Port of Seattle
Lora Lake Apartments

Stormwater Interim Action Work Plan

Prepared for

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FINAL

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List of Abbreviations and Acronyms

Acronym/Abbreviation	Definition
COC	Contaminant of concern
1,2-DCA	1,2-Dichloroethane
DQO	Data quality objective
Ecology	Washington State Department of Ecology
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbon
PCE	Tetrachloroethene
PCP	Pentachlorophenol
Port	Port of Seattle
PSEP	Puget Sound Estuary Program
RI/FS	Remedial Investigation/Feasibility Study
Site	Lora Lake Apartments Site
SOP	Standard operating procedure
STIA	Seattle-Tacoma International Airport
TCE	Trichloroethene
TEF	Toxic equivalency factor
TEQ	Toxic equivalent quantity
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound
WAC	Washington Administrative Code

1.0 Background

This document presents the Stormwater Interim Action Work Plan for the Lora Lake Apartments Site (Site), located at 15001 Des Moines Memorial Drive in Burien, Washington (Figure 1.1). The Site is located near the northwest corner of Seattle-Tacoma International Airport (STIA) and is the location of a former apartment building complex that was developed in 1987, under previous ownership, for use as residential housing.

The Site has an industrial use history. The land was the site of a barrel washing facility in the 1940s and 1950s, and was operated as an auto wrecking yard from the 1960s through the early 1980s. An apartment complex was constructed at the Site in 1987. Demolition of the aboveground portions of the apartment complex was completed by fall 2009. Electricity lines were removed. Water and sewer lines were plugged. Asphalt roads and parking areas and concrete foundations remain.

Environmental investigations conducted by the Port of Seattle (Port) in 2007 and 2008 identified impacted soil and groundwater. Investigations to date suggest that the site contaminants of concern (COCs) are carcinogenic polycyclic aromatic hydrocarbons (PAH), hydrocarbons (gasoline range, diesel range, and heavy oil range), dioxins, pentachlorophenol (PCP), tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethane (1,2-DCA), and arsenic.

The Port entered into a Model Toxics Control Act (MTCA) Agreed Order with the Washington State Department of Ecology (Ecology) to conduct a Remedial Investigation and Feasibility Study (RI/FS), in order to define appropriate methods to remediate contamination at the Site. Ecology and the Port also agreed to an Interim Remedial Action designed to protect site workers, and to prevent migration of contaminants away from the Site, during demolition of the remaining site structures in advance of further site investigation. That interim action has been completed.

On August 7, 2009, in response to a concern expressed by an interested citizen, Ecology requested the Port to conduct an additional interim action pursuant to Washington Administrative Code (WAC) 173-340-430(1)(a). Under the additional interim action, the Port would investigate whether contaminants leave the Site by drainage of stormwater through the site stormwater conveyance system and discharge to off-site receptors, including, specifically, Lora Lake. This scope of work was expected to be included in the RI/FS Work Plan scheduled for implementation in the wet weather season from 2010 to 2011. However, the Port has agreed with Ecology's request to accelerate the stormwater portion of the overall RI/FS to an interim action to be conducted during the wet weather season from 2009 to 2010.

This Stormwater Interim Action Work Plan establishes the details of the Lora Lake Apartments stormwater investigation to be performed November 2009 through no later than May 2010. Due to the focused nature of this interim action, this Work Plan incorporates all quality assurance (QA) and sampling and analysis project planning elements and has been prepared in accordance with Ecology's *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Ecology 2004).

2.0 Project Description

2.1 OBJECTIVES

The interim action technical scope of work addresses the primary concern expressed about site stormwater: What, if any, site contamination is conveyed from the Site by stormwater drainage? To address that concern, the interim action scope of work, and this Work Plan, provides for the following tasks, in the sequence shown:

1. Conduct a TV-type line inspection for the specific segment of the on-site storm drain system with structural limitations for stormwater in-line solids sample collection, as described in Section 5.3.2.
2. Collect stormwater samples at locations where stormwater enters and leaves the Site. Analyze samples for site COCs.
3. Collect catch basin sediment samples to assess sediment introduced from or influenced by site sources, and potentially transported off-site.
4. Remove catch basin sediment from the storm drainage system using vactor methods.
5. Conduct a TV-type line inspection to determine the potential for contaminated groundwater to enter the storm drain system and be discharged to Lora Lake.
6. Collect stormwater solids using in-line solids “sediment” traps to assess solids introduced from or influenced by site sources, and potentially transported from the Site. Collect one round of samples for analysis as sufficient solids accumulate between the date of installation and May 2010.
7. Continue to collect stormwater samples from locations where stormwater enters and leaves the Site following conveyance system cleaning to assess future conditions. Stormwater samples will be collected and analyzed from a total of 10 storm events, or fewer, as agreed by Ecology upon review of data.

3.0 Organization and Field Event Schedule

The following section identifies the project team, discusses the project schedule, identifies special training required for project implementation, and describes the process of revising this document.

3.1 ROLES AND RESPONSIBILITIES

Table 3.1 provides a list of the participants in the major aspects of the project. Personnel responsible for any potential revisions to this Work Plan document are also identified.

3.2 FIELD EVENT SCHEDULE

Table 3.2 indicates the anticipated implementation schedule for field activities related to this interim action. This schedule is dependent upon final Ecology approval of this Work Plan, as well as contract administration limitations. The specific schedule of individual stormwater sampling events is dependent on rainfall.

Sampling may include as many as 10 stormwater events, 1 sediment catch basin collection event, and 1 stormwater solids event. The actual number of stormwater sampling events completed will depend upon the ability to characterize site conditions, given the number of available qualifying storm events and the ability to effectively assess potential site influences on the quality of stormwater entering the Site. Methods to be used to evaluate the data and determine the completeness of the data set are described in Sections 10.1 and 10.2. The reporting schedule is presented in Section 10.3.

3.3 SPECIAL TRAINING NEEDS/CERTIFICATION

Project staff will receive the following training/certification as appropriate for their role in the project:

- Per the Site umbrella Health and Safety Plan, all field personnel who may disturb contaminated soils or sediment at the Site will have undergone Hazardous Waste Operations and Emergency Response (HAZWOPER) training.
- Field crews will be comprised of at least one lead person that has been HAZWOPER trained. This lead person will conduct a brief “tailgate” health and safety meeting prior to each site access event.
- Any field staff involved with monitoring equipment installation or equipment maintenance requiring confined space entry will have completed confined space entry training.

- Any field staff needing to access the monitoring sites will have undergone necessary Port security clearance and safety training.
- Field staff will receive training in sampling equipment operation, maintenance and calibration procedures specific to this project.
- Field staff will receive training on monitoring procedures specific to this project.
- Field staff will receive training in all necessary field data generation, sample collection, sample handling, and chain-of-custody for sediment, stormwater solids collection, stormwater grab, and stormwater composite sampling specific to this project.

3.4 REVISIONS

Ecology must review and approve this Work Plan for stormwater monitoring under the Interim Action Agreement. Substantial changes to this document must be submitted to Ecology for approval prior to their implementation. Substantial changes include but are not limited to changes in tasks to be completed, monitoring locations, analytes, types of samples collected, and number of samples collected. Other changes will be noted and the reason for the change documented.

4.0 Quality Objectives

This Work Plan establishes quality control (QC) procedures and QA criteria to meet the data quality objectives (DQOs) set forth for the stormwater and catch basin sediment sampling to be conducted at the Site. This Work Plan was developed in accordance with the Ecology *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Ecology 2004) and Washington State MTCA WAC 173-340-820 (Ecology 2007b).

4.1 DATA QUALITY OBJECTIVES

The DQOs for the stormwater investigation described in this Work Plan are to obtain the type and quantity of data in a manner such that the data are of known, appropriate, and sufficient quality to support the intended use. Analytical DQOs include obtaining data that are technically sound and properly documented, having been evaluated against established criteria for the principle data quality indicators (i.e., precision, accuracy, representativeness, completeness, and comparability) as defined in Ecology (Ecology 2001) and U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1998). Data quality indicator or quality assurance criteria are presented in Table 4.1.

The following information will be provided by the analytical laboratory to ensure that the analytical DQOs are accomplished:

- Method blank analyses for each sample and the concentration of all compounds of interest identified in those blanks
- Surrogate spike recovery data, including the name and concentration of all compounds added, percent recoveries, and range of recoveries
- Matrix spike recovery data, including name and concentration of all compounds added, percent recoveries, and range of recoveries
- Matrix duplicate analyses
- Relative retention times for each analyte detected in the samples
- Internal laboratory data, including sample storage, extraction, and preparation logs
- Instrument calibration logs
- Quantitative reports for all analyses performed

4.2 QUALITY CONTROL PROCEDURES

This section describes the procedures that will be implemented to:

- ensure sample integrity from the time of sample collection to the time of analysis in the laboratory,

- obtain the appropriate chemical data,
- collect field and laboratory QC samples.

Monitoring the performance of the laboratory measurement systems, corrections required for any deviations from the methods or QA requirements established in this Work Plan, and the reporting and validation of the project data are presented in subsequent sections.

5.0 Sampling Design

This section provides an overview of planned stormwater and catch basin sediment sampling activities, including an explanation of how the sampling design meets the objectives of the monitoring effort requested by Ecology. This section also details the site drainage system, describes the monitoring locations and why they were selected, and presents the approach for storm targeting and other sampling event particulars.

5.1 OVERVIEW OF PLANNED ENVIRONMENTAL MONITORING ACTIVITIES

There are three main environmental monitoring activities that are addressed in the sampling design of this Work Plan:

- Stormwater collection and analysis with supporting flow monitoring
- Catch basin sediment collection and analysis
- Stormwater solids collection and analysis

Stormwater samples will be collected from the drainage system beneath the Site at three key points where stormwater flows enter and exit the Site. Stormwater flows will be measured at these points as well. A field survey of the site stormwater drainage system was completed in September 2009 in order to verify system layout and assess current conditions (Appendix A). The system was found to contain a variety of features, including a series of catch basins, detention tanks, and control structures. Although the system was open and appeared in good condition, sediment was observed in a number of locations. This observation was supported by a drainage facility inspection completed by King County on September 2, 2009, which recommended the system be cleaned.

As part of the Port's effort to stabilize the Site while the RI/FS is in progress, conveyance, detention, and other drainage structures will be cleaned as soon as possible. However, accumulated sediment within the site drainage system may be influencing the quality of stormwater entering and leaving the Site. In order to characterize both current and future conditions, stormwater monitoring will be conducted before and after cleaning the site stormwater drainage system.

Prior to the start of the collection of stormwater samples a TV-type inspection of a focused segment of the Site storm drainage system will be conducted by the Port. The focused segment that will be inspected is the drainage system along the eastern portion of the Site, between CB5945 and CB4857 (Figure 5.1). This segment will be TV-inspected to access the quality of the drainage line and determine the potential for infiltration of adjacent soils as described in detail in Section 5.3.2. Stormwater samples will initially be collected from three locations selected to characterize stormwater entering and leaving the Site from up to two storms. These initial monitoring events will occur prior to a Port scheduled storm drainage system vactor cleaning effort. Data from these initial stormwater sampling events will provide a “snap shot” of recent past and current site conditions.

Sediment samples will be collected from four drainage structures (catch basins) within the Site located to adequately characterize the available sediment. Sediment sampling will occur after the initial stormwater sampling events have been completed. Accumulated sediment from within the site stormwater drainage network will then be removed by vactoring methods. A TV-type inspection of the drainage system will also be conducted by the Port following this phase of the project.

Sediment traps, designed to collect stormwater solids, will be installed at the three stormwater monitoring locations after the Port has completed vactoring and cleaning the drainage system. The in-line sediment traps will remain in place, accumulating stormwater solids, until their scheduled removal date in May 2010.

Stormwater sampling and flow monitoring will continue at the three selected site stormwater locations after the system has been cleaned. In total, up to 10 stormwater monitoring events are planned (1 to 2 before cleaning and 8 to 9 after cleaning). Fewer stormwater sampling events may be acceptable as agreed by Ecology based on data analysis and review. Interim data reports will be provided after the collection of two and six stormwater drainage events. These reports will include a preliminary assessment of data variability and general results to assess if fewer than 10 events will provide a sufficient body of results to determine if stormwater flowing into and leaving the Site are statistically different. The reporting schedule and statistical analysis approach is described in detail in Section 10.0.

Flow monitoring will be conducted on a continuous basis during each stormwater monitoring event.

5.2 DRAINAGE SYSTEM DETAILS

There are two distinct storm drainage systems at the Site. A large main line crosses the Site from west (upstream) to east (downstream) that conveys water in 24-inch or greater diameter pipes. This system is referred to as the “main stormwater line.” A second smaller on-site system drains only the northeast portion of the Site and conveys water in 12-inch or smaller diameter pipes. This system is referred to as the “on-site” system. Both storm drainage site systems are shown on Figure 5.1. The City of Burien and King County use different designations to identify the on-site catch basins. The City of Burien and King County catch basin designations are shown on the figures provided in Appendix A. Table 5.1 also provides a description of the catch basin type, associated control structures, and the origin of the catch basin designation for those locations selected for stormwater sampling activities.

The main stormwater line, owned by the City of Burien, enters the Site from the west, along 8th Avenue South, at the paired catch basin location CB4505/CB-31A (Figure 5.1).

Various inputs into this main stormwater line from roof and parking lot drains, as well as other surface entries, occur along its course throughout the Site. The main stormwater line exits the eastern side of the Site, approximately 100 feet south of the main driveway (South 149th Place) along Des Moines Memorial Drive at catch basin CB4857 (Figure 5.1). At this point the site stormwater becomes comingled with roadway runoff from Des Moines Memorial Drive. The main stormwater line continues eastward where it crosses beneath Des Moines Memorial Drive and eventually discharges into Lora Lake. Additional detailed information pertaining to the site drainage system is presented in Appendix A, including a more detailed drawing of the drainage features adjacent to CB4857.

Several stormwater detention tanks (consisting of 54-inch diameter x 100-foot to 110-foot corrugated metal pipes) were installed to provide on-site stormwater flow control and detention in the northwest portion of the Site (between AR-21 and CB-20, AR-21A and AR-19B, AR-21B and AR-19A) and southeast portion of the Site (between CB-13 and CB-12) (Figure 5.1). The detention tanks consist of corrugated metal pipes that were welded together and are sealed with steel end caps. These detention tanks control on-site stormwater flows into the main stormwater line. In addition to the detention tanks, there are several Type II vaults (CB-31A, CS/CB-19, CB-12) that are outfitted with various types of oil water separator / debris and flow control structures (Figure 5.1).

The smaller, on-site system collects stormwater from surface and roof inputs as well as a small (approximately 20-foot by 20-foot) detention pond. The collection area for the on-site system is bounded by the area between Building T in the west, Buildings X and Y in the east, Buildings U and V in the north and the main site driveway (South 149th Place) to the south (Figure 5.1). Stormwater flow enters the on-site system at the westernmost point, just east of the former Building T location, and exits in the northeast quadrant of the Site at CB-1 at its easternmost point. Flow from CB-1 is conveyed slightly further east to into the catch basins located within Des Moines Memorial Drive and at this point, the flow becomes comingled with runoff from Des Moines Memorial Drive. The “detention pond” within the smaller on-site drainage system appears to receive only localized surface drainage and appears to have functioned more as a landscape feature than a flow-control pond when the apartment complex was in operation.

Flows from the on-site system are routed south along Des Moines Memorial Drive, through various structures to join the flow coming from the City’s main stormwater line at Catch Basin CB4857 (Figure 5.1). From this point, flows pass beneath Des Moines Memorial Drive to another vault to the northeast before discharging into Lora Lake.

5.3 PROPOSED MONITORING LOCATIONS

The following sections describe the locations selected for stormwater sampling, stormwater solids sampling, and sediment sampling along with the rationale for selecting these locations. Figure 5.1 presents the various sampling and monitoring stations as they are located across the Site.

5.3.1 Stormwater Sampling

Stormwater samples will be collected at three monitoring locations to characterize the inlet and outlet flows at the Site. These are designated as CB4505/CB-31A, CB4857, and CB-1.

Catch Basin CB4505/CB-31A was selected because it is the inlet of all piped stormwater conveyance entering the Site. CB4505/CB-31A allows sampling access to all incoming flows from the City of Burien (main line system) to the Site before these flows are impacted by surface drainage from site runoff into this system. This catch basin is a large Type II vault split by a flow control / debris barrier weir wall. Stormwater sampling and flow monitoring will be conducted on the outlet, downstream side (east side), of the weir wall.

CB4857 was selected because it represents the outlet of the main drainage system line from the site property. Off-site flows comingle with site runoff within the CB4857 vault; therefore water samples will be collected from the inlet pipe to CB4857 coming from CB5945/Ex.CB-B to isolate site runoff. Flows will also be measured in this inlet pipe. CB4857 was selected as the sampling and flow monitoring location rather than the upstream CB5945/Ex.CB-B because there is interest in including flows that pass through the pipe between the two structures. The pipe crosses an area of the Site that has been identified to have soil and groundwater impacts and characterization of stormwater at this location is of interest to the upcoming Remedial Investigation at the Lora Lake Apartments Site. Thus, using the inlet pipe to CB4857 as the flow monitoring and sampling location will allow sample collection that is representative of site runoff while excluding sources outside of the Site (primarily road runoff from Des Moines Memorial Drive).

Outlet flows from the smaller on-site drainage system will be monitored at Catch Basin CB-1, a Washington State Department of Transportation Type II 4-foot by 3-foot grated vault (designed as an overflow structure). All drainage from the smaller on-site system is routed through CB-1. This structure also receives surface drainage through its grate from a small grass area. To avoid possible effects from this limited local surface drainage, samples will be collected from the inlet pipe to CB-1 coming from the upstream CB4555/CS/CB-2. Flow will also be measured in this pipe. CB-1 was selected as the monitoring location over the upstream CB4555/CS/CB-2 because this vault contains a flow control structure that would complicate flow measurement at that location, making representative sampling more straightforward at CB-1.

As mentioned in Section 5.4.1, groundwater levels will be taken into consideration as part of the storm targeting process. Several existing site groundwater monitoring wells will be utilized to assess shallow aquifer/water table levels and fluctuations over time.

Monitoring Wells MW-1 (central portion of site), MW-3 (southern portion of site), MW-4 (southeastern portion of site), and MW-6 (northeastern portion of site) will be used for these assessments. An electronic water level indicator will be used to make the necessary measurements.

5.3.2 Stormwater Solids Sampling

In-line sediment traps, designed to collect stormwater solids, will be positioned in three catch basins: CB4505 (CB-31A), CB5945 (Ex. CB-B), and CB4555 (CS/CB-2). These sites were chosen to pair up with the stormwater sampling stations to the maximum extent possible.

CB4505/CB-31A was selected as the location to represent stormwater solids entering the Site from the mainline drainage system. This location was selected for stormwater solids sampling for the same reasons it was selected for stormwater sampling, as described above in Section 5.3.1. Stormwater solids will be collected from the inlet side (west side) of the weir wall at CB4505/CB-31A.

CB5945/Ex.CB-B was selected as the location to represent stormwater solids leaving the Site through the mainline drainage system. This location was chosen for stormwater solids sampling instead of CB4857 (the corresponding stormwater sampling location) because an in-line sediment trap could not be installed at CB4857 in a position where a representative sample could be collected without impacts from off-site drainage, including roadway runoff. A suction line can be inserted into the upgradient portion of CB4857 to ensure a stormwater sample representative of on-site conditions and data on stormwater quality can be collected; however, there is no sump located in CB4857, therefore, an in-line solids sample collected via a sediment trap could only be placed such that the catch basin would have to fill during a stormwater event and would collect solids from both the on-site drainage system and the Des Moines Memorial Drive drainage system, impacting the ability to compare the stormwater quality entering the Site to the stormwater quality existing at the Site. Thus, CB5945/Ex.CB-B is the location furthest downstream in the mainline stormwater system that includes the most on-site drainage without the influence of downstream off-site drainage.

At CB5945/Ex.CB-B stormwater solids will be collected from within the sump of the vault near its outlet pipe. To make sure that the storm drain system segment from CB5945 to CB4857 is intact and in good quality such that soil would not be allowed to infiltrate the storm drain pipe segment, a TV line inspection will be performed by the Port prior to the start of the stormwater sampling events. If the TV line inspection in this segment indicates the potential for soil and groundwater infiltration (i.e., infiltration of roots, cracks in the drainage pipe, or damage/disconnects in the pipe joints), the proposed in-line solids monitoring locations may need to be revised in coordination with Ecology to ensure that the potential transport of stormwater solids are captured appropriately in the interim action monitoring program.

CB4555/CS/CB-2 was selected as the location to sample stormwater solids coming from the smaller on-site drainage system. This location was chosen for stormwater solids sampling rather than CB-1 (the corresponding stormwater sampling location) because it is expected that the flow control structure at CB4555/CS/CB-2 traps much of the stormwater solids before water flows into CB-1. Recent inspections of these structures found significantly more sediment accumulated in CB4555/CS/CB-2 than in CB-1. Additionally, a sediment trap could not be installed at CB-1 in a position where the sample would not be affected by local off-site drainage. Stormwater solids will be sampled from the central portion of the vault at CB4555/CS/CB-2.

5.3.3 Sediment Sampling

Sediment samples will be collected at four locations to characterize COCs from the inlet, outlet, and key junctions within both drainage systems beneath the Site (Figure 5.1). The sediment sampling locations and their relationship to the main stormwater line system are designated as follows:

- CB4505/CB-31A is the inlet to the main stormwater line system and to the entire Site.
- CS/CB-19 is a key junction receiving flow from all of the Type I and II catch basins and the associated detention tanks from the western portion of the Site.
- CB-12 is a key junction receiving flow from all of the Type I and II catch basins and the associated detention tank from the central portion of the Site.
- CB4555/CS/CB-2 is the assessment point for the entire smaller on-site drainage system.

Several discrete grab samples, homogenized into one location-specific composite sample, will be collected at each sediment sampling location.

5.4 STORM TARGETING AND EVENT PARTICULARS

This section presents sampling design details relating to storm targeting and other pertinent storm event sampling particulars. The actions listed below are compliant with Ecology's guidance for stormwater sampling at industrial facilities (Ecology 2002).

5.4.1 Storm Events

As noted in Section 3.2, up to 10 distinct stormwater sampling events will be conducted. The actual number of stormwater sampling events completed will depend upon the ability to represent site conditions given the number of available qualifying storm events and the ability to effectively assess potential site influences on the quality of stormwater entering the Site. Stormwater monitoring will occur during the wet weather period between November 2009 and May 2010. The objective is to collect stormwater samples over a range of representative storm sizes, rainfall intensities, and groundwater/soil water conditions at the Site. Consideration will be given to groundwater table fluctuations (as a measure of groundwater levels in select site monitoring wells), in order to characterize the potential subsurface contaminant transport through inflow and/or infiltration into the stormwater drainage system.

5.4.2 Target Storm Event

The project will target storms for sampling that are forecasted to produce at least 0.1 inch of precipitation in a 24-hour period with a 70 percent or greater probability of occurrence 24 hours prior to the anticipated event start. After April 30, this forecast probability will drop to 50 percent. Targeted storms must be preceded by 12 hours of dry weather and 24 hours with less than 0.1-inch of precipitation. The rain gauge on the Port Airport Office Building roof is designated as the “project gauge” and will be utilized for targeting considerations and in the determination of storm qualification.

5.4.3 Storm Qualification and Event Completion

There is no minimum or maximum size for a storm to qualify for sample collection. Sampled storms must be preceded by 12 hours of dry weather and 24 hours with less than 0.1-inch of precipitation. Grab samples must be collected when storm runoff is occurring. Composite samples must be composed of at least 8 discreet sub-samples (aliquots) that represent at least 75 percent of the storm hydrograph volume during the first 24 hours of the event[1].

A storm event composite sample can be considered completed once there has been a 6-hour period with no precipitation. However, stormwater composite sampling can continue until there has been a 12-hour period with no precipitation at which time the storm would be considered complete. Sampling events have no minimum duration requirements but can be considered complete after 24 hours.

5.5 STORMWATER SAMPLE COLLECTION

This study will use two methods to collect stormwater samples: flow-proportionate composite sampling and grab sampling. Composite sampling is a preferred method to obtain representative stormwater samples because the samples are made up of a number of smaller samples (subsamples) that are collected at intervals over the course of a storm event (Ecology 2002). Constituent concentrations measured in a flow-proportional composite sample are related to the mass of the constituents contained in the runoff from the storm because the subsamples comprising the composite sample represent equal amounts of stormwater discharge that occur during the storm. These types of samples will be useful for comparing the quality of stormwater entering and leaving the project site during each sampled storm.

[1] These qualifying sample criteria are from the Phase I Municipal Stormwater Permit, Section S8.

Most parameters included in this study can be analyzed from flow-proportional composite samples as described above. However a small group of parameters, volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPHs), must be analyzed from grab samples. Grab sampling techniques are necessary to avoid loss of volatile components or adherence of petroleum constituents to sampling containers, which might occur if composite sampling methods are used.

Attempts will be made to collect both grab and composite samples as an associated pair from the same storm event at each site. However, if, for whatever reason, all other storm requirements have been satisfied and only either the grab or the composite sample is collected from a catch basin, the sample would still be submitted for analysis and would be considered event-qualified data. If a grab or composite sample is not collected during a particular storm event then the sample type that was missed will be specifically collected during a future event.

5.5.1 Grab Sampling

A single grab sample will be collected from each site per storm event. Grab samples will be collected as early in a storm event as possible[1] (although runoff at a particular catch basin needs to be occurring) or when the storm hydrograph is at least 10 percent above pre-event flow level conditions.

Grab samples will be “manually” collected using a peristaltic pump that collects samples through dedicated sampler Teflon-lined tubing lines fixed at each stormwater sampling location. Manual grab sampling will be conducted for samples undergoing analysis for VOCs, and diesel and oil TPHs to minimize the loss of compounds via volatilization.

5.5.2 Composite Sampling

Flow-weighted composite samples will be made up from a set of discrete samples collected with an autosampler. These discrete samples will be collected at frequencies and quantities specific to individual stations and particular storm events. A single flow-weighted composite sample will be collected from each station per storm event.

Autosamplers and flow meters will be used to collect flow-paced samples. Area-velocity type flow meters will be used to measure flow (and will be utilized for sampler pacing) unless hydraulic conditions warrant a different approach. In order to calculate and evaluate an Event Mean Concentration (EMC) for a particular storm at a particular location, attempts will be made to directly flow pace the samplers via associated flow metering equipment. However, if direct flow pacing is not feasible, post-storm flow-weighted compositing will be manually completed.

In general, the autosampler units will be auto level-enabled via their connection to a flow meter, based on an increase in level as measured by the flow meter. The auto enable will be based on the current baseflow level plus a level change beyond the sensitivity (i.e., noise) of the instrument. This level change value is typically 0.03 to 0.1 feet. In some cases, direct (manual) enabling of the autosamplers may be necessary if the situation warrants this action (based on field staff observation of rainfall and a corresponding increase in runoff flow and/or drainage system response). All of the stormwater monitoring stations will require manual setting of the auto enable level condition at some point prior to the storm event. None of the project stations will be telemetered; therefore, under most scenarios, once the level enabling condition has been set, it cannot be changed again prior to the onset of a targeted event.

The objective of the composite sampling is to sample representative storm runoff. Thus, efforts will be made to exclude sampling during baseflow occurring after the end of a storm event. Intra-event baseflow (i.e., when flow rate falls to the baseflow level between short gaps within one storm event hydrograph) may be sampled if sufficient volume passes to accumulate the pacing volume.

5.5.2.1 Stormwater Composite Sample Analytical Parameters and Volume Requirements

Flow-weighted composite samples will be analyzed for the following parameters:

- PAHs and PCP
- Dioxin/furans
- Arsenic (total and dissolved)
- Total suspended solids (TSS)
- pH (field measurement)

The specific laboratory analyses and analytical limits for each of these parameters are presented in Section 7.0. If the volume of stormwater sample collected from a qualifying storm is insufficient to allow analysis for all parameters listed above, samples will be analyzed for as many parameters as possible. However, there is a low likelihood that an adequate volume of stormwater would not be available, but could occur due to sampling equipment operation error or breakage of sample containers. If a parameter was not analyzed for during a monitoring event due to lack of sample volume, that parameter will be given priority to be analyzed for in the following event. Table 5.2 lists the stormwater parameters in the priority order (in descending order of priority) of analysis and the required composite sample analysis volumes.

The priority of sample analyses was determined based on analyte detection in media at the Site as well as the likelihood of the analyte to be present in aqueous samples. A total composite sample volume of at least 1.9 liter (L) is needed and up to 4.5 L is recommended to run the required analyses. When field and laboratory QC samples are targeted (refer to Section 7.0), a composite sample volume of at least 3.8 to 5.7 L is needed and up to 9 to 13.5 L is recommended. If insufficient volume exists to run the next highest priority contaminant, that analysis will be bypassed and analyses run on lower priority contaminants in accordance with the remaining priority order to the extent possible.

5.6 STORMWATER SOLIDS SAMPLING

Stormwater solids will be collected over a period of months via an in-situ in-line passive sampling device (sediment trap). The sediment trap containers will be retrieved at the conclusion of the stormwater solids collection period. The material collected in the sediment trap containers will be capped and will not be field homogenized. The laboratory will complete all of the required homogenization and sub-sampling.

Samples will be analyzed for the following parameters:

- PAHs and PCP
- Arsenic and lead
- Dioxin/furans
- Oil and diesel-range TPH
- PCE, TCE, and 1,2- DCA (VOCs)
- Total solids
- Total organic carbon (TOC)

The specific laboratory analyses and analytical limits for each of these parameters are presented in Section 7.0. Depending on the amount of solids collected, analysis will be completed in a prioritized fashion. If a parameter was not analyzed for during a monitoring event due to lack of sample volume, that parameter will be given priority to be analyzed for in the following event. Table 5.3 lists the stormwater solids parameters in the priority order (in descending order of priority) of analysis and the required solids sample analysis volumes. As with stormwater samples, the priority of sample analyses was determined based on analyte detection in media at the Site as well as the likelihood of the analyte to be present in solid samples.

5.7 SEDIMENT SAMPLING

Sediment sampling will be conducted as a single event, where samples from all targeted stations are collected over the course of one scheduled field day. A number of grab samples, adequate to represent a particular catch basin, will be homogenized and composited into a single sample. The appropriate aliquot size will be divided into the required laboratory containers.

Sediment samples will be analyzed for the same compounds as stormwater solids (refer to Section 5.6). The specific laboratory analyses and analytical limits for each of these parameters are presented in Section 7.0. Depending on the amount of sediment volume available for collection, analysis will be completed in a prioritized fashion. Table 5.3 lists the sediment parameters in the priority order (in descending order of priority) of analysis and the required sediment sample analysis volumes. The priority of sample analyses was determined based on analyte detection in media at the Site as well as the likelihood of the analyte to be present in sediment samples.

5.8 MONITORING EQUIPMENT INSTALLATION AND SETUP

This section describes the type of monitoring equipment that will be deployed and the general configuration of equipment installation, including the rain gauge, flow meter, autosampler, and sediment sampler.

5.8.1 Precipitation Monitoring

A Hydrological Services Model TB3 tipping bucket rain gauge has previously been installed on the Port Airport Office Building roof as part of the Port's stormwater monitoring program under it's National Pollutant Discharge Elimination System (NPDES) permit. This instrument measures rainfall at 0.01-inch increments. A data logger connected to the rain gauge records rainfall data at 5-minute intervals. Remote access to the data logger is provided via the Port's NPDES telemetry network. The rain gauge system will be powered by the building's electrical system.

5.8.2 Stormwater Monitoring

Stormwater sample collection will be conducted with Isco™ 6712 or 3700 autosamplers (for the composite parameters) and a Masterflex™ E/S portable peristaltic pump. Autosamplers will be utilized in their "off-the-shelf" configuration; however, if the situation warrants, custom sampler bodies that allow for additional collection capacity, may be used in conjunction with the Isco™ sampler head component. Each stormwater monitoring station will be equipped with an Isco™ autosampler that is outfitted with multiple glass bottles. Also at each stormwater monitoring station, two individual Teflon-lined sample tubing lines will be attached with stainless steel fasteners to a desired location in the pipe or vault. One of the sample tubing lines will be dedicated to the autosampler and the other will only be used for grab parameter sampling. Both sampling lines will be outfitted with stainless steel or Teflon strainers, anchored with stainless steel or plastic fasteners. The peristaltic pump will use appropriately sized Tygon® silicon-cured pump head tubing. Laboratory cleaned connectors will be used to attach the pump head tubing of both the autosampler and the peristaltic pump to their dedicated sample tubing lines. Pump head tubing associated with the peristaltic pump will be utilized in a non-dedicated fashion, where it is used once and then discarded. The autosampler pump head tubing will be used in a dedicated fashion and will only be replaced as necessary.

Flow monitoring will be conducted using Isco™ 4000-series area-velocity meters at each stormwater monitoring station, unless the flow regime at a particular station presents hydraulic upset conditions. Hydraulic upset conditions may include the following:

- A depth of flow that is less than 2 inches
- Aeration of a zone surrounding the flow sensor (typically caused by pipe slopes greater than 2 to 3 percent grade)
- Excessive flow velocity (greater than 20 feet/second).

Hydraulic upset conditions may adversely affect the precision and accuracy of the flow monitoring data. If any of these hydraulic upset conditions exist, it may be necessary to either modify the piping system (e.g., creating a coffer dam, installing a weir plate, etc.) in a non-destructive manner or utilize other flow monitoring technologies (e.g., down-looking ultrasonic, wafer sensors, side-looking acoustic Doppler).

Typically, the flow meter sensor will be secured at a site with the aid of a stainless steel, scissor ring tension band and slide-in clip system. These meters will provide a continuous flow record, allow for assessment of storm hydrographs, and provide the means to level enable the autosamplers. Flow meter data will be manually downloaded using field laptop computers.

5.8.3 Stormwater Solids Sampling Apparatus

Stormwater solids (suspended particulate) samples will be collected with the use of in-line passive stormwater sediment traps. Construction details and performance of sediment traps is described in *Stormwater Sediment Trap Pilot Study* (Ecology 1996). A diagram of the construction details of the sediment traps used by Wilson and Norton (and the type to be used on this project) are presented in Figure 5.2. The sediment traps consist of a Teflon or glass vessel housed in a stainless steel cup that is held in place by brackets. Sediment traps are typically installed in larger diameter pipes (24-inches and greater) or in the sumps of catch basins. The base plate of the sediment trap will be secured to the wall of a pipe or vault with stainless steel anchors. The top of the sediment trap vessel will protrude just slightly above the current water line, in the case of a catch basin sump deployment, or at some level where typical baseflow will not contribute to the materials collected. As stormwater flows across the opening of the sediment trap, particulate material will settle into the trap; however, bed-load would not be captured.

5.8.4 Sediment Sampling Equipment

Sediment samples will be collected from catch basin vault sumps and/or associated drainage system piping. All sediment sampling equipment, including scoops, spoons, dip-cups (used on extension poles), and bowls will be made of stainless steel and decontaminated prior to sample collection. The main criteria for collection of sediment samples from within the site catch basins is to attempt to accurately represent any heterogeneity of that material, in the professional judgment of the sampling crew, that may possibly affect the analytic composition of the resultant composite sample. Aspects of the accumulated material, such as thickness of deposition, material type (sands, silts, clays), spatial distribution, appearance (obvious staining or other such impacts) and/or differential layering will be considered during the time of sediment collection. A certain number of discrete grab samples, which will be determined in the field by the sampling crew, adequate to create a representative sediment sample from within a particular catch basin, will be compiled into a single composite sample. This composite sample will be further homogenized before it is sub-sampled into its various required analytical fractions.

5.9 PERIODIC DRAINAGE SYSTEM INSPECTIONS

Periodically, field staff will inspect various components and locations along the drainage network, from both the main and on-site stormwater systems. Items such as sediment re-accumulation and baseflow will be noted, along with other such observations. Based on these field observations and coupled with other supporting data and information, recommendations may be made for additional interim actions (e.g., baseflow sampling, additional sediment sampling). If a situation warrants any additional action, then the Port will properly notify Ecology.

5.10 PREVENTATIVE MAINTENANCE

Periodic preventative maintenance of equipment will occur between targeted sample events to ensure proper operation. Worn or damaged equipment, equipment failure, or other maintenance issues will be documented in field notebooks or on field data forms and addressed between storm events. After each storm event, the sampler pump tubing will be inspected to see if it should be replaced, along with conducting other routine station re-set tasks.

6.0 Sampling Procedures

The following sections document activities associated with field instrument operation and maintenance, and sample collection and management. Additional details regarding field procedures implemented to ensure QC for sample collection and handling are provided in Sections 4.0, 7.0, and 8.0. All stormwater sampling and monitoring, stormwater solids, sediment, and other inspection/observation field forms as well as Chain-of-Custody Forms are provided in Appendix B.

6.1 PRECIPITATION AND FLOW MONITORING

Rain gauge data will be downloaded at least once each month and immediately prior to, during, and following sampled storm events. Field staff will inspect the rain gauge quarterly and service it as needed. Rain gauge calibration will occur using the method and at the frequency recommended.

Flow meters will be inspected and serviced immediately prior to storm events targeted for sampling. Flow data will be downloaded during these maintenance visits, as well as following sampled storm events. More frequent downloads will be completed as necessary.

6.2 STORMWATER SAMPLE COLLECTION

This section documents the procedures to prepare for and conduct stormwater sample collection for routine sampling.

6.2.1 Procedures for Storm Targeting

A target storm event will be identified by the Stormwater Consultant Technical Lead in consultation with the Consultant Project Manager and the Port Project Manager. When the decision is made to target a particular the storm, the Consultant Technical Lead or Consultant Project Manager will designate a “Storm Controller” for the targeted storm event. From that point until all samples related to the storm are delivered to the laboratories, the Storm Controller will be responsible for managing all field activities and sampling decisions related to the targeted storm event. The initial act of the Storm Controller will be to schedule a field team to conduct the pre-storm site set-up activities, described in the next section.

At least once each week during the project sampling period, the Consultant Technical Lead or designee will check rainfall forecasts for Seattle (for example, NWS – http://www.wrh.noaa.gov/sew/ or 180-hour GFS meteogram—http://www.wxmaps.org/) to determine if approaching weather systems meeting the minimum storm depth targeting criteria might occur during the next 7-day period. If a forecast suggests that a storm meeting the target criteria might occur, the Consultant Technical Lead or designee, and the Consultant Project Manager will confer to decide if the storm should be considered for targeting. If the decision is made to keep tracking the storm, then the Consultant Technical Lead or designee will continue reviewing forecasts once each day and update the other team members as to the status of the forecast.

The Port Project Manager will be notified in advance of the anticipated start of a targeted event. A decision whether or not to mobilize the field crew (*Go or No Go*) will be made within 24 hours prior to the anticipated start of the event, with concurrence from the Port Project Manager. Attempts will be made to mobilize the field crew 24 hours prior to the anticipated start of the storm event. However, a minimum of 6 hours will be necessary for the completion of the sampling station setup tasks.

During sample event targeting periods, Internet-based forecasts will be archived to document targeting decisions. These archived forecasts will be used for storm validation and event reporting purposes.

6.2.2 Pre-storm Site Setup

Within 24 hours prior to the onset of the targeted event, a field team will visit the monitoring site to prepare the monitoring equipment for sampling. Prior to this site visit, the Storm Controller will determine a sampler pacing rate based on the forecasted precipitation quantity, the expected duration of the storm, and expected resulting runoff volume (yield). Prior to deployment, autosampler bottles will have been cleaned by the analytical laboratory, as described in Section 6.5.3. The field team will not be deployed unless the antecedent precipitation criteria have been met or in the professional judgment of the Storm Controller are likely to be met.

During the pre-storm site visit, the field team will check/modify the autosampler and flow meter programs, conduct necessary maintenance and calibration activities, place sample bottles into the autosampler, and start the autosampler program. All setup, maintenance, and calibration activities will be recorded on a field data sheet along with notes of other relevant site conditions. During pre-storm setup, the following specific tasks will be performed:

1. Calibrate flow meter using appropriate method for the site.
2. Install new sampler pump tubing if needed and calibrate autosampler sample volume.
3. Back flush the sampler pump tubing and suction line with 1 gallon of reagent-grade water.
4. Inspect sampler strainer and water level sensor for debris and clean if necessary (confined space entry into the manhole might be required for this activity).
5. Prepare sampler, including removing bottle lids and filling the sampler base with ice if necessary.
6. Confirm sampler and flow meter programs and configuration settings.

7. Run sampler diagnostics to confirm operation of sampler distributor arm.
8. Start sampler program and confirm the sampler program is active and is disabled (awaiting a trigger signal from the flow meter to initiate sample collection).

6.2.3 Storm Event Grab Sample Collection

As the targeted storm event approaches, the Storm Controller will monitor the project rain gauge to confirm that antecedent conditions are met and to determine the start of the storm. During this period, the Storm Controller will be in contact with the field team to keep them apprised of the status of the impending storm. Once the targeted storm begins, the field team will be mobilized to conduct grab sampling. The field team will attempt to collect grab samples from as early in a storm event as possible; however, runoff must be occurring or the storm hydrograph needs to be at least 10 percent above pre-event flow level conditions. The field team will conduct the following tasks at the Site:

1. Check auto sampler status and replenish ice in base as needed. If problems are discovered, troubleshoot the issue and recover the sampling effort if possible.
2. Check autosampler battery voltage and replace battery if necessary.
3. Download the flow meter and review the flow record for obvious errors and hydrograph stage.
4. Attach the dedicated grab parameter-only sampling tubing line to the pump head tubing of a peristaltic pump. If connectors are used for this tubing link, they should be laboratory cleaned.
5. Purge the grab sampling line by discharging a small volume of water (less than 500 mL) out of the tubing back into the vault (downstream of the intake strainer), and then reversing the pump and evacuating the line. This will be repeated three times.
6. Us the peristaltic pump to fill the individual laboratory supplied containers to be used for analysis of specific parameters.
7. Disconnect the pump tubing from the pump and seal the end of the grab tubing line with laboratory glassware film.
8. Collect duplicate grab samples, if scheduled, as per Tasks 4 to 7 above.
9. Label and store samples on ice for transport to processing area or laboratory.
10. All activities and pertinent observations will be recorded on the same field data sheet used to document pre-storm setup activities.

6.2.4 Mid-event Site Visits

Over the course of the targeted storm event, the Storm Controller will track cumulative precipitation and make a judgment of whether or not the bottles in the autosamplers are likely to fill up before the storm ends. To make this judgment, the Storm Controller will consider the expected runoff yield from the cumulative rainfall, the sampler pacing rate, and the amount of precipitation forecasted for the remainder of the storm event. If the Storm Controller decides it is likely that the autosampler bottles may prematurely fill, then the Storm Controller will dispatch a field team to check the status of the sampler, and if necessary, swap in new sample bottles. During the mid-event site visit, the field crew activities will include the following:

1. Check the autosampler status. Determine if the sample bottles should be swapped-out in consultation with the Storm Controller via cell phone, if necessary. If the decision is made to swap out the bottles, the field crew will:
   a. review the sampler report and record data,
   b. cap and label sample containers and store on ice for transport to the Port of Seattle's stormwater laboratory/sample processing location where they will be stored for later compositing,
   c. deploy new bottles into the sampler,
   d. restart the sample program.
2. Replenish the ice in the sampler if necessary.
3. Check autosampler battery voltage and replace battery if necessary.
4. Download the flow meter and review the flow record for obvious errors and hydrograph stage.

All activities and pertinent observations will be recorded on the same field data sheet used during previous visits for the particular storm event.

Multiple mid-event site visits may occur during a targeted storm event if necessary to avoid gaps in or truncation of the composite sampling period.

6.2.5 Composite Sample Retrieval

Over the course of the targeted storm, the Storm Controller will monitor near-term forecasts and weather conditions to determine when the storm event has ended. Once the storm event has ended, a field team will be mobilized to retrieve the composite sample. Field teams will conduct the following tasks to retrieve the composite sample and demobilize each site after the sampling event is over:

1. Review sampler report and record data.
2. Cap and label sample containers and store on ice for transport to the sample processing location.

3. Collect equipment rinsate blank, if scheduled.
4. Download the flow meter and review the flow record for obvious errors.
5. Power-down the autosampler or place in "stand-by" mode.
6. Once back at the sample processing location a small portion (approximately 100-mL) of the completed composite sample will be poured off for pH measurement. This measurement will be recorded on the associated field sample collection form.

All activities and pertinent observations will be recorded on the same field data sheet used to document pre-storm setup and grab sampling activities.

6.2.6 Field Sample Validation

Prior to processing the samples and transferring custody to the analytical laboratory, the Storm Controller will validate the samples against the criteria presented in Section 5.4, Storm Targeting and Event Particulars. Validation activities for the grab samples and composite samples are presented below. As long as the criteria for either a grab or composite sample are met, then either sample can be submitted to the laboratory with or without its counterpart.

Grab Sample

- Confirm that required antecedent precipitation conditions existed prior to grab sample collection.
- Review field forms and the storm hydrograph to ensure that the grab sample was collected during a period of observed runoff and/or the water stage at the site gauge was at least 10 percent greater then pre-event levels.
- Review field notes to determine whether anomalous conditions were encountered that would disqualify the grab sample.
- Inspect the grab sample containers to ensure they are properly filled.
- If grab samples are determined to be valid, then no further processing is necessary. However, sample management stipulations do apply.

Composite Sample

- Determine if the sampled storm was a qualifying event.
- Review field notes to determine whether anomalous conditions were encountered that would disqualify the composite sample (e.g., missed aliquots or sample bottles overfilled).
- Confirm that the composite sample consists of at least eight aliquots.

- Check that sufficient sample volume has been collected to complete laboratory analyses.
- Review the storm hydrograph and timing of sample aliquot collection to ensure that the composite sample period included at least 75 percent of the hydrograph during the duration of the storm event.
- Initiate post-sampling processing tasks, as described in Section 6.2.7.

6.2.7 Stormwater Composite Sample Processing

At the end of a successful sampling event, composite sample containers will be transported by the field crew to the Port Stormwater Laboratory for processing prior to delivery to the contract analytical laboratory.

Post-storm event processing for routine composite samples will consist of first preparing a final composite sample from the available individual sample container volumes. Sample processing will be performed using available and accepted devices and may include the use of glass graduated cylinders and funnels. A pH measurement of the final composite sample will be conducted at the Port Stormwater Laboratory prior to the delivery of samples to the analytical laboratory.

Field crew and/or laboratory staff will follow methodologies established under the Port's NPDES Program for post-storm event sample handling and processing. All sample processing equipment will be decontaminated prior to use following established procedures (refer to Appendix C for decontamination standard operating procedure [SOP]). Samples will be properly labeled and formally transferred to the laboratory for analysis following established chain-of-custody procedures, as discussed below.

6.3 STORMWATER SOLIDS SAMPLE COLLECTION

Sediment traps will be continuously deployed for up to 5 months during the project monitoring period. Field personnel will deploy the sediment traps at three locations corresponding to the stormwater sampling stations. Field personnel will take care to consistently deploy the sediment traps at the catch basin vault locations to avoid introducing sampling bias due to the physical positioning.

Crews will periodically inspect the sediment collection bottle over the deployment period to: (1) ensure that the container opening is free of litter and other debris that could limit sample collection, (2) ensure that the collection bottle is not damaged, and (3) note the volume of material that has collected in the trap. Inspection site visits will occur monthly at the beginning of the deployment period; however, the frequency of subsequent inspections may be adjusted depending on how quickly the trap is filling.

At the end of the planned deployment period, or when a sediment trap is full or nearly full, the collection bottle will be removed from the mounting bracket, capped with a

Teflon or Teflon-lined lid, packaged, and placed in a cooler on ice for transport to the contract analytical laboratory for further processing. Under no circumstance will stormwater solids samples be frozen prior to being processed, as this may change the particle size distribution prior to analysis. Processing will begin within 24 hours of retrieval.

6.4 SEDIMENT SAMPLE COLLECTION

This section describes field procedures that will be utilized to ensure that sediment samples are collected in a consistent manner and are representative of the matrix being sampled. Procedures are described for collecting sediment samples and recording field measurements and conditions. Sampling procedures will generally follow the Puget Sound Estuary Program (PSEP) *Recommended Protocols for Measuring Environmental Variables in Puget Sound* (1986).

Nitrile gloves will be worn at all times while collecting sediment samples. Descriptions of field observations (including oil sheens and potential contributing activities) and sample characteristics (odor, amount, and type of particles being removed—size, description, color) will be included in field notes recorded during sample collection. All sediment collection equipment will be decontaminated following PSEP guidelines as (refer to below).

Catch basin and in-line (pipe) sediment samples will be collected using decontaminated stainless steel spoons and long-handled scoops or soil coring devices. Samples will be collected from the top 3 to 4 inches of sediment accumulated in the catch basin sump or in-line structure. Individual aliquots will be collected from at least four locations in the sump/structure, placed in a stainless steel bowl, and thoroughly mixed. Any particles greater than 2 centimeters in size will be removed from the sample and discarded. After mixing, samples will be placed into pre-cleaned sample containers provided by the analytical laboratory. Samples will be placed in a cooler and stored on ice until delivered to the analytical laboratory.

6.5 SAMPLE MANAGEMENT

This section describes the proper sampling handling and management techniques that will be employed during the course of the project. Whether or not detailed, otherwise discussed or implied or inferred in this Work Plan, all stormwater industry standard, scientifically accepted and environmentally sound practices, techniques and considerations that apply to sample collection and management for this project will be duly and appropriately exercised.

Required sample amounts, containers, preservatives, and analytical holding times for required chemical analyses are included in Table 6.1. In the event that additional analyses are to be performed, such as targeted collection of field and laboratory matrix QC samples, or the laboratory requests additional sample amounts for select parameters, the sample size will be increased as needed. In such cases, sample processing procedures will be adjusted accordingly to accommodate larger initial sample volumes.

6.5.1 Sample Collection Materials

Glass containers equipped with Teflon-lined lids will be used to collect and composite all of the samples slated for chemical analyses. This is done to avoid interferences that could result from using plastic containers for organic parameters. The use of stainless steel in various sample collection equipment is also acceptable. Additionally, autosampler suction tubing will be lined with Teflon. The exposed surfaces of sampling apparatuses or housings will not contain any of the metals included in the parameter list.

6.5.2 Sample Container Preparation

All sample containers will either be new or laboratory cleaned. If the analytical laboratory supplies new sample containers, they will be presented to the sampling team in unopened boxes that are accompanied by testing certificates from the manufacturer. If previously used containers are utilized, they will be cleaned by the laboratory via established and agreed upon methods.

The composite stormwater samples collected in 1-gallon glass containers will be transferred to 2.5-gallon glass jars (in accordance with the necessary compositing scheme) for transport to the analytical laboratory. The 2.5-gallon jars will be cleaned and prepared prior to sampling by the analytical laboratory. Glass jars will be washed with detergent and water, rinsed with acidified deionized water, rinsed with deionized water, rinsed with a 90 percent isopropylnol solution (organic solvent), rinsed with a 10 percent methanol solution, rinsed with deionized water, and allowed to air dry prior to sample collection. These cleaning procedures are compliant and consistent with the project analytical program and analytical method requirements. These methods are detailed in the Appendix C, Standard Operating Procedures – Stepwise Decontamination Procedure, Method A (Without Metal Parts).

6.5.3 Equipment Decontamination

Non-dedicated sampling equipment (e.g., stainless steel scoops, spoons, bowls, sample intake strainers, sediment trap housing) will be properly decontaminated prior to collection of each sample or at the onset of its use. Decontaminated sampling equipment will be handled in a manner that minimizes contact with potentially contaminated surfaces. Once decontaminated, equipment will be wrapped in aluminum foil and stored in air-tight, plastic zip-lock baggies or large bins until ready for deployment or use. Specific procedures for sampling equipment decontamination are presented in Appendix C, Standard Operating Procedures – Stepwise Decontamination Procedure, Method B (With Metal Parts).

6.5.4 Sample Documentation

Sampling activities will be documented in the field on appropriate forms and/or in field notebooks at the time of sampling. Sample container labels will be completed and affixed to each sample container. Sample collection times will be identified on each container. Grab samples will be assigned a time corresponding to the time of collection. Composite sample collection time will be based on the time the final sample aliquot is collected. Each sample container will be labeled and recorded on a chain-of-custody record as described below. Sample labels will identify the catch basin sample location, time and date of sample collection, sampler name, and project name.

6.5.5 Chain-of-Custody Procedures

Chain-of-custody procedures will be strictly followed to provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. Adequate sample custody will be achieved by means of approved field and analytical documentation. Such documentation includes the chain-of-custody record, which is initially completed by the sampler and is thereafter signed by those individuals who accept custody of the sample. A sample will be considered to be in custody if it is:

- in someone's physical possession,
- in someone's view,
- locked up or secured in a locked container or vehicle or otherwise sealed so that any tampering would be evident, or
- kept in a secured area, restricted to authorized personnel only.

The laboratory(s) will provide sufficient copies of blank Chain-of-Custody Forms. Example Chain-of-Custody Forms are included in Appendix B. All sample information (i.e., sample date/time, sample matrix, number of containers, etc.), including all required analyses, will be logged onto a Chain-of-Custody Form after sample processing in the Port of Seattle's Stormwater Laboratory, and prior to formal transfer of sample containers to the analytical laboratory(s). Any time possession of the samples is transferred, the individual(s) relinquishing and receiving the samples will respectively sign, date, and note the time of transfer on the Chain-of-Custody Form. This record documents the transfer of custody of samples from the samplers to the laboratory(s).

The person responsible for transfer/transport of the samples to the laboratory(s) will complete and sign the Chain-of-Custody Form. After the Chain-of-Custody Form has been completed, the sampler(s) will retain a copy for future reference, and the Chain-of-Custody Form will be place in a clear zip-lock bag and placed in the cooler.

Upon receipt of the samples, the laboratory(s) will assume responsibility for maintaining sample chain of custody, and will follow all applicable internal procedures for sample log in, storage and holding times, tracking, and control.

6.5.6 Sample Handling and Transport

Table 6.1 summarizes sample size, container type, preservation method and holding times for stormwater, stormwater solids, and sediment parameters. Proper handling, preservation and transport procedures will be followed. Samples will be iced during sample collection by adding ice or frozen gel-packs to the sampler bases during pre- and mid-storm visits. Pre-preserved sample containers will be provided by the contracted laboratory(s) as necessary. No field preservation of containers will be completed. Samples will be transported on ice to the analytical laboratory(s) for analysis in a timely manner so as not to exceed any holding times.

6.6 NON-DIRECT MEASUREMENTS

In the event that the project rain gauge malfunctions, precipitation data from a nearby city, county, or other governmental agency (e.g., NOAA) rain gauge data will be obtained to fill in gaps in the project precipitation record.

7.0 Laboratory Analytical Program

7.1 ANALYSIS PROGRAM

Stormwater, stormwater solids, and catch basin sediment samples will be analyzed for the following constituent groups using the methods noted below:

Stormwater Samples

- PAHs by USEPA Method 8270D-SIM-Low Level
- PCP by USEPA Method 8041
- Total petroleum hydrocarbons (diesel and oil range) by NWTPH-Dx
- Arsenic (total and dissolved) by USEPA Method 200.8
- Dioxin/furans by USEPA Method 1613
- PCE, TCE, and 1,2-DCA by USEPA Method 8260C-SIM
- Total suspended solids by USEPA Method 2540

The pH of all stormwater samples will be measured at the Port's Stormwater Laboratory prior to the delivery of samples to the analytical laboratory.

Stormwater Solids and Catch Basin Sediment Samples

- PAHs by USEPA Method 8270
- PCP by USEPA Method 8041
- Total petroleum hydrocarbons (diesel and oil range) by NWTPH-Dx
- Arsenic and lead by USEPA Method 6010
- Dioxin/furans by USEPA Method 1613
- PCE, TCE, and 1,2-DCA by USEPA Method 8260C
- Total solids by USEPA Method 2540
- Total organic carbon by Method Plumb 1981

Bulk catch basin sediment samples may also be collected if required for disposal profiling following catch basin sediment removal. Bulk sediment samples may then be analyzed for disposal criteria, such as Toxicity Characteristic Leaching Procedures (TCLP) metals.

Standard Ecology and USEPA sample preparation, cleanup, and analytical methods will be used for all chemical analyses. The laboratory internal Work Plan and standard operating procedures will provide data quality procedures at a level sufficient to meet the analytical DQOs.

7.2 REPORTING LIMITS

The analytical methods identified in this stormwater interim action Work Plan result in the lowest analytically achievable method detection limits and reporting limits or Practical Quantitation Limits (PQLs). Table 4.1 presents the target reporting limits and the project data quality assurance criteria for each analytical method as performed by Analytical Resources, Inc. (ARI) and Frontier. These reporting limits are goals only, insofar as instances may arise where high sample concentrations, non-homogeneity of samples, or matrix interferences preclude achieving the desired reporting limit and associated QC criteria. In such instances, the laboratory will report the reasons for deviations from these reporting limits.

7.3 SPECIFIC DIOXIN/FURAN DATA ANALYSES

Dioxins/furans are generally present in the environment as a complex mixture of chemical congeners that differ in terms of the number and location of chlorine atoms. The most toxic and best-studied of the dioxin/furan congeners is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Because of the need to evaluate the risks associated with the mixture of congeners, the toxicity equivalency factor (TEF) methodology is used. A TEF value is assigned to each congener relative to the toxicity of TCDD. The total toxic equivalent concentration (TEQ) of a mixture is the sum of the products of the concentration of each congener in a sample and the congeners corresponding TEF value. The TEF values used to calculate the TEQs are those resulting from the World Health Organization (WHO) re-evaluation of TEFs for dioxins performed in 2005 (Van den Berg et. al. 2006), as presented in MTCA Table 708-1. The dioxin/furans which will be analyzed for and evaluated using the methodology as described above are shown in Table 7.1.

7.4 LABORATORY WRITTEN REPORT

A written report will be prepared by the analytical laboratory documenting all the activities associated with sample analyses. At a minimum, the following will be included in the report:

- Case narrative summarizing the analytical results.
- Results of the laboratory analyses and QA/QC results.
- All protocols used during analyses.
- Chain-of-custody information including explanation of any deviation from those identified herein.
- Any protocol deviations from the approved sampling plan.

- Location and availability of data.
- As appropriate, this Work Plan may be referenced in describing protocols.

8.0 Quality Control Procedures

8.1 FIELD

Field QC samples will be collected to evaluate data precision and representativeness. Collection of field QC samples will allow identification of potential problems resulting from sample collection and/or sample processing in the field. A blind field duplicate will be collected at a frequency of at least 1 per 20 samples, excluding QC samples. The blind field duplicate sample will consist of a split sample collected at a single sample location. Split samples will be submitted blind to the laboratory as discrete samples with fictitious sample IDs. These blind field duplicate sample results will be used to evaluate data precision.

Trip blanks, three 40-ml VOA jars, will be included in each cooler with aqueous samples (stormwater) being analyzed for VOCs to ensure the sample containers do not contribute to any detected analyte concentrations and to identify any artifacts of improper sample handling, storage, or shipping.

Additional sample volume from the catch basin sediments, stormwater, and stormwater solids, if available, will also be collected and submitted to the laboratory for matrix spike/matrix spike duplicate (MS/MSD) analyses at a frequency of one per sampling event per media if enough sample volume is available.

Additional field QC procedures related to sample collection such as equipment decontamination and sample handling are discussed in Section 6.5.

8.2 LABORATORY

The chemistry quality assurance/quality control (QA/QC) procedures will follow the laboratory and USEPA analytical method QA/QC criteria.

Analytical laboratory QC samples will be collected to evaluate data precision, accuracy, representativeness, completeness, and comparability of the analytical results for this investigation, consistent with the DQOs, as described in Section 4.1. Laboratory QC samples will be of the type and frequency specified in the governing Ecology and USEPA analytical procedures.

9.0 Data Quality Review and Data Management

9.1 DATA VALIDATION AND REPORTING

Floyd|Snider will review the laboratory reports for internal consistency, transmittal errors, laboratory protocols, and for adherence to the DQOs as specified in this Work Plan. A Level III Data Quality Review (Summary Validation) will be performed on all the analytical data, except dioxins, which will have a Level IV, Tier III Data Quality Review (Full Validation).

A Level III Data Quality Review (Summary Validation) includes the following:

- Evaluation of package completeness.
- Verification that sample numbers and analyses match those requested on the chain-of-custody record.
- Review of method specified preservation and sample holding times.
- Verification that the required detection limits and reporting limits have been achieved.
- Verification that the field duplicates, matrix spikes/matrix spike duplicates, and laboratory control samples were analyzed at the proper frequency.
- Verification of analytical precision and accuracy via replicate analysis and analyte recoveries.
- Verification that the surrogate compound analyses have been performed and meet QC criteria.
- Verification that the laboratory method blanks are free of contaminants.
- Review of instrument performance—initial calibration, continuing calibration, tuning, sensitivity, and degradation.

A Level IV/Tier III Data Quality Review (Full Validation) will be performed for dioxin/furan high-resolution data to ensure appropriate QC requirements and avoidance of false positives. In addition to the above review elements, this review includes the following:

- Evaluation of all QC elements such as sample preservation, analytical holding times, blank contamination, precision, accuracy, and detection limits, consistent with the Compliance Screening Level 1 validation.
- Evaluation of instrument performance and calibration.
- Evaluation of compound identification and quantitation (transcription and calculation).

Data validation will be based on the QC criteria as recommended in the methods identified in this Work Plan and in the National Functional Guidelines for Organic and/or Inorganic Data Review (USEPA 2008 and 2004). The dioxin/furan data will also be evaluated using the *USEPA Region 10 SOP for Validation of Dioxins and Furans* (USEPA 1996).

Data usability, conformance with the DQOs, and any deviations that may have affected the quality of the data, as well as the basis of application of qualifiers, will be included in the final reporting of the data. Any required corrective actions based on the evaluation of the analytical data will be determined by the ARI Project Manager and Data Validator in consultation with the Floyd|Snider Project Manager and may include qualification of the data or rejection of the data.

9.2 DATA MANAGEMENT

Floyd|Snider owns and maintains a custom database used to store and query environmental chemistry results. This database will be used during Work Plan activities and data will be queried and provided to the Port and Ecology in their Environmental Information Management (EIM) systems. Field data collected will be entered into the database. Analytical laboratory data will be received in an electronic data deliverable (EDD) format suitable for importation into the database. Both laboratory data qualifiers and external data validation qualifiers are stored in the database. The database is managed and stored in a Structured Query Language (SQL) Server and subject to electronic backup every 2 hours.

Data will be mapped in ArcGIS v9.3. Furthermore, specialized queries may be written to aid in data analyses. Queried data will be tabulated in Excel spreadsheet format. Excel spreadsheets will be formatted to be compatible with export of data to comma separated values format. All numerical data such as coordinates, concentration values, distances, depths will be entered into the Excel spreadsheet as numbers.

10.0 Reporting and Schedule

10.1 REPORTING

Floyd|Snider will provide interim and final data reports. Interim data reports will be provided after the collection of two and six stormwater drainage events. These reports will include a preliminary assessment of data variability and general results to assess if 10 events will provide a sufficient body of results to determine if stormwater flowing into the Site and leaving the Site are statistically different. Recommendations for modifying the sample collection program, including the need and rationale for increasing or decreasing the number of events, shall be provided.

In addition, a third interim data report will be provided after receipt of the catch basin sediment data to assess presence of COCs.

The interim and final data reports will include the following:

- Field documentation, which includes sample collection locations, sampling equipment, physical description of the sample, sample collection forms, and chain-of-custody records.
- Laboratory reports from the chemical testing laboratories.
- Data validation reports for the chemical data.
- Tables and maps displaying the chemical test results.
- Descriptions and tables presenting the statistical evaluation of the data.
- Summary of findings and recommendations related to the need for additional sampling events.

10.2 STATISICAL ANALYSES OF MONITORING DATA

The stormwater monitoring data will be summarized statistically in the interim reports to support subsequent data evaluation following completion of the interim action monitoring activities. The interim action monitoring activities, based on monitoring data and results of statistical analyses maybe completed following 6 monitoring events or 10 monitoring events. The statistical analysis of the stormwater monitoring data will allow for the comparison of stormwater quality that leaves the Site to the stormwater quality that enters the Site and the determination of statistically significant changes in analyte concentrations.

The statistical analyses of stormwater monitoring data will consist of the following:

- Assessing the overall range and statistical characteristics of the Lora Lake stormwater quality and upgradient stormwater quality at each monitoring location (i.e., catch basins) for each analyte of concern using probability plots.

- Evaluating the degree of variation in the stormwater quality as detected at individual monitoring locations using box plots and analysis of variance (ANOVA) or, where appropriate, other comparable comparison of means tests.
- Characterizing each individual data set for each analyte monitored at each location by identifying outliers and confirming data distributions.

Statistical analysis, outlier analysis and summary statistics will be performed using the USEPA recommended software program ProUCL Version 4.00.02. Additional required statistical methods (comparison of means and graphical box plots) that are not available on ProUCL will be conducted using the Minitab Version 15 software program. The handling of non-detect data differs between the ProUCL and Minitab statistical programs due to the difference in statistical methods and software abilities. In all ProUCL analyses non-detects will be labeled as such and the detection limit value used. For all Minitab analyses non-detects will be entered as one-half the detection limit and will not be identified as non-detects.

10.3 REPORTING SCHEDULE

Floyd|Snider will provide up to three interim reports and one final data report as described above. Following the completion of qualifying monitoring activities (i.e., after two stormwater drainage events, after the catch basin sediment sampling event, after six stormwater drainage events, and after completion of the final stormwater drainage event) all chemical analyses of collected samples will be performed within 30 days. Each interim report, as well as the final report, will be prepared and submitted to Ecology within 30 days from receipt of the qualifying monitoring activities final analytical results or as otherwise approved by Ecology.

11.0 References

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Port of Seattle
Lora Lake Apartments

Stormwater Interim Action Work Plan

Tables

FINAL

Table 3.1
Project Participant Roles and Responsibilities

Position	Roles and Responsibilities
Department of Ecology Northwest Region – Toxics Cleanup Program Project Coordinator	Responsible for reviewing and approving Work Plan and project deliverables from the Port to Ecology.
Port of Seattle Project Manager	Responsible for overall management of the Port's Interim Action at the Lora Lake Apartments Site. Monitors and assesses the quality of work. Responsible for verifying that the Work Plan is followed and the project is producing data of known and acceptable quality. Responsible for the development, approval, implementation, and maintenance of the Work Plan and technical coordination with other project team members. Coordinates cleaning and TV-type inspections of the stormwater systems.
Stormwater Consultant (Taylor Associates, Inc.) Project Manager	Responsible for stormwater monitoring services project management and coordination with Port project team members and other associated consultants staff. Ensures adequate training. Develops, plans, and oversees stormwater monitoring activities and supervises and audits field data collection tasks. Any necessary revisions to the Work Plan pertaining to field methods as requested by the Port will be managed by the Project Manager.
Stormwater Consultant (Taylor Associates, Inc.) Technical Lead	Manages and oversees monitoring activities and data management conducted pursuant to the Work Plan by the Stormwater Consultant. Performs storm tracking and storm forecasting analysis and in coordination with the Stormwater Consultant Project Manager and Port Project Manager determines identification of a targeted storm event.
Stormwater Consultant (Taylor Associates, Inc.) Storm Controller	Once targeted storm event and sampling has been determined, the Storm Controller manages and oversees monitoring activities and sampling decisions for the specific targeted storm event. This position could be filled by the Project Manager, Technical Manager, Field Team Lead, or other qualified designee.

Position	Roles and Responsibilities
RI/FS Consultant (Floyd|Snider) Quality Assurance/Data Manager	Responsible for coordination with the Port and the Stormwater Consultant for interim action efforts relating to the pending Remedial Investigation/Feasibility Study (RI/FS). Conducts quality assurance (QA) management tasks on analytical data. Receives and reviews analytical data on a routine basis and makes recommendations based on that data to the Port for considerations by the Washington State Department of Ecology (Ecology). Performs interim action reporting, and validation and verification of data before the report is transmitted to the Port. Any necessary revisions to the Work Plan pertaining to analytical methods, data management or reporting as requested by the Port will be managed by the RI/FS Quality Assurance/Data Manager.
Analytical Laboratory (ARI and Frontier) Project Manager	Analytical Resources, Inc. (ARI) Laboratory in Tukwila, Washington will be the primary analytical laboratory, performing all chemical analyses on samples that are collected and submitted during the investigation, with the exception of dioxin/furan congener analyses. Frontier Analytical Laboratory (Frontier) in El Dorado Hills, California will be the subcontractor through ARI, receive submitted samples directly from ARI, and will be responsible for performing all the dioxin/furan congener analyses. Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for oversight of all operations, ensuring that all quality assurance/quality control (QA/QC) requirements are met, and documentation related to the analysis is complete and accurately reported. Enforces corrective action, as required.
Analytical Laboratory (ARI and Frontier) Quality Assurance Officer	Monitors the implementation of the laboratory and/or contracted Quality Assurance Plan and the project Work Plan within the analytical laboratory to ensure complete compliance with QA objectives as defined by the contract and in the Work Plan.

Position	Roles and Responsibilities
Data Validation (EcoChem. Inc.) Data Quality Review Manager	EcoChem, Inc. in Seattle, Washington will perform third-party data validation on all analytical data. EcoChem's duties, as managed by the RI/FS Consultant, will be to perform Level III Data Quality Review (Summary Validation) on all analytical data, except dioxins. A Level IV/Tier III Data Quality Review (Full Validation) will be performed for dioxin/furan high resolution data.

Abbreviations:

ARI	Analytical Resources, Inc.
Ecology	Washington State Department of Ecology
Frontier	Frontier Analytical Laboratory
Port	Port of Seattle
QA	Quality assurance
QC	Quality control
RI/FS	Remedial Investigation/Feasibility Study

Table 3.2
Anticipated Field Event Schedule

Activity	Anticipated Start Date	Anticipated End Date	Details
Project startup activities	9/22/09	11/18/09	Project planning, meetings with regulators, finalize Interim Action Work Plan.
TV-type inspection of specific storm drain system segment on-site	11/16/09	11/23/09	Port will conduct TV-type camera inspection of the storm drain system segment between CB5945 and CB4857.
Set up of stormwater monitoring stations	11/23/09	12/11/09	Set up monitoring stations, complete with security housings, water sampling equipment, dedicated grab sampling lines (where applicable) and flow metering.
Conduct 1 to 2 stormwater monitoring events	12/11/09	12/31/09	Conduct initial stormwater sampling at the Lora Lake Apartments Site from three monitoring stations.
Catch basin sediment sampling	1/4/09	1/8/09	Conduct a round of sediment sampling at selected monitoring sites (catch basins) at the Lora Lake Apartments Site.
Cleaning and TV-type inspections of the Lora Lake Apartments Site stormwater systems	1/11/10	1/21/10	Vactor cleaning and washing of the main line and on-site drainage systems. After the drainage systems have been vactored and washed, the Port will conduct TV-type camera inspections of the Lora Lake Apartments Site drainage system.
Installation of sediment traps and collection bottles	1/25/10	1/26/10	Install three in-line catch basin sediment traps (for analysis for stormwater solids) at several pre-selected monitoring locations.

Activity	**Anticipated Start Date**	**Anticipated End Date**	**Details**
Resumption of 8 to 9[1] stormwater sampling	1/27/10	5/21/10	Resume stormwater sampling throughout the wet season and early 2010 dry season. Samples will be collected from the previously established monitoring stations.
Retrieval of sediment trap bottles	5/24/10	5/24/10	Retrieve three sediment trap bottles and prepare these for analysis.
Field stand-down and demobilization	5/25/10	5/31/10	Conduct tasks required to inactivate the stormwater monitoring stations and demobilize any necessary gear.

Note:
1 This table presents the anticipated schedule for the stormwater interim action field events. It is subject to change based on field conditions during the wet season, such as adequate storm events, access to vault interiors, sample quality, and field condition safety.

Table 4.1
Quality Assurance Criteria and Method Reporting Limits

Parameter	Matrix	Units	Reporting Limit/PQL	Precision	Accuracy	Completeness	Reference
Stormwater Samples							
Polycyclic Aromatic Hydrocarbons	Water	µg/L	0.01	±50%	±60%	95%	USEPA Method 8270-SIM-Low Level
Pentachlorophenol	Water	µg/L	0.25	±50%	±60%	95%	USEPA Method 8041
Total Petroleum Hydrocarbons Diesel Range Heavy Oil Range	Water	mg/L	Diesel: 0.25 Oil: 0.50	±50%	±60%	95%	NWTPH-Dx
Arsenic, Total and Dissolved	Water	µg/L	0.2	±20%	±25%	95%	USEPA Method 200.8
Dioxin/Furans	Water	pg/L	5–50	±30%	±30%	95%	USEPA Method 1613
Volatile Organic Compounds Tetrachloroethene Trichloroethene 1,2-Dichloroethane	Water	µg/L	0.02	±50%	±50%	95%	USEPA Method 8260C-SIM

Parameter	Matrix	Units	Reporting Limit/PQL	Precision	Accuracy	Completeness	Reference
Total Suspended Solids	Water	mg/L	1.0	±20%	±25%	95%	SM 2540D
pH	Water	pH units	0.01	±25%	±20%	95%	USEPA Method 150.1
Stormwater Solids and Catch Basin Sediment Samples							
Polycyclic Aromatic Hydrocarbons	Solid/ Sed	µg/kg	20	±50%	±60%	95%	USEPA Method 8270D
Pentachlorophenol	Solid/ Sed	µg/kg	6.25	±50%	±60%	95%	USEPA Method 8041
Total Petroleum Hydrocarbons Diesel Range Heavy Oil Range	Solid/ Sed	mg/kg	Diesel: 5 Oil: 10	±50%	±50%	95%	NWTPH-Dx
Arsenic (As) and Lead (Pb)	Solid/ Sed	mg/kg	As: 5.0 Pb: 2.0	±20%	±25%	95%	USEPA Method 6010
Dioxin/Furans	Solid/ Sed	ng/kg	0.5–5	±30%	±30%	95%	USEPA Method 1613
Volatile Organic Compounds Tetrachloroethene Trichloroethene 1,2-Dichloroethane	Solid/ Sed	µg/kg	1.0	±50%	±50%	95%	USEPA Method 8260C

Parameter	**Matrix**	**Units**	**Reporting Limit/PQL**	**Precision**	**Accuracy**	**Completeness**	**Reference**
Total Solids	Solid/ Sed	%	0.1	±20%	±20%	95%	SM2540B
Total Organic Carbon	Solid/ Sed	mg/kg or %	200 or 0.02	±20%	±20%	95%	Plumb 1981

Abbreviations:

PQL Practical Quantitation Limit
Sed Catch Basin Sediments
SIM Select ion monitoring
USEPA U.S. Environmental Protection Agency

Table 5.1
Description of Catch Basin Type and Control Structures at the Selected Interim Action Sampling Locations

Catch Basin ID	ID Origination[1]	Catch Basin Type	Sample Collection Use	Existing Control Structures
CB-31A	King County	Type II	Inlet stormwater and flow, stormwater solids and sediment	Debris barrier and flow control via weir wall
CB5945	City of Burien	Type II	Outlet stormwater solids (paired with CB4857)	None
CB4857	City of Burien	Type II	Outlet stormwater and flow	None
CB4555	City of Burien	Type II	Outlet (on-site system) stormwater solids and sediment (paired with CB- 1)	Multiple orifice flow control
CB-1	King County	Type II	Outlet (on-site system) stormwater and flow	WSDOT Type II grated vault designed as an overflow structure
CS/CB-19	King County	Type II	Sediment, key node in drainage system	Multiple orifice flow control structure
CB-12	King County	Type II	Sediment, key node in drainage system	Multiple orifice flow control structure

Note:

1 Catch basin IDs used for this project were taken from the nomenclature used by the City of Burien and King County on maps presented in Appendix A, *Lora Lake Apartments Site Surface and Stormwater Drainage System Field Verification Survey Technical Memorandum*.

Table 5.2
Analysis Priority and Composite Sample Volume Required for Stormwater

Analysis Priority	Minimum Volume for Analysis (mL)	Optimum Volume for Analysis (mL)
1. Polycyclic Aromatic Hydrocarbons, Pentachlorophenol	500	1,000
2. Dioxin/furans	1,000	2,000
3. Arsenic	100	500
4. Total Suspended Solids	300	1,000
Total Volume	**1,900**	**4,500**

Table 5.3
Analysis Priority and Sample Volume Required for Sediment and Stormwater Solids

Analyses	Minimum Volume for Analysis (ounces or mL)	Optimum Volume for Analysis (ounces or mL)
1. Dioxin/Furans	8 oz	8 oz
2. Polycyclic Aromatic Hydrocarbons, Pentachlorophenol, Total Petroleum Hydrocarbons (Heavy Oil Range and Diesel Range[1])	4 oz	8 oz
3. Arsenic and Lead	1 oz	4 oz
4. Volatile Organic Compounds (Tetrachloroethene, Trichloroethene, 1,2-Dichloroethane)	120 mL	120 mL
5. Total Suspended Solids and Total Organic Carbon	2 oz	4 oz
Total Volume	**20 oz (120 mL)**	**32 oz (120mL)**

Note:
1 These analyses can be performed with a minimum of one 4-ounce jar.

Table 6.1
Analytical Requirements, Methods, Preservation, Bottle Type, and Holding Times

Sample Type	Analyses	Method	Bottle Type	Preservative	Holding Time
Stormwater Samples	Polycyclic Aromatic Hydrocarbons Pentachlorophenol	USEPA 8270D-SIM-Low Level USEPA 8041	(2) 500-mL amber glass	None, cool to 4˚C	7 days to extract, then 40 to analyze
	Total Petroleum Hydrocarbons—Heavy Oil Range and Diesel Range	NWTPH-Dx	(2) 500-mL amber glass	None, cool to 4˚C	7 days to extract, then 40 to analyze
	Arsenic, Total and Dissolved	USEPA 200.8	(1) 500-mL HDPE	Total Arsenic preserve with HNO_3, Dissolved Arsenic filter and preserve with HNO_3, cool to 4˚C	6 months
	Dioxin/Furans	USEPA 1613	(2) 1-L amber glass	None, cool to 4˚C	1 year
	Volatile Organic Compounds (Tetrachloroethene, Trichloroethene, 1,2-Dichloroethane)	USEPA 8260C-SIM	(3) 40-mL VOA vials	HCl to pH <2, cool to 4˚C, zero headspace	14 days to analyze
	Total Suspended Solids	SM2540D	(1) 1-L HDPE	None, cool to 4˚C	7 days
	pH	USEPA 150.1	(1) 500-mL HDPE	None, cool to 4˚C	Analyze Immediately

Sample Type	**Analyses**	**Method**	**Bottle Type**	**Preservative**	**Holding Time**
Stormwater Solids Samples and Catch Basin Sediment Samples	Polycyclic Aromatic Hydrocarbons Pentachlorophenol	USEPA 8270D USEPA 8041	(2) 8 oz WMG (1) 4 oz WMG	None, cool to 4°C	14 days to extract, then 40 days to analyze (or freeze for 1 year)
	Total Petroleum Hydrocarbons—Heavy Oil Range and Diesel Range	NWTPH-Dx		None, cool to 4°C	
	Arsenic and Lead	USEPA 6010		None, cool to 4°C	6 months
	Dioxin/Furans	USEPA 1613	(1) 8-oz WMG	None, cool to 4°C	1 year
	Volatile Organic Compounds (Tetrachloroethene, Trichloroethene, 1,2-Dichloroethane)	USEPA 8260C	(3) 40ml VOA vials	(2) vials with sodium bisulfate, (1) vial with MeOH, cool to 4°C	14 days to analyze
	Total Suspended Solids	SM2540B	(1) 4-oz WMG	None, cool to 4°C	6 months
	Total Organic Carbon	Plumb 1981		None, cool to 4°C	14 days to prep, then 6 months to analyze (or freeze for one year)

Abbreviations:
SIM Select Ion Monitoring
USEPA U.S. Environmental Protection Agency
WMG Wide-mouth glass jar

Table 7.1
TEFs for Chlorinated Dibenzo-p-Dioxin and Chlorinated Dibenzofuran Congeners[1]

CAS Number	Dioxin Congeners (CDDs)	TEF (unitless)
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	1
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)	1
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)	0.1
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)	0.1
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)	0.1
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.01
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.0003
CAS Number	**Furan Congeners (CDFs)**	**TEF (unitless)**
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)	0.1
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran (1,2,3,7,8-PeCDF)	0.03
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8- PeCDF)	0.3
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF)	0.1
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran (1,2,3,6,7,8- HxCDF)	0.1
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran (1,2,3,7,8,9- HxCDF)	0.1
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran (2,3,4,6,7,8-HxCDF)	0.1
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.01
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)	0.01
39001-02-0	1,2,3,4,6,7,8,9-Octachlorodibenzofuran (1,2,3,4,6,7,8,9-OCDF)	0.0003

Note:

1 2005 World Health Organization Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds (Van den Berg et al. 2006).

Abbreviations:

CDD Chlorinated dibenzo-p-dioxin

CDF Chlorinated dibenzofuran

TEF Toxic equivalency factor

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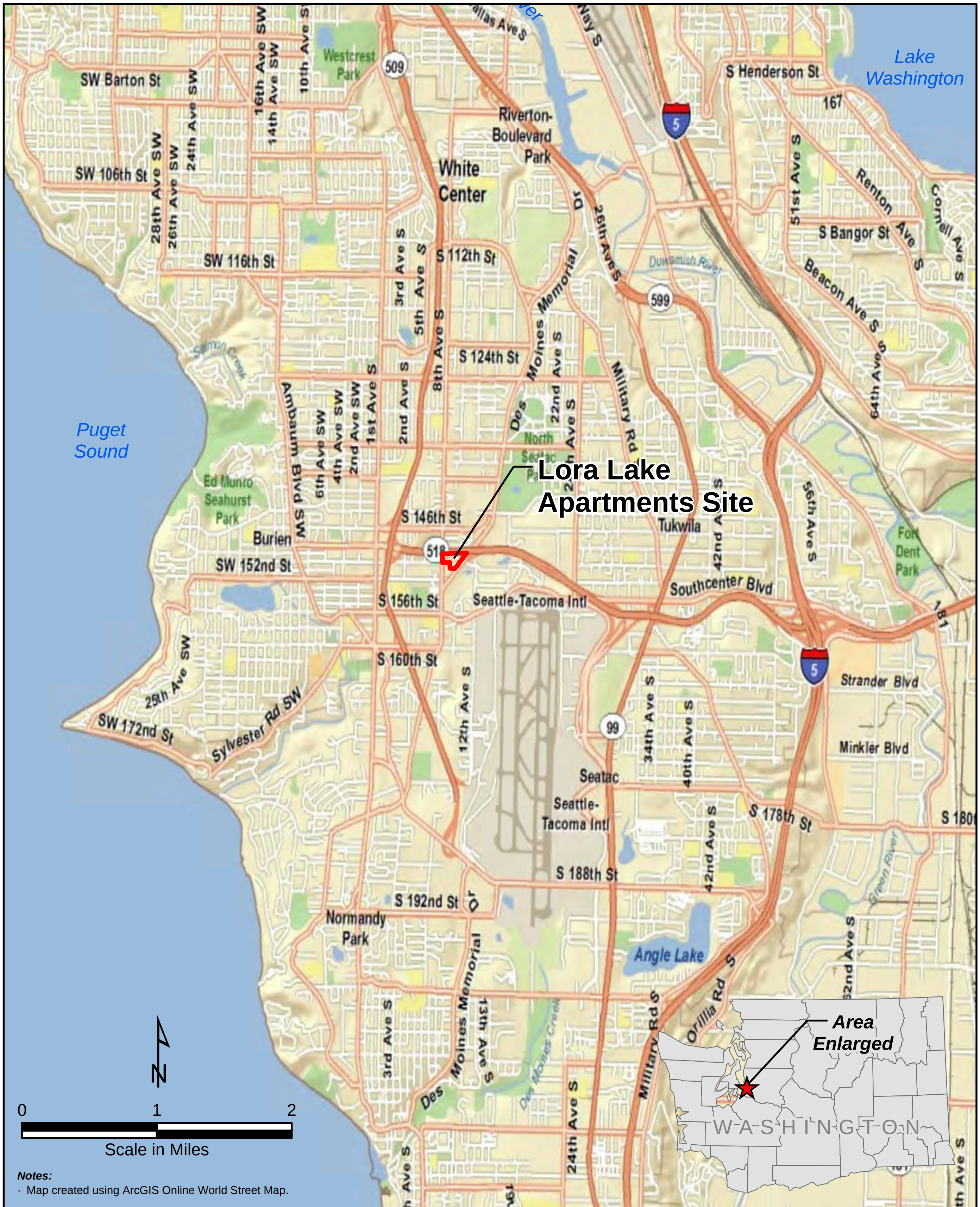
Stormwater Interim Action Work Plan

Figures

FINAL



Notes:
- Map created using ArcGIS Online World Street Map.

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Stormwater Interim Action Workplan** **Port of Seattle** **Lora Lake Apartments** **Burien, Washington**	Figure 1.1 Vicinity Map

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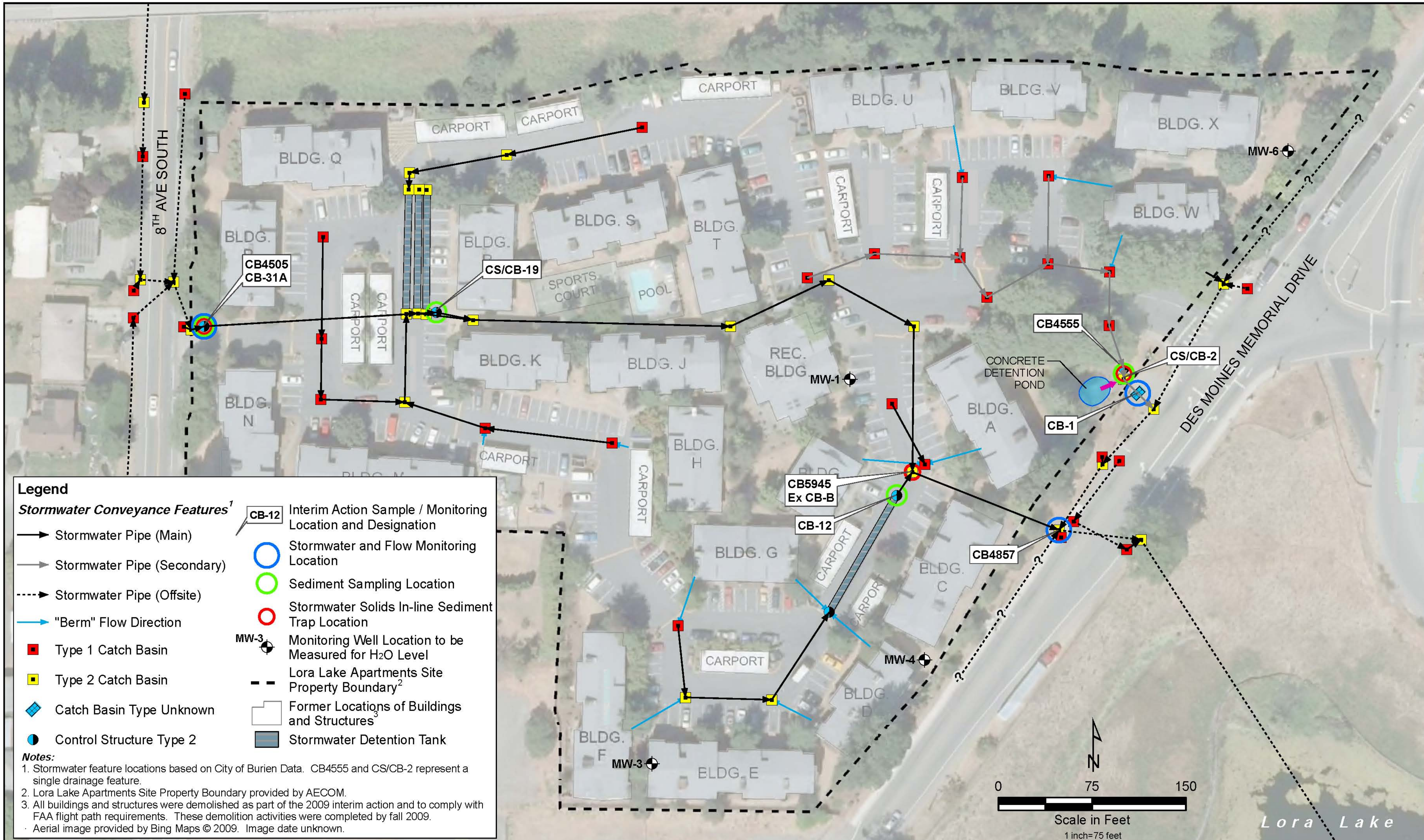

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Stormwater Interim Action Work Plan
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure 5.1
Interim Action Sampling and Monitoring Locations

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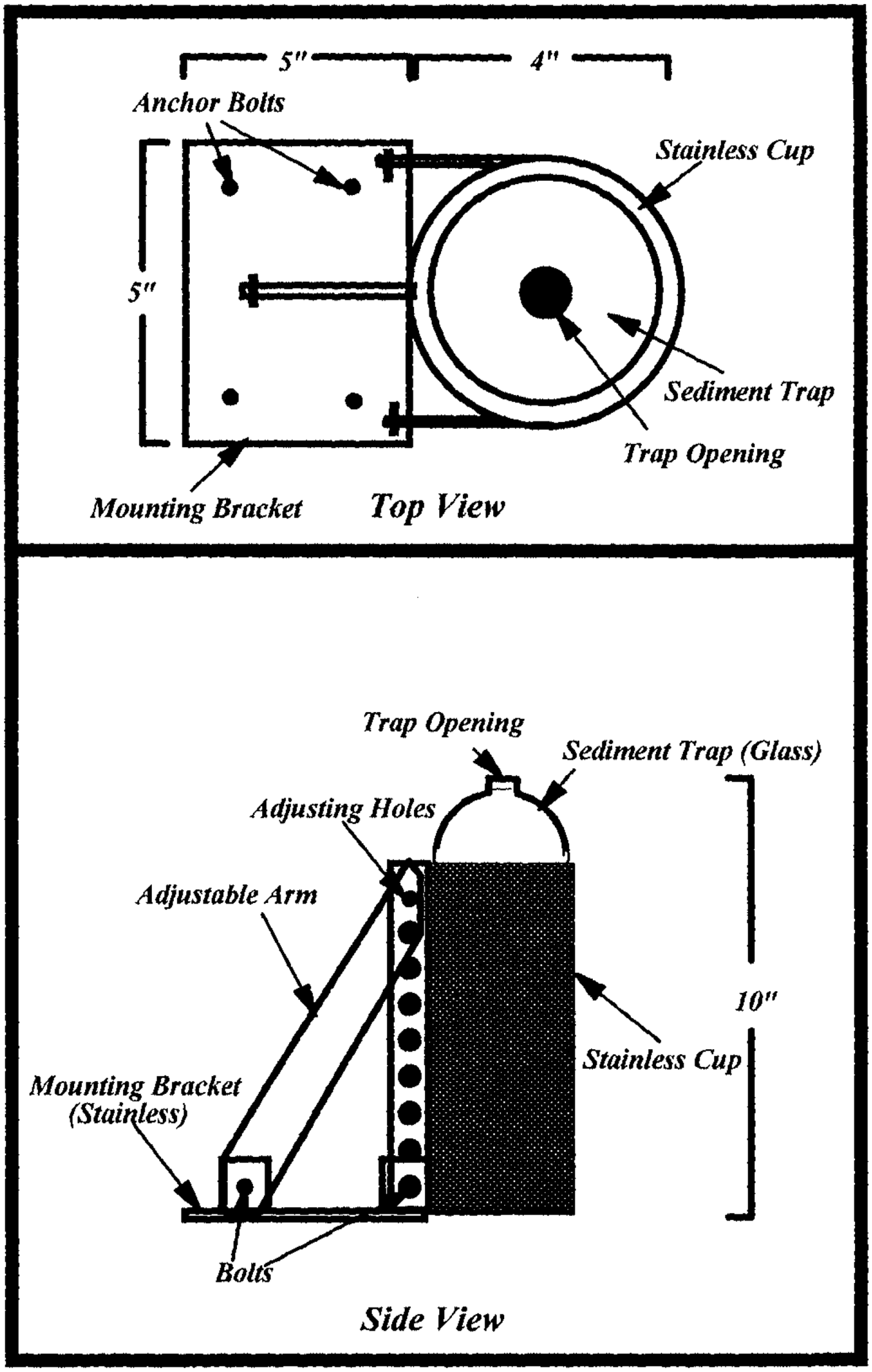

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Stormwater Interim Action Work Plan
Port of Seattle
Lora Lake Apartments
Burien, Washington

Figure 5.2
Details of Typical Stormwater Sediment Trap

Port of Seattle
Lora Lake Apartments

Stormwater Interim Action Work Plan

Appendix A
Technical Memorandum: Lora Lake Apartments Site Surface and Stormwater Drainage System Field Verification Survey

FINAL

Technical Memorandum

Lora Lake Apartments Site

Surface and Stormwater Drainage System

Field Verification Survey

Lora Lake Apartments Site

Final

October 8, 2009

Prepared for:
Port of Seattle
Aviation Environmental Programs
Seattle-Tacoma International Airport

Prepared by:
Taylor Associates, Inc.
Seattle, WA

TAYLOR ASSOCIATES, INC.

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Attachments

LIST OF FIGURES

1. INTRODUCTION

The Port of Seattle (POS) has entered into an Model Toxics Control Act (MTCA) Agreed Order with the Washington State Department of Ecology (Ecology) requiring a remedial investigation (RI) and cleanup of the Lora Lake Apartments (LLA) site. The site is located at 15001 Des Moines Memorial Drive, Burien WA, 98148. Figure 1 shows the LLA site and the surrounding community area.

The subject property has an industrial use history. The land was the site of a barrel washing facility in the 1940s and 1950s and was operated as an auto wrecking yard from the 1960s through the early 1980s. In the mid-1980s, a developer constructed an apartment complex at the site.

The RI of the site is scheduled to begin in the fall of 2009. On August 7, 2009, Ecology notified the Port it has received public comment regarding storm water discharge from the Lora Lake Apartments cleanup site. Based on these comments and other considerations, Ecology decided that sampling of stormwater entering the site's storm drain system is warranted. In preparation for RI planning and field tasks the POS conducted a field verification survey of the surface and stormwater drainage system at the LLA site. The findings from the field verification survey are detailed in this technical memorandum.

2. FIELD VERIFICATION SURVEY OBJECTIVES

The POS instructed Taylor Associates to focus the field verification survey efforts on attaining information regarding the following drainage system attributes:

1. Drainage structures identification and type. These items were confirmed based on figures provided by POS Aviation Environmental Programs,
2. Field locations of the various drainage structures. The positioning of these structures were compared with the figures provided by POS Aviation Environmental Programs,
3. Piping diameters and flow direction. These items were assessed based on direct measurement and observation, and
4. Thickness measurements of the sediment that has accumulated in each drainage system structure. This information was collected through direct measurement.

3. SUMMARY OF FIELD VERIFICATION SURVEY EVENTS

Two field verification surveys of the surface stormwater drainage system were conducted at the LLA. These two survey events were completed over the course of three days, between August 19th through the 21st and during a single day on September 30th, 2009. In all, 56 separate drainage structures were field surveyed during the first 3-day event. Due to the need for clarification of characteristics at several key nodes across the site, a second re-inspection event was conducted. Eleven structures were re-surveyed during the second event. Listed below are details regarding the methods used, survey event results, drainage system configuration information and engineered control structures encountered during the survey events.

4. FIELD VERIFICATION SURVEY METHODS

Each of the mapped (and several un-mapped) drainage structures within the LLA site and several locations adjacent to the property were visited. Field verification survey methods included confirming the identification code and positioning of each structure, checking the drainage structure type verses its listed designation, verifying pipe diameters, assessing flow direction, direct measurements of sediment thickness and sump depth, and noting any additional pertinent observations. These measurements were obtained with the use of steel measuring tapes, a multiple section retractable pole with marked increments and an electronic water level indicator. Standard confined space gear (tripod, winch, 4-gas meter, blower, harness) was used to gain access to the interior of catch basin vaults at several of the survey locations.

During the initial survey event each structure was accessed from the surface by removing either its grated cover or maintenance vault lid/s. All measurements, assessments and observations were made from the surface. During the second survey event several confined space entries were conducted to allow collection of more detailed information at certain key points in the system.

5. FIELD VERIFICATION SURVEY EVENT RESULTS

Identification and feature type (e.g. Type I or Type II catch basin, etc.) was confirmed at 56 structures across the LLA site. Figure 2 shows the City of Burien's map of the site and surrounding areas. The City uses catch basin (CB) designations that start with "CB" followed by a four digit code (e.g. CB4505). Figure 3 shows the King County map of the LLA site. The County uses two to five alpha code followed by a numbered/lettered sequence (e.g. CB-10A, CS/CB-19, AR-19A). Although most of the drainage and flow control structures are represented on both figures, there are certain features that are unique to each map. Therefore it is necessary to present both of these figures to provide a complete inventory of the drainage and flow control structures and features at the LLA site and surrounding area. All of the drainage structures listed in Figures 2 and 3 were visited during the survey events. Each of the 56 drainage structures matched both their location and type as listed on these figures.

Piping that entered each vault was assessed regarding its diameter (at the vault junction only) and its most probable flow direction. The configuration and flow direction of all of the side and main storm drainage lines, as depicted on Figures 2 and 3, were field confirmed. Several catch basin had unmapped 6-inch diameter (green plastic) drain lines attached to their vaults. It was assumed, based on direction and location of surround apartment structures and other surface features, that these were roof or swale/rockery drain lines. Two unmapped drainage structures were noted on the east side of Building N. These structures were not inspected. There was an area of interest along the eastern portion of the site adjacent to CB4857 (Figure 2). This is an area of interest because it is where stormwater leaves the LLA site property and is conveyed to Lora Lake. Figure 2 shows a cluster of drainage structures that are very difficult to discern. Figure 4 shows a close-up view of the area as an inset from Figure 2. Figure 5 provides a field interpretation of this area.

Sediment thickness was measured at each catch basin structure associated with the site. These measurements ranged from no measurable amount (at many locations) to 27-inches at CB31-A (Figure 3). Sediment thickness, as measured at the site catch basins was divided into three categories; less than 6 inches, 6 to 12 inches and greater than 12 inches. Based on this categorization, 57% (32 of 56) of the structures had less than 6 inches of sediment thickness, 34% (19 of 56) of the structures had 6 to 12 inches of sediment thickness and 9% (5 of 56) of the structures had greater than 12 inches of sediment thickness.

All of the collected event data was recorded on catch basin inspection forms, which are included in Attachment A. An overall assessment of the drainage system configuration is presented in the next section.

6. DRAINAGE SYSTEM CONFIGURATION

There are two distinct storm drainage systems at the LLA site. A larger main line, referred to as the “main stormwater line” and a second smaller on-site system referred to as the “on-site” system.

The main stormwater line crosses the site from west to east and conveys water in 24-inch or greater diameter pipes. The on-site system drains only the northeast portion of the site and conveys water in 12-inch or smaller diameter pipes.

The main stormwater line, owned by the City of Burien, enters the LLA site from the west, along 8th Avenue South, at the paired catch basin location CB4505/CB-31 (shown on both Figure 2 and 3) and OWSCB-31A (Figure 3). Various inputs into this main stormwater line from roof and parking lot drains as well as other surface entries occur along its course throughout the site. The main stormwater line system appears as a blue dotted line in Figure 3 and the onsite inputs to the main stormwater line system appear as red and blue solid lines on Figure 3. The main stormwater line exits the eastern side of the LLA site, approximately 100-feet south of the main driveway (South 149th Place) along Des Moines Memorial Drive (DMMD) at catch basin CB4857 (Figure 2). At this point flows from the main stormwater line becomes combined with the flows from the on-site system and co-mingled with roadway runoff from DMMD (see Figure 5).

The smaller, on-site system collects stormwater from surface and roof inputs as well as a small (approximately 20’ x 20’) detention pond (Figure 3). The “detention pond” within the smaller onsite drainage system appears to receive only localized surface drainage and is thought to have functioned more as a landscape feature than a flow-control pond when the apartment complex was in operation. Pipes associated with this onsite system appear as a purple solid line on Figure 3. The collection area for the onsite system is bounded by the area between Building T in the west, Buildings X and Y in the east, Buildings U and V in the north and the main site driveway (South 149th Place) to the south (Figure 3). Stormwater flow from this system enters CB5919/CB-9 (Figures 2 and 3) at its westernmost point and exits in the northeast quadrant of the LLA site at CB-1 (Figure 3) at its easternmost point. Flow from CB-1 is conveyed slightly further east to CB4866/Ex.CB-A (Figures 2 and 3). At this point, the on-site system flow becomes co-mingled with runoff from DMMD. The co-mingled flows are routed south along DMMD, through various structures (see Figure 2) to join the flow coming from the City's main stormwater line at catch basin CB4857 (Figures 2 and 5).

The combined flow from both lines (and the roadway contribution) continues a short distance eastward to CB4854 (Figures 2 and 5). At this point the combined flow crosses beneath the road and transferred to CB4862 (Figure 2), which is on the east side of DMMD. The combined flow then passes through one more vault to the northeast (not listed on either map) before discharging into Lora Lake.

7. ENGINEERED CONTROL STRUCTURES

Various engineered (flow, oil and debris) control structures were encountered at the site along both of the drainage system lines. Several stormwater detention tanks (consisting of 54-inch diameter x 100' to 110'corrugated metal pipes) were installed to provide on-site stormwater flow control and detention in the northwest portion of the site (between AR-21 and CB-20, AR-21A and AR-19B, AR-21B and AR-19A–see Figure 3) and southeast portion of the site (between CB-13 and CB-12–see Figure 3). These detention tanks control onsite stormwater flows into the main stormwater line. In addition to the detention tanks, there are several Type II vaults (OWSCB-31A, CS/CB-19, CB-12 – see Figure 3) (CB4555/CS/CB-2 – Figures 2 and 3) that are outfitted with various types of oil water separator / debris and flow control structures. Ten Type I catch basins (CB5946, CB5952, CB5920, CB4872, CB4871, CB4873, CB4869, CB4870, CB4868 and CB4867) (see Figure 2) were noted to contain passive sediment sock surface filters. The field inspection forms (Attachment A) contains noted observations and drawings pertaining to these control structures.

FIGURES

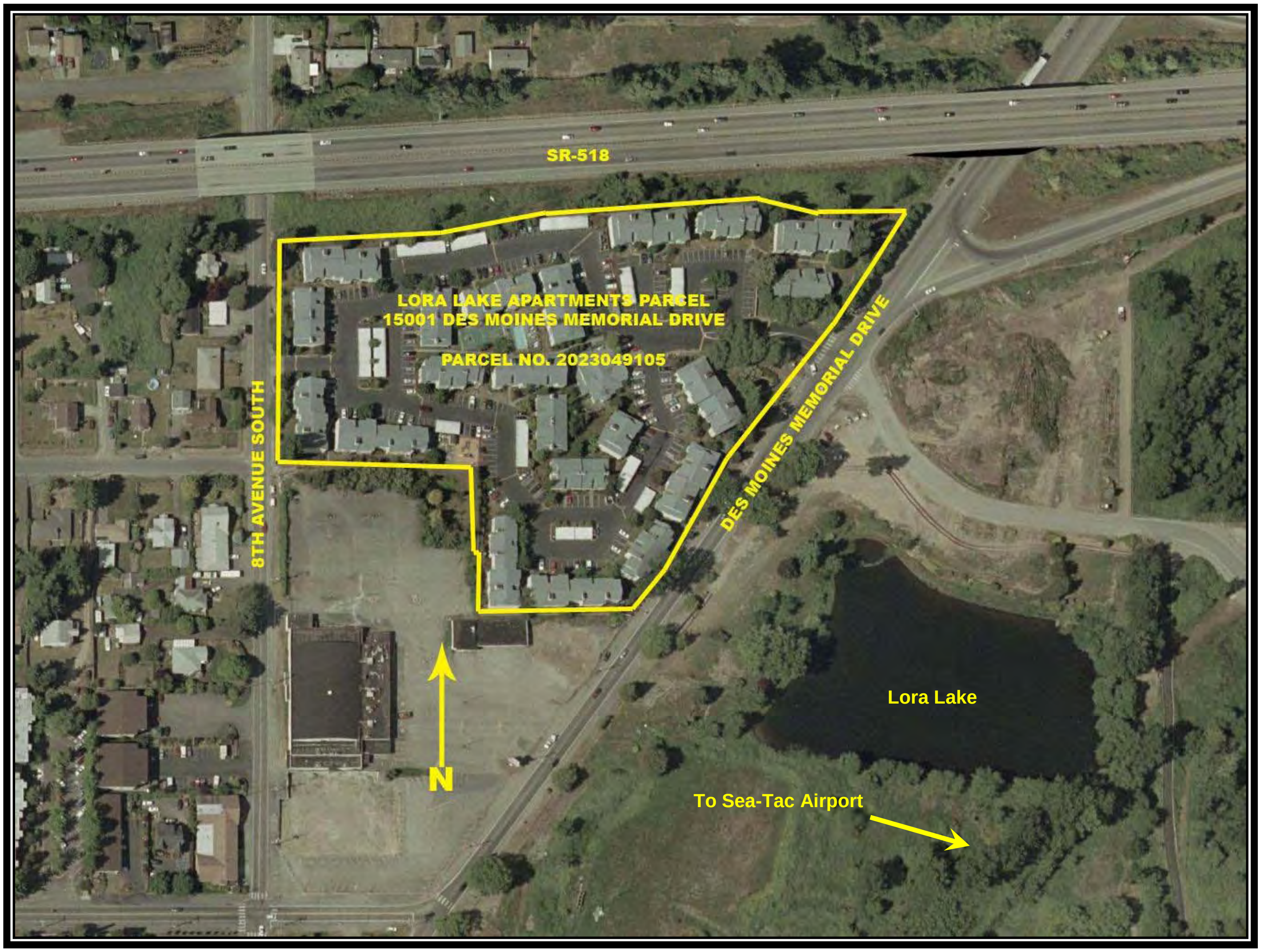


Figure 1. Lora Lake Apartments Site.

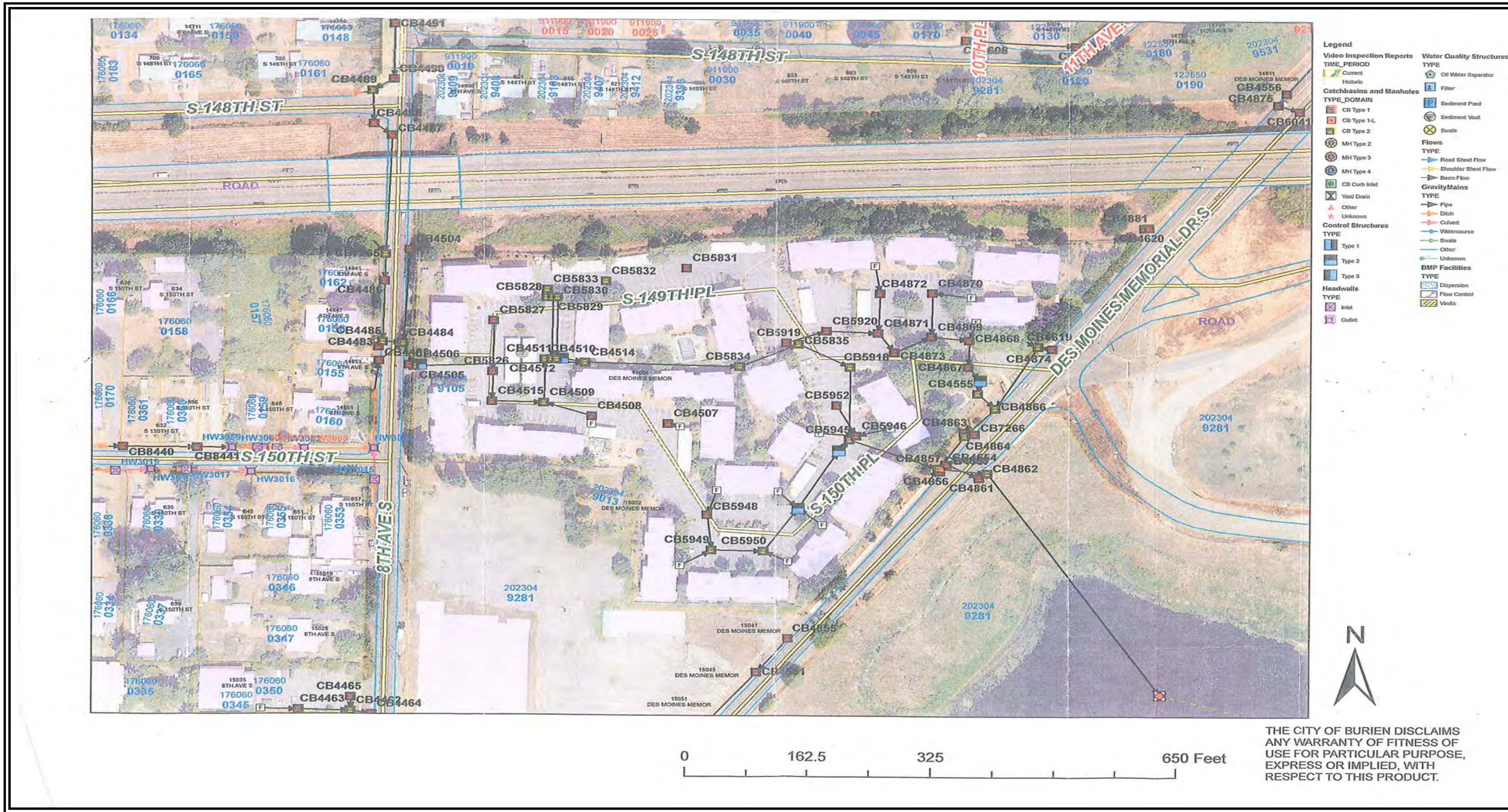


Figure 2. City of Burien Drainage Map with Structure IDs

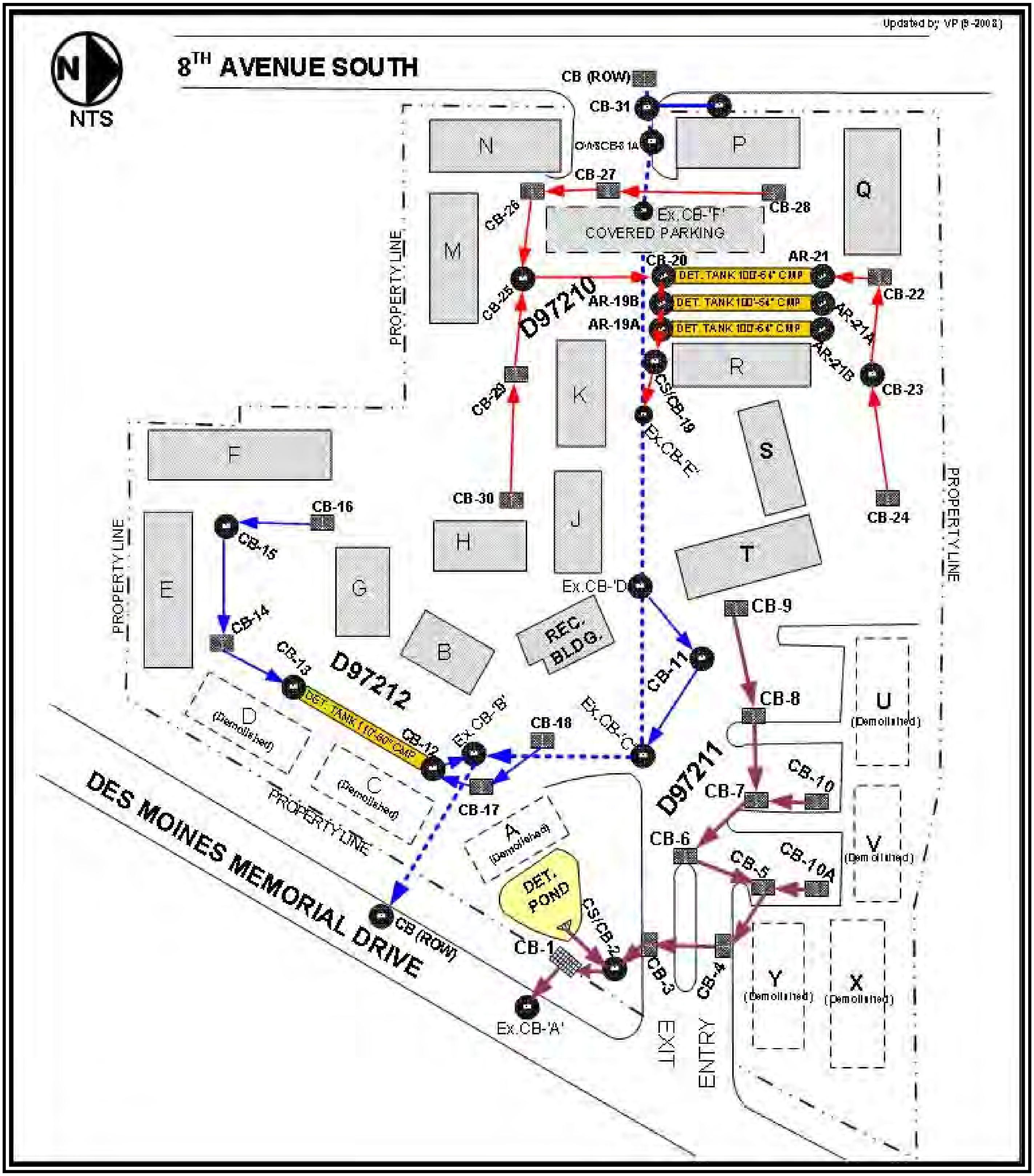


Figure 3. King County Drainage System Schematic

Figure 4. Inset from City of Burien Map, Area of Interest

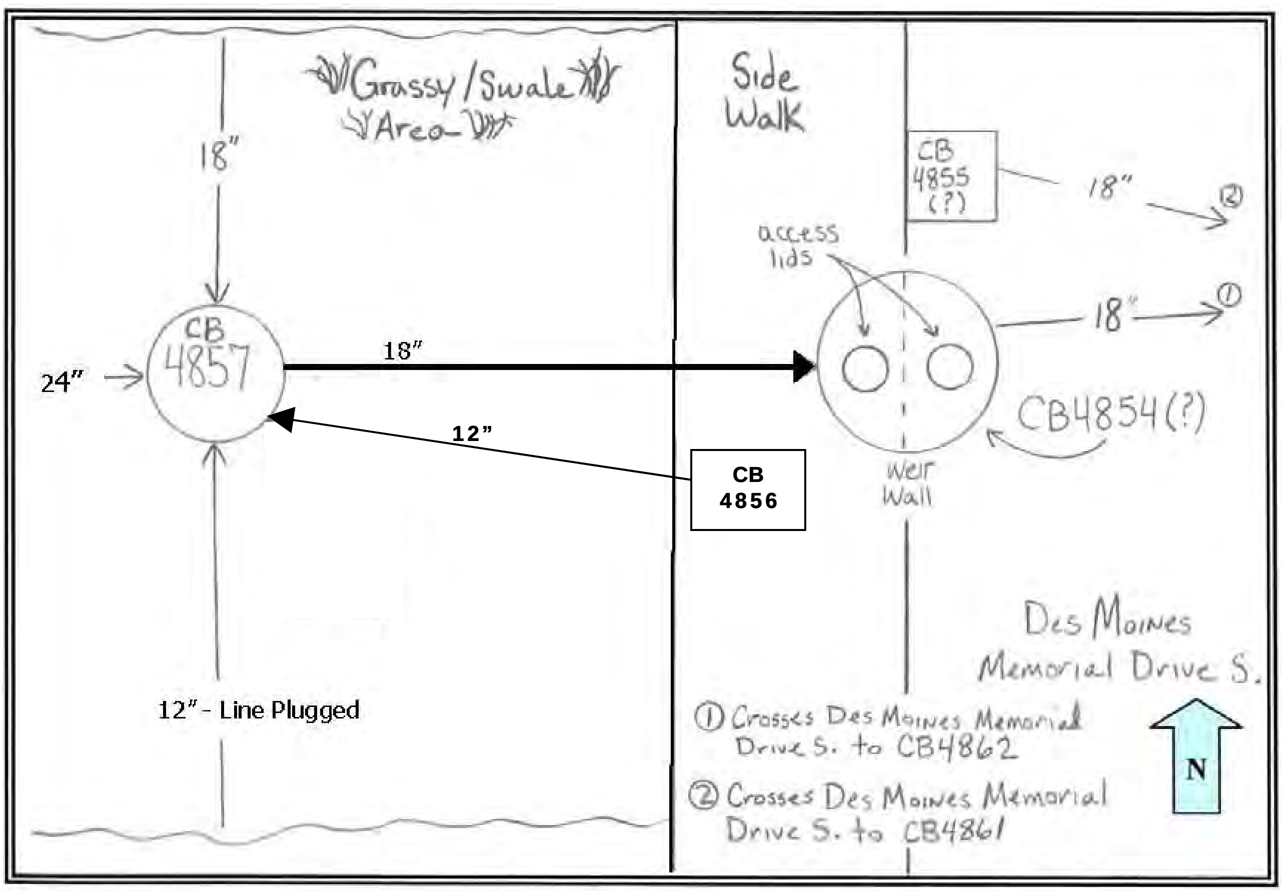


Figure 5. Field Interpretation of Area of Interest

ATTACHMENT A:

FIELD INSPECTION FORMS

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date: 08 / 19 / 2009

Insp. Personnel: D. Metallo, R. Simmons

Weather: Sunny, 80 - 90°, lite N. breeze

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
5831 /CB24	Type I	6"/N 6"/SE	12"/W	~4	19.5"	sed. is very fine grain & mucky, no odor SE inlet is likely roof drains * N inlet input unknown
5832 /CB23	Type II	6"/S 12"/E	12"/W	~6	1.54'	coarser grain sed., vault ~4' dia.
5833 / CB22	Type II	12"/E [illegible]	12"/S	~2"	0.86'	coaser grain sed; listed as Type II but seems to be a deeper (26"x22") Type I
5828 /AR-21	Type II	12"/N	4'/S	NA	NA	vault contains large CMP that passes to the south no other inlet or outlet noted, access lid westernmost of 3
5830 AR-21A	Type II	None noted/observ.	4'/S	~1-2"	NA	vault contains a 4' cmp that passes to the south, no apparent inlet (?) access lid middle of 3
5829 AR-21B	Type II	none observed	4'/S	2"-4"	NA	vault contains 4' cmp that passes to the south, no inlet observed vault bottom has sed + various debris,
5827 / CB-28	Type I	6"/N	12"/S	4-6"	18"	Type I vault 22"x26", coarse sed.,
5826 /CB27	Type I	12"/N	12"/S	~2"	21"	coarse sed., 22"x26" footprint
4484	Type II	12"/N 36"/W	36"/S	~2"	~2"	foul decay odor, 18" opening, on sidewalk, No STIA Enviro designation
4506 / CB-ROW	Tpye I	Surface grate	12"/E	~6"	~14"	CB in gutter, east side of 8th Ave S, collects surface drainage only

General Notes: Manhole cover listed as "SEWER" south of 5833, ~12'; 5829 is easternmost of 3 manhole lids

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date:	8/19/09
Insp. Personnel:	D. Metallo, R. Simmons
Weather:	Sunny, clear, 80-90°s, lite breeze

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
* 4505 / CB-31	Type II	12"/W 36"/N 6"/SE	36" E	~1-2"	level w/ invert	~7' surface to invert, 18" dia opening, this location seems to be the inlet to the site drainage system
UN #'ed / OWSCB-31A	Type II	32"/W	UNK	27"	~85" to weir top	Flow control strux., vault seperated by weir wall, trash-debris-sed-water on u.s. side of weir
Ex. CB-F	UNK	~32(?)/W	~32(?) E	~1-2"	109" to invert	circular column (18") from surface to invert, loc. is on STIA map but not on CoBurien Map, east of Build P.
CB 4512 / CB-20	Type II	10"/SE	~48-52" /N	lamination ~~None noted~~	level w/ invert	loc. is the southern end of CMP detention tank, surface grate
4511 / AR-19B	Type II	UNK	~48-52" /N	lamination ~~None noted~~	level w/ invert	loc is the southern end of CMP detention tank, 24" solid MH lid, 7'-8" invert to surface
4510 / AR-19A	Type II	UNK	~52"/N	~1"	level w/ invert	loc. is southern end of CMP detention tank, 24" solid lid, 8' invert to surface
UN #'ed CS/CB-19	Type II	~~[illegible]~~ ~48"/W	~24" riser w/ 2 elbows	~12-14"	water depth 52"	flow control strux w/ 2 elbow inputs (2 diff. heights) into main riser, sed. was v. mucky
4514 / Ex. CB-E	UNK	~~~48"~~ 36"/W ~16"/W	~36"/E	~1"	11'-1" surface to invert	circular column (18") from surface down to lower 36" pipe
4515 / CB-26	Type I	12"/N 6"/SW	12"/E	~2"	12"	sed. is "firm-compacted"
4509 / CB-25	Type II	12"/W 12"/ESE	12"/N	~1-2"	40"	18X24" grated cover, 8' surface to invert

General Notes: * 4505 = likely input to site drainage system; (2) drainage strux's (one circular, one w/ hinged louvered) that exist in front (E) of Build N that are not on any maps - not insp.'ed

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date:	08/19/2009
Insp. Personnel:	D. Metallo, R. Simmons
Weather:	Sunny, clear, 80-90°'s, lite breeze

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
4508 / CB-29	Type I	6"/N 6"/S 12"/E	12"/W	~6"	12"	grated cover 18X24", compacted-firm sed.
4507 / CB-30	Type I	6"/ENE	12"/W	~1"	13"	grated cover 18X24", mucky sed., water in sump to invert of outlet pipe
* 4862	Type	See Description Pg #6				east side of Des Monies Mem. Drive, bolted cover
CB5948 / CB-16	Type 1	6"/NE	12"/SW	4"	11"	22"x15" grate cover, water in sump
CB5949 CB-15	Type 2	6"/SW 12" CMP/N ~~12" CMP/E~~	12" CMP/E	~6"	26"	water in sump 22X15 grate
CB5950 CB-14	Type 2	12" CMP/W 12" CMP/NE	6" PVC/SSE	~6"	10"	Outlet pipe smallest at bottom 2 large inlet above Top photo N. 15x22 grate water in sump
A CB-13	Type 2	6" PVC/WNW 12" CMP/SSW 6" PVC/E 2"/NNE	52" CMP/N	6"	24"	water in sump, 22x18 grate 5 pipes, Top of ~~photo~~ to N
B CB-12	Type 2	12" CMP/N	52" CMP/S	6"	46 1/2"	Round lid CMP elbow down, Photo Top to N. Vertical pipe (12") with 2 elbow's. Water in sump, 25" lid
CB5945 EX. CB-B	Type 2	24" CMP/N 6-8"/S	24" CMP/ESE	No Sed.	10"	gravel at bottom, water in sump 24" Round lid No sed, just loose gravel.

General Notes:

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date: 8/20/09

Insp. Personnel: R. Simmons, S. Matthews

Weather: Sunny 70's clear, light Breeze

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
CB5946 CB-17	Type 1	12" Cmp /N 6" PVC ~~WNW~~ 6" PVC / ESE	12" Cmp/ ~~WSW~~ SSW	6"	14"	4 pipes 4P spent sock, Photo to N, 22x15 grate tubing & equipment installed. water in sump, removed sock
CB59~~15~~52 CB-18	Type 1		12" cmp/S	6"	13"	Sed. sock full water in sump one pipe 22x15 grate, removed sock
CB5920 ~~CB5918~~ CB-8	Type ~~2~~ 1	12" Cmp /ESE	12" cmp/WSW	6"	12"	Sed sock full, water in sump 22x15 grate, removed sock
CB 5918 Ex CB-C	Type 2	24" cmp/S 2" /ESE	30" cmp WNW		1"	30" little lower than 24" 3 lengths to measure sed, 25" Round lid, water in sump no sed accumulated
CB5835 CB-11	Type 2	24" cement /W	24" Cent/ESE	4"	13"	Cement Pipe, 3 lengths to measure Sed, 25" Round lid photo top to N, water in sump.
CB 5919 CB-9	Type 1	6" PVC/W	12" cmp /E		1"	Water in sump 22x15 grate Dry Bottom
CB5834 Ex CB-D	Type 2	12" cmp / WNW	30" Cement/ E	—	6"	Round lid 25", 3 lengths, water in sump hard bottom, over 15' deep
C		4" PVC W 6" PVC ENE				Corner of Bld T Both pipes 15" from Dry Bottom - not on any map
CB4872 /CB-10	Type I	6"/N	12"/S	None (water)	12"	6" inlet line likely roof drain, surface grate, 18X24" removed filter sock
CB 4871 CB-7	Type I	12"/N 12"/W	12"/S	~2"	11"	grated cover (18X24") - removed filter sock

General Notes:

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date: 08/21/2009
Insp. Personnel: D. Metallo, R. Simmons
Weather: Cloudy, lt. drizzle, 60-70°s

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
CB 4873 / CB-6	Type I	12"/NW	12"/E	~3"	12"	grated cover, 18X24", removed filter sock
CB 4869 / CB-5	Type I	12"/N 12"/W	12"/E	~1"	11"	grated cover, 18"X24", removed filter sock
CB 4870 / CB-10A	Type I	6"/NE	12"/S	4"	14"	grated cover, 18"X24", removed filter sock
CB4868 / CB-4	Type I	6"PVC/ENE 12"/W	12"/SSW	4"	14"	grated cover, 18X24", removed filter sock
* CB4867 CB-3	Type I	12"/N	12"/S	4"	12"	grated cover, 18X24", removed filter sock last Type I before water leaves the site
** CB 4555 CS/CB-2	Type II w/ control	12"/NW 6"PVC/W	12"/S	~12"	~48"	"Drain" MH solid lid (24"), vault has flow/backflow control - stand pipe mechanism (direction unk)
CB-1	~~Type II~~ Type II	12"/N	12"/E	~1"	24"	47"X 26" grated cover, appears on POS map but Not on City figure
CB 4866 / Ex CB-A	Type II	18 or 12"/N 12"/W	12"/S	~6-8"	UNK	18" MH cover, dry interior of vault, location collect both road + apt. Flows
CB 4863	Type I	10 or 12"/N	~6"/E	6"	6"	loc. not on POS map, grated cover (18X24"), loc. could collect surface sed. runoff
CB 4864	Type II	12"/W 12"/N	12"/S	~6" or more	~6"	loc. not on POS map, hard packed sed - true depth unk 18" solid MH cover

General Notes: ** CB4555 could facilitate compliance sampling of upper/NW-most complex specific storm drain line

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date:	08/21/2009
Insp. Personnel:	D. Metallo, Ro Simmons
Weather:	Overcast, breezy, 60-70°s

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
CB7266	I	—	—	—	—	ROW road side CB - not influencial to LLA system
CB4857	Type II	~32"/WSW ~18/N ~24/S	~32"/~~SE~~ NE 12"/SE	undeter. but >6"	undeter.	18" grated circular lid, flow directions of the 18 & 24" inlets ~~an~~ are v. likely as listed but not confirmed
						This loc. is where the main City line leaves the property, although this loc. comingles site drainages & possibly (likely)
						an off-site (road ??) input coming from the south
4856	Type I	surface grate	12"/NW	~3"	~18"	flows from vault to 4857
4854 (?) Inlet	Type II w/ weir	~24"/SW	weir wall spill over	10-12+"	~36"	~~too Id~~ Loc. Id. diff. to discern from City fig. - not on POS map. Inlet side contains debris & sed. input from 4857
4854 (?) outlet	Type II w/ weir	weir wall spill over	~18"/ENE	12+"	~36"	flow heads from vault across DMM drive, both inlet & outlet are 24" circular solid lids w/ 18" center access
4855 (?)	Type I	surface/roadway	~18"/ENE	6-8"	~14"	ROW CB, road drain, 18X24" grated cover, road drain only, no LLA input, flows across DMM drive to ROW CB 4861
4861	Type I	18"/W + surface drainage	18"/N	~4"	~9"	ROW CB connected to 4855(?), outlet to north does not seem to be directly connected to 4862
4862	Type II	30 or 24"/WNW 12"/N 12"/SW[1] 4"/E	24 or 30" /NE	~2"	~2"	[1] may be inactive, outlet heads to another vault in fenced area to the east before flowing into Lora LK

General Notes:

[1]Measured from invert of sump to invert of outlet pipe

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date: 09-30-09

Insp. Personnel: D. Metallo, B. Kwasnowski

Weather: Sunny, clear, lt. breeze, 60's

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
CB-31 CB-4505	Type II	24" N 8" E 6" ESE	24" E	varied, several inches covering vault bottom	No Sump	This vault collects surface + stormwater flows from various directions and types (including roadway, roof, and other offsite properties). This is the entrance point for the main stormwater line to the LLA property. Water quality, stormwater ~~sediment~~ solids or sediment could be collected at this site. However, a more advantageous location for this monitoring would be at the next SW strux downstream (CB-31A, no CoBurien designation)
CB-31A OWSCB	Type II	24" W	24" E	west half = 2 to 2.5' east half = UNK	4'	Water + debris on west side is 48" down from the top of the weir wall (which is 3" below inlet pipe invert). Water on east side of weir wall is level (or 1 to 2" below) w/ outlet pipe invert. There is likely a sluice hole/s at some depth below water line on west side of weir wall. This weir wall sluice hole is at or below the invert of the outlet pipe. The invert of the outlet pipe acts as the flow control point for the CB-31A vault.

Findings + Proposed Use of Vault to Monitor SW; Sed + Flow:

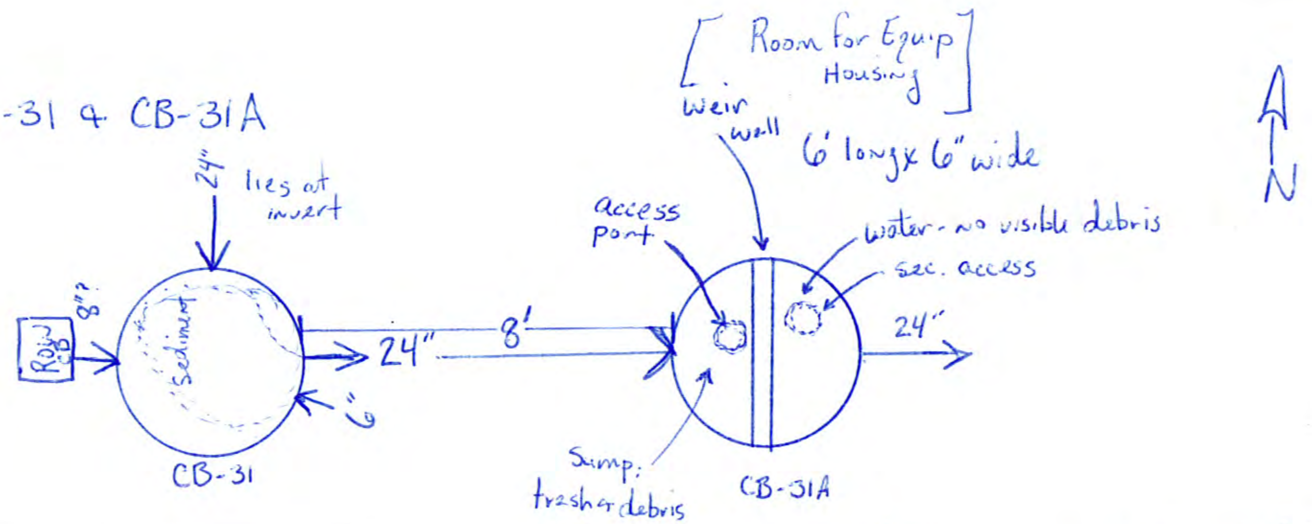
- Could use an A-V sensor place at the invert of the outlet pipe to meas. flow + to enable the sampler.
- Would sample SW from the east side of weir wall - this is the total combined flow entering the site.
- Discovered an access lid over top of the ~~ea~~ east side of the vault - dug this out of planter area

General Notes:

- Stormwater solids would be collected from the west side of the vault.

[1]Measured from invert of sump to invert of outlet pipe

CB-31 & CB-31A


Room for Equip Housing
Weir wall
6' long x 6" wide
24" lies at invert
access port
water - no visible debris
sec. access
ROW CB
8"?
Sediment
24"
8'
6"
24"
Sump: trash & debris
CB-31
CB-31A
N

TAYLOR ASSOCIATES, INC.

Port of Seattle - SeaTac International Airport
Lora Lake Apartments RI/FS Catch Basin Inspection Form

Date: 09-30-09

Insp. Personnel: D. Metallo, B. Kwasnowski

Weather: Sunny, clear, lt. breeze, 60°s

CB #	CB Type	Inlet Pipe Size / Direction	Outlet Pipe Size / Direction	Sediment Thickness (in)	[1]Sump Depth (in)	Observations:
CB-19	site has multi-level flow control strux					Re-checked for access concerns/logistics Sediment sampl. station - could be collected from surface
CB-12						Re-checked for access/logistics, sediment only loc, can be sampled from surface, vault has multi-level flow control strux
Ex. CB-B 5945				0-1"	140" total to vault rim	Insp. SW solids loc. - No sed in vault, ~2" sump not 10" as previously reported
CB-11 5835				4-6"	18' invert to vault rim	alternate SW solids site
CS/CB-2 4555	- if utilized, would be for SW + SWS only					Outside of perimeter fence, water in vault 2-3" below inlet invert (even w/ invert of clean out window on the control strux)
CB-1	Type II	12" NNW	12" ESE			Could do all monitoring here (SW, SWS + flow)
CB4619	Type II	12" WSW cmp 8" ENE cmp	18" S concrete	4-6" covers vault bottom	~2"	4' dia vault, 4' from rim to invert, 18" x 22" effective grated opening
~~Ct~~						8" inlet is from a ROW CB
CB4874	Type I	Surface collection only	8" cmp WSW			18x24" grated roadway CB
CB4857	Type II	Surface grate 24" W cmp 12" N cmp	18" ENE CMP	4-8" in sump	inlet/outlet @ invert	12" S (inlet) choked w/ 7" (increasing in depth to the south) sediment

General Notes:

12" S conc.
(this line clogged w/ sed)
12" CMP E (from ~~ROW~~ sidewalk CB)

[1]Measured from invert of sump to invert of outlet pipe

Port of Seattle
Lora Lake Apartments

Stormwater Interim Action Work Plan

Appendix B
Field Forms

FINAL

Field Forms

Lora Lakes Apartments Stormwater Interim Action - Stormwater Sampling — **Taylor Associates, Inc.**

Station: ____ **4 x 1 gallon bottle set-up** Page:___of___ (pages per station)

Section 1. Storm Setup and Inspection

Personnel:	Weather:		Arrival Date/Time:		
Carry-over maintenance to do prior to set-up:				done?	
Sampler Battery Voltage		Changed? Y N		New voltage	
Flow Meter Battery Voltage		Changed? Y N		New voltage	
Flowmeter		**Sampler**			
Date/time correct? (Yes/No)		Pump Tubing OK?			
Flowmeter cables OK? (Yes/No)		Pump Tubing Replaced? (Yes/No)			
Desiccant Canisters OK (Yes/No)		Sample Tubing & Strainer OK?			
Flow Meter Level (in)		Backflushed with DI?			
Actual level Reading (in)		Suction line & quick connect attached?			
Difference (in)		Clean bottles installed & lids off?			
Level calibrated? (Yes/No)		Diagnostics/Distrubutor arm check?			
Velocity (fps)		Enable Level (in)*			
Flow Rate (cfs)		Pacing Rate (cf)*			
Data Downloaded (Yes/No)		Program Reviewed? (Yes/No)			
Channel conditions/observations		Sampler "Running"...			
		Ice Deployed? (Yes/No)			
		* NA unless directed by Storm Controller			
Notes:					

Section 2. Grab Sample Collection/ Initial Station Check

Personnel:	Weather:	Arrival Date/Time:	
Grab Sample Data		Sample Observations:	
Runoff Present?			
Grab Collection Time (date/time)			
Grab Sample Bottle ID			
Grab Duplicates Collected?			
Grab Blank Collected?			
VOA trip blank in cooler?			
Internal Flowmeter		**Sampler**	
Flowmeter cables OK? (Yes/No)		Equipment running correctly?	
Flow Data Downloaded & Reviewed? (Y/N)		Composite Begin Time (date/time)	
Notes:		On Composite... (Bottle #/ Aliq #)	
		Ice deployed?	
		Sampler Battery Voltage (Changed?):	
		Bottle Swap needed? (if yes fill out Section 3)	

Section 3. Mid-Storm Check/Bottle Switch

Personnel:	Weather:	Arrival Date/Time:	
Composite Begin Time (date/time)		**Round #:**	
Last Aliquot Taken (date/time, bott #, aliq #)		Data downloaded?	
Comp Bottles Labeled? (Sta. & date)		Sampler Battery Voltage (Changed):	
Comp Sample Volume Collected		Ice deployed?	
Aliquots missed/NLD (date/time/bott #/aliq #) continue on back if needed			
Channel conditions/observations			
Notes/Maintenance Needed:			

Taylor Associates, Inc. — LLA Stormwater Field Sheet

Lora Lakes Apartments Stormwater Interim Action - Stormwater Sampling

Taylor Associates, Inc.

Station:

Page:___of___
pages per station

Section 4. Mid-Storm Check/Bottle Switch			
Personnel:	Weather:	Arrival Date/Time:	
Composite Begin Time (date/time)			Round #:
Last Aliquot Taken (date/time, bott #, aliq #)		Data downloaded?	
Comp Bottles Labeled? (Sta. & date)		Sampler Battery Voltage (Changed):	
Comp Sample Volume Collected		Ice deployed?	
Aliquots missed/NLD (date/time/bott #/aliq #) continue on back if needed			
Channel conditions/observations			
Notes/Maintenance Needed:			

Section 5. Comp Sample Collection/Post Storm			
Personnel:	Weather:	Arrival Date/Time:	
Sampler Battery Voltage		Changed? Y N	New voltage
Modem Battery Voltage		Changed? Y N	New voltage
Composite Begin Time (date/time)			Round #:
Last Aliquot Taken (date/time, bott #, aliq #)			
Comp Bottles Labeled? (Sta. & date)		Data downloaded?	
Comp Sample Volume Collected			
Aliquots missed/NLD (date/time/bott #/aliq #) continue on back if needed			
Channel conditions/observations			
Notes/Maintenance Needed:			

Section 6. QC Sampling			
Personnel:___________________			
Field Blank Collected? (date/time)		Duplicate comp sample? Yes/No	
Blank id:		Duplicate sample ID	
Notes:			

Taylor Associates, Inc.

LLA Stormwater Field Sheet

Lora Lake Apartments
Stormwater Interim Action

SEDIMENT TRAP INSTALLATION AND RETRIEVAL

Station	
Name:	Manhole/CB #:
Location Description:	
Sediment Trap Installation	
Personnel	Date/Time
Weather	
Mounting type: pipe wall other	Notes:
Pipe: concrete brick metal other	
Pipe condition: cracked eroded smooth other	
Pipe diameter (in):	
Sketch of Area	Sketch of MH
Photo #	Description
#	
#	
General Notes	
Sediment Trap Retrieval	
Personnel	Date/Time
Weather	
Sample ID:	
Sample time:	Bottle labeled?
Approx volume of sed in bottle:	water only <1/4 1/4-1/2 1/2-3/4 >3/4 4/4
Clean bottle put in trap?	Lid off? Screws tightened?
Notes:	

TAYLOR ASSOCIATES, INC.

Lora Lake Apartments **SEDIMENT GRAB SAMPLE COLLECTION FIELD SHEET**

Stormwater Interim Action

Personnel ______________________ Date/Time ______________________

Weather

Station					
Name:			Manhole/CB #:		
Location Description:					
Access:					
Traffic control:	cones	worker signs	lane closure	flaggers	none
Sediment Grab Sample	Sample ID:				
Sample time:	Bottles labeled?				
Sediment Present? Approx depth?					
Water Present? Approx depth?					
Water flowing? Stagnant?					
Sed. color: brown, black, grey, yellow, red, mottled	Sed. odor: petroleum, pungent, sewage, earthy, salty				
Sed. sheen: none, some, lots	Sed. consistency: gravelly, sandy, silty, clayey, organic				
Notes:	% of sample removed (particles ≥ 2 cm):				
General Notes and photos	**Sketch**				

Chain of Custody Record & Laboratory Analysis Request

Port of Seattle

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

ARI Assigned Number:	Turn-around Requested:	Date:	
ARI Client Company:	Phone:	Page:	of
Client Contact:		No. of Coolers:	Cooler Temps:
Client Project Name:			
Client Project #:	Samplers:		

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested								Notes/Comments

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name:	Printed Name:	Printed Name:	Printed Name:
	Company:	Company:	Company:	Company:
	Date & Time:	Date & Time:	Date & Time:	Date & Time:

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.