TERMINAL 115 BERTH 1
ENVIRONMENTAL SAMPLING AND COMPLIANCE MONITORING
P-033136307
PORT OF SEATTLE
6700 W MARGINAL WAY
SEATTLE, WA

RECONTAMINATION STUDY FOR T-115
WORK PLAN

March 2010

Prepared for:
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ACRONYMS AND ABBREVIATIONS

Columbia	Columbia Analytical Services Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSL	Cleanup Screening Levels
dw	dry weight
DQI	data quality indicators
DQO	data quality objective
Ecology	Washington Department of Ecology
ECD	electron capture
EDD	electronic data delivery
EPA	United States Environmental Protection Agency
HSP	Health and Safety Plan
kg	kilogram
LAET	lowest apparent threshold
2LAET	second lowest apparent threshold
LCS	laboratory control standard
LCSD	laboratory control standard duplicate
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LDWG RI	LDWG Phase II Remedial Investigation
LEL	lower explosive levels
LPAH	low molecular weight polycyclic aromatic hydrocarbons
HPAH	high molecular weight polycyclic aromatic hydrocarbons
HRCG/HRMS	High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry
GC/MS	gas chromatography/mass spectrometry
LVI	large volume injection
MDL	method detection limit
mg	milligrams
MRL	minimum reporting limit
MS	matrix spike
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
RL	reporting limits
RPD	relative percent difference
SAP	sampling and analysis plan

SEE	Science and Engineering for the Environment, LLC
SMS	Sediment Management Standards
SOP	standard operating procedures
SPU	Seattle Public Utilities
SQS	Sediment Quality Standards
SVOC	semi-volatile compounds
TEC Inc.	TEC
TOC	total organic carbon
TPH	total petroleum hydrocarbons

APPROVAL PAGE

TERMINAL 115 RECONTAMINATION STUDY WORK PLAN

	SIGNATURE	DATE
Port of Seattle Jon Sloan	______________________	______________
Science and Engineering for the Environment, LLC. Tim Thompson, Project Manager	______________________	______________
TEC Inc. Brian Rupert, Field Investigation Manager/ Field Health and Safety Coordinator	______________________	______________
TEC Inc. Rich Tremaglio, Task Manager	______________________	______________

1.0 INTRODUCTION

This Recontamination Study Work Plan (Work Plan) describes procedures for collecting and processing of storm drain sediment samples from the storm drain systems at the Port of Seattle's Terminal 115 (T-115) that drain into Berth 1. This work is being conducted by TEC Inc. (TEC) and Science and Engineering for the Environment, LLC (SEE) on behalf of the Port of Seattle (the Port). This project will collect and analyze sediment trap and sediment grab samples from the storm drain systems that discharge directly adjacent to Berth 1 at Terminal 115. The resultant data may subsequently be used to evaluate the potential for recontamination of the clean sand cover placed on the maintenance dredged area in Berth 1.

T-115 is located at 6700 West Marginal Way Southwest in the City of Seattle on the west bank of the Duwamish River (Figure 1). The site is situated in the Joint Model Toxics Control Act (MTCA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Lower Duwamish Waterway Group (LDWG) Superfund Site (Port of Seattle 2009).

Project Organization

Project personnel and quality assurance (QA) responsibilities related to execution of the Recontamination Study are listed in Table 1 below:

Table 1 Project Organization

NAME	ROLE	CONTACT INFORMATION
Tim Thompson SEE	Project Manager	4401 Latona Ave NE Seattle, WA 98105 206.418.6173 tthompson@seellc.com
Brian Rupert TEC	Field Investigation Manager / Field Health and Safety Coordinator	1450 114th Ave SE Suite 220 Bellevue, WA 98004 Phone: (425) 453-4040 bwrupert@tecinc.com
Rich Tremaglio TEC.	Task Manager	1450 114th Ave SE Suite 220 Bellevue, WA 98004 Phone: (425) 453-4040 ratremaglio@tecinc.com
Jeff Christian Columbia Analytical Services	Laboratory Project Manager	1317 South 13th Avenue Kelso, WA 98626 Phone: (360) 577-7222
Mingta Lin Pyron Environmental, Inc.	Data Validation Manager / QA Manger	3530 32nd Way, NW Olympia, WA 98502 Phone: (360 867-9543 mingta_lin@comcast.net

Project Manager: Tim Thompson is the Project Manager. He is ultimately responsible for coordinating with the Port and team members to implement the components of this Work Plan including:

- Interacting with the Port of Seattle and T-115 personnel as needed;
- Budget and schedule control;
- Providing guidance for project staff regarding technical issues/concerns; and
- Review of activities conducted under this task for concurrence with contract requirements and, as necessary, recommending and verifying corrective actions.

Field Operations Leader/Health and Safety Manager: Brian Rupert is the Task Field Investigation Manager/Field Health and Safety Coordinator. He is responsible for health and safety aspects of all project activities and ensures compliance with the Health and Safety Plan (HSP). He is also responsible for implementation of this work plan as related to field activities. In summary, his responsibilities include:

- Reviewing, approving, and administering the procedures contained in the HSP;
- Recommending corrective actions and verifying implementation of corrective actions as needed;
- Directing the field implementation of the Work Plan and ensuring compliance with all Standard Operating Procedures (SOPs) as defined in this Work Plan; and
- Identifying deviations from the Work Plan, if any, recording deviations in the field notebook, and reporting deviations to the QA Manager.

Task Manager: Rich Tremaglio at TEC Inc. is the Task Manager for the Recontamination Study. He is responsible for coordinating with the Port of Seattle, the Task Field Investigation Manager/Field Health and Safety Coordinator and the Project Manager to implement the components of this Work Plan including:

- Senior technical review of plans and deliverables;
- Providing guidance for project staff regarding QA issues/concerns; and
- Act as second point of contact for the Port.

Laboratory Project Manager: Jeff Christian at Columbia Analytical Services, Inc. (Columbia) is the Laboratory Project Manager. He is responsible for the successful and timely completion of sample analyses, as well as the following:

- Ensuring that samples are received and logged into the laboratory tracking system correctly, that correct analytical methods and modifications are used, and that data are reported within specified turnaround times.
- Reviewing analytical data to ensure that procedures are followed as required in this work plan and samples are analyzed and reported according to the required methods and laboratory standard operating procedures.
- Keeping the QA Manager and task manager apprised of the schedule and status of sample analyses and data package preparation.

Data Validation Specialist/Quality Assurance Manager: Mingta Lin at Pyron Environmental, Inc. is the project data validation specialist. He is responsible for:

- Validating the laboratory data,
- Communicating any data quality issues to the task and project managers,
- Working with the analytical laboratory to correct any data quality issues as needed; and
- Working closely with the task manager to ensure that the objectives of this Work Plan are met.

Schedule

The schedule for the Recontamination Study is presented below. Details for activities described in the schedule are detailed in Sections 3 though 10 of this Work Plan. The Recontamination Study for T-115 initially is planned to have two sets of sediment traps deployed, one in the second half of 2010, and one in the first half of 2011.

Table 2 Schedule

Activity	Schedule
Recontamination Study Work Plan (Task 5.10)	
Development of draft Work Plan	2/1/2010
Finalization of Work Plan	4/1/2010
Site reconnaissance for sampling locations	1/26/2010
Sample Collection and Processing (Task 5.20)	
Installation of Round 1 sediment traps and collection of grab samples	Tentatively April 2010 depending on tidal conditions and weather
Inspections of Round 1 sediment traps	2 months and 4 months after installation (approximately May/June 2010 and July/August 2010)
Collection of Round 1 sediment trap and grab samples and installation of Round 2 sediment traps.	6 months after installation (approximately end of September, 2010)
Inspections of Round 2 sediment traps	2 months and 4 months after installation(approximately November/December 2010 and February/March 2011)
Collection of Round 2 sediment trap samples and removal of in-line sediment mounts	6 months after installation (approximately end of March/Early April 2011)
Chemical analysis and validation (Task 5.30 and 5.31)	
Samples analysis	Complete by 5/31/2011
Data validation	Complete by 6/30/2011
Technical Memo (Task 5.40)	
Technical memo.	8/15/2011 (draft); 10/15/2011 (final)

Training

SEE/TEC field staff will be current on required health and safety training. This includes confined space entry training (29 CFR Part 1910.146), Hazardous Waste Operations and Emergency Response (29 CFR 1910.120), and training related to personal protective equipment. Additionally, SEE/TEC field team members will be proficient in collecting field samples and will follow SOPs as required by the Work Plan for the collection of storm drain sediment grab samples and installation of sediment traps.

Laboratory personnel will meet all training requirements set forth by the National Environmental Laboratory Accreditation Program. Laboratory personnel training will also include Washington State Department of Ecology (Ecology) laboratory accreditation requirements. Laboratory SOPs are available by request.

Personnel performing the data review and data validation should demonstrate broad and in-depth ability in analytical procedure compliance and data quality evaluation. As a minimum requirement, at least 10 years of professional training directly related to the laboratory procedures, analytical protocols, and analytical data reporting plus 5 years of hands-on data validation experience is expected (SPU 2009).

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2.0 PROJECT DESCRIPTION, SITE DESCRIPTION AND BACKGROUND

The Port is conducting construction activities at the Berth 1 facilities at T-115, including the removal of the existing wooden Pier B, fabrication of a new loading ramp, maintenance dredging to re-establish adequate depth to accommodate barge loading and unloading, and placement of a clean sand cover over dredged residuals. The U.S. Environmental Protection Agency (EPA) articulated a request that the Port "sample catch basins to address the potential for recontamination" in a letter dated March 17, 2009, addressed to the Lower Duwamish Waterway Working Group (LDWG). The LDWG consists of the Port, King County, the City of Seattle, and the Boeing Company The EPA requested the study under the authority of the Lower Duwamish Waterway Administrative Order on Consent (EPA/Ecology 2000). The Port agreed to coordinate the work requested by the EPA due to its interest in moving forward with maintenance dredging and other improvements proposed in Berth 1.

The Port developed and submitted to the EPA a draft scope for a T-115 Berth 1 Recontamination Study dated May 20, 2009. That draft scope specified, amongst other things, that the Port, together with the City of Seattle (the City):

- Develop a comprehensive utility map for the area and identify crucial data gaps in drainage utilities;
- Combine known information on existing sampling data, drainage utility maps, and land use to identify data gaps in storm drain sediments to address their potential to recontaminate T-115 "Berth 1" dredged and "clean-covered" area;
- Provide a plan to the EPA/Ecology summarizing existing information and identifying sampling to fill data gaps (this Work Plan);
- Sample and analyze storm drain sediments, and provide a report compiling the existing and new data, and noting any further data gaps to be filled; and
- Combine both post dredge cover monitoring data and storm drain sediment information in a report addressing recontamination issues at T-115 "Berth 1".

This Work Plan is intended to summarize the existing data, identify data gaps, and describe the sampling and analysis procedures that will be used to address data gaps.

The project will focus on collecting storm drain sediment from drainage basins that discharge stormwater to areas adjacent to the dredge and clean cover area at Berth 1 at T-115 (Figure 2). These data will be combined with data to be collected as part of the Sand Cover Monitoring Plan for Terminal 115 to assess the potential sources for recontamination of the cover.

Site Description

T-115 consists of approximately 70 acres of upland yard space that supports marine uses such as receipt and shipment of bulk cargo, barge cargo operations, repair and maintenance of cargo shipping containers, cargo warehouse activities, storage of metal and wood construction materials, and vessel outfitting, maintenance and repair.

In 2007 the LDWG published the Draft Phase II LDW Remedial Investigation (RI) Report. LDW outfall locations were identified as part of the LDWG RI, including those along the shoreline of T-115 (LDWG 2007). According to the LDWG RI, the shoreline adjacent to T-115 stretches approximately from south of river mile 1.5 to river mile 2.0[1]. In this area, all stormwater drains generally flow from West Marginal Way Southwest, east toward the LDW. The Recontamination Study area will be limited to the drainage areas of the four outfalls that discharge directly to the clean sand cap for the Berth 1 dredged area (Figure 2).

[1] For the purposes of this work plan, river miles indicated herein are those same as those used by LDWG. River mile 0 is at the southern end of Harbor Island

For the purposes of the Recontamination Study, the outfalls and drainage areas will be labeled using the labels from the LDWG RI. Drainage areas will simply be named "Drainage Area 2220" (etc.). Figure 2 shows the location of the stormwater outfalls and approximate extent of stormwater drainage systems including catch basins and manholes serving T-115 as listed in Table 3.

Table 3 Stormwater Outfalls

Outfall (listed by LDWG RI ID)[(a)]	City of Seattle Outfall Designation	Size[(b)]	Outfall Type[(b)]
2220	SWD3	24 inch concrete	Port Storm Drain
2123	SWD2	12 inch corrugated metal	Port Storm Drain
2125	SWD1	72 inch concrete	Highland Park Way SW Storm Drain
2124	Unlabeled-adjacent to SWD1	18 inch concrete lined iron	Port Storm Drain

Notes:
a) Outfall numbers taken from LDWG 2007, Map 9-6c.
b) Information from LDWG 2007b, Appendix H

Anecdotal evidence suggests that the storm drain outfalls located on T-115 are tidally influenced. High tides result in the storm drain system being flooded or nearly flooded while low tides result in the partial or complete emptying of the storm drain systems. The extent of the tidal influx into the storm drain system is unknown at this point. During the field reconnaissance on 26 January 2010, at least ten manholes or catch basins were opened and observed to be inundated, presumably with tidally-fluxed river water, and one manhole had at least ten feet of standing water.

Summary of Existing Data

The following documents pertaining to T-115 were reviewed to establish the site history and determine the adequacy of existing data:

- "Lower Duwamish Waterway Remedial Investigation Draft" Phase II by Lower Duwamish Waterway Group July 3, 2003. (http://yosemite.epa.gov/R10/CLEANUP.NSF/LDW/Technical+Documents)
- "Lower Duwamish Waterway Remedial Investigation Draft" Phase II by Lower Duwamish Waterway Group November 5, 2007. (http://yosemite.epa.gov/R10/CLEANUP.NSF/LDW/Technical+Documents)
- "Lower Duwamish Waterway Source Control Action Plan for Glacier Bay Source Control Area" by Washington State Department of Ecology. November 2007. (http://www.ecy.wa.gov/pubs/0709005.pdf)
- "Lower Duwamish Waterway Highland Park SD: source samples" map by City of Seattle. Date Unknown (included as Figure 3 of this Work Plan).
- "Lower Duwamish Source Control Status Reports" by Ecology. (multiple reports http://www.ecy.wa.gov/programs/tcp/sites/lower_duwamish/source_control/sc.html)
  - September 2008 to June 2009
  - April 2008 to August 2008
  - July 2007 to March 2008.

Analytical Data

SPU installed two sediment traps, HP-ST4 and HP-ST6, (Figure 3) in the Highland Park Way SW storm drain in 2008. Both sediment trap samples and grab samples of inline sediment have been collected. SPU also collected a sample from catch basin CB91 on T115 (see Figure 3). Locations HP-ST4 and HP-ST6 tie into the storm drain system that traverses T-115 and discharges at outfall location 2125 (Figure 2) (SPU 2008).

Preliminary analytical results from the September 2008 and March 2009 samples are presented in Table 4. Analyses for the sample include polychlorinated biphenyls (PCB), semi-volatile organic compounds (SVOC), metals, total organic carbon (TOC), grain size and diesel range total petroleum hydrocarbons (NWTPH-Dx) (Analytical Resources, Inc. 2008).

Table 4 Preliminary Results* from SPU

Station ID	HP-ST4	HP-ST6	CB91	HP-ST4	HP-ST6
Date	09/10/08	09/25/08	5/31/06	03/12/09	04/15/09
Sample type	Inline	Inline	Catch basin	Trap	Trap
Total solids (%)	86.6	20.3	65.30	68.9	35.6
Total organic carbon (%)	0.708	6.64 J	6.33	8.93	7.53
Metals (mg/kg)					
Arsenic	7	30	40 U	8 U	30
Copper	36.3	144	697	42.4	145
Lead	19	150	70	70	148
Mercury	0.04 U	0.26	0.06 U	0.07 U	0.34
Zinc	184	876	1,720	228	779
Total petroleum hydrocarbons (mg/kg)					
TPH-diesel	89	230 U	8,100 J	280	1,200
TPH-oil	540	470 U	6,900 J	1,600	4,800
LPAH (ug/kg dw)					
Acenaphthene	39 U	59 U	82,000	93 U	160 U
Acenaphthylene	39 U	59 U	2,300	93 U	160 U
Anthracene	39 U	59 U	95,000	93 U	160 U
Fluorene	39 U	59 U	99,000	93 U	160 U
Naphthalene	39 U	59 U	13,000	93 U	160 U
Phenanthrene	34 J	190	970,000	58 J	370
HPAH (ug/kg dw)					
Benzo(a)anthracene	34 J	130	130,000	93 U	160
Benzo(a)pyrene	37 J	150	57,000	93 U	160 U
Benzo(b)fluoranthene	66	240	90,000	93 U	190
Benzo(g,h,i)perylene	39 U	140	18,000	93 U	160 U
Benzo(k)fluoranthene	45	180	52,000	59 J	180
Chrysene	55	290	160,000	72 J	280
Dibenz(a,h)anthracene	39 U	59 U	8,900	93 U	160 U
Fluoranthene	110	380	890,000	93	620
Indeno(1,2,3-cd)pyrene	39 U	98	18,000	93 U	160 U
Pyrene	81	400	650,000	110	450
Phthalates (ug/kg dw)					
bis(2-ethylhexyl)phthalate	290	4,500	3,500 U	7,300	4,000
Butylbenzylphthalate	39 U	570	3,900	420	400
Diethylphthalate	39 U	59 U	740 U	93 U	160 U
Dimethylphthalate	39 U	72	740 U	93 U	160 U
Di-n-butylphthalate	39 U	69	740 U	93 U	160 U
Di-n-octyl phthalate	310	220	740 U	91 J	160 U
PCBs (ug/kg dw)					
Aroclor 1016	19 U	20 U	19 U	20 U	20 U
Aroclor 1221	19 U	20 U	19 U	20 U	20 U
Aroclor 1232	19 U	20 U	19 U	20 U	20 U
Aroclor 1242	19 U	20 U	19 U	20 U	20 U
Aroclor 1248	19 U	20 U	19 U	20 U	40
Aroclor 1254	19 U	20 U	19 U	22	30
Aroclor 1260	19 U	20 U	19 U	20 U	20 U
Total PCBs	19 U	20 U	19 U	22	70
Other organic compounds (ug/kg dw)					
1,2,4-Trichlorobenzene	39 U	59 U	740 U	93 U	160 U
1,2-Dichlorobenzene	39 U	59 U	740 U	93 U	160 U
1,3-Dichlorobenzene	39 U	59 U	740 U	93 U	160 U
1,4-Dichlorobenzene	39 U	59 U	740 U	93 U	160 U

Station ID Date Sample type	HP-ST4 09/10/08 Inline		HP-ST6 09/25/08 Inline		CB91 5/31/06 Catch basin		HP-ST4 03/12/09 Trap		HP-ST6 04/15/09 Trap	
Other organic compounds continued										
2,2'-Oxybis(1-chloropropane)	39	U	59	U	740	U	93	U	160	U
2,4,5-Trichlorophenol	200	U	300	U	3,700	U	460	U	790	U
2,4,6-Trichlorophenol	200	U	300	U	3,700	U	460	U	790	U
2,4-Dichlorophenol	200	U	300	U	3,700	U	460	U	790	U
2,4-Dimethylphenol[a]	39	U	59	U	740	U	93	U	160	U
2,4-Dinitrophenol	390	U	590	U	7,400	U	930	U	1,600	U
2,4-Dinitrotoluene	200	U	300	U	3,700	U	460	U	790	U
2,6-Dinitrotoluene	200	U	300	U	3,700	U	460	U	790	U
2-Chloronaphthalene	39	U	59	U	740	U	93	U	160	U
2-Chlorophenol	39	U	59	U	740	U	93	U	160	U
2-Methylnaphthalene	39	U	59	U	14,000		93	U	160	U
2-Methylphenol[a]	39	U	59	U	740	U	93	U	160	U
2-Nitroaniline	200	U	300	U	3,700	U	460	U	790	U
2-Nitrophenol	200	U	300	U	3,700	U	460	U	790	U
3,3'-Dichlorobenzidine	200	U	300	U	3,700	U	460	U	790	U
3-Nitroaniline	200	U	300	U	3,700	U	460	U	790	U
4,6-Dinitro-2-methylphenol	390	U	590	U	7,400	U	930	U	1,600	U
4-Bromophenyl-phenylether	39	U	59	U	740	U	93	U	160	U
4-Chloro-3-methylphenol	200	U	300	U	3,700	U	460	U	790	U
4-Chloroaniline	200	U	300	U	3,700	U	460	U	790	U
4-Chlorophenyl-phenylether	39	U	59	U	740	U	93	U	160	U
4-Methylphenol[a]	39	U	59	U	740	U	3,400		160	U
4-Nitroaniline	200	U	300	U	3,700	U	460	U	790	U
4-Nitrophenol	200	U	300	U	3,700	U	460	U	790	U
Benzoic acid[a]	390	U	590	U	7,400	U	930	U	1,600	U
Benzyl alcohol[a]	39	U	430		740	U	93	U	160	U
bis(2-Chloroethoxy) methane	39	U	59	U	740	U	93	U	160	U
bis(2-Chloroethyl) ether	39	U	59	U	740	U	93	U	160	U
Carbazole	39	U	59	U	22,000		93	U	160	U
Dibenzofuran	39	U	59	U	58,000		93	U	160	U
Hexachlorobenzene	39	U	59	U	740	U	93	U	160	U
Hexachlorobutadiene	39	U	59	U	740	U	93	U	160	U
Hexachlorocyclopentadiene	200	U	300	U	3,700	U	460	U	790	U
Hexachloroethane	39	U	59	U	740	U	93	U	160	U
Isophorone	39	U	59	U	740	U	93	U	160	U
Nitrobenzene	39	U	59	U	740	U	93	U	160	U
n-Nitroso-di-n-propylamine	200	U	300	U	3,700	U	460	U	790	U
n-Nitrosodiphenylamine	39	U	59	U	740	U	93	U	160	U
Pentachlorophenol[a]	200	U	300	U	3,700	U	460	U	790	U
Phenol[a]	39	U	72		740	U	190		160	U

Notes
- * Source: Seattle Public Utilities
- a Sediment trap sampling round (0 = initial grab collected when trap installed)
- dw dry weight
- LPAH low molecular weight polycyclic aromatic hydrocarbons
- HPAH high molecular weight polycyclic aromatic hydrocarbons
- TPH Total Petroleum Hydrocarbons

Qualifiers: (Analytical Resources Inc. 2008)
- J Estimated concentration when the value is less than reporting limit
- U Target analyte not detected at the reported concentration

Table 5 Grain Size Information

Station ID	HP-ST4	HP-ST6	HP-ST4	HP-ST6
Date	09/10/08	09/25/08	03/12/09	04/15/09
Sample type	Inline	Inline	Trap	Trap
Gravel	82.1	0.1	18.7	0.3
Very coarse sand	10.7	2.1	18.9	2.4
Coarse Sand	3.4	5.4	20.1	3
Medium Sand	1.2	8.7	19.6	6.4
Fine Sand	0.3	12.7	11.6	3.9
Very fine sand	0.1	7.8	4.8	5.5
Coarse Silt	1.7	7.7	1.8	21.1
Medium Silt	0.1	16.5	2.2	13.6
Fine Silt	0.1	14.4	1	13.3
Very fine silt	0.2	11.4	0.7	9.4
8-9 Phi Clay	0.1	3.7	0.3	6.9
9-10 Phi Clay	0.1 U	2.9	0.2	4.8
> 10 Phi Clay	0.1	6.6	0.3	9.4
Total Fines	2.3	63.3	6.3	78.5

Units = percent by weight.

Existing Flow Data

Flow data for the four outfalls being sampled are unavailable. According to on-site personnel interviewed 26 January 2010, sheet flow runoff from storm events flows down the hill west of West Marginal Way Southwest and occasionally forces closures of the road due to flooding.

Data Gaps

Data from one storm drain sediment grab sample is all that is available for sediment samples in the vicinity of T-115 (Table 4) and conflicting information exists regarding location, number, and nature of the storm drainage system on T-115. In addition, data gaps and unknowns include:

- Impact on schedule cause by tidal influence that may prevent field personnel entering storm drains to deploy tramps and collect samples
- Tidal effects on storm drain sediment trap sample accumulation rates.
- The hydraulic gradient of the storm drain system and the resulting influence on the particulate size and quantity of sediment captured in traps.
- The effect of manhole and storm drain fabric liners (installed to intercept sediment and debris prior to entry of the storm drain) on sediment accumulation rates in sediment taps and the availability of inline sediment deposits in the 2220, 2123, and 2124 drainages.
- The effect of additional off-site flow from surrounding neighborhoods on the quality and quantity of sediment entering drainage area 2125.

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3.0 DATA QUALITY OBJECTIVES

The intent of this project is to collect sufficient sediment samples to evaluate the potential of storm drain sediments to recontaminate Berth 1 dredged area clean sand cover. The overall data quality objectives (DQOs) for this project are to collect data of known and acceptable quality to support the evaluation of recontamination for the placed cover at Berth 1 of T115.

Specific DQOs will be evaluated in terms of data quality indicators (DQIs) including: precision, accuracy (bias), completeness, representativeness, sensitivity, and comparability. Control criteria are set forth for each of the DQIs in this work plan to ensure that data collection throughout the course of this project is at the same level of quality and usability. DQIs are described in detail in Section 7, Measurement Data Quality Control.

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4.0 SAMPLING DESIGN

This Work Plan utilizes SOPs for collecting of storm drain sediment samples that were developed by SPU. It also incorporates, where appropriate, the SOPs developed for stormwater sediment sampling by the Ecology (SPU 2008b, Ecology 2009). Storm drain sediments are expected to provide a more direct measure of the potential for recontamination and are generally more cost effective to collect than stormwater samples (SPU 2009).

Four drainage areas discharge to the LDW adjacent to Berth 1(Figure 2). Five sampling locations have been identified that were selected to isolate specific drainage sub-basins or entire drainage basins. Proposed sample locations are also shown on Figure 2.

Site Reconnaissance for Sediment Trap Location

Due to the requirements for installing successful sediment traps as defined in Ecology and SPU SOPs, site reconnaissance was performed to identify locations that not only met the requirements for sediment trap locations, but also allowed access and were protective of health and safety. Ideal locations require minimum travel of the field team members through confined spaces, but also have the potential to have sufficient stormwater flow to produce samples with sufficient storm drain sediment for analysis. Reconnaissance was performed prior to issuance of the draft version of this Work Plan to identify sampling locations. Proposed sampling locations are shown on Figure 2.

Sampling Locations

Locations for deploying sediment traps will be finalized at the time of installation. Initial site reconnaissance indicates acceptable locations for sediment traps are:

1. The stormwater drain pipe man hole immediately up-gradient of the outfall 2220 – Location ID T115-2220A;
2. The stormwater drain pipe catch basin immediately up-gradient of the outfall 2123 – Location ID T115-2123A;
3. The stormwater drain pipe catch basin immediately up-gradient of the outfall 2124 – Location ID T115-2124A;
4. The stormwater drain pipe catch basin where drainage from the north end of the 2125 drainage area converge with the main 2125 drain line – Location ID T115-2125A; and
5. The stormwater drain pipe catch basin located where the stormwater drainage lines from the off-site flow converge to flow towards the outfall 2125 - Location ID T115-2125B (Figure 2).

Sediment trap placement will take into account the following criteria (Ecology 2009, SPU 2008):

- Wherever possible, traps will be mounted in quiescent areas (e.g., maintenance holes and vaults) to maximize sample collection. Sampling locations will be selected to avoid small diameter pipes (e.g., less than 24-inch diameter) because a large storm event is generally needed in these systems to inundate the approximately 8-inch tall sample bottle;
- Traps will be placed in pairs if possible to collect more sediment; and
- If base flow is present, bottles should be installed with the mouth just above base flow line.

Two SOPs are provided for installation of sediments traps, Ecology's SOP for Collection of Stormwater Sediments Using In-Line Sediment Traps (Appendix B) and SPU's SOP Water & Sediment Quality C3100 – In-line Sediment Traps (Appendix C).

All sampling locations are assumed to be confined spaces. During work at sampling locations, all procedures related to confined space entry will be followed including but not limited to the following:

- Visually observe conditions of the confined space (e.g., means of access, physical size);
- All sampling locations will be required to have physical means of access for the field team members under their own power (e.g., a ladder into the manhole).

- The confined space atmosphere will be monitored with a multi-gas meter before and during the entire activity within the confined space. Results will be recorded on a Confined Space Entry Permit Form for each entry. Atmosphere will be monitored and controlled as shown in Table 6.

Table 6 Atmospheric Controls for Atmospheric Monitoring

Hazard	Control
1. Oxygen	The desirable level of oxygen is 20.8%. If the oxygen levels deviate from this level, field team members will not enter/will promptly exit the confided space.
2. Combustible gases and vapors	If any combustible gas or vapor is detected in excess of 10% of its LEL, field team members will not enter/will promptly exit the confided space.
3. Toxic gases and vapors (carbon monoxide, hydrogen sulfide)	If any toxic gas or vapor is detected, field team members will not enter the space until testing shows a non-detect.

LEL lower explosive limit

- If the confined space has been deemed acceptable for entry by the Field Health and Safety Coordinator, one person will enter the confined space after properly donning a safety harness that is attached to a retrieval device. A second team member will remain outside the confined space at all times as an attendant, will perform no other duties that interfere will detract from the attendant duties and will at no time enter the confined space, even during rescue operations.

Confined space entry procedures are discussed in more detail in Attachment 7 of the Terminal 115 Recontamination Study, site specific HSP (TEC 2010).

A total of five sediment trap samples and five storm drain sediment grab samples will be collected, once during the 'dry' season (April-October) and a second time during the 'wet' season (October – April).

Sediment traps consist of a bracket mounted inside a storm drain that contains a Teflon® bottle to passively collect suspended particulate material that passes by the sampling station. Grab samples also represent contributions on a basinwide or subbasin scale, however, grab samples represent the heavier material that accumulates within storm drain lines (e.g., bedload material).

Sediment Trap Deployment

At each of the five sampling locations, two sediment traps will be mounted to the wall of a maintenance hole, vault, or pipe just above the base flow level within the storm drain to collect sediment associated with storm flows. Two sediment traps will be utilized because of unknown and potentially low sediment capture rates. Sediment traps will be acquired by SEE/TEC from Precision Touch Machining, and Teflon® sample containers will be acquired from Columbia.

One of the two sampling locations in Drainage Area 2220 will have two sets of sediment traps (total of four traps) in order to collect sufficient quantity of sediment a field duplicate.

Sediment traps will be deployed for approximately six (6) month intervals. Traps will remain in place from April to October 2010 to capture spring/summer storm flows and will be deployed again from October 2010 to April 2011 collect fall/winter storm flows.

Sediment Grab Samples

If present in suitable quantities, sediment that accumulates within the pipe will also be collected at each sediment trap location during deployment and retrieval of the sediment trap bottles. Sediment grab samples will be collected using a stainless steel scoop attached to a telescoping rod to reach the bottom of the maintenance hole, in-line vault, or pipe where sediment accumulates, or with a handheld stainless steel spoon or scoop.

Sample Analysis

Sediment samples will be analyzed for polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo dioxins/furans (dioxins/furans), total solids, total organic carbon, SVOCs, metals (arsenic, copper, lead, mercury, and zinc), and grain size. If insufficient sediment is collected for any sample, the analyses will be prioritized in the following order:

1. SIM-PAHs
2. dioxins/furans,
3. Total Solids,
4. TOC,
5. SVOCs
6. Metals, , and
7. grain size

The analytical methodologies will follow protocols listed in Table 8 (page 21).

Specific methods for each analytical parameter are listed in Appendix A. The potential exists that sediment collected in sediment traps will be limited in volume. Consequently, grain size analyses may be limited to grab samples only.

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5.0 FIELD PROCEDURES

This section describes field procedures that will be utilized to ensure that samples are collected in a consistent manner and will be representative of the matrix being sampled, and the data will be comparable to data collected by other existing and future monitoring programs. Procedures are described for collecting sediment samples, decontaminating sampling equipment, and recording field measurements and conditions. Requirements for sample containers and preservation, sample identification, and field quality control procedures are also described. Sampling procedures will generally follow the procedures that SPU uses for the LDW Source Tracing (the *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound* (EPA/PSWQA 1989) *(also known as the* PSEP 1986) and Ecology's *Standard Operating Procedure for Collection of Stormwater Sediments Using In-Line Sediment Traps, Version 1* (Ecology 2009).

Sediment Sample Collection

Sediment samples will be collected using the following guidelines. Descriptions of field observations (including sheens, weather conditions, flow rates, site activities, etc) 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 prior and after sample collection (see below). Latex/nitrile gloves will be worn at all times while collecting and handling samples and sample containers.

Sediment Trap Samples

SOPs for sediment trap installation and sample collection are provided in Appendix B and C. Traps will be left in place for a period of about six (6) months to allow sufficient sample volume to accumulate. If possible, sediment traps will be retrieved after a period of three (3) days of dry weather to allow for additional settling of particulate and colloidal materials in the collected sample. The sample containers will be removed from the sediment trap in a manner that will minimize re-suspension of sediment and the height of sediment within the sample container will be measured to the nearest millimeter. The samples will be delivered directly to the analytical laboratory for processing in the original Teflon® sample containers. Samples will be preserved according to Puget Sound Estuary Program (PSEP) guidelines (see Table 7) and held on ice during transport to the laboratory.

Sediment Grab Sample

SOPs for sediment grab sampling are provided in Appendix B. Sediment grab samples will be collected using stainless steel spoons and long-handled scoops or soil coring devices. Samples will be collected from the top 3-4 inches of sediment accumulated in the catch basin sump or in-line structure. Individual aliquots will be collected from at least three locations in the sump/structure, placed in a stainless steel bowl, and thoroughly mixed. Any particles greater than 2 centimeter 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 (SPU 2009).

Equipment Decontamination

All sampling equipment, including the sample bottles and stainless-steel materials, will be decontaminated after each sampling event. The following decontamination procedures from SPU 2009 and Puget Sound Estuary guidelines will be followed.

Decontamination of Sediment traps and Teflon® sample bottles (completed by Columbia following their SOPs) shall include the following:

- Phosphate-free detergent wash and tap water rinse,
- Reagent-grade water rinse,
- Reagent-grade nitric acid rinse,
- Reagent grade water rinse,

- Reagent grade isopropyl alcohol rinses,
- Reagent grade water rinse,
- Air dry, and
- Place the cap on the bottle during transport to site.

Decontamination of stainless-steel scoop, mixing bowl, and spoons (completed by field team members or analytical laboratory) shall include the following:

- Phosphate-free detergent wash and tap water rinse,
- Reagent-grade water rinse,
- Reagent-grade nitric acid rinse,
- Reagent grade water rinse,
- Reagent-grade isopropyl alcohol rinse,
- Reagent grade water rinse,
- Air dry, and
- New uncoated aluminum foil wrap after dry.

After the decontamination procedures have been completed, the sampling equipment will be capped or sealed with new uncoated aluminum foil and the sampling device will be protected and kept clean until needed.

Sample Containers, Preservation and Holding Times

Pre-cleaned sample containers will be supplied by the Columbia for the required analyses. Spare sample containers will be carried by the field team in case of breakage or possible contamination. Sample containers (for sediment grab samples), preservation techniques, and holding times will follow PSEP (1986) guidelines as summarized in Table 7.

Table 7 Sample Containers, Preservation and Holding Times

Chemical	Sample Container	Holding Time [(a)]	Preservation
TOC	4 oz glass	6 months	Freeze
Grain size	32 oz WM glass jar	6 months	Cool to 4º C
Total Solids	4 oz glass	6 months	Freeze
Arsenic, copper, lead, zinc	4 oz glass	6 months	Cool to 4º C
Mercury	4 oz glass	28 days	Cool to 4º C
SVOCs	4 oz glass	14 days; 40 days	Cool to 4º C
PAHs	4 oz glass	14 days; 40 days	Cool to 4º C
Dioxin/furans	4 oz glass	30 days; 40 days	Cool to 4º C

Notes:
For SVOCs, PAHs, and Dioxins/Furans, holding times for extraction are extended to one year if samples are stored at -20º C.
TOC – total organic carbon
SVOCs – semivolatile organic compounds
PAHs – polycyclic aromatic hydrocarbons
Dioxins/furans – polychlorinated dibenzo-dioxins and dibenzolfurans

Sample Identification and Labeling

A unique site number including the type of sample (sediment trap (ST) or grab sample (G), the sample location, and the date of collection will identify each sample. For example, the sediment trap located in Drainage Area 2220, collected June 29, 2010, would be labeled ST2220-290610. Grab samples collected at sediment trap locations will be denoted with a "G" following the sample date (ST2220-290610G).

Prior to filling, sample containers will be labeled with the following information using indelible ink:

- Sample identification number,
- Date of collection (day/month/year),
- Time of collection (24-hour format),
- Analytes, and
- Sampler ID

Field Notes

When visiting each sampling station, field team members will record at a minimum the following information in the field notes that are maintained in a waterproof field notebook:

- Date (day/month/year),
- Time of sample collection or visit (24-hour format),
- Name(s) of sampling personnel,
- Weather conditions,
- Number and type of samples collected,
- Log of photographs taken to document sampling location/sample characteristics,
- Comments on the working condition of the sampling equipment,
- Deviations from sampling procedures,
- Unusual conditions (e.g., water color or turbidity, presence of oil sheen, odors, and land disturbances),
- Map showing location of catch basin on the property, and
- Date the catch basin was last cleaned (if information is available).

Within one week of sample collection, field notes will be copied and reviewed by the QA Manager. Copies of field notes will be maintained by SEE/TEC and will be made available to Port and EPA/Ecology upon request.

Sample Transport and Custody

All samples will be transported on ice in a cooler to the analytical laboratory. Samples will be delivered to the lab and stored in a refrigerator at 4°C. A chain-of-custody record will accompany the samples (see Appendix D). Upon return to the office, the QA lead will review a copy of the signed chain-of-custody record.

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6.0 LABORATORY PROCEDURES

The chemical analyses of samples collected in this project will be performed by Columbia in Kelso, Washington. The following sections specify laboratory procedures for sample handling, custody storing, archiving, sample processing, preparation, and analysis, and analytical result reporting.

Laboratory Sample Handling and Custody

The samples are deemed to be under Columbia's custody at the point when the laboratory personnel sign the chain-of-custody form accompanying the samples. The laboratory will ensure that sample-tracking records are maintained that follows each sample through all stages of laboratory processing. Any sample needing further analysis or the remaining aliquots of sediment samples will be stored at -20±4°C. for 12 months following the completion of data reporting. Disposal of excessive and archived samples should be approved by the project manager.

Sediment Trap Sample Processing

The entire contents of the sediment trap bottles will be delivered as-is to Columbia and processed in the laboratory. The samples will be processed as described below by the analytical laboratory:

- Decant the overlying water into a pre-cleaned container;
- Transfer the solid portion of the sediment to the centrifuge tube;
- Use the decanted water to rinse the sampling vessel into the centrifuge tube to ensure no residual sediment remains in the vessel;
- Centrifuge the sample; and
- Discard the overlying water and perform chemical analyses on the underlying storm drain sediment.

Analytical Methods

Sample extraction, cleanup, and analysis methods for sediment samples are specified in Table 8.

Table 8 Sample Preparation and Analysis Methods

Analysis	Preparation Method	Procedure	Analytical Method	Procedure
TOC	Plumb 1981	Acid pretreatment	Plumb et al. 1981	Combustion; coulometric titration
Grain Size	PSEP 1986	Oven Dry	PSEP 1986	Sieve and pipette
Total Solids	PSEP 1997	Homogenization	PSEP 1997	Oven Dry
Arsenic, Copper, Lead, Zinc	EPA 3050A	Acid Digestion	EPA 6010B	ICPAES
Mercury	EPA 7471	Oxidation	EPA 7471A	CVAAS
SVOCs	EPA 3541	Sonication extraction	EPA 8270C	GC/MS-LVI
PAHs	EPA 3541	Sonication extraction	EPA 8270C	GC/MS-SIM
Dioxin/furans	EPA 3541	Soxhlet extraction	EPA 8290	HRCG/HRMS

Notes
All methods cited herein are based on EPA (1995), unless otherwise noted.
ICPAES – inductively coupled plasma atomic emission spectrometry
CVAAS – cold vapor atomic absorption spectrometry
GC/MS - gas chromatography/mass spectrometry
LVI – large volume injection
SIM – selective ion monitoring
SVOCs – semi-volatile organic compounds
Dioxins/furans – polychlorinated dibenzodioxins and dibenzolfurans
HRCG/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry

Laboratory Deliverables

The analytical laboratory reports will be submitted in hard copy and electrically in portable document format (.pdf) and electronic data deliverable (EDD) format. Laboratory reports should satisfy requirements for a full (Level IV) validation, and provide specific information including the following, as applicable for the analytical methods:

- Case narrative identifying the laboratory analytical batch number and identifying/addressing any anomalies (including those related to instrument calibrations and calibration verifications), Quality Control (QC) outliers, and corrective action taken. The laboratory manager or their designee must sign the narrative.
- Copy of chain-of-custody and sample receipt forms for all samples included in the sample delivery group
- Tabulated sample analytical results with:
    - units,
    - data qualifiers,
    - percent solids,
    - sample weight or volume,
    - dilution factor,
    - laboratory batch and sample number,
    - field sample number, and
    - dates sampled, received, extracted, and analyzed;
    - sample-specific method reporting limits (MRL) and method detection limit (MDL) for each target analyte;
    - soil sample results should be reported on a dry-weight basis and evaluated to the MDL levels
- Instrument tuning and performance check
- Instrument calibration and calibration verifications
- Surrogate percent recoveries and control limits for organic analyses.
- Internal standard peak area and retention time summaries and control limits for all analyses including samples, blanks, calibration verifications, and associated QC analyses for organic analytical methods using internal standard calibrations.
- Blank result summaries.
- Matrix spike/matrix spike duplicates (MS/MSD) (or duplicate for inorganic analyses) results with calculated percent recovery and relative percent difference values and laboratory control limits. In cases where the MS/MSD analyses were not performed on the project sample(s), batch QC information should be included to ensure sufficient information for data precision and accuracy evaluation.
- Laboratory control sample results with calculated percent recovery values and laboratory control limits.
- All instrument printouts, preparation log instrument run log, chromatograms, ion spectra, analysts' benchsheets, and all applicable raw data supporting all reported summarized results listed above.

7.0 MEASUREMENT DATA QUALITY CONTROL

To assure and control the quality of data collected in this project, field and laboratory QC samples will be collected/prepared and analyzed along with project samples. The purpose of each type of QC sample, collection and analysis frequency, and evaluation criteria are described in this section.

Field Quality Control Samples

Field QC is accomplished through the analysis of controlled samples that are introduced to the laboratory from the field. Field duplicates will be collected and submitted to the investigation laboratory to provide a means of assessing the quality of data resulting from the field sampling program (SPU 2009).

Field Duplicates

Field duplicate samples will be used to check the reproducibility of sampling and analysis. Field duplicate samples will be collected at a frequency of one duplicate per every ten samples. Field duplicate samples will be analyzed by the same methods as the primary samples. Sample control limits for field duplicate precision are 50 percent RPD for sediment samples. In order to collect sufficient material for a field duplicate, additional traps will be installed as described on Page 19 *Sediment Trap Deployment*.

Laboratory Quality Control Samples

Laboratory QC is accomplished by analyzing blanks, laboratory control standards (LCS), MS/MSD pairs, and laboratory control standard duplicate (LCSD) samples (SPU 2009).

Method Blanks

Method blanks will be used to check for laboratory and reagent contamination, instrument bias, and accuracy. Laboratory method blanks will be analyzed at a minimum frequency of 5 percent or one per analytical batch for all chemical parameter groups.

Laboratory Control Samples or Standard Reference Materials

LCSs will be extracted and analyzed with each batch of samples. Results will be compared on a per batch basis and are used to evaluate the laboratory's performance for accuracy. Analysis of LCS duplicates also allows for evaluation of laboratory precision. LCSs may also be used to identify any background contamination of the analytical system that may lead to the reporting of elevated concentrations or false-positive measurements.

Matrix Spike

MS analyses will be used to assess sample matrix interferences, as well as to measure the accuracy of the analysis. For MS samples, known concentrations of analytes will be added to environmental samples; the samples will then be processed through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery of the known spiked amount. MS analyses will be performed on one of the field samples for each sample medium. The samples for MS analyses will be designated in the field and specified on the chain-of-custody form accompanying the samples.

Laboratory Duplicate Samples

Precision of the analytical system is evaluated by analyzing laboratory duplicates. Laboratory duplicates will be two portions of a single homogeneous sample analyzed for the same parameter. Laboratory duplicates will be prepared and analyzed on one of the field samples for each sample medium.

Data Quality Indicators

The quality and usability of data collected in this project will be determined, based on the outcomes of data verification and validation, and expressed in terms of DQIs - precision, accuracy (bias), representativeness, comparability, completeness, and sensitivity. Table 9 presents a summary of QC samples and parameters corresponding to each of the DQIs. The definitions of the DQIs are presented in the following sections.

Table 9 QC Parameters Corresponding to DQIs

Data Quality Indicators	QC Parameters
Precision	RPD values of: (1) LCS/LCSD (2) MS/MSD (or Laboratory Duplicate) (3) Field Duplicates
Accuracy	%RPD, %R, %D, or %D_f values of: (1) Initial Calibration and Calibration Verification (2) Surrogate Spikes (3) Internal Standards (4) Labeled Compounds (5) LCS (6) MS Results of: (1) Instrument and Calibration Blank (2) Method (Preparation) Blank (3) Trip Blank (4) Field Blank (5) Equipment Rinsate Blank (6) Filtration Blank
Representativeness	(1) Results of All Blanks (2) Sample Integrity (3) Holding Times
Comparability	(1) Sample-specific Method Reporting Limits (MRLs) (2) Sample Collection Methods (3) Laboratory Analytical Methods
Completeness	(1) Data qualifiers (2) Laboratory deliverables (3) Requested/Reported valid results
Sensitivity	Sample-specific MRLs

(Source: SPU 2009)

Accuracy and Bias

Accuracy and bias, the degree to which the analytical results reflect the true value of the sample, will be assessed using analyses of laboratory preparation blanks, MS, and control standards. The following calculation is used to determine percent recovery for a MS sample:

$$\%R = \frac{M - U}{C} \times 100$$

%R = Percent recovery

M = Measured concentration in the spiked sample

U = Measured concentration in the un-spiked sample

C = Concentration of the added spike

The following calculation is used to determine percent recovery for an LCS or reference material:

$$\%R = \frac{M}{C} \times 100$$

%R = Percent recovery

M = Measured in the reference material

C = Established reference concentration

Values for blanks will not exceed 2 times the reporting limit. Generally, the percent recovery of matrix spikes will be between approximately 50 and 150 percent for organic compounds (PCBs and SVOCs). Matrix spike recovery limits for individual compounds may vary outside these ranges. The percent recovery of control standards will be within control limits reported by the analytical laboratory that are based on historic performance. Columbia's laboratory recovery limits for individual compounds are presented in Appendix A.

Precision

Precision is a measure of the scatter in the data due to random error caused primarily from sampling and analytical procedures. Precision will be assessed using laboratory duplicates, matrix spike duplicates, and field duplicates (i.e., split samples). Laboratory duplicates will be analyzed with every sample batch. The RPD between laboratory duplicates will be less than 20 percent for metals and less than 50 percent for organics if both duplicate values are greater than 5 times the reporting limit. The difference between laboratory duplicates will be ±1 times the reporting limit for metals and ±2 times the reporting limit for organics if either duplicate is less than or equal to 5 times the reporting limit. For organic analyses, precision will be determined between the MS/MSD.

The following equation is used to calculate the RPD between measurements:

$$\mathrm{RPD} = \frac{|\mathrm{C}_1 - \mathrm{C}_2|}{(\mathrm{C}_1 - \mathrm{C}_2)/2} \times 100$$

C_1 = First measurement
C_2 = Second measurement
RPD = Relative percent difference

Representativeness

The sampling program is designed to provide samples that reflect pollutant concentrations in sediment samples collected to evaluate the potential for recontamination of the clean sand cover at Berth 1. Sample representativeness will be ensured by employing consistent and standard sampling procedures. Equipment decontamination and sample handling procedures will be employed to prevent contamination of sediment samples.

Completeness

Completeness will be determined by comparing sampling and analyses completed with the project goal. Completeness will be calculated as the ratio of usable data (i.e., unqualified data and J-qualified data) to requested data, expressed as a percentage. The overall completeness goal will be 95 percent.

Comparability

Data comparability will be ensured through the application of standard sampling procedures, analytical methods, units of measurement, and detection limits. The results will be tabulated in standard spreadsheets for comparison with threshold limits and background data. Additional laboratory QC procedures will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects. QC samples and procedures are specified in each method protocol (see Table 8). All QC requirements will be completed by the analytical laboratories as described in the protocols, including the following:

- Instrument tuning,
- Initial calibration,
- Initial calibration verification,
- Continuing calibration,
- Calibration or instrument blanks,
- Method blanks, and

- LCS

Internal standards

- Surrogate spikes,
- Serial dilutions,
- MS, and
- MSD or laboratory duplicates.

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported results when associated QC samples or procedures do not meet control limits. Data qualifiers are described in the Data Review and Validation section.

Sensitivity

Sensitivity will be determined by reviewing reporting limits (RLs). RLs will be set low enough to allow meaningful comparisons with screening criteria to the extent possible, taking into account matrix effects. MDLs have been determined by Columbia for each analyte as required by the EPA. MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix with 99 percent confidence that a false positive result has not been reported. Columbia will establish method reporting limits (MRLs) at levels above the MDLs for the project analytes. These values are based on the laboratories' experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system. The concentration of the lowest standard in the initial calibration curve for each analysis is at the level of the MRL, allowing reliable quantification of concentrations to the MRL. Analyte concentrations for the Recontamination Study program will be reported to the MDL. Analytes detected at concentrations between the MRL and the MDL will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MRL. The MRL will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference.

Criteria for Measurement Data

To ensure the project DQOs will be met during the course of data generation activities and to set forth criteria to assess the data quality and usability, specific QC criteria are established in this Work Plan, and summarized in Appendix A. The QC criteria are derived from the analytical laboratory's in-house performance-based statistics, developed according to the National Environmental Laboratory Accreditation Program and EPA requirements.

8.0 DATA REVIEW AND VALIDATION

Data Quality Review

The purpose of the data quality review will be to eliminate unacceptable analytical data and to designate a data qualifier for any data quality limitation discovered. A formal data quality review will be performed on 100 percent of the laboratory data. This will include a review of laboratory performance criteria and sample-specific criteria. The reviewer will determine whether the measurement performance criteria have been met, and will calculate the data completeness for the project. If significant data quality issues are identified during the data quality review, a full data validation following EPA guidance may be performed on the remaining data at the discretion of the project manager.

Data quality review consists of a review of the data summary forms that are generated by the analytical laboratory. At a minimum, chain-of-custody records, the case narrative, and the summary results for project samples and quality control samples will be reviewed. The data shall be reviewed in accordance with the criteria contained in this Work Plan, including verification of the following:

- Compliance with the chain-of-custody and Work Plan,
- Proper sample collection and handling procedures,
- Holding times,
- Laboratory and trip blank analysis,
- Detection and reporting limits,
- Laboratory duplicate precision,
- MS/MSD percent recoveries and precision, as required by the method,
- Laboratory control sample recovery,
- Data completeness and format, and
- Data qualifiers assigned by the laboratory.

Qualifiers will be added to data during the review as necessary. Laboratory-assigned qualifiers will be reviewed and replaced by the data reviewer. Qualifiers applied to the data as a result of the review will be limited to the following:

U The analyte was analyzed for but was not detected above the reporting limit;

J The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample;

UJ The analyte was not detected above the sample reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample;

N Detection of the analyte was not qualitatively confirmed;

NJ Detection of the analyte is not confirmed and the reported value is estimated; and

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

Only one result will be reported for each sample and analyte. For example, if a sample is diluted several times to get the instrument response for each analyte within calibration range, dilution results that were outside the calibration range will be rejected and not included in the data summary and project electronic database. However, results from analysis of undiluted and diluted samples shall be included in the data package.

Results of the data quality review will be included in a data validation report that will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions and/or comprehensive data validation. The data validation reports shall be provided to the QA Manager and will be maintained in SEE/TEC project files. .

Data Validation

In addition to the review of data summary outputs described above for data quality evaluation, one batch of data per sample media (e.g., sediment traps, and sediment grabs) will be fully validated. The purpose of the data validation will be to eliminate unacceptable data, minimize suspect analytical data, and designate a data qualifier for any data quality limitation discovered. A full data validation will include a review of laboratory performance criteria and sample-specific criteria. The validator will determine whether the measurement performance criteria have been met, and will calculate the data completeness for the project. In addition, the validator could improve data quality, where appropriate, through review of instrument raw data. The data will be reviewed in accordance with the criteria contained in EPA guidance documents modified for the analytical method used. Data will be reviewed in accordance with this Work Plan, the referenced analytical methods, or most recent, EPA's Contract Laboratory Program National Functional guidelines (EPA 2004, EPA 2008). The full data validation shall include verification of the following:

- Compliance with the analytical methods and this Work Plan,
- Proper sample collection and handling procedures,
- Holding times,
- Instrument performance check, calibration, and calibration verification,
- Laboratory blank analysis,
- Detection limits and MRLs,
- Laboratory precision,
- MS percent recoveries,
- LCS recoveries,
- Data completeness,
- Data qualifiers assigned by the laboratory,
- Surrogate compound recoveries,
- Internal standard recovery,
- Primary and secondary column verification,
- Verification of reported data and analyte identification by inspection of instrument raw data including chromatograms, and
- Re-calculation of reported sample and QC results.

Qualifiers will be added to data during the review as necessary.

9.0 DATA MANAGEMENT AND REPORTING

TEC will maintain records documenting all activities and data related to field sampling and chemical analyses.

Field Documentation

Paper or electronic copies of field notes and completed chain-of-custody forms will be submitted to the Task Manage following each sampling event. The Task Manager lead will review the field information to evaluate the validity of chain-of-custody documentation and all field notes with the intent to identify any unusual field conditions and/or deviations from the work plan.

Laboratory Documentation

All activities and results related to sample analysis will be documented by the analytical laboratory. Internal laboratory procedures are described in Columbia's quality assurance plan.

The analytical laboratories will submit a complete data package documenting the sampling results within 30 days of the date that samples were submitted to the laboratory to TEC. The data package will include the following:

- Sample results and explanation of data qualifiers, including notation of units;
- Results for all quality control analyses, including LCS, duplicates, MS/MSD, laboratory blanks, and surrogate recoveries (for organic analyses);
- Case narrative describing any analytical problems and corrective actions taken.

Data Quality Documentation

The data validator will review the laboratory data package to determine whether the project data quality objectives were met. Any deficiencies will be immediately reported to the project manager and subsequently communicated to the analytical laboratory for action or clarification.

Data validation reports for each laboratory data package will be prepared by the data validator. Data validation reports will be submitted to the project QA Manager and will include:

- A list of samples/analytes that are qualified based on validation and reason for qualifying;
- Explanation of QA/QC control parameters used to validate the data;
- A narrative analysis of overall measurement performance for each analyte.

Project Documentation

Results of sampling activities including sampling locations and data tables will be provided to the Port of Seattle after completion of all sampling activities. Source sediment sampling results will be compared with the Washington State sediment management standards (SMS). Although the SMS do not apply to storm drain sediments, they will be used to provide a rough indication of the storm drain sediment quality. The SMS establish two levels:

- Sediment Quality Standards (SQS): Concentrations below the SQS are expected to have no adverse effects on biological resources and no significant human health risk.
- Clean-up Screening Levels (CSL): Minor effects level used to identify areas of potential concern.

SMS for some organic compounds are based on TOC normalized results. Where sample TOC concentrations are outside the range of 0.5 to 4.0 percent, the lowest apparent threshold (LAET) or two times the lowest apparent threshold (2LAET) values established by the Ecology are used instead of the SQS/CSL. The SMS applicable to the T-115 Recontamination Study are listed in Appendix E.

The sample results from the in-line sediment and grab samples will be compared to the SMS using a simple Microsoft Excel table to list sample concentration and SMS level. Comparison of storm drain sediment from catch basins, sediment traps, and in-line samples to SMS is considered conservative. If source sediment samples are below the SMS, there is reduced probability of source sediment samples re-contaminating offshore sediments. Samples below the SMS will have no coloring. A concentration above the SMS does not necessarily indicate that the sediment offshore of the outfall will exceed the SMS due to mixing zone effects between the storm drain sediment and offshore sediments. Any concentrations detected above the SMS will be highlighted in yellow in the tables. Finally, an analysis will be conducted in an attempt to identify a remaining data gaps.

Data Management

Sample documentation (e.g., laboratory reports, QA worksheets, chain-of-custody forms, copies of field notes, data analysis, and any problems and corrective actions taken) will be maintained in the Port files. All sample results, including data qualifiers will be entered into Microsoft Excel spreadsheets or Microsoft Access database for management during the reporting. Excel spreadsheets will be supplied for final document submittal.

Plan Updates

This Work Plan will be reviewed annually if the project runs longer than 12 months. This Work Plan should also be updated as needed based on:

- any changes in study organization, objectives, and methods,
- address deficiencies and non-conformance,
- improve operational efficiency, and
- accommodate unique or unanticipated circumstances.

Updates will be provided to the Port and to the agencies by the Port as appropriate.

10.0 REFERENCES

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FIGURES

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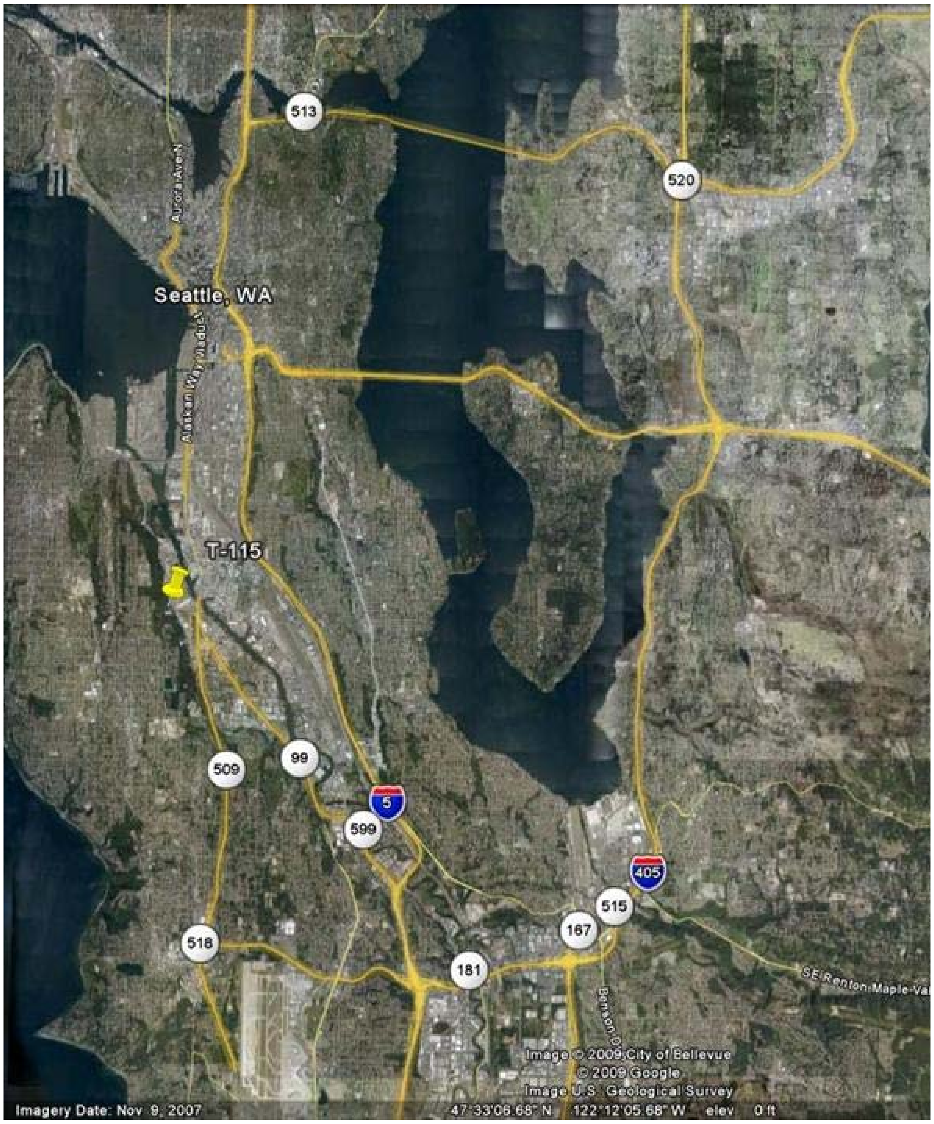

Figure 1 General Site Location

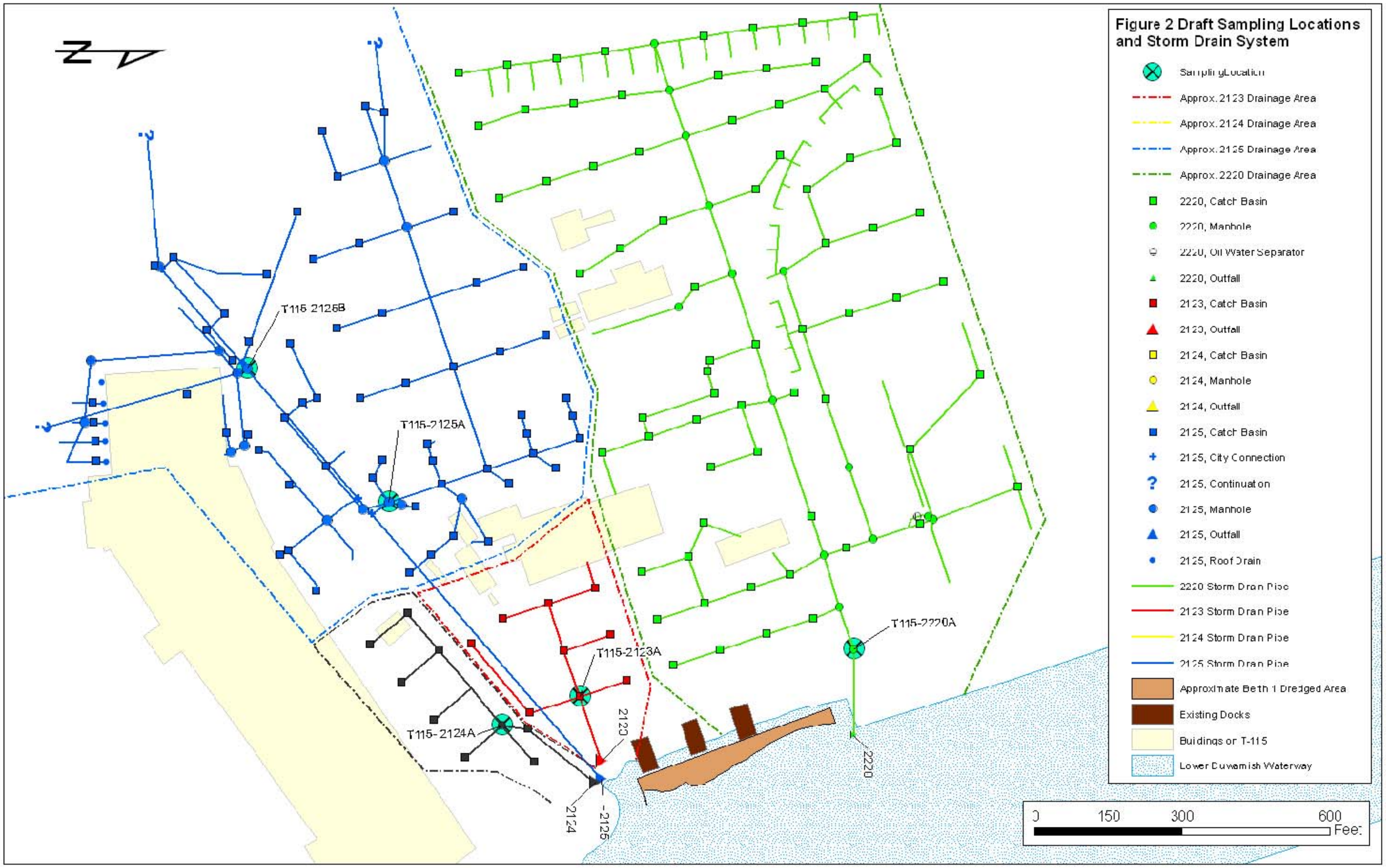

Figure 2 Draft Sampling Locations and Storm Drain System

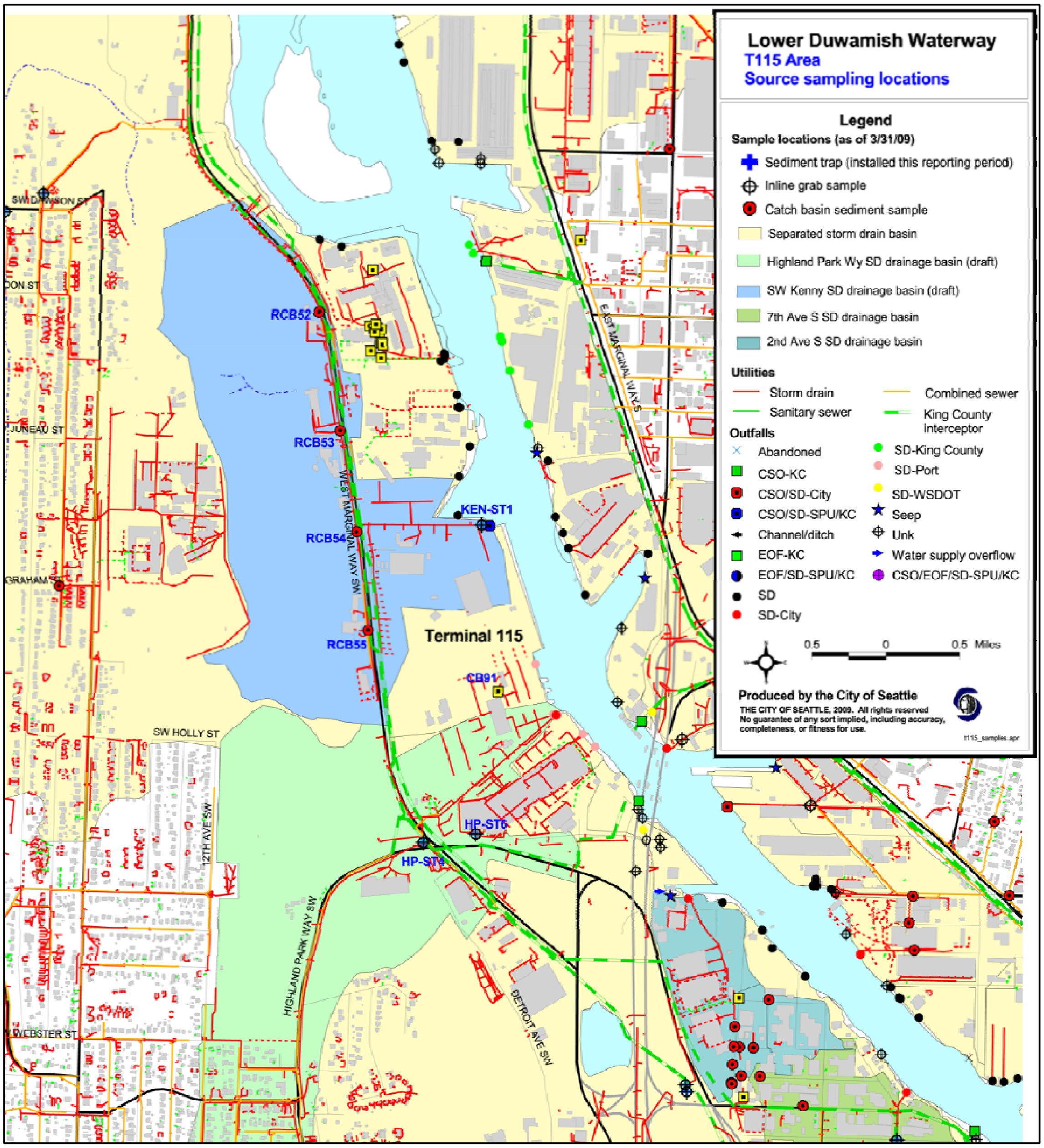

Figure 3 **Lower Duwamish Waterway: Highland Park SD: source samples**
(zoomed to project area)

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APPENDIX A: MEASUREMENT DATA QUALITY CONTROL CRITERIA

APPENDIX B: WASHINGTON STATE DEPARTMENT OF ECOLOGY STANDARD OPERATING PROCEDURES

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APPENDIX C: SEATTLE PUBLIC UTILITIES STANDARD OPERATING PROCEDURES

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APPENDIX D: EXAMPLE CHAIN OF CUSTODY

APPENDIX E: SMS APPLICABLE TO RECONTAMINATION STUDY

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APPENDIX A: MEASUREMENT DATA QUALITY CONTROL CRITERIA

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Table A-1 Precision, Accuracy, and Completeness Control Criteria for Sediment [1]

Analyte	Preparation Method[2]	Analytical Method[2]	Laboratory MDL	Laboratory MRL	Surrogate Spike (% R)	LCS (% R)	Matrix Spike (% Rec.)	Precision (RPD)	Completeness (%)
Conventional Inorganic Parameters (%)									95
Total Solids	Method	PSEP	NA	0.1		90-110	NA	20	
Total Organic Carbon	Method	PSEP	NA	0.02		90-110	75-125	20	
Grain Size	Method	PSEP	NA	0.1		NA	NA	20	
Metals (mg/kg)									95
Arsenic	3050B	6010	5	20		81-123	49-139	30	
Copper	3050B	6010	0.7	2		85-118	51-147	30	
Lead	3050B	6010	7	20		82-131	49-148	30	
Mercury	Method	7471A	0.006	0.02		75-118	60-123	30	
Zinc	3050B	6010	0.9	2		88-126	32-168	30	
Semi-volatile Organic Compounds (µg/kg)									95
1,2,4-Trichlorobenzene	3541	8270-LVI	2.6	10		31-83	18-91	40	
1,2-Dichlorobenzene	3541	8270-LVI	2.9	10		29-83	11-91	40	
1,3-Dichlorobenzene	3541	8270-LVI	3.0	10		27-82	10-90	40	
1,4-Dichlorobenzene	3541	8270-LVI	2.9	10		27-82	11-88	40	
2,4,5-Trichlorophenol	3541	8270-LVI	1.5	10		34-89	24-104	40	
2,4,6-Trichlorophenol	3541	8270-LVI	1.4	10		31-86	18-105	40	
2,4-Dichlorophenol	3541	8270-LVI	1.0	10		33-83	19-98	40	
2,4-Dimethylphenol	3541	8270-LVI	5.5	50		10-63	10-99	40	
2,4-Dinitrophenol	3541	8270-LVI	17	200		10-100	10-131	40	
2,4-Dinitrotoluene	3541	8270-LVI	1.5	10		40-98	25-114	40	
2,6-Dinitrotoluene	3541	8270-LVI	2.0	10		36-94	29-109	40	
2-Chloronaphthalene	3541	8270-LVI	1.6	10		31-86	24-97	40	
2-Chlorophenol	3541	8270-LVI	2.0	10		31-83	19-92	40	
2-Methyl-4,6-dinitrophenol	3541	8270-LVI	1.4	100		27-102	10-126	40	
2-Methylphenol	3541	8270-LVI	1.5	10		14-79	10-94	40	
2-Nitroaniline	3541	8270-LVI	3.2	20		32-97	26-107	40	
2-Nitrophenol	3541	8270-LVI	1.5	10		33-89	25-96	40	
3,3'-Dichlorobenzidine	3541	8270-LVI	3.7	100		13-98	10-86	40	
3-Nitroaniline	3541	8270-LVI	2.5	20		31-91	10-97	40	

Table A-1 Precision, Accuracy, and Completeness Control Criteria for Sediment [1]

Analyte	Preparation Method[2]	Analytical Method[2]	Laboratory MDL	Laboratory MRL	Surrogate Spike (% R)	LCS (% R)	Matrix Spike (% Rec.)	Precision (RPD)	Completeness (%)
Semi-volatile Organic Compounds continued									95
4-Bromophenyl Phenyl Ether	3541	8270-LVI	1.6	10		38-90	30-108	40	
4-Chloro-3-methylphenol	3541	8270-LVI	1.4	10		28-87	12-106	40	
4-Chloroaniline	3541	8270-LVI	1.9	10		19-78	10-75	40	
4-Chlorophenyl Phenyl Ether	3541	8270-LVI	1.4	10		34-87	31-97	40	
4-Methylphenol	3541	8270-LVI	1.5	10		14-82	10-104	40	
4-Nitroaniline	3541	8270-LVI	1.8	20		33-99	10-106	40	
4-Nitrophenol	3541	8270-LVI	18	100		32-110	11-131	40	
Benzoic Acid	3541	8270-LVI	96	200		10-48	10-126	40	
Benzyl Alcohol	3541	8270-LVI	2.1	20		27-88	19-102	40	
Bis(2-chloroethoxy)methane	3541	8270-LVI	1.5	10		33-85	27-93	40	
Bis(2-chloroethyl) Ether	3541	8270-LVI	1.9	10		29-86	21-100	40	
Bis(2-chloroisopropyl) Ether	3541	8270-LVI	2.6	10		23-88	14-95	40	
Bis(2-ethylhexyl) Phthalate	3541	8270-LVI	7.0	100		40-122	20-138	40	
Butyl Benzyl Phthalate	3541	8270-LVI	3.2	10		41-114	30-126	40	
Dibenzofuran	3541	8270-LVI	1.2	10		35-85	21-106	40	
Diethyl Phthalate	3541	8270-LVI	1.3	10		39-98	29-110	40	
Dimethyl Phthalate	3541	8270-LVI	1.0	10		38-91	26-107	40	
Di-n-butyl Phthalate	3541	8270-LVI	7.9	20		40-116	27-125	40	
Di-n-octyl Phthalate	3541	8270-LVI	1.7	10		43-119	32-132	40	
Hexachlorobenzene	3541	8270-LVI	1.2	10		39-90	30-106	40	
Hexachlorobutadiene	3541	8270-LVI	2.5	10		28-87	14-92	40	
Hexachlorocyclopentadiene	3541	8270-LVI	29	50		10-66	10-71	40	
Hexachloroethane	3541	8270-LVI	3.1	10		25-84	10-96	40	
Isophorone	3541	8270-LVI	1.0	10		33-83	25-92	40	
Nitrobenzene	3541	8270-LVI	2.2	10		29-87	21-95	40	
N-Nitrosodi-n-propylamine	3541	8270-LVI	2.4	10		24-89	14-104	40	
N-Nitrosodiphenylamine	3541	8270-LVI	1.6	10		29-92	13-113	40	
Pentachlorophenol	3541	8270-LVI	20	100		21-97	10-123	40	
Phenol	3541	8270-LVI	2.0	30		28-91	15-98	40	

Table A-1 Precision, Accuracy, and Completeness Control Criteria for Sediment [1]

Analyte	Preparation Method[2]	Analytical Method[2]	Laboratory MDL	Laboratory MRL	Surrogate Spike (% R)	LCS (% R)	Matrix Spike (% Rec.)	Precision (RPD)	Completeness (%)
Semi-volatile Organic Compounds continued									95
2,4,6-Tribromophenol (Surr)	3541	8270-LVI			10-119				
2-Fluorobiphenyl (Surr)	3541	8270-LVI			25-97				
2-Fluorophenol (Surr)	3541	8270-LVI			11-80				
Nitrobenzene-d5 (Surr)	3541	8270-LVI			27-91				
Phenol-d6 (Surr)	3541	8270-LVI			20-86				
Terphenyl-d14 (Surr)	3541	8270-LVI			33-129				
Polycyclic Aromatic Hydrocarbons (µg/kg)									95
2-Methylnaphthalene	3541	8270-SIM	0.39	5.0		41-113	21-120	40	
Acenaphthene	3541	8270-SIM	0.23	5.0		47-113	25-123	40	
Acenaphthylene	3541	8270-SIM	0.24	5.0		46-115	33-115	40	
Anthracene	3541	8270-SIM	0.47	5.0		53-116	23-134	40	
Benz(a)anthracene	3541	8270-SIM	0.48	5.0		58-111	18-140	40	
Benzo(a)pyrene	3541	8270-SIM	0.14	5.0		57-119	11-146	40	
Benzo(b)fluoranthene	3541	8270-SIM	0.25	5.0		53-125	15-144	40	
Benzo(g,h,i)perylene	3541	8270-SIM	0.64	5.0		43-122	13-135	40	
Benzo(k)fluoranthene	3541	8270-SIM	0.15	5.0		54-123	21-131	40	
Chrysene	3541	8270-SIM	0.25	5.0		53-122	14-147	40	
Dibenz(a,h)anthracene	3541	8270-SIM	0.28	5.0		37-126	14-133	40	
Dibenzofuran	3541	8270-SIM	0.59	5.0		44-116	26-119	40	
Fluoranthene	3541	8270-SIM	0.61	5.0		54-120	12-150	40	
Fluorene	3541	8270-SIM	0.5	5.0		49-115	15-138	40	
Indeno(1,2,3-cd)pyrene	3541	8270-SIM	0.16	5.0		43-119	11-132	40	
Naphthalene	3541	8270-SIM	0.37	5.0		47-103	24-111	40	
Phenanthrene	3541	8270-SIM	0.75	5.0		52-111	15-138	40	
Pyrene	3541	8270-SIM	0.37	5.0		53-120	12-152	40	
Fluoranthene-d10 (Surr.)	3541	8270-SIM			10-141	NA	NA	NA	
Fluorene-d10 (Surr.)	3541	8270-SIM			10-126	NA	NA	NA	
Terphenyl-d14 (Surr.)	3541	8270-SIM			25-139	NA	NA	NA	

Table A-1 Precision, Accuracy, and Completeness Control Criteria for Sediment [1]

Analyte	Preparation Method[2]	Analytical Method[2]	Laboratory MDL	Laboratory MRL	Surrogate Spike (% R)	LCS (% R)	Matrix Spike (% Rec.)	Precision (RPD)	Completeness (%)
Dioxins/Furans (ng/kg)									95
2,3,7,8-TCDD	3541	8290	0.051	1.0		87-135	87-126	25	
1,2,3,7,8-PeCDD	3541	8290	0.050	2.5		88-135	88-124	25	
1,2,3,4,7,8-HxCDD	3541	8290	0.049	2.5		81-138	81-138	25	
1,2,3,6,7,8-HxCDD	3541	8290	0.048	2.5		82-136	82-136	25	
1,2,3,7,8,9-HxCDD	3541	8290	0.048	2.5		77-135	77-135	25	
1,2,3,4,6,7,8-HpCDD	3541	8290	0.059	2.5		93-144	93-144	25	
OCDD	3541	8290	0.164	5.0		93-162	93-162	25	
2,3,7,8-TCDF	3541	8290	0.048	1.0		82-141	82-141	25	
1,2,3,7,8-PeCDF	3541	8290	0.038	2.5		92-139	92-139	25	
2,3,4,7,8-PeCDF	3541	8290	0.036	2.5		74-145	74-145	25	
1,2,3,4,7,8-HxCDF	3541	8290	0.041	2.5		86-142	86-142	25	
1,2,3,6,7,8-HxCDF	3541	8290	0.041	2.5		88-162	88-162	25	
1,2,3,7,8,9-HxCDF	3541	8290	0.050	2.5		66-156	66-156	25	
2,3,4,6,7,8-HxCDF	3541	8290	0.044	2.5		80-150	80-150	25	
1,2,3,4,6,7,8-HpCDF	3541	8290	0.064	2.5		91-131	91-131	25	
1,2,3,4,7,8,9-HpCDF	3541	8290	0.083	2.5		69-169	69-169	25	
OCDF	3541	8290	0.104	5.0		82-200	82-200	25	
^{13}C-2,3,7,8-TCDD	3541	8290			40-135			25	
^{13}C-1,2,3,7,8-PeCDD	3541	8290			40-135			25	
^{13}C -1,2,3,6,7,8-HxCDD	3541	8290			40-135			25	
^{13}C -1,2,3,4,6,7,8-HpCDD	3541	8290			40-135			25	
^{13}C-OCDD	3541	8290			40-135			25	
^{13}C-2,3,7,8-TCDF	3541	8290			40-135			25	
^{13}C-1,2,3,7,8-PeCDF	3541	8290			40-135			25	
^{13}C-1,2,3,4,7,8-HxCDF	3541	8290			40-135			25	
^{13}C-1,2,3,4,6,7,8-HpCDF	3541	8290			40-135			25	

Table A-1 Precision, Accuracy, and Completeness Control Criteria for Sediment [1]

Notes:

[1] - Listed surrogate spike, precision, and accuracy control limits are based on in-house performance statistics of Columbia Analytical Services, Inc.-Kelso, Washington. The values are subject to change as the laboratory is updating the control limits per EPA requirements.

[2] - All preparation and analytical methods were based on USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, December 1996, unless otherwise noted.

NWTPH-Dx - Analytical Methods for Petroleum Hydrocarbons, ECY 97-602, Washington State Department of Ecology, June 1997.

LCS – Laboratory control sample

LL – Large Volume Injection

MDL – Method detection limit

MRL – Method reporting limit

MS – Matrix spike

PSEP – Puget Sound Estuary Program

%R - Percent recovery

mg/kg – milligram per kilogram

μg/kg = microgram per kilogram

ng/kg – nanogram per kilogram

NA - Not applicable

RPD - Relative precent difference

SIM - Selective ion monitoring

Surr - Surrogate

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APPENDIX B: WASHINGTON STATE DEPARTMENT OF ECOLOGY STANDARD OPERATING PROCEDURES

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Washington State Department of Ecology

Standard Operating Procedure for Collection of Stormwater Sediments Using In-Line Sediment Traps

Version 1.0

Author - Rick Fuller, City of Tacoma
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QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date – 9/16/2009

ECY003

APPROVED

Signatures on File

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)

1.0 Purpose and Scope

1.1 This document delineates the Department of Ecology's Standard Operating Procedure (SOP) for field procedures to passively collect suspended particulate matter from stormwater runoff in storm drains using in-line sediment traps. These traps are deployed over periods of time (up to 6 months) with regular site visits and basic maintenance to collect suspended particulate matter. Quantity collected can range from 50 to several hundred grams (dry weight) for laboratory analysis (Ecology, 1996).

1.2 Volume obtained can be dependent upon site conditions and the contributing drainage area.

1.3 Use of this SOP ensures that sediment traps are installed in a consistent manner and are representative of the matrix being sampled, and that the data will be comparable to data collected by other existing and future monitoring programs. Laboratory data generated from the analysis of these particulates can NOT be used to determine sediment loadings due to inherent design bias of the sediment trap.

2.0 Applicability

2.1 Suspended particulate matter in stormwater runoff is transported through natural channels, ditches, culverts and engineered pipe and treatment systems. Each monitored pipe discharge system will have its own individual characteristics that require a specific configuration of equipment and installation that best enables the collection of representative samples.

2.2 A successful location for sediment traps features stable construction and the ability to install a sediment trap (Ecology, 1996).

2.3 These traps are designed to passively capture suspended particulate matter from stormwater in high energy storm drains for characterization and source control purposes.

2.4 These traps are not designed to capture bed load material.

2.5 These traps are designed to be mounted inside a stormwater conveyance system/stormwater pipe.

2.6 These traps should be located in pipe diameters of 24” in diameter or greater because a large storm event is generally needed to inundate the 8” tall sample bottle (Seattle, 2008).

2.7 The sediment trap works best where velocity flows are greater than 5 feet per second through a pipe.

2.8 Flexibility of trap design is allowable, but may require adjusting sampling procedures described in this SOP.

3.0 Definitions

3.1 **Base Flow**: Water flow that occurs consistently or intermittently within a stormwater conveyance systems during dry weather.

3.2 **Bed Load**: Small particles that are re-suspended during periods of elevated storm flows that produce suspended sediment load (USGS, 2003).

3.3 **Conveyance System**: A single pipe or series of pipes that convey stormwater as part of a municipal separate storm sewer drainage system (EPA, 2008).

3.4 **Dry Weather**: Less than or equal to 0.02” of rain in the previous 72 hours (NPDES Phase I, 2009).

3.5 **High Energy Flow**: Flow with a velocity of greater than 5 feet per second through a pipe.

3.6 **Mounting Ring**: A mechanical device used to hold sampling equipment inside a pipe which is pressed against the inside of the pipe for mounting of the sampling device.

4.0 Personnel Qualifications/Responsibilities

4.1 Site training by qualified personnel is mandatory prior to trap installation/sediment sample retrieval.

4.2 If confined space entry is required for trap installation/checking traps/sample retrieval, personnel must have OSHA 8-Hour Confined Space Entry Certification.

5.0 Equipment, Reagents, and Supplies

5.1 Sediment Trap Hardware

5.1.1 Inline sediment traps generally consist of two components: a stainless steel mounting assembly (including a mounting base plate, sample bottle cylinder, collar and arm) and a narrow or wide mouth sample bottle (Seattle, 2008).

5.1.2 Stormwater solids are captured by the sediment trap through fluid exchange of particle-laden flow over the downstream edge of the sediment trap bottle, causing particles to settle out into the trap.

5.1.3 Traps can be mounted directly in stormwater pipes or other areas of the conveyance system positioned on the side of the drainage pathway to avoid interference with base flow.

5.1.4 If base flow is present in the pipe, the traps should be situated just above the base flow water level to ensure storm flows will inundate the traps. The idea is to position the trap for submergence of the trap during storm flows to settle sediments into the bottle.

5.1.5 These sediment traps (Figure 1 and Photo 1) were originally designed and used by the Washington State Department of Ecology (Wilson and Norton 1996, Barnard and Wilson 1995, Norton 1997) and have since been modified by both the City of Tacoma and City of Seattle.

5.1.5.1 Seattle's modifications uses a wide mouth bottle and expand on Tacoma's changes to enable the sample bottle to be installed in a vertical position in most field conditions (i.e., maintenance holes, vaults, and pipes).

5.1.5.2 Brackets are mounted onto the wall of the pipe (Photo 2), maintenance hole, or other structure using metal hit anchors.

5.1.5.3 Extension plates can be used when the sediment trap bracket is mounted to a vertical wall and the bracket is submerged below the water level.

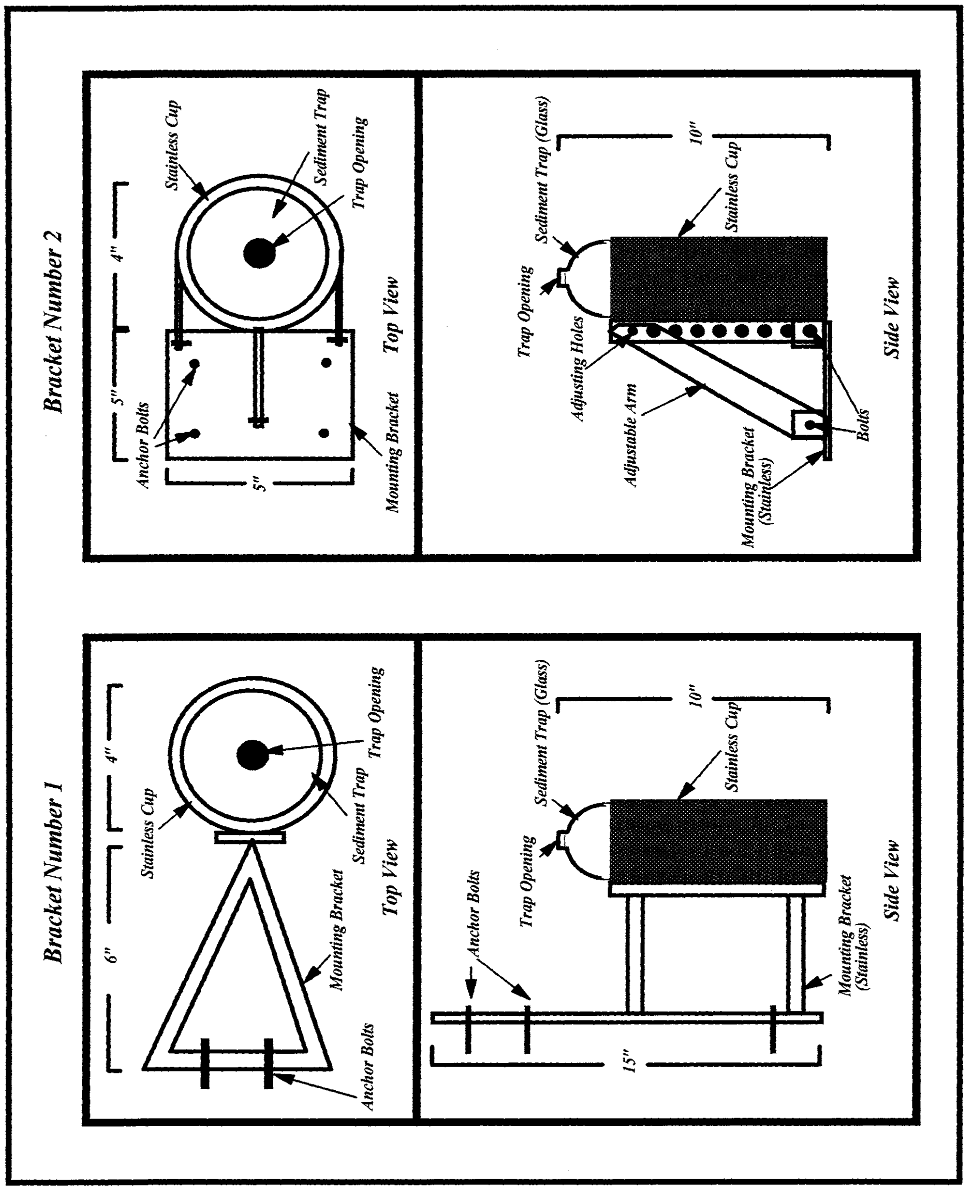

Figure A7: Construction Details of Stormwater Sediment Trap.

Figure 1 (Ecology, 1998)

Photo 1 and 2 (City of Tacoma)

5.2 Supplies for installation and sediment sample retrieval include but are not limited to:

5.2.1 Containers for sediment traps - laboratory cleaned (2 per mount for replacement of a cleaned bottle can occur while at the sampling location at the same time the sample is retrieved and transported to the laboratory for analysis). Teflon containers are recommended for sediment traps, but bottle type is dependent upon parameters to be analyzed.

5.2.2 Hammer drill with ¼" concrete drill bit.

5.2.3 Stainless Steel metal hit anchors.

5.2.4 Hammer.

5.2.5 Latex gloves.

5.2.6 Cooler with ice.

5.2.7 Field notebook.

5.2.8 Sample labels.

5.2.9 Chain-of-custody forms.

5.2.10 Personal Protective Equipment (PPE).

5.2.11 Camera.

5.2.12 Sample jars/containers with preservatives.

5.2.13 Confined space entry equipment (if applicable). (Seattle, 2008)

6.0 Summary of Procedure

6.1 Sediment Trap Site Selection

6.1.1 Install sediment traps in appropriate drainage pipes once the drainage area(s) has been evaluated.

6.1.2 Note observations including nearby discharges to receiving water or other pipe connections in field books.

6.1.3 Locate sediment traps at key points throughout the entire stormwater collection system to identify sources of contaminants found in stormwater and/or stormwater outfalls representing the entire drainage area.

6.1.4 Specific monitoring locations will be based on Quality Assurance Project Plan (QAPP) or project goals and objectives.

6.1.5 Avoid locations with small diameter pipes (less than 24-inches) to avoid plugging the pipe and backing up water.

6.1.6 Where possible, mount more than one sediment trap at the sampling location. This typically provides more sediment volume for analysis. A typical mounting configuration is shown in Figure 2 below.

6.2 Sediment Trap Installation

6.2.1 Personal protective equipment should be worn at all times during sediment trap installation.

6.2.2 Before installing the bracket, test fit the bracket at the intended location and adjust the angle of the bracket into the most vertical position. The angle of the bracket is adjustable in order to install the sediment trap in a vertical position (Figure 2, Seattle, 2008).

6.2.3 Mount the traps in the drainage system using a hammer drill equipped with a ¼" concrete drill bit to drill the pilot holes for mounting the bracket. Traps can also be mounted within the stormwater pipe itself (Seattle, 2008).

6.2.4 Drill the pilot holes through the four mounting holes located on each corner of the bracket and insert stainless steel metal hit anchors through the bracket and into the pilot holes (Seattle, 2008).

6.2.5 Drive the pin of the metal hit anchors with a hammer to secure the bracket into place (Seattle, 2008).

6.2.7 In vaults or maintenance holes with base flow or standing water, an extension plate can be used to mount the bracket below the water level. If an extension plate is used, the bracket must be mounted to the extension plate using short 1/4" diameter bolts before mounting into place (Seattle, 2008).

6.2.8 For sampling locations that are equipped with sumps, mount the trap so the mouth of the sample bottle just above the base flow level or static water level in order to capture sediments in storm flows. For other locations, traps should be installed at the lowest point in the pipe, but not directly on the bottom of the pipe where interference could occur (Seattle, 2008).

6.2.9 Once the sediment traps are mounted and in place, insert the bottles into the mounting bracket and secure the bottles with sediment trap collar.

6.2.10 Tighten the trap assembly hardware.

6.2.11 Using clean gloves, remove the lids from sediment trap bottles.

6.2.12 Place the lids in aluminum foil and store in clean plastic, sealable bags for subsequent field checks and sediment trap bottle removal.

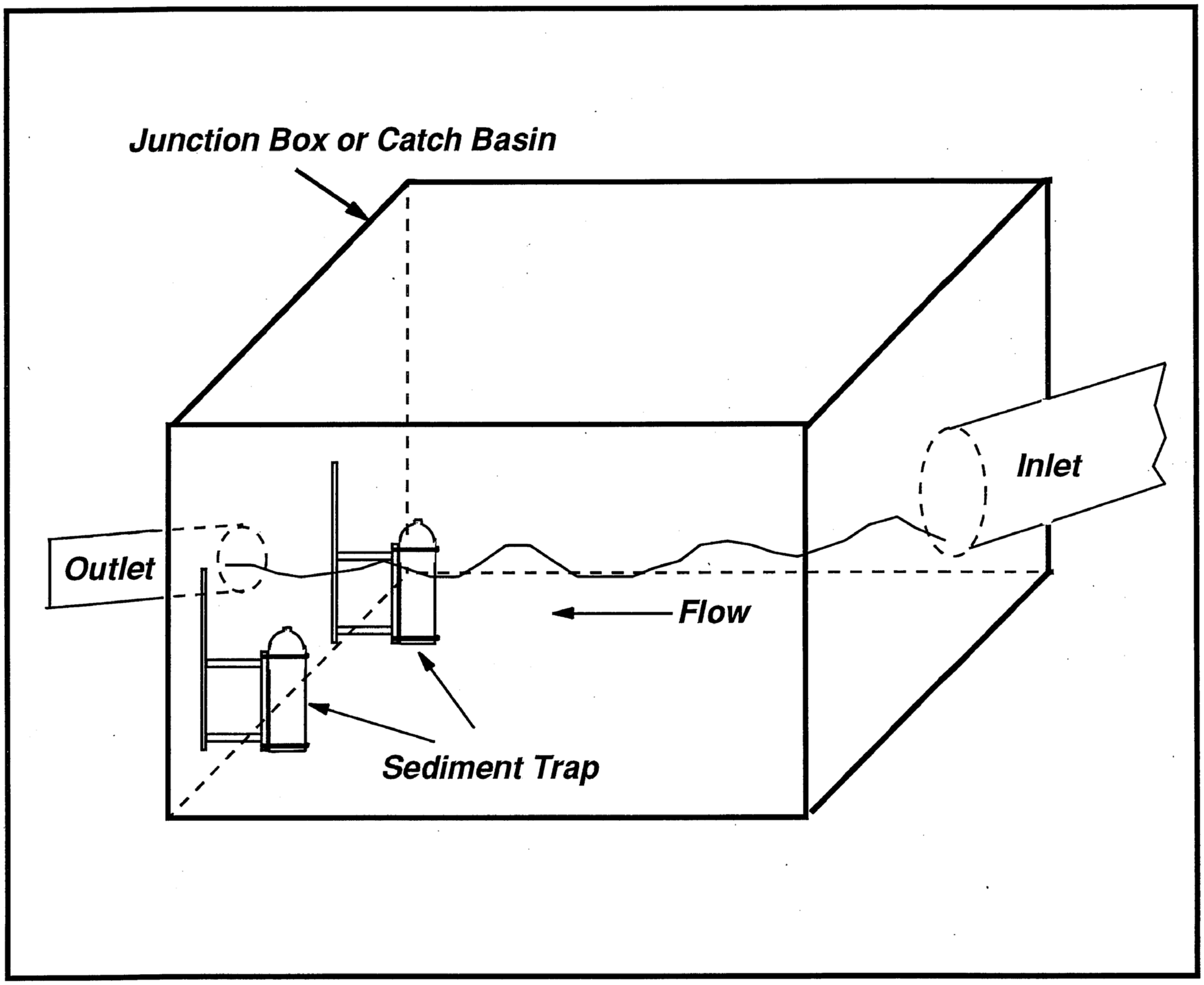

Figure 2 (Ecology 1996)

6.3 Sediment Trap Checks/ Evaluation

6.3.1 After initial installation, check traps within two weeks and then on a monthly basis to:

6.3.1.1 Determine that the trap assembly is still intact and structurally sound.

6.3.1.2 That the trap is not causing a flow impediment to the collection system.

6.3.1.3 Ensure that bottles are not being underfilled/overfilled with sediment.

6.4 Sediment Trap Retrieval/Sediment Trap Checks

6.4.1 Sediment trap retrieval typically occurs before and after winter wet season.

6.4.2 Winter wet season in Western Washington is from October 1st through April 30th (Ecology WWSWM 2005). Winter wet season in Eastern Washington is from October 1st through June 30th (Ecology EWSWM 2004).

6.4.3 Check traps for sediment volume accumulation and/or repair any damage that may have occurred.

6.4.4 Wear gloves prior to contact with sediment trap mounting rings, Teflon bottles and other equipment at the sampling station.

6.4.5 After accessing the traps, remove each bottle from the trap to inspect sediment accumulation volume.

6.4.6 Depending on QAPP-listed parameters for analysis, a priority list of parameters should be included in your QAPP when insufficient volumes are collected.

6.4.7 If sediment trap samples are retrieved, place Teflon-lined caps on the bottles and place the bottles in clean, plastic sealable bags (double-bagged).

6.4.8 Place samples directly on ice.

6.4.9 Prior to submittal and/or laboratory analysis, centrifuging may be needed. Centrifuging may be performed by the laboratory or by field staff if appropriate equipment is available. Centrifuge procedures for field staff are listed in Section 6.6 below.

6.4.10 Replace the Teflon bottle securely within the trap with a new laboratory-cleaned bottle.

6.5 Modifications to Collect More Volume

6.5.1 If more volume is needed and traps are re-deployed, modify the trap installation set-up by:

6.5.2 Installing more traps on the mounting ring or by inserting another mounting ring with traps secured.

6.5.3 Install debris deflectors, check the trap monthly and/or after significant rainfall to prevent debris (e.g., plastic bags) from blocking the trap.

6.5.4 Install a weir or other structure to enhance sediment deposition by ensuring that the sample bottle is inundated under most storm flows.

6.5.5 Relocated traps to a new location.

6.5.6 Document all sample retrieval and modification information in a field notebook.

6.5.7 If delivering samples to the laboratory, fill out the Chain-of-Custody form and deliver samples immediately.

6.5.8 Record all observations and activities on field forms and/or in field notebooks.

6.6 Centrifuge Sample Processing

6.6.1 Analyses of the sediment trap contents are performed on the solids fraction of the collected sample. In order to separate the liquid fraction a centrifuge is used to spin the samples and decant the overlying water. The remaining sediment/solid portion is then submitted for analysis.

6.6.2 Apparatus for centrifuge includes:

6.6.2.1 Centrifuge equipment.

6.6.2.2 600 mL beakers, KIMAX 14005 or equivalent.

6.6.2.3 Selected apparatus should meet a recommended Relative Centrifugal Force (RCF) rating of >5,000 kg (RCF).

6.6.2.4 Rinse water: Retain the overlying/decanted water.

6.7 Centrifuge Processing Procedure

6.7.1 Place the samples (Teflon bottles with sediment/water mix) in a clean area for settling. Allow the sample to settle for at least 12 hours or overnight prior to conducting the next step.

6.7.2 Decant off a portion of the overlying water from the sample and retain in clean 600 mL beaker from the original 1 L sample container, slurry the remaining solids using retained decant water from the sample being processed.

6.7.3 Distribute equal portions of the slurried sample into each of the two 600 mL beakers.

6.7.4 Transfer the remaining solids from the 1 liter collection bottle into the 600 mL beakers.

6.7.5 Use all of the retained decant water to rinse remaining solids from the 1 liter sample. If additional rinses are necessary, reagent grade water may be used.

6.7.6 Place the two beakers into the centrifuge making sure both beakers are of equal weight.

6.7.7 Centrifuge the beakers for 15 minutes at 2000 rpm (see recommendation in 6.16.2.3) until the overlying water contains no visible suspended solids. Decant water and discard overlying liquid fraction.

6.7.8 Transfer the solids from the bottom of the beakers and composite into a glass jar cleaned appropriately for the analysis to be performed using clean stainless steel spatulas or scoops.

6.7.9 Submit centrifuged sediment solids to the laboratory for analysis.

7.0 Records Management

7.1 Field data forms and/or field notebooks should be used during trap installation and retrieval. The following information should be recorded for each site, but is not limited to:

7.1.1 Name of samplers, weather conditions, times, and date of installation and sample retrieval.

7.1.2 Number of traps installed.

7.1.3 Problems with installation.

7.1.4 Drainage area (acres/land use).

7.1.5 Confined space entry logs.

7.1.6 Name of equipment installed.

7.1.7 Sample retrieval procedures with any problems encountered.

7.1.8 Flow conditions in the pipe at the time of retrieval.

7.1.9 Volume retrieved from each trap.

7.1.10 Needed maintenance/conducted maintenance of mounting bracket or traps.

7.1.11 Field sample process procedures.

7.1.12 Any field observations including but not limited to:

7.1.12.1 Potential construction activities occurring within the sampled drainage area that could result in an increase of sediment load.

7.1.12.2 Presence of sheen, odor, or discoloration.

7.2 Record rainfall measurements. Rainfall records should be evaluated and recorded for the days during sediment trap deployment.

7.3 Total precipitation and any flow records (if recorded) should be used to determine the quantity of particulates collected by the traps that represent the storm events that occurred during the sampling period. This information will help determine deployment time of each trap versus precipitation to estimate whether or not traps need to be deployed for a longer time period.

8.0 Quality Control and Quality Assurance Section

8.1 Sediment trap retrieval should be audited by experienced staff at least once a year to ensure proper collection of samples.

8.2 Quality control samples are dependent upon QAPP project goals and objectives. Typically, one duplicate sample is collected for 10% of the sampling events; however, if only one or two samples are collected per year, more quality control samples may be needed to test quality.

8.3 At a minimum, equipment blanks of the trap bottles should be taken at least once per year to ensure the decontamination procedures are sufficient.

9.0 Safety

9.1 There are many hazards associated with sediment sampling from stormwater. Some of these hazards include fast moving water, deep water, steep slopes to sampling sites and hostile dogs or people. Use extreme caution when exiting vehicles, walking along busy roads and approaching your sampling site.

9.2 Safety is top priority for field staff and supervisors. A site specific health and safety plan and/or a safety procedure manual will be read and understood by monitoring personnel before site visits are conducted and samples are collected.

9.3 References to help develop safety programs/manuals or site specific safety plans include (see full reference in Section 10.0, Reference Section):

9.3.1 The WSDOT Safety Procedures and Guidance Manual.

9.3.2 WSDOT Work Zone and Traffic Control Guidelines.

9.3.3 WSDOT Pre-Activity Safety Plan (Appendix A).

9.3.4 U.S. Geological Survey, Safety in Field Activities.

9.3.5 An Example Health and Safety Plan (Appendix B of USDOT, 2001).

10.0 References

10.1 Washington State Department of Ecology, Norton, D, *Stormwater Sediment Trap Pilot Study*, Publication # 96-347, November 1996.

10.2 Washington State Department of Ecology Report # 95-309, Barnard, B. and C. Wilson, *Stormwater Sediment Trap Literature Review and Design Consideration,* February 1995.

10.3 City of Seattle Public Utilities, SOP WQ&S S3301 R0D1, *Sediment Trap Installation*, March 2008.

10.4 U.S. Geologic Survey, Water Resources Investigations Report 03-4194, *Suspended Sediment and Bed Load in Three Tributaries to Lake Emory in the Upper Little Tennessee River Basin, North Carolina*, 2003.

10.5 Environmental Protection Agency, Assessment and Watershed Protection Division Office of Wetlands, Oceans and Watersheds, Water Permits Division Office of Wastewater Management and Region 5, *Draft TMDLs to Stormwater Permits Handbook,* November 2008.

10.6 Washington State Department of Ecology, Phase *I Municipal Stormwater Permit,* January 2009.

10.7 Washington State Department of Ecology Report, Sediment Trap Monitoring of Suspended Particulates in Stormwater Discharges to Thea Foss Waterway, 1998.

10.8 Washington State Department of Ecology Stormwater Management Manual for Western Washington, Publication No. 05-10-029, February 2005.

10.9 Washington State Department of Ecology Stormwater Management Manual for Eastern Washington, Publication No. 04-10-076, September 2004.

10.10 Washington State Department of Transportation, Maintenance Operations Division, Safety and Health Services Office, *Safety Procedures and Guidance Manual*, M75-01.13, July 2009.

10.11 Washington State Department of Transportation, Maintenance and Operations Division, Traffic Operations, *Work Zone Traffic Control Guidelines*, M 54-44.01, May 2008.

10.12 U.S. Geological Survey, National Field Manual for the Collection of Water Quality Data, Chapter A9, *Safety in Field Activities*, October 1997.

10.13 U.S. Department of Transportation, Federal Highway Administration, *Guidance Manual for Monitoring Highway Runoff Water Quality*, Publication No. FHWA-EP-01-022, June 2001.

Appendix A: Example Pre-Activity Safety Plan

PRE-ACTIVITY SAFETY PLAN

WETLAND ASSESSMENT *(UPDATED12 MAY 09)*

SITE:

Date:_____________ Employee:_________________________________

1. Complete pre-travel checklist prior to travel.
2. Plan for drinking water per WAC 296-62-095
3. Review / discusses the Pre-activity Safety Plan controls for each safety hazard identified on the completed hazard assessment checklist with all staff in the field.
4. Team lead maintains completed safety hazard checklist until all have checked in with their supervisor. Save document in the project folder for the next person or time that site may be visited.
5. Fill in the registration sheet (last sheet of this document).

Location: SR_____MP_____ County _________________
Region Contact:_____________________________________
Phone #: (____) _____ - _________
Nearest Medical Facility: ____________________________
Traffic Control Needed yes no
Cell Phone Service yes no
Closest phone:
____
____

Parking Location: SEE PAGE 5

Pre-Travel Checklist

- ☐ **CHECK WITH REGION TRAFFIC MANAGEMENT CENTER ABOUT RUSH HOUR SHOULDER CLOSURES**
- ☐ **Traffic Control Plan**
- ☐ Environmental Safety Hazard Assessment and Mitigation Booklet
- ☐ Washington State Hospital List
- ☐ Pre-Trip Vehicle Inspection and Familiarization
- ☐ 1st Aid Kit
- ☐ Flares/Triangles/Signs
- ☐ Radio Contact List
- ☐ Emergency Contact Phone List
- ☐ Beacons/signage/traffic cones available in vehicle
- ☐ Check SR View for parking possibilities (http://www.srview.wsdot.wa.gov/home.htm)

PPE's

- ☐ Vest
- ☐ Hard Hat
- ☐ Eye Protection
- ☐ Gloves
- ☐ Work Boots
- ☐ Hearing Protection
- ☐ Drinking Water
- ☐ Hip Boots or waders
- ☐ PFD
- ☐ Throw rope bag
- ☐ Sunblock
- ☐ Insect repellent
- ☐ Other: ____________

Task/Hazard	Control	Site Specific Comments	Requirements
1. Walking over uneven terrain. ☐ Yes ☐ No	1. Be aware of loose material, excavation drop-offs, tripping hazards (ruts, holes, etc.), uneven ground and other obstructions. 2. Move carefully in areas with the potential for slips, trips, or falls. 3. Wear appropriate footwear with adequate traction and support.		☐ Work boots ☐ Leather gloves (Optional put recommended in areas where blackberries are dominant)
2. Working on or around rip-rap ☐ Yes ☐ No	1. Evaluate rip-rap for loose, rolling, or unstable rocks. 2. Wear hard hat and evaluate need for leather gloves when loose or unstable rock conditions exist or when there is potential for falling rocks.		☐ Work boots and gloves
3. Working in noisy area ☐ Yes ☐ No	1. Wear hearing protection if sustained noise is at or above 85db (for example next to a freeway, or if you have to shout to be heard by a person 3 feet away from you).		☐ Hearing Protection needed

* The PASP's shouldn't include medical information. If employees elect to volunteer medical information to their supervisor and/or crew that's allowed, but the supervisor and/or crew shouldn't be soliciting that information and it **should not be recorded on this form**. If a worker volunteers information to co-workers or supervisor you can discuss options if that issue arises, but if they choose not to let anybody know it's their prerogative

Task/Hazard	Control	Site Specific Comments	Requirements
4. Bridge Work ☐ Yes ☐ No	1. Reference controls for: -Walking over uneven terrain -Working around a stream -Working around natural/manmade overhead hazards -Working around fall hazards 2. Coordinate with Maintenance personnel when working from bridge structures. Follow site specific PASP as required. 3. Box girder bridges may have confined spaces requiring training.		☐ Hard hat
5. Working around bridges, signs, light fixtures, power lines ☐ Yes ☐ No	1. Continuously assess potential for falling rock or other overhead hazards, especially in windy weather. 2. When possible, avoid, restrict time in, or work during times of least activity in hazard areas. 3. When in hazard area, wear hard hat, gloves, and safety glasses along with approved vest and footwear.		☐ Hard hat, gloves, boots
6. Isolated sites / 'bad neighborhoods' ☐ Yes ☐ No	1. Consider whether location warrants two people or a team to minimize exposure time. 2. Have cell phone or check-in plan in case of emergency.		☐ Two people on site ☐ Cell phone
7. Potential for confrontation with adjacent landowner ☐ Yes ☐ No	1. Evaluate the need for informing local residents of purpose of field work. 2. If an adjacent landowner is known to be problematic, evaluate providing a written or phone notice prior to the visit. 3. If confronted by a disgruntled landowner, speak calmly and leave the site. If threatened, in addition to the above, contact police, as well as your supervisor.		☐ Known problematic land owner: Name: ____________ Location: _________ Phone #: __________
8. Potential for transients or human biohazards ☐ Yes ☐ No	1. Avoid confrontations with transients. 2. Avoid contact with human waste, needles, or other drug paraphernalia. 3. Request assistance from maintenance to remove hazard, when necessary.		
9. Potential for confrontation with a domestic animal ☐ Yes ☐ No	1. If there is a known potentially dangerous animal on or around the site, contact the person responsible for that animal prior to visit. 2. Consider carrying a deterrent such as a shovel, whistle or mace. 3. If harmed, or confronted with the threat of harm, contact animal control, as well as your supervisor.		☐ Known problematic animal: Owner: ____________ Location: __________ Phone #: ___________

Task/Hazard	Control	Site Specific Comments	Requirements
10. Poisonous snake or large carnivore hazard ☐ Yes ☐ No	1. When working in a snake or large carnivore area, consider two or more people for site visits. 2. When in carnivore habitat, make your presence known by talking, whistling, etc. 3. Stay in sight of partner or in radio contact.		☐ Two people on site ☐ Radios
11. Harmful / poisonous plants ☐ Yes ☐ No	1. Be aware of what poison ivy/oak looks like (http://poisonivy.aesir.com/ has many images and information). 2. Be aware of potential for injury from vegetation around you. 3. Bring hand-pruners and glasses to prevent injury in thick brush and briers.		☐ Hand pruners ☐ Eye protection
12. Risk of insect / invertebrate problems ☐ Yes ☐ No	1. Determine if field staff are allergic to bees or yellow jackets. Bring appropriate first aid. Confirm location of nearest hospital. 2. Listen and look for bees frequently in the air and on the surface. When spotted, inform others in the field of the location. Evaluate carefully flagging location for future visits.		☐ Person with allergy?
13. Working around natural overhead hazards. ☐ Yes ☐ No	1. Assess potential for falling rock or other overhead hazards. 2. When possible, avoid or restrict time in the hazard area. 3. When in hazard area, wear hard hat, gloves, and safety glasses along with approved vest and footwear. 4. Request assistance from maintenance to remove hazard, if possible.		☐ Hard hat, gloves, boots
14. Working around fall hazards* ☐ Yes ☐ No	1. Do not work in the fall hazard area without appropriate safety equipment and training. 2. Observe fall protection rules in WAC 296-155 Part C-1**. Prepare a fall protection plan, WSDOT form 750-001, prior to performing the work		☐ Fall protection plan needed
17a. Hot weather - Is forecast is for >77 degrees? *** ☐ Yes ☐ No	1. Consider field partner. 2. Wear weather appropriate clothing. 3. Bring sunscreen and hat for sun protection. 4. Rest as needed; take off hat and vest on breaks. 5. Replenish fluids (drink 1 quart per hour). 6. Stay in sight of partner or in radio contact. 7. Evaluate team for heat-related illness and monitor for need of medical attention	Note in Safety Meeting documentation	☐ Two people on site ☐ Radios ☐ Hat, sunscreen ☐ Drink fluids
17b. Cold weather ☐ Yes ☐ No	1. In very cold/snow/stormy conditions, consider field partner. 2. Wear appropriate clothing – gloves, hat, thermal underwear, heavy jacket. 3. Stay in sight of partner or in radio contact 4. Is the vehicle equipped with chains/traction tires?		☐ Two people on site ☐ Appropriate attire ☐ Vehicle equipped with appropriate cold weather gear

** Fall hazard area: An area where you may lose your footing, slide, trip, or loose balance.
* WAC 296-155 is available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=296-155-24501

***Outdoor Heat Exposure WAC: http://www.lni.wa.gov/rules/AO06/40/0640Proposal.pdf

Task/Hazard	Control	Site Specific Comments	Requirements
18. Working in or around areas of shallow or slowly moving water ☐ Yes ☐ No	1. Evaluate water depth hazard. 2. Evaluate slippery/steep/hidden water edge conditions and need for avoidance or uphill partner. 3. Evaluate large woody debris hazard at the work site and down stream of it. 4. Assess depth of mud and evaluate safe exit. 5. Evaluate potential rescue options that are safe for the rescuer. When warranted, establish person with throw rope bag down slope of work area and between work area and any downstream hazard.		
19. Working around a stream defined as a water hazard (currents greater than 10cfs or deeper than 1-ft) ☐ Yes ☐ No	1. Evaluate potential rescue options that are safe for the rescuer. 2. Evaluate need for additional support from maintenance, bridge boat, or dive crews. 3. When appropriate, establish person with throw rope bag down slope of work area and any downstream in-channel hazard.		☐ Throw rope bag ☐ Hip boots or waders ☐ PFD
20. Working in a stream defined as a water hazard ☐ Yes ☐ No	1. No wading under hazard conditions without safety equipment and training or specialized crews. 2. For in-water work, wear hip waders, tight-fitting neoprene chest wader, or equivalent. In rocky areas, boots with slip resistant felt-like material soles are recommended. 3. Wear personal flotation device in swift/deep water conditions.		

Tool Used	Control	Site Specific Comments	Requirements
1. Shovel	1. Wear gloves, keep handles in good condition or replace.		☐ Gloves
2. Soils knife	1. Point away from bodies, sheath when not in use.		
3. Shears/clippers	1. Keep fingers clear of blades		

PARKING ISSUES

IF WORK OR PARKING IS ON PAVEMENT, SEE LANE CLOSURE REQUIREMENTS IN M54-44. Copy of pertinent parts of M54-44 are in vehicle. Park in areas that provide safe entrance and exit of the work area, do not create potential conflicts with other vehicles and equipment or fire hazard on tall grass.

1. SHOULDER CLOSURES: Park and/or work on roadside <15 ft. from edge of pavement more than 1 hour ☐ Yes ☐ No	1. Coordinate with region Traffic Management Center about rush hours 2. Use beacon lights per WAC 204-38* requirements. 3. Follow the signage and work provisions in the M54-44** for long duration work zones. **USE Chapter 2 - TCP 5 or 6. Keep appropriate TCP with you.** 4. Modify positions of cones if there is limited visibility or curves in road. 5. Evaluate noise level. If over 85db, use hearing protection.	☐ >1 hour = Stationary work zone. **Use signs and cones with beacon lights: TCP 5 or 6** ☐ Vest needed ☐ Hearing Protection ☐ Hard Hat

2. Park and/or work on <15 ft. from edge of pavement less than 1 hour ☐ Yes ☐ No	1. Use beacon lights if adequate sight distance per WAC 204-38*. Use signs/cones if reduced visibility 2. Follow the signage and work provisions in the M54-44** for short duration work zones - Chapter 3. 3. If high speed and volume, close shoulder as above. 4. Evaluate noise level. If over 85db, use hearing protection.	☐ < 1 hour Short Duration Work Zone, vehicle beacon lights ☐ Vest needed ☐ Hearing Protection ☐ Hard Hat
3. Traffic an issue, but parking and/or work locations are >15 ft from edge of pavement ☐ Yes ☐ No	1. Face oncoming traffic while on foot. 2. Be aware of or develop emergency escape routes. 3. Always wear appropriate high visibility apparel; minimum is ANSI class II vest. Avoid working alone. 4. Evaluate noise level. If over 85db, use hearing protection.	☐ Vest needed ☐ Hearing Protection ☐ Hard Hat
5. Walking from vehicle to work area near high-speed lane ☐ Yes ☐ No	1. When you can not face oncoming traffic while, try to be aware of what is happening behind you. 2. Be aware of or develop emergency escape routes. 3. Always wear appropriate high visibility apparel; minimum is ANSI class II vest. Avoid working alone. 4. Be especially careful of crossing lanes of traffic and uneven footing that could cause falls into traffic lanes. 5. Evaluate noise level. If over 85db, use hearing protection.	☐ Vest needed ☐ Hearing Protection ☐ Hard Hat

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

** M54-44 is available at http://www.wsdot.wa.gov/publications/manuals/fulltext/M54-44/Workzone.pdf

HQ: Frank Newboles, State Workzone Safety & Mobility Manager (Policy)
Marty Weed, State Traffic Control Engineer (Technical)
Steve Haapala, State Workzone Training Specialist
Marlin Zimmerman, Traffic Operations Engineer (Training)

Registration Sheet

On-site Checklist

1.Specific concerns: allergies and injuries
2.Cell phones on site
3.Prepared for day (water jug full, clothing…)
4.bio or chemical hazards

Biologist Name and Additional Staff Initials	Date	Notes and Concerns

APPENDIX C: SEATTLE PUBLIC UTILITIES STANDARD OPERATING PROCEDURES

Identifier:	Revision:	Draft revised on:
W&SQ C3100	R0D2(DRAFT)	4/9/2008
Custodian:		Authorization Authority:
Brian Robinson		Beth Schmoyer

Water & Sediment Quality

Standard Operating Procedure

WQ&S C3100 – In-line Sediment Traps

Seattle Public Utilities
Seattle , Washington

This document is part of the Science Information Quality System and describes standard operating procedures to ensure a systematic consistent approach is followed for collecting, assessing, and documenting environmental data of known and documented quality.

WQ&S C3100 – In-line In-line Sediment Traps

See also the following Standard Operating Procedures:

WQ&S Q1000 General (Specific program needs - training, roles & responsibilities, etc.)

WQ&S Q1100 Data Validation (review & verification, validation, assessment)

WQ&S Q1200 Data Management (retrieval through archiving)

WQ&S Q1300 Data Requests

A. Introduction, Scope, and Applicability

Sediment traps are designed to passively collect samples of suspended solids present in stormwater runoff. This Standard Operating Procedure (SOP) describes field procedures that will be utilized to ensure that sediment traps are installed in a consistent manner to collect samples that are representative of the matrix being sampled, and the data will be comparable to data collected by other existing and future monitoring programs. Procedures are described for installing sediment traps, retrieving sample bottles, decontaminating sample bottles, and recording field measurements and conditions.

Sampling procedures will generally follow Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1997) and the NPDES Stormwater Sampling Guidance Manual (U.S. EPA 1992).

B. Training

SPU staff must comply with City confined space entry procedures before entering drainage and/or combined sewer systems for sediment trap installation (see SPU 2007).

All personnel implementing this SOP are required to be currently certified for:

40 hour hazardous waste operations training per WAC 296-843.

Confined space entry training per WAC 296-809.

C. General Considerations

Wherever possible, traps will be mounted in quiescent areas (e.g., maintenance holes and vaults) to maximize sample collection. Sampling locations will be selected to avoid small diameter pipes (e.g., less than 24-inch diameter) because a large storm event is generally needed in these systems to inundate the approximately 8-inch tall sample bottle.

D. Equipment and Supplies

Sediment traps consist of a stainless steel bracket mounted inside the storm drain system. The bracket holds a wide-mouth Teflon bottle (Figure 1). Sediment traps were initially designed by the State Department of Ecology (Wilson and Norton 1996, Barnard and Wilson 1995) and have since been modified by both Tacoma (Norton 1997) and SPU. SPU's modifications permit the use of a wide mouth bottle and expand on Tacoma's changes to enable the sample bottle to be installed in a vertical position in most field conditions (i.e., maintenance holes, vaults, and pipes). Brackets are mounted onto the wall of the pipe, maintenance hole, or other structure using metal hit anchors (Hilti®). Extension plates can be used when the sediment trap bracket is mounted to a vertical wall and the bracket is submerged below the water level.

Equipment and supplies needed to implement this SOP include:

- Confined space entry and safety equipment:
  - Confined space entry/safety equipment (tripod/winch, safety harness, 4-gas meter, emergency contacts)
  - Maintenance hole hook
  - Hard hat
  - Safety vest
  - Steel toe boots
- Sampling equipment:
  - Sediment trap brackets
  - Teflon containers for sediment traps - SPU supplied/laboratory cleaned
  - Rotohammer drill with ¼" concrete drill bit
  - Stainless steel metal hit anchors (Hilti®)
  - Hammer
- Sampling supplies:
  - Latex gloves
  - Cooler with ice
- Documentation supplies:
  - Field notebook
  - Sample labels
  - Chain-of-custody forms
  - Camera.

E. Procedures

The field lead is responsible for ensuring that the sampling team meets the training requirements, that traffic control is in place if needed, and all confined space procedures are followed as appropriate.

SEDIMENT TRAP INSTALLATION

Two traps will be installed at each monitoring location to ensure that an adequate volume of sample is collected for chemical analysis. In vaults and maintenance holes that are equipped with sumps, the trap will be mounted so that the mouth of the sample bottle is just above the base flow level or static water level to sample only storm flows. In pipes and other locations, the trap will be installed at the lowest point in the pipe.

The angle of the bracket is adjustable in order to install the sediment trap in a vertical position. The bracket is designed to be mounted with the angle adjustment plane perpendicular to the flow (see Figure 1). Before installing the bracket, test fit the bracket at the intended location and adjust the angle of the bracket into the most vertical position.

A rotohammer drill equipped with a ¼" concrete drill bit is used to drill the pilot holes for mounting the bracket. The pilot holes are drilled through the four mounting holes located on each corner of the bracket. Stainless steel hit anchors are inserted through the bracket and into the pilot holes. The pin of the metal hit anchor is driven down with a hammer to secure the bracket into place. Figure 2 shows a typical sediment trap installation at the lowest point in the pipe. In vaults or maintenance holes with base flow or standing water, an extension plate can be used to mount the bracket so that the bottle opening is flush or slightly higher than the standing water level. If an extension plate is used, the bracket must be mounted to the extension plate using short 1/4'" diameter bolts before mounting into place. Figure 3 shows sediment traps mounted to the vertical wall of a vault using extension plates.

At the end of the project, the sediment traps will be retrieved and decontaminated. The cleaning protocol for sediment traps is summarized below:

- Phosphate-free detergent wash and tap water rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse
- Air dry.

SEDIMENT TRAP INSPECTION

Traps will be checked every 6 months, or as specified by the Quality Assurance Project Plan, to evaluate their condition (e.g., damage and sediment volume). If necessary, installations may be modified to improve sample collection and/or repair any damage that may occur. Possible changes include:

- Install more traps (if less than 0.5 inches of sediment deposited during a 6-month period)
- Install debris deflectors to protect the trap and prevent debris (e.g., plastic bags) from blocking the trap

- Install a weir or other structure to enhance sediment deposition by ensuring that the sample bottle is inundated under most storm flows
- Move traps to a different location.

SAMPLE COLLECTION

This section describes procedures for retrieving the sample from the sediment trap, preparing quality control samples, and cleaning the sample trap bottles.

Sample Bottle Retrieval

Traps will be checked every 6 months, or as specified by the Quality Assurance Project Plan, to evaluate their condition (e.g., damage and sediment volume) and to retrieve the bottles for chemical analysis. Traps will be retrieved before and after the winter wet season, approximately September and March of each year.

Sample bottles will be retrieved following PSEP (1997) sample handling guidelines. Latex gloves will be worn at all times when collecting sediment samples. The sample bottles will be capped in place with a clean Teflon lid, removed from the bracket, stored in a cooler on ice, and transported directly to the analytical laboratory. Clean Teflon bottles will be immediately redeployed for the next 6-month sampling period. Descriptions of field observations (e.g., potential construction activities that could interfere with sample collection) and sample characteristics (e.g., sheen, odor, color, amount and type of particles being removed, size description) will be included in the field notes recorded during sample collection.

Sample Bottle Cleaning

Teflon sample bottles will be cleaned by the analytical laboratory and returned to SPU for storage and re-use. After cleaning, the bottles will be capped for storage and transport. The cleaning protocol is summarized below:

- Phosphate-free detergent wash and tap water rinse
- 10 percent ultra-pure hydrochloric acid rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse
- Air dry.

F. Records and Documentation

Copies of the field notes, the signed chain-of-custody, and the sample results (pdf and electronic data deliverable file received from the analytical laboratory) will be maintained in the project file.

G. References

Barnard, B. and C. Wilson. 1995. Stormwater sediment trap literature review and design consideration. No. 95-309. Washington Department of Ecology, Olympia, WA.

Norton, D. 1997. Stormwater sediment trap monitoring of discharges to The Foss Waterway. No. 97-322. Washington Department of Ecology, Olympia, WA.

SPU. 2007. Seattle safety policy and procedures in confined space entry. SPU–SAF–001. Seattle Public Utilities, Safety Office, Seattle, WA.

PSEP. 1997. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Prepared by Washington Department of Ecology, Olympia, Washington for EPA, Region 10, Office of Puget Sound, Seattle, WA. April 1997.

Wilson, C. and D. Norton. 1996. Stormwater sediment trap pilot study. No. 96-347. Washington Department of Ecology, Olympia, WA.

H. List of Revisions

The current list of revisions for this SOP follows.

Revision Number	Effective Date	Review Status	Revised by	Revision Summary
R0D1	3/3/2008	Draft	Brian Robinson	Draft
R0D1	4/8/2008	Draft	Beth Schmoyer	Review comments.
R0D2	4/9/2008	Draft	Shelly Basketfield	Modified headings. Revised number from WQ&S 3301.

I. Tables, Forms, and Figures

Figure 1: SPU sediment trap mounting bracket.

Figure 2: Typical sediment trap installation.

Figure 3: Sediment traps mounted vertically on the sidewall of a vault.

Identifier: W&SQ S3300	Revision: R0D2(DRAFT)	Draft revised on: 4/8/2008	Seattle Public Utilities
Custodian: Brian Robinson		Authorization Authority: Beth Schmoyer	

Water & Sediment Quality

Standard Operating Procedure

W&SQ S3300 – Storm Drain Sediment Sampling: Catch basin and in-line grab sample collection

Seattle Public Utilities
Seattle , Washington

This document is part of the Science Information Quality System and describes standard operating procedures to ensure a systematic consistent approach is followed for collecting, assessing, and documenting environmental data of known and documented quality.

Table of Contents

WQ&S S3300 –Storm Drain Sediment Sampling: Catch basin and in-line grab sample collection

See also the following Standard Operating Procedures:

WQ&S Q1000 General (Specific program needs - training, roles & responsibilities, etc.)

WQ&S Q1100 Data Validation (review & verification, validation, assessment)

WQ&S Q1200 Data Management (retrieval through archiving)

WQ&S Q1300 Data Requests

WQ&S S3301 In-line Sediment Trap Installation

J. Introduction, Scope, and Applicability

This section describes field procedures that will be utilized to collect grab samples of accumulated sediment from drainage and wastewater structures such as catch basins, inlets, maintenance holes, and vaults. Seattle Public Utilities (SPU) developed these procedures to ensure that samples are collected in a consistent manner and are representative of the matrix being sampled, and the data will be comparable to data collected by other existing and future monitoring programs. Procedures are described for collecting sediment samples, decontaminating sampling equipment, and recording field measurements and conditions. Requirements for sample containers and preservation, sample identification, and field quality control procedures are also described.

Sampling procedures will generally follow Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1997) and the NPDES Stormwater Sampling Guidance Manual (U.S. EPA 1992).

K. Training

Special training is required and must be documented for all personnel who implement this SOP. The required training includes:

- 40-hour hazardous waste operations training per WAC 296-843.
- Confined space entry training per WAC 296-809.

L. General Considerations

SPU staff must comply with City confined space entry procedures before entering storm drain and/or combined sewer systems for sediment trap installation (see SPU 2007).

M. Equipment and Supplies

Equipment and supplies needed to implement this SOP include:

- Sampling equipment:
  - Glass sample containers supplied by laboratory
  - Stainless steel scoops and/or extension pole with swivel attachment
  - Stainless steel mixing bowls
  - Stainless steel spoons
- Sampling supplies:
  - Ziploc® bags
  - Cooler with ice
  - Latex gloves
- Safety equipment:
  - Hard hat
  - Safety vest
- Documentation supplies:
  - Field notebook
  - Sample labels
  - Chain-of-custody forms
  - Camera.

N. Procedures

Sediment samples will be collected following PSEP (1997) guidelines for sediment sample collection. Latex 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, and color) will be included in field notes recorded during sample collection. All sediment collection equipment will be decontaminated following PSEP guidelines (see below).

SEDIMENT SAMPLE COLLECTION

Catch-basin and in-line sediment samples will be collected using stainless steel spoons and long-handled scoops or soil coring devices. Samples will be collected from the top 3-4 inches of sediment accumulated in the catch basin sump or in-line structure. Individual aliquots will be collected from at least three locations in the sump/structure, placed in a stainless steel bowl, and thoroughly mixed. Any particles greater than 2 centimeter in size (e.g., sticks, leaves, beverage containers, miscellaneous pieces of plastic and metal, stones and gravel) will be removed from the sample and discarded. After mixing, samples will be placed into laboratory supplied sample containers provided. Samples will be placed in a cooler and stored on ice until delivered to the analytical laboratory.

SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Sample containers will be supplied by the analytical laboratory for the required analyses. Spare sample containers will be carried by the field samplers in case of breakage or possible contamination. Sample containers, preservation techniques, and holding times will follow PSEP (1997) guidelines and the Quality Assurance Project Plan (QAAP) under which samples are collected.

SAMPLE IDENTIFICATION AND LABELING

Unless otherwise specified in the SAP, a unique site number and the date of collection will identify each sample (e.g., ST1-032803-1 for the first sample collected from sediment trap #1 on March 28, 2003). Prior to filling, sample containers will be labeled with the following information using indelible ink:

- Sample identification number
- Date of collection (day/month/year)
- Time of collection (military format)
- Project name (basin name)
- Analytes
- Sampler ID.

FIELD NOTES

When visiting the sampling station, field personnel will record the following information on field forms that are maintained in a waterproof field notebook.

- Date
- Time of sample collection or visit
- Name(s) of sampling personnel
- Description of sampling location (e.g., street intersection, SPU IMS identification number for city-owned structures, site address and location of drainage structure on the property)
- Weather conditions
- Number and type of samples collected

- Field measurements
- Log of photographs taken
- Comments on the working condition of the sampling equipment
- Deviations from sampling procedures
- Unusual conditions (e.g., water color or turbidity, presence of oil sheen, odors, and land disturbances)
- Visual observations of color, texture (estimate particle size fractions per standard soil classification), and amount and type of debris.

For onsite catch basin samples, the following additional information will be recorded on the field form and field notebook:

- Map showing location of catch basin on the property
- Date site was last inspected by City source control staff
- Date the catch basin was last cleaned.

Sample Transport and Custody

All samples will be stored on ice at 4°C in a cooler and transported directly to the analytical laboratory. A chain-of-custody record will accompany the samples.

Field Duplicates

Field duplicates will be collected for each type of sediment sample at a minimum frequency of 5 percent, unless otherwise specified in the SAP. If sufficient sample volume exists, field duplicates may be collected and archived (frozen) for future analysis if necessary. Additional volume will be collected and mixed thoroughly for the collection of the field duplicate.

Equipment Decontamination

All sampling equipment, including stainless-steel materials will be decontaminated prior to each sampling event. The following decontamination procedures will be followed after every sampling event:

Stainless-Steel Scoop and Mixing Bowl

- Phosphate-free detergent wash and tap water rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse

- Air dry
- Wrapped in new aluminum foil

After the decontamination procedures have been completed, the sampling equipment will be capped or sealed with new aluminum foil and the sampling device will be protected and kept clean.

O. Records and Documentation

Copies of the field notes, the signed chain-of-custody, and the sample results (pdf and electronic date deliverable file received from the analytical laboratory) will be maintained in the project file..

P. References

EPA 1996. Environmental investigations standard operating procedures and quality assurance manual. Prepared by U.S. Environmental Protection Agency, Region 4, Athens, Georgia.

PSEP. 1997. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Prepared by Washington Department of Ecology, Olympia, Washington for EPA, Region 10, Office of Puget Sound, Seattle, WA. April 1997.

SPU 2007. Seattle safety policy and procedures in confined space entry. SPU–SAF–001. Seattle Public Utilities, Safety Office, Seattle, Washington.

Q. List of Revisions

The current list of revisions for this SOP follows.

Revision Number	Effective Date	Review Status	Revised y	Revision Summary
R0D1	11/5/2007	Draft	RheaumA	draft
R0D2	4/8/2008	Draft	SchmoyB	final

R. Tables, Forms, and Figures

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APPENDIX D: EXAMPLE CHAIN OF CUSTODY

CHAIN OF CUSTODY

COC #__________

Project #	Purchase Order #
Project Name	
Company Name	
Project Manager or Contact & Phone #	Report Copy to:
Requested Completion Date:	Site ID

Sample Disposal: Dispose ☐ Return ☐

TOTAL # OF CONTAINERS

Requested Analytical Method #

Preservative (to be filled out by customer)

THIS AREA FOR LAB USE ONLY		
Lab #	Page	of
Lab PM	Custody Review	
Log In	LIMS Verification	
pH	Custody Seals Y N	
	Ice Y N	
QC Level 1 2 3 Other______		
Cooler Temperature		

Sampling: Date	Sampling: Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	Matrix: AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Requested Analytical Method #									Alternate Description	Lab ID

Sampled By and Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via UPS Fed-Ex Other______	Shipping #

Special Instructions:

INVOICE INFORMATION

P.O. # __________

Bill To __________

Instructions and Agreement Provisions on Reverse Side

Distributions – Original - Lab. Yellow - Lab. Pink - Client

Typical Chain of Custody for Sampling

APPENDIX E: SMS APPLICABLE TO RECONTAMINATION STUDY

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Table E-1 SMS Standards from Chapter 173-204 WAC

Analyte	CAS Number	SQS[1]	CSL[2]
Conventional Inorganic Parameters (%)			
Total Solids		N/A	N/A
Total Organic Carbon		N/A	N/A
Grain Size		N/A	N/A
Metals (mg/kg dry weight)			
Arsenic		57	93
Copper		390	390
Lead		450	530
Mercury		0.41	0.59
Zinc		410	960
Semi-volatile Organic Compounds (mg/kg Organic Carbon)			
1,2,4-Trichlorobenzene	120-82-1	0.81	1.8
1,2-Dichlorobenzene	95-50-1	2.3	2.3
1,3-Dichlorobenzene	541-73-1	N/A	N/A
1,4-Dichlorobenzene	104-46-7	3.1	9
2,4,5-Trichlorophenol	95-95-4	N/A	N/A
2,4,6-Trichlorophenol	88-06-2	N/A	N/A
2,4-Dichlorophenol	120-83-2	N/A	N/A
2,4-Dinitrophenol	51-28-5	N/A	N/A
2,4-Dinitrotoluene	121-14-2	N/A	N/A
2,6-Dinitrotoluene	606-20-2	N/A	N/A
2-Chloronaphthalene	91-58-7	N/A	N/A
2-Chlorophenol	95-57-8	N/A	N/A
2-Methyl-4,6-dinitrophenol	534-52-1	N/A	N/A
2-Nitroaniline	88-74-4	N/A	N/A
2-Nitrophenol	88-75-5	N/A	N/A
3,3'-Dichlorobenzidine	91-94-1	N/A	N/A
3-Nitroaniline	99-09-2	N/A	N/A
4-Bromophenyl Phenyl Ether	101-55-3	N/A	N/A
4-Chloro-3-methylphenol	59-50-7	N/A	N/A
4-Chloroaniline	106-47-8	N/A	N/A
4-Chlorophenyl Phenyl Ether	7005-72-3	N/A	N/A
4-Nitroaniline	100-01-6	N/A	N/A
4-Nitrophenol	100-02-7	N/A	N/A
bis(2-Chloroethoxy)methane	111-91-1	N/A	N/A
bis(2-Chloroethyl) Ether	111-44-4	N/A	N/A
bis(2-Chloroisopropyl) Ether	108-60-1	N/A	N/A
bis(2-ethylhexyl) Phthalate	117-81-7	47	78
Butyl Benzyl Phthalate	85-68-7	4.9	64
Dibenzofuran	132-64-9	15	58
Diethyl Phthalate	84-66-2	61	110
Dimethyl Phthalate	131-11-3	53	53
Di-n-butyl Phthalate	84-74-2	220	1700
Di-n-octyl Phthalate	117-84-0	58	4500

Table E-1 SMS Standards from Chapter 173-204 WAC

Analyte	CAS Number	SQS[1]	CSL[2]
Semi-volatile Organic Compounds (mg/kg Organic Carbon) continued			
Hexachlorobenzene	118-74-1	0.38	2.3
Hexachlorobutadiene	87-68-3	3.9	6.2
Hexachlorocyclopentadiene	77-47-7	N/A	N/A
Hexachloroethane	67-72-1	N/A	N/A
Isophorone	78-59-1	N/A	N/A
Nitrobenzene	98-95-3	N/A	N/A
n-Nitrosodi-n-propylamine	621-64-7	N/A	N/A
n-Nitrosodiphenylamine	86-30-6	11	11
Semi-volatile Organic Compounds (µg/kg dry weight)			
Benzoic Acid	65-85-0	650	650
Benzyl Alcohol	100-51-6	57	73
4-Methylphenol	106-44-5	670	670
2-Methylphenol	95-48-7	63	63
2,4-Dimethylphenol	105-67-9	29	29
Pentachlorophenol	87-86-5	360	690
Phenol	108-95-2	420	1200
Polycyclic Aromatic Hydrocarbons (mg/kg Organic Carbon)			
2-Methylnaphthalene	91-57-6	N/A	N/A
Acenaphthene	83-32-9	16	57
Acenaphthylene	208-96-8	66	66
Anthracene	120-12-7	220	1200
Benz(a)anthracene	56-55-3	110	270
Benzo(a)pyrene	50-32-8	99	210
Benzo(b)fluoranthene	205-99-2	N/A	N/A
Benzo(g,h,i)perylene	191-24-2	31	78
Benzo(k)fluoranthene	207-08-9	N/A	N/A
Chrysene	218-01-9	110	460
Dibenz(a,h)anthracene	53-70-3	12	33
Fluoranthene	206-44-0	160	1200
Fluorene	86-73-7	23	79
Indeno(1,2,3-cd)pyrene	193-39-5	34	88
Naphthalene	91-20-3	99	170
Phenanthrene	85-01-8	100	480
Pyrene	129-00-0	1000	1400
Dioxins/Furans (ng/kg)			
2,3,7,8-TCDD		N/A	N/A
1,2,3,7,8-PeCDD		N/A	N/A
1,2,3,4,7,8-HxCDD		N/A	N/A
1,2,3,6,7,8-HxCDD		N/A	N/A
1,2,3,7,8,9-HxCDD		N/A	N/A
1,2,3,4,6,7,8-HpCDD		N/A	N/A
OCDD		N/A	N/A
2,3,7,8-TCDF		N/A	N/A

Table E-1 SMS Standards from Chapter 173-204 WAC

Analyte	CAS Number	SQS[1]	CSL[2]
1,2,3,7,8-PeCDF		N/A	N/A
2,3,4,7,8-PeCDF		N/A	N/A
1,2,3,4,7,8-HxCDF		N/A	N/A
1,2,3,6,7,8-HxCDF		N/A	N/A
1,2,3,7,8,9-HxCDF		N/A	N/A
2,3,4,6,7,8-HxCDF		N/A	N/A
1,2,3,4,6,7,8-HpCDF		N/A	N/A
1,2,3,4,7,8,9-HpCDF		N/A	N/A
OCDF		N/A	N/A

Notes:

1 WAC173-204-320: Table I:Marine Sediment Quality Standards - Chemical Criteria

2 WAC 173-204-520 Table III Puget Sound Marine Sediment Cleanup Screening Levels Minimum Cleanup Levels —Chemical Criteria

N/A – Not Available
mg/kg – milligram per kilogram
µg/kg – microgram per kilogram
ng/kg - nanogram per kilogram