loading Study locations) for the duration of the sampling event to prevent the sampling of tidal water within the storm drain lines. Sampling intervals greater than 4 hours in length were generally required to collect sufficient filtered solids to warrant analysis. As a result of the tidal elevation and sampling duration requirements, numerous potential storm events were not selected for sampling.

Mobilization

Once a potential storm event that met tidal elevation and sampling duration requirements was identified, a decision was made whether or not to sample the event. While attempts were made to sample most of these events, occasionally events were passed over due to either late changes in the amount or timing of predicted rainfall, or the unavailability of staff. The decision to sample an event was generally made the day before the predicted event due to the time required to mobilize and deploy sampling equipment. On the day prior to the sampling event, a 14-foot box truck was rented and loaded at the NewFields office with Isco units, batteries, pre-weighed filter bags, and tools required for sampling equipment deployment.

On the day of a sampling event, generally 8 to 10 hours before the initiation of sampling, the box truck was loaded with sampling equipment at the NewFields warehouse by the three or four field personnel who would be responsible for sampler deployment. Equipment stored at the warehouse included stormwater filtration units and pumps, harnesses for suspending equipment in the maintenance holes, the tripod and winch required to deploy gear, and safety equipment Typically, decontaminated carboys were picked up from ARI on the day of the sampling event. Filtration units were loaded with filter bags and Iscos were loaded with carboys at the warehouse to minimize the onsite preparation time of the samplers.

Deployment and Sampling

Upon arrival at a sampling location, the area in the vicinity of the maintenance hole was secured and blocked off from traffic using orange safety cones and signage in accordance with Street Use Permits obtained from the City of Seattle Department of Transportation. After removal of the maintenance hole cover, the stormwater suction line and flow sensor cord were retrieved from the hole and attached to the Isco. Two fully charged 12-volt batteries were secured to the top of the filtration frame and were connected to independent control boxes for the Isco and filtration unit. The Isco pump was tested to ensure the suction line was not clogged. Immediately before the deployment of the sampling gear, time programs were set for both the Isco whole water sampler and stormwater filtration units to run during the predetermined sampling event time interval. While in the field, the most current Doppler radar images were monitored to assess the trajectory and likely arrival time of the storm using the NOAA website: http://radar.weather.gov/radar.php?rid=atx&product=N0R&overlay=11101111&loop=no.

The tripod was set up over the open maintenance hole, and the Isco, filtration unit, and pump housing were suspended in tandem from the tripod winch line. As this equipment package was lowered into the maintenance hole, field personnel took care to ensure that electrical and suction lines did not become stressed or kinked. Once the package was hanging within the hole, a tag line was used to position and secure the pump housing in the center of the storm drain channel. At this point the weight of the equipment was transferred to the hanger bracket positioned across the maintenance hole opening. The final step in deployment was the replacement of the maintenance hole cover. Deployment of equipment generally took an hour per location.

Sample Recovery and Demobilization

Generally, the sampling interval ended within 12 hours. The sampling locations were revisited to retrieve equipment and collect the samples. The tripod and winch were utilized to remove the equipment package from the maintenance hole. Once the equipment was at the surface, the Isco sampler was opened and the carboy containing stormwater was capped and transferred to an ice-filled cooler. Filter housing stopcocks were opened to allow the retained stormwater to drain back into the maintenance hole. Filter bags were squeezed of excess water, placed in plastic bags, and stored on ice. Totalizer volumes were recorded in the field logbook. The suction line was disconnected from the Isco, capped, and secured in the maintenance hole along with the flow sensor cord.

After the sampling equipment had been recovered from all sampling locations, sample carboys and filters were immediately delivered to ARI on ice. Filtration units and deployment gear were returned to the NewFields warehouse. Isco samplers and batteries were returned to the NewFields office. Batteries were charged in preparation for the next sampling event, and both flow and conductivity data were downloaded from the Isco units. The precipitation record for the sampling event was obtained using the Seattle Boeing Field (KBFI) rain gauge data available at: http://www.wrh.noaa.gov/mesowest/getobext.php?wfo=sew&sid=KBFI&num=48&raw=0&dbn=m.

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Appendix C
Challenges of Stormwater Sampling

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Challenges of Stormwater Sampling

The purpose of this appendix is to document many of the challenges incurred during the execution of the LDW Stormwater Lateral Loading Study and Accelerated Source Tracing Study. Specifics regarding the difficulties associated with weather predictions, site conditions, and sampling equipment are included in this discussion. Because the same challenges will likely be confronted during future LDW stormwater sampling efforts, the lessons learned from this study can be used to help increase the efficiency and sampling efficacy of future stormwater sampling projects.

Rainfall Prediction

The decision to initiate storm event sampling was based largely on quantitative precipitation forecasts for the south Seattle region available from NOAA. These forecasts are frequently updated with the percent chance of precipitation, precipitation quantity estimates, and the timing of predicted rainfall. A storm event was generally selected for sampling when an uninterrupted interval of precipitation totaling greater than 0.2 inch was predicted in the 24-hour forecast. The storm event also had to meet tidal requirements (see Section 2.0).

Unfortunately, predicted storm events often did not materialize as they were forecasted. Storm activity often shifted several hours, generally occurring later than was predicted in the previous 24 hours. On numerous occasions, sampling equipment was installed and programmed to sample during the tidal window, but the late onset of precipitation caused the collected samples to consist mainly of base flow. Instances also occurred when storm activity shifted so far beyond the tidal window that sampling was cancelled mid-way through the equipment installation process. To minimize such occurrences, adjustments of sample start/stop times were made in the field to account for the current, rather than predicted, weather conditions. This was accomplished in the field by using cell phones to view real-time Doppler radar images in order to track the movement of specific storm pulses.

Tidal Constraints

Stormwater outfalls that empty into the LDW are often submerged at high tide stages, allowing river water to flow up into the storm drain lines. Figure C-1 identifies the extent of tidal intrusion into stormwater lines in the LDW basin at mean higher high water (MHHW). MHHW for the LDW is +11 feet MLLW. Lateral lines and private storm drain lines are not included on this figure. Large areas where no structures are displayed in Figure C-1 generally indicate regions drained by private storm drain lines, regions that drain to combined sewers, or areas where public storm drain lines have no available elevation data associated with them.

Figure C-1, in conjunction with observations made during field reconnaissance, suggests the following:

- Public storm drain lines west of the LDW experience tidal intrusion to the base of the Highland Park hill.

- Most private and public storm drain lines east of the LDW experience some tidal intrusion.
- Certain storm drain lines east of the LDW, such as the Duwamish/Diagonal CSO/SD and the I-5 storm drain to Slip 4, experience tidal intrusion all the way to I-5.

Stormwater sampling of a tidally influenced storm drain greatly constrains the storm event sampling window to prevent stormwater contamination by tidal water. The elevations of sampling locations for the *Stormwater Lateral Loading Study* ranged from +5.4 to +9.1 feet MLLW (Table A-2). Tides played a substantial role in determining whether a predicted storm event was selected for sampling since simultaneous sampling of all locations could only occur below a tidal elevation of +5.4 feet MLLW. This requirement generally restricted sampling to a 6- to 10-hour low-tide window. Such restriction of the sampling window prevented sampling over the entire duration of the storm hydrograph. Figure C-2 displays the tide and precipitation records for a two-week period over the wet season. During this time interval there were periods when tides were too high to allow sampling, acceptable tides without precipitation, and both successful and unsuccessful storm sampling events.

Not only did tides constrain the window over which samples could be collected, but they also constrained the window within which subsurface sampling equipment could be installed. Depending upon the sampling location, as much as 6 feet of tidal water could be present within the maintenance hole at high tide. While the sampling equipment was designed to be water-resistant, the digital timer, totalizers, batteries, and Isco units could not be submerged. Therefore, the long-term deployment of the sampling equipment would have resulted in severe damage. This restriction required recovery of sampling equipment before the onset of the highest tides.

Calculation of lateral loading requires an estimate of stormwater volume. This volume can be derived through measured flows, modeling, or a combination of the two. In the case of estimating loading from an intertidal outfall, tidal exchanges influence both water velocity and depth measured by in-line flow sensors. Unfortunately, the resulting flow data cannot easily be corrected for tidal influence. Tidal water in the storm drain lines regularly increased water depth in the maintenance hole by many feet and slowed drain line velocity to near zero. Also, the Isco unit required to record these data could not remain deployed long-term at the sampling location without risking damage to the unit at high tides. Therefore, contaminant mass loading calculations for intertidal outfalls must rely heavily on predicted stormwater flows derived through watershed modeling.

Mobilization Time

Simultaneous storm event sampling at multiple locations required significant time immediately prior to the storm to prepare and install stormwater sampling equipment. After a predicted storm event that meets precipitation and tidal requirements was identified, the following mobilization tasks had to be completed before the onset of the storm:

- Rent box truck,
- Acquire decontaminated carboys and weighed filter bags from ARI,
- Install carboys in Isco units and filter bags in filtration units,

- Program Isco and filtration unit timers based on precipitation prediction and tidal elevation,
- Transport Isco units, batteries, filtration units, stormwater pumps, deployment tools, and safety equipment to sampling locations, and
- Deploy subsurface sampling equipment at sampling locations.

These tasks generally required a minimum of 8 hours to complete prior to sampling. Because of this extensive preparation time, mobilization activities usually were begun the day before a sampling event. On occasion, this investment of time and effort was lost when mobilization activities were begun the day before an event, and then sampling was cancelled the next day due to a change in the precipitation prediction.

Site Access

One of the criteria used to choose specific storm drain access locations for sampling was their ease of access. Despite this, activities by other parties involved in storm drain maintenance, subsurface utility work, and surface asphalt repairs occasionally restricted the ability to sample a particular location. In one instance (1/4/2011) a sampling event was cancelled because Seattle Public Utilities was in the process of jet cleaning the Snoqualmie storm drain line when the field crew arrived on site. It is likely that this jet cleaning disrupted the bedload sediment trap deployed at location SQ3. On another date, sampling equipment could not be deployed at a sampling location (DK1) because Seattle Public Utilities was performing a video survey of the drain line. During the entire month of April, access to locations DK3 and DK4 was impeded during daylight hours due to sewer work and road repair along S Dakota Street.

Subsurface Sampler Placement

All sampling equipment for this study was deployed subsurface within storm drain maintenance holes in order to provide security for the equipment and prevent obstructions in roadways. Although all sampling location maintenance holes had diameters of 24 inches, subsurface ladders and ledges restricted the maximum horizontal dimension of sampling equipment to 17 inches. This dimension limited the volume of whole water and filtered solids that could be collected by restricting the size of the samplers that could be deployed. The Isco 6712c, with a maximum carboy size of 2.5 gallons, was the largest whole water sampler that would fit in all locations. The solids filtration units were designed with a maximum horizontal dimension of 16 inches, the minimum dimension required to fit two parallel filter housings.

Once sampling equipment was fully deployed within the maintenance hole, it remained in place until after the conclusion of a sampling event. The equipment took up so much space within the maintenance hole that it was difficult to do any troubleshooting after deployment. Occasionally a critical error would occur during sampler deployment (e.g., suction hose dislodging) that would not be recognized until sampler recovery. Also, modifying the sampling time program (adjust Isco and filtration unit timers) to account for changing weather predictions could not easily be done without complete removal of the sampling equipment from the maintenance hole.

DC Power

Two 12-volt DC batteries were required to power the Isco sampler, flow sensor, conductivity sensor, filtration unit timer, and bilge pump. This was sufficient power to run all components concurrently for a minimum of 12 hours. Back-to-back sampling of two storm events within a day of each other was not possible because the batteries required a full day to recharge after an event.

The use of DC power limited the design and capacity of the stormwater pumps that could be used for the filtration unit. The pumps used had a maximum capacity of 2,000 gallons per hour when operating with no resistance. However, back-pressure created by the filter bags and hydraulic head caused by the position of the pump below the filtration housings dramatically reduced the pump capacity. In order to minimize resistance, filtration housings were lowered as close to the bottom of the maintenance hole as possible to minimize the amount of hydraulic head that the filtration pumps would have to overcome.

Deterioration of Subsurface Equipment

Harsh conditions within the maintenance holes deteriorated much of the sampling equipment over the course of the sampling season. The flow sensors and suction lines were the only equipment that remained installed in the maintenance holes throughout the duration of the sampling season. Suction line inlets, located along the bottom of the storm drain lines, at locations KC2062 and PS2220 intermittently became clogged with solids. An air compressor was used to clear the line at KC2062, but solids from the PS2220 line could not be dislodged. The suction line installed at PS2220 was abandoned, and instead a new suction line was deployed attached to the filtration unit pump during every sampled event.

Although the sampling equipment was only deployed within the maintenance holes during sampling events, this was sufficient exposure to damage some of their components. While hanging in the maintenance holes, the sampling units were subjected to surface runoff pouring into the holes through the access hole and partial submergence by tidal water. These wet, dirty conditions caused a deterioration of numerous electrical fittings and fuses. All electrical connections needed to be tested prior to deployment to ensure they were working properly. In one instance, filtered solids samples were not collected during sampler deployment due to a blown fuse.

Transport, deployment, and recovery of sampling equipment also contributed to sampler wear. The tight fit of the filtration units within the maintenance holes occasionally caused sampler hoses to snag on ladders within the vaults, causing loosened connections or cracks in the hose. The glass carboys contained within the Isco samplers were subjected to substantial jostling during deployment and recovery. Three carboys broke subsequent to sample collection over the course of the sampling season, likely due in part to hairline fractures created in the glass after repeated use.

High Velocity Locations

Over the course of the sampling season it became evident that water velocity and depth could not be accurately measured at locations DK1 and DK2 using the Isco flow sensor. Stormwater velocity at these two locations was greater than at other sampled locations due to the steep gradient of the drain lines. Stormwater velocity and depth data were not obtained from either location because of sensor malfunctions that may have been caused by the turbulence of the stormwater flow. In the case of location DK1, the velocity during heavy rain events was intense enough to shear the bolts securing the flow sensor to the mounting ring, causing significant damage to the sensor. At location DK2, the high velocity and steep gradient caused flowing water to spray throughout the vault as it passed over the flow sensor, preventing the sensor from collecting accurate measurements.

The high velocity flow at DK2 prevented the collection of filtered solids using the same filtration unit design deployed at other locations. Even with 20 pounds of weight secured to the pump cage, the storm flow at DK2 caused the pump to hydroplane. The pump design was reconfigured for this location to create a stilling well, increasing the water depth and decreasing turbulence. The pump was fastened inside of a 5-gallon bucket that had holes drilled through its lower half. A confined space entry crew was utilized to install an anchoring point (eye bolt) to the center of the storm drain pipe directly below the maintenance hole. During pump deployment for a sampling event, the base of the stilling well was secured to the anchor using a rope. This anchored stilling well allowed a sufficient amount of water to continually collect to keep the pump operating.

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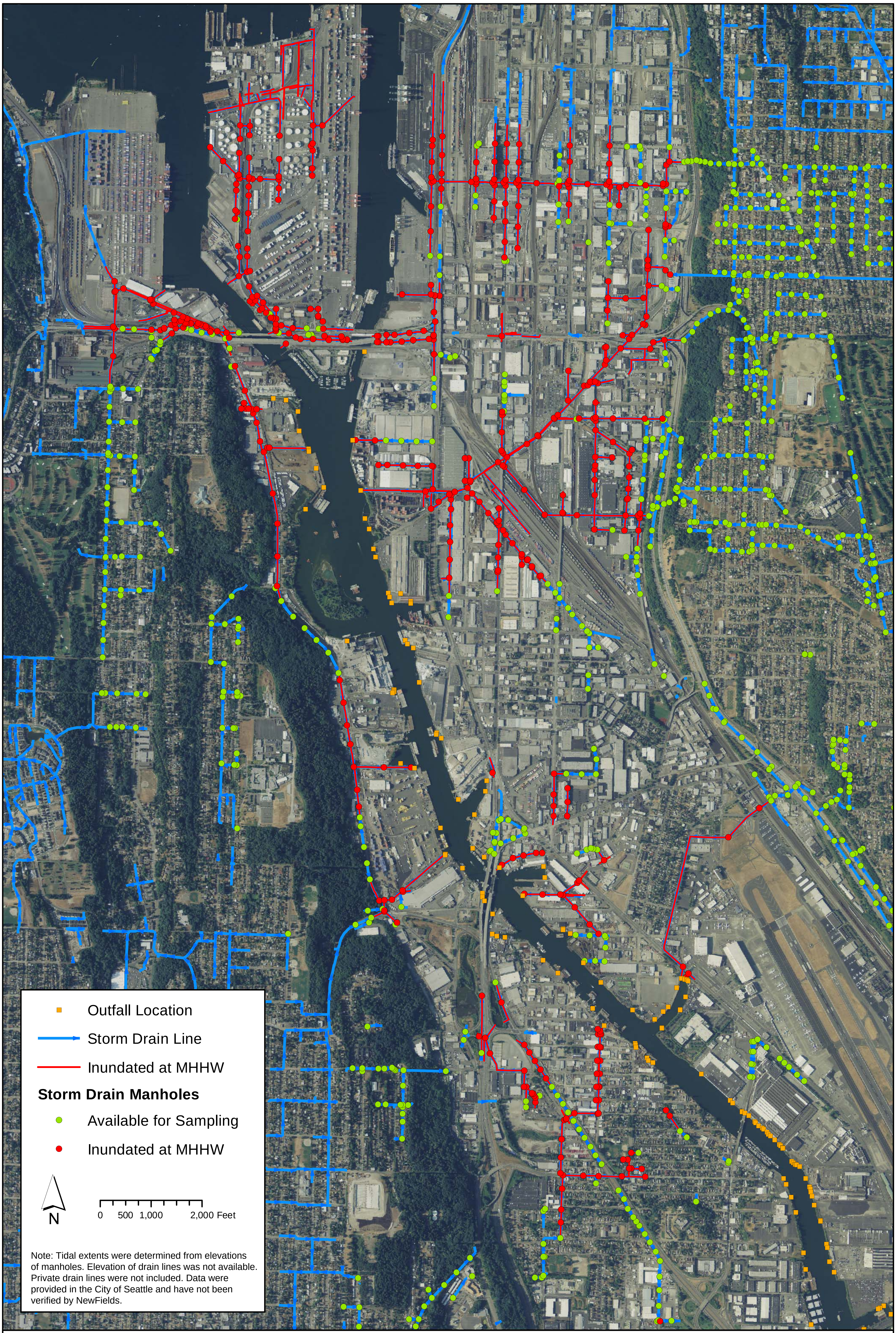

Figure C–1. Extent of Storm Drain Tidal Water Inundation

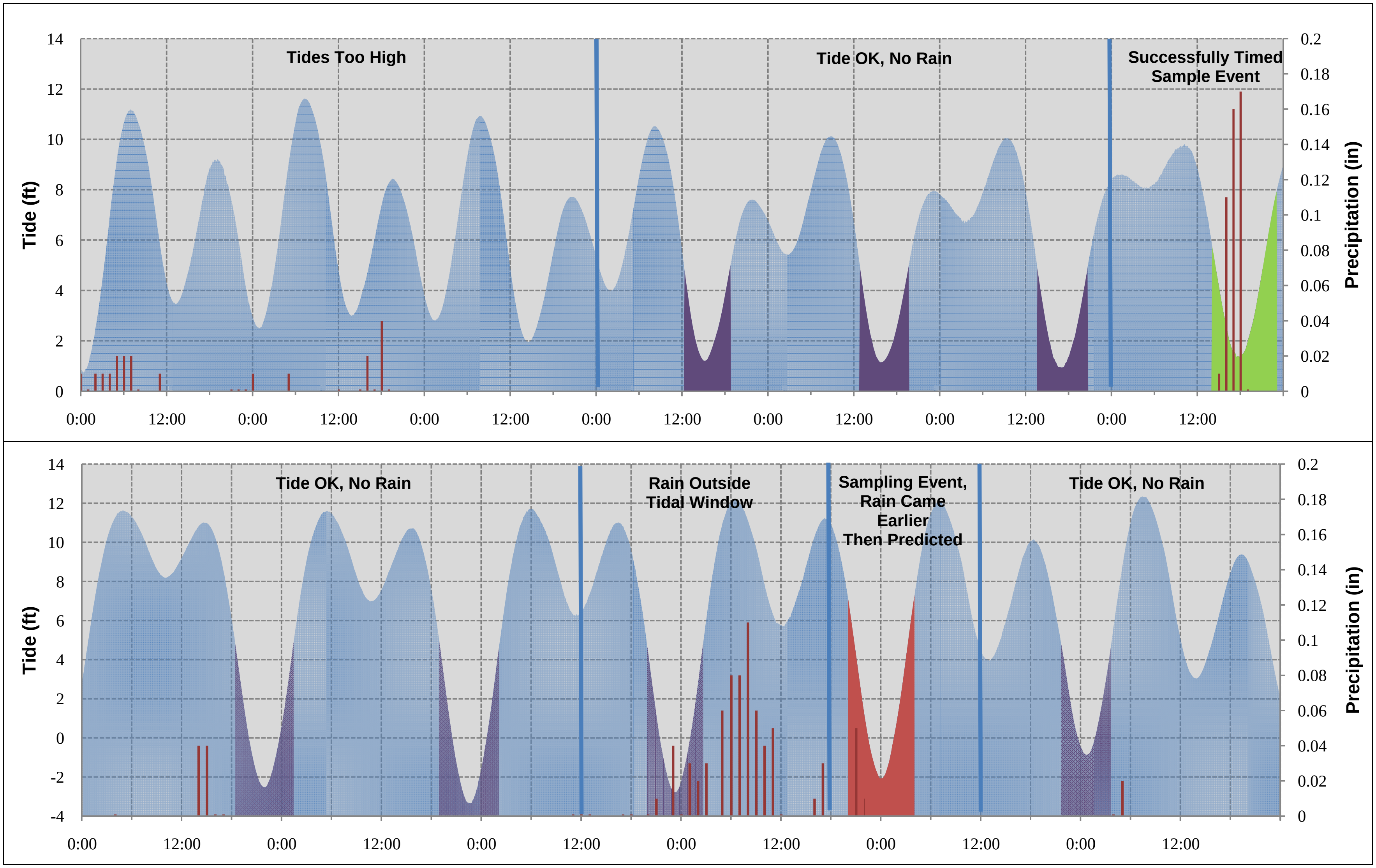

Figure C–2. Sampling Restriction Caused by Tides and Precipitation

Appendix D
Field Logs

11/4/10 low tide 4'3" @ 9:54
8th St. Station

ClearCreek installations

Dakota Street (660 S. Dakota St)

☆ 9am tidal influence abates
~10 am tidal influence

- 2 nalgene sed traps
- 1 sed trap box
- Flow sensor and intake line

- 2 eye bolts (pump cage + filter frame)

1

"Rite in the Rain"

11/4/2010 10:15am

3925 9th ave S (End of Dakota)

Photo on iPhone of parking/cones
- Flashing truck lights. 4 4.5' Narrow cones

- 2 sed traps + bottles in

- Flow sensor + inlet tubing + tie strap

- eye bolt for pump.

large drop before vault, room for vertical harness,

2

"Rite in the Rain"

12:30 4601 6th ave S.

* photo of traffic diversion setup

- Flow sensor and intake hose + Steel strap
  (2x#4; 2x#2; 1x#1 60")
- 2 sediment traps
- 1 ecology sed trap
- no eyebolts installed, tie from rung

* Caps removed from sed traps

finished @ 13:45

We'll have to suspend pump about
1.5 feet above vault floor. Pumpstand? 3

Rite in the Rain

13:55 Snoqualmie + airport way

- no tidal influence yet
- 2 sed traps
- Flow sensor and intake
  (2x#1) 24"
- no eyebolts

* Caps removed from sed traps

leave @ 14:55

4

Rite in the Rain

15:05 4535 10th ave S 98144
(Decatur + 10th)

- Residential neighborhood, no traffic

- 2 sed traps installed
- Flow sensor + intake
  ↳ (2 #2 · 30")

- 1 eyebolt installed near inflow side

5

Rite in the Rain

Field notes Nov 12 2010

Bad sensor readings

- End of Dakota
- Snoqualmie and 6th

☆ Site name for Snoq + Airport must be programmed on the ISCO

6

Rite in the Rain

1/11/11

ISCO Programming Parameters

Site	Pipe (inches)	Time
NF2095	36"	5pm - 10pm
KC 2062	48"	5pm - 10pm
PS 2220	30"	3pm - 8pm
BDC 2088	(?) 24"	6pm - 10pm

- 1L every hour
- Set minimum level as low as possible

7

Rite in the Rain

1/12/2011 Lateral Loading

Deployment of gear for sampling

9:30 Arrive @ storage unit to prep gear

10:45 Install gear @ Port

2:00 meet up with Clearcreek
to ~~1st~~ install flow sensor at
BDC 2088. 36" diameter

4:00 Sampler installed at BDC

4:15 Install gear at KC 2062
ISCO left outside of manhole
Large amount of baseflow

5:30 Install gear @ NF2095

8:00 Rain starts in Seattle

8

Rite in the Rain

1/13/01 Lateral Load Recovery

7:30 Check inventory
Go to storage to get
Ziplocks and carboy lids.

8:30 Arrive @ BDC 2088
Carboy is half full, program
ended before filling due to
delayed rain.
No Solids filtration due to
late rain.

Line is underwater @ ~ 8 ft.

9:30 Done @ BDC 2088
Water Sample was the only collected

9:35 Arrive @ NF 2095

[signature] 9

Rite in the Rain

10:00 NF 2095 No water
Issue with time program
Totalizers: 740
773
Filter bags have some sediment
but not much
LDW/LL-NF2095A-011211-S
LDW/LL-NF2095B-011211-S

10:33 Done at KC 2062
Water and Sediment collected
Carboy over filled, but water
sample was fine.
ISCO Purge program will need
to be adjusted.
This line is inundated with
tidal water at ~ 8 ft
Totalizers A = 375 B = 346
11:30 Done @ PS 2220
Water sample collected

[signature] 10

Rite in the Rain

1/13/11

PS2220 No sediment sample collected. There is a ledge underneath the ladder. The filter housing needs to be slid into place with the tether line. The pump will only sit along the bottom if this tether is used to move it into place.

11:45 On way to warehouse to offload gear. Samples will be delivered to lab. Batteries and tools will be returned to Edmonds office.

11

Rite in the Rain

- Dakota 9th modification 1-19-2011
- Replace AST Sed traps

1600: Arrive @ Dakota & 9th
low enough flow to install eyebolt in center of vault. Intake line reinforced w/ hose clamps and wire. Presence of steel ring and sensor causes flow to kick up significantly. Collected sed trap bottles w/ good amt. of sediment. labeled DK2 temporarily

o 1800 Arrive @ Snoqualmie Airport to replace sed traps. Labeled SQ1. Gear is in good shape.

12

Rite in the Rain

0 1835: Arrive @ Snoqualmie + 7th
No issue w/ standing water.
Pulled old sed traps, installed
new ones. Labeled bottles SQ2
Gear looks good.

0 1855: Arrive @ Snoqualmie + 6th
Some standing water in vault to
level of pipe, Possibly more
sediment in vault compared to recon.
Replace bottles, labeled old ones
SQ3. Gear looks good. Sed trap OK.

0 1910 Arrive @ Dakota + 7th, no tidal
effects. Replacing bottles w/ new
ones. Samples labeled DK3
Steel sed trap was turned 180°;
Clearcreek faced it correctly.

13

Rite in the Rain

0 1925 Arrive @ Dakota + 6th
Replace Bottles w/ new ones. Samples
labeled DK4. Gear looks good
No tidal effects

0 1940 Arrive @ Snoqualmie + 4th
Replace Bottles w/ new ones
Samples labeled SQ4.
No tidal effects

0 2000: Arrive @ Dakota + 10th
Replace bottles w/ new ones
Samples labeled DK1. One
sed trap came loose, bottle missing
(Just the hinge-bolt came loose).
ONLY one Sample for DK1.

14

Rite in the Rain

o 2210: Arrived @ Norfolk to put ISCO in storm drain w/ Salinity sensor. ~~BDC~~ ISCO is being used to test flow meter/level sensor. ISCO Renamed to NF2095 and installed w/ a top hanging Battery, w/ pump cage hanging from steel ring.

[signature]

15

Rite in the Rain.

1/20/11

Sampling Event #2
Lateral Loading
AST ~~Adr~~ Dakota Line

Filtered Solids Samples

Bag #	Sample Name	Weight
17	LDW/LL PS2220A-012011	62.26
18	PS2220B	64.33
19	BDC2088A	62.05
20	BDC2088B	63.63
21	NF2095A	67.77
22	NF2095B	62.73
23	KC2062A	61.88
24	KC2062B	69.86
25	DK1A	63.23
26	DK1B	61.73
27	DK2A	60.93
28	DK2B	60.63

[signature]

16

Rite in the Rain.

#29	DK3A	65.48
30	DK3B	67.31
31	DK4A	62.33
32	DK4B	63.05

12:54 At warehouse preping gear
No rain yet

Preston
Jon
Will

1309 On way to Install @ Port
Left AST gear in warehouse

1320 Check in w/ Al Zvrawski @
Northland Services

1400 Done installing PS2220
Time program:
8PM - 2 AM

17

"Rite in the Rain"

15:22 Done at Norfolk
NF2095
Time Program: 8PM - 2AM

15:35 Done at BDC
BDC2088
Time Program: 8 PM - 2AM

16:15 Done with install @ KC
KC2062
Water in pipe @ 16:00
tide or puddle?
Time Program: 8 PM - 2AM

1620 On way to warehouse to
get AST gear

18:00 Done with install @ DKZ
Time Program 8PM-4AM

18

"Rite in the Rain"

1900 Done with install @ DK1
Pump filtration housing and ISCO
are hung independently

1915 Reprogram ISCO @ DK2
1930 Dinner break

2030 Set up gear @ DK3
All gear is on surface
We can see this site from DK4
No program set, will trigger
manually

2200 Setup gear @ DK4
ISCO on surface, Filtration
suspended from hanger

2300 Still waiting for rain

2330 Abort! No rain. Tide is rising
Samples collected to this point is baseflow

"Rite in the Rain" 19

1/21/11 Sampler Recovery

830 Preston, Jasper, Jon meet
at warehouse

930 Gear removed from PS2220
Water sample collected
No solids ~~et~~ collected, flow was
probably too low to trigger float

LDW/LL-PS2220-012011-W

1010 Gear removed from BDC 2088
No water or sediment samples
Water was probably to low to
trigger pump
Suction hose came lose, so
no water was collected

"Rite in the Rain" 20

~~107~~
1/21/11

10:20 NF2095
Water ~~sam~~ and Sediment
Samples collected.
Filter Solids Totalizers
A = 958 g
B = 860 g

1055 Removed gear from KC2062
Sediment Sample Collected
No Water Collected
Not enough rain to be
above baseflow trigger

Lateral Load Summary

PS2220	X	Water
BDC 2088	X	X
NF2095	Sed	Water
KC2062	Sed	X

21

"Rite in the Rain"

1/21/11

11:30 Removed gear from DK2
Half a water sample
No sediment - this setup
will not work. One of
the totalizers registerd 8000g
to other zero. Must have
something to due with air
pressure.

12:45 Gear removed from DK1
Sediment sampled, but no water
May be due to program or
baseflow setting or Air
in Line
Totalizer Readings
A = 186
B = 27
Not much water filtered

22

"Rite in the Rain"

1/21/11

1250 Heading to warehouse to drop off gear

AST Summary

DK1	Sed	X
DK2	X	Water
DK3	X	X
DK4	X	X

"Rite in the Rain"

23

1/26/11 Baseflow Sampling

Filter Bags

Lab #	ID	Weight (g)
33	LDW/LL-NF2095A-012611-S	59.15
34	NF2095B	64.79
35	KC2062A	63.75
36	KC2062B	63.31
37	PS2220A	61.18
38	PS2220B	60.79
39	LDW/AST-DK1A-012611	62.38
40	DK1B	67.27
41	DK2A	61.45
42	DK2B	63.27
43	DK3A	70.54
44	DK3B	63.92
45	DK4A	62.30
46	DK4B	67.71

"Rite in the Rain"

24

7:00 Jon picks up deconned carboys from ARI

8:00 Jon, Preston and Jasper meet at warehouse to load gear

10:00 Done @ NF2095
Water sample collected immediately
Solids sampler left in manhole
Time Program 10 AM - 5 PM

10:33 Done with install @ KC2062
Water and solids samplers set for low tide window
Time Program 2 PM - 8 PM

11:24 Done with install @ DK1
Water sample collected immediately
Solids sampler left in manhole
Time Program 11:20 AM - 11 PM

25

"Rite in the Rain"

1310 Done with install @ DK2
Water sample collected immediately
Sandbag set at downstream end of vault. Pump set in puddle upstream of sandbag
Time Program 1:00 PM - 12 PM

1410 Back at warehouse to load gear for DK3 and DK4

1450 Arrive @ DK4 and attempt water sample
No Baseflow

1530 Begin Sampling at DK3
Water collected immediately

1736 Stop filtration units at DK3

[signature]

26

"Rite in the Rain"

1/27/11 Baseflow Sample Pick-up

10:00 Meet at warehouse
Leon
Alisa - SAIC
Preston
Jon

1050 Done at NF2095
Solids samples collected

1106 No water collected at KC2062
~~probably the rain~~
The program was set for a 1 foot trigger. We will come back later in the day to collect water.

1151 No solids collected at DK2
Water not deep enough.
Won't ever be able to get solids here

"Rite in the Rain" 27

1218 Solids collected at DK1
Sandbag worked well

1320 Water sample collected at KC2062
Filtration setup removed

1451 Offload gear at warehouse
remove all samples from ISCOs and filter housings

1500 Take samples to lab

Totalizer Log

DK1	A = 2516	B = 2837
DK3	A = 429	B = 293
NF2095	A = 1850	B = 1485
KC2062	A = 107	B = 102

"Rite in the Rain" 28

2/2/11 Base flow Sampling
Snoqualmie line

Filter Bags

#	Sample	Weight (g)
47	SQ1A-020211	62.81
48	SQ1B-020211	66.19
49	SQ2A-020211	66.91
50	SQ2B-020211	69.60
51	SQ3A-020211	61.74
52	SQ3B-020211	61.60
53	SQ4A-020211	65.83
54	SQ4B-020211	59.43

8:00 Jen, Jasper, and Preston meet at warehouse to load gear

9:24 Water sample collected at SQ3 Filtration Unit left pumping

29

"Rite in the Rain"

10:00 Water sample collected at SQ2. Filter unit left pumping. 1 sand bag

10:05 Dead battery in truck! Jumped using our battery and cables

10:50 Water sample collected at SQ1 Filter unit left pumping 2 sandbags placed

11:20 Water sample collected at SQ4 Very little baseflow, too little for filtered solids sampling.

1355 Collect Filtered Solids @ SQ3
Platizers A = 1242 g
B = 1430 g

30

"Rite in the Rain"

14:05 Pull filtered solids at SQ2
Totalizers:
A = 1389 g
B = 1315 g

14:20 Pull filtered solids at SQ1
Totalizers:
A: 1193 g
B = 920 g

1425 Heading to warehouse to offload gear.

1505 Done offloading. Deliver Samples to ARI.

31

"Rite in the Rain"

2/4/11 Lateral Loading Sampling

Filter Bags

#	Location	Weight (g)
53	NF2095A	65.83
54	NF 2095B	59.43
55	KC 2062A	67.18
56	KC 2062B	64.21
57	BDC 2088A	61.80
58	BDC 2088B	66.05
59	PS 2220A	63.39
60	PS 2220B	61.45

7:30 Meet at warehouse to load gear for LL locations Jasper, Jon, Jason Little
Samplers set from Sat. 9PM - 3AM
This is the tidal window for all locations.

32

"Rite in the Rain"

9:00 Gear installed at NF2085
Lots of baseflow.
Time program set Sat 9PM-3AM

9:34 Gear installed at KC2062
Lots of baseflow
Time program set Sat 9PM-3AM

10:17 Gear installed at BDC2088
No flow. Tide out
Time program set Sat 9PM-3AM

11:00 Gear installed at PS2220
Low flow, pretty clean compared to previous visits. Catch basin sediment sock at bottom of vault. Excavation taking place all around manhole. Tide out.
Time Program set 9PM-3AM

33

"Rite in the Rain"

2/7/11 LL Sample Recovery

920 Meet at warehouse to load gear.
Crew: Jasper, Jon, Jason Little

There was far less rain than initial predicted during the 9PM to 3AM window.

Today is dry and overcast. Rain was predicted for today too.

940 Talked with Al Zurawski at Port. He said that the area around PS2220 is having an overflow tank installed underground. The area should be repaved by the end of the month.

34

"Rite in the Rain"

10:08 Done removing gear at PS2220
Both water and solids collected.
Water level in the carboy is
low, indicating water level in
the drain line was low for
most of the sampling interval.

10:32 Done removing gear at KC2062
Water and solids collected.
Totalizers registered low volumes.
Either the filters clogged
quickly or there is an issue
with the pump.

10:55 Done removing gear at BDC 2088
Only water collected. No solids
filtered, probably due to low
water level.

35

"Rite in the Rain"

1110 Done removing gear from NF2095
Water and solids collected
Vault smells like poo.
Heading back to warehouse
to offload gear and process
samples.

11:56 Totalizer Volumes

PS2220 A	919 gallons
PS2220 B	1162
NF2095 A	1288
NF2095 B	1449
KC2062A	77.4
KC2062B	68.9
BDC 2088 A	0
BDC 2088 B	0

12:00 Take samples to ARI

36

"Rite in the Rain"

2/11/11 LL/AST Sampling Deployment

7:00 Meet at warehouse to load gear. Preston went to lab to get carboys.

Jon, Jasper, Preston, Jason Little

8:15 10ft tide * Bridged float switch
installed the Port ISCO & solids units,
set timers to sample
Sat (12th) 1500 – 22:00

9:10 installed @ Norfolk
set timers to sample
14:00 – 23:00 Sat (12th)

9:35 Installed @ BDC
Bridged float switch
14:00 - 23:00 Sat (12th)

37

"Rite in the Rain"

10:00 Install @ KC
Bridged float switch
14:00 – 23:00 Sat 12th

11:20 Install @ SQ3
set timers for 14-23:00
Sat 12th

12:15 Install SQ1
set timers 14:00 - 23:00
Sat 12th

2/14/11
Crew: Jasper B. Preston M.
Jon N.

10:03 recovered @ the Port
- ISCO only sampled
~1 Liter of water
* ISCO line appears to be
clogged → trouble pumping
water both forward & back

38

10:30 Recover @ Norfolk
- Full recovery on ISCO
- minimal volume on filtered solids unit
- pump tested out fine so likely clogged filter bags

10:50 Recovered @ BDC
- Full ISCO

11:10 - Recovered @ King County Airport
- Full ISCO

11:45 - Recovered @ SQ1
- Full ISCO
- Filtered Solids collected

12:00 Recovered @ SQ2
NO ISCO * kinked hose
Filter Solids collected

39

"Rite in the Rain"

12:17 Recovered @ SQ3
- Full ISCO
- Filter Solids collected

12:40 Recovered @ SQ4
- Full ISCO
- Filtered Solids Collected

1326 Totalizer Log

Location	Volume (g)
PS2220A	103
PS2220B	140
NF2095A	26
NF2095B	63
BDC2088A	80
BDC2088B	72
KC2062A	89
KC2062B	63

40

Totalizer Log Cont.

Location	Volume (g)
SQ1A	557
SQ1B	454
SQ2A	83
SQ2B	93
SQ3A	522
SQ3B	464
SQ4A	223
SQ4B	289

1345: Deliver Samples to Lab

Rite in the Rain

41

3/1/11 Sampler Deployment

11:30 Leave Edmonds for warehouse

Jon, Preston, Jasper

12:00 Prep gear at warehouse
Install all filter bags and carboys

13:15 Check in with Al at Port

14:00 Tried to clear line at Port
using air compressor, but this
didn't work too well.
Set 7PM-12

1440 Gear installed at NF2095
Set 7PM-12

1525 Gear installed at BDC2088
Set 7PM-12

42

3/1/11

★ NF 2095 and KC 2062 filter bags have been swithed

Bag	Sample	Weight (g)
★ 77	KC2062A	59.71
78	KC2062B	66.06
79	NF 2095A	64.50
80	NF 2095B	64.08

1615 Gear installed at KC2062
Suction line was plugged. Used air compressor to clear line. Error message on Isco suggests changing pump line tubing.
Set 7PM - 12

1630 Load DK gear at warehouse

[signature]

Rite in the Rain

43

3/1/11

17:55 Gear installed at DK2
Water sample collected immediately. New filtration unit seems to be working
Set 6PM - 12

1900 Gear deployed at DK1
Set 7pm - 12

Waiting for it to rain before sampling at ~~DK2~~ DK3 and DK4

2130 No rain yet. Radar shows no incoming rain.

Sampling abandoned for the evening

[signature]

44

3/2/11 Sample Recovery

900 Meet at warehouse to unload gear from last night.

945 Gear removed from PS2220 Filtered solids collected, but no water. The suction line is still clogged. For the next event a new, weighted suction line should be ~~brou~~ brought out and deployed from surface.

1015 Gear removed from NF2095 Both filtered solids and water collected.

1030 Gear removed from BDC2088 Both solids and water collected

[signature]

Rite in the Rain 45

3/2/11

1045 Gear removed from KC2062 Solids and water collected

1115 Gear removed from DK2 Solids collected. Water collected yesterday

1140 Gear removed from DK1 Water collected ~~by~~ but no solids. Fuse on filter unit blew.

1150 Unload gear at warehouse Prep samples for lab

[signature]

46

3/2/11

Totalize Volumes

NF2095A	1435
NF2095B	1011
KC2062A	248
KC2062B	255
PS2220A	1697
PS2220B	1677
BDC2088A	121
BDC2088B	115
DK2 A	883
DK2 B	4205

"Rite in the Rain" 47

3/4/11 Sampling LL and SQ lines - Will, Preston, Jasper

8:00 met at storage facility

9:45 installed samplers at Port. set timers for 7PM FRI to 3AM SAT

installed new ISCO suction line ~15ft

10:00 Installed Norfolk 7PM FRI – 3A SAT

10:40 Installed BDC 7PM Fri – 3A SAT

1105 Installed KC 7PM Fri – 3A SAT

[signature]

49

1320 Installed SQ4
Timers set 7P Fri – 3A Sat

1345
~~1400~~ Installed SQ3
Timers set 7P Fri – 3A Sat

1415 Installed SQ2
Timers set 7P Fri – 3A Sat

- drains at both SQ3 and SQ2 contain a white material, possibly plastic? with coarse particle size

1430 Installed SQ1
Timers 7P Fri – 3A set

Back to warehouse.

[signature]

Rite in the Rain

49

3/7/11 Will, Jasper, Preston
left office

1000 Port
totalizer
A 272
B 257.7
Isco collected sample

1030 Norfolk
A 1555.26
B 1587.0
Isco collected sample

1045 BDC
A 43.1
B 82.2
Isco collected sample

[signature]

50

1105 KC
Totalizer
A 740.6
B 395
Isco collected sample

1145 SQ4
A 1619.6
B 820.8
Isco collected sample

1240 SQ3
A 1041.1
B 62.1
Isco sample collected

1300 SQ2
A 28.9
B 32.3
Isco sample collected

Rite in the Rain 51

1315 SQ1,
no filtered solids,
Isco sample collected

1330 To Cosco to pick up
sec-trap caps left by Beth

1515 samples to lab

5/10/11 Crew: J. Baas, J. Nunes,
L. Delwiche, R. Martin

8:00 meet @ warehouse load
bags & carboys

9:40 Deploy @ Port
Timers set 12-5pm (10th)

10:15 Deploy @ Norfolk
timers set 12-5pm (10th)

52

10:30 Abort Sampling
Rain isn't developing as predicted
→ pulling all deployed units

10:50 Recovered @ Norfolk
11:20 Recoverd @ Port

"Rite in the Rain" 53

3/15/11 Stormwater Sampling

8:00 Meet at warehouse to load gear and prep units
Jon, Jasper, Preston, Jason Little

9:27 Gear installed at PS2220
Set: 5 PM - 11:30 PM
10:00 Gear installed at NF 2095
Set 5 PM - 11:30 PM

10:25 Gear installed at BDC 2088
Set 5 PM - 11:30 PM

10:50 Gear installed at KC2062
Set 5PM - 11:30 PM

11:00 Return to warehouse to get AST SQ gear.

54

12:15 Gear installed at SQ3
Set 5PM - 11:30 PM

12:35 Gear installed at SQ2
Set. 5PM - 11:30 PM

13:15 Gear installed at SQ1
set 5 PM - 11:30 PM

13:45 Gear installed at SQ4
Set 5 PM - 11:30 PM

Heading back to warehouse
to drop off gear

Rite in the Rain 55

Stormwater Sampling 3/16/11
gear recovery
Preston, Jasper, Leon, Jason (SAIC)

8:00 Meet up at Stormore

8:30 Gear recovery @ Port
good water sample
good filtered solids sample
totalizer A: 657.9
B: 641.6

9:05 Recovery @ Norfolk
~~good water sample~~ broken carboy
good filtered solids sample
totalizer A 1708.9
B: 1373.2

9:20 Recovery @ BDC
good water, good solids
Totalizer A: 293.5 B: 201.0

56

3/16/11

9:40 Recovery @ KC
good water sample; good solids
Totalizer A: 211.7 B: 230.5

10:15 Recovery @ SQ3
good water; solids ok (stopcock on B partially open)
Totalizer A: 702.1 B: 112.56

10:30 Recovery @ SQ2
good water, good solids
Totalizer A: 71.9 B: 32.2

10:42 Recovery @ SQ1
good water; solids OK (totalizer B malfunct)
Totalizer A: 497.7 B: 0.64
→ ISCO Hanger dropped down!!

11:05 Recovery @ SQ4
good water; good solids
Totalizer A 2460.0 B: 2.7
→ Pix connector partly submerged!!

Dennis P Martin

57

11:15: Back to the warehouse

Pulling filters and filling out COC's

1:15 Lunch

1:50 Drop off samples @ ARI
A Bags, B bags, water

Notes: check totalizers on
SQ4 (B)
SQ1 (B)
– Readings were way too low
edit: SQ1 (B) sediment bag was also much clearer than SQ1 (A)

Dennis P Martin

58

3/23/11 P. Martin, J. Boas

13:20 on site @ Port

14:10 - attempted scraping the storm line → no scrapable material in the line

Tide: Off.

14:24

JB ~~16:24~~ on site @ Norfolk

~~16:35~~ 14:35 no scrapable material @ a negative tide

14:40 on site @ BDC
- no material @ original sampling site

14:55
- cross the road (east)
- manhole upstream
- really stagnant water might have scrapables

15:00 on site @ KC
- able to scrape 32oz of seds

"Rite in the Rain" 59

1/4/11 AST Sampling Event
Snoqualmie Line

7:10 Arrive @ storage unit to prep samplers

Filter Bags Samples

SQ1	NBF/AST-SQ1A-010411-S
	-SQ1B-
SQ2	-SQ2A-
	-SQ2B-
SQ3	-SQ3A-
	-SQ3B
SQ4	-SQ4A-
	-SQ4B-

Whole Water Samples

SQ1	NBF/AST-SQ1-010411-W
SQ2	-SQ2-
SQ3	-SQ3-
SQ4	-SQ4-

60

Scale: 1 square = ______

10:40am Crew: J. Baus, L. Delwiche
SAIC Michael, Jason

11:25 Deployed @ SQ3
Timers set for
1800 → 23:59

11:45 Deployed @ SQ2
Timers set for
1800 → 23:59

12:13 Deployed @ SQ1
Timers set for
18:00 → 23:59

12:45 Deployed @ SQ4
Timers set for
1800 → 23:59

16:15 Deployed @ DK1
Sand bag diffuser below
sed. traps - reset sand bag
flow sensor detached from
pipe ring
time set 18:00 - 23:59

Scale: 1 square = ______

61

17:15 Deployed @ DK2
Timers set for
1800 → 23:59

09:50 Recover DK1
no water in filter solids
some in canyon - suction
hose kinked flow sensor detached
from pipe ring

10:45 Recover @ DK2
- Total A = 128.27
- Total B = 9127.21
- Nothing in ISCO

10:30 Recover @ SQ3
- Total A: 1432
- Total B: 1331
- ISCO 4/5 Full → returned to manhole

10:45 Recover @ SQ2
Total A: 145
Total B: 163
ISCO = Returned to manhole

Scale: 1 square = ______

62

11:00 Recover @ SQ1
- Totalizers @ zero no water pumped
- ISCO was Full but returned to the man hole
Not enough Rain

11:20 Recover @ SQ4
ISCO empty
→ ISCO Line is kinked need to fix or replace
Total A: 616
Total B: 000

63

Scale: 1 square = ________

4/7/11 8:00 AM @ Warehouse
Crew: J. Boas; P. Martin; W. Hafner
Jason, Mike (SAIC)

9:00 on site @ SQ3 waiting for Clearcreek

10:45 - The Bedload sampler @ SQ3 was turned around backwards
- no sediment collected in the trap consequently
- Also the catch basin has been dredged of all material previously present.

11:00 ~~___~~ ~~___~~
Sampler & ISCO deployed
Timers set for:
1930 → 2300

11:05 on site @ SQ1

11:15 Bedload Sampler de-coned and reinstalled @ SQ1

64

Scale: 1 square = ________

11:15 on site @ DK3
11:35 Recovered Bedload Sampler
@ DK3
- recieved quite a bit
of material from trap
→ Installed solids sampler
set Timers for:
17:00 start

12:20 on site @ DK1
for Bedload Sampler
install

13:30 • reinstalled Bedload Sampler
• removed pipe ring → repaired
the suction line
• uninstalled the flow
sensor
• took the sandbag out
• flow sensor mounting screws
sheared off and damaged
plastic sensor housing

65

Scale: 1 square = ______

15:20 on site @ SQ2
15:55 installed @ SQ2
Solids & ISCO
Timers set
20:00 → 22:30

16:00 on site @ SQ4
installed @ SQ4
set timers for
1930 → 2300

17:25 on site @ DK3
There is no tidal water
present, still net outgoing
water flow
Tide = 4.72ft
* Our elevation values for
this location are incorrect!

17:30 pump on! Tide has
arrived
Tide = 4.96ft

66

Scale: 1 square = ______

18:20 Deployed @ DK4
- Solids sampler began pumping during install

20:35 Stopped DK3 pump

Total A 1423.31
Total B 1236.04

- Flow rate not impeded very much.
- Not much TSS in tidal water

20:45 on site @ DK4
pulled ISCO water

21:00 Solids sampler turned off
Total A = 1025
Total B = 926

67

Scale: 1 square = ____

4/8/11

7:00 At Edmonds loading gear
J. Boas P. Martin

8:32 loaded gear and filter bags @ warehouse

8:45 on site @ Port

9:02 Deployed @ Port
Timers set
Sun (4/10) 13:00 → 20:00

9:15 on site @ Norfolk

9:30 Deployed at Norfolk
Timers set
(4/10) Sun, 13:00 → 20:00

9:35 on site @ BDC
953 deployed @ BDC
Timers set
Sun (4/10) 1300 → 2000

9:55 onsite @ King County Air
Deployed @ KC
1020 Timers set 1300 → 2000 (4/10)

Scale: 1 square = ____

68

10:25 on site @ BDC
to set solids timers
10:35 solids time set
Sun (4/10) 1300 → 2000

10:47 on site @ SQ3 for
recovery
Total A = 676.00
Total B = 761.98
solids & ISCO collected

11:00 on site @ SQ2 for
recovery
Total A = 628.79
Total B = 601.18

solids & ISCO collected

11:17 on site @ SQ4 for
recovery
Total A = 431.99
* Total B = 0

Solids collected
ISCO hose was kinked.
resetting ISCO to pull tidal
water 2230 → 300 Sunday 4/10/11 69

12:00 installed ISCO @
SQ4
headed for the warehouse

4/11/11 Crew: J Boas, J. Nguyen
P. Martin

10:50 Recovery @ Port

Total A = 94
Total B = 0
No water collected ISCO

11:15 Recovery @ Norfolk

Full ISCO - returned to
site not representative of
a storm event

Total A = 200
Total B = 0
11:30 Recovery @ BDL
Full ISCO returned to site

Total A = 0
Total B = 60.6 70

Scale: 1 square = ______

11:47 Recovery @ KC
- Full ISCO returned to site

Total A =
Total B =

12:15 Recovery @ SQ4
Full ISCO
Tidal H_2O

71

Scale: 1 square = ______

1025 Arrive @ SQ3
Install sampler and ISCO
Timers set 1040 – 1615

1045 Arrive @ SQ2
Install sampler + ISCO
timers set 1100 - 1620
☆ Grabbed sample w/ ISCO @ ~1110
Troubleshooting pump connector on pumpside. Inlet plumbing crack.

1135 Arrive @ SQ1
Install Sampler + ISCO
timer 1145 - 1745

1215 Abort event. Too much rain for baseflow, not enough prediction for storm. Nothing on radar...

1220 Lunch

1330 Retrieve gear from SQ1
dump ISCO from SQ1 + SQ2
~3 gal pumped

DM 72

Scale: 1 square = ______

1345 Retrieve gear @ SQ2
dumped carboy ~500gal
through the filters (each)

1405 Retrieve gear @ SQ3
dumped carboy. 000 on the
totalizers

1425 Retrieve gear @ SQ1
dumped carboy

1500 Retrieve gear @ Port
dumped carboy
Totalizer 1 = 263 gal
Totalizer 2 = 0.0

1530 Dump gear @ Storage
left 5 clean carboys as
well as LL & SQ ISCO's
Jason L. took 5 carboys to
ARI for decon.

73

Scale: 1 square =

800 4/21/11 @ Warehouse loading
gear
Crew: J Boas, L Dewicke, J Little

908 on site @ SQ1
Deployed SQ1
Timers set:
930 → 18:30

929 on site @ SQ2
Deployed SQ2
Timers set for
945 - 1830
* Both ISCO & Solids units
began pumping while on site

950 on site @ SQ3
Deployed @ SQ3
Timers set 1000 → 18:30
* Solids unit began pumping
while on site

10:15 on site @ SQ4
Deployed @ SQ4
Timers set 1030 - 1830
* ISCO began pumping while on
site 74

Scale: 1 square =

* no water in the line so
I dont anticipate getting
any samples

11:00 on site @ Port
11:32 Deployed @ Port
- Installed sand bag
- bridged switch

* ISCO began pumping
while onsite
Timers set: 11:30-1715

11:45 on site @ Norfolk
12:10 Deployed @ Norfolk
- Both isco & pump started
while on site
- set to off @ 18:30

12:15 onsite @ BDC
12:35 install @ BDC
Timers set: 1235-1830
! ISCO began as we were onsite
* NO Water in line!

75

Scale: 1 square = _______

1245 on site King County
1305 deployed @ KC
Timers set: 1300-1830
- ISCO began while on site

14:55 on site @ SQ1 to recover
15:05 Recovered SQ1
- Full ISCO
- No filtered solids
→ Not enough water to
pump solids unit

15:08 on site @ SQ2
→ Filtered solids
Total A = 2871.32
Total B = 1475.18

* ISCO Half full → filled
the rest of way on
site manually

1530 on site SQ3

Total A = 1666.14
Total B = 1483.39
- Full ISCO

76

Scale: 1 square = _______

15:50 on site @ SQ4
1605 Recoverd @ SQ4
* Both totalizers read zero!
* Full ISCO recovered

Notes:
- Need to fix 1 pigtail for yellow box
- Fix pump power cord SQ3
- O ring DK3

4/22/11 met @ Subway
800 Crew: J. Beas P. Martin
J. Little (SAIC)
815 Onsite @ Port for recovery
- Total A = 1194.76
- Total B = 1127.24
- Full ISCO

846 on site @ Norfolk
Total A = 1274.46
Total B = 1491.68
Full ISCO
9:05 on site @ BDC

77

Scale: 1 square = ______

BDC continued
915 - NO water pumped in ISCO or filtered solids unit
- Not enough flow in the BDC Line
925 on site @ King County for recovery

9:35 Total A = 0
Total B = 0
* Time for unit was set incorrectly (J.L)

* Full ISCO

78

Scale: 1 square = ______

14:00 on site @ DK2
- Not enough water to sample ISCO
- Filtered solids unit pumping water

1430- Stopped raining

4/27/2011

8:00 @ Warehouse loading carboys & filter bags

Filter bag Weights:

PSA	#307	61.72g
PSB	#332	62.44g
DK1A	#315	61.52g
DK1B	#336	58.92g
DK2A	#335	63.26g
DK2B	#327	62.63g
KCA	#300	64.40g
KCB	#305	64.24g
NF A	#309	58.60g
NF B	#317	60.05g
BDC A	#319	63.29g
BDC B	#321	61.06g

79

Scale: 1 square = ______

9:25 on site @ Port for install
9:45 deployed @ Port
Timers set 1745-2230

10:00 on site @ Norfolk for deploy
10:16 deployed @ NF
Timers set 1700-2300
10:26 on site @ BDC for deployment
Timers set 1700-2300

1055 on site @ KC for deploy
11:16 deployed @ KC
Timers set 1700-2300

11:34 on site @ DK1
Timers set 1700-2300
Installed New ISCO line attached to pump cage

12:25 on site @ DK2
Timers set 1700-2300
Installed new ISCO line to bucket pump

80

Scale: 1 square = ______

4/28/11 Sample Recovery

800 Load gear at warehouse.

840 Pulled gear at PS2220
Water and solids collected.

930 Pulled gear at NF2095
Low totalizer volumes
Water and solids collected

942 Pulled gear at IDC 2088
Low totalizer volumes
Water and solids collected

1000 Pulled gear at KC2062
Only 1 water aliquot collected
before the suction line clogged
We were not able to unclog line
Solids and small volume of
water collected.

1010 Purchase ice.

81

Scale: 1 square = ______

1032 Pulled gear at DK2
Water collected but no solids
Human error timer was not
set correctly

1041 Onsite at DK1
SPU on site doing video survey
at the sampling location.
ISCO has been removed.
SPU unplugged the ISCO from
the battery and replugged after
setting the ISCO on the surface

1110 Pulled gear at DK1
Water collected. Solids maybe.
Totalizer read zero, but the
filter housings were full
of water.

Totalizers	PS2220 A	587 g
	B	1017 g
	NF2095A	40.4 g
	B	48.8

82

Scale: 1 square = ______

BDC 2088A 29.2
B 32.2
KC 2062 A 75.9
71.5
DK1 A 0.9 → Not
B 1.2 Working

1305 At warehouse removing samples from filter housings
1330 Drop off samples at ARI

83

5/2/11 Stormwater Sampling

900 Pick up carboys from ARI

930 Load Dakota gear at warehouse. Gear for DK2, DK3, DK4

10:30 Install gear at DK3
ISCO and Filtration unit left running while we go to DK4

1045 Install gear at DK4
Water collected at 1045
Filtration unit left running in vault.

1130 Finish collecting water sample at DK3. Filtration unit left running.

1315 Remove Filter unit from DK3
Totalizers
DK3A 237 g
DK3B 333 g

84

Scale: 1 square = ______

1335 Gear removed from DK4
Totalizers
DK4A 509 g
DK4B 513

1410 Drop off samples at ARI

1430 Offload gear at warehouse.

1025 @ warehouse
Crew: J Boas, J Little, L Dewitty

11:10 onsite @ Port for install
11:30 deployed @ Port
Timers set: 17:30 - 2200

11:50 on site @ Norfolk
12:15 deployed @ NF
Timers set: 1730 - 2300

12:18 on site @ BDC for deploy
12:40 deployed @ BDC
Timers set: 1730-2300

85

Scale: 1 square = ______

12:45 on site @ King County
1305 deployed @ KC
Timers set 1730-2300

5/5/2011

800 @ Costco Parking Lot

825 @ Beacon Hill to recover sed trap bottles & bedload sampler

* Sed trap bottles recovered → one has a hole in the bottom likely from fast moving debris
* bedload sampler recovered small amount of sed trapped hydro foil bent upwards due to high velocity current
* took pictures of sed recovery in bedload sampler

9:25 Finished @ Beacon Hill

9:35 on site @ SQ1
10:00 Bottles recovered @ SQ1
Bedload Sampler recovered

86

Scale: 1 square = ______

10:45 on site @ Port for solids/ISCO recovery

Total A = 1706.50
Total B = 1544.05
* Full ISCO sampled

11:20 on site @ Norfolk for solids/ISCO recovery

Total A = 0
Total B = 12.42
* Both solids cartridges full of water
* Both totalizers may be malfunctioning
* Full ISCO sampled

11:45 on site @ BDC
Total A = 124.25
Total B = 1.54
* Full ISCO

12:10 on site @ King County
Total A = 701.70
Total B = 893.21

87

Scale: 1 square = ______

* Full ISCO @ Port

1245 Clear Creek on site @ KC to recover Bottles & Traps

13:20 on site @ BDC of sed trap bottle recovery

68

Scale: 1 square = ______

5/6/11 LL Stormwater Sampling

Filter Bags

	#	Weight (g)
PS2220A	354	61.18
B	344	60.90
NF2095A	341	64.64
B	346	63.22
KC2062A	342	60.64
B	347	60.62
BDC2088A	340	61.41
B	350	64.51

900 At office load gear for both LL and DK

10:00 At warehouse. Not enough rain to sample DK today. Install gear at LL instead

10:55 on site @ Port for install solids / ISCO units

11:05 gear installed, pump looked good. Timers set for Sat 1100-1700

89

Scale: 1 square = ______

11:40 Gear installed at NF2095

1200 Gear installed at BDC2088

1220 Gear installed at KC2062

1345 At warehouse.
Load filterhousing for SQ1

	#	Weight (g)
SQ1A	353	62.45
SQ1B	355	61.65

1415 Filter bags from 1/20/11 delivered to ARI

1515 Gear installed at SQ1
Filtration unit only
Pigtail connector on filter housing needed a pin fixed.
Pump was dead, so we replaced it.

1600 Unload gear at office

90

Scale: 1 square = ______

5/9/11 onsite warehouse to
load gear
Crew: J. Boas, L. Delwiche, P. Martin

11:40 onsite @ SQ1 for
solids/ ISCO recovery

11:50 re-deployed ISCO to
gather flow data

* Both fixes: control Box
pigtail & new pump
successful

Total A: 1100 gal
Total B: 1200 gal

1200 on site @ SQ2 for
ISCO deployment to
gather flow data

12:15 installed ISCO
removed sandbag to
gather accurate flow
data

91

Scale: 1 square = ______

12:17 onsite @ SQ3
to deploy an ISCO
for flow data

12:30 deployed ISCO
@ SQ3

1345 on site @ Norfolk
to recover solids/ ISCO
units

13:55 re-deployed ISCO to
gather flow data

1400 on site @ BDC
for recovery of solids/ISCO
units

14:15 re-deployed ISCO to
gather flow data

14:37 on site @ King County
to recover solids/ ISCO

14:45 re-deployed ISCO to gather
flow data

92

Scale: 1 square = ______

15:05 onsite @ Port for
recovery of solids/ ISCO

15:15 re-deployed ISCO to
gather flow data

5/11/2011
1000 @ warehouse to load
gear
Crew: J. Boas, L Delwiche
J. Little

10:35 on site @ DK1
for solids sampler install
Timers set 1200 → 1700

11:12 on site @ DK2 for
solids sampler install
11:40 Timer set 1200 - 1700
11:45 on site @ SQ1 for
solids install
Timers set 1200 - 1700

1205 on site @ SQ2 to
recover ISCO

93

Scale: 1 square = ______

1215 on site @ SQ3
to recover ISCO

1415 on site @ DK3
to install solids unit
& ISCO
+ lightly raining looks
like enough water in the
line to pump

1510 DK 3 & DK4 filtered
solids units installed
* raining pretty good

Timers DK3 1500 - 2030
Timers DK4 1515 - 2030

1620 onsite @ DK3
water flowing / pump pumping

Total A: 43.43 gal
Total B: 38.89 gal
> Totalizer not tallying flow yet water is moving through them

94

Scale: 1 square = ______

16:45 Stopping DK3 → the filtered solids unit has stopped pumping water through
- The bags are likely full

1710 stopped DK4
- filtered solids flow reduced to a trickle
- bags likely full

1800 warehouse to unload gear

5/12/2011 @ warehouse to
930 load gear and personel
Crew: J Boas, L. Delwiche

Totalizer Readings

DK4 A = 48.38
B = 56.62

DK3 A = 48.45
B = 35.12

95

Scale: 1 square =

1050 on site @ Beacon Hill for solids sampler recovery
Total A = 192.30 Total B = 179.97

1110 on site @ DK2 for solids sampler recovery

* Bags are FULL

- Stop cocks on filter unit were both open
- Jason Little installed bags (Strike 2)

1130 on site @ SQ1 for solids sampler recovery

* Pigtail coming out of the control box shorted out
* need to throw out this pigtail & use a different one

96

Scale: 1 square = ______

5/19/2011 1030 loaded uhaul truck in Edmonds
• heading to pick up 4 ISCOS @ the LL locations they've been in the lines since the 9th of May
• will also attempt to get scrape/grab samples from King County & SQ3

1130 on site @ Port to recover ISCO & pump cage

1205 on site to recover ISCO & pump cage @ Norfolk

12:15 on site @ BDC to recover ISCO & pump cage

1230 on site @ KC to recover ISCO & pump cage

* recovered 16oz jar of grab sample → on ice

Scale: 1 square = 97

12:45 lunch

2:15 @ warehouse offloading gear

245
* headed to the lab to pick-up carboys

5/20/2011
830 @ Warehouse loading gear for baseflow sampling
• will be setting gear out @ DK1, DK2, DK3

Filter bags

DK1A:	63.84g	# 351
DK1B	64.50g	# 349
DK3A	60.33g	# 343
DK3B	63.82g	# 352

950 truck loaded
935 on site @ DK1 to deploy

10:15 filtered solids & ISCO deployed

Scale: 1 square = 96

* The pump @ DK1 appears to be burnt out
* very weak sounding
* ISCO able to pump
Timers 1015 → 1250

10:40 installed ISCO @ DK2
Timers 1040 → 1310

10:45 onsite @ DK3 for solids & ISCO install

Timers 1105 → 13:30

1310 Recovered @ DK4
Full ISCO
No Filtered solids
* pump is dead

1310 Recovered @ DK2

* No ISCO sample
* Not enough flow

99

Scale: 1 square = ______

1332 Recovered @ DK3

- Total A = 718.74
- Total B = 612.78

- Full ISCO

1350 en route to ARI

5/25/11 Crew: J. Baas L. Delwiche (SAIC) J. Little

900 @ Warehouse to load filter bags & carboys

10:00 on site @ SQ3 to install filter unit & ISCO

10:25 Timers set: 1100-1700

10:26 onsite @ SQ2 for filtered solids & ISCO installation

100

Scale: 1 square = ______

Timers set: 1100 - 1700

10:45 onsite @ SQ1
for filtered solids & ISCO
install

Timers set: 11:00 - 17:00

11:05 on site @ DK2
for solids unit install

11:55 install complete
+ filtered solids unit
began pumping while onsite

Timer set 11:25 - 17:00

12:00 on site @ DK1
for ISCO install

1225 Program set 12:10 - 1700

12:30 onsite @ SQ4 for
filtered solids & ISCO install

Timers set 12:45 - 1700

Scale: 1 square = 101

unit began pumping while
on site

13:03 done headed to
lunch

5/26/11

800 @ warehouse to load
coolers

Crew: J. Boas, J. Little
M. Pagel

8:32 on site @ SQ4
for solids & ISCO
recovery

Total A: 84.92
Total B: 0

+ ISCO only 1/8th full
looks like the weight of
the flex hose, once filled
with water, caused the
extra to fall down and
kink the hose @ the first
Scale: 1 square = latter rung.

102

Totalizer B is non-functional
this is ~~it~~ not the first time
it has registered 0
and a full filter housing
of water came out the
stop cock

845 loaded sampling equip
needed to SQ3

8:50 on site @ SQ3 for
solids & ISCO recovery

Total A: 450.36
Total B: 436.73

* Full ISCO

9:10 onsite @ SQ2
for filtered solids & ISCO
recovery

Total A: 174.60
Total B: 179.72

* Full ISCO

Scale: 1 square = 103

920 on site @ SQ1 for
filtered solids & ISCO recovery

Total A: 807.18
Total B: 0

* Totalizer B is malfunctioning

* Both filter housings full
of water

* Full ISCO

9:35 onsite @ DK2 for
filtered solids unit
recovery

Total A: ~~188.~~ 183.17
Total B: 15904.1

* Total B is likely malfunctioning
* Both filter housings full
of water

104
Scale: 1 square = ______

9:55 on site @ DK1
for ISCO recovery

Full ISCO

10:30 back @ warehouse to
offload gear and
prepare samples for Lab

6/9/2011 Crew: J Baus, W. Hafner, P. Martin
9 AM load vehical w/ flow
measuring equipment

10:30 on site @ Norfolk to
measure flow

water depth: 3/4"

velocity Avg: N/A

Note: Not enough moving water but water in the
line to spin the blades of
the flow meter.

105

Scale: 1 square = ______

10:45 on site @ BDC to
measure flow

water depth: N/A

Avg. velocity: no flow

note: stagnant water less
than 1 inch

11:52 on site @ King County

water depth: 1 3/4"
Avg Velocity: 1.2 fps
w/out lift pump on
w/Pump velocity: 4.6 fps
water deph: 8 1/2"

* velocity varies from top
to bottom

12:05 on site @ DK2

water depth: 1 1/4" inch
Avg velocity: 3.5 fps

106

Scale: 1 square = ______

13:30 on site @ Beacon Hill

water depth : 1/4"
Avg Velocity : N/A

Note: not enough water to spin blades of flow meter

13:52 on site @ SQ1

~~pool water depth : 3 inches~~
Avg Velocity : 0.6 fps

water depth : 1 1/8"

14:10 on site SQ2

water depth : 1/2"

guess velocity : 1 fps

14:15 on site @ SQ3
water depth : 1 7/8"
Avg velocity : 0 - 0.2 fps
~~water depth vault~~

Scale: 1 square = 107

6/10/2011 Crew J. Boas P. Martin

~~14:25~~ on site @ DK3
8:10
water depth = 2"
Avg Velocity = 0.3

8:15 on site @ DK4

water depth = 1 1/4"
Avg Velocity = 0.0

8:25 on site @ SQ4

water depth = 1/8"
Avg Velocity = 0.0

8:40 @ Port

water depth = 1/4"
Guess Avg velocity = 0.8

108

Scale: 1 square =

6/15/11

9:10 @ COSTCO to meet Clear Creek

Crew: J. Boas, J. Little
ClearCreek: Rob, Mike

9:25 on site @ Beacon Hill (DK1)

to recover bedload sampler & pipe ring

10:00 → recovered bedload sampler
- hydrofoil missing

note: - sampler was installed and forward facing velocity must have been great enough to rip it from the sampler
- recoverd 1/2 8oz jar of SS mostly gravel size

→ recovered pipe ring & suction line

109

Scale: 1 square = ______

10:07 @ DK2 for pipe ring recovery

- Recoverd pipe ring and flow sensor

10:25 on site @ DK3 for pipe ring recovery

10.45 recoverd pipe ring & sensor @ DK3

10.50 on site @ DK4 for pipe ring recovery

11:00 recovered pipe ring & sensor @ DK4

11:05 on site @ SQ3
11:15 recovered pipe ring & sensor

11:20 on site @ SQ2
11:30 recovered pipe ring @ SQ2

110

Scale: 1 square = ______

11:32 on site @ SQ 1

11:55 recovered bedload sampler (Full)

recovered pipe ring & sensor

13:30 Dropped Bedload sample off @ Lab

~~Site date = BT~~

III

Scale: 1 square = ______

Appendix E
Chemistry Results Summary Tables

Table E-1. Whole Water Sample Analytical Results

Event ID / Location ID / Sample ID / Collection Date	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1		SW3		SW4		SW6		TS		BF1		BF2		BF3	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		KC2062		KC2062		KC2062	
Sample ID				BDC2088-011211-W		BDC2088-021111-W		BDC2088-030411-W		BDC2088-042711-W		BDC2088-050411-W		KC2062-012611-W		KC2062-020411-W		KC2062-042111-W	
Collection Date				1/13/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
PCBs (µg/L)																			
Aroclor 1016	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1221	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1232	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1242	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1248	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1254	EPA 8082			0.010	U	**0.016**		**0.013**		**0.019**		0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1260	EPA 8082			0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Total PCBs	EPA 8082	0.03	10	0.010	U	**0.016**		**0.013**		**0.019**		0.010	U	0.010	U	0.010	U	0.010	U
Metals – Total (µg/L)																			
Arsenic	EPA 200.8			**0.6**		**0.8**		**0.3**		**0.4**		**0.8**		**2.7**		**4.6**		**2.6**	
Cadmium	EPA 200.8			**0.2**		**0.4**		0.2	U	**0.2**		0.1	U	0.2	U	0.2	U	0.1	U
Calcium	EPA 6010B			**1910**		**3450**		**3330**		**1250**		**8550**		**24300**		**23700**		**23100**	
Chromium	EPA 200.8			**5.4**		**5.7**		**4.0**		**5.2**		**0.9**		1	U	1	U	2	U
Copper	EPA 200.8			**11.0**		**14.5**		**5.4**		**7.5**		**1.4**		**1.2**		**2.5**		**1.0**	
Lead	EPA 200.8			**10**		**12**		**2**		**5.0**		**0.2**		1	U	**1**		**0.2**	
Magnesium	EPA 6010B			**490**		**770**		**2180**		**290**		**6680**		**11500**		**11300**		**11300**	
Mercury	EPA 7470A			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Nickel	EPA 200.8			**2.8**		**3.7**		**2.1**		**2.0**		**1.0**		**1.6**		**1.5**		**1.0**	
Selenium	EPA 200.8			0.5	U	0.5	U	0.5	U	0.5	U	**0.8**		0.5	U	0.5	U	**0.5**	
Silver	EPA 200.8			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Zinc	EPA 200.8			**102**	**J**	**191**	**J**	**92**		**81**		**13**		**6**		**16**	**J**	4	U
Metals – Dissolved (µg/L)																			
Arsenic	EPA 200.8	36	69	0.2	U	**0.2**		0.2	U	0.2	U	**0.6**		**0.9**		**0.8**		**0.8**	
Cadmium	EPA 200.8	9.3	42	0.2	U	0.2	U	0.2	U	0.1	U	0.1	U	0.2	U	0.2	U	0.1	U
Chromium	EPA 200.8			**0.8**		0.5	U	**1.3**		**0.8**		0.5	U	1	U	0.5	U	2	U
Copper	EPA 200.8	3.1	4.8	**1.7**		**2.7**		**2.6**		**2.4**		**0.7**		**0.7**		**1.3**		**0.8**	
Lead	EPA 200.8	8.1	210	1	U	1	U	1	U	**0.2**		0.1	U	1	U	1	U	0.1	U
Mercury	EPA 7470A	0.025	1.8	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U
Nickel	EPA 200.8	8.2	74	0.5	U	**0.7**		**1.5**		**1.0**		**1.0**		**1.4**		**1.2**		**0.9**	
Selenium	EPA 200.8	71	290	0.5	U	0.5	U	0.5	U	0.5	U	**0.8**		0.5	U	0.5	U	0.5	U
Silver	EPA 200.8		1.9	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Zinc	EPA 200.8	81	90	**43**		**72**		**75**		**38**		**10**		4	U	**5**	**J**	4	U
Pesticides (µg/L)																			
Aldrin	EPA 8081B	0.0019	0.71	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
alpha-BHC	EPA 8081B			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
beta-BHC	EPA 8081B			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
delta-BHC	EPA 8081B			0.050	U	0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ
Lindane	EPA 8081B		0.16	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
cis-Chlordane	EPA 8081B	0.004	0.09	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
trans-Chlordane	EPA 8081B	0.004	0.09	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
Chlordane	EPA 8081B			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
4,4'-DDD	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDE	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDT	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
Total DDTs	EPA 8081B			0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
Dieldrin	EPA 8081B	0.0019	0.71	0.10	U	0.10	U	0.10	U	0.10	UJ	0.10	U	0.10	U	0.10	U	0.10	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1		SW3		SW4		SW6		TS		BF1		BF2		BF3	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		KC2062		KC2062		KC2062	
Sample ID				BDC2088-011211-W		BDC2088-021111-W		BDC2088-030411-W		BDC2088-042711-W		BDC2088-050411-W		KC2062-012611-W		KC2062-020411-W		KC2062-042111-W	
Collection Date				1/13/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
Endosulfan I	EPA 8081B	0.0087	0.034	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
Endosulfan II	EPA 8081B	0.0087	0.034	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	UJ	0.10	U	0.10	U
Endosulfan Sulfate	EPA 8081B	0.0087	0.034	0.10	U	0.10	UJ	0.10	U	0.10	UJ	0.10	U	0.10	U	0.10	U	0.10	U
Endrin	EPA 8081B	0.0023	0.037	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
Endrin Aldehyde	EPA 8081B			0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
Endrin Ketone	EPA 8081B			0.10	U	0.10	U	0.10	U	0.10	UJ	0.10	U	0.10	U	0.10	U	0.10	U
Heptachlor	EPA 8081B	0.0036	0.05	0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
Heptachlor Epoxide	EPA 8081B			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
Methoxychlor	EPA 8081B			0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toxaphene	EPA 8081B	0.0002	0.21	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Phenols (µg/L)																			
2,4-Dimethylphenol	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	UJ
o-Cresol	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
p-Cresol	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Pentachlorophenol	EPA 8270D			5.0	U	5.0	U	5.0	U	5.0	U	5.0	UJ	5.0	U	5.0	U	5.0	U
Phenol	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Phthalates (µg/L)																			
Bis(2-Ethylhexyl) Phthalate	EPA 8270D			**1.1**		**1.0**		1.0	U	8.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Butyl benzyl phthalate	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Dibutyl phthalate	EPA 8270D			**1.4**		1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Diethyl phthalate	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Dimethyl phthalate	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
Di-n-Octyl phthalate	EPA 8270D			**5.9**		**3.8**		1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
PAHs (µg/L)																			
1-Methylnaphthalene	EPA 8270DSIM			0.010	U	**0.022**		0.010	U	0.010	U	0.010	U	**0.010**		0.010	U	0.010	U
2-Methylnaphthalene	EPA 8270DSIM			**0.014**		**0.036**		**0.018**		0.010	U	0.010	U	0.010	U	**0.011**		0.010	U
Acenaphthene	EPA 8270DSIM			**0.023**		**0.19**		0.010	U	**0.011**		0.010	U	0.010	U	0.010	U	0.010	U
Acenaphthylene	EPA 8270DSIM			0.010	U	**0.030**		0.010	U	0.010	U	0.010	U	0.010	U	0.010	U	0.010	U
Anthracene	EPA 8270DSIM			**0.11**		**0.82**		**0.013**		**0.044**		0.010	U	0.010	U	**0.049**	**J**	0.010	U
Benzo(a)anthracene	EPA 8270DSIM			**0.88**		**3.7**		**0.098**		**0.29**		0.010	U	0.010	U	**0.44**	**J**	0.010	U
Benzo(a)pyrene	EPA 8270DSIM			**0.91**		**4.2**		**0.15**		**0.40**		0.010	U	0.010	U	**0.42**		0.010	U
Benzo(g,h,i)perylene	EPA 8270DSIM			**0.86**		**2.7**	**J**	**0.14**		**0.37**		0.010	U	0.010	U	**0.28**		0.010	U
Benzofluoranthene	EPA 8270DSIM			**2.3**		**8.5**		**0.36**		**0.92**		0.010	U	**1.6**		**0.84**		0.010	U
Chrysene	EPA 8270DSIM			**1.2**	**J**	**4.5**		**0.21**		**0.53**		**0.011**		**1.2**		**0.48**	**J**	0.010	U
Dibenzo(a,h)anthracene	EPA 8270DSIM			**0.32**		**1.1**		**0.043**		**0.11**		0.010	U	0.010	U	**0.11**		0.010	U
Dibenzofuran	EPA 8270DSIM			**0.033**		**0.20**		0.010	U	**0.018**		0.010	U	0.010	U	0.010	U	0.010	U
Fluoranthene	EPA 8270DSIM			**3.3**		**15**		**0.42**		**0.94**		**0.016**		**2.5**		**1.5**	**J**	0.010	U
Fluorene	EPA 8270DSIM			**0.043**		**0.33**		**0.010**		**0.020**		0.010	U	0.010	U	0.010	U	0.010	U
Indeno(1,2,3-cd)pyrene	EPA 8270DSIM			**0.81**		**2.7**		**0.12**		**0.34**		0.010	U	0.010	U	**0.27**		0.010	U
Naphthalene	EPA 8270DSIM			0.030	U	**0.074**		**0.057**		0.037	U	**0.033**		0.016	U	0.039	U	**0.024**	
Phenanthrene	EPA 8270DSIM			**0.96**		**5.5**		**0.15**		**0.44**		**0.011**		0.010	U	**0.36**		0.010	U
Pyrene	EPA 8270DSIM			**1.8**		**7.4**		**0.30**		**0.73**		**0.016**		**1.8**		**0.90**		0.010	U
Total HPAHs	EPA 8270DSIM			**12**	**J**	**50**	**J**	**1.8**		**4.6**		**0.043**		**7.1**		**5.2**	**J**	0.010	U
Total LPAHs	EPA 8270DSIM			**1.1**		**6.9**		**0.23**		**0.52**		**0.044**		0.016	U	**0.41**	**J**	**0.024**	
SVOCs (µg/L)																			
1,2,4-Trichlorobenzene	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1		SW3		SW4		SW6		TS		BF1		BF2		BF3	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		KC2062		KC2062		KC2062	
Sample ID				BDC2088-011211-W		BDC2088-021111-W		BDC2088-030411-W		BDC2088-042711-W		BDC2088-050411-W		KC2062-012611-W		KC2062-020411-W		KC2062-042111-W	
Collection Date				1/13/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
1,3-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,4-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Benzoic Acid	EPA 8270D			10	U	10	U	10	U	10	U	10	UJ	10	U	10	U	10	U
Benzyl Alcohol	EPA 8270D			5.0	U	5.0	U	5.0	U	5.0	U	5.0	UJ	5.0	U	5.0	U	5.0	U
Hexachlorobenzene	8270D			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	0.050	U	0.050	U	0.050	U
Hexachlorobutadiene	8260C			0.050	U	0.050	U	0.050	U	0.050	U	**1.4**	**JN**	0.050	U	0.050	U	0.050	U
Hexachloroethane	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U
N-Nitrosodiphenylamine	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	UJ
VOCs (µg/L)																			
1,1,1,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,1-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,2,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,2-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2,3-Trichlorobenzene	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,3-Trichloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,4-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dibromo-3-chloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3,5-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Hexanone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
4-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Acetone	EPA 8260C			6.8	U	5.0	UJ	14	U	5.0	U	5.0	U	5.0	U	5.0	U	12	U
Acrolein	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Acrylonitrile	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Bromobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromochloromethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromomethane	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Carbon Disulfide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Carbon Tetrachloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-11	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-113	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorodibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloromethane	EPA 8260C			0.5	U	0.5	UJ	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	**0.3**		**0.2**		**0.2**	
cis-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1		SW3		SW4		SW6		TS		BF1		BF2		BF3	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		KC2062		KC2062		KC2062	
Sample ID				BDC2088-011211-W		BDC2088-021111-W		BDC2088-030411-W		BDC2088-042711-W		BDC2088-050411-W		KC2062-012611-W		KC2062-020411-W		KC2062-042111-W	
Collection Date				1/13/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
Cumene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dichlorobromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylene Dibromide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Methyl ethyl ketone	EPA 8260C			5.0	U	5.0	UJ	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methyl Iodide	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Methyl isobutyl ketone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methylene Chloride	EPA 8260C			1.1	U	1.6	U	1.7	U	14	U	3.2	U	0.8	U	2.8	U	2.6	U
n-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
n-Propylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
p-Isopropyltoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
sec-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Styrene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
tert-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Tetrachloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,4-Dichloro-2-butene	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Trichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Vinyl Acetate	EPA 8260C			1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Vinyl Chloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
BTEX (µg/L)																			
Benzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Toluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.4	U	0.2	U	0.2	U	0.2	U	0.2	U
m, p-Xylene	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
o-Xylene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Total Xylenes	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Brominated Diphenylethers (pg/L)																			
BDE-007	EPA 1614							3.61	U	12.5	U							0.426	U
BDE-008	EPA 1614							2.67	CU	**16.9**	**CJ**							0.407	CU
BDE-010	EPA 1614							3.84	U	0.421	U							0.46	U
BDE-011	EPA 1614							C8		C8								C8	
BDE-012	EPA 1614							2.29	CU	**3.82**	**CJ**							0.283	CU
BDE-013	EPA 1614							C12		C12								C12	
BDE-015	EPA 1614							**3.15**	**J**	**21**	**J**							0.507	U
BDE-017	EPA 1614							**76.2**	**CJ**	**355**	**C**							5.15	CU
BDE-025	EPA 1614							C17		C17								C17	
BDE-028	EPA 1614							**97.5**	**CJ**	**629**	**C**							**6.61**	**CJ**
BDE-030	EPA 1614							5.07	U	1.49	U							0.346	U
BDE-032	EPA 1614							4.18	U	3.2	U							1.31	U
BDE-033	EPA 1614							C28		C28								C28	
BDE-035	EPA 1614							3.6	U	8.13	U							0.543	U
BDE-037	EPA 1614							**5.03**	**J**	**24.5**	**J**							0.0486	U
BDE-047	EPA 1614							**1290**		**6690**								**280**	
BDE-049	EPA 1614							**159**		**648**								**11.4**	**J**
BDE-051	EPA 1614							**20.4**	**J**	**72.6**								**4.3**	**J**

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1		SW3		SW4		SW6		TS		BF1		BF2		BF3	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		KC2062		KC2062		KC2062	
Sample ID				BDC2088-011211-W		BDC2088-021111-W		BDC2088-030411-W		BDC2088-042711-W		BDC2088-050411-W		KC2062-012611-W		KC2062-020411-W		KC2062-042111-W	
Collection Date				1/13/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
BDE-066	EPA 1614							**111**		**514**								14.4	U
BDE-071	EPA 1614							**32.4**	**J**	**113**								**3.54**	**J**
BDE-075	EPA 1614							7.84	U	**36.3**	**J**							0.711	U
BDE-077	EPA 1614							1.12	U	1.66	U							1.18	U
BDE-079	EPA 1614							2.16	U	**61.2**								3.07	U
BDE-085	EPA 1614							**68.1**		**400**								18.9	U
BDE-099	EPA 1614							**1330**		**7560**								**322**	
BDE-100	EPA 1614							**377**		**1840**								**59.4**	
BDE-105	EPA 1614							8.36	U	17.6	U							4.2	U
BDE-116	EPA 1614							10.9	U	28.3	U							11.6	U
BDE-119	EPA 1614							**18.9**	**CJ**	**44.7**	**CJ**							3.16	CU
BDE-120	EPA 1614							C119		C119								C119	
BDE-126	EPA 1614							3.54	U	9.73	U							2.13	U
BDE-128	EPA 1614							5.47	U	21.2	U							7.21	U
BDE-138	EPA 1614							18.3	CU	**108**	**C**							**10.9**	**CJ**
BDE-140	EPA 1614							**6.09**	**J**	**42.6**	**J**							**3.8**	**J**
BDE-153	EPA 1614							**123**		**658**								**47.5**	**J**
BDE-154	EPA 1614							**114**		**635**								24.9	U
BDE-155	EPA 1614							**7.7**	**J**	**43.7**	**J**							**2.94**	**J**
BDE-166	EPA 1614							C138		C138								C138	
BDE-181	EPA 1614							10.1	U	15.4	U							1.2	U
BDE-183	EPA 1614							**39.8**	**J**	**181**								71.1	U
BDE-190	EPA 1614							6.28	U	54.4	U							5.32	U
BDE-203	EPA 1614							**134**		**311**								120	U
BDE-206	EPA 1614							399	U	**1260**								**655**	
BDE-207	EPA 1614							**906**		**2010**								614	U
BDE-208	EPA 1614							623	U	**1760**								**416**	
BDE-209	EPA 1614							**4570**		**16700**								**1370**	
Total BDEs	EPA 1614							**9490**	**CJ**	**41600**	**CJ**							**3190**	**CJ**
Conventionals																			
Alkalinity as Bicarbonate (mg/L)	SM2320			**4.3**		**5.1**		**6.9**		**2.6**		**35.0**		**149**		**151**		**157**	
Alkalinity as Carbonate (mg/L)	SM2320			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity as Hydroxide (mg/L)	SM2320			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity, Total (mg/L)	SM2320			**4.3**		**5.1**		**6.9**		**2.6**		**35.0**		**149**		**151**		**157**	
Chloride (mg/L)	EPA 300.0			**0.6**		**2.6**		**30.5**		**0.9**		**77.0**		**15.4**		**16.3**		**15.6**	
Dissolved Organic Carbon (mg/L)	EPA 415.1			1.50	U	**3.20**		**2.85**		**2.00**		**1.86**		**6.94**		**6.83**		**6.78**	
Hardness as CaCO3 (mg/L)	EPA 6010B			**6.8**		**12**		**17**		**4.3**		**49**		**110**		**110**		**100**	
Nitrate (mg/L)	EPA 300.0			**0.2**		**0.2**		0.2	U	0.1	U	0.3	U	**0.1**		0.1	U	0.1	U
pH (su)	PH			**6.82**		**6.84**		**7.48**		**7.10**		**7.26**		**7.18**		**7.29**		**7.28**	
Sulfate (mg/L)	EPA 300.0			**0.6**		**1.5**		**4.4**		**0.7**		**14.0**		**6.8**		**5.9**		**6.1**	
Total Organic Carbon (mg/L)	EPA 415.1			**2.08**		**4.59**		**3.17**		**3.56**		**2.19**		**8.54**		**9.94**		**8.09**	
Total Solids (percent)	EPA 160.3									**0**								**0.019**	
Total Suspended Solids (mg/L)	EPA 160.2			**37.0**		**68.0**		**8.7**		**17.5**		**5.8**		**38.5**		**82.8**		**19.2**	

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW1	SW3	SW4	SW6	TS	BF1	BF2	BF3
Location ID				BDC2088	BDC2088	BDC2088	BDC2088	BDC2088	KC2062	KC2062	KC2062
Sample ID				BDC2088-011211-W	BDC2088-021111-W	BDC2088-030411-W	BDC2088-042711-W	BDC2088-050411-W	KC2062-012611-W	KC2062-020411-W	KC2062-042111-W
Collection Date				1/13/2011	2/12/2011	3/5/2011	4/27/2011	5/4/2011	1/26/2011	2/5/2011	4/21/2011

Bold results - Detected concentrations

yellow highlighted results - Washington State Chronic Marine Water Quality Criteria Exceedance

blue highlighted results - Washington State Acute Marine Water Quality Criteria Exceedance

BF = base flow; SW = storm water; TS = tidal sampling

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

N - Tentative identification

Total BDEs - BDE-007, BDE-008, BDE-010, BDE-011, BDE-012, BDE-013, BDE-015, BDE-017, BDE-025, BDE-028, BDE-030, BDE-032, BDE-033, BDE-035, BDE-037, BDE-047, BDE-049, BDE-051, BDE-066, BDE-071, BDE-075, BDE-077, BDE-079, BDE-085, BDE-099, BDE-100, BDE-105, BDE-116, BDE-119, BDE-120, BDE-126, BDE-128, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183, BDE-190, BDE-203, BDE-206, BDE-207, BDE-208, BDE-209

Chlordane - cis-Chlordane, trans-Chlordane

Total DDTs - 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Total Xylenes - m, p-Xylene, o-Xylene

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS		BF1		BF2		BF3	
Location ID				KC2062		KC2062		KC2062		KC2062		KC2062		NF2095		NF2095		NF2095	
Sample ID				KC2062-021111-W		KC2062-030411-W		KC2062-031511-W		KC2062-042711-W		KC2062-050411-W		NF2095-012611-W		NF2095-020411-W		NF2095-042111-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
PCBs (µg/L)																			
Aroclor 1016	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1221	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1232	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1242	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1248	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1254	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Aroclor 1260	EPA 8082			0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Total PCBs	EPA 8082	0.03	10	0.010	U	0.010	U	0.010	U			0.010	U	0.010	U	0.010	U	0.010	U
Metals – Total (µg/L)																			
Arsenic	EPA 200.8			**2.7**		**2.0**		**2.7**				**2.4**		**1.0**		**1.0**		**1.1**	
Cadmium	EPA 200.8			0.2	U	**0.2**		**0.3**				0.1	U	0.2	U	0.2	U	0.1	U
Calcium	EPA 6010B			**25100**		**16400**		**12000**				**15700**		**37800**		**43300**		**47100**	
Chromium	EPA 200.8			1	U	1	U	**1.1**				**0.5**		**0.7**		1	U	**0.6**	
Copper	EPA 200.8			**1.0**		**4.1**		**4.6**				**1.3**		**2.9**		**2.1**		**2.0**	
Lead	EPA 200.8			1	U	**2**		**3**				**0.4**		1	U	1	U	**0.3**	
Magnesium	EPA 6010B			**12400**		**6430**		**4740**				**18900**		**13200**		**14400**		**16700**	
Mercury	EPA 7470A			0.1	U	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U
Nickel	EPA 200.8			**1.1**		**1.3**		**3.6**				**1.1**		**2.9**		**3.5**		**3.2**	
Selenium	EPA 200.8			0.5	U	0.5	U	0.5	U			2	U	0.5	U	0.5	U	0.5	U
Silver	EPA 200.8			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Zinc	EPA 200.8			4	U	**40**		**34**				4	U	**21**		**23**	**J**	**16**	
Metals – Dissolved (µg/L)																			
Arsenic	EPA 200.8	36	69	**1.0**		**0.9**		**1.0**				**1.1**		**0.4**		**0.5**		**0.6**	
Cadmium	EPA 200.8	9.3	42	0.2	U	0.2	U	0.2	U			0.1	U	0.2	U	0.2	U	0.1	U
Chromium	EPA 200.8			0.5	U	0.5	U	0.5	U			0.5	U	0.5	U	0.5	U	0.5	U
Copper	EPA 200.8	3.1	4.8	**1.1**		**2.4**		**1.6**				**1.4**		**1.7**		**1.4**		**1.5**	
Lead	EPA 200.8	8.1	210	1	U	1	U	1	U			0.1	U	1	U	1	U	0.1	U
Mercury	EPA 7470A	0.025	1.8			0.02	U	0.0200	U			0.02	U	0.02	U	0.02	U	0.02	U
Nickel	EPA 200.8	8.2	74	**1.1**		**1.2**		**2.2**				**1.0**		**2.3**		**2.5**		**3.2**	
Selenium	EPA 200.8	71	290	0.5	U	0.5	U	0.5	U			**1.4**		0.5	U	0.5	U	0.5	U
Silver	EPA 200.8		1.9	0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Zinc	EPA 200.8	81	90	4	U	**23**		**13**				4	U	**7**		**14**	**J**	**17**	
Pesticides (µg/L)																			
Aldrin	EPA 8081B	0.0019	0.71	0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
alpha-BHC	EPA 8081B			0.050	U	0.050	U	0.050	UJ			0.050	U	0.050	U	0.050	U	0.050	U
beta-BHC	EPA 8081B			0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
delta-BHC	EPA 8081B			0.050	UJ	0.050	UJ	0.050	UJ			0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ
Lindane	EPA 8081B		0.16	0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
cis-Chlordane	EPA 8081B	0.004	0.09	0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
trans-Chlordane	EPA 8081B	0.004	0.09	0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
Chlordane	EPA 8081B			0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
4,4'-DDD	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U			0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDE	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U			0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDT	EPA 8081B	0.001	0.13	0.10	U	0.10	U	0.10	U			0.10	U	0.10	U	0.10	U	0.10	U
Total DDTs	EPA 8081B			0.10	U	0.10	U	0.10	U			0.10	U	0.10	U	0.10	U	0.10	U
Dieldrin	EPA 8081B	0.0019	0.71	0.10	U	0.10	U	0.10	U			0.10	U	0.10	U	0.10	U	0.10	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3	SW4	SW5	SW6	TS	BF1	BF2	BF3
Location ID				KC2062	KC2062	KC2062	KC2062	KC2062	NF2095	NF2095	NF2095
Sample ID				KC2062-021111-W	KC2062-030411-W	KC2062-031511-W	KC2062-042711-W	KC2062-050411-W	NF2095-012611-W	NF2095-020411-W	NF2095-042111-W
Collection Date				2/12/2011	3/5/2011	3/15/2011	4/27/2011	5/4/2011	1/26/2011	2/5/2011	4/21/2011
Endosulfan I	EPA 8081B	0.0087	0.034	0.050 U	0.050 U	0.050 U		0.050 U	0.050 U	0.050 U	0.050 U
Endosulfan II	EPA 8081B	0.0087	0.034	0.10 U	0.10 U	0.10 UJ		0.10 U	0.10 UJ	0.10 U	0.10 U
Endosulfan Sulfate	EPA 8081B	0.0087	0.034	0.10 UJ	0.10 U	0.10 UJ		0.10 U	0.10 U	0.10 U	0.10 U
Endrin	EPA 8081B	0.0023	0.037	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde	EPA 8081B			0.10 U	0.10 U	0.10 U		0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone	EPA 8081B			0.10 U	0.10 U	0.10 UJ		0.10 U	0.10 U	0.10 U	0.10 U
Heptachlor	EPA 8081B	0.0036	0.05	0.050 U	0.050 U	0.050 U		0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide	EPA 8081B			0.050 U	0.050 U	0.050 U		0.050 U	0.050 U	0.050 U	0.050 U
Methoxychlor	EPA 8081B			0.50 U	0.50 U	0.50 U		0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	EPA 8081B	0.0002	0.21	5.0 U	5.0 U	5.0 U		5.0 U	5.0 U	5.0 U	5.0 U
Phenols (µg/L)											
2,4-Dimethylphenol	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 UJ
o-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
p-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Pentachlorophenol	EPA 8270D			5.0 U	5.0 U	5.0 U		5.0 U	5.0 U	5.0 U	5.0 U
Phenol	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Phthalates (µg/L)											
Bis(2-Ethylhexyl) Phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		**1.8**	1.0 U	**1.0**	1.0 U
Butyl benzyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Dibutyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Diethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Dimethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
Di-n-Octyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U
PAHs (µg/L)											
1-Methylnaphthalene	EPA 8270DSIM			0.010 U	**0.021**	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
2-Methylnaphthalene	EPA 8270DSIM			**0.013**	**0.030**	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
Acenaphthene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U		0.010 U	**0.010**	0.010 U	0.010 U
Acenaphthylene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
Anthracene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)anthracene	EPA 8270DSIM			0.010 U	**0.022**	**0.039**		0.010 U	0.010 U	0.010 U	0.010 U
Benzo(a)pyrene	EPA 8270DSIM			0.010 U	**0.036**	**0.083**		0.010 U	0.010 U	0.010 U	0.010 U
Benzo(g,h,i)perylene	EPA 8270DSIM			0.010 U	**0.036**	**0.086**		0.010 U	0.010 U	0.010 U	0.010 U
Benzofluoranthene	EPA 8270DSIM			0.010 U	**0.11**	**0.28**		0.010 U	0.010 U	0.010 U	0.010 U
Chrysene	EPA 8270DSIM			0.010 U	**0.067**	**0.16**		0.010 U	0.010 U	0.010 U	0.010 U
Dibenzo(a,h)anthracene	EPA 8270DSIM			0.010 U	**0.010**	**0.026**		0.010 U	0.010 U	0.010 U	0.010 U
Dibenzofuran	EPA 8270DSIM			0.010 U	0.010 U	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
Fluoranthene	EPA 8270DSIM			0.010 U	**0.13**	**0.29**		**0.017**	0.010 U	0.010 U	0.010 U
Fluorene	EPA 8270DSIM			0.010 U	**0.010**	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U
Indeno(1,2,3-cd)pyrene	EPA 8270DSIM			0.010 U	**0.031**	**0.080**		0.010 U	0.010 U	0.010 U	0.010 U
Naphthalene	EPA 8270DSIM			**0.054**	**0.080**	**0.024**		**0.035**	**0.037**	**0.067**	**0.054**
Phenanthrene	EPA 8270DSIM			0.010 U	**0.058**	**0.099**		0.010 U	0.010 U	**0.013**	0.010 U
Pyrene	EPA 8270DSIM			0.010 U	**0.091**	**0.18**		**0.012**	0.010 U	0.010 U	0.010 U
Total HPAHs	EPA 8270DSIM			0.010 U	**0.53**	**1.2**		**0.029**	0.010 U	0.010 U	0.010 U
Total LPAHs	EPA 8270DSIM			**0.054**	**0.15**	**0.12**		**0.035**	**0.047**	**0.080**	**0.054**
SVOCs (µg/L)											
1,2,4-Trichlorobenzene	EPA 8260C			0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	EPA 8260C			0.2 U	0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS		BF1		BF2		BF3	
Location ID				KC2062		KC2062		KC2062		KC2062		KC2062		NF2095		NF2095		NF2095	
Sample ID				KC2062-021111-W		KC2062-030411-W		KC2062-031511-W		KC2062-042711-W		KC2062-050411-W		NF2095-012611-W		NF2095-020411-W		NF2095-042111-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
1,3-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,4-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Benzoic Acid	EPA 8270D			10	U	10	U	10	U			10	U	10	U	10	U	10	U
Benzyl Alcohol	EPA 8270D			5.0	U	5.0	U	5.0	U			5.0	U	5.0	U	5.0	U	5.0	U
Hexachlorobenzene	8270D			0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
Hexachlorobutadiene	8260C			0.050	U	0.050	U	0.050	U			0.050	U	0.050	U	0.050	U	0.050	U
Hexachloroethane	EPA 8270D			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
N-Nitrosodiphenylamine	EPA 8270D			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	UJ
VOCs (µg/L)																			
1,1,1,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1,1-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1,2,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1,2-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,2,3-Trichlorobenzene	EPA 8260C			0.5	U	0.5	U	0.5	U			0.5	U	0.5	U	0.5	U	0.5	U
1,2,3-Trichloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U			0.5	U	0.5	U	0.5	U	0.5	U
1,2,4-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dibromo-3-chloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U			0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,3,5-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
2,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
2-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
2-Hexanone	EPA 8260C			5.0	U	5.0	U	5.0	U			5.0	U	5.0	U	5.0	U	5.0	U
4-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Acetone	EPA 8260C			5.0	UJ	11	U	21	U			51	U	5.0	U	11	U	5.0	U
Acrolein	EPA 8260C			5.0	U	5.0	U	5.0	U			5.0	U	5.0	U	5.0	U	5.0	U
Acrylonitrile	EPA 8260C			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Bromobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Bromochloromethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Bromoethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Bromoform	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Bromomethane	EPA 8260C			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Carbon Disulfide	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Carbon Tetrachloride	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
CFC-11	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
CFC-113	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Chlorodibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Chloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Chloroform	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Chloromethane	EPA 8260C			0.5	UJ	0.5	U	0.5	U			0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
cis-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS		BF1		BF2		BF3	
Location ID				KC2062		KC2062		KC2062		KC2062		KC2062		NF2095		NF2095		NF2095	
Sample ID				KC2062-021111-W		KC2062-030411-W		KC2062-031511-W		KC2062-042711-W		KC2062-050411-W		NF2095-012611-W		NF2095-020411-W		NF2095-042111-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
Cumene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Dibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Dichlorobromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Ethylene Dibromide	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Methyl ethyl ketone	EPA 8260C			5.0	UJ	5.0	U	5.0	U			5.0	U	5.0	U	5.0	U	5.0	U
Methyl Iodide	EPA 8260C			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Methyl isobutyl ketone	EPA 8260C			5.0	U	5.0	U	5.0	U			5.0	U	5.0	U	5.0	U	5.0	U
Methylene Chloride	EPA 8260C			1.4	U	1.1	U	2.2	U			1.4	U	1.0	U	3.1	U	2.0	U
n-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
n-Propylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
p-Isopropyltoluene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
sec-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Styrene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
tert-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Tetrachloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
trans-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
trans-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
trans-1,4-Dichloro-2-butene	EPA 8260C			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Trichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Vinyl Acetate	EPA 8260C			1.0	UJ	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Vinyl Chloride	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
BTEX (µg/L)																			
Benzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Ethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Toluene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
m, p-Xylene	EPA 8260C			0.4	U	0.4	U	0.4	U			0.4	U	0.4	U	0.4	U	0.4	U
o-Xylene	EPA 8260C			0.2	U	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U
Total Xylenes	EPA 8260C			0.4	U	0.4	U	0.4	U			0.4	U	0.4	U	0.4	U	0.4	U
Brominated Diphenylethers (pg/L)																			
BDE-007	EPA 1614					2.57	U											0.627	U
BDE-008	EPA 1614					1.9	CU											0.137	CU
BDE-010	EPA 1614					2.73	U											0.409	U
BDE-011	EPA 1614					C8												C8	
BDE-012	EPA 1614					1.63	CU											0.564	CU
BDE-013	EPA 1614					C12												C12	
BDE-015	EPA 1614					1.38	U											0.344	U
BDE-017	EPA 1614					3.8	CU											**2.8**	**CJ**
BDE-025	EPA 1614					C17												C17	
BDE-028	EPA 1614					**9.1**	**CJ**											**3.49**	**CJ**
BDE-030	EPA 1614					3.73	U											0.573	U
BDE-032	EPA 1614					3.07	U											0.029	U
BDE-033	EPA 1614					C28												C28	
BDE-035	EPA 1614					2.65	U											0.0297	U
BDE-037	EPA 1614					2.51	U											0.43	U
BDE-047	EPA 1614					**266**												**103**	
BDE-049	EPA 1614					**14.6**	**J**											3.78	U
BDE-051	EPA 1614					1.83	U											0.379	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS		BF1		BF2		BF3	
Location ID				KC2062		KC2062		KC2062		KC2062		KC2062		NF2095		NF2095		NF2095	
Sample ID				KC2062-021111-W		KC2062-030411-W		KC2062-031511-W		KC2062-042711-W		KC2062-050411-W		NF2095-012611-W		NF2095-020411-W		NF2095-042111-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011		1/26/2011		2/5/2011		4/21/2011	
BDE-066	EPA 1614					**12.8**	**J**											3.28	U
BDE-071	EPA 1614					2.46	U											0.0689	U
BDE-075	EPA 1614					2.2	U											0.401	U
BDE-077	EPA 1614					1.47	U											0.0645	U
BDE-079	EPA 1614					1.76	U											0.573	U
BDE-085	EPA 1614					**11.3**	**J**											**8.26**	**J**
BDE-099	EPA 1614					**301**												**99.2**	
BDE-100	EPA 1614					**62.3**												**24.8**	**J**
BDE-105	EPA 1614					7.1	U											0.26	U
BDE-116	EPA 1614					9.24	U											**4.98**	**J**
BDE-119	EPA 1614					5.06	CU											1.43	CU
BDE-120	EPA 1614					C119												C119	
BDE-126	EPA 1614					3.11	U											0.789	U
BDE-128	EPA 1614					5.21	U											0.362	U
BDE-138	EPA 1614					**8.41**	**CJ**											9.16	CU
BDE-140	EPA 1614					3.07	U											2.12	U
BDE-153	EPA 1614					34.4	U											9.32	U
BDE-154	EPA 1614					28.2	U											**11**	**J**
BDE-155	EPA 1614					3.09	U											**1.63**	**J**
BDE-166	EPA 1614					C138												C138	
BDE-181	EPA 1614					4.51	U											9.32	U
BDE-183	EPA 1614					**21.1**	**J**											19.7	U
BDE-190	EPA 1614					8.44	U											4	U
BDE-203	EPA 1614					24.5	U											19.3	U
BDE-206	EPA 1614					149	U											60.8	U
BDE-207	EPA 1614					**305**												166	U
BDE-208	EPA 1614					**216**												**85.4**	
BDE-209	EPA 1614					**1960**												**737**	
Total BDEs	EPA 1614					**3190**	**CJ**											**1080**	**CJ**
Conventionals																			
Alkalinity as Bicarbonate (mg/L)	SM2320			**163**		**88.6**		**72.2**				**64.6**		**132**		**149**		**179**	
Alkalinity as Carbonate (mg/L)	SM2320			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity as Hydroxide (mg/L)	SM2320			1.0	U	1.0	U	1.0	U			1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity, Total (mg/L)	SM2320			**163**		**88.6**		**72.2**				**64.6**		**132**		**149**		**179**	
Chloride (mg/L)	EPA 300.0			**16.7**		**8.9**		**6.8**				**230**		**11.1**		**14.1**		**16.2**	
Dissolved Organic Carbon (mg/L)	EPA 415.1			**7.77**		**12.9**		**4.19**				**2.92**		**5.90**		**6.37**		**7.60**	
Hardness as CaCO3 (mg/L)	EPA 6010B			**110**		**67**		**50**				**120**		**150**		**170**		**190**	
Nitrate (mg/L)	EPA 300.0			0.1	U	0.2	U	**0.2**				0.3	U	**0.4**		**0.3**		**0.2**	
pH (su)	PH			**7.32**		**7.33**		**6.95**				**7.19**		**7.15**		**7.28**		**7.25**	
Sulfate (mg/L)	EPA 300.0			**5.3**		**5.6**		**3.7**				**36.4**		**34.4**		**40.1**		**37.2**	
Total Organic Carbon (mg/L)	EPA 415.1			**9.21**		**13.8**		**5.26**				**3.76**		**7.17**		**7.27**		**8.97**	
Total Solids (percent)	EPA 160.3																	**0**	
Total Suspended Solids (mg/L)	EPA 160.2			**21.6**		**16.0**		**11.9**		**77.0**		**18.0**		**10.0**		**8.9**		**10.4**	

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3	SW4	SW5	SW6	TS	BF1	BF2	BF3
Location ID				KC2062	KC2062	KC2062	KC2062	KC2062	NF2095	NF2095	NF2095
Sample ID				KC2062-021111-W	KC2062-030411-W	KC2062-031511-W	KC2062-042711-W	KC2062-050411-W	NF2095-012611-W	NF2095-020411-W	NF2095-042111-W
Collection Date				2/12/2011	3/5/2011	3/15/2011	4/27/2011	5/4/2011	1/26/2011	2/5/2011	4/21/2011

Bold results - Detected concentrations

yellow highlighted results - Washington State Chronic Marine Water Quality Criteria Exceedance

blue highlighted results - Washington State Acute Marine Water Quality Criteria Exceedance

BF = base flow; SW = storm water; TS = tidal sampling

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

N - Tentative identification

Total BDEs - BDE-007, BDE-008, BDE-010, BDE-011, BDE-012, BDE-013, BDE-015, BDE-017, BDE-025, BDE-028, BDE-030, BDE-032, BDE-033, BDE-035, BDE-037, BDE-047, BDE-049, BDE-051, BDE-066, BDE-071, BDE-075, BDE-077, BDE-079, BDE-085, BDE-099, BDE-100, BDE-105, BDE-116, BDE-119, BDE-120, BDE-126, BDE-128, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183, BDE-190, BDE-203, BDE-206, BDE-207, BDE-208, BDE-209

Chlordane - cis-Chlordane, trans-Chlordane

Total DDTs - 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Total Xylenes - m, p-Xylene, o-Xylene

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2	SW3	SW4	SW6	TS	BF2	BF3	SW2
Location ID				NF2095	NF2095	NF2095	NF2095	NF2095	PS2220	PS2220	PS2220
Sample ID				NF2095-012011-W	NF2095-021111-W	NF2095-030411-W	NF2095-042711-W	NF2095-050411-W	PS2220-020411-W	PS2220-042111-W	PS2220-012011-W
Collection Date				1/21/2011	2/12/2011	3/5/2011	4/27/2011	5/4/2011	2/5/2011	4/21/2011	1/21/2011
PCBs (µg/L)											
Aroclor 1016	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1221	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1232	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1242	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1248	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1254	EPA 8082			**0.010**	0.010 U	0.010 U	**0.014**	0.010 U	0.010 U	0.010 U	**0.011**
Aroclor 1260	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Total PCBs	EPA 8082	0.03	10	**0.010**	0.010 U	0.010 U	**0.014**	0.010 U	0.010 U	0.010 U	**0.011**
Metals – Total (µg/L)											
Arsenic	EPA 200.8			**1.1**	**1.4**	**0.5**	**0.9**	**1.2**	**1.2**	**1.1**	**3.3**
Cadmium	EPA 200.8			0.2 U	0.2 U	0.2 U	**0.3**	0.1 U	0.2 U	0.1 U	0.2 U
Calcium	EPA 6010B			**41500**	**43400**	**16100**	**7990**	**34700**	**28700**	**24500**	**21800**
Chromium	EPA 200.8			**0.9**	**0.9**	**0.9**	**2.0**	1 U	**43.8**	**1.0**	**23**
Copper	EPA 200.8			**3.4**	**3.5**	**4.4**	**7.1**	**2.7**	**5.4**	**4.9**	**21.9**
Lead	EPA 200.8			1 U	1 U	**1**	**6.2**	**0.4**	**2**	**1.6**	**9**
Magnesium	EPA 6010B			**14400**	**15400**	**4840**	**2930**	**12700**	**37700**	**26100**	**11800**
Mercury	EPA 7470A			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	EPA 200.8			**3.6**	**3.6**	**2.0**	**2.0**	**3.2**	**9.6**	**2.5**	**11.5**
Selenium	EPA 200.8			0.5 U	0.5 U	0.5 U	0.5 U	**0.8**	2 U	2 U	**0.6**
Silver	EPA 200.8			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	EPA 200.8			**29 J**	**29 J**	**42**	**57**	**14**	**45 J**	**101**	**360**
Metals – Dissolved (µg/L)											
Arsenic	EPA 200.8	36	69	**0.5**	**0.4**	**0.3**	0.2 U	**0.7**	0.5 U	**0.8**	**0.9**
Cadmium	EPA 200.8	9.3	42	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.2 U	0.1 U	0.2 U
Chromium	EPA 200.8			0.5 U	0.5 U	0.5 U	0.5 U	1 U	**0.6**	0.5 U	**0.8**
Copper	EPA 200.8	3.1	4.8	**1.7**	**1.5**	**2.8**	**2.2**	**1.8**	**1.0**	**1.4**	**1.6**
Lead	EPA 200.8	8.1	210	1 U	1 U	1 U	**0.2**	0.1 U	1 U	0.1 U	1 U
Mercury	EPA 7470A	0.025	1.8	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel	EPA 200.8	8.2	74	**3.3**	**2.1**	**1.7**	**1.1**	**3.2**	**7.3**	**1.7**	**3.2**
Selenium	EPA 200.8	71	290	0.5 U	0.5 U	0.5 U	0.5 U	**0.8**	2 U	2 U	0.5 U
Silver	EPA 200.8		1.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	EPA 200.8	81	90	**39 J**	**9**	**33**	**22**	**5**	**10 J**	**45**	**120**
Pesticides (µg/L)											
Aldrin	EPA 8081B	0.0019	0.71	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
alpha-BHC	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
beta-BHC	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
delta-BHC	EPA 8081B			0.050 U	0.050 UJ	0.050 UJ	0.050 UJ	0.050 UJ		0.050 UJ	0.050 U
Lindane	EPA 8081B		0.16	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
cis-Chlordane	EPA 8081B	0.004	0.09	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
trans-Chlordane	EPA 8081B	0.004	0.09	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
Chlordane	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
4,4'-DDD	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
4,4'-DDE	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
4,4'-DDT	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
Total DDTs	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
Dieldrin	EPA 8081B	0.0019	0.71	0.10 U	0.10 U	0.10 U	0.10 UJ	0.10 U		0.10 U	0.10 U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2	SW3	SW4	SW6	TS	BF2	BF3	SW2
Location ID				NF2095	NF2095	NF2095	NF2095	NF2095	PS2220	PS2220	PS2220
Sample ID				NF2095-012011-W	NF2095-021111-W	NF2095-030411-W	NF2095-042711-W	NF2095-050411-W	PS2220-020411-W	PS2220-042111-W	PS2220-012011-W
Collection Date				1/21/2011	2/12/2011	3/5/2011	4/27/2011	5/4/2011	2/5/2011	4/21/2011	1/21/2011
Endosulfan I	EPA 8081B	0.0087	0.034	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
Endosulfan II	EPA 8081B	0.0087	0.034	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
Endosulfan Sulfate	EPA 8081B	0.0087	0.034	0.10 U	0.10 UJ	0.10 U	0.10 UJ	0.10 U		0.10 U	0.10 U
Endrin	EPA 8081B	0.0023	0.037	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
Endrin Aldehyde	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 U	0.10 U		0.10 U	0.10 U
Endrin Ketone	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 UJ	0.10 U		0.10 U	0.10 U
Heptachlor	EPA 8081B	0.0036	0.05	0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
Heptachlor Epoxide	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 UJ	0.050 U		0.050 U	0.050 U
Methoxychlor	EPA 8081B			0.50 U	0.50 U	0.50 U	0.50 U	0.50 U		0.50 U	0.50 U
Toxaphene	EPA 8081B	0.0002	0.21	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U		5.0 U	5.0 U
Phenols (µg/L)											
2,4-Dimethylphenol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	**2.6**
o-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
p-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Pentachlorophenol	EPA 8270D			5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Phthalates (µg/L)											
Bis(2-Ethylhexyl) Phthalate	EPA 8270D			1.0 U	1.0 U	1.2 U	1.2 U	1.0 U	1.0 U	1.0 U	1.0 U
Butyl benzyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dibutyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Diethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dimethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-Octyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PAHs (µg/L)											
1-Methylnaphthalene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	**0.010**	0.010 U	0.010 U	**0.086** J
2-Methylnaphthalene	EPA 8270DSIM			0.010 U	0.010 U	**0.011**	0.010 U	**0.015**	**0.011**	0.010 U	**0.10** J
Acenaphthene	EPA 8270DSIM			0.010 U	**0.012**	0.010 U	0.010 U	**0.016**	0.010 U	0.010 U	**0.54** J
Acenaphthylene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.021** J
Anthracene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	**0.028**	**0.026** J	0.010 U	**0.33** J
Benzo(a)anthracene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	**0.050**	**0.039**	**0.11** J	**0.039**	**0.62** J
Benzo(a)pyrene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	**0.084**	**0.025**	**0.072**	**0.012**	**0.29** J
Benzo(g,h,i)perylene	EPA 8270DSIM			0.010 U	0.010 U	**0.014**	**0.12**	**0.014**	**0.038**	**0.012**	**0.17** J
Benzofluoranthene	EPA 8270DSIM			**0.011** J	**0.012**	**0.026**	**0.22**	**0.037**	**0.18**	**0.080**	**0.72** J
Chrysene	EPA 8270DSIM			0.010 U	0.010 U	**0.019**	**0.14**	**0.046**	**0.12** J	**0.084**	**0.60** J
Dibenzo(a,h)anthracene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	**0.026**	0.010 U	**0.017**	0.010 U	**0.087** J
Dibenzofuran	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.33** J
Fluoranthene	EPA 8270DSIM			**0.012** J	**0.019**	**0.028**	**0.19**	**0.10**	**0.27** J	**0.12**	**4.1** J
Fluorene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	**0.013**	**0.014**	0.010 U	**0.46** J
Indeno(1,2,3-cd)pyrene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	**0.10**	**0.011**	**0.032**	0.010 U	**0.15** J
Naphthalene	EPA 8270DSIM			0.032 U	**0.042**	**0.058**	**0.049**	**0.043**	0.019 U	**0.017**	**0.5**
Phenanthrene	EPA 8270DSIM			0.010 U	**0.014**	0.020 U	**0.076**	**0.091**	**0.052**	**0.022**	**0.89** J
Pyrene	EPA 8270DSIM			**0.012** J	**0.015**	**0.028**	**0.17**	**0.12**	**0.17**	**0.11**	**2.2** J
Total HPAHs	EPA 8270DSIM			**0.035** J	**0.046**	**0.12**	**1.1**	**0.39**	**1.0** J	**0.46**	**8.9** J
Total LPAHs	EPA 8270DSIM			0.032 U	**0.068**	**0.058**	**0.13**	**0.19**	**0.092** J	**0.039**	**2.7** J
SVOCs (µg/L)											
1,2,4-Trichlorobenzene	EPA 8260C			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2		SW3		SW4		SW6		TS		BF2		BF3		SW2	
Location ID				NF2095		NF2095		NF2095		NF2095		NF2095		PS2220		PS2220		PS2220	
Sample ID				NF2095-012011-W		NF2095-021111-W		NF2095-030411-W		NF2095-042711-W		NF2095-050411-W		PS2220-020411-W		PS2220-042111-W		PS2220-012011-W	
Collection Date				1/21/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		2/5/2011		4/21/2011		1/21/2011	
1,3-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,4-Dichlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Benzoic Acid	EPA 8270D			10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzyl Alcohol	EPA 8270D			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Hexachlorobenzene	8270D			0.050	U	0.050	U	0.050	U	0.050	UJ	0.050	U	1.0	U	0.050	U	0.050	U
Hexachlorobutadiene	8260C			0.050	U	0.050	U	0.050	U	0.050	U	0.050	U	0.5	U	0.050	U	0.050	U
Hexachloroethane	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
N-Nitrosodiphenylamine	EPA 8270D			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	UJ	1.0	U
VOCs (µg/L)																			
1,1,1,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,1-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,2,2-Tetrachloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1,2-Trichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2,3-Trichlorobenzene	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,3-Trichloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2,4-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dibromo-3-chloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3,5-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Hexanone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
4-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Acetone	EPA 8260C			5.0	U	5.0	UJ	11	U	6.4	U	8.0	U	6.3	U	5.0	U	11	U
Acrolein	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Acrylonitrile	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Bromobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromochloromethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromomethane	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Carbon Disulfide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Carbon Tetrachloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-11	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-113	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorodibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	**1.1**		0.2	U
Chloromethane	EPA 8260C			0.5	U	0.5	UJ	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
cis-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2		SW3		SW4		SW6		TS		BF2		BF3		SW2	
Location ID				NF2095		NF2095		NF2095		NF2095		NF2095		PS2220		PS2220		PS2220	
Sample ID				NF2095-012011-W		NF2095-021111-W		NF2095-030411-W		NF2095-042711-W		NF2095-050411-W		PS2220-020411-W		PS2220-042111-W		PS2220-012011-W	
Collection Date				1/21/2011		2/12/2011		3/5/2011		4/27/2011		5/4/2011		2/5/2011		4/21/2011		1/21/2011	
Cumene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dichlorobromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylene Dibromide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Methyl ethyl ketone	EPA 8260C			5.0	U	5.0	UJ	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methyl Iodide	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Methyl isobutyl ketone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methylene Chloride	EPA 8260C			0.8	U	1.3	U	1.1	U	3.6	U	2.4	U	2.3	U	2.0	U	0.8	U
n-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
n-Propylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
p-Isopropyltoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
sec-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Styrene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
tert-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Tetrachloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,4-Dichloro-2-butene	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Trichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Vinyl Acetate	EPA 8260C			1.0	U	1.0	UJ	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Vinyl Chloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
BTEX (µg/L)																			
Benzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Toluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
m, p-Xylene	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
o-Xylene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Total Xylenes	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Brominated Diphenylethers (pg/L)																			
BDE-007	EPA 1614							1.81	U	0.542	U					0.286	U		
BDE-008	EPA 1614							1.34	CU	0.535	CU					0.731	CU		
BDE-010	EPA 1614							1.93	U	0.389	U					0.508	U		
BDE-011	EPA 1614							C8		C8						C8			
BDE-012	EPA 1614							1.15	CU	2.12	CU					0.957	CU		
BDE-013	EPA 1614							C12		C12						C12			
BDE-015	EPA 1614							1.02	U	0.979	U					0.86	U		
BDE-017	EPA 1614							**7.77**	**CJ**	11.9	CU					3.38	CU		
BDE-025	EPA 1614							C17		C17						C17			
BDE-028	EPA 1614							11.8	CU	32.5	CU					7.22	CU		
BDE-030	EPA 1614							2.46	U	0.12	U					0.826	U		
BDE-032	EPA 1614							2.03	U	0.0864	U					0.549	U		
BDE-033	EPA 1614							C28		C28						C28			
BDE-035	EPA 1614							1.75	U	1.82	U					3.37	U		
BDE-037	EPA 1614							1.66	U	1.55	U					2.87	U		
BDE-047	EPA 1614							**592**		**723**						**162**			
BDE-049	EPA 1614							17.8	U	46.5	U					15.3	U		
BDE-051	EPA 1614							5.03	U	**6.05**	**J**					5.07	U		

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2	SW3	SW4	SW6	TS	BF2	BF3	SW2
Location ID				NF2095	NF2095	NF2095	NF2095	NF2095	PS2220	PS2220	PS2220
Sample ID				NF2095-012011-W	NF2095-021111-W	NF2095-030411-W	NF2095-042711-W	NF2095-050411-W	PS2220-020411-W	PS2220-042111-W	PS2220-012011-W
Collection Date				1/21/2011	2/12/2011	3/5/2011	4/27/2011	5/4/2011	2/5/2011	4/21/2011	1/21/2011
BDE-066	EPA 1614					**28.8** J	33.6 U			11.9 U	
BDE-071	EPA 1614					5.23 U	**5.81** J			7.44 U	
BDE-075	EPA 1614					1.69 U	3.01 U			0.141 U	
BDE-077	EPA 1614					1.02 U	0.172 U			**2.85** J	
BDE-079	EPA 1614					1.02 U	**5.93** J			**4.01** J	
BDE-085	EPA 1614					**39.3** J	**50.6**			**10.5** J	
BDE-099	EPA 1614					**819**	**947**			**209**	
BDE-100	EPA 1614					**169**	**214**			**43.3** J	
BDE-105	EPA 1614					5.55 U	6.13 U			3.21 U	
BDE-116	EPA 1614					7.23 U	**27.1** J			5.16 U	
BDE-119	EPA 1614					3.96 CU	7.31 CU			5.97 CU	
BDE-120	EPA 1614					C119	C119			C119	
BDE-126	EPA 1614					2.41 U	**2.58** J			1.54 U	
BDE-128	EPA 1614					8.5 U	15.7 U			6.3 U	
BDE-138	EPA 1614					16.5 CU	**27.9** CJ			9.45 CU	
BDE-140	EPA 1614					**3.45** J	11.3 U			2.33 U	
BDE-153	EPA 1614					**83.2**	**124**			**29.9** J	
BDE-154	EPA 1614					**67.2**	**118**			20.7 U	
BDE-155	EPA 1614					**5.17** J	7.32 U			3.52 U	
BDE-166	EPA 1614					C138	C138			C138	
BDE-181	EPA 1614					10.1 U	59.4 U			0.712 U	
BDE-183	EPA 1614					**59.5**	255 U			20.9 U	
BDE-190	EPA 1614					5.56 U	106 U			13.2 U	
BDE-203	EPA 1614					**310**	**1120**			34.8 U	
BDE-206	EPA 1614					**1100**	**4210**			**170**	
BDE-207	EPA 1614					**2300**	**6360**			**231**	
BDE-208	EPA 1614					**1540**	**5240**			**133**	
BDE-209	EPA 1614					**10900**	**34600**			1620 U	
Total BDEs	EPA 1614					**18000** CJ	**53800** CJ			**996** J	
Conventionals											
Alkalinity as Bicarbonate (mg/L)	SM2320			**150**	**159**	**53.6**	**32.4**	**140**	**160**	**106**	**108**
Alkalinity as Carbonate (mg/L)	SM2320			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Alkalinity as Hydroxide (mg/L)	SM2320			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Alkalinity, Total (mg/L)	SM2320			**150**	**159**	**53.6**	**32.4**	**140**	**160**	**106**	**108**
Chloride (mg/L)	EPA 300.0			**13.4**	**13.3**	**11.2**	**2.6**	**11.6**	**492**	**333**	**60.3**
Dissolved Organic Carbon (mg/L)	EPA 415.1			**6.88**	**6.43**	**5.23**	**3.96**	**6.93**	**4.34**	**3.03**	**9.00**
Hardness as CaCO3 (mg/L)	EPA 6010B			**160**	**170**	**60**	**32**	**140**	**230**	**170**	**100**
Nitrate (mg/L)	EPA 300.0			**0.5**	**0.2**	0.3 U	0.2 U	0.2 U	**0.2**	0.1 U	**0.2**
pH (su)	PH			**7.24**	**7.40**	**7.72**	**6.96**	**7.54**	**7.77**	**7.54**	**7.48**
Sulfate (mg/L)	EPA 300.0			**39.1**	**35.4**	**11.5**	**4.6**	**23.6**	**77.6**	**49.8**	**17.3**
Total Organic Carbon (mg/L)	EPA 415.1			**8.76**	**9.16**	**6.06**	**6.72**	**7.84**	**4.73**	**3.56**	**10.4**
Total Solids (percent)	EPA 160.3						**0**			**0**	
Total Suspended Solids (mg/L)	EPA 160.2			**10.8**	**30.8**	**7.3**	**35.8**	**10.4**	**75.8**	**9.9**	**163**

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW2	SW3	SW4	SW6	TS	BF2	BF3	SW2
Location ID				NF2095	NF2095	NF2095	NF2095	NF2095	PS2220	PS2220	PS2220
Sample ID				NF2095-012011-W	NF2095-021111-W	NF2095-030411-W	NF2095-042711-W	NF2095-050411-W	PS2220-020411-W	PS2220-042111-W	PS2220-012011-W
Collection Date				1/21/2011	2/12/2011	3/5/2011	4/27/2011	5/4/2011	2/5/2011	4/21/2011	1/21/2011

Bold results - Detected concentrations

yellow highlighted results - Washington State Chronic Marine Water Quality Criteria Exceedance

blue highlighted results - Washington State Acute Marine Water Quality Criteria Exceedance

BF = base flow; SW = storm water; TS = tidal sampling

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

N - Tentative identification

Total BDEs - BDE-007, BDE-008, BDE-010, BDE-011, BDE-012, BDE-013, BDE-015, BDE-017, BDE-025, BDE-028, BDE-030, BDE-032, BDE-033, BDE-035, BDE-037, BDE-047, BDE-049, BDE-051, BDE-066, BDE-071, BDE-075, BDE-077, BDE-079, BDE-085, BDE-099, BDE-100, BDE-105, BDE-116, BDE-119, BDE-120, BDE-126, BDE-128, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183, BDE-190, BDE-203, BDE-206, BDE-207, BDE-208, BDE-209

Chlordane - cis-Chlordane, trans-Chlordane

Total DDTs - 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Total Xylenes - m, p-Xylene, o-Xylene

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS	
Location ID				PS2220		PS2220		PS2220		PS2220		PS2220	
Sample ID				PS2220-021111-W		PS2220-030411-W		PS2220-031511-W		PS2220-042711-W		PS2220-050411-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011	
PCBs (µg/L)													
Aroclor 1016	EPA 8082					0.010	U	0.010	UJ	0.010	U	0.010	U
Aroclor 1221	EPA 8082					0.010	U	0.010	UJ	0.010	U	0.010	U
Aroclor 1232	EPA 8082					0.010	U	0.010	UJ	0.010	U	0.010	U
Aroclor 1242	EPA 8082					0.010	U	0.010	UJ	0.010	U	0.010	U
Aroclor 1248	EPA 8082					0.013	U	0.010	UJ	0.010	U	0.010	U
Aroclor 1254	EPA 8082					**0.013**		0.010	UJ	0.010	U	0.010	U
Aroclor 1260	EPA 8082					0.010	U	0.010	UJ	0.010	U	0.010	U
Total PCBs	EPA 8082	0.03	10			**0.013**		0.010	UJ	0.010	U	0.010	U
Metals – Total (µg/L)													
Arsenic	EPA 200.8					**24.6**		**32.4**		**2.9**		**2**	
Cadmium	EPA 200.8					**0.3**		**0.3**		**0.2**		0.2	U
Calcium	EPA 6010B					**20100**		**20100**		**11500**		**82700**	
Chromium	EPA 200.8					**15**		**20.9**		**7.9**		1	U
Copper	EPA 200.8					**73.6**		**102**		**35.6**		**3**	
Lead	EPA 200.8					**20**		**30**		**12.1**		0.2	U
Magnesium	EPA 6010B					**10700**		**7480**		**3230**		**234000**	
Mercury	EPA 7470A					0.1	U	0.1	U	0.1	U	0.1	U
Nickel	EPA 200.8					**18.2**		**24.8**		**8.0**		**4**	
Selenium	EPA 200.8					0.5	U	0.5	U	0.5	U	**6**	
Silver	EPA 200.8					0.2	U	0.2	U	0.2	U	0.5	U
Zinc	EPA 200.8					**390**		**550**		**221**		**10**	
Metals – Dissolved (µg/L)													
Arsenic	EPA 200.8	36	69			**14.1**		**17.2**		**0.9**		**1**	
Cadmium	EPA 200.8	9.3	42			0.2	U	0.2	U	0.1	U	0.2	U
Chromium	EPA 200.8					**1.2**		**4.5**		**1.4**		1	U
Copper	EPA 200.8	3.1	4.8			**7.6**		**6.6**		**9.1**		**2**	
Lead	EPA 200.8	8.1	210			1	U	1	U	**0.2**		0.2	U
Mercury	EPA 7470A	0.025	1.8			0.02	U	0.0200	U	0.02	U	0.02	U
Nickel	EPA 200.8	8.2	74			**1.2**		**1.1**		**1.2**		**4**	
Selenium	EPA 200.8	71	290			0.5	U	0.5	U	0.5	U	5	U
Silver	EPA 200.8		1.9			0.2	U	0.2	U	0.2	U	0.5	U
Zinc	EPA 200.8	81	90			**14**		**5**		**32**		10	U
Pesticides (µg/L)													
Aldrin	EPA 8081B	0.0019	0.71			0.050	U	0.050	U	0.050	UJ	0.050	U
alpha-BHC	EPA 8081B					0.050	U	0.050	UJ	0.050	UJ	0.050	U
beta-BHC	EPA 8081B					0.050	U	0.050	U	0.050	UJ	0.050	U
delta-BHC	EPA 8081B					0.050	UJ	0.050	UJ	0.050	UJ	0.050	UJ
Lindane	EPA 8081B		0.16			0.050	U	0.050	U	0.050	UJ	0.050	U
cis-Chlordane	EPA 8081B	0.004	0.09			0.050	U	0.050	U	0.050	UJ	0.050	U
trans-Chlordane	EPA 8081B	0.004	0.09			0.050	U	0.050	U	0.050	UJ	0.050	U
Chlordane	EPA 8081B					0.050	U	0.050	U	0.050	UJ	0.050	U
4,4'-DDD	EPA 8081B	0.001	0.13			0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDE	EPA 8081B	0.001	0.13			0.10	U	0.10	U	0.10	U	0.10	U
4,4'-DDT	EPA 8081B	0.001	0.13			0.10	U	0.10	U	0.10	U	0.10	U
Total DDTs	EPA 8081B					0.10	U	0.10	U	0.10	U	0.10	U
Dieldrin	EPA 8081B	0.0019	0.71			0.10	U	0.10	U	0.10	UJ	0.10	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS	
Location ID				PS2220		PS2220		PS2220		PS2220		PS2220	
Sample ID				PS2220-021111-W		PS2220-030411-W		PS2220-031511-W		PS2220-042711-W		PS2220-050411-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011	
Endosulfan I	EPA 8081B	0.0087	0.034			0.050	U	0.050	U	0.050	UJ	0.050	U
Endosulfan II	EPA 8081B	0.0087	0.034			0.10	U	0.10	UJ	0.10	U	0.10	U
Endosulfan Sulfate	EPA 8081B	0.0087	0.034			0.10	U	0.10	UJ	0.10	UJ	0.10	U
Endrin	EPA 8081B	0.0023	0.037			0.10	U	0.10	U	0.10	U	0.10	U
Endrin Aldehyde	EPA 8081B					0.10	U	0.10	U	0.10	U	0.10	U
Endrin Ketone	EPA 8081B					0.10	U	0.10	UJ	0.10	UJ	0.10	U
Heptachlor	EPA 8081B	0.0036	0.05			0.050	U	0.050	U	0.050	UJ	0.050	U
Heptachlor Epoxide	EPA 8081B					0.050	U	0.050	U	0.050	UJ	0.050	U
Methoxychlor	EPA 8081B					0.50	U	0.50	U	0.50	U	0.50	U
Toxaphene	EPA 8081B	0.0002	0.21			5.0	U	5.0	U	5.0	U	5.0	U
Phenols (µg/L)													
2,4-Dimethylphenol	EPA 8270D					**3.6**		**0.8**	**J**	1.0	U	1.0	U
o-Cresol	EPA 8270D					**2.1**		1.0	U	1.0	U	1.0	U
p-Cresol	EPA 8270D					**6.5**		1.0	U	1.0	U	1.0	U
Pentachlorophenol	EPA 8270D					5.0	U	5.0	U	5.0	U	5.0	U
Phenol	EPA 8270D					**6.6**		**0.7**	**J**	1.0	U	1.0	U
Phthalates (µg/L)													
Bis(2-Ethylhexyl) Phthalate	EPA 8270D					1.7	U	1.0	U	1.0	U	1.0	U
Butyl benzyl phthalate	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
Dibutyl phthalate	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
Diethyl phthalate	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
Dimethyl phthalate	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
Di-n-Octyl phthalate	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
PAHs (µg/L)													
1-Methylnaphthalene	EPA 8270DSIM					**0.058**		**0.19**		0.010	U	0.010	U
2-Methylnaphthalene	EPA 8270DSIM					**0.094**		**0.30**		0.010	U	0.010	U
Acenaphthene	EPA 8270DSIM					**0.44**		**0.96**		**0.022**		0.010	U
Acenaphthylene	EPA 8270DSIM					**0.020**		0.050	U	0.010	U	0.010	U
Anthracene	EPA 8270DSIM					**0.38**		**0.74**		**0.048**		0.010	U
Benzo(a)anthracene	EPA 8270DSIM					**1.0**		**1.2**		**0.16**		0.010	U
Benzo(a)pyrene	EPA 8270DSIM					**0.83**		**0.85**		**0.14**		0.010	U
Benzo(g,h,i)perylene	EPA 8270DSIM					**0.31**		**0.62**		**0.14**		0.010	U
Benzofluoranthene	EPA 8270DSIM					**1.7**		**2.2**		**0.40**		0.010	U
Chrysene	EPA 8270DSIM					**1.5**		**2.2**		**0.39**		0.010	U
Dibenzo(a,h)anthracene	EPA 8270DSIM					**0.13**		**0.27**		**0.042**		0.010	U
Dibenzofuran	EPA 8270DSIM					**0.31**		**0.72**		0.010	U	0.010	U
Fluoranthene	EPA 8270DSIM					**5.6**		**6.4**		**0.70**		0.010	U
Fluorene	EPA 8270DSIM					**0.42**		**1.1**		**0.028**		0.010	U
Indeno(1,2,3-cd)pyrene	EPA 8270DSIM					**0.28**		**0.48**		**0.12**		0.010	U
Naphthalene	EPA 8270DSIM					**0.19**		**0.8**	**J**	0.010	U	**0.041**	
Phenanthrene	EPA 8270DSIM					**1.3**		**3.8**		**0.22**		0.010	U
Pyrene	EPA 8270DSIM					**4.0**		**4.6**		**0.61**		0.010	U
Total HPAHs	EPA 8270DSIM					**15**		**19**		**2.7**		0.010	U
Total LPAHs	EPA 8270DSIM					**2.8**		**7.4**	**J**	**0.32**		**0.041**	
SVOCs (µg/L)													
1,2,4-Trichlorobenzene	EPA 8260C					0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichlorobenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS	
Location ID				PS2220		PS2220		PS2220		PS2220		PS2220	
Sample ID				PS2220-021111-W		PS2220-030411-W		PS2220-031511-W		PS2220-042711-W		PS2220-050411-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011	
1,3-Dichlorobenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,4-Dichlorobenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Benzoic Acid	EPA 8270D					10	U	10	U	10	U	10	U
Benzyl Alcohol	EPA 8270D					5.0	U	5.0	U	5.0	U	5.0	U
Hexachlorobenzene	8270D					0.050	U	0.050	U	0.050	UJ	0.050	U
Hexachlorobutadiene	8260C					0.050	U	0.050	U	0.050	U	0.050	U
Hexachloroethane	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
N-Nitrosodiphenylamine	EPA 8270D					1.0	U	1.0	U	1.0	U	1.0	U
VOCs (µg/L)													
1,1,1,2-Tetrachloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1,1-Trichloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1,2,2-Tetrachloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1,2-Trichloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloroethene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,1-Dichloropropene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,2,3-Trichlorobenzene	EPA 8260C					0.5	U	0.5	U	0.5	U	0.5	U
1,2,3-Trichloropropane	EPA 8260C					0.5	U	0.5	U	0.5	U	0.5	U
1,2,4-Trimethylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dibromo-3-chloropropane	EPA 8260C					0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dichloropropane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,3,5-Trimethylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichloropropane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
2,2-Dichloropropane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
2-Chlorotoluene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
2-Hexanone	EPA 8260C					5.0	U	5.0	U	5.0	U	5.0	U
4-Chlorotoluene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Acetone	EPA 8260C					21	U	8.5	U	6.2	U	9.9	U
Acrolein	EPA 8260C					5.0	U	5.0	U	5.0	U	5.0	U
Acrylonitrile	EPA 8260C					1.0	U	1.0	U	1.0	U	1.0	U
Bromobenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Bromochloromethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Bromoethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Bromoform	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Bromomethane	EPA 8260C					1.0	U	1.0	U	1.0	U	1.0	U
Carbon Disulfide	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Carbon Tetrachloride	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
CFC-11	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
CFC-113	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Chlorodibromomethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Chloroethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Chloroform	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Chloromethane	EPA 8260C					0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
cis-1,3-Dichloropropene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS	
Location ID				PS2220		PS2220		PS2220		PS2220		PS2220	
Sample ID				PS2220-021111-W		PS2220-030411-W		PS2220-031511-W		PS2220-042711-W		PS2220-050411-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011	
Cumene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Dibromomethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Dichlorobromomethane	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Ethylene Dibromide	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Methyl ethyl ketone	EPA 8260C					5.0	U	5.0	U	5.0	U	5.0	U
Methyl Iodide	EPA 8260C					1.0	U	1.0	U	1.0	U	1.0	U
Methyl isobutyl ketone	EPA 8260C					5.0	U	5.0	U	5.0	U	5.0	U
Methylene Chloride	EPA 8260C					1.2	U	12	U	2.3	U	2.8	U
n-Butylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
n-Propylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
p-Isopropyltoluene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
sec-Butylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Styrene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
tert-Butylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Tetrachloroethene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
trans-1,2-Dichloroethene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
trans-1,3-Dichloropropene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
trans-1,4-Dichloro-2-butene	EPA 8260C					1.0	U	1.0	U	1.0	U	1.0	U
Trichloroethene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Vinyl Acetate	EPA 8260C					1.0	U	1.0	U	1.0	U	1.0	U
Vinyl Chloride	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
BTEX (µg/L)													
Benzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Ethylbenzene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Toluene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
m, p-Xylene	EPA 8260C					0.4	U	0.4	U	0.4	U	0.4	U
o-Xylene	EPA 8260C					0.2	U	0.2	U	0.2	U	0.2	U
Total Xylenes	EPA 8260C					0.4	U	0.4	U	0.4	U	0.4	U
Brominated Diphenylethers (pg/L)													
BDE-007	EPA 1614					2.92	U			1.35	U		
BDE-008	EPA 1614					2.16	CU			1.06	CU		
BDE-010	EPA 1614					3.1	U			1.55	U		
BDE-011	EPA 1614					C8				C8			
BDE-012	EPA 1614					1.85	CU			1.06	CU		
BDE-013	EPA 1614					C12				C12			
BDE-015	EPA 1614					2.48	U			1.06	U		
BDE-017	EPA 1614					**24.9**	**CJ**			6.48	CU		
BDE-025	EPA 1614					C17				C17			
BDE-028	EPA 1614					**45.1**	**CJ**			12.8	CU		
BDE-030	EPA 1614					3.44	U			1.06	U		
BDE-032	EPA 1614					2.84	U			1.06	U		
BDE-033	EPA 1614					C28				C28			
BDE-035	EPA 1614					7.66	U			4.12	U		
BDE-037	EPA 1614					**2.5**	**J**			1.14	U		
BDE-047	EPA 1614					**1140**				**372**			
BDE-049	EPA 1614					**65.4**				**23**	**J**		
BDE-051	EPA 1614					**7.57**	**J**			2.36	U		

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3		SW4		SW5		SW6		TS	
Location ID				PS2220		PS2220		PS2220		PS2220		PS2220	
Sample ID				PS2220-021111-W		PS2220-030411-W		PS2220-031511-W		PS2220-042711-W		PS2220-050411-W	
Collection Date				2/12/2011		3/5/2011		3/15/2011		4/27/2011		5/4/2011	
BDE-066	EPA 1614					**55.9**				**17.3**	**J**		
BDE-071	EPA 1614					9.9	U			4.25	U		
BDE-075	EPA 1614					4.61	U			1.16	U		
BDE-077	EPA 1614					2.09	U			1.06	U		
BDE-079	EPA 1614					1.01	U			1.43	U		
BDE-085	EPA 1614					**61.3**				**20.1**	**J**		
BDE-099	EPA 1614					**1360**				**404**			
BDE-100	EPA 1614					**289**				**87**			
BDE-105	EPA 1614					12.2	U			3.53	U		
BDE-116	EPA 1614					15.9	U			5.49	U		
BDE-119	EPA 1614					8.7	CU			3	CU		
BDE-120	EPA 1614					C119				C119			
BDE-126	EPA 1614					5.36	U			1.79	U		
BDE-128	EPA 1614					60.5	U			34.8	U		
BDE-138	EPA 1614					**30.6**	**CJ**			11.5	CU		
BDE-140	EPA 1614					10.9	U			6.88	U		
BDE-153	EPA 1614					**168**				**51.3**	**J**		
BDE-154	EPA 1614					**123**				**39.7**	**J**		
BDE-155	EPA 1614					8.35	U			4.76	U		
BDE-166	EPA 1614					C138				C138			
BDE-181	EPA 1614					17.6	U			17.3	U		
BDE-183	EPA 1614					**178**				**55.9**			
BDE-190	EPA 1614					32.9	U			31.5	U		
BDE-203	EPA 1614					**321**				95.7	U		
BDE-206	EPA 1614					**1610**				**397**			
BDE-207	EPA 1614					**2360**				**661**			
BDE-208	EPA 1614					**1670**				**344**			
BDE-209	EPA 1614					**15200**				**3780**			
Total BDEs	EPA 1614					**24700**	**CJ**			**6250**	**J**		
Conventionals													
Alkalinity as Bicarbonate (mg/L)	SM2320					**48.1**		**51.1**		**29.6**		**51.6**	
Alkalinity as Carbonate (mg/L)	SM2320					1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity as Hydroxide (mg/L)	SM2320					1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity, Total (mg/L)	SM2320					**48.1**		**51.1**		**29.6**		**51.6**	
Chloride (mg/L)	EPA 300.0					**70.0**		**9.2**		**7.0**		**3750**	
Dissolved Organic Carbon (mg/L)	EPA 415.1					**8.64**		**6.10**		**5.53**		**1.81**	
Hardness as CaCO3 (mg/L)	EPA 6010B					**94**		**81**		**42**		**1200**	
Nitrate (mg/L)	EPA 300.0					0.2	U	**0.2**		0.2	U	0.6	U
pH (su)	PH					**7.67**		**7.91**		**6.89**		**7.34**	
Sulfate (mg/L)	EPA 300.0					**11.4**		**4.1**		**4.6**		**558**	
Total Organic Carbon (mg/L)	EPA 415.1					**21.3**		**16.8**		**14.9**		**2.08**	
Total Solids (percent)	EPA 160.3									**0**			
Total Suspended Solids (mg/L)	EPA 160.2			**271**		**207**		**280**		**107**		**5.7**	

Table E-1. Whole Water Sample Analytical Results

Event ID	Method	Washington State Marine Water Quality Chronic	Washington State Marine Water Quality Acute	SW3	SW4	SW5	SW6	TS
Location ID				PS2220	PS2220	PS2220	PS2220	PS2220
Sample ID				PS2220-021111-W	PS2220-030411-W	PS2220-031511-W	PS2220-042711-W	PS2220-050411-W
Collection Date				2/12/2011	3/5/2011	3/15/2011	4/27/2011	5/4/2011

Bold results - Detected concentrations

yellow highlighted results - Washington State Chronic Marine Water Quality Criteria Exceedance

blue highlighted results - Washington State Acute Marine Water Quality Criteria Exceedance

BF = base flow; SW = storm water; TS = tidal sampling

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

N - Tentative identification

Total BDEs - BDE-007, BDE-008, BDE-010, BDE-011, BDE-012, BDE-013, BDE-015, BDE-017, BDE-025, BDE-028, BDE-030, BDE-032, BDE-033, BDE-035, BDE-037, BDE-047, BDE-049, BDE-051, BDE-066, BDE-071, BDE-075, BDE-077, BDE-079, BDE-085, BDE-099, BDE-100, BDE-105, BDE-116, BDE-119, BDE-120, BDE-126, BDE-128, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183, BDE-190, BDE-203, BDE-206, BDE-207, BDE-208, BDE-209

Chlordane - cis-Chlordane, trans-Chlordane

Total DDTs - 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Total Xylenes - m, p-Xylene, o-Xylene

Table E-2. Filtered Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	SW3		SW3		SW4		SW4		SW5		SW5		SW6		SW6	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088	
Sample ID				BDC2088A-021111-S		BDC2088B-021111-S		BDC2088A-030411-S		BDC2088B-030411-S		BDC2088A-031511-S		BDC2088B-031511-S		BDC2088A-042711-S		BDC2088B-042711-S	
Collection Date				2/12/2011		2/12/2011		3/5/2011		3/5/2011		3/15/2011		3/15/2011		4/27/2011		4/27/2011	
Filter				A		B		A		B		A		B		A		B	
Mass Of Solids (g)				36.07		37.41		6.37		6.37		21.14		21.14		2.87		2.87	
Dioxins and Furans (pg/g)																			
1,2,3,4,6,7,8-HPCDD	EPA 1613					**306**								**577**					
1,2,3,4,7,8-HXCDD	EPA 1613					**5.3**	J							**12.9**					
1,2,3,6,7,8-HXCDD	EPA 1613					**16.4**								**29.0**					
1,2,3,7,8,9-HXCDD	EPA 1613					**12.7**	J							**56.3**					
1,2,3,7,8-PECDD	EPA 1613					**2.57**	J							**6.58**					
2,3,7,8-TCDD	EPA 1613					0.506	U							**0.653**	J				
OCDD	EPA 1613					**2430**								**4390**					
1,2,3,4,6,7,8-HPCDF	EPA 1613					**66.5**								**93.7**					
1,2,3,4,7,8,9-HPCDF	EPA 1613					**3.64**	J							**6.10**					
1,2,3,4,7,8-HXCDF	EPA 1613					**7.14**	J							**7.33**					
1,2,3,6,7,8-HXCDF	EPA 1613					**3.86**	J							**4.65**					
1,2,3,7,8,9-HXCDF	EPA 1613					**0.209**	J							**0.202**	J				
1,2,3,7,8-PECDF	EPA 1613					**1.65**	J							**1.37**	J				
2,3,4,6,7,8-HXCDF	EPA 1613					**3.27**	J							**3.89**					
2,3,4,7,8-PECDF	EPA 1613					**2.47**	J							**1.89**	J				
2,3,7,8-TCDF	EPA 1613					**1.52**	J							**2.26**					
OCDF	EPA 1613					**141**								**207**					
Total HpCDD	EPA 1613					**618**								**1050**					
Total HxCDD	EPA 1613					**114**								**267**					
Total PeCDD	EPA 1613					**18.8**								**46.5**					
Total TCDD	EPA 1613					**8.86**								**11.0**					
Total HpCDF	EPA 1613					**170**								**246**					
Total HxCDF	EPA 1613					**109**								**107**					
Total PeCDF	EPA 1613					**50.8**								**39.1**					
Total TCDF	EPA 1613					**35.5**								**29.4**					
TOTAL Dioxin/Furan TEQ, ND*0.5	EPA 1613					**13.2**	J							**27.6**	J				
PCBs (mg/kg)																			
Aroclor 1016	EPA 8082			0.014	U					0.078	U					0.35	U		
Aroclor 1221	EPA 8082			0.014	U					0.078	U					0.35	U		
Aroclor 1232	EPA 8082			0.014	U					0.078	U					0.35	U		
Aroclor 1242	EPA 8082			0.014	U					0.078	U					0.35	U		
Aroclor 1248	EPA 8082			0.042	U					0.24	U					0.35	U		
Aroclor 1254	EPA 8082			**0.10**						**0.60**						**0.42**			
Aroclor 1260	EPA 8082			**0.11**						**0.22**						0.35	U		
Total PCBs	EPA 8082	0.13	1	**0.21**						**0.82**						**0.42**			
Metals – Total (mg/kg)																			
Arsenic	EPA 6010B	57	93	20	U														
Cadmium	EPA 6010B	5.1	6.7	**3.7**															
Chromium	EPA 6010B	260	270	**122**															
Copper	EPA 6010B	390	390	**168**															
Lead	EPA 6010B	450	530	**173**															
Mercury	EPA 7471A	0.41	0.59	**0.21**															
Silver	EPA 6010B	6.1	6.1	**3**															
Zinc	EPA 6010B	410	960	**1520**															

Table E-2. Filtered Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	SW3		SW3		SW4		SW4		SW5		SW5		SW6		SW6	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088	
Sample ID				BDC2088A-021111-S		BDC2088B-021111-S		BDC2088A-030411-S		BDC2088B-030411-S		BDC2088A-031511-S		BDC2088B-031511-S		BDC2088A-042711-S		BDC2088B-042711-S	
Collection Date				2/12/2011		2/12/2011		3/5/2011		3/5/2011		3/15/2011		3/15/2011		4/27/2011		4/27/2011	
Filter				A		B		A		B		A		B		A		B	
Mass Of Solids (g)				36.07		37.41		6.37		6.37		21.14		21.14		2.87		2.87	
PAHs (mg/kg)																			
1-Methylnaphthalene	EPA 8270D							**0.33**				0.14	U					**1.1**	
2-Methylnaphthalene	EPA 8270D	0.67	1.4					**0.35**				**0.17**						**1.4**	
Acenaphthene	EPA 8270D	0.5	0.73					**0.31**				0.14	U					**1.2**	
Acenaphthylene	EPA 8270D	1.3	1.3					0.19	U			0.14	U					0.87	U
Anthracene	EPA 8270D	0.96	4.4					**0.72**				**0.25**						**2.4**	
Benzo(a)anthracene	EPA 8270D	1.3	1.6					**5.0**				**1.8**						**15**	
Benzo(a)pyrene	EPA 8270D	1.6	3					**6.3**				**2.3**						**21**	
Benzo(g,h,i)perylene	EPA 8270D	0.67	0.72					**5.5**				**1.8**						**19**	
Benzofluoranthene	EPA 8270D	3.2	3.6					**16**				**5.7**						**49**	
Chrysene	EPA 8270D	1.4	2.8					**8.6**				**3.4**						**28**	
Dibenzo(a,h)anthracene	EPA 8270D	0.23	0.54					**0.31**				0.14	U					0.87	U
Dibenzofuran	EPA 8270D	0.54	0.7					**0.55**				**0.17**						**1.8**	
Fluoranthene	EPA 8270D	1.7	2.5					**22**				**4.7**						**45**	
Fluorene	EPA 8270D	0.54	1					**0.57**				**0.17**						**1.6**	
Indeno(1,2,3-cd)pyrene	EPA 8270D	0.6	0.69					**5.2**				**1.7**						**16**	
Naphthalene	EPA 8270D	2.1	2.4					**0.46**				**0.24**						**2.6**	
Phenanthrene	EPA 8270D	1.5	5.4					**7.8**				**2.6**						**25**	
Pyrene	EPA 8270D	2.6	3.3					**9.7**				**4.7**						**34**	
Total HPAHs	EPA 8270D	12	17					**78**				**26**						**230**	
Total LPAHs	EPA 8270D	5.2	13					**9.9**				**3.3**						**33**	
Grain Size (percent)																			
Phi Scale -1 to 0	PSEP-PS																		
Phi Scale <-1	PSEP-PS																		
Phi Scale 0 to 1	PSEP-PS																		
Phi Scale 1 to 2	PSEP-PS																		
Phi Scale 2 to 3	PSEP-PS																		
Phi Scale 3 to 4	PSEP-PS																		
Phi Scale 4 to 5	PSEP-PS																		
Phi Scale 5 to 6	PSEP-PS																		
Phi Scale 6 to 7	PSEP-PS																		
Phi Scale 7 to 8	PSEP-PS																		
Phi Scale 8 to 9	PSEP-PS																		
Phi Scale 9 to 10	PSEP-PS																		
Phi Scale >10	PSEP-PS																		
Percent Gravel (>2.0 mm)	PSEP-PS																		
Percent Sand (<2.0 mm - 0.06 mm)	PSEP-PS																		
Percent Silt (0.06 mm - 0.004 mm)	PSEP-PS																		
Percent Clay (<0.004 mm - 0.004 mm)	PSEP-PS																		
Total Fines (Silt/Clay)	PSEP-PS																		

Table E-2. Filtered Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	SW3		SW3		SW4		SW4		SW5		SW5		SW6		SW6	
Location ID				BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088		BDC2088	
Sample ID				BDC2088A-021111-S		BDC2088B-021111-S		BDC2088A-030411-S		BDC2088B-030411-S		BDC2088A-031511-S		BDC2088B-031511-S		BDC2088A-042711-S		BDC2088B-042711-S	
Collection Date				2/12/2011		2/12/2011		3/5/2011		3/5/2011		3/15/2011		3/15/2011		4/27/2011		4/27/2011	
Filter				A		B		A		B		A		B		A		B	
Mass Of Solids (g)				36.07		37.41		6.37		6.37		21.14		21.14		2.87		2.87	

Bold results - Detected concentrations

yellow highlighted results - Washington State SQL/LAET Criteria Exceedance

blue highlighted results - Washington State CSL/2LAET Criteria Exceedance

BF = base flow; SW = storm water; TS = tidal sampling

SQS - Washington State Sediment Quality Standard

CSL - Washington State Cleanup Screening Level

LAET - lowest apparent effects threshold

2LAET - second lowest apparent effects threshold

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Percent Clay (<0.004 mm - 0.004 mm) - Phi Scale 8 to 9, Phi Scale 9 to 10, Phi Scale >10

Percent Gravel (>2.0 mm) - Phi Scale <-1

Percent Sand (<2.0 mm - 0.06 mm) - Phi Scale -1 to 0, Phi Scale 0 to 1, Phi Scale 1 to 2, Phi Scale 2 to 3, Phi Scale 3 to 4

Percent Silt (0.06 mm - 0.004 mm) - Phi Scale 4 to 5, Phi Scale 5 to 6, Phi Scale 6 to 7, Phi Scale 7 to 8

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Table E-3. Sediment Trap Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Sediment Trap		Sediment Trap		Sediment Trap		Sediment Trap	
Location ID				BDC2088		KC2062		NF2095		PS2220	
Sample ID				BDC2088-050511-T		KC2062-050511-T		NF2095-050511-T		PS2220-050511-T	
Collection Date				5/5/2011		5/5/2011		5/5/2011		5/5/2011	
Dioxins and Furans (ng/kg)											
1,2,3,4,6,7,8-HPCDD	EPA 1613					109		402		1990	
1,2,3,4,7,8-HXCDD	EPA 1613					2.85	J	8.7	J	19.3	J
1,2,3,6,7,8-HXCDD	EPA 1613					7.01	J	19.6	J	74.9	J
1,2,3,7,8,9-HXCDD	EPA 1613					8.95	J	21.8	J	48.1	J
1,2,3,7,8-PECDD	EPA 1613					2.23	J	4.84	J	7.33	J
2,3,7,8-TCDD	EPA 1613					1.49		1.83		0.782	J
OCDD	EPA 1613					824		3530		19500	
1,2,3,4,6,7,8-HPCDF	EPA 1613					22.6		96		1030	
1,2,3,4,7,8,9-HPCDF	EPA 1613					1.62	J	6.16		73.5	
1,2,3,4,7,8-HXCDF	EPA 1613					2.26	J	7.64		21.7	
1,2,3,6,7,8-HXCDF	EPA 1613					1.72	J	5.53		15.1	
1,2,3,7,8,9-HXCDF	EPA 1613					0.102	J	0.297	J	0.748	J
1,2,3,7,8-PECDF	EPA 1613					0.654	J	2.22	J	2.13	J
2,3,4,6,7,8-HXCDF	EPA 1613					1.67	J	5.19		13.2	
2,3,4,7,8-PECDF	EPA 1613					1.15	J	3.73	J	2.65	J
2,3,7,8-TCDF	EPA 1613					1.24		7.08		2.3	J
OCDF	EPA 1613					44		225		5560	
Total HpCDD	EPA 1613					235		849		4140	
Total HxCDD	EPA 1613					69.8		177		460	
Total PeCDD	EPA 1613					19		46.6		33.7	
Total TCDD	EPA 1613					9.29		26.1		5.79	
Total HpCDF	EPA 1613					56.6		251		4030	
Total HxCDF	EPA 1613					37.6		121		775	
Total PeCDF	EPA 1613					31.6		79.6		84.4	
Total TCDF	EPA 1613					23.2		78.3		25.7	
TOTAL Dioxin/Furan TEQ, ND*0.5	EPA 1613					8.26	J	21.6	J	67.0	J
Phenols (mg/kg)											
2,4-Dimethylphenol	EPA 8270D	0.029	0.029	0.23	UJ	0.094	UJ	0.098	UJ	0.27	UJ
o-Cresol	EPA 8270D	0.063	0.063	0.23	U	0.094	U	0.098	U	0.27	U
p-Cresol	EPA 8270D	0.67	0.67	0.30		0.094	U	0.41		0.27	U
Pentachlorophenol	EPA 8270D	0.36	0.69	0.21	J	0.47	U	0.49	U	0.26	J
Phenol	EPA 8270D	0.42	1.2	0.49		0.071	J	0.17		0.18	J
Phthalates (mg/kg)											
Bis(2-Ethylhexyl) Phthalate	EPA 8270D	1.3	1.9	6.3		0.77		2.3		13	
Butyl benzyl phthalate	EPA 8270D	0.063	0.9	0.38		0.052	J	1.8		1.0	
Dibutyl phthalate	EPA 8270D	1.4	5.1	0.29		0.094	U	0.098	U	0.31	
Diethyl phthalate	EPA 8270D	0.2	1.2	0.23	U	0.094	U	0.098	U	0.27	U

Table E-3. Sediment Trap Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Sediment Trap		Sediment Trap		Sediment Trap		Sediment Trap	
Location ID				BDC2088		KC2062		NF2095		PS2220	
Sample ID				BDC2088-050511-T		KC2062-050511-T		NF2095-050511-T		PS2220-050511-T	
Collection Date				5/5/2011		5/5/2011		5/5/2011		5/5/2011	
Dimethyl phthalate	EPA 8270D	0.071	0.16	0.23	U	0.094	U	**0.054**	**J**	0.27	U
Di-n-Octyl phthalate	EPA 8270D	6.2		**7.3**		**0.090**	**J**	**0.73**		**0.29**	
PAHs (mg/kg)											
1-Methylnaphthalene	EPA 8270D			0.23	U	0.094	U	0.098	U	**0.16**	**J**
2-Methylnaphthalene	EPA 8270D	0.67	1.4	0.23	U	0.094	U	**0.054**	**J**	**0.54**	
Acenaphthene	EPA 8270D	0.5	0.73	**0.35**		**0.1**		0.098	U	**1.6**	
Acenaphthylene	EPA 8270D	1.3	1.3	0.23	U	0.094	U	0.098	U	0.27	U
Anthracene	EPA 8270D	0.96	4.4	**1.3**		**0.29**		**0.063**	**J**	**4.3**	
Benzo(a)anthracene	EPA 8270D	1.3	1.6	**7.8**		**1.6**		**0.23**		**5.5**	
Benzo(a)pyrene	EPA 8270D	1.6	3	**9.3**		**1.8**		**0.35**		**2.5**	
Benzo(g,h,i)perylene	EPA 8270D	0.67	0.72	**7.2**		**1.5**		**0.43**		**2**	
Benzofluoranthene	EPA 8270D	3.2	3.6	**20**		**4.4**		**0.86**		**7**	
Chrysene	EPA 8270D	1.4	2.8	**14**		**2.6**		**0.6**		**7.4**	
Dibenzo(a,h)anthracene	EPA 8270D	0.23	0.54	**2.6**		**0.47**		**0.088**	**J**	**0.74**	
Dibenzofuran	EPA 8270D	0.54	0.7	**0.46**		**0.099**		**0.049**	**J**	**2**	
Fluoranthene	EPA 8270D	1.7	2.5	**33**	**J**	**6.2**	**J**	**0.94**	**J**	**37**	**J**
Fluorene	EPA 8270D	0.54	1	**0.51**		**0.11**		**0.058**	**J**	**3.9**	
Indeno(1,2,3-cd)pyrene	EPA 8270D	0.6	0.69	**6.9**		**1.3**		**0.31**		**1.5**	
Naphthalene	EPA 8270D	2.1	2.4	**0.17**	**J**	**0.066**	**J**	**0.12**		**0.23**	**J**
Phenanthrene	EPA 8270D	1.5	5.4	**13**		**2.5**		**0.43**		**24**	
Pyrene	EPA 8270D	2.6	3.3	**19**		**3.9**		**0.71**		**20**	
Total HPAHs	EPA 8270D	12	17	**120**	**J**	**24**	**J**	**4.5**	**J**	**84**	**J**
Total LPAHs	EPA 8270D	5.2	13	**15**	**J**	**3.1**	**J**	**0.67**	**J**	**34**	**J**
SVOCs (mg/kg)											
1,2,4-Trichlorobenzene	EPA 8270D	0.031	0.051	0.23	U	0.094	U	0.098	U	0.27	U
1,2-Dichlorobenzene	EPA 8270D	0.035	0.05	0.23	U	0.094	U	0.098	U	0.27	U
1,3-Dichlorobenzene	EPA 8270D			0.23	U	0.094	U	0.098	U	0.27	U
1,4-Dichlorobenzene	EPA 8270D	0.11	0.12	0.23	U	0.094	U	0.098	U	0.27	U
Benzoic Acid	EPA 8270D	0.65	0.65	**1.2**	**J**	0.94	U	**0.54**	**J**	2.7	U
Benzyl Alcohol	EPA 8270D	0.057	0.073	**0.31**		0.094	U	**0.12**		0.27	U
Hexachlorobenzene	EPA 8270D	0.022	0.07	0.23	U	0.094	U	0.098	U	0.27	U
Hexachlorobutadiene	EPA 8270D	0.011	0.12	0.23	U	0.094	U	0.098	U	0.27	U
Hexachloroethane	EPA 8270D			0.23	U	0.094	U	0.098	U	0.27	U
N-Nitrosodiphenylamine	EPA 8270D	0.028	0.04	0.23	U	0.094	U	0.098	U	0.27	U

Table E-3. Sediment Trap Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Sediment Trap		Sediment Trap		Sediment Trap		Sediment Trap	
Location ID				BDC2088		KC2062		NF2095		PS2220	
Sample ID				BDC2088-050511-T		KC2062-050511-T		NF2095-050511-T		PS2220-050511-T	
Collection Date				5/5/2011		5/5/2011		5/5/2011		5/5/2011	
Brominated Diphenylethers (ng/kg)											
BDE-007	EPA 1614					**4.91**	**J**	**42.7**		**2.94**	**J**
BDE-008	EPA 1614					3.49	CU	**9.71**	**CJ**	6.18	CU
BDE-010	EPA 1614					0.773	U	1.04	U	1.62	U
BDE-011	EPA 1614					C8		C8		C8	
BDE-012	EPA 1614					1.51	CU	6.74	CU	**3.92**	**CJ**
BDE-013	EPA 1614					C12		C12		C12	
BDE-015	EPA 1614					**7.93**	**J**	**13.7**	**J**	**10.4**	**J**
BDE-017	EPA 1614					**123**	**C**	**230**	**C**	**91.3**	**CJ**
BDE-025	EPA 1614					C17		C17		C17	
BDE-028	EPA 1614					**135**	**C**	**229**	**C**	**182**	**C**
BDE-030	EPA 1614					0.952	U	3.14	U	2.48	U
BDE-032	EPA 1614					**0.807**	**J**	2.51	U	1.91	U
BDE-033	EPA 1614					C28		C28		C28	
BDE-035	EPA 1614					3.69	U	11.1	U	19.9	U
BDE-037	EPA 1614					**9.24**	**J**	**14.3**	**J**	**9.52**	**J**
BDE-047	EPA 1614					**6890**		**10600**		**7100**	
BDE-049	EPA 1614					**375**		**625**		**351**	
BDE-051	EPA 1614					**30.2**		**53.2**		**35.7**	**J**
BDE-066	EPA 1614					**279**		**418**		**271**	
BDE-071	EPA 1614					**42.8**		**96.5**		**36.6**	**J**
BDE-075	EPA 1614					**13.5**	**J**	**26.7**		16.6	U
BDE-077	EPA 1614					**2.47**	**J**	**9.76**	**J**	4.42	U
BDE-079	EPA 1614					**6.92**	**J**	**22.4**		4.29	U
BDE-085	EPA 1614					**601**		**763**		**437**	
BDE-099	EPA 1614					**9360**		**15100**		**8800**	
BDE-100	EPA 1614					**2110**		**3170**		**1820**	
BDE-105	EPA 1614					20.3	U	33.3	U	26.5	U
BDE-116	EPA 1614					31	U	32.8	U	48.5	U
BDE-119	EPA 1614					**44.4**	**C**	**126**	**C**	**70.7**	**CJ**
BDE-120	EPA 1614					C119		C119		C119	
BDE-126	EPA 1614					8.93	U	**11.4**	**J**	13.3	U
BDE-128	EPA 1614					169	U	498	U	311	U
BDE-138	EPA 1614					**276**	**C**	**418**	**C**	**200**	**C**
BDE-140	EPA 1614					**82.9**		**148**		52.2	U
BDE-153	EPA 1614					**1260**		**2100**		**1460**	
BDE-154	EPA 1614					**1050**		**1790**		**817**	
BDE-155	EPA 1614					**27.6**		**85.8**		**55.5**	**J**

Table E-3. Sediment Trap Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Sediment Trap		Sediment Trap		Sediment Trap		Sediment Trap	
Location ID				BDC2088		KC2062		NF2095		PS2220	
Sample ID				BDC2088-050511-T		KC2062-050511-T		NF2095-050511-T		PS2220-050511-T	
Collection Date				5/5/2011		5/5/2011		5/5/2011		5/5/2011	
BDE-166	EPA 1614					C138		C138		C138	
BDE-181	EPA 1614					**46.1**		**343**		84.3	U
BDE-183	EPA 1614					**608**		**2160**		**3190**	
BDE-190	EPA 1614					**180**		**1010**		**451**	
BDE-203	EPA 1614					**841**		**6930**		**1360**	
BDE-206	EPA 1614					**11500**		**90400**		**7290**	
BDE-207	EPA 1614					**13600**		**105000**		**10700**	
BDE-208	EPA 1614					**9130**		**70600**		**6360**	
BDE-209	EPA 1614					**179000**		**734000**		**125000**	
Total BDEs	EPA 1614					**237000**	**J**	**1050000**	**CJ**	**176000**	**CJ**
Conventionals											
Total Organic Carbon (percent)	PLUMB, 1981					**5.03**		**7.27**		**11.8**	
Total Solids (percent)	EPA 160.3			**29.80**		**38.20**		**50.00**		**58.90**	

Bold results - Detected concentrations

yellow highlighted results - Washington State SQL/LAET Criteria Exceedance

blue highlighted results - Washington State CSL/2LAET Criteria Exceedance

SQS - Washington State Sediment Quality Standard

CSL - Washington State Cleanup Screening Level

LAET - lowest apparent effects threshold

2LAET - second lowest apparent effects threshold

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Total BDEs - BDE-007, BDE-008, BDE-010, BDE-011, BDE-012, BDE-013, BDE-015, BDE-017, BDE-025, BDE-028, BDE-030, BDE-032, BDE-033, BDE-035, BDE-037, BDE-047, BDE-049, BDE-051, BDE-066, BDE-071, BDE-075, BDE-077, BDE-079, BDE-085, BDE-099, BDE-100, BDE-105, BDE-116, BDE-119, BDE-120, BDE-126, BDE-128, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183, BDE-190, BDE-203, BDE-206, BDE-207, BDE-208, BDE-209

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Table E-4. Inline Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Catch Basin	
Location ID				KC2062	
Sample ID				KC2062-051911-CB	
Collection Date				5/19/2011	
Metals – Total (mg/kg)					
Arsenic	EPA 6010B	57	93	**90**	
Cadmium	EPA 6010B	5.1	6.7	**6**	
Chromium	EPA 6010B	260	270	**29**	
Copper	EPA 6010B	390	390	**44**	
Lead	EPA 6010B	450	530	**60**	
Mercury	EPA 7471A	0.41	0.59	0.08	U
Silver	EPA 6010B	6.1	6.1	3	U
Zinc	EPA 6010B	410	960	**640**	**J**
Phenols (mg/kg)					
2,4-Dimethylphenol	EPA 8270D	0.029	0.029	0.020	UJ
o-Cresol	EPA 8270D	0.063	0.063	0.020	U
p-Cresol	EPA 8270D	0.67	0.67	**0.057**	**JN**
Pentachlorophenol	EPA 8270D	0.36	0.69	0.098	UJ
Phenol	EPA 8270D	0.42	1.2	**0.15**	
Phthalates (mg/kg)					
Bis(2-Ethylhexyl) Phthalate	EPA 8270D	1.3	1.9	**0.25**	
Butyl benzyl phthalate	EPA 8270D	0.063	0.9	**0.056**	
Dibutyl phthalate	EPA 8270D	1.4	5.1	0.020	U
Diethyl phthalate	EPA 8270D	0.2	1.2	0.020	U
Dimethyl phthalate	EPA 8270D	0.071	0.16	**0.028**	
Di-n-Octyl phthalate	EPA 8270D	6.2		0.020	U
PAHs (mg/kg)					
1-Methylnaphthalene	EPA 8270D			0.02	U
2-Methylnaphthalene	EPA 8270D	0.67	1.4	**0.021**	
Acenaphthene	EPA 8270D	0.5	0.73	**0.022**	
Acenaphthylene	EPA 8270D	1.3	1.3	0.02	U
Anthracene	EPA 8270D	0.96	4.4	**0.07**	
Benzo(a)anthracene	EPA 8270D	1.3	1.6	**0.59**	
Benzo(a)pyrene	EPA 8270D	1.6	3	**0.87**	
Benzo(g,h,i)perylene	EPA 8270D	0.67	0.72	**1.2**	
Benzofluoranthene	EPA 8270D	3.2	3.6	**2.4**	
Chrysene	EPA 8270D	1.4	2.8	**1.1**	
Dibenzo(a,h)anthracene	EPA 8270D	0.23	0.54	**0.33**	
Dibenzofuran	EPA 8270D	0.54	0.7	**0.026**	
Fluoranthene	EPA 8270D	1.7	2.5	**1.8**	
Fluorene	EPA 8270D	0.54	1	**0.022**	
Indeno(1,2,3-cd)pyrene	EPA 8270D	0.6	0.69	**1.1**	
Naphthalene	EPA 8270D	2.1	2.4	**0.036**	
Phenanthrene	EPA 8270D	1.5	5.4	**0.61**	
Pyrene	EPA 8270D	2.6	3.3	**1.4**	
Total HPAHs	EPA 8270D	12	17	**11**	
Total LPAHs	EPA 8270D	5.2	13	**0.76**	
SVOCs (mg/kg)					
1,2,4-Trichlorobenzene	EPA 8270D	0.031	0.051	0.020	U
1,2-Dichlorobenzene	EPA 8270D	0.035	0.05	0.020	U
1,3-Dichlorobenzene	EPA 8270D			0.020	U
1,4-Dichlorobenzene	EPA 8270D	0.11	0.12	0.020	U

Table E-4. Inline Solids Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	Catch Basin	
Location ID				KC2062	
Sample ID				KC2062-051911-CB	
Collection Date				5/19/2011	
Benzoic Acid	EPA 8270D	0.65	0.65	**0.59**	
Benzyl Alcohol	EPA 8270D	0.057	0.073	0.020	U
Hexachlorobenzene	EPA 8270D	0.022	0.07	0.020	U
Hexachlorobutadiene	EPA 8270D	0.011	0.12	0.020	U
Hexachloroethane	EPA 8270D			0.020	U
N-Nitrosodiphenylamine	EPA 8270D	0.028	0.04	0.020	U
Grain Size (percent)					
Phi Scale -1 to 0	PSEP-PS			**0.3**	
Phi Scale <-1	PSEP-PS			0.1	U
Phi Scale 0 to 1	PSEP-PS			**3.6**	
Phi Scale 1 to 2	PSEP-PS			**7.8**	
Phi Scale 2 to 3	PSEP-PS			**8.8**	
Phi Scale 3 to 4	PSEP-PS			**8.7**	
Phi Scale 4 to 5	PSEP-PS			**13.7**	
Phi Scale 5 to 6	PSEP-PS			**17.9**	
Phi Scale 6 to 7	PSEP-PS			**15.5**	
Phi Scale 7 to 8	PSEP-PS			**10.8**	
Phi Scale 8 to 9	PSEP-PS			**5.7**	
Phi Scale 9 to 10	PSEP-PS			**3.2**	
Phi Scale >10	PSEP-PS			**4.0**	
Clay	PSEP-PS			**12.9**	
Percent Gravel (>2.0 mm)	PSEP-PS			0.1	U
Percent Sand (<2.0 mm - 0.06 mm)	PSEP-PS			**29.2**	
Percent Silt (0.06 mm - 0.004 mm)	PSEP-PS			**57.9**	
Percent Clay (<0.004 mm - 0.004 mm)	PSEP-PS			**12.9**	
Total Fines (Silt/Clay)	PSEP-PS			**70.8**	
Conventionals					
Total Organic Carbon (percent)	1981			**3.47**	
Total Solids (percent)	EPA 160.3			**21.90**	

Bold results - Detected concentrations

yellow highlighted results - Washington State SQL/LAET Criteria Exceedance

blue highlighted results - Washington State CSL/2LAET Criteria Exceedance

SQS - Washington State Sediment Quality Standard

CSL - Washington State Cleanup Screening Level

LAET - lowest apparent effects threshold

2LAET - second lowest apparent effects threshold

C - Coelution

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Percent Clay (<0.004 mm - 0.004 mm) - Phi Scale 8 to 9, Phi Scale 9 to 10, Phi Scale >10

Percent Gravel (>2.0 mm) - Phi Scale <-1

Percent Sand (<2.0 mm - 0.06 mm) - Phi Scale -1 to 0, Phi Scale 0 to 1, Phi Scale 1 to 2, Phi Scale 2 to 3, Phi Scale 3 to 4

Percent Silt (0.06 mm - 0.004 mm) - Phi Scale 4 to 5, Phi Scale 5 to 6, Phi Scale 6 to 7, Phi Scale 7 to 8

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Table E-5. Whole Water Failed Event Sample Analytical Results

Event ID	Method	Washington State Marine Water	Washington State Marine Water Quality	non-event	non-event	non-event	non-event	non-event	non-event
Location ID				BDC2088	BDC2088	KC2062	KC2062	NF2095	PS2220
Sample ID				BDC2088-020411-W	BDC2088-030111-W	KC2062-011211-W	KC2062-030111-W	NF2095-030111-W	PS2220-011211-W
Collection Date				2/5/2011	3/2/2011	1/13/2011	3/2/2011	3/2/2011	1/13/2011
PCBs (µg/L)									
Aroclor 1016	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1221	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1232	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1242	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1248	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1254	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1260	EPA 8082			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Total PCBs	EPA 8082	0.03	10	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Metals – Total (µg/L)									
Arsenic	EPA 200.8			**0.4**	**0.3**	**2.7**	**1.8**	**0.7**	**4.7**
Cadmium	EPA 200.8			0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	**0.4**
Calcium	EPA 6010B			**2820**	**2100**	**19100**	**8730**	**24100**	**21900**
Chromium	EPA 200.8			**1.5**	**3.0**	**2**	**0.7**	**1.2**	**115**
Copper	EPA 200.8			**5.9**	**6.4**	**3.7**	**4.3**	**4.1**	**61.9**
Lead	EPA 200.8			**1**	**2**	**2**	**2**	**1**	**19**
Magnesium	EPA 6010B			**320**	**300**	**8310**	**3760**	**8240**	**9920**
Mercury	EPA 7470A			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	EPA 200.8			**1.1**	**1.6**	**1.5**	**1.0**	**2.6**	**27.6**
Selenium	EPA 200.8			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Silver	EPA 200.8			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	EPA 200.8			**162 J**	**102 J**	**19 J**	**31 J**	**34 J**	**440 J**
Metals – Dissolved (µg/L)									
Arsenic	EPA 200.8	36	69	**0.3**	0.2 U	**1.2**	**1.1**	**0.3**	**0.8**
Cadmium	EPA 200.8	9.3	42	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	EPA 200.8			**0.7**	**1.0**	0.5 U	0.5 U	0.5 U	**0.9**
Copper	EPA 200.8	3.1	4.8	**3.7**	**3.0**	**1.1**	**2.1**	**1.9**	**2.9**
Lead	EPA 200.8	8.1	210	1 U	1 U	1 U	1 U	1 U	1 U
Mercury	EPA 7470A	0.025	1.8	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel	EPA 200.8	8.2	74	**0.9**	**1.0**	**1.0**	**0.8**	**1.7**	**2.4**
Selenium	EPA 200.8	71	290	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Silver	EPA 200.8		1.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	EPA 200.8	81	90	**140 J**	**76 J**	**7**	**19 J**	**22 J**	**11**
Pesticides (µg/L)									
Aldrin	EPA 8081B	0.0019	0.71	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
alpha-BHC	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
beta-BHC	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
delta-BHC	EPA 8081B			0.050 UJ	0.050 UJ	0.050 U	0.050 UJ	0.050 UJ	0.050 U
Lindane	EPA 8081B		0.16	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
cis-Chlordane	EPA 8081B	0.004	0.09	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
trans-Chlordane	EPA 8081B	0.004	0.09	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Chlordane	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
4,4'-DDD	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	EPA 8081B	0.001	0.13	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Total DDTs	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Dieldrin	EPA 8081B	0.0019	0.71	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	EPA 8081B	0.0087	0.034	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Endosulfan II	EPA 8081B	0.0087	0.034	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan Sulfate	EPA 8081B	0.0087	0.034	0.10 U	0.10 UJ	0.10 U	0.10 UJ	0.10 UJ	0.10 U
Endrin	EPA 8081B	0.0023	0.037	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone	EPA 8081B			0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Heptachlor	EPA 8081B	0.0036	0.05	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide	EPA 8081B			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U

Table E-5. Whole Water Failed Event Sample Analytical Results

Event ID	Method	Washington State Marine Water	Washington State Marine Water Quality	non-event	non-event	non-event	non-event	non-event	non-event
Location ID				BDC2088	BDC2088	KC2062	KC2062	NF2095	PS2220
Sample ID				BDC2088-020411-W	BDC2088-030111-W	KC2062-011211-W	KC2062-030111-W	NF2095-030111-W	PS2220-011211-W
Collection Date				2/5/2011	3/2/2011	1/13/2011	3/2/2011	3/2/2011	1/13/2011
Methoxychlor	EPA 8081B			0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	EPA 8081B	0.0002	0.21	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenols (µg/L)									
2,4-Dimethylphenol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**11**
o-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**7.8**
p-Cresol	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**21**
Pentachlorophenol	EPA 8270D			5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenol	EPA 8270D			1.0 U	**3.1**	**1.8 J**	**4.0**	1.0 U	**48 J**
Phthalates (µg/L)									
Bis(2-Ethylhexyl) Phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**1.6**
Butyl benzyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dibutyl phthalate	EPA 8270D			**0.9 J**	**1.5**	1.0 U	1.0 U	1.0 U	1.0 U
Diethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dimethyl phthalate	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-Octyl phthalate	EPA 8270D			**2.5**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PAHs (µg/L)									
1-Methylnaphthalene	EPA 8270DSIM			0.010 U	0.010 U	**0.011**	**0.014**	0.010 U	**0.14**
2-Methylnaphthalene	EPA 8270DSIM			**0.018**	**0.018**	**0.014**	**0.020**	0.010 U	**0.22**
Acenaphthene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.82**
Acenaphthylene	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.025**
Anthracene	EPA 8270DSIM			0.010 U	0.010 U	**0.024**	0.010 U	0.010 U	**0.19**
Benzo(a)anthracene	EPA 8270DSIM			**0.043 J**	**0.058**	**0.23**	**0.024**	0.010 U	**0.62**
Benzo(a)pyrene	EPA 8270DSIM			**0.063**	**0.094**	**0.36**	**0.048**	0.010 U	**0.32**
Benzo(g,h,i)perylene	EPA 8270DSIM			**0.057**	**0.094**	**0.33**	**0.053**	**0.012**	**0.20**
Benzofluoranthene	EPA 8270D/8270DSIM			**0.16**	**0.26**	**0.88**	**0.18**	**0.018**	**0.90**
Chrysene	EPA 8270D/8270DSIM			**0.080 J**	**0.15**	**0.34**	**0.11**	**0.016**	**0.69**
Dibenzo(a,h)anthracene	EPA 8270DSIM			**0.018**	**0.028**	**0.12**	**0.014**	0.010 U	**0.095**
Dibenzofuran	EPA 8270DSIM			0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.58**
Fluoranthene	EPA 8270D/8270DSIM			**0.20 J**	**0.28**	**0.68**	**0.20**	**0.021**	**3.6**
Fluorene	EPA 8270DSIM			0.010 U	0.010 U	**0.012**	0.010 U	0.010 U	**0.71**
Indeno(1,2,3-cd)pyrene	EPA 8270DSIM			**0.053**	**0.077**	**0.31**	**0.048**	0.010 U	**0.15**
Naphthalene	EPA 8260C/8270DSIM			**0.046**	**0.080**	0.024 U	**0.059**	**0.058**	**0.8**
Phenanthrene	EPA 8270DSIM			**0.068**	**0.11**	**0.22**	**0.079**	**0.015**	**1.8**
Pyrene	EPA 8270D/8270DSIM			**0.11**	**0.22**	**0.45**	**0.13**	**0.026**	**1.9**
Total HPAHs	EPA 8270D/8270DSIM			**0.78 J**	**1.3**	**3.7**	**0.81**	**0.093**	**8.5**
Total LPAHs	EPA 8270D/8270DSIM			**0.11**	**0.19**	**0.26**	**0.14**	**0.073**	**4.3**
SVOCs (µg/L)									
1,2,4-Trichlorobenzene	EPA 8260C			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,3-Dichlorobenzene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,4-Dichlorobenzene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Benzoic Acid	EPA 8270D			10 U	10 U	10 U	10 U	10 U	10 U
Benzyl Alcohol	EPA 8270D			5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorobenzene	EPA 8081B/8270D			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Hexachlorobutadiene	EPA 8081B/8270D			0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Hexachloroethane	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
N-Nitrosodiphenylamine	EPA 8270D			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
VOCs (µg/L)									
1,1,1,2-Tetrachloroethane	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,1-Trichloroethane	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2,2-Tetrachloroethane	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2-Trichloroethane	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethane	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloropropene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2,3-Trichlorobenzene	EPA 8260C			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,3-Trichloropropane	EPA 8260C			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trimethylbenzene	EPA 8260C			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

Table E-5. Whole Water Failed Event Sample Analytical Results

Event ID	Method	Washington State Marine Water	Washington State Marine Water Quality	non-event		non-event		non-event		non-event		non-event		non-event	
Location ID				BDC2088		BDC2088		KC2062		KC2062		NF2095		PS2220	
Sample ID				BDC2088-020411-W		BDC2088-030111-W		KC2062-011211-W		KC2062-030111-W		NF2095-030111-W		PS2220-011211-W	
Collection Date				2/5/2011		3/2/2011		1/13/2011		3/2/2011		3/2/2011		1/13/2011	
1,2-Dibromo-3-chloropropane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3,5-Trimethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2,2-Dichloropropane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
2-Hexanone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
4-Chlorotoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Acetone	EPA 8260C			5.3	U	5.0	U	18	U	6.8	U	5.0	U	6.0	U
Acrolein	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Acrylonitrile	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Bromobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromochloromethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromoform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Bromomethane	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Carbon Disulfide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Carbon Tetrachloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-11	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
CFC-113	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorodibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloroform	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chloromethane	EPA 8260C			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	**0.3**		0.2	U	0.2	U	0.2	U
cis-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Cumene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dibromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Dichlorobromomethane	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylene Dibromide	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Methyl ethyl ketone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methyl Iodide	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Methyl isobutyl ketone	EPA 8260C			5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methylene Chloride	EPA 8260C			1.9	U	3.7	U	1.1	U	4.2	U	2.8	U	1.0	U
n-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
n-Propylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
p-Isopropyltoluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
sec-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Styrene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
tert-Butylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Tetrachloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,2-Dichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,3-Dichloropropene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
trans-1,4-Dichloro-2-butene	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Trichloroethene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Vinyl Acetate	EPA 8260C			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Vinyl Chloride	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
BTEX (µg/L)															
Benzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Ethylbenzene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Toluene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
m, p-Xylene	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
o-Xylene	EPA 8260C			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Total Xylenes	EPA 8260C			0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Conventionals															
Alkalinity as Bicarbonate (mg/L)	SM2320			**5.6**		**5.5**		**119**		**51.4**		**83.4**		**61.1**	

Table E-5. Whole Water Failed Event Sample Analytical Results

Event ID	Method	Washington State Marine Water	Washington State Marine Water Quality	non-event		non-event		non-event		non-event		non-event		non-event	
Location ID				BDC2088		BDC2088		KC2062		KC2062		NF2095		PS2220	
Sample ID				BDC2088-020411-W		BDC2088-030111-W		KC2062-011211-W		KC2062-030111-W		NF2095-030111-W		PS2220-011211-W	
Collection Date				2/5/2011		3/2/2011		1/13/2011		3/2/2011		3/2/2011		1/13/2011	
Alkalinity as Carbonate (mg/L)	SM2320			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity as Hydroxide (mg/L)	SM2320			1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Alkalinity, Total (mg/L)	SM2320			**5.6**		**5.5**		**119**		**51.4**		**83.4**		**61.1**	
Chloride (mg/L)	EPA 300.0			**1.2**		**9.7**		**11.2**		**4.9**		**23.1**		**13.6**	
Dissolved Organic Carbon (mg/	EPA 415.1			**2.02**		**2.46**		**8.53**		**5.66**		**4.30**		**5.34**	
Hardness as CaCO3 (mg/L)	EPA 6010B			**8.3**		**6.5**		**82**		**37**		**94**		**96**	
Nitrate (mg/L)	EPA 300.0			**0.4**	**J**	0.2	U	**0.2**		0.2	U	0.4	U	**0.2**	
pH (su)	PH			**6.39**		**7.13**		**7.22**		**6.84**		**6.76**		**7.83**	
Sulfate (mg/L)	EPA 300.0			**1.2**		**0.6**		**5.6**		**2.2**		**20.1**		**4.2**	
Total Organic Carbon (mg/L)	EPA 415.1			**2.50**		**3.42**		**9.80**		**6.74**		**5.25**		**6.73**	
Total Suspended Solids (mg/L)	EPA 160.2			**6.6**		**7.1**		**13.7**		**8.0**		**8.5**		**280**	

Bold results - Detected concentrations

yellow highlighted results - Washington State Chronic Marine Water Quality Criteria Exceedance

blue highlighted results - Washington State Acute Marine Water Quality Criteria Exceedance

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

N - Tentative identification

Chlordane - cis-Chlordane, trans-Chlordane

Total DDTs - 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Total Xylenes - m, p-Xylene, o-Xylene

Table E-6. Filtered Solids Failed Event Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	non-event		non-event		non-event		non-event		non-event	
Location ID				KC2062		KC2062		NF2095		NF2095		PS2220	
Sample ID				KC2062A-011211-S		KC2062A-030111-S		NF2095A-011211-S		NF2095A-030111-S		PS2220A-030111-S	
Collection Date				1/13/2011		3/2/2011		1/13/2011		3/2/2011		3/2/2011	
Filter				A		A		A		A		A	
Mass Of Solids (g)				9.07		1.03		8.23		17.32		20.42	
PCBs (mg/kg)													
Aroclor 1016	EPA 8082			0.055	U	0.49	U	0.061	U	0.029	U	0.24	U
Aroclor 1221	EPA 8082			0.055	U	0.49	U	0.061	U	0.029	U	0.24	U
Aroclor 1232	EPA 8082			0.055	U	0.49	U	0.061	U	0.029	U	0.24	U
Aroclor 1242	EPA 8082			0.055	U	0.49	U	0.061	U	0.029	U	0.24	U
Aroclor 1248	EPA 8082			0.055	U	0.49	U	0.24	U	0.035	U	0.24	U
Aroclor 1254	EPA 8082			**0.099**		**0.58**		**0.60**		**0.069**		0.24	U
Aroclor 1260	EPA 8082			**0.15**		**0.78**		**0.24**		**0.064**		0.24	U
Total PCBs	EPA 8082	0.13	1	**0.25**		**1.4**		**0.84**		**0.13**		0.24	U
Metals – Total (mg/kg)													
Arsenic	EPA 6010B	57	93	40	U			40	U	50	U		
Cadmium	EPA 6010B	5.1	6.7	**3**				**5**		**3**			
Chromium	EPA 6010B	260	270	**38**				**104**		**121**			
Copper	EPA 6010B	390	390	**85**				**217**		**200**			
Lead	EPA 6010B	450	530	**70**				**170**		**110**			
Mercury	EPA 7471A	0.41	0.59	**0.09**				**0.2**		0.2	U		
Silver	EPA 6010B	6.1	6.1	2	U			2	U	3	U		
Zinc	EPA 6010B	410	960	**424**				**1400**		**1130**	**J**		
Grain Size (percent)													
Phi Scale -1 to 0	PSEP-PS			**0.8**									
Phi Scale <-1	PSEP-PS			0.1	U								
Phi Scale 0 to 1	PSEP-PS			**0.7**									
Phi Scale 1 to 2	PSEP-PS			**3.5**									
Phi Scale 2 to 3	PSEP-PS			**16.5**									
Phi Scale 3 to 4	PSEP-PS			**21.4**									
Phi Scale 4 to 5	PSEP-PS			**1.2**									
Phi Scale 5 to 6	PSEP-PS			**7.1**									
Phi Scale 6 to 7	PSEP-PS			**6.8**									
Phi Scale 7 to 8	PSEP-PS			**11.6**									
Phi Scale 8 to 9	PSEP-PS			**10.4**									
Phi Scale 9 to 10	PSEP-PS			**6.3**									
Phi Scale >10	PSEP-PS			**13.7**									
Percent Gravel (>2.0 mm)	PSEP-PS			0.1	U								
Percent Sand (<2.0 mm - 0.06 mm)	PSEP-PS			**42.9**									

Table E-6. Filtered Solids Failed Event Sample Analytical Results

Event ID	Method	Washington State SQS/LAET	Washington State CSL/2LAET	non-event		non-event		non-event		non-event		non-event	
Location ID				KC2062		KC2062		NF2095		NF2095		PS2220	
Sample ID				KC2062A-011211-S		KC2062A-030111-S		NF2095A-011211-S		NF2095A-030111-S		PS2220A-030111-S	
Collection Date				1/13/2011		3/2/2011		1/13/2011		3/2/2011		3/2/2011	
Filter				A		A		A		A		A	
Mass Of Solids (g)				9.07		1.03		8.23		17.32		20.42	
Percent Silt (0.06 mm - 0.004 mm)	PSEP-PS			**26.7**									
Percent Clay (<0.004 mm - 0.004 mm	PSEP-PS			**30.4**									
Total Fines (Silt/Clay)	PSEP-PS			**57.1**									

Bold results - Detected concentrations

yellow highlighted results - Washington State SQL/LAET Criteria Exceedance

blue highlighted results - Washington State CSL/2LAET Criteria Exceedance

SQS - Washington State Sediment Quality Standard
CSL - Washington State Cleanup Screening Level
LAET - lowest apparent effects threshold
2LAET - second lowest apparent effects threshold
J - Estimated concentration when the value is less than established reporting limits.
U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Percent Clay (<0.004 mm - 0.004 mm) - Phi Scale 8 to 9, Phi Scale 9 to 10, Phi Scale >10
Percent Gravel (>2.0 mm) - Phi Scale <-1
Percent Sand (<2.0 mm - 0.06 mm) - Phi Scale -1 to 0, Phi Scale 0 to 1, Phi Scale 1 to 2, Phi Scale 2 to 3, Phi Scale 3 to 4
Percent Silt (0.06 mm - 0.004 mm) - Phi Scale 4 to 5, Phi Scale 5 to 6, Phi Scale 6 to 7, Phi Scale 7 to 8
Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Table E-7. Filtered Solids Low Mass Sample Analytical Results

Event ID	Method	non-event		TS		TS		TS		TS	
Location ID		BDC2088		BDC2088		BDC2088		NF2095		NF2095	
Sample ID		BDC2088A-030111-S		BDC2088A-050411-S		BDC2088B-050411-S		NF2095A-050411-S		NF2095B-050411-S	
Collection Date		3/2/2011		5/4/2011		5/4/2011		5/4/2011		5/4/2011	
Filter		A		A		B		A		B	
Mass Of Solids (g)		-0.55		-0.01		-0.01		-1.16		-1.16	
PCBs (µg)											
Aroclor 1016	EPA 8082	0.5	U	0.5	U			0.5	U		
Aroclor 1221	EPA 8082	0.5	U	0.5	U			0.5	U		
Aroclor 1232	EPA 8082	0.5	U	1.0	U			1.0	U		
Aroclor 1242	EPA 8082	0.5	U	0.5	U			0.5	U		
Aroclor 1248	EPA 8082	0.5	U	0.5	U			0.5	U		
Aroclor 1254	EPA 8082	0.5	U	0.5	U			0.5	U		
Aroclor 1260	EPA 8082	0.5	U	0.5	U			0.5	U		
Total PCBs	EPA 8082	0.5	U	1.0	U			1.0	U		
PAHs (µg)											
1-Methylnaphthalene	EPA 8270D					**3.3**				**2.1**	
2-Methylnaphthalene	EPA 8270D					**4.2**				**2.4**	
Acenaphthene	EPA 8270D					**1.5**				**1.1**	
Acenaphthylene	EPA 8270D					**0.8**				**0.5**	
Anthracene	EPA 8270D					0.5	U			0.5	U
Benzo(a)anthracene	EPA 8270D					0.5	U			0.5	U
Benzo(a)pyrene	EPA 8270D					**0.6**				0.5	U
Benzo(g,h,i)perylene	EPA 8270D					**0.5**				0.5	U
Benzofluoranthene	EPA 8270D					**1.4**				0.5	U
Chrysene	EPA 8270D					**0.8**				0.5	U
Dibenzo(a,h)anthracene	EPA 8270D					0.5	U			0.5	U
Dibenzofuran	EPA 8270D					**2.9**				**2.2**	
Fluoranthene	EPA 8270D					**1.7**				0.5	U
Fluorene	EPA 8270D					**2.3**				**1.8**	
Indeno(1,2,3-cd)pyrene	EPA 8270D					0.5	U			0.5	U
Naphthalene	EPA 8270D					**4.8**				**2.6**	
Phenanthrene	EPA 8270D					**2.1**				**1.5**	
Pyrene	EPA 8270D					**1.3**				**0.5**	
Total HPAHs	EPA 8270D					**6.3**				**0.5**	
Total LPAHs	EPA 8270D					**12**				**7.5**	

Bold results - Detected concentrations

TS = tidal sampling

J - Estimated concentration when the value is less than established reporting limits.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Total HPAHs - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzofluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene

Total LPAHs - Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene

Total PCBs - Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260

Table E-8. Chemicals Not Detected in Whole Water Samples

Analyte
PCBs (µg/L)
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1260
Metals – Total (µg/L)
Mercury
Silver
Metals – Dissolved (µg/L)
Cadmium
Mercury
Selenium
Silver
Pesticides (µg/L)
Aldrin
alpha-BHC
beta-BHC
delta-BHC
Lindane
cis-Chlordane
trans-Chlordane
Chlordane
4,4'-DDD
4,4'-DDE
4,4'-DDT
Total DDTs
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Endrin Ketone
Heptachlor
Heptachlor Epoxide
Methoxychlor
Toxaphene
Phenols (µg/L)
Pentachlorophenol
Phthalates (µg/L)
Butyl benzyl phthalate
Diethyl phthalate
Dimethyl phthalate
PAHs (µg/L)
SVOCs (µg/L)
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzoic Acid
Benzyl Alcohol
Hexachlorobenzene
Hexachlorobutadiene
Hexachloroethane
N-Nitrosodiphenylamine

Analyte
VOCs (µg/L)
1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,1-Dichloropropene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trimethylbenzene
1,2-Dibromo-3-chloropropane
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichloropropane
2,2-Dichloropropane
2-Chlorotoluene
2-Hexanone
4-Chlorotoluene
Acetone
Acrolein
Acrylonitrile
Bromobenzene
Bromochloromethane
Bromoethane
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
CFC-11
CFC-113
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Cumene
Dibromomethane
Dichlorobromomethane
Ethylene Dibromide
Methyl ethyl ketone
Methyl Iodide
Methyl isobutyl ketone
n-Butylbenzene
n-Propylbenzene
p-Isopropyltoluene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethene
trans-1,2-Dichloroethene
trans-1,3-Dichloropropene
trans-1,4-Dichloro-2-butene
Trichloroethene
Vinyl Acetate
Vinyl Chloride

Analyte
BTEX (µg/L)
Benzene
Ethylbenzene
Toluene
m, p-Xylene
o-Xylene
Total Xylenes

Table E-9. Chemicals Not Detected in Filtered Solids Samples

Analyte
PCBs (mg/kg)
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
PAHs (mg/kg)
Acenaphthylene

Table E-10. Chemicals Not Detected in Sediment Trap Samples

Analyte
Phenols (mg/kg)
2,4-Dimethylphenol
o-Cresol
PAHs (mg/kg)
Acenaphthylene
SVOCs (mg/kg)
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Hexachlorobenzene
Hexachlorobutadiene
Hexachloroethane
N-Nitrosodiphenylamine
Brominated Diphenylethers (ng/kg)
BDE-010
BDE-030
BDE-035
BDE-105
BDE-116
BDE-128

Appendix G
Data Validation Report

EcoChem, INC.
Environmental Data Quality

DATA VALIDATION REPORT

WASHINGTON DOE TOXICS CLEANUP PROGRAM

STORMWATER LATERAL LOADING STUDY
LOWER DUWAMISH WATERWAY, WASHINGTON

Prepared for:

SAIC
18912 North Creek Parkway, Suite 101
Bothell, Washington 98011

Prepared by:

EcoChem, Inc.
710 Second Avenue, Suite 660
Seattle, Washington 98104

EcoChem Project: C4146-1

August 10, 2011

Approved for Release

Christine Ransom
Project Manager
EcoChem, INC.

PROJECT NARRATIVE

Basis for Data Validation

This report summarizes the results of the data validation performed on stormwater, filter bag (with sediment), and sediment samples; and quality control (QC) sample data for the Lateral Load Study – Lower Duwamish Waterway, Seattle, WA. Approximately 10% of the data received a full (EPA Stage 4 or EPA Stage 3) validation. The remaining data were validated at a summary level (EPA Stage 2B). Equipment rinsates received a compliance level review (EPA Stage 2A). A complete list of samples is provided in the **Sample Index**.

Dioxin/furan and polybrominated diphenylether (PBDE) analyses were performed by Axys Analytical, Sydney, British Columbia. Analytical Resources Inc (ARI), Tukwila, Washington performed all other analyses. The analytical methods and EcoChem project chemists are listed below.

Analysis	Method of Analysis	Primary Review	Secondary Review
Volatile Organic Compounds	SW8260C	Mark Brindle, Glenn Esler Dorothy Kerlin	Christine Ransom Melissa Swanson Christina Mott
Semivolatile Organic Compounds	SW8270D	Mark Brindle Eric Clayton Glenn Esler Dorothy Kerlin Christine Ransom	Christine Ransom Melissa Swanson Christina Mott
Polycyclic Aromatic Hydrocarbons (PAH)	SW8270D and 8270D-SIM	Mark Brindle Eric Clayton Glenn Esler Dorothy Kerlin Christine Ransom	Christine Ransom Melissa Swanson Christina Mott
PCB Aroclors	SW8082	Mark Brindle Glenn Esler Christine Ransom	Christine Ransom Melissa Swanson Christina Mott
Pesticides	SW8081B	Mark Brindle Glenn Esler Christine Ransom	Christine Ransom Melissa Swanson Christina Mott
Polybrominated diphenylethers (PBDE)	Axys MLA-033 (EPA 1614)	Melissa Swanson	Eric Strout Christine Ransom
Dioxin and Furan Compounds	Axys MLA-017 (EPA 1613B)	Mark Brindle Melissa Swanson	Eric Strout Christine Ransom
Metals and Mercury	SW6010B, EPA 200.8, SW7470A, SW7471A	Jeremy Maute Glenn Esler	Christine Ransom Melissa Swanson
Conventionals	EPA 300.0, 353.2, 150.1, 160.2, 160.3, 415.1, SM2320, Plumb, PSEP	Jeremy Maute Glenn Esler	Christine Ransom Melissa Swanson

The data were reviewed using guidance and quality control criteria documented in the analytical methods listed in the table above; *Combined Sampling and Analysis Plan and Quality Assurance Project Plan: Stormwater Lateral Loading Study, Lower Duwamish Waterway, WA* (SAIC, Dec. 21, 2010); *USEPA National Functional Guidelines for Organic Data Review* (EPA, 2008); *USEPA National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* (EPA, 2002,2005); and *USEPA National Functional Guidelines for Inorganic Data Review* (EPA, 1994, 2004).

EcoChem's goal in assigning data validation qualifiers is to assist in proper data interpretation. If values are estimated (assigned a J), data may be used for site evaluation purposes but reasons for data qualification should be taken into consideration when interpreting sample concentrations. Data that have been rejected (R) should not be used for any purpose. Values with no data qualifier meet all data quality goals as outlined in the EPA Functional Guidelines.

Data qualifier definitions, reason codes, and validation criteria are included as **Appendix A**. **Appendix B** contains the Qualified Data Summary Table. Data validation worksheets are kept on file at EcoChem. A qualified laboratory electronic data deliverable is also submitted with this report.

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
RY37	LL-FILTER-ER	RY37A		√				√					√						
	LL-ISCO-ER	RY37C	√	√	√	√	√	√											
SE58	NF2095A-011211-S	SE58A											√						
	NF2095A-011211-S	SE58B															√		
	KC2062A-011211-S	SE58C											√						
	KC2062A-011211-S	SE58D															√	√	
SE60	BDC2088-011211-W	SE60A	√	√	√	√	√	√			√								
	KC2062-011211-W	SE60B	√	√	√	√	√	√			√								
	PS2220-011211-W	SE60C	√	√	√	√	√	√			√								
	BDC2088-011211-W	SE60D							√										
	KC2062-011211-W	SE60E							√										
	PS2220-011211-W	SE60F							√										
SE62	BDC2088-011211-W	SE62A								√									
	KC2062-011211-W	SE62B								√									
	PS2220-011211-W	SE62C								√									
SF68	PS2220-012011-W	SF68B	√	√	√	√	√	√			√								
	NF2095-012011-W	SF68C	√	√	√	√	√	√			√								
	PS2220-012011-W	SF68E							√										
	NF2095-012011-W	SF68F							√										
SF70	PS2220-012011-W	SF70B								√									
	NF2095-012011-W	SF70C								√									
SF75	KC2062A-012011-S	SF75A													√				
	KC2062A-012011-S	SF75B															√	√	
	NF2095A-012011-S	SF75C													√				
SG55	KC2062-012611-W	SG55A	√	√	√	√	√	√			√								
	NF2095-012611-W	SG55B	√	√	√	√	√	√			√								
	KC2062-012611-W	SG55F							√										
	NF2095-012611-W	SG55G							√										
SG56	KC2062-012611-W	SG56A								√									
	NF2095-012611-W	SG56B								√									
SG60	NF2095A-012611-S	SG60A													√				
	NF2095A-012611-S	SG60B															√		
	KC2062A-012611-S	SG60C													√				
	KC2062A-012611-S	SG60D															√	√	

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
SH75	BDC2088-020411-W	SH75A	√	√	√	√	√	√			√								
	KC2062-020411-W	SH75B	√	√	√	√	√	√			√								
	PS2220-020411-W	SH75C	√	√	√	√		√			√								
	NF2095-020411-W	SH75D	√	√	√	√	√	√			√								
	BDC2088-020411-W	SH75E							√										
	KC2062-020411-W	SH75F							√										
	PS2220-020411-W	SH75G							√										
	NF2095-020411-W	SH75H							√										
	KC2062A-020411-S	SH75I													√				
	KC2062A-020411-S	SH75J															√	√	
	PS2220A-020411-S	SH75K													√				
	PS2220A-020411-S	SH75L															√		
	NF2095A-020411-S	SH75M													√				
	NF2095A-020411-S	SH75N															√		
SH76	BDC2088-020411-W	SH76A								√									
	KC2062-020411-W	SH76B								√									
	PS2220-020411-W	SH76C								√									
	NF2095-020411-W	SH76D								√									
SI89	PS2220-021111-W	SI89A										√							
	NF2095-021111-W	SI89B	√	√	√	√	√	√			√								
	KC2062-021111-W	SI89C	√	√	√	√	√	√			√								
	BDC2088-021111-W	SI89D	√	√	√	√	√	√			√								
	NF2095-021111-W	SI89H							√										
	KC2062-021111-W	SI89I							√										
	BDC2088-021111-W	SI89J							√										
SI90	NF2095-021111-W	SI90A								√									
	KC2062-021111-W	SI90B								√									
	BDC2088-021111-W	SI90C								√									
SJ02	PS2220A-021111-S	SJ02A											√						
	PS2220A-021111-S	SJ02B															√		
	NF2095A-021111-S	SJ02C											√						
	NF2095A-021111-S	SJ02D															√	√	
	BDC2088A-021111-S	SJ02E											√						
	BDC2088A-021111-S	SJ02F															√		
	KC2062A-021111-S	SJ02G											√						
	KC2062A-021111-S	SJ02H															√	√	
	NF2095-030111-W	SL23A	√	√	√	√	√	√			√								

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
SL23	KC2062-030111-W	SL23B	√	√	√	√	√	√			√								
	BDC2088-030111-W	SL23C	√	√	√	√	√	√			√								
	NF2095-030111-W	SL23F							√										
	KC2062-030111-W	SL23G							√										
	BDC2088-030111-W	SL23H							√										
	NF2095A-030111-S	SL23K											√						
	NF2095A-030111-S	SL23L															√		
	KC2062A-030111-S	SL23M											√						
	BDC2088A-030111-S	SL23O											√						
	PS2220A-030111-S	SL23Q											√						
SL24	NF2095-030111-W	SL24A								√									
	KC2062-030111-W	SL24B								√									
	BDC2088-030111-W	SL24C								√									
SL81	NF2095A-030411-S	SL81A													√				
	NF2095A-030411-S	SL81B															√		
	KC2062A-030411-S	SL81C													√				
	KC2062A-030411-S	SL81D															√		
	BDC2088A-030411-S	SL81E													√				
	PS2220A-030411-S	SL81G													√				
	PS2220A-030411-S	SL81H															√		
SL82	NF2095-030411-W	SL82A	√	√	√	√	√	√			√								
	KC2062-030411-W	SL82B	√	√	√	√	√	√			√								
	BDC2088-030411-W	SL82C	√	√	√	√	√	√			√								
	PS2220-030411-W	SL82D	√	√	√	√	√	√			√								
	NF2095-030411-W	SL82I							√										
	KC2062-030411-W	SL82J							√										
	BDC2088-030411-W	SL82K							√										
	PS2220-030411-W	SL82L							√										
SL83	NF2095-030411-W	SL83A								√									
	KC2062-030411-W	SL83B								√									
	BDC2088-030411-W	SL83C								√									
	PS2220-030411-W	SL83D								√									

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
SN46	KC2062-031511-W	SN46A	√	√	√	√	√	√			√								
	PS2220-031511-W	SN46B	√	√	√	√	√	√			√								
	KC2062-031511-W	SN46G							√										
	PS2220-031511-W	SN46H							√										
SN47	KC2062-031511-W	SN47A								√									
	PS2220-031511-W	SN47B								√									
SN50	NF2095A-031511-S	SN50A													√				
	NF2095A-031511-S	SN50B															√		
	KC2062A-031511-S	SN50C													√				
	BDC2088A-031511-S	SN50E													√				
	PS2220A-031511-S	SN50G													√				
	PS2220A-031511-S	SN50H															√		
ST39	KC2062-042111-W	ST39A	√	√	√	√	√	√			√								
	PS2220-042111-W	ST39B	√	√	√	√	√	√			√								
	NF2095-042111-W	ST39C	√	√	√	√	√	√			√								
	KC2062-042111-W	ST39H							√										
	PS2220-042111-W	ST39I							√										
	NF2095-042111-W	ST39J							√										
ST40	KC2062-042111-W	ST40A								√									
	PS2220-042111-W	ST40B								√									
	NF2095-042111-W	ST40C								√									
ST60	PS2220A-042111-S	ST60A											√						
	NF2095A-042111-S	ST60C											√						
SU45	PS2220-042711-W	SU45A	√	√	√	√	√	√			√								
	NF2095-042711-W	SU45B	√	√	√	√	√	√			√								
	BDC2088-042711-W	SU45C	√	√	√	√	√	√			√								
	KC2062-042711-W	SU45D										√							
	PS2220-042711-W	SU45E							√										
	NF2095-042711-W	SU45F							√										
	BDC2088-042711-W	SU45G							√										
	PS2220-042711-W	SU46A								√									
	NF2095-042711-W	SU46B								√									
	BDC2088-042711-W	SU46C								√									

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
SU49	PS2220A-042711-S	SU49A											√						
	NF2095A-042711-S	SU49C											√						
	NF2095A-042711-S	SU49D															√	√	
	BDC2088A-042711-S	SU49E											√						
	KC2062A-042711-S	SU49G											√						
	KC2062A-042711-S	SU49H															√	√	
SV44	PS2220B-042111-S	SV44A													√				
	NF2095B-042111-S	SV44B													√				
	PS2220B-042711-S	SV44C													√				
	NF2095B-042711-S	SV44D													√				
	BDC2088B-042711-S	SV44E													√				
	KC2062B-042711-S	SV44F													√				
SV69	BDC2088-050411-W	SV69A	√	√	√	√	√	√			√								
	KC2062-050411-W	SV69B	√	√	√	√	√	√			√								
	PS2220-050411-W	SV69C	√	√	√	√	√	√			√								
	NF2095-050411-W	SV69D	√	√	√	√	√	√			√								
	BDC2088-050411-W	SV69E							√										
	KC2062-050411-W	SV69F							√										
	PS2220-050411-W	SV69G							√										
	NF2095-050411-W	SV69H							√										
	BDC2088A-050411-S	SV69I											√						
	BDC2088A-050411-S	SV69J															√	√	
	BDC2088B-050411-S	SV69K													√				
	KC2062A-050411-S	SV69L											√						
	KC2062A-050411-S	SV69M															√	√	
	KC2062B-050411-S	SV69N													√				
	PS2220A-050411-S	SV69O											√						
	PS2220A-050411-S	SV69P															√	√	
	PS2220B-050411-S	SV69Q													√				
	NF2095A-050411-S	SV69R											√						
	NF2095A-050411-S	SV69S															√	√	
	NF2095B-050411-S	SV69T													√				
SV70	BDC2088-050411-W	SV70A								√									
	KC2062-050411-W	SV70B								√									
	PS2220-050411-W	SV70C								√									
	NF2095-050411-W	SV70D								√									
	NF2095B-030411-S	SV77A											√						

SAMPLE INDEX
Lower Duwamish Waterway- Lateral Loading Study
Analytical Resources, Inc.

			WATERS										SEDIMENTS						
SDG	SampleID	Lab ID	VOC	SVOC	PAH SIM	LL PCB	Pest	Tot Metals	Diss Metals	LL Hg	CONV	TSS	PCB	SVOC	PAH SVOC	Pest	Metals	Grain Size	TOC
SV77	KC2062B-030411-S	SV77B											√						
	BDC2088B-030411-S	SV77C											√						
	PS2220B-030411-S	SV77D											√						
SV79	NF2095B-012011-S	SV79A																	
	KC2062B-012011-S	SV79B																	
SW02	PS2220-050511-T	SW02A												√					√
	NF2095-050511-T	SW02B												√					√
	BDC2088-050511-T	SW02C												√					
	KC2062-050511-T	SW02D												√					√
SX82	KC2062-051911-CB	SX82A												√			√	√	√

SAMPLE INDEX
Lower Duwamish Waterway - Lateral Loading Study
Axys Analytical

SDG Dioxins	SDG PBDEs	Sample ID	Lab ID	Dioxin/Furans	PBDEs
WG35790		NF2095B-012611-S	L16165-1	√	
		KC2062B-012611-S	L16165-2	√	
		KC2062B-020411-S	L16165-3	√	
		PS2220B-020411-S	L16165-4	√	
		NF2095B-020411-S	L16165-5	√	
		PS2220B-021111-S	L16165-6	√	
		NF2095B-021111-S	L16165-7	√	
		KC2062B-021111-S	L16165-9	√	
WG36100		BDC2088B-021111-S	L16165-8	√	
		NF2095B-031511-S	L16287-1	√	
		KC2062B-031511-S	L16287-2	√	
		BDC2088B-031511-S	L16287-3	√	
		PS2220B-031511-S	L16287-4	√	
	WG36152	NF2095-030411-W	L16286-1		√
		KC2062-030411-W	L16286-2		√
		BDC2088-030411-W	L16286-3		√
		PS2220-030411-W	L16286-4		√
	WG36561	KC2062-042111-W	L16431-1		√
		PS2220-042111-W	L16431-2		√
		NF2095-042111-W	L16431-3		√
		NF2095-042711-W	L16431-4		√
		BDC2088-042711-W	L16431-5		√
	WG36677	PS2220-042711-W	L16453-1		√
WG36676	WG36845	PS2220-050511-T	L16450-1	√	√
	WG36676	NF2095-050511-T	L16450-2	√	√
		KC2062-050511-T	L16450-3	√	√

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Dioxin & Furan Compounds by Axys Method MLA-017 (EPA 1613B)

This report documents the review of analytical data from the analyses of filter bag and sediment samples and the associated laboratory quality control (QC) samples. Samples were analyzed by Axys Analytical Services, Ltd. of Sidney, British Columbia, Canada. See the **Sample Index** for a list of samples.

SDG	Number of Samples	DV Level
WG35790	3 Filter Bag & 5 Sediment	EPA Stage 4
WG36100	2 Filter Bag	EPA Stage 4
WG36676	3 Sediment	EPA Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements reviewed are summarized in the following table:

1	Sample Receipt, Preservation, and Holding Times	2	Standard Reference Materials (SRM)
	System Performance and Resolution Checks		Ongoing Precision and Recovery (OPR)
	Initial Calibration (ICAL)		Target Analyte List
	Calibration Verification (CVER)	1	Reported Results
1	Method Blanks	2	Compound Identification
2	Labeled Compounds	1	Calculation Verification
1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)		

*[1] **Quality control results are discussed below, but no data were qualified.***
*[2] **Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The temperatures of some sample coolers were outside of these limits, ranging from 0°C to 8°C. These temperature outliers did not impact data quality and no action was taken.

Method Blanks

One or more target analytes were detected in the method blanks. In order to assess the impact of blank contamination on the reported sample results, action levels were established at five times the blank concentrations. All results in the associated samples were greater than the action levels; therefore no qualification of data based on method blank contamination was required.

The laboratory assigned K-flags to results when a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are "estimated maximum possible concentrations". When these occurred in the method blank the results were considered as false positives. No action levels were established for these analytes.

Labeled Compound Recovery

SDG WG36676: The percent recovery (%R) for the labeled compound 13C-2,3,7,8-TCDF was less than the lower control limit in Sample PS2220-050511-T. The result for 2,3,7,8-TCDF in this sample was estimated (J-13) to indicate a potential low bias.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates or laboratory duplicates were not analyzed due to insufficient sample volume. Accuracy was assessed using the labeled compound, standard reference material, and ongoing precision and recovery (OPR) standard results. Precision for the analytical batch could not be assessed; however OPR results within the laboratory control limits indicate acceptable laboratory precision from batch to batch.

Standard Reference Materials

The standard reference material (SRM) NIST 1944 was analyzed with each batch. Results were within the control limits of ±20% of the 95% confidence interval, with the exceptions noted below. For recoveries less than the lower control limit, results in the associated samples were estimated (J/UJ-12) to indicate a potential low bias. For results greater than the upper control limit, positive results only tin the associated samples were estimated (J-12) to indicate a potential high bias.

Outliers for the following analytes resulted in qualification of data:

SDG WG35790: 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, and 1,2,3,4,7,8-HxCDD - (J-12) high bias

SDG WG36100: 2,3,7,8-TCDD - (J-12) high bias

SDG WG36676: 1,2,3,7,8-PeCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,7,8-HxCDD, and 2,3,4,7,8-PeCDF - (J-12) high bias

Reported Results

All samples were analyzed at various dilution factors. The lower dilution factors were used by the laboratory to reduce the effects of interference present in the samples. When analyte concentrations were greater than the calibrated linear range of the instrument, the laboratory reanalyzed the samples at higher dilution factors. In all cases, the laboratory reported only the most appropriate positive result for each compound, from either the original or diluted analysis. No further action was necessary.

SDG WG35790: The dry weight of Sample BDC2088B-021111-S was not recorded prior to extraction. The laboratory removed this sample from the analytical batch. No results were reported for this sample. The sample was analyzed at the request of NewFields and reported in SDG WG36100.

Compound Identification

All results for 2,3,7,8-TCDF were confirmed on a DB-225 column as required by the method. Although the 2,3,7,8-TCDF results from both columns were reported in the raw data, only the results from the DB-225 column were reported in the EDD. No action was necessary.

The laboratory assigned K-flags to numerous values to indicate that the criterion for ion abundance ratio was not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy (HRMS), an outlier indicates that the reported value may be a false positive or estimated maximum possible concentration (EMPC). All laboratory K-flagged results were qualified as not detected (U-22) at the reported value.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the labeled compound, SRM, and OPR recovery values. Precision within a batch could not be assessed.

Data were qualified as not detected due to ion ratio criteria outliers. Data were estimated due to SRM recovery outliers. One data point was estimated due to a labeled compound recovery outlier.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Polybrominated Diphenyl Ethers (PBDE) by Axys Method MLA-033
(EPA Draft 1614)

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. Samples were analyzed by Axys Analytical Services, Ltd. of Sidney, British Columbia, Canada. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
WG36676	2 Sediment	EPA Stage 4
WG36845	1 Sediment	EPA Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)
	GC/MS Instrument Performance Check		Ongoing Precision and Recovery (OPR)
	Initial Calibration (ICAL)	1	Laboratory Duplicate
	Continuing Calibration (CCAL)	2	Compound Identification
1	Laboratory Blanks		Reported Results
	Labeled Compounds	1	Calculation Verification

[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The temperature of the sample cooler upon receipt at the laboratory was 8.0°C. This temperature outlier did not impact data quality and no action was taken.

Laboratory Blanks

Method blanks were analyzed at the appropriate frequency. To assess the impact of each blank contaminant on the reported sample results, an action level was established at five times the concentration detected in the blank. Several PBDE compounds were detected in the method blanks; however, no results required qualification. All associated results were either greater than the action level or not-detected.

The laboratory assigned K-flags to values when a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are "estimated maximum possible concentrations". When these occurred in the method blank the results were considered as false positives. No action levels were established for these analytes.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates (MS/MSD) or laboratory duplicates were not analyzed due to insufficient sample volume. Accuracy was assessed using the labeled compound and ongoing precision and recovery (OPR) standard results. Precision for the analytical batch could not be assessed; however OPR results within the laboratory control limits indicate acceptable laboratory precision from batch to batch.

Laboratory Duplicates

Laboratory duplicates were not analyzed due to insufficient sample volume. Precision for the analytical batch could not be assessed; however OPR results within the laboratory control limits indicate acceptable laboratory precision from batch to batch.

Compound Identification

The laboratory assigned a "K" flag to one or more analytes in all samples to indicate the ion ratio criterion were not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy, an outlier indicates that the reported result may be a false positive. The "K" flagged results were qualified as not detected at elevated detection limits (U-22).

Calculation Verification

Several results were verified by recalculation form the raw data. No transcription or calculation errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable, as demonstrated by the labeled compound and OPR recoveries. Precision within each batch could not be assessed.

Detection limits were elevated due to ion ratio outliers.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Polybrominated Diphenyl Ethers (PBDE) by Axys Method MLA-033
(EPA Draft 1614)

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory quality control (QC) samples. Samples were analyzed by Axys Analytical Services, Ltd. of Sidney, British Columbia, Canada. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
WG36152	4 Stormwater	EPA Stage 4
WG36561	5 Stormwater	EPA Stage 4
WG36677	1 Stormwater	EPA Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)
	GC/MS Instrument Performance Check		Ongoing Precision and Recovery (OPR)
	Initial Calibration (ICAL)	1	Laboratory Duplicate
	Continuing Calibration (CCAL)	2	Compound Identification
1	Laboratory Blanks		Reported Results
	Labeled Compounds	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The temperatures of some sample coolers were outside of these limits, ranging from 0° to 8°C. These temperature outliers did not impact data quality and no action was taken.

Laboratory Blanks

Method blanks were analyzed at the appropriate frequency. To assess the impact of each blank contaminant on the reported sample results, an action level was established at five times the concentration detected in the blank. Several PBDE compounds were detected in the method blanks; however, no results required qualification. All associated results were either greater than the action level or not-detected.

The laboratory assigned K-flags to values when a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are "estimated maximum possible concentrations". When these occurred in the method blank the results were considered as false positives. No action levels were established for these analytes.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates or laboratory duplicates were not analyzed due to insufficient sample volume. Accuracy was assessed using the labeled compound and ongoing precision and recovery (OPR) standard results. Precision for the analytical batch could not be assessed; however OPR results within the laboratory control limits indicate acceptable laboratory precision from batch to batch.

Laboratory Duplicates

Laboratory duplicates were not analyzed due to insufficient sample volume. Precision for the analytical batch could not be assessed; however OPR results within the laboratory control limits indicate acceptable laboratory precision from batch to batch.

Compound Identification

The laboratory assigned a "K" flag to one or more analytes in all samples to indicate the ion ratio criterion were not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy, an outlier indicates that the reported result may be a false positive. The "K" flagged results were qualified as not detected at elevated detection limits (U-22).

Calculation Verification

Several results were verified by recalculation form the raw data. No transcription or calculation errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable, as demonstrated by the labeled compound and OPR recoveries. Precision within each batch could not be assessed.

Detection limits were elevated due to ion ratio outliers.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Volatile Organic Compounds by SW846 Method 8260C

This report documents the review of analytical data from the analyses of stormwater samples and the associated laboratory and field quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
SU45	3 Stormwater	EPA Stage 2B
SV69	4 Stormwater	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG SU45: Sample NF2095-042711-W was incorrectly listed as “NF20925-042711-S” on the Form I and summary forms.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spikes/Matrix Spike Duplicates (MS/MSD)
1	Initial Calibration (ICAL)		Internal Standards
2	Continuing Calibration (CCAL)		Target Analyte List
	Laboratory Blanks		Reporting Limits
2	Field (Equipment Rinsate) Blanks		Compound Identification
	Surrogate Compounds	2	Reported Results
2	Laboratory Control Samples (LCS/LCSD)	1	Calculation Verification

[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Initial Calibration

The initial calibration (ICAL) percent relative standard deviations (%RSD) were within the control limit of ±30%. The relative response factor (RRF) values were greater than the minimum of 0.05, with exceptions of acetone, acrolein, and 4-methyl-2-pentanone. The RRF values for these compounds are historically low. The responses were stable as indicated by the ICAL %RSD values; therefore no action was taken based on the low RF values.

Continuing Calibration

The RRF values were greater than the minimum control limit, with the exceptions noted above. The RRF values for these analytes are historically low; therefore no action was taken. The values for percent difference (%D) were within the ±25% control limits, with some exceptions. For outliers indicative of a decrease in instrument response, associated positive results and non-detects were estimated (J/UJ-5B) to indicate a potential low bias. For outliers indicative of an increase in instrument response associated positive results only were estimated (J-5B) to indicate a potential high bias.

Outliers for the following analytes resulted in qualification of data:

SDG SI89: acetone and 2-butanone - (UJ-5B) low bias

SDG ST39: naphthalene - (UJ-5B) low bias

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate, LL-ISCO-ER, was submitted. This blank is associated with all stormwater and base flow samples. Methylene chloride, acetone, and toluene were detected in this blank. In order to determine the effect on the field samples, action levels were established at 5x the toluene concentration and 10x the acetone and methylene chloride concentrations (common laboratory contaminants). Positive results in the field samples that were less than the action levels were qualified as not-detected (U-6). See the **Qualified Data Summary Table** in **APPENDIX B** for a list of qualified results.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. For LCS/LCSD recoveries that were less than the lower control limit, positive results and/or non-detects in the associated samples were estimated (J/UJ-10) to indicate a potential low bias. For recoveries greater than the upper control limit, positive results only in the associated samples were estimated (J-10) to indicate a potential high bias. No action was taken if only one of the LCS or LCSD recoveries was outside of the control limit.

Outliers for the following analytes resulted in qualification of data:

SDG SI89: chloromethane, vinyl acetate, and 2-butanone – (UJ-10) low bias

SDG SN46: naphthalene – (J-10) high bias

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the LCS/LCSD results.

Reported Results

The analyte 2-chloroethyl vinyl ether requires the collection of an unpreserved sample due to the highly reactive nature of the analyte. All of the VOA sample vials were received preserved to pH<2; all data for 2-chloroethyl vinyl ether were rejected (R-1).

Calculation Verification

SDG SE60, ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the surrogate and

LCS/LCSD percent recovery (%R) values. Precision was acceptable as demonstrated by the LCS/LCSD relative percent difference values.

Data were estimated based on CCAL %D and LCS/LCSD %R outliers. Data were qualified as not detected based on field blank contamination. All results for 2-chloroethyl vinyl ether were rejected because the samples were acid preserved.

Data that have been rejected should not be used for any purpose.

All other data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Semivolatile Organic Compounds by Method 8270D

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a list of samples that were reviewed.

SDG	Number of Samples	Validation Level
SW02	4 Sediment	EPA Stage 2B
SX82	1 Sediment	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicate (MS/MSD)
	Initial Calibration (ICAL)		Internal Standards
2	Continuing Calibration (CCAL)		Target Analyte List
	Laboratory Blanks	1	Reporting Limits
1	Field (Equipment Rinsate) Blanks		Compound Identification
	Surrogate Compounds	2	Reported Results
2	Laboratory Control Samples (LCS)		Calculation Verification

[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received a sample cooler with a temperature outside of these control limits, at 0.6°C. This temperature outlier did not impact data quality and no qualifiers were assigned.

Continuing Calibration

All relative response factor (RRF) values were greater than the 0.05 minimum control limit. The values for percent difference (%D) were within the ±25% control limit, with the exceptions noted below. For outliers indicative of a decrease in instrument response, results in the associated samples were estimated (J/UJ-5B) to indicate a potential low bias. For outliers indicative of an increase in instrument response, positive results only in the associated samples were estimated (J-5B) to indicate a potential high bias.

Outliers for the following analytes resulted in qualification of data:

SDG SW02: benzoic acid and pentachlorophenol – (J-5B) high bias

Field (Equipment Rinsate) Blanks

There was no equipment rinsates associated with the samples in these SDG.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. For LCS/LCSD recoveries that were less than the lower control limit, positive results and/or non-detects in the parent sample only were estimated (J/UJ-10) to indicate a potential low bias. If the recoveries were also less than 10%, positive results were estimated (J-10) and non-detects were rejected (R-10) due to the extreme low bias. For recoveries greater than the upper control limit, positive results only in the parent sample were estimated (J-10) to indicate a potential high bias. No action was taken if only one of the LCS or LCSD recoveries was outside of the control limit.

The following outliers resulted in qualification of data:

SDG SW02: 2,4-dimethylphenol - (UJ-10) low bias

SDG SX82: 2,4-dimethylphenol - (UJ-10) low bias

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the LCS/LCSD recovery and relative percent difference (RPD) values.

Reporting Limits

SDG SW02: Samples PS2220-050511-T (5x) and BDC2088-050511-T (5x) were analyzed at dilutions. The reporting limits were elevated accordingly.

Reported Results

SDG SX82: The 4-methylphenol result in Sample KC2062-051911-CB was "M" flagged by the laboratory to indicate that the analyte was detected and confirmed, but with low spectral match. The 4-methylphenol result was qualified as estimated and tentatively identified (NJ-14).

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD %R values. Precision was acceptable as demonstrated by the LCS/LCSD RPD values.

Data were estimated based on CCAL %D and LCS/LCSD accuracy outliers. One data point was estimated and tentatively identified due to low spectral match.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Semivolatile Organic Compounds by Method 8270D

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory and field quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
SU45	3 Stormwater	EPA Stage 2B
SV69	4 Stormwater	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG SU45: Sample NF2095-042711-W was incorrectly listed as “NF20925-042711-S” on the Form I and summary forms.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicate (MS/MSD)
	Initial Calibration (ICAL)		Internal Standards
	Continuing Calibration (CCAL)		Target Analyte List
2	Laboratory Blanks		Reporting Limits
1	Field (Equipment Rinsate) Blanks		Compound Identification
2	Surrogate Compounds		Reported Results
2	Laboratory Control Samples (LCS)	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

SDG SU45: Sample BDC2088-042711-W was re-extracted due to low surrogate recoveries in the original analysis. The re-extraction was done after the holding time had expired; therefore the results from the original analysis should be used.

SDG SV69: Sample BDC2088-050411-W was re-extracted outside of holding time due to low surrogate recoveries in the original analysis. The re-extraction was done after the holding time had expired; therefore the results from the original analysis should be used.

Laboratory Blanks

In order to determine the effect of method blank contamination on the associated field sample data, action levels were established at five times the blank concentration. Positive results in the associated samples that were less than the action levels were qualified as not-detected (U-7). No action was taken for non-detects. The following analytes were qualified in one or more samples based on method blank contamination:

***SDG SL82*:** bis(2-ethylhexyl)phthalate - (U-7)

SDG SU45: bis(2-ethylhexyl)phthalate - (U-7)

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate, LL-ISCO-ER, was submitted. This blank is associated with all stormwater and base flow samples. There were no target analytes detected in this blank.

Surrogate Compounds

SDG SE60: The percent recovery (%R) for the surrogate compound p-terphenyl-d14 was less than the lower control limit in Sample PS2220-011211-W. All other surrogate %R values were within control limits; therefore no action was taken.

SDG SH75: The %R value for 2-fluorophenol was less than the lower control limit in Sample PS2220-020411-W. All other surrogate %R values were within control limits; no action was taken.

SDG SU45: The %R values for 1,2-dichlorobenzene-d4 and 2-chlorophenol-d4 were less than the lower control limits in Sample BDC2088-042711-W. One outlier per acid fraction and base-neutral fraction is allowed; therefore no action was necessary.

SDG SV69: The %R values for all surrogate compounds, except p-terphenyl-d14, were less than the lower control limit in Sample BDC2088-050411-W. The sample was re-extracted and reanalyzed; however the re-extraction was done after the holding time had expired. The results from the original analysis should be used. All results for this sample were estimated (J/UJ-13) to indicate a potential low bias.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. For LCS/LCSD recoveries that were less than the lower control limit, positive results and/or non-detects in the parent sample only were estimated (J/UJ-10) to indicate a potential low bias. If the recoveries were also less than 10%, positive results were estimated (J-10) and non-detects were rejected (R-10) due to the extreme low bias. For recoveries greater than the upper control limit, positive results only in the parent sample were estimated (J-10) to indicate a potential high bias. No action was taken if only one of the LCS or LCSD recoveries was outside of the control limit.

The following outliers resulted in qualification of data:

SDG ST39: 2,4-dimethylphenol and n-nitrosodiphenylamine - (UJ-10) low bias

SDG SV69: LCS/LCSD (5/11/11) – dibenzofuran and total benzofluoranthenes - (UJ-10) low bias

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the LCS/LCSD recovery and relative percent difference (RPD) values.

Calculation Verification

SDG SE60, ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD %R values. Precision was acceptable as demonstrated by the LCS/LCSD RPD values.

Data were estimated based on LCS/LCSD and surrogate recovery outliers. Data were qualified as not-detected based on method blank contamination.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Polycyclic Aromatic Hydrocarbons by Method 8270D

This report documents the review of analytical data from the analysis of filter bag samples and the associated laboratory and field quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a list of samples that were reviewed.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SF75	2 Filter Bag	EPA Stage 2B
SG55	2 Filter Bag	EPA Stage 2B
SG60	2 Filter Bag	EPA Stage 2B
SH75	3 Filter Bag	EPA Stage 2B
SL81	4 Filter Bag	EPA Stage 4
SN46	4 Filter Bag	EPA Stage 2B
SN50	4 Filter Bag	EPA Stage 2B
SV44	6 Filter Bag	EPA Stage 2B
SV69	4 Filter Bag	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1 Sample Receipt, Preservation, and Holding Times
Initial Calibration (ICAL)
Continuing Calibration (CCAL)
2 Laboratory Blanks
1 Field (Equipment Rinsate) Blanks
Surrogate Compounds
Laboratory Control Samples (LCS/LCSD)
1 Matrix Spike/Matrix Spike Duplicates (MS/MSD)
Internal Standards
Target Analyte List
Reporting Limits
Compound Identification
Reported Results
1 Calculation Verification

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*[1] **Quality control results are discussed below, but no data were qualified.***
*[2] **Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside control limits, ranging from 1.8° to 17.4°C. Where temperatures greater than the upper control limit occurred, there may not have been sufficient time for the samples and coolers to achieve a lower temperature because the laboratory received the samples within 6 hours of collection. These temperature outliers did not impact data quality and no qualifiers were assigned.

Laboratory Blanks

SDG SE60: Naphthalene was detected in the method blank. In order to evaluate the effect on the sample results, an action level was established at five times the blank concentration. The naphthalene results in Samples BDC2088-011211-W and KC2062-011211-W were less than the action level and were qualified as not detected (U-7).

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate, LL-FILTER-ER, was submitted. No target analytes were detected in this blank.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recovery and relative percent difference (RPD) values.

Calculation Verification

SDG SL81: Several results were verified by recalculation form the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD recoveries. Precision was also acceptable as demonstrated by the LCS/LCSD RPD values.

Data were qualified as not detected based on method blank contamination.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Polycyclic Aromatic Hydrocarbons by Method 8270D-SIM

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory and field quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a list of samples that were reviewed.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
SU45	3 Stormwater	EPA Stage 2B
SV69	4 Stormwater	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG SU45: Sample NF2095-042711-W was incorrectly listed as "NF20925-042711-S" on the Form I and summary forms.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)
	Initial Calibration (ICAL)		Internal Standards
2	Continuing Calibration (CCAL)		Target Analyte List
2	Laboratory Blanks		Reporting Limits
1	Field (Equipment Rinsate) Blanks		Compound Identification
2	Surrogate Compounds		Reported Results
2	Laboratory Control Samples (LCS)	1	Calculation Verification

1 Quality control results are discussed below, but no data were qualified.
2 Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside control limits, ranging from 1.8° to 17.4°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Continuing Calibration

All values for the relative response factor (RRF) values were greater than the 0.05 minimum control limits. The values for percent difference (%D) were within the ±25% control limit, with the exceptions noted below.

SDG SF68: The %D value for chrysene in the CCAL analyzed 1/31/11 on instrument NT11 was outside of the control limits and indicated a potential high bias. The positive chrysene result for Sample PS2220-012011-W was estimated (J-5B).

Laboratory Blanks

In order to determine the effect of method blank contamination on the associated field sample data, action levels were established at five times the blank concentration. Positive results in the associated samples that were less than the action levels were qualified as not-detected (U-7). No action was taken for non-detects. The following analytes were qualified in one or more samples based on method blank contamination:

SDG SE60: naphthalene - (U-7)

SDG SF68: naphthalene - (U-7)

SDG SG55: naphthalene - (U-7)

SDG SH75: naphthalene - (U-7)

SDG SL82: phenanthrene - (U-7)

SDG SU45: naphthalene - (U-7)

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate blank, LL-ISCO-ER, was submitted. This blank is associated with all stormwater and base flow samples. No target analytes were detected in this blank.

Surrogate Compounds

SDG SF68: The percent recovery (% R) values for the surrogate compounds d10-2-methylnaphthalene in Sample PS2220-012011-W and d14-dibenzo(a,h)anthracene in Sample NF2095-012011-W were greater than the upper control limit. All positive results in these two samples were estimated (J-13) to indicate a potential high bias.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. For LCS/LCSD recoveries that were less than the lower control limit, positive results and/or non-detects in the parent sample only were estimated (J/UJ-10) to indicate a potential low bias. If the recoveries were also less than 10%, positive results were estimated (J-10) and non-detects were rejected (R-10) due to the extreme low bias. For recoveries greater than the upper control limit, positive results only in the parent sample were estimated (J-10) to indicate a potential high bias. No action was taken if only one of the LCS or LCSD recoveries was outside of the control limit.

Outliers for the following analytes resulted in qualification of data.

SDG SF68: 2-methylnaphthalene, fluorene, phenanthrene, anthracene, fluoranthene, and benzo(a)anthracene - (J-10) high bias

SDG SH75: anthracene, fluoranthene, and benzo(a)anthracene - (J-10) high bias

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the LCS/LCSD recovery and relative percent difference (RPD) values.

Calculation Verification

SDG SE60 and ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions previously noted, accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD %R values. Precision was acceptable as demonstrated by the LCS/LCSD RPD values.

Data were estimated based on surrogate %R, CCAL %D, and LCS/LCSD %R outliers. Data were qualified as not-detected based on method blank contamination.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
PCB Aroclors by SW846 Method 8082

This report documents the review of analytical data from the analysis of filter bag samples and the associated field and laboratory quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE58	2 Filter Bag	EPA Stage 4
SJ02	4 Filter Bag	EPA Stage 2B
SL23	4 Filter Bag	EPA Stage 2B
ST60	2 Filter Bag	EPA Stage 2B
SU49	4 Filter Bag	EPA Stage 2B
SV69	4 Filter Bag	EPA Stage 2B
SV77	5 Filter Bag	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%).

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times		Field Duplicates
	Initial Calibration (ICAL)		Internal Standards
	Continuing Calibration (CCAL)		Target Analyte List
	Laboratory Blanks	2	Reporting Limits
1	Field (Equipment Rinsate) Blanks		Compound Identification
1	Surrogate Compounds		Reported Results
	Laboratory Control Samples (LCS/LCSD)	1	Calculation Verification
1	Matrix Spikes/Matrix Spike Duplicates (MS/MSD)		

[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate blank, LL-FILTER-ER, was submitted. This rinsate is associated with all filter bag samples. No target analytes were detected in this blank.

Surrogate Compounds

SDG SV44: The percent recovery (%R) value for decachlorobiphenyl (DCBP) was less than the lower control limit in Sample PS2220B-030411-S. The tetrachlorometaxylene %R value was within control limits; no qualifiers were required for the single outlier.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the laboratory control sample/laboratory control sample duplicate (LCS/LCSD) results.

Reporting Limits

The method reporting limits were sometimes greater than the limits specified in the QAPP. Several chromatograms indicated non-target background interference. The reporting limits for these analytes were flagged "Y" by the laboratory. These "Y" flagged results were qualified (U-22) to indicate the analyte is not-detected at an elevated reporting limit. The following results were qualified:

SDG SE58: NF2095A-011211-S: Aroclor 1248

SDG SJ02: All samples: Aroclor 1248

SDG SL23: NF2095A-030111-S: Aroclor 1248

SDG ST60: PS2220A-042111-S: Aroclor 1248 and Aroclor 1260
NF2095A-042111-S: Aroclor 1248

SDG SU49: PS2220A-042711-S: Aroclor 1248 and Aroclor 1260

SDG SV69: BDC2088A-050411-S, KC2062A-050411-S, NF2095A-050411: Aroclor 1232
PS2220A-050411-S: Aroclor 1248

SDG SV77: KC2062B-030411-S, BDC2088B-030411-S, PS2220B-030411-S: Aroclor 1248

Calculation Verification

SDG SE58: Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory performed the specified analytical method. With the exception noted above, accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD recoveries, with the exception noted above. Precision was acceptable as demonstrated by the relative percent difference values for the LCS/LCSD analyses.

Reporting limits were elevated based on non-target background interferences.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
PCB Aroclors by SW846 Method 8082

This report documents the review of analytical data from the analyses of stormwater samples and the associated field and laboratory quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
SU45	3 Stormwater	EPA Stage 2B
SV69	4 Stormwater	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG SU45: Sample NF2095-042711-W was incorrectly listed as “NF20925-042711-S” on the Form I and summary forms.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%).

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times		Field Duplicates
	Initial Calibration (ICAL)		Reference Materials
1	Continuing Calibration (CCAL)	2	Internal Standards
	Laboratory Blanks		Target Analyte List

1	Field (Equipment Rinsate) Blanks	2	Reporting Limits
	Surrogate Compounds		Compound Identification
	Laboratory Control Samples (LCS)		Reported Results
1	Matrix Spikes/Matrix Spike Duplicates (MS/MSD)	1	Calculation Verification (Full Validation Only)

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Continuing Calibration

SDG SN46: The percent difference (%D) values on the ZB5 column for Aroclor 1260 peaks #1 and #2 were greater than the 25% control limit in the 3/23/11 05:56 CCAL. All %D values were within control limits on the ZB35 column. No qualifiers were required.

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate blank, LL-ISCO-ER, was submitted. This blank is associated with all stormwater and base flow samples. No target analytes were detected in this blank.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the laboratory control sample/laboratory control sample duplicate (LCS/LCSD) results.

Internal Standards

SDG SN46: The hexabromobiphenyl percent recovery (%R) value was less than the lower control limit in Sample PS2220-031511-W on the ZB5 column. The %R value was within control limits on the ZB35 column. No Aroclors were detected in the sample; the reporting limits were estimated (UJ-19).

SDG SV69: Several internal standard %R values were greater than the upper control limit in this SDG. These outliers were indicative of a potential high bias. No positive results were detected in the associated samples. No qualifiers were required.

Reporting Limits

The method reporting limits were sometimes greater than the limits specified in the QAPP. Several chromatograms indicated non-target background interference. The reporting limits for these analytes were flagged "Y" by the laboratory. These "Y" flagged results were qualified (U-22) to indicate the analyte is not-detected at an elevated reporting limit. The following results were qualified:

SDG SL82: PS2220-030411-W: Aroclor 1248

Calculation Verification

SDG SE60, ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory performed the specified analytical method. Accuracy was acceptable, as demonstrated by the surrogate and LCS/LCSD recoveries. Precision was also acceptable as demonstrated by the relative percent difference values for the LCS/LCSD analyses.

Reporting limits were elevated based on non-target background interferences. Data were estimated based on an internal standard outlier.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Chlorinated Pesticides by SW846 Method 8081B

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Rinsate	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	3 Stormwater	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
SU45	3 Stormwater	EPA Stage 2B
SV69	4 Stormwater	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG SU45: Sample NF2095-042711-W was incorrectly listed as “NF20925-042711-S” on the Form I and summary forms.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. Laboratory QC results were also verified (10%). No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)
	Initial Calibration (ICAL)		Internal Standards
1	Continuing Calibration (CCAL)		Target Analyte List
	Laboratory Blanks		Reporting Limits
1	Field (Equipment Rinsate) Blanks		Compound Identification
1	Surrogate Compounds	2	Reported Results
2	Laboratory Control Samples (LCS/LCSD)	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Continuing Calibration

SDG ST39: The percent difference (%D) value on the CLP1 column for toxaphene peak #2 was greater than the ±25% control limit in the 5/2/11 20:31 CCAL. All %D values were within control limits on the CLP2 column. No qualifiers were required.

The %D value on the CLP2 column for toxaphene peak #1 was greater than the ±25% control limit in the 5/3/11 04:12 CCAL. All %D values were within control limits on the CLP1 column. No qualifiers were required.

Field (Equipment Rinsate) Blanks

SDG RY37: One field blank, LL-ISCO-ER, was submitted. This rinsate is associated with all stormwater and base flow samples. No target analytes were detected in this blank.

Surrogate Compounds

SDG SU45: The surrogate tetrachlorometaxylene (TCMX) was not recovered in the method blank. The TCMX percent recovery (%R) values were less than the lower control limit in the LCS/LCSD. No action was taken as qualifiers are not assigned to QC samples.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. For LCS/LCSD recoveries that were less than the lower control limit, positive results and/or non-detects in the parent sample only were estimated (J/UJ-10) to indicate a potential low bias. If the recoveries were also less than 10%, positive results were estimated (J-10) and non-detects were rejected (R-10) due to the extreme low bias. For recoveries greater than the upper control limit, positive results only in the parent sample were estimated (J-10) to indicate a potential high bias. No action was taken if only one of the LCS or LCSD recoveries was outside of the control limit.

Outliers for the following analytes resulted in qualification of data:

SDG SG55: delta-BHC and endosulfan II - (UJ-10) low bias

SDG SH75: delta-BHC - (UJ-10) low bias

SDG SI89: delta-BHC and endosulfan II - (UJ-10) low bias

SDG SL23: delta-BHC and endosulfan sulfate – (UJ-10) low bias

SDG SL82: delta-BHC – (UJ-10) low bias

SDG SN46: alpha-BHC, delta-BHC, endosulfan II, endosulfan sulfate, and endrin ketone – (UJ-10) low bias

SDG ST39: delta-BHC – (UJ-10) low bias

SDG SU45: alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, heptachlor, aldrin, heptachlor epoxide, endosulfan I, dieldrin, endosulfan sulfate, endrin ketone, trans-chlordane, cis-chlordane, and hexachlorobenzene - (UJ-10) low bias

SDG SV69: delta-BHC – (UJ-10) low bias

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicate (MS/MSD) analyses were not performed due to insufficient sample volume. Precision and accuracy were evaluated using the LCS/LCSD results.

Reported Results

SDG SV69: The hexachlorobutadiene result in Sample BDC2088-050411-W was “P” flagged by the laboratory to indicate that the relative percent difference (RPD) between the primary and confirmation columns exceeded 40% for this analyte (130%). The hexachlorobutadiene result was estimated and tentatively identified (NJ-3) for this sample.

Calculation Verification

SDG SE60 and ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the surrogate and LCS/LCSD %R values. Precision was acceptable as demonstrated by the LCS/LCSD RPD values.

Data were qualified based on LCS/LCSD recovery and second column confirmation %D outliers.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Metals by Methods 6010B, 7470A, & 7471A

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Blank	EPA Stage 2A
SE58	2 Sediment	EPA Stage 4
SF75	1 Sediment	EPA Stage 2B
SG60	2 Sediment	EPA Stage 2B
SH75	3 Sediment	EPA Stage 2B
SJ02	4 Sediment	EPA Stage 2B
SL23	1 Sediment	EPA Stage 2B
SL81	3 Sediment	EPA Stage 2B
SN50	2 Sediment	EPA Stage 2B
SX82	1 Sediment	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	2	Laboratory Duplicates
	Initial Calibration		Field Duplicates
	Calibration Verification		Interference Check Samples
1	Reporting Limit Standards		Serial Dilutions
	Laboratory Blanks		ICP-MS Internal Standards
1	Field (Equipment Rinsate) Blanks		Reporting Limits
	Laboratory Control Samples (LCS)	1	Reported Results
2	Matrix Spikes (MS)	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Reporting Limit Standards

SDG SJ02: The reporting limit (RL) standard recovery for copper (132.5%) was greater than the upper control limit of 130%. The copper results in the associated field samples were greater than 2x the reporting limit; therefore no qualification of data was necessary.

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment blank, LL-FILTER-ER, was submitted. This blank is associated with all sediment samples. Copper and zinc were detected in this blank. In order to determine the effect on the field samples, action levels were established at 5X the copper and zinc concentrations. All copper and zinc results in the sediment samples were greater than the action levels and no qualification of data was necessary.

Matrix Spikes

SDGs RY37, SE58, SG60, SL23, SL81, & SN50: Matrix spike samples (MS) were not analyzed due to insufficient sample mass. The laboratory control samples (LCS) were used to evaluate laboratory accuracy.

SDG SX82: The MS percent recovery (%R) value for zinc (68.5%) was less than the lower control limit of 75%. The zinc result in the associated field sample was estimated (J-8) to indicate a potential low bias.

Laboratory Duplicates

SDGs RY37, SE58, SG60, SL23, SL81, & SN50: Laboratory duplicate analyses were not performed due to insufficient sample mass. Analytical precision could not be assessed.

SDG SF75: For QC Sample KC2062A012011-S, the relative percent difference (RPD) value for zinc (99.6%) was greater than the control limit of 20%. The zinc result for this sample was estimated (J-9).

Reported Results

Several samples were not analyzed due to insufficient sample volume. The samples that were cancelled are listed below.

SDG SL23: Samples KC2062A-030111-S, BDC2088A-030111-S, and PS2220A-030111-S were not analyzed.

SDG SL81: Sample BDC2088A-030411-S was not analyzed.

Calculation Verification

SDG SE58: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the LCS and MS sample recoveries. With the exceptions noted above, precision was acceptable as demonstrated by the laboratory duplicate RPD values.

Data were estimated based on an MS %R recovery value outlier and a laboratory duplicate RPD outlier.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Total and Dissolved Metals by Methods 6010B, 200.8, &7470A

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
RY37	1 Equipment Blank	EPA Stage 2A
SE60	3 Stormwater	EPA Stage 4
SE62	3 Stormwater (Low Level Hg only)	EPA Stage 4
SF68	2 Stormwater	EPA Stage 2B
SF70	2 Stormwater (Low Level Hg only)	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SG56	2 Stormwater (Low Level Hg only)	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SH76	4 Stormwater (Low Level Hg only)	EPA Stage 2B
SI89	3 Stormwater	EPA Stage 2B
SI90	3 Stormwater (Low Level Hg only)	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL24	3 Stormwater (Low Level Hg only)	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SL83	4 Stormwater (Low Level Hg only)	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
SN47	2 Stormwater (Low Level Hg only)	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 4
ST40	3 Stormwater (Low Level Hg only)	EPA Stage 4
SV69	4 Stormwater	EPA Stage 2B
SV70	4 Stormwater (Low Level Hg only)	EPA Stage 2B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	2	Laboratory Duplicates
	Initial Calibration		Field Duplicates
1	Calibration Verification	2	Interference Check Samples
1	Reporting Limit Standards		Serial Dilutions
	Laboratory Blanks		ICP-MS Internal Standards
1	Field (Equipment Rinsate) Blanks		Reporting Limits
	Laboratory Control Samples (LCS)	2	Reported Results
1	Matrix Spikes (MS)	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that the cooler temperatures should be within an advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside of these control limits, ranging from 1.0° to 15.1°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Calibration Verification

SDG SI89: Three continuous calibration verification (CCV) standard recoveries for selenium (113.8%, 112.7%, & 111.7%) were greater than the upper control limit of 110%. Selenium was not detected in the associated field samples; therefore no qualification of data was necessary based on the potential high bias.

Reporting Limit Standards

SDG SF70: The reporting limit (RL) standard recovery for mercury (178%) was greater than the upper control limit of 130%. Mercury was not detected in the associated samples; no qualification of data was necessary based on the potential high bias.

SDG SV69: The RL standard recovery for arsenic (135%) was greater than the upper control limit of 130%. All associated results were greater than 2x the RL; no qualification of data was necessary based on the potential high bias.

Field (Equipment Rinsate) Blanks

SDG RY37: One equipment rinsate, LL-ISCO-ER, was submitted. This blank is associated with all stormwater samples. No target analytes were detected in the equipment rinsate.

Matrix Spikes

SDGs RY37, SF68, SF70, SG55, SG56, SI89, SI90, SL82, SL83, SN46, SN47, ST39, ST40, SV69, & SV70: Matrix spike samples (MS) were not analyzed due to insufficient sample volume. The laboratory control sample (LCS) was used to evaluate laboratory accuracy.

Laboratory Duplicates

The relative percent difference (RPD) control limit is 20% for results greater than 5x the RL. For results less than 5x the RL, the difference between the sample and duplicate must be less than the RL. For RPD or difference values exceeding the control limits, associated positive results and non-detects were estimated (J/UJ-9). The following outliers were noted:

SDGs RY37, SF68, SF70, SG55, SG56, SI89, SI90, SL82, SL83, SN46, SN47, ST39, ST40, SV69, & SV70: Laboratory duplicate samples were not analyzed due to insufficient sample volume. Laboratory precision could not be assessed.

SDG SE60: For QC Sample KC2062-011211-W, the difference between the zinc results for the sample and duplicate was greater than the RL. All associated total zinc and dissolved zinc results were estimated (J/UJ-9).

ICP Interference Check Samples

SDG SH75: The interference check sample analyses (ICSAB) percent recovery (%R) value was greater than the upper control limit for zinc, at 120.5%. All associated zinc results were estimated (J-17) to indicate a potential high bias.

SDG SI89: The ICSAB %R value was greater than the upper control limit for zinc, at 123.5%. All associated zinc results were estimated (J-17) to indicate a potential high bias.

SDG SL23: The ICSAB %R value was greater than the upper control limit for zinc, at 120.5%. All associated zinc results were estimated (J-17) to indicate a potential high bias.

Reported Results

SDG SF68: The dissolved zinc result was greater than the total zinc result in Sample NF2095-012011-W. The RPD of 29.4% was greater than the laboratory precision criterion of 20%. The total and dissolved zinc results for Sample NF2095-012011-W were estimated (J-14).

SDG SI89: The dissolved copper result was greater than the total copper result in Sample KC2062-021111-W. The copper results were less than 5X the RL. The difference between results was less than the RL. Results were within normal analytical error. No data were qualified.

Sample PS2220-021111-W was not analyzed due to insufficient volume.

SDG SN46: The carboy containing Sample BDC2088-042111-W was broken during log-in at the laboratory. The entire sample was lost and could not be analyzed.

SDG SV69: The dissolved copper result was greater than the total copper result in Sample KC2062-050411-W. The copper results were less than 5x the RL. The difference between results was less than the RL. Results were within normal analytical error. No data were qualified.

Calculation Verification

SDGs SE60, SE62, ST39, & ST40: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the LCS and MS sample recoveries. With the exception noted above, precision was acceptable as demonstrated by the laboratory duplicate results.

Data were estimated based on a laboratory duplicate precision outlier and ICP interference check sample percent recovery outliers. Data were also estimated due to a dissolved result exceeding the total result.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Conventionals Analyses

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
SE58	2 Sediment	EPA Stage 4
SF75	1 Sediment	EPA Stage 2B
SG60	1 Sediment	EPA Stage 2B
SH75	3 Sediment	EPA Stage 2B
SJ02	4 Sediment	EPA Stage 2B
SL23	1 Sediment	EPA Stage 2B
SL81	3 Sediment	EPA Stage 2B
SN50	2 Sediment	EPA Stage 2B
SW02	4 Sediment	EPA Stage 2B
SX82	1 Sediment	EPA Stage 2B

The analytical tests that were performed are summarized below:

Parameter	Method
Grain Size	PSEP
Total Solids	EPA 160.3
Total Organic Carbon (SW02 & SX82 only)	Plumb, 1981

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed in the following table.

1	Sample Receipt, Preservation, and Holding Times		Matrix Spikes (MS)
	Initial Calibration	1	Laboratory Replicates
	Calibration Verification		Field Replicates
	Laboratory Blanks		Reporting Limits

	Laboratory Control Samples (LCS)	1	Reported Results
1	Reference Materials	1	Calculation Verification

[1] Quality control results are discussed below, but no data were qualified.

Sample Receipt, Preservation, and Holding Times

As stated in validation guidance documents, sample shipping coolers should arrive at the laboratory within the advisory temperature range of 2° to 6°C. The laboratory received sample coolers with temperatures outside control limits, ranging from 1.0° to 9.6°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

Reference Materials

SDG SW02 and SX82: The standard reference material NIST 1941B was analyzed for total organic carbon (TOC). All recoveries were within the certified acceptance ranges.

Laboratory Duplicates

SDGs SE58, SF75, SG60, SH75, SJ02, SL23, SL81, & SN50: Laboratory duplicate samples were not performed due to insufficient sample mass. Analytical precision could not be assessed.

Reported Results

Several samples could not be analyzed for all requested parameter due to insufficient sample size. Discrepancies between requested and reported analyses are noted below.

SDG SE58: Sample NF2095a-011211-S was not analyzed for grain size.

SDG SF75: Sample NF2095A-12011-S was not analyzed for grain size.

SDG SG60: Sample NF2095A-012611-S was not analyzed for grain size.

SDG SH75: Samples PS2220A-020411-S and NF2095A-0202411-S were not analyzed for grain size.

SDG SJ02: Samples PS2220A-021111-S and BDC2088A-021111-S were not analyzed for grain size.

SDG SL23: Sample NF2095A-030111-S was not analyzed for grain size. Samples KC2062A-030111-S, BDC2088A-030111-S, and PS2220A-030111-S were not analyzed for any parameters.

SDG SL81: Sample BDC2088A-030411-S was not analyzed for total solids. No field samples were analyzed for grain size.

SDG SN50: Samples were analyzed for total solids only.

SDG SW02: Sample BDC2088-050511-T was not analyzed for total organic carbon (TOC). Samples PS2220-050511-T, NF2095-050511-T, BDC2088-050511-T, and KC2062-050511-T were not analyzed for grain size.

Calculation Verification

SDG SE58: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the laboratory control sample, reference material, and matrix spike sample recoveries. Precision was acceptable as demonstrated by the laboratory duplicate relative percent difference values.

No data were qualified for any reason.

All data, as reported, are acceptable for use.

DATA VALIDATION REPORT
Lower Duwamish Waterway - Lateral Loading Study
Conventionals Analyses

This report documents the review of analytical data from the analysis of stormwater samples and the associated laboratory quality control (QC) samples. Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. See the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
SE60	3 Stormwater	EPA Stage 3
SF68	2 Stormwater	EPA Stage 2B
SG55	2 Stormwater	EPA Stage 2B
SH75	4 Stormwater	EPA Stage 2B
SI89	4 Stormwater	EPA Stage 2B
SL23	3 Stormwater	EPA Stage 2B
SL82	4 Stormwater	EPA Stage 2B
SN46	2 Stormwater	EPA Stage 2B
ST39	3 Stormwater	EPA Stage 3
SV69	4 Stormwater	EPA Stage 2B

The analytical tests that were performed are summarized below:

Parameter	Method
pH	EPA 150.1
Alkalinity	SM 2320
Total Suspended Solids	EPA 160.2
Chloride	EPA 300.0
N-Nitrate	EPA 300.0
Sulfate	EPA 300.0
Total Organic Carbon	EPA 415.1
Dissolved Organic Carbon	EPA 415.1
Hardness	SW6010B

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO HARDCOPY VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the hardcopy laboratory data package. No errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed in the following table.

2	Sample Receipt, Preservation, and Holding Times	1	Matrix Spikes (MS)
	Initial Calibration	1	Laboratory Replicates
	Calibration Verification		Field Replicates
2	Laboratory Blanks		Reporting Limits
	Laboratory Control Samples (LCS)	1	Reported Results
1	Reference Materials	1	Calculation Verification

[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Sample Receipt, Preservation, and Holding Times

As stated in validation guidance documents, sample shipping coolers should arrive at the laboratory within the advisory temperature range of 2° to 6°C. The laboratory received samples coolers with temperatures outside the control limits, ranging from 1.0° to 9.6°C. Where temperatures were greater than the upper control limit, it was noted that the samples were received within six hours of collection and there was insufficient time for the samples temperature to equilibrate with the ice used as a preservative. These temperature outliers did not impact data quality and no qualifiers were assigned.

SDG SH75: Sample BDC2088-020411-W was analyzed for nitrate after the holding time had expired. The nitrate result for Sample BDC2088-020411-W was estimated (J-1) to indicate a potential low bias.

Laboratory Blanks

To assess the impact of each blank contaminant on the reported sample results, an action level is established at five times (5x) the concentration detected in the blank. If a contaminant is detected in an associated field sample and the concentration is less than the action level, the result is qualified (U-7) at the reported concentration to indicate an elevation of the reporting limit. No action is taken if the sample result is greater than the action level or for non-detected results.

Method and instrument blanks were analyzed at the appropriate frequency. Various target analytes were detected in the method or instrument blanks, however only the following analytes required qualification in one or more samples:

SDG SL23: nitrate – not detected (U-7)

SDG SL82: nitrate – not detected (U-7)

SDG SV69: nitrate – not detected (U-7)

Reference Materials

The standard reference material (SRM) ERA #P114506 was analyzed for alkalinity. The reference materials ERA #230109 and ERA #220109 were analyzed for chloride and sulfate. The SRM ERA #09127 was analyzed for N-nitrate. The SRM ERA #0513-10-06 was analyzed for total organic carbon (TOC) and dissolved organic carbon (DOC). All recoveries were within the certified acceptance ranges.

Matrix Spike

SDGs SF68, SG55, SI89, SL82, SN46, ST39, & SV69: Due to insufficient sample volume, matrix spike samples (MS) were not analyzed for hardness analysis by method 6010B. The laboratory control sample (LCS) was used to evaluate accuracy.

Laboratory Duplicates

SDGs SF68, SG55, SI89, SL82, SN46, ST39, & SV69: Due to insufficient sample volume, laboratory duplicate samples were not analyzed for hardness by Method 6010B. Laboratory precision could not be evaluated.

Reported Results

SDG SI89: Sample PS2220-021111-W was analyzed for total suspended solids (TSS) only. Remaining analyses could not be performed due to insufficient volume.

SDG ST39: Sample BDC2088-042111-W was received by the laboratory in an empty carboy yielding insufficient sample for analysis. Sample BDC2088-042111-W was not analyzed.

Sample SQ2-042111-W was received by the laboratory in a cracked carboy. The carboy broke during sample reception. A limited amount of sample volume was retained and analysis of Sample SQ2-042111-W was limited to TSS.

Calculation Verification

SDGs SE60 and ST39: Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the laboratory control sample, reference material, and matrix spike sample recoveries. Precision was acceptable as demonstrated by the laboratory duplicate relative percent difference values.

One nitrate result was estimated based on an exceeded holding time. Data were qualified as not detected due to laboratory blank contamination.

All data, as qualified, are acceptable for use.

EcoChem, INC.
Environmental Data Quality

APPENDIX A

DATA QUALIFIER DEFINITIONS
REASON CODES
AND CRITERIA TABLES

DATA VALIDATION QUALIFIER CODES
Based on National Functional Guidelines

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents the approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following is an EcoChem qualifier that may also be assigned during the data review process:

DNR	Do not report; a more appropriate result is reported from another analysis or dilution.

DATA QUALIFIER REASON CODES

1	Holding Time/Sample Preservation
2	Chromatographic pattern in sample does not match pattern of calibration standard.
3	Compound Confirmation
4	Tentatively Identified Compound (TIC) (associated with NJ only)
5A	Calibration (initial)
5B	Calibration (continuing)
6	Field Blank Contamination
7	Lab Blank Contamination (e.g., method blank, instrument, etc.)
8	Matrix Spike(MS & MSD) Recoveries
9	Precision (all replicates)
10	Laboratory Control Sample Recoveries
11	A more appropriate result is reported (associated with "R" and "DNR" only)
12	Reference Material
13	Surrogate Spike Recoveries (a.k.a., labeled compounds & recovery standards)
14	Other (define in validation report)
15	GFAA Post Digestion Spike Recoveries
16	ICP Serial Dilution % Difference
17	ICP Interference Check Standard Recovery
18	Trip Blank Contamination
19	Internal Standard Performance (e.g., area, retention time, recovery)
20	Linear Range Exceeded
21	Potential False Positives
22	Elevated Detection Limit Due to Interference (i.e., laboratory, chemical and/or matrix)

EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler/Storage Temperature	Waters/Solids < 4°C Tissues <-10°C	EcoChem PJ, see TM-05	1
Holding Time	Extraction - Water: 30 days from collection *Note:* Under CWA, SDWA, and RCRA the HT for H2O is 7 days* Extraction - Soil: 30 days from collection Analysis: 40 days from extraction	J(+)/UJ(-) if ext > 30 days J(+)/UJ(-) if analysis > 40 Days EcoChem PJ, see TM-05	1
Mass Resolution	>=10,000 resolving power at m/z 304.9824 Exact mass of m/z 380.9760 w/in 5 ppm of theoretical value (380.97410 to 380.97790) . Analyzed prior to ICAL and at the start and end of each 12 hr. shift	R(+/-) if not met	14
Window Defining Mix and Column Performance Mix	Window defining mixture/Isomer specificity std run before ICAL and CCAL Valley < 25% (valley = (x/y)*100%) x = ht. of TCDD y = baseline to bottom of valley For all isomers eluting near 2378-TCDD/TCDF isomers (TCDD only for 8290)	J(+) if valley > 25%	5A (ICAL) 5B (CCAL
Initial Calibration	Minimum of five standards %RSD < 20% for native compounds %RSD <30% for labeled compounds (%RSD <35% for labeled compounds under 1613b)	J(+) natives if %RSD > 20%	5A
	Abs. RT of $^{13}C_{12}$-1234-TCDD >25 min on DB5 >15 min on DB-225	EcoChem PJ, see TM-05	
	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	EcoChem PJ, see TM-05	
	S/N ratio > 10 for all native and labeled compounds in CS1 std.	If <10, elevate Det. Limit or R(-)	

EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Continuing Calibration	Analyzed at the start and end of each 12 hour shift. %D+/-20% for native compounds %D +/-30% for labeled compounds (Must meet limits in Table 6, Method 1613B) (If %Ds in the closing CCAL are w/in 25%/35% the avg RF from the two CCAL may be used to calculate samples per Method 8290, Section 8.3.2.4)	Do not qualify labeled compounds. Narrate in report for labeled compound %D outliers. For native compound %D outliers: 8290: J(+)/UJ(-) if %D = 20% - 75% J(+)/R(-) if %D > 75% 1613: J(+)/UJ(-) if %D is outside Table 6 limits J(+)/R(-) if %D is +/- 75% of Table 6 limit	5B
	Abs. RT of $^{13}C_{12}$-1234-TCDD and ^{13}C12-123789-HxCDD +/- 15 sec of ICAL.	EcoChem PJ, see ICAL section of TM-05	
	RRT of all other compounds must meet Table 2 of 1613B.	EcoChem PJ, see TM-05	
	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	EcoChem PJ, see TM-05	
	S/N ratio > 10	If <10, elevate Det. Limit or R(-)	
Method Blank	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	7
Field Blanks (Not Required)	No positive results	If sample result <5X action level, qualify U at reported value.	6
LCS / OPR	Concentrations must meet limits in Table 6, Method 1613B or lab limits.	J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) using PJ if %R <<LCL (< 10%)	10
MS/MSD (recovery)	May not analyze MS/MSD %R should meet lab limits.	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	May not analyze MS/MSD RPD < 20%	J(+) in parent sample if RPD > CL	9

EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Lab Duplicate	RPD <25% if present.	J(+)/UJ(-) if outside limts	9
Labeled Compounds / Internal Standards	*Method 8290:* %R = 40% - 135% in all samples ------ *Method 1613B:* %R must meet limits specified in Table 7, Method 1613	J(+)/UJ(-) if %R = 10% to LCL J(+) if %R > UCL J(+)/R(-) if %R < 10%	13
Quantitation/ Identification	Ions for analyte, IS, and rec. std. must max w/in 2 sec. S/N >2.5 IA ratios meet limits in Table 9 of 1613B or Table 8 of 8290 RRTs w/in limits in Table 2 of 1613B	If RT criteria not met, use PJ (see TM-05) If S/N criteria not met, J(+). if unlabelled ion abundance not met, change to EMPC If labelled ion abundance not met, J(+).	21
EMPC (estimated maximum possible concentration)	If quantitation idenfication criteria are not met, laboratory should report an EMPC value.	If laboratory correctly reported an EMPC value, qualify with U to indicate that the value is a detection limit.	14
Interferences	PCDF interferences from PCDPE	If both detected, change PCDF result to EMPC	14
Second Column Confirmation	All 2378-TCDF hits must be confirmed on a DB-225 (or equiv) column. All QC specs in this table must be met for the confirmation analysis.	Report lower of the two values. If not performed use PJ (see TM-05).	3
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
Two analyses for one sample	Report only one result per analyte	"DNR" results that should not be used	11

EcoChem Validation Guidelines for PBDE Analysis by HRMS
(Based on EPA SW-846, Method 1614, draft, 8/2003)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler/Storage Temperature	Waters/Solids < 6°C Tissues <-10°C	EcoChem PJ, see TM-05	1
Holding Time	Samples : Up to one year if stored in the dark; <6°C for waters; <-10°C for solids/tissues. Extracts: Up to one year if stored in the dark; <-10°C.	J(+)/UJ(-) if HT > 1 year EcoChem PJ, see TM-05	1
Mass Resolution	>=5,000 resolving power at 554.9665 (or other significant fragment between 540 and 580) Analyzed prior to ICAL and at the beginning and end of each 12 hr. shift	R(+/-) if not met	14
Instrument Performance (all ICAL & CCAL)	PBDE209 RT must be >48 minutes Tailing factor for congener 99L in CS-3 standard must be <3.00 (Figure 13 in EPA Method 625; 40 CFR136, Appendix A)	Note in Narrative and use Professional Judgement to qualify	5A (ICAL) 5B (CCAL)
	If PBDEs other than 28, 47, 99, 100, 153, 154, 183, & 209 are to be determined: The valley height between PBDE-49 and PBDE-71 must be <40%. Valley Height = (x / y)*100% x = ht. of valley y = ht of shortest peak	J(+) if valley >40%	
Initial Calibration	Minimum of five standards %RSD < 20% for native compounds %RSD < 35% for labeled compounds (100% for PBDE-209L)	J(+) natives if %RSD > 20%	5A
	Ion Abundance ratios within QC limits (See Table 8 of Method 1614, draft)	EcoChem PJ, see TM-05	
	RRT of all compounds within limits (See Table 2 of Method 1614, draft)	EcoChem PJ, see TM-05	
	S/N ratio > 10 for all native and labeled compounds in CS1 std.	If <10, elevate Det. Limit or R(-)	

EcoChem Validation Guidelines for PBDE Analysis by HRMS
(Based on EPA SW-846, Method 1614, draft, 8/2003)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Continuing Calibration	Analyzed at the start of each 12 hour shift. %D +/-30% for most native compounds %D +/-50% for most labeled compounds (See limits for 209, 209L, and 139L in Table 6 of Method 1614, draft)	Do not qualify labeled compounds. Narrate labeled compound %D outliers in report. For native compound %D outliers: J(+)/UJ(-) natives if %D = 30% - 75% J(+)/R(-) if %D > 75%	5B
	Ion Abundance ratios within QC limits (See Table 8 of Method 1614, draft)	EcoChem PJ, see TM-05	
	RRT of all compounds within limits (See Table 2 of Method 1614, draft)	EcoChem PJ, see TM-05	
	Absolute RTs must be within +/-15 seconds of RT from ICAL		
	S/N ratio > 10	If <10, elevate Det. Limit or R(-)	
Method Blank	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	7
Rinse/Field Blank (if required)	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	6
LCS / OPR	One per matrix per batch %R Values w/in limits stated in Table 6, Method 1614, draft	J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) using PJ if %R <<LCL (< 10%)	10
MS/MSD (if required)	Accuracy: %R values within laboratory limits	Qualify parent sample only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
	Precision: RPD < 20%	J(+) in parent sample if RPD > 20%	9
Duplicate (if required)	RPD <25% if present.	J(+)/UJ(-) if outside limts	9

EcoChem Validation Guidelines for PBDE Analysis by HRMS
(Based on EPA SW-846, Method 1614, draft, 8/2003)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Labeled Compounds & Internal Standards	%R Values w/in limits specified in Method 1614, Table 6: 25% - 150% for most compounds; 20% - 200% for PBDE209L 139L (Clean-up Std): 30% - 135%	J(+)/UJ(-) if %R = 10% to LCL J(+) if %R > UCL J(+)/R(-) if %R < 10%	13
Quantitation/ Identification	Ions for analyte, IS, and rec. std. must max w/in 2 sec. S/N >2.5 Ion abundance (IA ratios) must meet limits stated in Table 8 of Method 1614, draft. Relative retention times (RRT) must be w/in limits stated in Table 2 of Method 1614, draft	If RT criteria not met, use PJ (see TM-05) If S/N criteria not met, J(+). if unlabelled ion abundance not met, change to EMPC If labelled ion abundance not met, J(+).	21
Interferences	Lock masses must not deviate +/- 20%	Change result to EMPC	14
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
Two analyses for one sample	Report only one result per analyte	"DNR" results that should not be used to avoid reporting two results	11

EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS
(Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature	4°C ±2°	J(+)/UJ(-) if greater than 6 deg. C (EcoChem PJ)	1
Holding Time	Water: 7 days from collection Soil: 14 days from collection Analysis: 40 days from extraction	<u>Water</u>: J(+)/UJ(-) if ext. > 7 and < 21 days J(+)/R(-) if ext > 21 days (EcoChem PJ) <u>Solids/Wastes</u>: J(+)/UJ(-) if ext. > 14 and < 42 days J(+)/R(-) if ext. > 42 days (EcoChem PJ) J(+)/UJ(-) if analysis >40 days	1
Tuning	DFTPP Beginning of each 12 hour period Method acceptance criteria	R(+/-) all analytes in all samples associated with the tune	5A
Initial Calibration (Minimum 5 stds.)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5A
	%RSD < 30%	(EcoChem PJ, see TM-06) J(+) if %RSD > 30%	5A
Continuing Calibration (Prior to each 12 hr. shift)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5B
	%D <25%	(EcoChem PJ, see TM-06) If > +/-90%: J+/R- If -90% to -26%: J+ (high bias) If 26% to 90%: J+/UJ- (low bias)	5B
Method Blank	One per matrix per batch No results > CRQL	U(+) if sample (+) result is less than CRQL and less than appropriate 5X or 10X rule (raise sample value to CRQL)	7
		U(+) if sample (+) result is greater than or equal to CRQL and less than appropriate 5X and 10X rule (at reported sample value)	7
	No TICs present	R(+) TICs using 10X rule	7
Field Blanks (Not Required)	No results > CRQL	Apply 5X/10X rule; U(+) < action level	6

EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS
(Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
MS/MSD (recovery)	One per matrix per batch Use method acceptance criteria	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	One per matrix per batch Use method acceptance criteria	J(+) in parent sample if RPD > CL	9
LCS low conc. H2O SVOA	One per lab batch Within method control limits	J(+) assoc. cmpd if > UCL J(+)/R(-) assoc. cmpd if < LCL J(+)/R(-) all cmpds if half are < LCL	10
LCS regular SVOA (H2O & solid)	One per lab batch Lab or method control limits	J(+) if %R > UCL J(+)/UJ(-) if %R <LCL J(+)/R(-) if %R < 10% (EcoChem PJ)	10
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J(+)/UJ(-) assoc. cmpd. in all samples	9
Surrogates	Minimum of 3 acid and 3 base/neutral compounds Use method acceptance criteria	Do not qualify if only 1 acid and/or 1 B/N surrogate is out unless <10% J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) if %R < 10%	13
Internal Standards	Added to all samples Acceptable Range: IS area 50% to 200% of CCAL area RT within 30 seconds of CC RT	J(+) if > 200% J(+)/UJ(-) if < 50% J(+)/R(-) if < 25% RT>30 seconds, narrate and Notify PM	19
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
TICs	Major ions (>10%) in reference must be present in sample; intensities agree within 20%; check identification	NJ the TIC unless: R(+) common laboratory contaminants See Technical Director for ID issues	4
Quantitation/ Identification	RRT within 0.06 of standard RRT Ion relative intensity within 20% of standard All ions in std. at > 10% intensity must be present in sample	See Technical Director if outliers	14 21 (false +)

EcoChem Validation Guidelines for Volatile Analysis by GC/MS
(Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature	4°C±2°C Water: HCl to pH < 2	J(+)/UJ(-) if greater than 6 deg. C **(EcoChem PJ)**	1
Hold Time	Waters: 14 days preserved 7 Days: unpreserved (for aromatics) Solids: 14 Days	J(+)/UJ(-) if hold times exceeded If exceeded by > 3X HT: J(+)/R(-) **(EcoChem PJ)**	1
Tuning	BFB Beginning of each 12 hour period Method acceptance criteria	R(+/-) all analytes in all samples associated with the tune	5A
Initial Calibration (Minimum 5 stds.)	RRF > 0.05	**(EcoChem PJ, see TM-06)** If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5A
	%RSD < 30%	**(EcoChem PJ, see TM-06)** J(+) if %RSD > 30%	5A
Continuing Calibration (Prior to each 12 hr. shift)	RRF > 0.05	**(EcoChem PJ, see TM-06)** If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5B
	%D <25%	**(EcoChem PJ, see TM-06)** If > +/-90%: J+/R- If -90% to -26%: J+ (high bias) If 26% to 90%: J+/UJ- (low bias)	5B
Method Blank	One per matrix per batch No results > CRQL	U(+) if sample (+) result is less than CRQL and less than appropriate 5X or 10X rule (raise sample value to CRQL)	7
		U(+) if sample (+) result is greater than or equal to CRQL and less than appropriate 5X and 10X rule (at reported sample value)	7
	No TICs present	R(+) TICs using 10X rule	7
Storage Blank	One per SDG <CRQL	U(+) the specific analyte(s) results in all assoc.samples using the 5x or 10x rule	7
Trip Blank	Frequency as per project QAPP	Same as method blank for positive results remaining in trip blank after method blank qualifiers are assigned	18
Field Blanks (if required in QAPP)	No results > CRQL	Apply 5X/10X rule; U(+) < action level	6

EcoChem Validation Guidelines for Volatile Analysis by GC/MS (Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
MS/MSD (recovery)	One per matrix per batch Use method acceptance criteria	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% **PJ if only one %R outlier**	8
MS/MSD (RPD)	One per matrix per batch Use method acceptance criteria	J(+) in parent sample if RPD > CL	9
LCS *low conc. H2O VOA*	One per lab batch Within method control limits	J(+) assoc. cmpd if > UCL J(+)/R(-) assoc. cmpd if < LCL J(+)/R(-) all cmpds if half are < LCL	10
LCS *regular VOA (H2O & solid)*	One per lab batch Lab or method control limits	J(+) if %R > UCL J(+)/UJ(-) if %R <LCL J(+)/R(-) if %R < 10% **(EcoChem PJ)**	10
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J(+)/UJ(-) assoc. cmpd. in all samples	9
Surrogates	Added to all samples Within method control limits	J(+) if %R >UCL J(+)/UJ(-) if %R <LCL but >10% **(see PJ[1])** J(+)/R(-) if <10%	13
Internal Standard (IS)	Added to all samples Acceptable Range: IS area 50% to 200% of CCAL area RT within 30 seconds of CC RT	J(+) if > 200% J(+)/UJ(-) if < 50% J(+)/R(-) if < 25% RT>30 seconds, **narrate and Notify PM**	19
Field Duplicates	**Use QAPP limits. If no QAPP:** Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (if either result < 5X RL)	Narrate and qualify if required by project **(EcoChem PJ)**	9
TICs	Major ions (>10%) in reference must be present in sample; intensities agree within 20%; check identification	NJ the TIC unless: R(+) common laboratory contaminants **See Technical Director for ID issues**	4
Quantitation/ Identification	RRT within 0.06 of standard RRT Ion relative intensity within 20% of standard All ions in std. at > 10% intensity must be present in sample	**See Technical Director if outliers**	14 21 (false +)

PJ[1] No action if there are 4+ surrogates and only 1 outlier.

EcoChem Validation Guidelines for Pesticides, PCBs, Herbicides, and Phenol by GC/ECD
(Based on Organic NFG 1999 & EPA SW-846 Methods 8081/8082/8041/8151)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature	4°C ±2°	J(+)/UJ(-) if greater than 6 deg. C (EcoChem PJ)	1
Holding Time	Water: 7 days from collection Soil: 14 days from collection Analysis: 40 days from extraction	J(+)/UJ(-) if ext/analyzed > HT J(+)/R(-) if ext/analyzed > 3X HT (EcoChem PJ)	1
Resolution Check	Beginning of ICAL Sequence Within RTW Resolution >90%	Narrate (Use Professional Judgement to qualify)	14
Instrument Performance (Breakdown)	DDT Breakdown: < 20% Endrin Breakdown: <20% Combined Breakdown: <30% Compounds within RTW	J(+) DDT NJ(+) DDD and/or DDE R(-) DDT - If (+) for either DDE or DDD J(+) Endrin NJ(+) EK and/or EA R(-) Endrin - If (+) for either EK or EA	5A
Retention Times	Surrogates: TCX (+/- 0.05); DCB (+/- 0.10) Target compounds: elute before heptachlor epoxide (+/- 0.05) elute after heptachlor epoxide (+/- 0.07)	NJ(+)/R(-) results for analytes with RT shifts For full DV, use PJ based on examination of raw data	5B
Initial Calibration	Pesticides: Low=CRQL, Mid=4X, High=16X Multiresponse - one point Calibration %RSD<20% %RSD<30% for surr; two comp. may exceed if <30% Resolution in Mix A and Mix B >90%	J(+)/UJ(-)	5A
Continuing Calibration	Alternating PEM standard and INDA/INDB standards every 12 hours (each preceeded by an inst. Blank) %D < 25% Resolution >90% in IND mixes; 100% for PEM	J(+)/UJ(-) J(+)R(-) if %D > 90% PJ for resolution	5B
Method Blank	One per matrix per batch No results > CRQL	U(+) if sample result is < CRQL and < 5X rule (raise sample value to CRQL) U(+) if sample result is > or equal to CRQL and < 5X rule (at reported sample value)	7
Instrument Blanks	Analyzed at the beginning of every 12 hour sequence No analyte > 1/2 CRQL	Same as Method Blank	7
Field Blanks	Not addressed by NFG No results > CRQL	Apply 5X rule; U(+) < action level	6

EcoChem Validation Guidelines for Pesticides, PCBs, Herbicides, and Phenol by GC/ECD
(Based on Organic NFG 1999 & EPA SW-846 Methods 8081/8082/8041/8151)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
MS/MSD (recovery)	One set per matrix per batch Method Acceptance Criteria	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	One set per matrix per batch Method Acceptance Criteria	J(+) in parent sample if RPD > CL	9
LCS	One per SDG Method Acceptance Criteria	J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) using PJ if %R <<LCL (< 10%)	10
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J(+)/UJ(-) assoc. cmpd. in all samples	9
Surrogates	TCX and DCB added to every sample %R = 30-150%	J(+)/UJ(-) if both %R = 10 - 60% J(+) if both >150% J(+)/R(-) if any %R <10%	13
Quantitation/ Identification	Quantitated using ICAL calibration factor (CF) RPD between columns <40%	J(+) if RPD = 40 - 60% NJ(+) if RPD >60% EcoChem PJ - See TM-08	3
Two analyses for one sample	Report only one result per analyte	"DNR" results that should not be used to avoid reporting two results for one sample	11
Sample Clean-up	GPC required for soil samples Florisil required for all samples Sulfur is optional Clean-up standard check %R within CLP limits	J(+)/UJ(-) if %R < LCL J(+) if %R > UCL	14
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate (Qualifiy if required by project QAPP)	9

EcoChem Validation Guidelines for Metals Analysis by ICP
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler temperature: 4°C ±2° Waters: Nitric Acid to pH < 2 For Dissolved Metals: 0.45um filter & preserve after filtration Tissues: Frozen	EcoChem Professional Judgment - no qualification based on cooler temperature outliers J(+)/UJ(-) if pH preservation requirements are not met	1
Holding Time	180 days from date sampled Frozen tissues - HT extended to 2 years	J(+)/UJ(-) if holding time exceeded	1
Initial Calibration	Blank + minimum 1 standard If more than 1 standard, r > 0.995	J(+)/UJ(-) if r < 0.995 (multi point cal)	5A
Initial Calibration Verification (ICV)	Independent source analyzed immediately after calibration %R within ±10% of true value	J(+)/UJ(-) if %R 75-89% J(+) if %R = 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5A
Continuing Calibration Verification (CCV)	Every ten samples, immediately following ICV/ICB and at end of run %R within ±10% of true value	J(+)/UJ(-) if %R = 75-89% J(+) if %R 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5B

Initial and Continuing Calibration Blank (ICB/CCB)	After each ICV and CCV
	every ten samples and end of run
	| blank | < IDL (MDL)
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		(Refer to TM-02 for additional information)
			7

Reporting Limit Standard	2x RL analyzed beginning of run Not required for Al, Ba, Ca, Fe, Mg, Na, K %R = 70%-130% (50%-150% Sb, Pb, Tl)	R(-)/J(+) < 2x RL if %R <50% (< 30% Sb, Pb, Tl) J(+) < 2x RL, UJ(-) if %R 50-69% (30-49% Sb, Pb,Tl) J(+) < 2x RL if %R 130-180% (150-200% Sb, Pb, Tl) R(+) < 2x RL if %R > 180% (200% Sb, Pb, Tl)	14
Interference Check Samples (ICSA/ICSAB)	ICSAB %R 80 - 120% for all spiked elements | ICSA | < MDL for all unspiked elements except: K, Na	For samples with Al, Ca, Fe, or Mg > ICS levels R(+/-) if %R < 50% J(+) if %R >120% J(+)/UJ(-) if %R= 50 to 79% Use Professional Judgment for ICSA to determine if bias is present see TM-09 for additional details	17
Method Blank	One per matrix per batch (batch not to exceed 20 samples) blank < MDL	Action level is 5x blank concentration U(+) results < action level	7
Laboratory Control Sample (LCS)	One per matrix per batch		10
	Blank Spike: %R within 80-120%	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	
	CRM: Result within manufacturer's certified acceptance range or project guidelines	J(+)/UJ(-) if < LCL, J(+) if > UCL	

EcoChem Validation Guidelines for Metals Analysis by ICP
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Matrix Spikes	One per matrix per batch 75-125% for samples less than 4x spike level	J(+) if %R > 125% J(+)/UJ(-) if %R < 75% J(+)/R(-) if %R < 30% or J(+)/UJ(-) if Post Spike %R 75-125% Qualify all samples in batch	8
Post-digestion Spike	If Matrix Spike is outside 75-125%, spike at twice the sample conc.	No qualifiers assigned based on this element	
Laboratory Duplicate (or MS/MSD)	One per matrix per batch RPD < 20% for samples > 5x RL Diff < RL for samples >RL and < 5x RL (Diff < 2x RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL (2x RL for solids) qualify all samples in batch	9
Serial Dilution	5x dilution one per matrix %D < 10% for original sample conc. > 50x MDL	J(+)/UJ(-) if %D >10% qualify all samples in batch	16
Field Blank	Blank < MDL	Action level is 5x blank conc. U(+) sample values < action level in associated field samples only	6
Field Duplicate	For results > 5x RL: Water: RPD < 35% Solid: RPD < 50% For results < 5 x RL: Water: Diff < RL Solid: Diff < 2x RL	J(+)/UJ(-) in parent samples only	9
Linear Range	Sample concentrations must fall within range	J values over range	20

EcoChem Validation Guidelines for Metals Analysis by ICP-MS
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler temperature: 4°C ±2° Waters: Nitric Acid to pH < 2 For Dissolved Metals: 0.45um filter & preserve after filtration	EcoChem Professional Judgment - no qualification based on cooler temperature outliers J(+)/UJ(-) if pH preservation requirements are not met	1
Holding Time	180 days from date sampled Frozen tissues - HT extended to 2 years	J(+)/UJ(-) if holding time exceeded	1
Tune	Prior to ICAL monitoring compounds analyzed 5 times wih Std Dev. ≤ 5% mass calibration <0.1 amu from True Value Resolution < 0.9 AMU @ 10% peak height or <0.75 amu @ 5% peak height	Use Professional Judgment to evaluate tune J(+)/UJ(-) if tune criteria not met	5A
Initial Calibration	Blank + minimum 1 standard If more than 1 standard, r>0.995	J(+)/UJ(-) if r<0.995 (for multi point cal)	5A
Initial Calibration Verification (ICV)	Independent source analyzed immediately after calibration %R within ±10% of true value	J(+)/UJ(-) if %R 75-89% J(+) if %R = 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5A
Continuing Calibration Verification (CCV)	Every ten samples, immediately following ICV/ICB and at end of run ±10% of true value	J(+)/UJ(-) if %R = 75-89% J(+) if %R 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5B

Initial and Continuing Calibration Blanks (ICB/CCB)	After each ICV and CCV
	every ten samples and end of run
	| blank | < IDL (MDL)
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Reporting Limit Standard (CRI)	2x RL analyzed beginning of run Not required for Al, Ba, Ca, Fe, Mg, Na, K %R = 70%-130% (50%-150% Co,Mn, Zn)	R(-),(+) < 2x RL if %R < 50% (< 30% Co,Mn, Zn) J(+) < 2x RL, UJ(-) if %R 50-69% (30%-49% Co,Mn, Zn) J(+) < 2x RL if %R 130%-180% (150%-200% Co,Mn, Zn) R(+) < 2x RL if %R > 180% (200% Co, Mn, Zn)	14
Interference Check Samples (ICSA/ICSAB)	Required by SW 6020, but not 200.8 ICSAB %R 80% - 120% for all spiked elements | ICSA | < IDL (MDL) for all unspiked elements	For samples with Al, Ca, Fe, or Mg > ICS levels R(+/-) if %R < 50% J(+) if %R >120% J(+)/UJ(-) if %R = 50% to 79% Use Professional Judgment for ICSA to determine if bias is present see TM-09 for additional details	17
Method Blank	One per matrix per batch (batch not to exceed 20 samples) blank < MDL	Action level is 5x blank concentration U(+) results < action level	7

EcoChem Validation Guidelines for Metals Analysis by ICP-MS
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Laboratory Control Sample (LCS)	One per matrix per batch Blank Spike: %R within 80%-120%	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	10
	CRM: Result within manufacturer's certified acceptance range or project guidelines	J(+)/UJ(-) if < LCL, J(+) if > UCL	
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	One per matrix per batch 75-125% for samples where results do not exceed 4x spike level	J(+) if %R>125% J(+)/UJ(-) if %R <75% J(+)/R(-) if %R<30% or J(+)/UJ(-) if Post Spike %R 75%-125% Qualify all samples in batch	8
Post-digestion Spike	If Matrix Spike is outside 75-125%, Spike parent sample at 2x the sample conc.	No qualifiers assigned based on this element	
Laboratory Duplicate (or MS/MSD)	One per matrix per batch RPD < 20% for samples > 5x RL Diff < RL for samples > RL and < 5 x RL (Diff < 2x RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9
Serial Dilution	5x dilution one per matrix %D < 10% for original sample values > 50x MDL	J(+)/UJ(-) if %D >10% All samples in batch	16
Internal Standards	Every sample SW6020: 60%-125% of cal blank IS 200.8: 30%-120% of cal blank IS	J (+)/UJ (-) all analytes associated with IS outlier	19
Field Blank	Blank < MDL	Action level is 5x blank conc. U(+) sample values < AL in associated field samples only	6
Field Duplicate	For results > 5x RL: Water: RPD < 35% Solid: RPD < 50% For results < 5 x RL: Water: Diff < RL Solid: Diff < 2x RL	J(+)/UJ(-) in parent samples only	9
Linear Range	Sample concentrations must fall within range	J values over range	20

EcoChem Validation Guidelines for Mercury Analysis by CVAA
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler temperature: 4°C ±2° Waters: Nitric Acid to pH < 2 For Dissolved Metals: 0.45um filter & preserve after filtration	EcoChem Professional Judgment - no qualification based on cooler temperature outliers J(+)/UJ(-) if pH preservation requirements are not met	1
Holding Time	28 days from date sampled Frozen tissues: HT extended to 6 months	J(+)/UJ(-) if holding time exceeded	1
Initial Calibration	Blank + 4 standards, one at RL r > 0.995	J(+)/UJ(-) if r<0.995	5A
Initial Calibration Verification (ICV)	Independent source analyzed immediately after calibration %R within ±20% of true value	J(+)/UJ(-) if %R = 65%-79% J(+) if %R = 121-135% R(+/-) if %R < 65% R(+) if %R > 135%	5A
Continuing Calibration Verification (CCV)	Every ten samples, immediately following ICV/ICB and at end of run %R within ±20% of true value	J(+)/UJ(-) if %R = 65%-79% J(+) if %R = 121-135% R(+/-) if %R < 65% R(+) if %R > 135%	5B

Initial and Continuing Calibration Blanks (ICB/CCB)	after each ICV and CCV
	every ten samples and end of run
	| blank | < IDL (MDL)
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Reporting Limit Standard (CRA)	conc at RL - analyzed beginning of run %R = 70-130%	R(-),(+)<2xRL if %R <50% J(+)<2x RL, UJ(-) if %R 50-69% J(+) <2x RL if %R 130-180% R(+)<2x RL if %R>180%	14
Method Blank	One per matrix per batch (batch not to exceed 20 samples) blank < MDL	Action level is 5x blank concentration U(+) results < action level	7
Laboratory Control Sample (LCS)	One per matrix per batch		10
	Blank Spike: %R within 80-120%	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	
	CRM: Result within manufacturer's certified acceptance range or project guidelines	J(+)/UJ(-) if < LCL, J(+) if > UCL	
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One per matrix per batch 5% frequency 75-125% for samples less than 4x spike level	J(+) if %R>125% J(+)/UJ(-) if %R <75% J(+)/R(-) if %R<30% all samples in batch	8
Laboratory Duplicate (or MS/MSD)	One per matrix per batch RPD < 20% for samples > 5x RL Diff < RL for samples > RL and < 5x RL (Diff < 2x RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9

EcoChem Validation Guidelines for Mercury Analysis by CVAA
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Field Blank	Blank < MDL	Action level is 5x blank conc. U(+) sample values < action level in associated field samples only	6
Field Duplicate	For results > 5x RL: Water: RPD < 35% Solid: RPD < 50% For results < 5x RL: Water: Diff<RL Solid: Diff < 2x RL	J(+)/UJ(-) in parent samples only	9
Linear Range	Sample concentrations must be less than 110% of high standard	J values over range	20

EcoChem Validation Guidelines for Conventional Chemistry Analysis
(Based on EPA Standard Methods)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler Temperature 4°C ±2°C Preservation: Method Specific	Use Professional Judgment to qualify based to qualify for coole temp outliers J(+)/UJ(-) if preservation requirements not met	1
Holding Time	Method Specific	Professional Judgment J(+)/UJ(-) if holding time exceeded J(+)/R(-) if HT exceeded by > 3X	1
Initial Calibration	Method specific r>0.995	Use professional judgment J(+)/UJ(-) for r < 0.995	5A
Initial Calibration Verification (ICV)	Where applicable to method Independent source analyzed immediately after calibration %R method specific, usually 90% - 110%	R(+/-) if %R significantly < LCL J(+)/UJ(-) if %R < LCL J(+) if %R > UCL R(+) if %R significantly > UCL	5A
Continuing Cal Verification (CCV)	Where applicable to method Every ten samples, immed. following ICV/ICB and end of run %R method specific, usually 90% - 110%	R(+/-) if %R significantly < LCL J(+)/UJ(-) if %R < LCL J(+) if %R > UCL R(+) if %R significantly > UCL	5B

Initial and Continuing Cal Blanks (ICB/CCB)	Where applicable to method
	After each ICV and CCV every ten samples and end of run
	| blank| < MDL
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Method Blank	One per matrix per batch
	(not to exceed 20 samples)
	blank < MDL
		Action level is 5x absolute value of blank conc.
		For (+) blk value, U(+) results < action level
		For (-) blk value, J(+)/UJ(-) results < action level
			7

Laboratory Control Sample	Waters: One per matrix per batch %R (80-120%)	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	10
	Soils: One per matrix per batch Result within manufacturer's certified acceptance range	J(+)/UJ(-) if < LCL, J(+) if > UCL	10
Matrix Spike	One per matrix per batch; 5% frequency 75-125% for samples less than 4 x spike level	J(+) if %R > 125% or < 75% UJ(-) if %R = 30-74% R(+/-) results < IDL if %R < 30%	8
Laboratory Duplicate	One per matrix per batch RPD <20% for samples > 5x RL Diff <RL for samples >RL and <5 x RL (may use RPD < 35%, Diff < 2X RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9

EcoChem Validation Guidelines for Conventional Chemistry Analysis (Based on EPA Standard Methods)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Field Blank	blank < MDL	Action level is 5x blank conc. U(+) sample values < action level in associated field samples only	6
Field Duplicate	For results > 5X RL: Water: RPD < 35% Solid: RPD < 50% For results < 5 x RL: Water: Diff<RL Solid: Diff < 2X RL	J(+)/UJ(-) in parent samples only	9

EcoChem, INC.
Environmental Data Quality

APPENDIX B
QUALIFIED DATA SUMMARY TABLE

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
RY37	LL-ISCO-ER	RY37C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SE58	NF2095A-011211-S	SE58A	SW8082	Aroclor 1248	2	ug	Y	U	22
SE60	BDC2088-011211-W	SE60A	EPA200.8	Zinc	102	ug/l		J	9
SE60	BDC2088-011211-W	SE60A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SE60	BDC2088-011211-W	SE60A	SW8260C	Acetone	6.8	ug/l		U	6
SE60	BDC2088-011211-W	SE60A	SW8260C	Methylene Chloride	1.1	ug/l		U	6
SE60	BDC2088-011211-W	SE60A	SW8270DSIM	Naphthalene	0.03	ug/l	B	U	7
SE60	KC2062-011211-W	SE60B	EPA200.8	Zinc	19	ug/l		J	9
SE60	KC2062-011211-W	SE60B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SE60	KC2062-011211-W	SE60B	SW8260C	Acetone	18	ug/l		U	6
SE60	KC2062-011211-W	SE60B	SW8260C	Methylene Chloride	1.1	ug/l		U	6
SE60	KC2062-011211-W	SE60B	SW8270DSIM	Naphthalene	0.024	ug/l	B	U	7
SE60	PS2220-011211-W	SE60C	EPA200.8	Zinc	440	ug/l		J	9
SE60	PS2220-011211-W	SE60C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SE60	PS2220-011211-W	SE60C	SW8260C	Acetone	6	ug/l		U	6
SE60	PS2220-011211-W	SE60C	SW8260C	Methylene Chloride	1	ug/l		U	6
SF68	PS2220-012011-W	SF68B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SF68	PS2220-012011-W	SF68B	SW8260C	Acetone	11	ug/l		U	6
SF68	PS2220-012011-W	SF68B	SW8260C	Methylene Chloride	0.8	ug/l		U	6
SF68	PS2220-012011-W	SF68B	SW8270DSIM	1-Methylnaphthalene	0.086	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	2-Methylnaphthalene	0.1	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Acenaphthene	0.54	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Acenaphthylene	0.021	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Anthracene	0.33	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Benzo(a)anthracene	0.62	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Benzo(a)pyrene	0.29	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Benzo(g,h,i)perylene	0.17	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Chrysene	0.6	ug/l	Q	J	5B,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Dibenz(a,h)anthracene	0.087	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Dibenzofuran	0.33	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Fluoranthene	4.1	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Fluorene	0.46	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Indeno(1,2,3-cd)pyrene	0.15	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Naphthalene	0.1	ug/l	B	J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Phenanthrene	0.89	ug/l		J	10,13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Pyrene	2.2	ug/l		J	13
SF68	PS2220-012011-W	SF68B	SW8270DSIM	Total Benzofluoranthenes	0.72	ug/l		J	13
SF68	NF2095-012011-W	SF68C	EPA200.8	Zinc	29	ug/l		J	14
SF68	NF2095-012011-W	SF68C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SF68	NF2095-012011-W	SF68C	SW8260C	Methylene Chloride	0.8	ug/l		U	6
SF68	NF2095-012011-W	SF68C	SW8270DSIM	Fluoranthene	0.012	ug/l		J	10,13
SF68	NF2095-012011-W	SF68C	SW8270DSIM	Naphthalene	0.032	ug/l	B	U	7
SF68	NF2095-012011-W	SF68C	SW8270DSIM	Pyrene	0.012	ug/l		J	13
SF68	NF2095-012011-W	SF68C	SW8270DSIM	Total Benzofluoranthenes	0.011	ug/l		J	13
SF68	NF2095-012011-W	SF68F	EPA200.8	Zinc	39	ug/l		J	14
SF75	KC2062A012011-S	SF75B	SW6010B	Zinc	2090	mg/kg		J	9
SG55	KC2062-012611-W	SG55A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SG55	KC2062-012611-W	SG55A	SW8081B	Endosulfan II	0.1	ug/l	U	UJ	10
SG55	KC2062-012611-W	SG55A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SG55	KC2062-012611-W	SG55A	SW8270DSIM	Naphthalene	0.016	ug/l	B	U	7
SG55	NF2095-012611-W	SG55B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SG55	NF2095-012611-W	SG55B	SW8081B	Endosulfan II	0.1	ug/l	U	UJ	10

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SG55	NF2095-012611-W	SG55B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SH75	BDC2088-020411-W	SH75A	EPA200.8	Zinc	162	ug/l		J	17
SH75	BDC2088-020411-W	SH75A	EPA300.0	Nitrate	0.4	mg/L		J	1
SH75	BDC2088-020411-W	SH75A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SH75	BDC2088-020411-W	SH75A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SH75	BDC2088-020411-W	SH75A	SW8270DSIM	Benzo(a)anthracene	0.043	ug/l		J	10
SH75	BDC2088-020411-W	SH75A	SW8270DSIM	Fluoranthene	0.2	ug/l		J	10
SH75	KC2062-020411-W	SH75B	EPA200.8	Zinc	16	ug/l		J	17
SH75	KC2062-020411-W	SH75B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SH75	KC2062-020411-W	SH75B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SH75	KC2062-020411-W	SH75B	SW8270DSIM	Anthracene	0.049	ug/l		J	10
SH75	KC2062-020411-W	SH75B	SW8270DSIM	Benzo(a)anthracene	0.44	ug/l		J	10
SH75	KC2062-020411-W	SH75B	SW8270DSIM	Fluoranthene	1.5	ug/l		J	10
SH75	KC2062-020411-W	SH75B	SW8270DSIM	Naphthalene	0.039	ug/l	B	U	7
SH75	PS2220-020411-W	SH75C	EPA200.8	Zinc	45	ug/l		J	17
SH75	PS2220-020411-W	SH75C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SH75	PS2220-020411-W	SH75C	SW8270DSIM	Anthracene	0.026	ug/l		J	10
SH75	PS2220-020411-W	SH75C	SW8270DSIM	Benzo(a)anthracene	0.11	ug/l		J	10
SH75	PS2220-020411-W	SH75C	SW8270DSIM	Fluoranthene	0.27	ug/l		J	10
SH75	PS2220-020411-W	SH75C	SW8270DSIM	Naphthalene	0.019	ug/l	B	U	7
SH75	NF2095-020411-W	SH75D	EPA200.8	Zinc	23	ug/l		J	17
SH75	NF2095-020411-W	SH75D	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SH75	NF2095-020411-W	SH75D	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SH75	BDC2088-020411-W	SH75E	EPA200.8	Zinc	140	ug/l		J	17
SH75	KC2062-020411-W	SH75F	EPA200.8	Zinc	5	ug/l		J	17
SH75	PS2220-020411-W	SH75G	EPA200.8	Zinc	10	ug/l		J	17
SH75	NF2095-020411-W	SH75H	EPA200.8	Zinc	14	ug/l		J	17
SH75	KC2062A-020411-S	SH75J	SW6010B	Zinc	170	mg/kg		J	17
SH75	PS2220A-020411-S	SH75L	SW6010B	Zinc	2040	mg/kg		J	17
SH75	NF2095A-020411-S	SH75N	SW6010B	Zinc	840	mg/kg		J	17
SI89	NF2095-021111-W	SI89B	EPA200.8	Zinc	29	ug/l		J	17
SI89	NF2095-021111-W	SI89B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SI89	NF2095-021111-W	SI89B	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SI89	NF2095-021111-W	SI89B	SW8260C	2-Butanone	5	ug/l	U	UJ	5B,10
SI89	NF2095-021111-W	SI89B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SI89	NF2095-021111-W	SI89B	SW8260C	Acetone	5	ug/l	U	UJ	5B
SI89	NF2095-021111-W	SI89B	SW8260C	Chloromethane	0.5	ug/l	U	UJ	10
SI89	NF2095-021111-W	SI89B	SW8260C	Methylene Chloride	1.3	ug/l		U	6
SI89	NF2095-021111-W	SI89B	SW8260C	Vinyl Acetate	1	ug/l	U	UJ	10
SI89	KC2062-021111-W	SI89C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SI89	KC2062-021111-W	SI89C	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SI89	KC2062-021111-W	SI89C	SW8260C	2-Butanone	5	ug/l	U	UJ	5B,10
SI89	KC2062-021111-W	SI89C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SI89	KC2062-021111-W	SI89C	SW8260C	Acetone	5	ug/l	U	UJ	5B
SI89	KC2062-021111-W	SI89C	SW8260C	Chloromethane	0.5	ug/l	U	UJ	10
SI89	KC2062-021111-W	SI89C	SW8260C	Methylene Chloride	1.4	ug/l		U	6
SI89	KC2062-021111-W	SI89C	SW8260C	Vinyl Acetate	1	ug/l	U	UJ	10
SI89	BDC2088-021111-W	SI89D	EPA200.8	Zinc	191	ug/l		J	17
SI89	BDC2088-021111-W	SI89D	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SI89	BDC2088-021111-W	SI89D	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SI89	BDC2088-021111-W	SI89D	SW8260C	2-Butanone	5	ug/l	U	UJ	5B,10
SI89	BDC2088-021111-W	SI89D	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SI89	BDC2088-021111-W	SI89D	SW8260C	Acetone	5	ug/l	U	UJ	5B
SI89	BDC2088-021111-W	SI89D	SW8260C	Chloromethane	0.5	ug/l	U	UJ	10
SI89	BDC2088-021111-W	SI89D	SW8260C	Methylene Chloride	1.6	ug/l		U	6
SI89	BDC2088-021111-W	SI89D	SW8260C	Toluene	0.2	ug/l		U	6
SI89	BDC2088-021111-W	SI89D	SW8260C	Vinyl Acetate	1	ug/l	U	UJ	10
SJ02	PS2220A-021111-S	SJ02A	SW8082	Aroclor 1248	0.8	ug	Y	U	22
SJ02	NF2095A-021111-S	SJ02C	SW8082	Aroclor 1248	0.8	ug	Y	U	22
SJ02	BDC2088A-021111-S	SJ02E	SW8082	Aroclor 1248	1.5	ug	Y	U	22
SJ02	KC2062A-021111-S	SJ02G	SW8082	Aroclor 1248	0.6	ug	Y	U	22
SL23	NF2095-030111-W	SL23A	EPA200.8	Zinc	34	ug/l		J	17
SL23	NF2095-030111-W	SL23A	EPA300.0	Nitrate	0.4	mg/L		U	7
SL23	NF2095-030111-W	SL23A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL23	NF2095-030111-W	SL23A	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SL23	NF2095-030111-W	SL23A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL23	NF2095-030111-W	SL23A	SW8260C	Methylene Chloride	2.8	ug/l		U	6
SL23	KC2062-030111-W	SL23B	EPA200.8	Zinc	31	ug/l		J	17
SL23	KC2062-030111-W	SL23B	EPA300.0	Nitrate	0.2	mg/L		U	7
SL23	KC2062-030111-W	SL23B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL23	KC2062-030111-W	SL23B	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SL23	KC2062-030111-W	SL23B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL23	KC2062-030111-W	SL23B	SW8260C	Acetone	6.8	ug/l		U	6
SL23	KC2062-030111-W	SL23B	SW8260C	Methylene Chloride	4.2	ug/l		U	6
SL23	BDC2088-030111-W	SL23C	EPA200.8	Zinc	102	ug/l		J	17
SL23	BDC2088-030111-W	SL23C	EPA300.0	Nitrate	0.2	mg/L		U	7
SL23	BDC2088-030111-W	SL23C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL23	BDC2088-030111-W	SL23C	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SL23	BDC2088-030111-W	SL23C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL23	BDC2088-030111-W	SL23C	SW8260C	Methylene Chloride	3.7	ug/l		U	6
SL23	NF2095-030111-W	SL23F	EPA200.8	Zinc	22	ug/l		J	17
SL23	KC2062-030111-W	SL23G	EPA200.8	Zinc	19	ug/l		J	17
SL23	BDC2088-030111-W	SL23H	EPA200.8	Zinc	76	ug/l		J	17
SL23	NF2095A-030111-S	SL23K	SW8082	Aroclor 1248	0.6	ug	Y	U	22
SL23	NF2095A-030111-S	SL23L	SW6010B	Zinc	1130	mg/kg		J	17
SL82	NF2095-030411-W	SL82A	EPA300.0	Nitrate	0.3	mg/L		U	7
SL82	NF2095-030411-W	SL82A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL82	NF2095-030411-W	SL82A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL82	NF2095-030411-W	SL82A	SW8260C	Acetone	11	ug/l		U	6
SL82	NF2095-030411-W	SL82A	SW8260C	Methylene Chloride	1.1	ug/l		U	6
SL82	NF2095-030411-W	SL82A	SW8270D	bis(2-Ethylhexyl)phthalate	1.2	ug/l	B	U	7
SL82	NF2095-030411-W	SL82A	SW8270DSIM	Phenanthrene	0.02	ug/l	B	U	7
SL82	KC2062-030411-W	SL82B	EPA300.0	Nitrate	0.2	mg/L		U	7
SL82	KC2062-030411-W	SL82B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL82	KC2062-030411-W	SL82B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL82	KC2062-030411-W	SL82B	SW8260C	Acetone	11	ug/l		U	6
SL82	KC2062-030411-W	SL82B	SW8260C	Methylene Chloride	1.1	ug/l		U	6
SL82	BDC2088-030411-W	SL82C	EPA300.0	Nitrate	0.2	mg/L		U	7
SL82	BDC2088-030411-W	SL82C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SL82	BDC2088-030411-W	SL82C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL82	BDC2088-030411-W	SL82C	SW8260C	Acetone	14	ug/l		U	6
SL82	BDC2088-030411-W	SL82C	SW8260C	Methylene Chloride	1.7	ug/l		U	6
SL82	PS2220-030411-W	SL82D	EPA300.0	Nitrate	0.2	mg/L		U	7
SL82	PS2220-030411-W	SL82D	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10

QUALIFIED DATA SUMMARY TABLE
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SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SL82	PS2220-030411-W	SL82D	SW8082	Aroclor 1248	0.013	ug/l	Y	U	22
SL82	PS2220-030411-W	SL82D	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SL82	PS2220-030411-W	SL82D	SW8260C	Acetone	21	ug/l		U	6
SL82	PS2220-030411-W	SL82D	SW8260C	Methylene Chloride	1.2	ug/l		U	6
SL82	PS2220-030411-W	SL82D	SW8270D	bis(2-Ethylhexyl)phthalate	1.7	ug/l	B	U	7
SN46	KC2062-031511-W	SN46A	SW8081B	alpha-BHC	0.05	ug/l	U	UJ	10
SN46	KC2062-031511-W	SN46A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SN46	KC2062-031511-W	SN46A	SW8081B	Endosulfan II	0.1	ug/l	U	UJ	10
SN46	KC2062-031511-W	SN46A	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SN46	KC2062-031511-W	SN46A	SW8081B	Endrin Ketone	0.1	ug/l	U	UJ	10
SN46	KC2062-031511-W	SN46A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SN46	KC2062-031511-W	SN46A	SW8260C	Methylene Chloride	2.2	ug/l		U	6
SN46	PS2220-031511-W	SN46B	SW8081B	alpha-BHC	0.05	ug/l	U	UJ	10
SN46	PS2220-031511-W	SN46B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SN46	PS2220-031511-W	SN46B	SW8081B	Endosulfan II	0.1	ug/l	U	UJ	10
SN46	PS2220-031511-W	SN46B	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SN46	PS2220-031511-W	SN46B	SW8081B	Endrin Ketone	0.1	ug/l	U	UJ	10
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1016	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1221	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1232	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1242	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1248	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1254	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8082	Aroclor 1260	0.01	ug/l	U	UJ	19
SN46	PS2220-031511-W	SN46B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SN46	PS2220-031511-W	SN46B	SW8260C	Naphthalene	0.8	ug/l		J	10
ST39	KC2062-042111-W	ST39A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
ST39	KC2062-042111-W	ST39A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
ST39	KC2062-042111-W	ST39A	SW8260C	Methylene Chloride	2.6	ug/l		U	6
ST39	KC2062-042111-W	ST39A	SW8270D	2,4-Dimethylphenol	1	ug/l	U	UJ	10
ST39	KC2062-042111-W	ST39A	SW8270D	N-Nitrosodiphenylamine	1	ug/l	U	UJ	10
ST39	PS2220-042111-W	ST39B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
ST39	PS2220-042111-W	ST39B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
ST39	PS2220-042111-W	ST39B	SW8260C	Methylene Chloride	2	ug/l		U	6
ST39	PS2220-042111-W	ST39B	SW8270D	2,4-Dimethylphenol	1	ug/l	U	UJ	10
ST39	PS2220-042111-W	ST39B	SW8270D	N-Nitrosodiphenylamine	1	ug/l	U	UJ	10
ST39	NF2095-042111-W	ST39C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
ST39	NF2095-042111-W	ST39C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
ST39	NF2095-042111-W	ST39C	SW8260C	Methylene Chloride	2	ug/l		U	6
ST39	NF2095-042111-W	ST39C	SW8260C	Toluene	0.2	ug/l		U	6
ST39	NF2095-042111-W	ST39C	SW8270D	2,4-Dimethylphenol	1	ug/l	U	UJ	10
ST39	NF2095-042111-W	ST39C	SW8270D	N-Nitrosodiphenylamine	1	ug/l	U	UJ	10
ST60	PS2220A-042111-S	ST60A	SW8082	Aroclor 1248	1.2	ug	Y	U	22
ST60	PS2220A-042111-S	ST60A	SW8082	Aroclor 1260	0.8	ug	Y	U	22
ST60	NF2095A-042111-S	ST60C	SW8082	Aroclor 1248	1	ug	Y	U	22
SU45	PS2220-042711-W	SU45A	EPA300.0	Nitrate	0.2	mg/L		U	7
SU45	PS2220-042711-W	SU45A	SW8081B	Aldrin	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	alpha-BHC	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	beta-BHC	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	cis-Chlordane	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Dieldrin	0.1	ug/l	U	UJ	10

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SU45	PS2220-042711-W	SU45A	SW8081B	Endosulfan I	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Endrin Ketone	0.1	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	gamma-BHC (Lindane)	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Heptachlor	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Heptachlor Epoxide	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	Hexachlorobenzene	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8081B	trans-Chlordane	0.05	ug/l	U	UJ	10
SU45	PS2220-042711-W	SU45A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SU45	PS2220-042711-W	SU45A	SW8260C	Acetone	6.2	ug/l		U	6
SU45	PS2220-042711-W	SU45A	SW8260C	Methylene Chloride	2.3	ug/l		U	6
SU45	PS2220-042711-W	SU45A	SW8270D	bis(2-Ethylhexyl)phthalate	1	ug/l	B	U	7
SU45	NF2095-042711-W	SU45B	EPA300.0	Nitrate	0.2	mg/L		U	7
SU45	NF2095-042711-W	SU45B	SW8081B	Aldrin	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	alpha-BHC	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	beta-BHC	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	cis-Chlordane	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Dieldrin	0.1	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Endosulfan I	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Endrin Ketone	0.1	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	gamma-BHC (Lindane)	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Heptachlor	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Heptachlor Epoxide	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	Hexachlorobenzene	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8081B	trans-Chlordane	0.05	ug/l	U	UJ	10
SU45	NF2095-042711-W	SU45B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SU45	NF2095-042711-W	SU45B	SW8260C	Acetone	6.4	ug/l		U	6
SU45	NF2095-042711-W	SU45B	SW8260C	Methylene Chloride	3.6	ug/l		U	6
SU45	NF2095-042711-W	SU45B	SW8270D	bis(2-Ethylhexyl)phthalate	1.2	ug/l	B	U	7
SU45	BDC2088-042711-W	SU45C	EPA300.0	Nitrate	0.1	mg/L		U	7
SU45	BDC2088-042711-W	SU45C	SW8081B	Aldrin	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	alpha-BHC	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	beta-BHC	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	cis-Chlordane	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Dieldrin	0.1	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Endosulfan I	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Endosulfan Sulfate	0.1	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Endrin Ketone	0.1	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	gamma-BHC (Lindane)	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Heptachlor	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Heptachlor Epoxide	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	Hexachlorobenzene	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8081B	trans-Chlordane	0.05	ug/l	U	UJ	10
SU45	BDC2088-042711-W	SU45C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SU45	BDC2088-042711-W	SU45C	SW8270D	bis(2-Ethylhexyl)phthalate	8	ug/l	B	U	7
SU45	BDC2088-042711-W	SU45C	SW8270DSIM	Naphthalene	0.037	ug/l	B	U	7
SU49	PS2220A-042711-S	SU49A	SW8082	Aroclor 1248	1.5	ug	Y	U	22
SU98	PS2220A-042711-S	SU49A	SW8082	Aroclor 1260	2	ug	Y	U	22
SV69	BDC2088-050411-W	SV69A	EPA300.0	Nitrate	0.3	mg/L		U	7

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SV69	BDC2088-050411-W	SV69A	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SV69	BDC2088-050411-W	SV69A	SW8081B	Hexachlorobutadiene	1.4	ug/l	P	NJ	3
SV69	BDC2088-050411-W	SV69A	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SV69	BDC2088-050411-W	SV69A	SW8260C	Methylene Chloride	3.2	ug/l		U	6
SV69	BDC2088-050411-W	SV69A	SW8270D	1,2,4-Trichlorobenzene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	1,2-Dichlorobenzene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	1,3-Dichlorobenzene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	1,4-Dichlorobenzene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	1-Methylnaphthalene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	2,4-Dimethylphenol	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	2-Methylnaphthalene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	2-Methylphenol	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	4-Methylphenol	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Acenaphthene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Acenaphthylene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Anthracene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Benzo(a)anthracene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Benzo(a)pyrene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Benzo(g,h,i)perylene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Benzoic Acid	10	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Benzyl Alcohol	5	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	bis(2-Ethylhexyl)phthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Butylbenzylphthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Chrysene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Dibenz(a,h)anthracene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Dibenzofuran	1	ug/l	U	UJ	10,13
SV69	BDC2088-050411-W	SV69A	SW8270D	Diethylphthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Dimethylphthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Di-n-Butylphthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Di-n-Octyl phthalate	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Fluoranthene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Fluorene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Hexachlorobenzene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Hexachlorobutadiene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Hexachloroethane	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Indeno(1,2,3-cd)pyrene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Naphthalene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	N-Nitrosodiphenylamine	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Pentachlorophenol	5	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Phenanthrene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Phenol	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Pyrene	1	ug/l	U	UJ	13
SV69	BDC2088-050411-W	SV69A	SW8270D	Total Benzofluoranthenes	1	ug/l	U	UJ	13
SV69	KC2062-050411-W	SV69B	EPA300.0	Nitrate	0.3	mg/L		U	7
SV69	KC2062-050411-W	SV69B	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SV69	KC2062-050411-W	SV69B	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SV69	KC2062-050411-W	SV69B	SW8260C	Methylene Chloride	1.4	ug/l		U	6
SV69	KC2062-050411-W	SV69B	SW8270D	Dibenzofuran	1	ug/l	U	UJ	10
SV69	PS2220-050411-W	SV69C	EPA300.0	Nitrate	0.6	mg/L		U	7
SV69	PS2220-050411-W	SV69C	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SV69	PS2220-050411-W	SV69C	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SV69	PS2220-050411-W	SV69C	SW8260C	Methylene Chloride	2.8	ug/l		U	6

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
SV69	PS2220-050411-W	SV69C	SW8270D	Dibenzofuran	1	ug/l	U	UJ	10
SV69	NF2095-050411-W	SV69D	EPA300.0	Nitrate	0.2	mg/L		U	7
SV69	NF2095-050411-W	SV69D	SW8081B	delta-BHC	0.05	ug/l	U	UJ	10
SV69	NF2095-050411-W	SV69D	SW8260C	2-Chloroethylvinylether	1	ug/l	U	R	1
SV69	NF2095-050411-W	SV69D	SW8260C	Methylene Chloride	2.4	ug/l		U	6
SV69	NF2095-050411-W	SV69D	SW8270D	Dibenzofuran	1	ug/l	U	UJ	10
SV69	BDC2088A-050411-S	SV69I	SW8082	Aroclor 1232	1	ug	Y	U	22
SV69	KC2062A-050411-S	SV69L	SW8082	Aroclor 1232	1	ug	Y	U	22
SV69	PS2220A-050411-S	SV69O	SW8082	Aroclor 1248	0.9	ug	Y	U	22
SV69	NF2095A-050411-S	SV69R	SW8082	Aroclor 1232	1	ug	Y	U	22
SV77	KC2062B-030411-S	SV77B	SW8082	Aroclor 1248	1	ug	Y	U	22
SV77	BDC2088B-030411-S	SV77C	SW8082	Aroclor 1248	1.5	ug	Y	U	22
SV77	PS2220B-030411-S	SV77D	SW8082	Aroclor 1248	1.4	ug	Y	U	22
SW02	PS2220-050511-T	SW02A	SW8270D	2,4-Dimethylphenol	270	ug/kg	U	UJ	10
SW02	PS2220-050511-T	SW02A	SW8270D	Pentachlorophenol	260	ug/kg	J	J	5B
SW02	NF2095-050511-T	SW02B	SW8270D	2,4-Dimethylphenol	98	ug/kg	U	UJ	10
SW02	NF2095-050511-T	SW02B	SW8270D	Benzoic Acid	540	ug/kg	J	J	5B
SW02	BDC2088-050511-T	SW02C	SW8270D	2,4-Dimethylphenol	230	ug/kg	U	UJ	10
SW02	BDC2088-050511-T	SW02C	SW8270D	Benzoic Acid	1200	ug/kg	J	J	5B
SW02	BDC2088-050511-T	SW02C	SW8270D	Pentachlorophenol	210	ug/kg	J	J	5B
SW02	KC2062-050511-T	SW02D	SW8270D	2,4-Dimethylphenol	94	ug/kg	U	UJ	10
SX82	KC2062-051911-CB	SX82A	SW6010B	Zinc	640	mg/kg		J	8
SX82	KC2062-051911-CB	SX82A	SW8270D	2,4-Dimethylphenol	20	ug/kg	U	UJ	10
SX82	KC2062-051911-CB	SX82A	SW8270D	4-Methylphenol	57	ug/kg	M	NJ	14
SX82	KC2062-051911-CB	SX82A	SW8270D	Pentachlorophenol	98	ug/kg	U	UJ	5B
WG35790	NF2095B-012611-S	L16165-1 W	E1613	1,2,3,4,7,8-HXCDD	14.7	PG/sample	DJ	J	12
WG35790	NF2095B-012611-S	L16165-1 W	E1613	1,2,3,7,8-PECDD	8.01	PG/sample	DJ	J	12
WG35790	NF2095B-012611-S	L16165-1 W	E1613	1,2,3,7,8-PECDF	2.73	PG/sample	KDJ	U	22
WG35790	NF2095B-012611-S	L16165-1 W	E1613	2,3,7,8-TCDD	2.55	PG/sample	KDJ	U	22
WG35790	KC2062B-012611-S	L16165-2 W	E1613	1,2,3,4,7,8-HXCDD	2.47	PG/G	DJ	J	12
WG35790	KC2062B-012611-S	L16165-2 W	E1613	1,2,3,7,8-PECDD	1.4	PG/G	DJ	J	12
WG35790	KC2062B-012611-S	L16165-2 W	E1613	2,3,7,8-TCDD	0.835	PG/G	DJ	J	12
WG35790	KC2062B-020411-S	L16165-3 W	E1613	1,2,3,4,7,8-HXCDD	1.27	PG/G	DJ	J	12
WG35790	KC2062B-020411-S	L16165-3 W	E1613	1,2,3,6,7,8-HXCDF	0.67	PG/G	KDJ	U	22
WG35790	KC2062B-020411-S	L16165-3 W	E1613	1,2,3,7,8,9-HXCDF	0.091	PG/G	KDJ	U	22
WG35790	KC2062B-020411-S	L16165-3 W	E1613	1,2,3,7,8-PECDD	0.761	PG/G	DJ	J	12
WG35790	KC2062B-020411-S	L16165-3 W	E1613	1,2,3,7,8-PECDF	0.297	PG/G	KDJ	U	22
WG35790	KC2062B-020411-S	L16165-3 W	E1613	2,3,7,8-TCDD	0.371	PG/G	DJ	J	12
WG35790	PS2220B-020411-S	L16165-4 LW	E1613	1,2,3,4,7,8-HXCDD	760	PG/sample	D	J	12
WG35790	PS2220B-020411-S	L16165-4 LW	E1613	2,3,7,8-TCDD	35.6	PG/sample	D	J	12
WG35790	PS2220B-020411-S	L16165-4 LW3	E1613	1,2,3,7,8-PECDD	307	PG/sample	DJ	J	12
WG35790	NF2095B-020411-S	L16165-5 W	E1613	1,2,3,4,7,8-HXCDD	30	PG/sample	DJ	J	12
WG35790	NF2095B-020411-S	L16165-5 W	E1613	1,2,3,7,8-PECDD	12.5	PG/sample	DJ	J	12
WG35790	NF2095B-020411-S	L16165-5 W	E1613	2,3,7,8-TCDD	2.25	PG/sample	KDJ	U	22
WG35790	PS2220B-021111-S	L16165-6 LW	E1613	1,2,3,4,7,8-HXCDD	18.5	PG/G	D	J	12
WG35790	PS2220B-021111-S	L16165-6 LW	E1613	1,2,3,7,8-PECDD	7.06	PG/G	DJ	J	12
WG35790	PS2220B-021111-S	L16165-6 LW	E1613	2,3,7,8-TCDD	0.79	PG/G	KDJ	U	22
WG35790	NF2095B-021111-S	L16165-7 LW	E1613	1,2,3,4,7,8-HXCDD	21.6	PG/G	D	J	12
WG35790	NF2095B-021111-S	L16165-7 LW	E1613	1,2,3,7,8-PECDD	15.2	PG/G	D	J	12
WG35790	NF2095B-021111-S	L16165-7 LW	E1613	2,3,7,8-TCDD	7.7	PG/G	D	J	12
WG35790	KC2062B-021111-S	L16165-9 LW	E1613	1,2,3,4,7,8-HXCDD	9.07	PG/G	DJ	J	12
WG35790	KC2062B-021111-S	L16165-9 LW	E1613	1,2,3,7,8-PECDD	5.15	PG/G	DJ	J	12

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
WG35790	KC2062B-021111-S	L16165-9 LW	E1613	2,3,7,8-TCDD	1.61	PG/G	DJ	J	12
WG36100	BDC2088B-021111-S	L16165-8 LW	E1613	2,3,7,8-TCDD	0.506	PG/G	KDJ	U	22
WG36100	NF2095B-031511-S	L16287-1 LW	E1613	2,3,7,8-TCDD	148	PG/sample	D	J	12
WG36100	KC2062B-031511-S	L16287-2 LW	E1613	1,2,3,7,8,9-HXCDF	0.352	PG/G	KDJ	U	22
WG36100	KC2062B-031511-S	L16287-2 LW	E1613	2,3,7,8-TCDD	1.66	PG/G	DJ	J	12
WG36100	BDC2088B-031511-S	L16287-3 LW	E1613	2,3,7,8-TCDD	13.8	PG/sample	D	J	12
WG36100	PS2220B-031511-S	L16287-4 LW	E1613	2,3,7,8-TCDD	0.642	PG/G	DJ	J	12
WG36152	NF2095-030411-W	L16286-1	AXYS MLA-033	2,2',3,4,4',5'-HXBDE	16.5	PG/L	CKJ	U	22
WG36152	NF2095-030411-W	L16286-1	AXYS MLA-033	2,2',4,5'-TEBDE	17.8	PG/L	KJ	U	22
WG36152	NF2095-030411-W	L16286-1	AXYS MLA-033	2,2',4,6'-TEBDE	5.03	PG/L	KJ	U	22
WG36152	NF2095-030411-W	L16286-1	AXYS MLA-033	2,3',4',6-TEBDE	5.23	PG/L	KJ	U	22
WG36152	NF2095-030411-W	L16286-1	AXYS MLA-033	2,4,4'-TRIBDE	11.8	PG/L	CKJ	U	22
WG36152	KC2062-030411-W	L16286-2	AXYS MLA-033	2,2',3,3',4,4',5,5',6-NOBDE	149	PG/L	KB	U	22
WG36152	KC2062-030411-W	L16286-2	AXYS MLA-033	2,2',3,4,4',5,5',6-OCBDE	24.5	PG/L	KJ	U	22
WG36152	KC2062-030411-W	L16286-2	AXYS MLA-033	2,2',4,4',5,5'-HXBDE	34.4	PG/L	KJ	U	22
WG36152	KC2062-030411-W	L16286-2	AXYS MLA-033	2,2',4,4',5,6'-HXBDE	28.2	PG/L	KJ	U	22
WG36152	BDC2088-030411-W	L16286-3	AXYS MLA-033	2,2',3,3',4,4',5,5',6-NOBDE	399	PG/L	KB	U	22
WG36152	BDC2088-030411-W	L16286-3	AXYS MLA-033	2,2',3,3',4,5,5',6,6'-NOBDE	623	PG/L	KB	U	22
WG36152	BDC2088-030411-W	L16286-3	AXYS MLA-033	2,2',3,4,4',5'-HXBDE	18.3	PG/L	CKJ	U	22
WG36152	BDC2088-030411-W	L16286-3	AXYS MLA-033	2,4,4',6-TEBDE	7.84	PG/L	KJ	U	22
WG36152	PS2220-030411-W	L16286-4	AXYS MLA-033	2,3',4',6-TEBDE	9.9	PG/L	KJ	U	22
WG36152	PS2220-030411-W	L16286-4	AXYS MLA-033	3,3',4-TRIBDE	7.66	PG/L	KJ	U	22
WG36152	PS2220-030411-W	L16286-4	AXYS MLA-033	4,4'-DIBDE	2.48	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,3',4,4',5,6,6'-NOBDE	614	PG/L	KB	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,3',4,4'-HXBDE	7.21	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,4,4',5,5',6-OCBDE	120	PG/L	KB	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,4,4',5,6-HPBDE	1.2	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,4,4',5',6-HPBDE	71.1	PG/L	KB	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',3,4,4'-PEBDE	18.9	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',4,4',5,6'-HXBDE	24.9	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,2',4-TRIBDE	5.15	PG/L	CKJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,3,3',4,4',5,6-HPBDE	5.32	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,3',4,4'-TEBDE	14.4	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,3,4,5,6-PEBDE	11.6	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,4,4',6-TEBDE	0.711	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,4,6-TRIBDE	0.346	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,4',6-TRIBDE	1.31	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	2,4'-DIBDE	0.407	PG/L	CKJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	3,3',4,4'-TEBDE	1.18	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	3,3',4,5'-TEBDE	3.07	PG/L	KJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	3,3',4-TRIBDE	0.543	PG/L	KBJ	U	22
WG36561	KC2062-042111-W	L16431-1 i	AXYS MLA-033	4,4'-DIBDE	0.507	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',3,3',4,4',5,5',6,6'-DEBDE	1620	PG/L	KB	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',3,3',4,4'-HXBDE	6.3	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',3,4,4',5,5',6-OCBDE	34.8	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',3,4,4',5',6-HPBDE	20.9	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',3,4,4',5'-HXBDE	9.45	PG/L	CKBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',4,4',5,6'-HXBDE	20.7	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',4,4',6,6'-HXBDE	3.52	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',4,5'-TEBDE	15.3	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',4,6'-TEBDE	5.07	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,2',4-TRIBDE	3.38	PG/L	CKJ	U	22

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,3,3',4,4',5,6-HPBDE	13.2	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,3',4,4',6-PEBDE	5.97	PG/L	CKBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,3',4,4'-TEBDE	11.9	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,3',4',6-TEBDE	7.44	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,4,4'-TRIBDE	7.22	PG/L	CKBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,4'-DIBDE	0.731	PG/L	CKJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,4-DIBDE	0.286	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	2,6-DIBDE	0.508	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	3,3',4-TRIBDE	3.37	PG/L	KBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	3,4,4'-TRIBDE	2.87	PG/L	KJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	3,4-DIBDE	0.957	PG/L	CKBJ	U	22
WG36561	PS2220-042111-W	L16431-2 i	AXYS MLA-033	4,4'-DIBDE	0.86	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,3',4,4',5,5',6-NOBDE	60.8	PG/L	K	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,3',4,4',5,6,6'-NOBDE	166	PG/L	KB	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,4,4',5,5',6-OCBDE	19.3	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,4,4',5,6-HPBDE	9.32	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,4,4',5',6-HPBDE	19.7	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',3,4,4',5'-HXBDE	9.16	PG/L	CKBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',4,4',5,5'-HXBDE	9.32	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',4,5'-TEBDE	3.78	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,2',4,6'-TEBDE	0.379	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,3,3',4,4',5,6-HPBDE	4	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,3',4,4',6-PEBDE	1.43	PG/L	CKBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,3',4,4'-TEBDE	3.28	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,4,4',6-TEBDE	0.401	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,4,6-TRIBDE	0.573	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,4'-DIBDE	0.137	PG/L	CKJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,4-DIBDE	0.627	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	2,6-DIBDE	0.409	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	3,3',4,4',5-PEBDE	0.789	PG/L	KBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	3,3',4,5'-TEBDE	0.573	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	3,4,4'-TRIBDE	0.43	PG/L	KJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	3,4-DIBDE	0.564	PG/L	CKBJ	U	22
WG36561	NF2095-042111-W	L16431-3 i	AXYS MLA-033	4,4'-DIBDE	0.344	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',3,3',4,4'-HXBDE	15.7	PG/L	KJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',3,4,4',5,6-HPBDE	59.4	PG/L	K	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',3,4,4',5',6-HPBDE	255	PG/L	KB	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',3,4,4',6'-HXBDE	11.3	PG/L	KJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',4,4',6,6'-HXBDE	7.32	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',4,5'-TEBDE	46.5	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,2',4-TRIBDE	11.9	PG/L	CKJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,3,3',4,4',5,6-HPBDE	106	PG/L	K	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,3,3',4,4'-PEBDE	6.13	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,3',4,4',6-PEBDE	7.31	PG/L	CKBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,3',4,4'-TEBDE	33.6	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,4,4',6-TEBDE	3.01	PG/L	KJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,4,4'-TRIBDE	32.5	PG/L	CKBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,4'-DIBDE	0.535	PG/L	CKJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	2,4-DIBDE	0.542	PG/L	KJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	3,3',4-TRIBDE	1.82	PG/L	KBJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	3,4,4'-TRIBDE	1.55	PG/L	KJ	U	22
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	3,4-DIBDE	2.12	PG/L	CKBJ	U	22

QUALIFIED DATA SUMMARY TABLE
Lower Duwamish Waterway - Lateral Loading Study

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Qualifier	DV Qualifier	DV Reason Code
WG36561	NF2095-042711-W	L16431-4 i	AXYS MLA-033	4,4'-DIBDE	0.979	PG/L	KBJ	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	2,2',3,4,4',5,6-HPBDE	15.4	PG/L	KJ	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	2,3,3',4,4',5,6-HPBDE	54.4	PG/L	K	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	2,4',6-TRIBDE	3.2	PG/L	KBJ	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	2,4-DIBDE	12.5	PG/L	KJ	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	3,3',4,4'-TEBDE	1.66	PG/L	KJ	U	22
WG36561	BCD2088-042711-W	L16431-5 i	AXYS MLA-033	3,3',4-TRIBDE	8.13	PG/L	KBJ	U	22
WG36676	PS2220-050511-T	L16450-1	E1613	1,2,3,4,7,8-HXCDD	19.3	PG/G		J	12
WG36676	PS2220-050511-T	L16450-1	E1613	1,2,3,6,7,8-HXCDD	74.9	PG/G		J	12
WG36676	PS2220-050511-T	L16450-1	E1613	1,2,3,7,8,9-HXCDD	48.1	PG/G		J	12
WG36676	PS2220-050511-T	L16450-1	E1613	1,2,3,7,8-PECDD	7.33	PG/G		J	12
WG36676	PS2220-050511-T	L16450-1	E1613	2,3,4,7,8-PECDF	2.65	PG/G	J	J	12
WG36676	PS2220-050511-T	L16450-1	E1613	2,3,7,8-TCDF	2.3	PG/G		J	13
WG36676	NF2095-050511-T	L16450-2	AXYS MLA-033	2,3,3',4,4'-PEBDE	33.3	PG/G	K	U	22
WG36676	NF2095-050511-T	L16450-2	AXYS MLA-033	3,3',4-TRIBDE	11.1	PG/G	KJ	U	22
WG36676	NF2095-050511-T	L16450-2	AXYS MLA-033	3,4-DIBDE	6.74	PG/G	CKJ	U	22
WG36676	NF2095-050511-T	L16450-2	E1613	1,2,3,4,7,8-HXCDD	8.7	PG/G		J	12
WG36676	NF2095-050511-T	L16450-2	E1613	1,2,3,6,7,8-HXCDD	19.6	PG/G		J	12
WG36676	NF2095-050511-T	L16450-2	E1613	1,2,3,7,8,9-HXCDD	21.8	PG/G		J	12
WG36676	NF2095-050511-T	L16450-2	E1613	1,2,3,7,8-PECDD	4.84	PG/G	J	J	12
WG36676	NF2095-050511-T	L16450-2	E1613	2,3,4,7,8-PECDF	3.73	PG/G	J	J	12
WG36676	KC2062-050511-T	L16450-3	AXYS MLA-033	2,4'-DIBDE	3.49	PG/G	CKJ	U	22
WG36676	KC2062-050511-T	L16450-3	AXYS MLA-033	3,3',4-TRIBDE	3.69	PG/G	KJ	U	22
WG36676	KC2062-050511-T	L16450-3	AXYS MLA-033	3,4-DIBDE	1.51	PG/G	CKJ	U	22
WG36676	KC2062-050511-T	L16450-3	E1613	1,2,3,4,7,8-HXCDD	2.85	PG/G	J	J	12
WG36676	KC2062-050511-T	L16450-3	E1613	1,2,3,6,7,8-HXCDD	7.01	PG/G		J	12
WG36676	KC2062-050511-T	L16450-3	E1613	1,2,3,7,8,9-HXCDD	8.95	PG/G		J	12
WG36676	KC2062-050511-T	L16450-3	E1613	1,2,3,7,8-PECDD	2.23	PG/G	J	J	12
WG36676	KC2062-050511-T	L16450-3	E1613	2,3,4,7,8-PECDF	1.15	PG/G	J	J	12
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,2',3,4,4',5,5',6-OCBDE	95.7	PG/L	KB	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,2',4,6'-TEBDE	2.36	PG/L	KJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,2',4-TRIBDE	6.48	PG/L	CKJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,3',4',6-TEBDE	4.25	PG/L	KJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,4,4',6-TEBDE	1.16	PG/L	KJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	2,4,4'-TRIBDE	12.8	PG/L	CKBJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	3,3',4,5'-TEBDE	1.43	PG/L	KJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	3,3',4-TRIBDE	4.12	PG/L	KJ	U	22
WG36677	PS2220-042711-W	L16453-1	AXYS MLA-033	3,4,4'-TRIBDE	1.14	PG/L	KJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	2,2',3,4,4',6'-HXBDE	52.2	PG/G	KDJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	2,4,4',6-TEBDE	16.6	PG/G	KDJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	2,4'-DIBDE	6.18	PG/G	CKDJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	3,3',4,4'-TEBDE	4.42	PG/G	KDJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	3,3',4,5'-TEBDE	4.29	PG/G	KBDJ	U	22
WG36845	PS2220-050511-T	L16450-1 RLW2	AXYS MLA-033	3,3',4-TRIBDE	19.9	PG/G	KDJ	U	22

Appendix H
Recommendations for Future Lateral Loading Studies

Appendix H

Recommendations for Future Lateral Loading Studies

The purpose of this appendix is to provide recommendations for future LDW stormwater sampling studies. Lessons learned during the Stormwater Lateral Loading Study sampling location reconnaissance, sampler design and construction, sampling activities, and data analysis can be used to help define the scope of future stormwater sampling efforts in order to efficiently provide data required to estimate stormwater lateral loadings or trace contaminant sources to the LDW.

Sampler Design

Isco Samplers

The Isco 6712c samplers employed in this study performed well for the collection of whole water samples and as data loggers for flow and conductivity. The 2.5-gallon carboys used for this study were of sufficient volume to allow analysis of all desired analytes. Larger Isco units, which can collect a larger volume, are not recommended for similar sampling endeavors where the subsurface deployment of equipment is required, as they would not fit within many of the maintenance vault configurations.

Collection of flow-weighted whole water samples requires a determination of the precipitation/ runoff relationship for a sampling location prior to a sampling event. Determining this relationship requires data from a range of storm events, requiring months to collect. Additionally, flow sensors must be functioning properly during a storm event in order to collect stormwater aliquots based on stormwater flow. Turbulent flow during large storm events often resulted in erroneous data collected by flow sensors. Maintaining properly functioning flow sensors also requires effort to periodically clean the surface of the sensors, generally requiring confined-space entry into the maintenance vault. The additional time, effort, and potential complications involved in collecting flow-weighted whole water samples should be considered when deciding between the collection of flow-weighted or time-weighted samples.

For this study, the Isco stormwater suction lines were mounted on stainless steel rings installed within the storm drain for the duration of the sampling season. On occasion the suction lines became clogged by solids as their inlets were intermittently buried with storm drain solids or debris. The long-term deployment of the suction lines also caused them to become brittle, and frequent deployment and removal of equipment made them susceptible to kinking. It is recommended that suction lines only be deployed during sampling events. This methodology was used at location PS2220 after the suction line became too clogged to clear with compressed air. Suction lines can easily be attached to filtration pumps and be deployed along the bottom of the drain line.

Filtered Solids Samplers

The analysis of filtered solids samples was often limited by the quantity of solids captured. Increasing the quantity of solids captured requires increasing the volume of stormwater filtered.

Higher capacity pumps would increase flow through the filters, but they have the potential of draining the DC power supply before the end of a sampling event because they draw more current.

Float switches were a part of the filtered solids sampler design to prevent the sampling of base flow before or after a storm event. Float switches were not a reliable means of activating filtration pumps, as they were often held down in the off position by turbulent stormwater flow. The float switch housing can be redesigned to minimize turbulent flow in the vicinity of the float; however, the use of float switches is not recommended for equipment that is intermittently deployed in a storm drain. Because the vertical position of the float switch must be adjusted to the depth of base flow, the pump must remain stationary during deployment and be deployed in the same position in the storm drain for all events. However, every time a sampler pump is placed in the storm drain it sits in a slightly different position and is subject to movement by flowing stormwater. Instead of using float switches, programmable timers worked well for activating the pumps. The timers were set to turn the pumps on during low tidal stages when rain was expected.

Flow totalizers were not successful at recording the volume of water sampled, preventing the calculation of stormwater total suspended solids concentrations. A possible source of error involves the turbine design of the totalizers, which can become clogged with debris, underestimating the volume of water filtered. Overestimates of volume were also observed to occur when storm flow through the storm drain was low, allowing air to be pumped through the system, and registering on the totalizer as filtered stormwater. Such errors are difficult to prevent when using inexpensive turbine or “paddlewheel” style totalizers. In order to make sure a valid total suspended solids measurement is available to apply to the filtered solids data, collection of a whole water grab sample is recommended whenever filtered solids are being collected. However, because TSS can fluctuate during a storm event, the use of a whole water grab sample could contribute significant uncertainty to loading calculations.

Sediment Traps

The design of the sediment traps allows the capture of stormwater solids, while being too tall for the capture of base flow solids. Deployment of multiple sediment traps at a location will increase the amount of solids captured, allowing for either more frequent analysis or the analysis of a more extensive list of analytes. Rather than individual bottles being deployed as traps, arrays of 8 to 10 bottles could be attached to a weighted frame, which is tethered inside the storm drain maintenance vault. This style of sediment trap could be deployed/recovered without the need for confined space entry into the maintenance vault.

Types of Samples to Collect

Advantages and disadvantages of several different methods of sampling stormwater for chemical analysis have been discussed by Anchor and Integral (2007), SAIC (2009a), and others. Table H–1 summarizes the pros and cons of the sampling methods used in this study.

Table H–1. Advantages and Disadvantages of Stormwater Sample Types

Sampling Type	Advantages	Disadvantages
Whole-water Composite Samples	• Measure of dissolved load. • Sampling can extend over a large portion of a storm event. • Samples can be composited based on flow to create a sample representative of the entire event. • Samples for multiple storm events can be used to assess variability. • Can be used to measure stormwater TSS.	• Require confined-space-entry to deploy flow sensors and suction lines. • Require onsite power source. • Preferentially capture only the fines portion of the particulate load. • Cannot provide concentrations for the particulate fraction unless a very large sample volume is available. • Analytical detection limits may not be adequate to detect chemicals present in stormwater at very low concentrations, particularly for hydrophobic chemicals, unless large volumes are collected. • Samples are collected over a relatively short period of time (hours) and must be integrated to determine chemical loadings. • Collecting flow-weighted samples requires continuous flow measurements and an estimate of total precipitation for the event.
Bottle-type Sediment Trap Solids Samples	• Measure of particulate load. • Integrate the particulate-associated chemical loading over a relatively long period of time (months). • Logistically simple to implement.	• Require confined-space-entry to deploy. • Do not measure dissolved load. • Long sampling period (months) is required to collect adequate sample volume for analysis. • Flow depth must be deeper than trap height (8 inches). • Do not collect particles transported as bedload. • Provide a much less direct measurement of the overall stormwater chemical load, and may not be representative of the actual stormwater discharge. • When deployed at intertidal locations, may trap particles entrained in overlying tidal water.
Filtered Solids Samples	• Measure of particulate load. • Can be used in locations where flow is not deep enough for sediment traps. • Sampling can extend over a large portion of a storm event. • Samples for multiple storm events can be used to assess variability.	• Require onsite power source. • Do not measure dissolved load. • Sampling is labor intensive. • Sample collection requires pumping that may exclude coarse-grained particles. • Samples are collected over a relatively short period of time (hours) and must be integrated to determine chemical loadings. • Polypropylene filter bags should not be analyzed for TOC and phthalates. • Filter bags cannot undergo multiple chemical extractions.
Catch Basin Solids Grab Samples	• Measure of particulate load. • Logistically easy and inexpensive to collect.	• Do not measure dissolved load. • Grab samples from storm drain structures such as catch basins and manholes tend to contain a smaller percentage of fine-grained particles (fine silt, clay) than stormwater, and thus may not be representative of chemical concentrations in stormwater. • Many storm drain structures do not retain solids.

Table H–1 can be used to identify which sample types should be collected based upon the specific data needs of a study. The following sampling recommendations are based on the sample types used in the Stormwater Lateral Loading Study and are not inclusive of all sampling options. In the case of stormwater lateral loading studies, stormwater data are needed to characterize typical contaminant concentrations in storm flow and base flow, as well as outfall discharge volumes associated with each. If base flow can be shown to represent a small proportion of total contaminant loading, sediment traps provide a useful and cost-effective means of collecting stormwater solids for COPC analysis. Based on the limited data collected for the Stormwater Lateral Loading Study, sediment traps solids appear to satisfactorily account for the natural variability of storm events and integrate storm flow over the wet season. The reliance on sediment trap solids data for future studies would greatly reduce the amount of field effort required for sample collection, as the substantial effort required to target independent storm events is not required.

In addition to the stormwater solids contaminant concentrations provided by the sediment traps, stormwater TSS and discharge volume data are necessary to calculate contaminant loading. TSS measurements could be made using either whole water grab or composite samples collected during a variety of storm events over the course of the wet season. TSS could also be assumed based on a statistical evaluation of existing LDW stormwater data. Stormwater discharge volume should be estimated based on watershed models for LDW outfalls, as direct measurement of storm flow using velocity and depth sensors is hindered by the intertidal nature of the outfalls.

Potential Sampling Locations

Considerable thought regarding sampling logistics and extensive reconnaissance of potential storm drain access locations is highly recommended in determining LDW stormwater outfalls to be sampled for future lateral loading studies. The *Scoping of the Lateral Loading Study, Site Reconnaissance Report* (SAIC 2009b) provides a review of 34 LDW outfalls (with outfall pipe diameters greater than 24 inches) investigated for potential stormwater sampling. The report recommends 15 outfalls and associated drain line access locations that were considered to logistically be the easiest to sample. The recommended drain line access locations were chosen because they:

- Are found in close proximity to the outfall,
- Allow minimally obstructed surface access to storm drain lines, and
- Provide adequate conditions for the long-term installation of stormwater sampling equipment.

At the time these recommendations were made, collection of filtered solids was not part of the scope of work for lateral loading stormwater sampling. Solids filtration units were first designed and built by SAIC for the stormwater sampling at North Boeing Field in August 2009 (SAIC 2009c). The original design was modified by NewFields to allow for subsurface installation in 2010. Therefore, the recommended sampling sites provided in June 2009 (SAIC 2009b) were not assessed based on their potential for use to collect filtered solids.

During additional field reconnaissance by SAIC and NewFields in autumn 2010, the 15 outfalls/ access locations recommended for sampling in SAIC (2009b) were revisited to assess whether or not composite whole water samples, filtered solids, and sediment trap solids could be collected simultaneously during storm events. The new set of criteria (and reasoning) used to deem outfalls/access locations capable of being sampled consisted of the following:

- Outfall elevation is above +5 feet MLLW (provides adequate sampling duration between high tides),
- Outfall pipe diameter is greater than 24 inches (allows flow depth necessary for sediment traps solids collection),
- Access location is found in close proximity to the outfall and is downstream of oil-water separators (samples are representative of outfall discharge),
- Access location can be accessed 24-hours a day with little prior notice to property owner (limits restrictions on storm event sampling), and
- Maintenance vault provides a minimum of 9 feet of headspace and 17 inches of horizontal clearance (allows room for sampling equipment deployment).

Of the 15 outfalls/access locations recommended for sampling in SAIC (2009b), only four met the above set of criteria. Two of these were sampled as a part of the *Stormwater Lateral Loading Study* (KC2062 and NF2095). The other two outfalls that have the potential to be sampled by the above methodology are RI#2026 (S Myrtle Street SD) and #2147 (SW Idaho Street SD). PS2220 and BDC2088 were not recommended for sampling in SAIC (2009b) based on restricted access to private property, but they were deemed acceptable for sampling after the establishment of Site Access Agreements between Ecology and both the Port of Seattle and The Boeing Company.

There are likely many additional LDW outfalls that are good candidates for stormwater sampling, although sampling methodology may need to be revised based on location specifics. Many outfalls smaller than 24 inches in diameter drain private property along the banks of the LDW. Filtered solids and composite whole water samples can likely be collected from these small drain lines without issue; however, stormwater flow depth may rarely exceed the 8 inch minimum required for the collection of sediment trap solids. Successful collection of stormwater sediment trap solids at these locations would require a shorter trap bottle.

It was observed during field reconnaissance that small drain lines generally have maintenance vaults that cannot accommodate the subsurface deployment of filtered solids samplers and Isco whole water samplers. Subsurface deployment ensures the security of sampling gear while it is left on site during sampling events. However, as long as the private property is secure, subsurface deployment of sampling equipment may not be necessary and equipment can be left on the surface adjacent to the maintenance vault access hole during sampling events.

When to Sample

Collecting samples during the early wet season (October – December) is likely essential for characterizing the annual loading for an outfall. Sampling for the *Stormwater Lateral Loading Study* began in January, four months into the western Washington wet season. Numerous studies have indicated that the highest contaminant loadings occur early in the storm season (Lee et al. 2004; Kayhanian and Stenstrom 2005; Soller et al. 2005; Han et al. 2006; Stein et al. 2007). This suggests that the magnitude of contaminant load associated with stormwater runoff depends, at least in part, on the amount of time available for contaminant buildup on surfaces during dry periods. These seasonal “first flush” events can contribute to contaminant concentrations that are between 1.2 and 20 times higher than storm event concentrations later in the season (Lee et al. 2004). Therefore, the fact that storm events early in the wet season were not sampled for the *Stormwater Lateral Loading Study* may have resulted in low estimates of contaminant loadings for the entire wet season.

Additionally, an estimate of annual contaminant loading for an outfall requires assessment of the dry season loading. Although dry season storm events may be less intense than those of the wet season, the longer antecedent dry period between dry season storms may contribute to enhanced stormwater contaminant concentrations. However, targeting storm events during the dry season likely does not provide the same cost-to-benefit ratio as sampling during the wet season, as the fixed costs associated with being prepared to sample (equipment rental, warehouse lease, etc.) will inevitably result in fewer dry season sampled events.

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