EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY
FINAL QUALITY ASSURANCE PROJECT PLAN
SURFACE WATER COLLECTION AND CHEMICAL ANALYSIS

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

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Prepared by:

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East Waterway Surface Water Collection and Chemical Analysis
Quality Assurance Project Plan

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Acronyms and Abbreviations

ACRONYM	Definition
%RSD	percent relative standard deviation
ANSETS	Analytical Services Tracking System
ARI	Analytical Resources, Inc.
Brooks Rand	Brooks Rand Labs LLC
CSO	combined sewer overflow
DGPS	differential global positioning system
DQI	data quality indicator
DQO	data quality objective
DRC	dynamic reaction cell
Ecology	Washington State Department of Ecology
EPC	exposure point concentration
EPA	US Environmental Protection Agency
ERA	ecological risk assessment
EW	East Waterway
EWG	East Waterway Group
FEP	fluorinated ethylene propylene
FC	field coordinator
GC/ECD	gas chromatography/electron capture detection
GC/MS	gas chromatography/mass spectrometry
CFR	Code of Federal Regulations
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HHRA	human health risk assessment
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
HSP	health and safety plan
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
LCS	laboratory control sample
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate

ACRONYM	Definition
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PM	project manager
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SIM	selective ion monitoring
SOP	standard operating procedure
SRI/FS	supplemental remedial investigation/feasibility study
SRM	standard reference material
Striplin	Striplin Environmental Associates, Inc.
SVOC	semivolatile organic compound
TBT	tributyltin
TM	task manager
TRV	toxicity reference value
UCL	upper confidence limit
Windward	Windward Environmental LLC
WQA	water quality assessment
WQS	water quality standard

1 Introduction

This quality assurance project plan (QAPP) describes the sampling design and quality assurance (QA) objectives for collecting and analyzing surface water samples in the East Waterway (EW) as part of the supplemental remedial investigation/feasibility study (SRI/FS). Details about project organization and management, field data collection methods, sample handling, laboratory analytical protocol, and data management and documentation are also provided. This QAPP was prepared in accordance with guidance for preparing QAPPs from the US Environmental Protection Agency (EPA) (2002).

In combination with existing data, data from this study will be used to support the EW SRI and FS.

This QAPP is organized into the following sections:

- Section 2 – project management
- Section 3 – data generation and acquisition
- Section 4 – assessment and oversight
- Section 5 – data validation and usability
- Section 6 – references

Appendix A is a health and safety plan (HSP) designed to protect onsite personnel from physical, chemical, and other hazards posed by the field sampling effort. Field collection forms are included as Appendix B. Data management procedures are included as Appendix C. Risk-based analytical concentration goals are presented in Appendix D. Appendix D contains a list of all compounds that will be analyzed, including laboratory method detection limits (MDLs) and reporting limits (RLs).

2 Project Management

This section describes the overall management structure of the project, identifies key personnel, and describes their responsibilities, including field coordination, QA and quality control (QC), laboratory management, and data management. The East Waterway Group (EWG) and EPA will be involved in all aspects of this project, including discussion, review, and approval of the QAPP, and interpretation of the results of the investigation.

2.1 Project Organization and Team Member Responsibilities

This sampling effort will be performed by Windward Environmental LLC (Windward) for the EWG. The overall project organization and the individuals responsible for the various tasks required for the surface water chemistry sample collection and analysis

are shown in Figure 2-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following subsections.

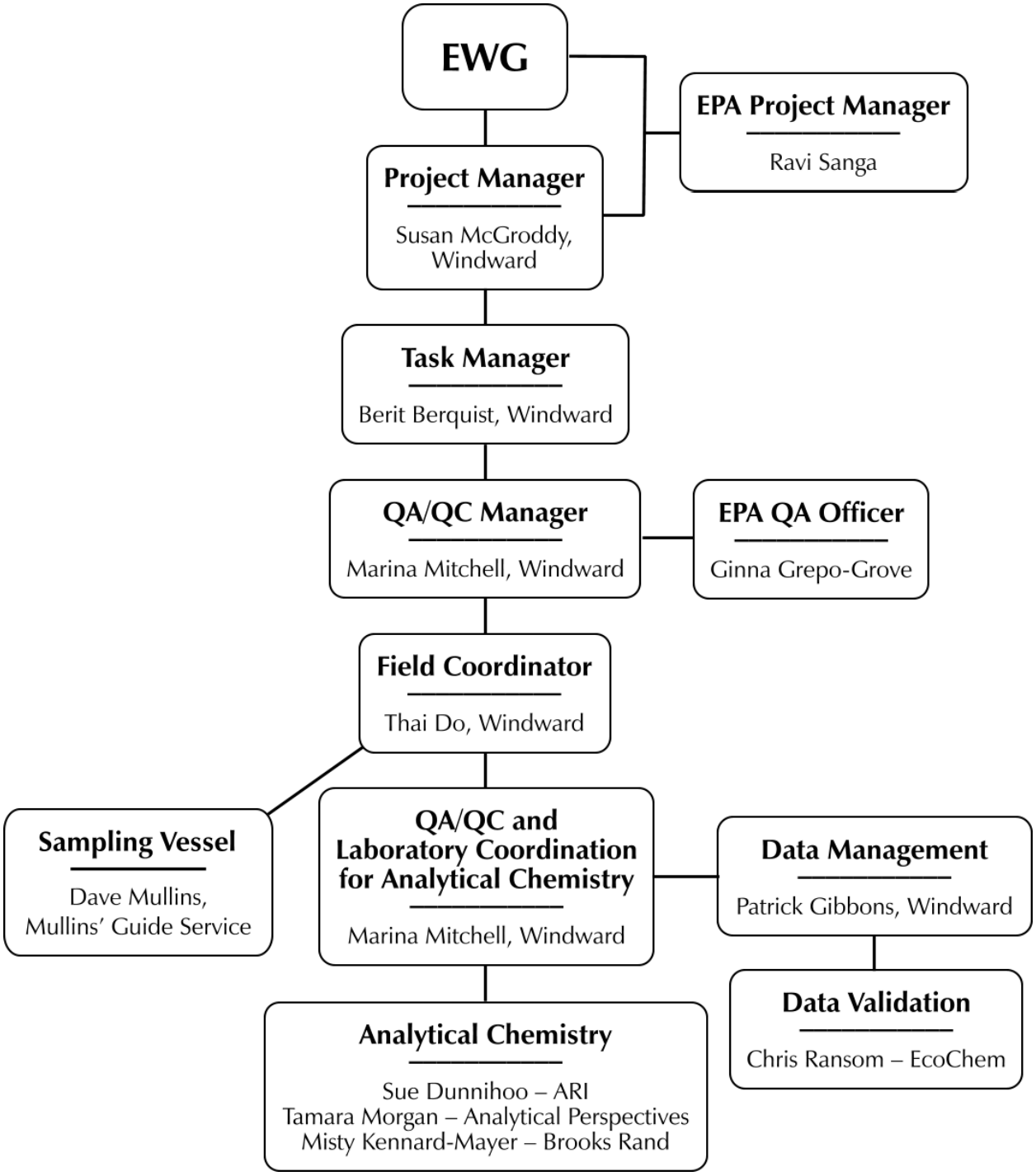

Figure 2-1. Project organization and team responsibilities

2.1.1 Project management

EPA will be represented by its PM, Ravi Sanga. Mr. Sanga can be reached as follows:

Mr. Ravi Sanga
US Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
ECL-111
Seattle, WA 98101-3140
Telephone: 206.553.4092
Facsimile: 206.553.0124
E-mail: Sanga.Ravi@epamail.epa.gov

Susan McGroddy will serve as the Windward PM and will be responsible for overall project coordination and providing oversight on planning and coordination, work plans, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. She will also be responsible for coordinating with EWG and EPA on schedule, deliverables, and other administrative details. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.577.1292
Facsimile: 206.217.0089
E-mail: susanm@windwardenv.com

Berit Bergquist will serve as the Windward task manager (TM). The TM is responsible for project planning and coordination, production of work plans, production of project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The TM is responsible for communicating with the Windward PM on progress of project tasks and any deviations from the QAPP. Significant deviations from the QAPP will be further reported to EWG and EPA. Ms. Bergquist can be reached as follows:

Berit Bergquist
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5403
Facsimile: 206.217.0089
E-mail: beritb@windwardenv.com

2.1.2 Field coordination

Thai Do will serve as the Windward field coordinator (FC). The FC is responsible for managing the field sampling activities and general field and QA/QC oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will oversee delivery of environmental samples to the designated laboratories for chemical analysis. Deviations from this QAPP will be reported to the TM and PM for consultation. Significant deviations from the QAPP will be further reported to representatives of EWG and EPA. Mr. Do can be reached as follows:

Mr. Thai Do
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5407
Facsimile: 206.217.0089
E-mail: thaid@windwardenv.com

Dave Mullins will serve as the boat captain and is responsible for operating the boat. The boat captain will work in close coordination with the FC to ensure that sample collection is consistent with the methods and procedures presented in this QAPP. Mr. Mullins can be reached as follows:

Mr. Dave Mullins
Mullins' Guide Service
(b) (6) [redacted]
Lynnwood, WA 98037
Telephone: 425.743.7266
Mobile: (b) (6) [redacted]
E-mail: (b) (6) [redacted]

2.1.3 Quality assurance/quality control

Marina Mitchell of Windward will oversee QA/QC for the project. As the QA/QC manager, she will oversee coordination of the field sampling and laboratory programs and supervise data validation and project QA coordination, including coordination with the EPA QA officer, Ginna Grepo-Grove.

Ms. Mitchell can be reached as follows:

Ms. Marina Mitchell
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5424
Facsimile: 206.217.0089
E-mail: marinam@windwardenv.com

Ms. Grepo-Grove can be reached as follows:

Ms. Ginna Grepo-Grove
US Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900 (OEA-095)
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Telephone: 206.553.1632
E-mail: grepo-grove.gina@epa.gov

EcoChem Inc. will provide independent third-party review and validation of analytical chemistry data. Chris Ransom will act as the data validation PM and can be reached as follows:

Ms. Chris Ransom
EcoChem Inc.
Dexter Horton Building
710 Second Avenue, Suite 600
Seattle WA 98104
Telephone: 206.233.9332
E-mail: cransom@ecochem.net

2.1.4 Laboratory project management

Marina Mitchell of Windward will serve as the laboratory coordinator for the analytical chemistry laboratories (see contact information in Section 2.1.3). Analytical Resources, Inc. (ARI), Analytical Perspectives, and Brooks Rand Labs LLC (Brooks Rand) will perform chemical analyses. Sue Dunnihoo will serve as the laboratory PM for ARI, Tamara Morgan will serve as the laboratory PM for Analytical Perspectives, and Misty Kennard-Mayer will serve as laboratory PM for Brooks Rand. The laboratory PMs can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 S 134th Place, Suite 100
Tukwila, WA 98168
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E-mail: sue@arilabs.com

Ms. Tamara Morgan
Analytical Perspectives
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Wilmington, NC 28405
Telephone: 910.794.1613
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E-mail: tmorgan@ultratrace.com

Ms. Misty Kennard-Mayer
Brooks Rand Labs LLC
3958 Sixth Avenue NW
Seattle, WA 98107
Telephone: 206.632.6206
Facsimile: 206.632.6017
E-mail: misty@brooksrand.com

The laboratories will do the following:

- Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure
- Adhere to documentation, custody, and sample logbook procedures
- Implement QA/QC procedures defined in this QAPP
- Meet all reporting requirements
- Deliver electronic data files as specified in this QAPP
- Meet turnaround times for deliverables as described in this QAPP
- Allow EPA and the QA/QC manager, or a representative, to perform laboratory and data audits

2.1.5 Data management

Mr. Patrick Gibbons will oversee data management to ensure that analytical data are incorporated into the EW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the EW SRI/FS.

2.2 PROBLEM DEFINITION/BACKGROUND

The primary objectives for surface water chemistry sampling in the EW are to supplement existing surface water data for the EW and to provide a dataset of sufficient quantity and quality to evaluate risk to humans, fish, and wildlife exposed to environmental media of the EW. Specific objectives for evaluating risk to humans, fish, and wildlife from surface water exposure are described in the following subsections.

Surface water data may also be needed to support the development of a food web model and for the evaluation of sediment transport and associated recontamination potential in the EW. Surface water data from the EW are not needed for the source identification or estimating lateral source loadings to the EW. Data collected from upland areas is more appropriate for those tasks. The sediment transport evaluation is a separate task; specific data needs with respect to surface water will be identified in the work plan, which will be submitted to EPA in the fall of 2008. Thus, although the surface water sampling plan described in this QAPP is designed for data collection for

the risk assessments, these data may also be used in support of the sediment transport evaluation, if appropriate.

2.2.1 Human health risk evaluation

For the evaluation of surface water exposures, the EW human health risk assessment (HHRA) will focus on risks to humans from exposures that occur during water recreation (i.e., swimming). Risks from other surface water exposure pathways (i.e., shore recreation, occupational exposure, netfishing, fishing, and shellfishing) will be evaluated qualitatively because the exposure is likely to be much lower compared with that under the swimming scenario.[1]

The quantitative evaluation of the swimming exposure pathway for direct contact with water will use the same exposure parameters and methods as those used in the King County HHRA for the entire Duwamish River, which included the EW and West Waterway (King County 1999). This HHRA was conducted using an extensive surface water dataset as described in the Section 2.3.1. Sampling was generally conducted on a weekly basis from October 1996 to June 1997, plus three consecutive days following storm events. Within the EW, 41 samples were collected for most organic compounds and up to 174 samples for metals. Results of the HHRA indicated that risks associated with surface water contact are very low.[2] In addition, the report found that risks associated with the water component of the swimming scenario were small compared to the risks associated with the sediment component (e.g., risks from water exposure made up 25% or less of the total risk).

The EW HHRA will use a dataset that consists of both new and existing EW surface water data to calculate exposure point concentrations (EPCs) following a usability analysis to evaluate how these two datasets will be combined for use in the HHRA. This analysis will include the consideration of RLs, the use of non-detected results, and the spatial and temporal variability of the data in both datasets. The EPC for each chemical will be calculated with the combined dataset as the 95% upper confidence limit (UCL) on the mean. The uncertainty analysis of the HHRA will evaluate the effect of using the data from each sampling location rather than all sampling locations combined.

In summary, the objective of surface water sampling in the EW for the evaluation of human health risks is to supplement the existing data and enable the recalculation of risk estimates for people exposed to surface water from swimming, using parameters

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[1] This approach was also used in the LDW HHRA (Windward 2007).

[2] The King County HHRA included both water and sediment exposure and estimated health risks associated with swimming in the Duwamish River and Elliott Bay. The report concluded that the risks from chemical exposure during swimming were generally within the range of risks considered acceptable by EPA. Excess cancer risks associated with swimming events in the Duwamish River (exposure duration was assumed to be 2.6 hours/day and event frequency was assumed to be 24 days/year) were highest for arsenic and PCBs, ranging from 2×10^{-7} for adults (exposed to PCBs) to 4×10^{-6} for young children (exposed to arsenic). All non-cancer hazard quotients were less than 1.

and methods previously applied by King County for the Duwamish River (King County 1999).

2.2.2 Fish risk evaluation

Risk to fish from exposure to chemicals in the EW will be evaluated through both a critical tissue-residue approach and a dietary approach. The critical tissue-residue approach integrates exposure from all pathways (e.g., direct sediment contact, water contact, and diet), by using fish tissue data rather than data from the environmental media to which fish are exposed. However, for polycyclic aromatic hydrocarbons (PAHs) and most metals (excluding mercury and selenium), the critical tissue-residue approach does not accurately reflect the exposure associated with effects because fish readily metabolize PAHs and they regulate the content of metals in their bodies. Thus, assessment of risks to fish from exposure to PAHs and metals will use a dietary approach, in which concentrations in fish prey and sediment as appropriate will be compared to dietary toxicity reference values (TRVs) from the scientific literature. In addition to the dietary approach for PAHs and metals, risk associated with direct water contact will be evaluated for these chemicals by comparing concentrations in surface water with TRVs derived from the Washington State marine water quality standards (WQS) or EPA ambient water quality criteria for the protection of aquatic life. When these are not available, TRVs will be derived from scientific literature that reports effects on survival, growth, or reproduction (or biomarkers or histological endpoints that can be quantitatively linked to these endpoints) associated with surface water exposure.

The risk assessment for fish from water exposures to metals and PAHs will use both new and existing water data to calculate EPCs, following a usability analysis to determine appropriate methods for combining the datasets. In summary, the objective of surface water sampling for evaluating risk to fish is to collect data to supplement the existing surface water data for the EW to provide a dataset of sufficient quantity and quality to represent exposure of fish to PAHs and metals in surface water of the EW.

2.2.3 Wildlife risk evaluation

The EW risk assessment for wildlife (i.e., birds and mammals) will estimate the dietary doses of chemicals obtained through ingestion of prey and incidental ingestion of sediment and surface water. These dietary doses will be compared to doses associated with adverse effects obtained from the scientific literature. The risk assessment for wildlife will use both new and existing surface water data to calculate surface water EPCs, following a usability analysis to determine appropriate methods for combining the datasets. The EPC for each chemical will be calculated with the combined dataset as the 95% UCL on the mean. Thus, the objective of surface water sampling for evaluating risk to birds and mammals in the EW is to supplement the existing surface water data for the EW to provide a dataset of sufficient quantity and quality to represent the portion of chemical dose obtained through the incidental ingestion of surface water.

2.3 EXISTING WATER QUALITY DATA

This section describes and summarizes existing surface water data collected in the EW as part of previous sampling events. In addition, this section evaluates a subset of these data for variability associated with time and depth at the transect collected in the EW near the Hanford Street combined sewer overflow (CSO) location, which was sampled as part of the King County water quality assessment (WQA).

2.3.1 Summary of existing data

Three previous investigations in the EW included the chemical analysis of surface water samples. One of the investigations was the King County WQA, which monitored and modeled water quality throughout the Duwamish River and Elliott Bay; the other two investigations were conducted by Windward (Anchor and Windward 2005) and Striplin Environmental Associates, Inc. (Striplin) (2000), to monitor water quality during dredging events. Locations of surface water sampling during these events are shown on Figure 2-2.

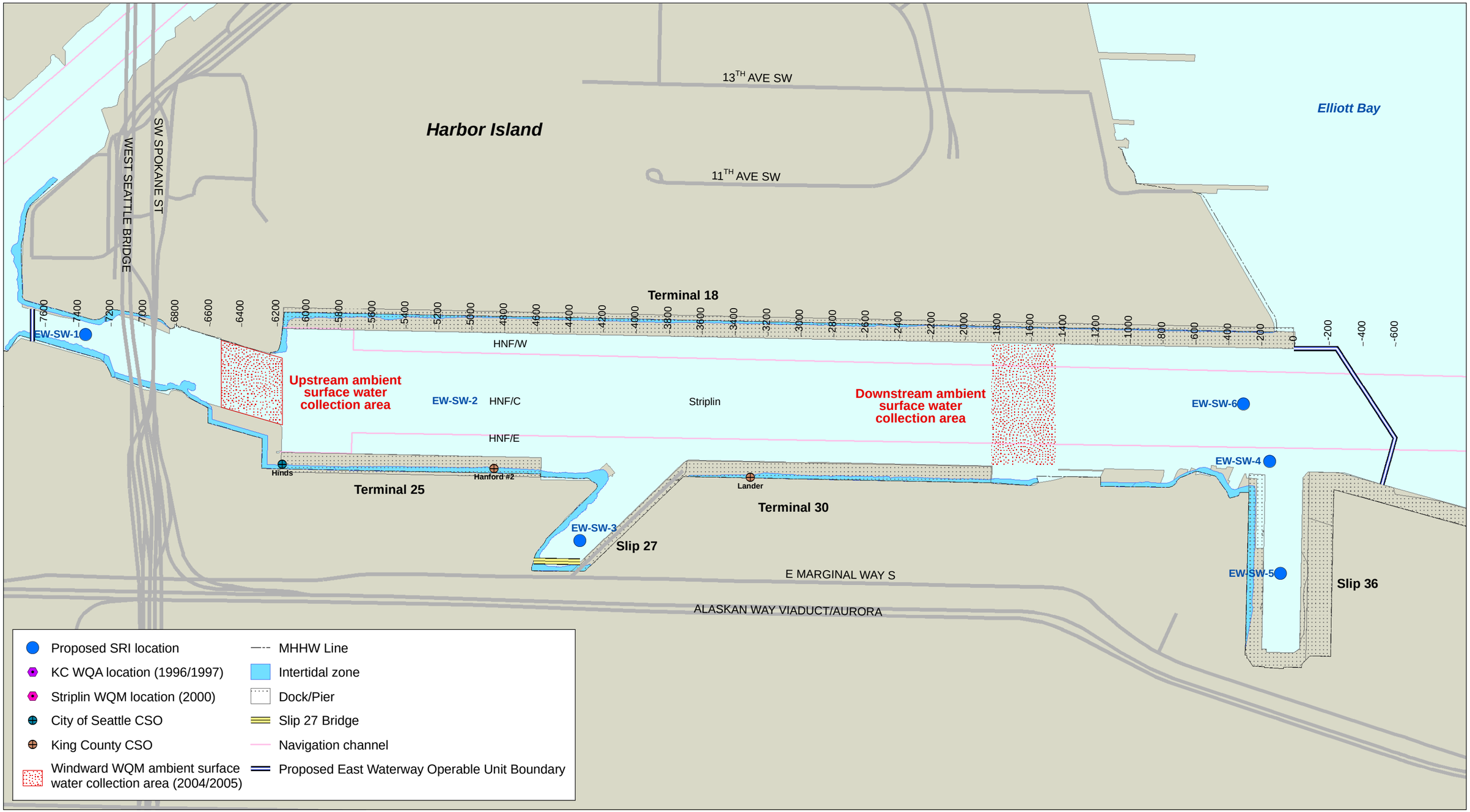


Figure 2-2. Surface water sampling locations for the EW SRI and historical sampling events

Prepared by CEH, 11/25/08; MAP #3941; W:\Projects\92-08-08 East Waterway\EW Ri-FS\Data\GIS\Events\Surface water sampling 09-08

In the King County WQA, three locations were sampled along a transect across the EW off of the Hanford Street CSO (Figure 2-2). Discrete grab samples were collected at 1 m below the water surface and 1 m above the bottom of the EW at each transect location. Sampling was conducted on a weekly basis from October 1996 to June 1997. Samples were also collected for three consecutive days following select storm events. Samples were analyzed for metals and semivolatile organic compounds (SVOCs). A variety of metals were frequently detected; whereas SVOCs were detected very infrequently (Table 2-1). PAHs were not detected in any samples at detection limits ranging from 0.094 to 0.39 µg/L. No detected chemicals exceeded marine acute or chronic WQS for Washington State. In addition, detection limits for non-detected chemicals did not exceed marine acute or chronic WQS.

Table 2-1. Summary of surface water data collected during the King County WQA at three locations along a transect in the EW near the Hanford Street CSO (October 1996 to June 1997)

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Chronic	Acute
Metals and Trace Elements								
Antimony (dissolved)	65/65	100	0.0340 J	0.121	na	na	na	na
Antimony (total)	168/168	100	0.0150	0.119	na	na	na	na
Arsenic (dissolved)	71/71	100	0.507	1.43	na	na	36	69
Arsenic (total)	168/168	100	0.287	1.47	na	na	36	69
Beryllium (dissolved)	0/60	0	nd	nd	0.013	0.016	na	na
Beryllium (total)	1/163	1	0.0150	0.0150	0.014	0.016	na	na
Cadmium (dissolved)	71/71	100	0.0300	0.0827	na	na	9.3	42
Cadmium (total)	174/174	100	0.0320	0.0958	na	na	9.3	42
Chromium (dissolved)	59/59	100	0.140 J	0.612 J	na	na	50	1,100
Chromium (total)	156/156	100	0.160 J	0.629 J	na	na	50	1,100
Cobalt (dissolved)	71/71	100	0.0180	0.0598	na	na	na	na
Cobalt (total)	156/156	100	0.0140	0.298	na	na	na	na
Copper (dissolved)	66/66	100	0.327 J	0.964 J	na	na	3.1	4.8
Copper (total)	169/169	100	0.434 J	1.84 J	na	na	3.1	4.8
Lead (dissolved)	71/71	100	0.00740 J	0.814 J	na	na	8.1	210
Lead (total)	174/174	100	0.0200 J	8.04 J	na	na	8.1	210
Mercury (dissolved)	8/9	89	0.000130	0.000690	0.0001	0.0001	0.025	1.8
Mercury (total)	8/15	53	0.000100	0.00116	0.0001	0.20	0.025	1.8
Nickel (dissolved)	60/66	91	0.315 J	0.855 J	0.294	0.385	8.2	74
Nickel (total)	157/163	96	0.360 J	0.814 J	0.402	0.529	8.2	74
Selenium (dissolved)	0/71	0	nd	nd	0.13	0.16	na	na
Selenium (total)	0/162	0	nd	nd	0.13	0.16	na	na
Silver (dissolved)	0/71	0	nd	nd	0.10	0.13	na	1.9
Silver (total)	0/174	0	nd	nd	0.11	0.13	na	1.9
Thallium (dissolved)	70/71	99	0.00520	0.0120	0.0046	0.0046	na	na
Thallium (total)	172/174	99	0.00500	0.0120	0.0048	0.0050	na	na
Vanadium (dissolved)	53/53	100	0.376	1.48	na	na	na	na
Vanadium (Total)	132/132	100	0.618	1.66	na	na	na	na
Zinc (dissolved)	70/70	100	0.832 J	3.34 J	na	na	81	90
Zinc (total)	174/174	100	0.620 J	4.87 J	na	na	81	90

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Chronic	Acute
PAHs								
2-Chloronaphthalene	0/41	0	nd	nd	0.14	0.15	na	na
2-Methylnaphthalene	0/41	0	nd	nd	0.38	0.39	na	na
Acenaphthene	0/41	0	nd	nd	0.094	0.097	na	na
Acenaphthylene	0/41	0	nd	nd	0.14	0.15	na	na
Anthracene	0/41	0	nd	nd	0.14	0.15	na	na
Benzo(a)anthracene	0/41	0	nd	nd	0.14	0.15	na	na
Benzo(a)pyrene	0/41	0	nd	nd	0.24	0.24	na	na
Benzo(b)fluoranthene	0/41	0	nd	nd	0.38	0.39	na	na
Benzo(g,h,i)perylene	0/41	0	nd	nd	0.24	0.24	na	na
Benzo(k)fluoranthene	0/41	0	nd	nd	0.38	0.39	na	na
Chrysene	0/41	0	nd	nd	0.14	0.15	na	na
Dibenzo(a,h)anthracene	0/41	0	nd	nd	0.38	0.39	na	na
Dibenzofuran	0/41	0	nd	nd	0.24	0.24	na	na
Fluoranthene	0/41	0	nd	nd	0.14	0.15	na	na
Fluorene	0/41	0	nd	nd	0.14	0.15	na	na
Indeno(1,2,3-cd)pyrene	0/41	0	nd	nd	0.24	0.24	na	na
Naphthalene	0/41	0	nd	nd	0.38	0.39	na	na
Phenanthrene	0/41	0	nd	nd	0.14	0.15	na	na
Pyrene	0/41	0	nd	nd	0.14	0.15	na	na
Phthalates								
Bis(2-ethylhexyl) phthalate	8/41	20	0.150	4.85	0.14	1.06	na	na
Butyl benzyl phthalate	0/41	0	nd	nd	0.14	0.15	na	na
Diethyl phthalate	0 41	0	nd	nd	0.24	0.24	na	na
Dimethyl phthalate	0/41	0	nd	nd	0.094	0.097	na	na
Di-n-butyl phthalate	2/41	5	0.270	0.390	0.24	0.24	na	na
Di-n-octyl phthalate	0/41	0	nd	nd	0.14	0.15	na	na
Other SVOCs								
1,2,4-Trichlorobenzene	0/41	0	nd	nd	0.14	0.15	na	na
1,2-Dichlorobenzene	0/41	0	nd	nd	0.14	0.15	na	na
1,2-Diphenylhydrazine	0/41	0	nd	nd	0.47	0.49	na	na
1,3-Dichlorobenzene	0/41	0	nd	nd	0.14	0.15	na	na
1,4-Dichlorobenzene	0/41	0	nd	nd	0.14	0.15	na	na
2,4,5-Trichlorophenol	0/41	0	nd	nd	0.94	0.97	na	na
2,4,6-Trichlorophenol	0/41	0	nd	nd	0.94	0.97	na	na
2,4-Dichlorophenol	0/41	0	nd	nd	0.24	0.24	na	na
2,4-Dimethylphenol	0/41	0	nd	nd	0.24	0.24	na	na
2,4-Dinitrophenol	0/41	0	nd	nd	0.47	0.49	na	na
2,4-Dinitrotoluene	0/41	0	nd	nd	0.094	0.097	na	na
2,6-Dinitrotoluene	0/41	0	nd	nd	0.094	0.097	na	na
2-Chlorophenol	0/41	0	nd	nd	0.47	0.49	na	na
2-Methylphenol	0/41	0	nd	nd	0.24	0.24	na	na
2-Nitroaniline	0/41	0	nd	nd	0.94	0.97	na	na
2-Nitrophenol	0/41	0	nd	nd	0.24	0.24	na	na
3,3'-Dichlorobenzidine	0/41	0	nd	nd	0.24	0.24	na	na
3-Nitroaniline	0/41	0	nd	nd	0.94	0.97	na	na
4,6-Dinitro-o-cresol	0/41	0	nd	nd	0.47	0.49	na	na
4-Bromophenyl phenyl ether	0/41	0	nd	nd	0.094	0.097	na	na
4-Chloro-3-methylphenol	0/41	0	nd	nd	0.47	0.49	na	na
4-Chloroaniline	0/41	0	nd	nd	0.47	0.49	na	na
4-Chlorophenyl phenyl ether	0/41	0	nd	nd	0.14	0.15	na	na
4-Methylphenol	0/41	0	nd	nd	0.24	0.24	na	na

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Chronic	Acute
4-Nitroaniline	0/41	0	nd	nd	0.94	0.97	na	na
4-Nitrophenol	0/41	0	nd	nd	0.47	0.49	na	na
Aniline	0/41	0	nd	nd	0.47	0.49	na	na
Benzidine	0/41	0	nd	nd	5.7	5.8	na	na
Benzoic acid	1/41	2	1.30	1.30	0.94	0.97	na	na
Benzyl alcohol	0/41	0	nd	nd	0.24	0.24	na	na
bis(2-chloroethoxy)methane	0/41	0	nd	nd	0.24	0.24	na	na
bis(2-chloroethyl)ether	0/41	0	nd	nd	0.14	0.15	na	na
bis(2-chloroisopropyl)ether	0/41	0	nd	nd	0.47	0.49	na	na
Caffeine	4/41	10	0.0490	0.0660	0.047	0.049	na	na
Carbazole	0/41	0	nd	nd	0.24	0.24	na	na
Coprostanol	0/41	0	nd	nd	0.94	0.97	na	na
Hexachlorobenzene	0/41	0	nd	nd	0.14	0.15	na	na
Hexachlorobutadiene	0/41	0	nd	nd	0.24	0.24	na	na
Hexachlorocyclopentadiene	0/41	0	nd	nd	0.24	0.24	na	na
Hexachloroethane	0/41	0	nd	nd	0.24	0.24	na	na
Isophorone	0/41	0	nd	nd	0.24	0.24	na	na
Nitrobenzene	0/41	0	nd	nd	0.24	0.24	na	na
n-Nitrosodimethylamine	0/41	0	nd	nd	0.94	0.97	na	na
n-Nitroso-di-n-propylamine	0/41	0	nd	nd	0.24	0.24	na	na
n-Nitrosodiphenylamine	0/41	0	nd	nd	0.24	0.24	na	na
Pentachlorophenol	0/41	0	nd	nd	0.24	0.24	7.9	13
Phenol	0/41	0	nd	nd	0.94	0.97	na	na

CSO – combined sewer overflow
EW – East Waterway
J – estimated concentration
na – not applicable
nd – not detected
PAH – polycyclic aromatic hydrocarbon
SVOC – semivolatile organic compound
WQA – water quality assessment
WQS –water quality standard

Striplin conducted water quality monitoring during dredging along Terminal 18 in 2000, and Windward conducted monitoring during the Stage 1A dredge event in 2004-2005. For both of these events, only the results from the reference site in the EW are summarized in Tables 2-2 and 2-3 because these locations were not influenced by suspended dredge material and thus should represent ambient conditions. The relatively small number of samples in these studies as well as the elevated RLs limit the usability of these datasets for the risk assessments. These data can be used in the discussion of nature and extent of contamination in the SRI.

Table 2-2. Summary of surface water data collected at ambient EW locations during the Striplin water quality monitoring event

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Acute	Chronic
Metals (dissolved)								
Cadmium	0/6	0	nd	nd	4	4	42	9.3
Lead	1/6	17	10 J	10 J	5	5	210	8.1
Mercury	6/6	100	0.001470	0.003630	n/a	na	1.8	0.025
Silver	0/6	0	nd	nd	1	1	1.9	na
Zinc	0/6	0	nd	nd	10	10	90	81
PCBs								
Total PCBs	0/6	0	nd	nd	0.03	0.03	10	0.03
Pesticides								
Aldrin	0/6	0	nd	nd	0.0008	0.0008	0.71	0.002
Dieldrin	0/6	0	nd	nd	0.0015	0.0017	0.71	0.002
Total DDT	0/6	0	nd	nd	0.0015	0.0017	0.13	0.001
Total chlordane	0/6	0	nd	nd	0.0008	0.0008	0.09	0.004
Organometals								
Tributyltin	1/6	17	0.005 J	0.005 J	0.020	0.022	0.42	0.0074

EW – East Waterway
J – estimated concentration
na – not applicable
nd – not detected
PCB – polychlorinated biphenyl
WQS –water quality standard

Table 2-3. Summary of surface water data collected at ambient EW locations during the Windward water quality monitoring event (2004 and 2005)

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Acute	Chronic
Metals (dissolved)								
Cadmium	0/36	0	nd	nd	2.0	2.0	42	9.3
Copper	36/36	100	6	15	na	na	4.8	3.1
Lead	0/36	0	nd	nd	10	11	210	8.1
Mercury	0/36	0	nd	nd	0.1	0.1	1.8	0.025
Silver	0/36	0	nd	nd	2.0	5.0	1.9	na
Zinc	0/36	0	nd	nd	40	40	90	81

Chemical	Detection Frequency		Concentration (µg/L)				Marine WQS (µg/L)	
	Ratio	%	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Acute	Chronic
PCBs								
Total PCBs	0/36	0	nd	nd	0.040	0.60	10	0.03
Pesticides								
Dieldrin	0/36	0	nd	nd	0.10	0.11	0.71	0.002
Total DDT	0/36	0	nd	nd	0.10	0.11	0.13	0.001
Organometals								
Tributyltin	0/36	0	nd	nd	0.022	0.022	0.42	0.0074

EW – East Waterway
na – not applicable
nd – not detected
PCB – polychlorinated biphenyl
WQS – water quality standard

During both events, whole water samples (i.e., unfiltered) were analyzed for tributyltin (TBT) ion, total polychlorinated biphenyls (PCBs) (as Aroclors), dieldrin, and total DDTs and filtered water samples for metals (i.e., cadmium, lead, mercury, silver, and zinc). Samples were also analyzed for aldrin and chlordane during the 2000 dredge event and for copper during the 2004-2005 dredge event. During each event, samples were collected from three depths at each location: 1 m below the surface, in the middle of the water column, and 1 m above the bottom.

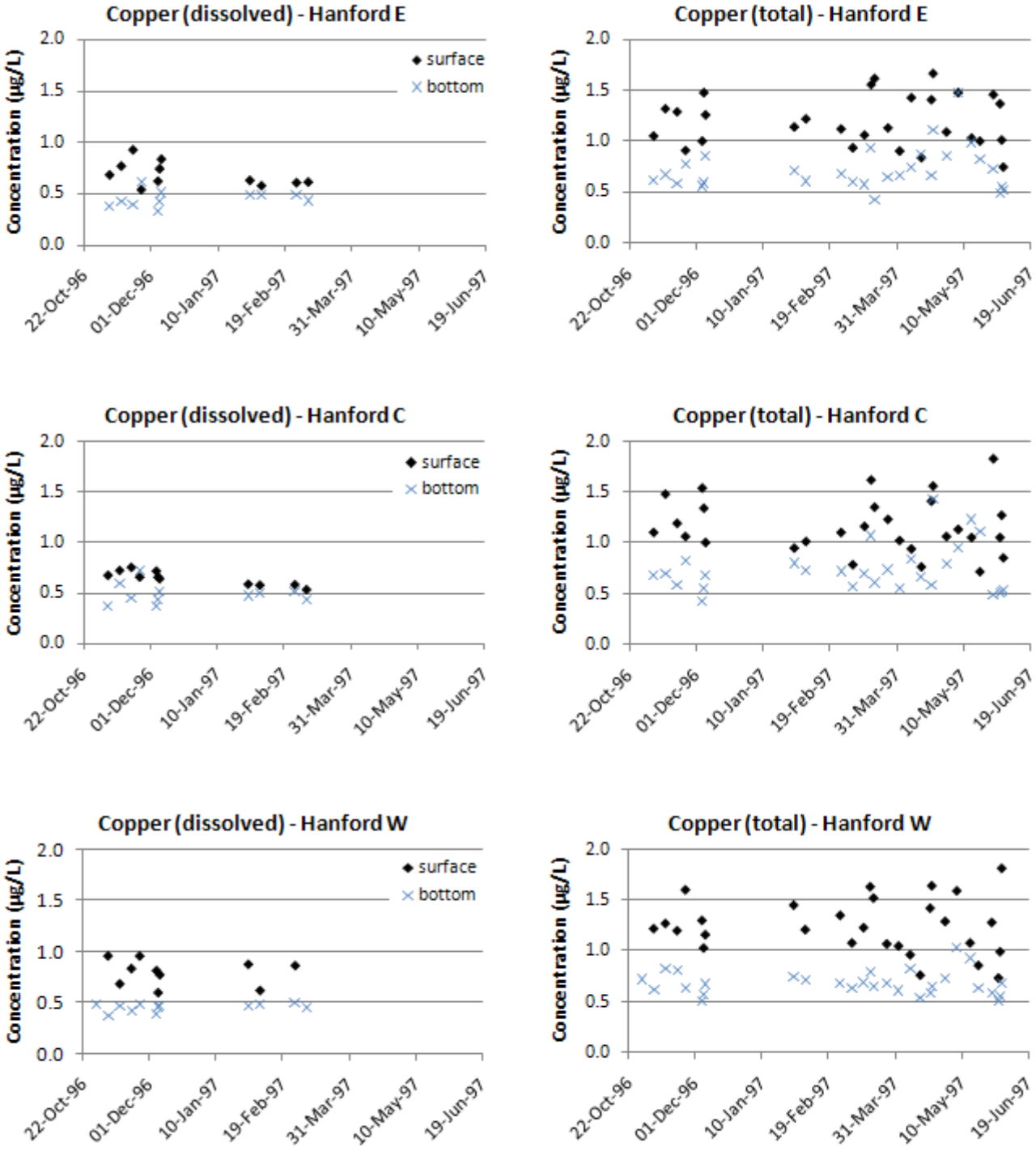
The chemicals detected in the six samples collected during the 2000 event were lead (one sample), TBT ion (one sample), and mercury (all six samples). The detected lead concentration of 10 µg/L exceeded the Washington State marine chronic WQS of 8.1 µg/L. The only chemical detected in the 36 samples collected during the 2004-2005 event was copper, which was detected at a maximum concentration of 15 µg/L. All detected copper concentrations exceeded the Washington State marine chronic WQS of 3.1 µg/L. It should be noted that the mercury RLs for the 2004-2005 event were higher than the detected concentrations in the 2000 event, so mercury could have been detected during 2004-2005 if RLs had been lower. Copper was not analyzed in the 2000 event.

2.3.2 Analysis of existing data

Surface water data from the King County WQA (locations along the transect near Hanford Street CSO) were evaluated to determine whether there were patterns over time, depth, and location across the channel. Metals were the only chemicals with a sufficient number of detected concentrations over time to allow for this analysis. Dissolved and total copper concentrations, which were detected in every sample, were evaluated as an example of the patterns found for metals.

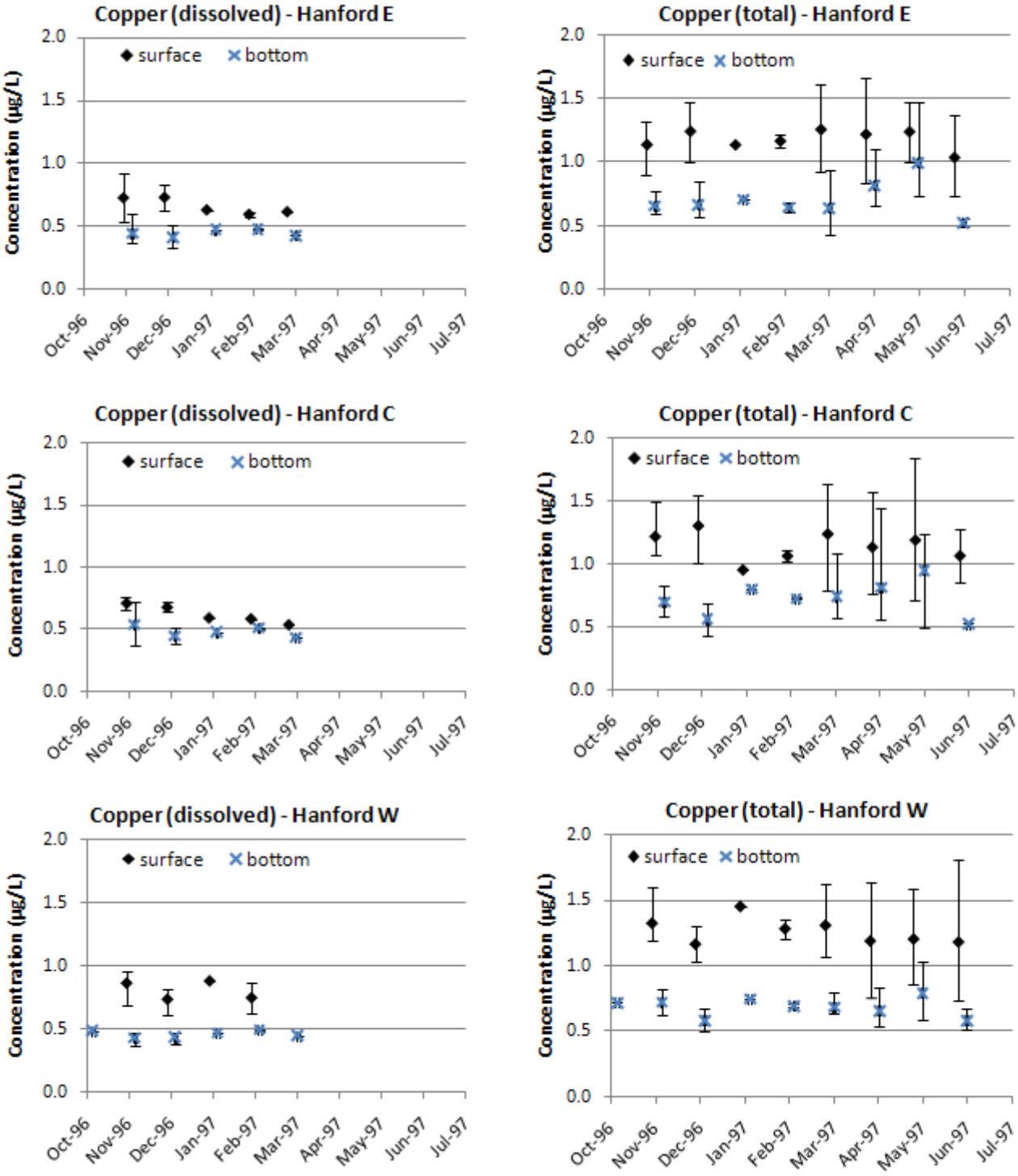
Plots of the copper data show that concentrations varied with depth, but there were no distinct patterns by location across the channel or over time (Figure 2-3).Concentrations of arsenic and lead, which were also detected in every sample, were also evaluated over time and no distinct temporal trends were observed. Box plots also showed differences in copper concentrations with depth (Figure 2-4). Based on these figures, it is recommended that RI samples be collected from both the surface and the bottom of the water column but that only one sample from across the width of the channel be collected. In addition, temporal changes do not appear significant enough to warrant sampling on a frequent basis (i.e., weekly or monthly) based on this review of copper data alone. This temporal analysis is limited to the October to June sampling period and does not capture the lower freshwater flow conditions associated with July through September, although the majority of EW is expected to be dominated by Elliott Bay conditions during this time.

Copper data were also evaluated to determine whether samples collected after storm events had higher concentrations than samples collected during routine monitoring, and also to determine whether concentrations were higher in samples collected closest to the CSO (Hanford E) during storm events. As shown in Figure 2-5, although concentrations of dissolved and total copper differ with depth in the water column, they are similar regardless of the time of sampling and location along a transect across the channel.



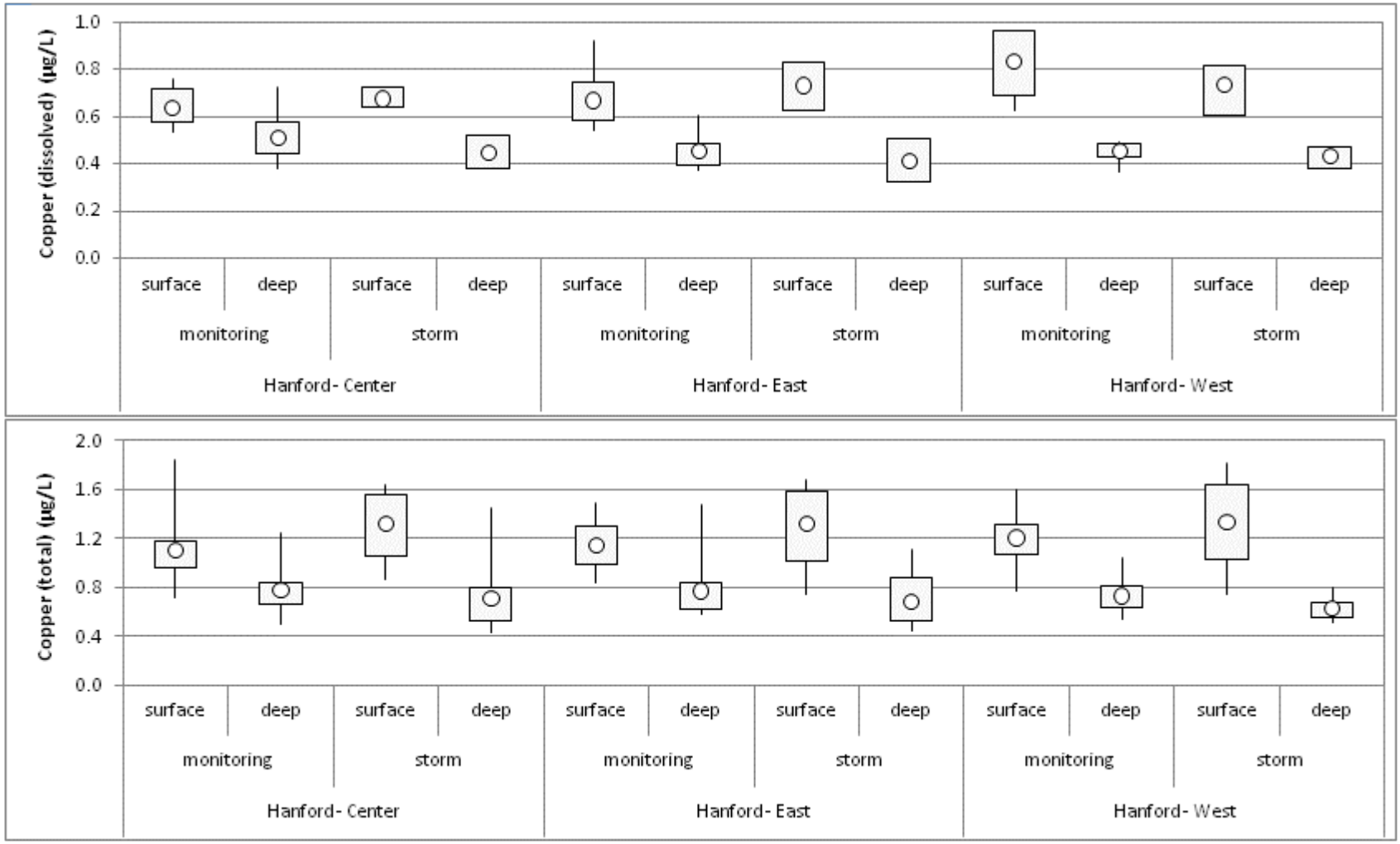
Note: E – east, C – channel, W – west

Figure 2-3. Concentrations of dissolved and total copper in surface water samples collected along a transect near the Hanford Street CSO location in the EW



Note: Error bars show minimum and maximum values. E – east, C – channel, W – west.

Figure 2-4. Monthly mean concentrations of dissolved and total copper in surface water samples collected along a transect near the Hanford Street CSO location in the EW



Note: Points show mean concentrations; boxes show concentrations between the 25th and 75th percentiles; and error bars show ranges between the minimum and maximum values. Monitoring data include samples collected during routine sampling and storm data include samples collected within three days of a storm event resulting in CSO discharge.

Figure 2-5. Concentrations of dissolved and total copper during ambient and storm conditions at transect locations at the Hanford sampling location in the EW

2.4 PROJECT/TASK DESCRIPTION AND SCHEDULE

This section provides an overview of the sampling and analysis activities and schedule for the studies designed to address the data needs outlined in Section 2.2. A detailed study design is presented in Section 3.1

Five separate surface water sampling events will be conducted. The rationale for the selection of sampling dates is presented in Section 3.1. The first two target sampling dates are September 11 and 26, 2008. The second two sampling events will be conducted in December 2008; the specific dates for these sampling events will be identified in coordination with EPA. An additional event will be conducted between January and March 2009 to capture conditions following a storm event, as described in Section 3.1.

Chemical data packages will be received from the laboratories within a standard turn-around-time of four weeks from sample receipt for each sampling event. The data for each event will be validated within 4 weeks of receiving data packages from the respective laboratories. A draft data report, including electronic versions of the data, will be submitted to EPA 5 weeks after receipt of the final validated analytical results for the last sampling event.

2.5 QUALITY OBJECTIVE AND CRITERIA FOR CHEMICAL DATA

The overall data quality objective (DQO) for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. These parameters are discussed in detail in Section 3.4, along with specific data quality indicators (DQIs) for surface water laboratory analyses and for field measurements.

2.6 SPECIAL TRAINING/CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 requires the Secretary of Labor to issue regulations through the Occupational Safety and Health Administration (OSHA) to provide health and safety standards and guidelines for workers engaged in hazardous waste operations. Federal regulation 29CFR1910.120 requires training to provide employees with the knowledge and skills necessary to enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the OSHA regulations.

2.7 DOCUMENTATION AND RECORDS

This section describes the documentation and records needed for field activities and laboratory analyses, as well as the data reduction process and contents of the data report.

2.7.1 Field observations

All field activities will be recorded in a field logbook maintained by the FC. The field logbook will include a description of all sampling activities associated with the surface water sampling event, sampling personnel, and weather conditions, plus a record of all modifications to the procedures and plans identified in this QAPP and the HSP (Appendix A). The field logbook will consist of bound, numbered pages. All entries will be made in indelible ink. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

The following field data will be recorded on the surface water collection form (included as Appendix B) and will also be used to record pertinent information during sample collection:

- Project name and task designation
- Date and time of sample collection and name of person filling out form
- Names of crew members
- Weather conditions
- Location identification (ID) number
- Sampling method
- Global positioning system (GPS) coordinates
- Conventional water quality parameter results

2.7.2 Laboratory records

This section describes the laboratory record requirements for the surface water chemistry data. The chemistry laboratories will be responsible for internal checks on sample handling and analytical data reporting, and will correct errors identified during the QA review. Close communication will be maintained with the laboratory to resolve any QC problems in a timely manner. The laboratory data package will be submitted electronically and will include the following:

- **Project narrative**: This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.
- **Records**: Legible copies of the chain-of-custody forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.

- **Sample results**: The data package will summarize the results for each sample analyzed. The summary will include the following information, when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction/digestion
  - Date and time of analysis
  - Volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Percent moisture in the samples
  - Identification of the instruments used for analysis
  - MDLs and RLs
  - All data qualifiers and their definitions
- **QA/QC summaries:** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information as that required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.
  - The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), relative percent differences (RPDs), and retention time for each analyte will be listed, as appropriate. Results for standards analyzed at the RL to determine instrument sensitivity will be reported.
  - The internal standard area summary will report the internal standard areas, as appropriate.
  - The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
  - The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
  - The matrix spike (MS) recovery summary will report the MS or MS duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits

will be included in the data package. The RPD for all MS/MSD analyses will be reported.

  - The laboratory replicate summary will report the RPD for all laboratory replicate analyses. The QC limits for each compound or analyte will be listed.
  - The standard reference material (SRM) analysis summary will report the results and recoveries of the SRM analyses and list the accuracy, as defined in Section 3.4.2, for each analyte, when available.
  - The laboratory control sample (LCS) analysis summary will report the results of the analyses of the LCS. The QC limits for each compound or analyte will be included in the data package.
  - The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.

- **Original data:** Legible copies of the original data generated by the laboratory will be provided, including the following:
  - Sample preparation, extraction/digestion, and cleanup logs
  - Instrument analysis logs for all instruments used on days of calibration and analysis
  - Chromatograms for all samples, blanks, calibration standards, MS/MSD, laboratory replicate samples, LCS, and SRM samples for all gas chromatography analyses
  - Reconstructed ion chromatograms of target chemicals detected in the field samples and method blanks for all gas chromatography/mass spectrometry (GC/MS) analyses
  - Enhanced spectra of target chemicals detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all GC/MS analyses
  - Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MS/MSD, laboratory replicates, LCS, and SRMs

The contract laboratories for this project will submit data electronically, in EarthSoft EQuIS® standard four-file or EZ_EDD format. Guidelines for electronic data deliverables for chemical data is provided on the EarthSoft website, http://www.earthsoft.com/en/index.html, and additional information will be communicated to the laboratories by the project QA/QC coordinator or data manager. All electronic data submittals must be tab-delimited text files with all results, MDLs, and RLs reported to the appropriate number of significant figures. If laboratory replicate analyses are conducted on a single submitted field sample, the laboratory sample identifier must distinguish among the replicate analyses.

2.7.3 Data reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate data analysis. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory data review specialists, laboratory PM, project QA/QC coordinator, project PM, and independent data reviewers. The data will be generated in a form amenable to review and evaluation. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

2.7.4 Data report

A data report will be prepared to document all activities associated with the collection, handling, and analysis of samples. At a minimum, the following will be included in the data report:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Summary spreadsheet that contains information from field forms
- Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot.
- Summary of the QA/QC review of the analytical data
- Results from the chemical and conventional analyses of surface water samples, including summary statistics (mean, minimum, maximum, frequency of detection)
- Copies of field logs (appendix)
- Laboratory report forms (Form Is) and cross-tab data tables produced from Windward's database (appendix)
- Data validation report (appendix)
- Tables of all raw data (appendix)

Once the data report has been approved by EPA, a database export will be created from Windward's database. The data will be exported in a format compatible with the Washington State Department of Ecology's (Ecology's) Environmental Information Management System, which consists of separate tables for events, locations, samples, and results. Data will also be provided to EPA in MS Access. Any relevant geographic information system (GIS) files will also be transmitted to EPA.

3 Data Generation and Acquisition

This section describes the methods that will be used to collect and analyze water samples collected from the EW. Elements include sampling design; sampling locations; sampling methods; sample handling and custody requirements; analytical chemistry methods; QA/QC; instrument and equipment testing, inspection, and maintenance; instrument calibration; supply inspection and acceptance; non-direct measurements; and data management.

3.1 SAMPLING DESIGN

To meet the objectives for evaluating risk from surface water exposure, samples should be collected from different environments within the EW potentially used by people, fish, and wildlife. Most of the EW consists of a deep-water channel with a relatively thin layer of freshwater from the LDW flowing above a denser saltwater layer (Anchor et al. 2008b). Water in the main body of the EW is expected to be well-mixed within each of these layers based on velocity data presented in the draft sediment transport evaluation approach memorandum (Anchor et al. 2008a). Therefore, two locations within the channel should be sufficient to represent this well-mixed deep water environment (EW-SW-2 and EW-SW-4 in Figure 2-2). Existing data for samples collected from a transect across the channel near the Hanford Street CSO show similar chemical concentrations (see Section 2.3.2), so only one location in the center of the channel will be sampled at each of these two locations. The existing data support the characterization of the main channel of EW as a well-mixed system. The two slips are areas where the surface water may be less well-mixed and more influenced by local inputs or sediment in the shallow areas. Sampling locations in each slip will be sampled at two depths.

There is a possibility that small areas with unique concentration regimes could exist in areas with specific aqueous sources of contaminants to the water column. A review of existing groundwater data (Anchor and Windward 2008) did not identify any areas with elevated groundwater concentrations that would be expected to affect the surface water concentrations. If unique inputs to surface water are identified in the source control evaluation then further investigation into localized surface water concentrations may be necessary.The area south of the Spokane Street bridge represents a unique environment of the EW, and the surface freshwater layer at this location is likely to be more influenced by LDW than other parts of the EW because of its proximity to the LDW and the shallow sill. This location will be sampled (EW-SW-1). Slip 27 (EW-SW-3) was selected because it is a shallow slip with limited current flow and contaminated sediment. Slip 36 will not be sampled because it is a deep slip in close proximity to Elliott Bay and is therefore is expected to be well-mixed with surrounding waters and similar to EW-SW-4. The four sampling locations and the rationale for the selection of these locations is outlined as follows:

- **EW-SW-01: In the upstream shallow portion of EW**. Because of the shallow sill present in the upstream portion of the EW, this location represents a unique environment within the EW.
- **EW-SW-02: In the EW channel near the Hanford Street CSO outfall**. This location has been selected because it was sampled previously as part of the King County WQA and will characterize the typical conditions of the main body reach of the EW.
- **EW-SW-03: Shallow subtidal area in Slip 27.** This location has been selected to characterize the conditions in Slip 27 where the water depth is relatively shallow and sediment contamination is relatively higher than that in other EW areas.
- **EW-SW-04: Mouth of Slip 36.** This location was selected as an interim location pending approval from the Coast Guard to sample in Slip 36.
- **EW-SW-05: In Slip 36.** This location has been selected to characterize the conditions within Slip 36. Approval from the Coast Guard is required to enter and sample Slip 36. This location replaces location SW-04 following the first sampling event.
- **EW-SW-06: The mouth of the waterway.** This location has been selected to characterize the northernmost portion of the waterway.

Surface water locations were selected throughout the waterway. Sampling locations in Slip 27 and Slip 36 were located to characterize the confined areas within the slips. The intent of the surface water sampling is to characterize surface water conditions throughout the waterway. The surface water data is not intended to characterize short-term inputs of CSO and stormwater discharges on the surface water of the waterway; however, the results of cumulative inputs from all outfalls on the waterway as a whole would be captured.

Each location will be sampled at two depths within the water column (1 m below the surface and 1 m above the bottom), except for location EW-SW-03 in Slip 27. Location EW-SW-03 is expected to be relatively shallow, so it will be sampled 1 m above the bottom only.

Sampling will be conducted on an outgoing tide. Chemical concentrations in surface water are likely to be higher during an outgoing tide when the flow will be less influenced by Elliott Bay water. In addition, it is expected that chemical concentrations would be highest during a low tide when groundwater and seep discharge from potential upland sources might occur. An exception is location EW-SW-03 in Slip 27 because it is in a relatively shallow area with elevated concentrations in sediment. To represent worst-case conditions at this site and within the waterway, this location will be sampled at slack tide (i.e., within a window of 15 minutes on either side of the lowest

tide). The other locations will be sampled on an outgoing tide, within no more than 3 hours prior to the low tide.[3]

Five separate surface water sampling events will be conducted to supplement the existing King County data. Two sampling events will be conducted in September 2008 to capture typical conditions associated with the dry season, including low water flow and warmer air temperatures. The first event will be conducted early in September as soon as the QAPP is approved by EPA. Water sampling will not be conducted during the fish sampling effort the week of September 1, because trawling may cause the entrainment of sediment into the water column. During the week of September 8, the timing of a relatively low tide is most favorable for sampling on September 11, so this date is targeted for the first event.[4] The second event will be conducted approximately two weeks following the first event, on September 26. This date was selected based on a combination of timing and height of the low tide.[5]

In addition to the two dry season sampling events, two events will be conducted in December 2008 to characterize conditions during the wet season. The dates of sampling in December will be coordinated with EPA. An additional event will be conducted between January and March 2009 to capture a storm event. The targeted storm event will have an intensity of at least 0.25 inch of rain in a 24-hour period as recorded at the Boeing Field National Weather Service station. Sampling of the event will occur either during the storm event or as soon as possible after the event, but no longer than 24 hours after the event.

3.2 SAMPLE COLLECTION METHODS

The methods for water sampling are described in this section. All field activities will be performed under the direction of the Windward FC or other oversight personnel, as determined by EWG and EPA.

3.2.1 Location and sample identification

Each surface water sampling location will be assigned a unique alphanumeric sample location ID number. The first two characters of the location ID are "EW" to identify the East Waterway project area. The next characters are "SW" with two consecutive numbers to identify the medium sampled (surface water) and which of the four specific locations is being sampled within the EW area. The sample ID will consist of the location ID followed by an identifier for water depth: U (upper, 1 m below the water

[3] In addition to sampling on the outgoing tide, the main channel locations will be sampled at depth on the incoming tide as part of the second event in September in order to characterize both tidal conditions.

[4] The low tide at Lockheed Shipyard on Harbor Island will be at 8:46 a.m. on September 11, with a height of 0.6 ft MLLW.

[5] The low tide at Lockheed Shipyard on Harbor Island will be at 9:12 a.m. on September 26, with a height of 0.3 ft MLLW.

surface) or L (lower, 1 m above the bottom). The final character will identify the sampling event (e.g., 1 for the first of the five sampling events).

For example, the location ID of the sample taken in the upstream shallow portion of EW is EW-SW-1. The sample ID of the sample collected at this location from 1 m below the water's surface during the first sampling event will be EW-SW-1-U-1.

Field QA/QC samples will be assigned modified sample IDs as described below:

- Field replicate samples will be assigned a location ID beginning with the number 101 regardless of the location where the field replicated is collected. For example, the first field replicate will be assigned a location ID of EW-SW-101. The location ID will be followed by the identifiers for water depth and sampling event. For example, the first field replicate collected from 1 m below the surface during the first sampling event would be EW-SW-101-U-1.
- Field rinsate blanks and atmospheric blanks will be assigned the same sample ID as the sample collected immediately prior to the blank, followed by "RB" or "AB." For example, the rinsate blank collected at location EW-SW01 immediately after the upper surface water sample during the first sampling event would be EW-SW-1-U-1-RB.

3.2.2 Location positioning

Sampling locations will be documented using a differential GPS (DGPS). A DGPS unit will be mounted on the sampling vessel. The DGPS unit is wide-area augmentation system enabled and will receive DGPS signals from satellites to both triangulate a position and provide a locational correction factor, resulting in positioning accuracy of within 3 m. Washington State Plane coordinates North (NAD 83) will be used for the horizontal datum.

3.2.3 Surface water sample collection

Surface water sampling will be conducted from a boat. Field measurements and grab water samples will be collected at all locations at two depths within the water column, 1 m below the surface and 1 m above the bottom, with the exception of location EW-SW-03 in Slip 27 which will be sampled at one depth, as described in Section 3.1.

Before collecting grab water samples, conventional water quality parameters will be measured in the field at each surface water sampling location using a Hydrolab water quality meter. The Hydrolab will be lowered to the targeted depth and allowed to equilibrate before taking measurements of conductivity, temperature, dissolved oxygen, and pH. Results for water quality parameters will be recorded on the surface water collection form.

Surface water samples will be collected by pumping water to the surface using a peristaltic pump and a combination of Masterflex® and Teflon®-fluorinated ethylene propylene (FEP) tubing. A small portion of tubing running through the pump will

consist of the Masterflex® tubing and the remainder will be made of Teflon®-FEP. The tubing will be attached to a line weighted with a stainless steel or Teflon®-coated weight and will be lowered to the target depth for sample collection, which will be measured using meter markings on the line. To determine when the tubing has reached 1 m from the bottom without disturbing the sediment, the depth of the water column will be obtained using the boat's depth sounder and the line will be lowered to 1 m above this depth. The current may cause lateral displacement of the line at the two deepest locations, resulting in some uncertainty about the exact depth of the tubing. However, all attempts will be made to use sufficient weight on the line to minimize this uncertainty. The Masterflex® and Teflon®-FEP tubing will be pre-cleaned by the laboratory. Before sampling at each location, the entire length of the tubing will be purged with EW water at that location.

Upon retrieval, the water sample will be decanted directly into the appropriate sample containers (Table 3-1). All relevant information for each sample, including location ID, sample ID, sample date and time will be recorded on the surface water collection form (Appendix B). Sample containers will be labeled with the sampling event name, sample ID, sampling date and time, required analyses, and initials of the individual processing the sample. The FC or designee will check all container labels, custody form entries, and logbook entries for completeness and accuracy at the end of each sampling day.

Table 3-1. Container type, and preservation for chemical analyses

Parameter	Container	Preservation	Laboratory
Mercury (dissolved – lab filtered)	250-mL FEP bottle[a]	preserved with hydrochloric acid or bromine chloride at the laboratory, cool, 0 – 6 °C	Brooks Rand
Mercury (total)	250-mL FEP bottle	cool, 0 – 6 °C	Brooks Rand
Metals (dissolved – field filtered)	1-L HDPE bottle	preserved with nitric acid to pH < 2 at laboratory, cool, 0 – 6 °C	Brooks Rand
Metals (total)	1-L HDPE bottle	preserved with nitric acid to pH < 2 at laboratory, cool, 0 – 6 °C	Brooks Rand
PCB congeners	two 1-L amber glass bottles	cool, 0 – 6 °C	Analytical Perspectives
SVOCs	two 500-mL amber glass bottles[b]	cool, 0 – 6 °C, dark	ARI
PAHs (low-level analyses)	two 500-mL amber glass bottles[b]	cool, 0 – 6 °C, dark	ARI
Butyltins	two 500-mL amber glass bottles[b]	cool, 0 – 6 °C, dark	ARI
Total organic carbon	250 mL glass bottle[a]	preserved with sulfuric acid to pH < 2 in the field, cool, 0 – 6 °C	ARI
Dissolved organic carbon	250 mL glass bottle[a]	cool, 0 – 6 °C	ARI
Total suspended solids	1-L HDPE bottle[a]	cool, 0 – 6 °C	ARI
Salinity, turbidity	500-mL HDPE bottle	cool, 0 – 6 °C	ARI

[a] One sample per ten will be collected with twice the sample volume for laboratory QC analysis.

[b] One sample per twenty will be collected with three times the sample volume for laboratory QC analysis.

ARI – Analytical Resources, Inc.
FEP – fluorinated ethylene propylene
HDPE– high-density polyethylene
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound

Samples for analysis of metals, including mercury, will be collected according to guidelines in EPA Method 1669 for sampling metals at trace levels (EPA 1996). [6] The following steps will be taken to minimize the potential for sample contamination for trace metals and mercury analyses:

- All equipment that comes in contact with the sample during sample collection, including sample bottles and tubing, will be pre-cleaned, lot-tested, and packaged by Brooks Rand as described in EPA Method 1669 (EPA 1996) before use in the field.
- Sample bottles will be double-bagged by Brooks Rand.
- All operations involving contact with the sample bottle, the inner zip-lock bag containing the sample bottle, and transfer of the sample from the Masterflex® tubing to the sample bottle will be handled only by an individual designated as "clean hands."
- An individual designated as "dirty hands" is responsible for all activities that do not involve direct contact with the sample bottle or inner zip-lock bag containing the sample bottle, such as opening the cooler or outer zip-lock bag.
- Sampling personnel will wear clean, non-talc gloves when handling sampling equipment and sample containers.
- The boat will be positioned downstream from the sampling location.
- Sample bottles will be rinsed three times with reagent water supplied by Brooks Rand before sample collection.
- Laboratory equipment blanks will be collected at Brooks Rand using the FEP and Masterflex® tubing to verify the cleanliness of the tubing prior to field sampling.
- Samples will be delivered to Brooks Rand within 24 hours of sample collection. Brooks Rand will filter a portion of the sample for dissolved mercury analysis within 24 hours of receipt at the laboratory. All samples will be preserved for metals analysis at the laboratory, as listed in Table 3-1.
- Field rinsate blanks will be collected to check for cross contamination between sample collection, as described in Section 3.5.1.3.

[6] Method 1669 is intended as guidance for sampling water for trace metals; best professional judgment was used in determining the methods for this QAPP.

- Atmospheric field blanks will be collected to check for airborne contamination of mercury, as described in Section 3.5.1.3.

Samples will be collected using appropriate sample containers as listed in Table 3-1. Samples for dissolved metals analysis (except mercury) will be filtered in the field by attaching an in-line disposable filter cartridge to the end of the Masterflex® tubing. The filtered water will be decanted directly into sample containers. The initial 25 to 50 mL of sample flushed through the filter will not be collected.

Sample containers will be packed in sturdy coolers with double-bagged wet ice or frozen gel-packs. Each sample container will be wrapped with bubble-wrap to avoid breakage and will be transported or shipped to the analytical laboratory using standard chain-of-custody procedures. The chain-of custody form will be placed in a plastic bag and sealed inside the cooler. Appropriate signatures will be obtained to document the sample transfer process.

3.2.4 Field equipment

The items needed in the field for each sampling method are identified in Table 3-2. The FC will check that all equipment is available and in working order each day before sampling personnel go into the field.

Table 3-2. Surface water sampling field equipment

FIELD EQUIPMENT	
Quality assurance project plan	Ice (wet and dry)
Health and safety plan	Hydrolab water quality meter
Key personnel contact information list	Sample collection containers
Field collection forms	Zip-lock freezer bags (assorted sizes)
Field notebooks (Rite in the Rain®)	Powder-free nitrile exam gloves
Chain-of-custody forms	Rubber work gloves
Pens, pencils, Sharpies®	Rubber boots
Tide tables	Rain gear
Study area maps and location coordinates	Personal flotation devices
GPS (with extra batteries)	Head lamps
Digital camera	Peristaltic pump and Masterflex® tubing
Cellular phone	In-line disposable water filter cartridges
Alconox® detergent	Personal flotation devices (life jackets)
Scrub brushes	First aid kit
Bucket for decontamination	Duct tape
Paper towels	Squirt bottle with deionized water
Garbage bags	Reagent-grade water
Coolers	

GPS – global positioning system

3.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

This section describes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analyses. In addition, this section describes sample custody procedures and shipping requirements. Sample custody is a critical aspect of environmental investigations. Sample possession and handling must be traceable from the time of sample collection, through laboratory and data analysis, to delivery of the sample results to the recipient.

3.3.1 Sample handling procedures

The types of sample containers to be used, preservation, and sample volumes are summarized in Table 3-1. Preservative will be added to sample bottles prior to field sampling for all analytes except mercury (filtered and unfiltered) and dissolved organic carbon; for those analytes preservative will be added in the laboratory upon receipt of samples. Each jar will be sealed, completely labeled, and stored under appropriate conditions as outlined in Table 3-1. Labels will be filled out as completely as possible prior to the field event.

Sample labels will be waterproof and self-adhering. Each sample label will contain the project number, sample identification, preservation technique, analyses, date and time of collection, and initials of the person(s) preparing the sample. A completed sample label will be affixed to each sample container and covered with clear tape.

Each sample will be assigned a unique laboratory tracking number upon receipt at the laboratories. The laboratories will ensure that a sample-tracking record follows each sample through all stages of laboratory processing. The sample-tracking record must contain, at a minimum, the name/initials of responsible individuals performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed.

All samples will be handled so as to prevent contamination or loss of any sample. Samples will be assigned a specific storage area within the laboratories and will be kept there until analyzed. The laboratories will not dispose of the environmental samples or sample extracts for this project until authorized by Windward.

3.3.2 Sample tracking and custody procedures

Custody procedures will be used for all samples throughout the collection, transport, and analytical process. Custody procedures will be initiated during sample collection. A chain-of-custody form will accompany all samples to the analytical laboratory. Each person who has custody of the samples will sign the chain-of-custody form and ensure that the samples are not left unattended unless properly secured.

Samples are considered to be in custody if they are: 1) in the custodian's possession or view, 2) retained in a secured place (under lock) with restricted access, or 3) placed in a container and secured with an official seal(s) such that the sample cannot be reached

without breaking the seal(s). Minimum documentation of sample handling and custody will include:

- Project name and unique sample ID
- Sample collection date and time
- Any special notations on sample characteristics or problems
- Initials of the person collecting the sample
- Date sample was sent to the laboratory
- Shipping company name and waybill number

The FC will be responsible for all sample tracking and custody procedures for samples in the field. The FC will be responsible for final sample inventory and will maintain sample custody documentation. The FC will also complete COC forms prior to removing samples from the sampling area. At the end of each day, and prior to transfer, COC entries will be made for all samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms will accompany all samples, and will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to the data reports. Surface water samples will be shipped or hand delivered to the analytical laboratories in sealed coolers with custody seals.

The laboratories will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC or other sample receipt forms. The laboratories will contact the FC or project QA/QC coordinator immediately if discrepancies are discovered between the COC forms and the sample shipment upon receipt.

The laboratories will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The sample tracking record for chemistry samples must contain, at a minimum, the name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analyses, and the types of analyses being performed.

3.3.3 Shipping requirements

Sample coolers containing samples for chemical analyses will be transported directly to ARI and Brooks Rand. Samples for PCB congener analyses will be shipped over night in sturdy coolers with ice or frozen gel packs to Analytical Perspectives. The temperature inside the cooler(s) containing chemistry samples will be checked by the laboratory upon receipt of the samples. The laboratory will specifically note any coolers that that are not sufficiently cold (4 ° ± 2 °C) upon receipt.

3.4 ANALYTICAL METHODS

This section provides the selected analytical methods, sample handling requirements, and data quality indicators for laboratory and field water quality analyses. All samples will be analyzed for metals, including mercury (total and filtered), PCB congeners, SVOCs, TBT, total suspended solids, total organic carbon, and dissolved organic carbon using methods of chemical analysis and associated laboratory sample handling requirements as identified in Table 3-3. Samples for dissolved mercury analysis will be filtered at the laboratory as soon as possible after samples are received and before preservatives are added.

Table 3-3. Laboratory analytical methods and sample handling requirements

PARAMETER	ANALYTICAL METHOD	FILTRATION[a]	SAMPLE PREPARATION METHOD	CLEANUP METHOD	HOLDING TIME	LABORATORY
Mercury (dissolved)	CVAF (EPA 1631E)	0.45-µm filter in the laboratory	EPA 1631E	EPA 1631E	90 days	Brooks Rand
Mercury (total)	CVAF (EPA 1631E)	none	EPA 1631E	EPA 1631E	90 days	Brooks Rand
Metals (filtered)	ICP-MS (EPA 1640 modified)	0.45-µm capsule filter in the field	1% nitric acid closed-vessel oven digest	DRC	6 months	ARI
Metals (total)	ICP-MS (EPA 1640 modified)	none	1% nitric acid closed-vessel oven digest	DRC	6 months	ARI
SVOCs	GC/MS (EPA 8270D)	none	EPA 3510C or EPA 3520C	EPA 3640A (GPC) optional	7 days[b]	ARI
PAHs	GC/MS-SIM (EPA 8270D-SIM)	none	EPA 3520C	lab SOP	7 days[b]	ARI
TBT	GC/MS-SIM (Krone)	none	EPA 3510C	none	7 days[b]	ARI
PCB congeners	HRGC/HRMS (EPA 1668A)	none	lab SOP	lab SOP	1 year	Analytical Perspectives
Total organic carbon	non-dispersive infrared combustion (EPA 415.1)	none	EPA 415.1	none	28 days	ARI
Dissolved organic carbon	direct combustion (EPA 415.1)	1.0-µm glass fiber filter in the laboratory	EPA 415.1	none	28 days	ARI
Total suspended solids	gravimetric (EPA 160.2)	0.45-µm paper filter in the laboratory	EPA 160.2	none	7 days	ARI
Salinity	electrometric (SM 2520B)	none	none	none	28 days	ARI
Turbidity	nephelometric (EPA 180.1)	none	none	none	48 hours	ARI

[a] Samples for dissolved mercury analyses will be filtered in the laboratory. Samples for other metal analyses will be filtered in the field.

[b] Seven days until extraction; forty days to analysis from time of extraction.

ARI – Analytical Resources, Inc.
CVAF – cold vapor atomic fluorescence
DRC – dynamic reaction cell
EPA – US Environmental Protection Agency
GC/ECD – gas chromatography/electron capture detection
GC/MS – gas chromatography/mass spectrometry
HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry
ICP-MS – inductively coupled plasma-mass spectrometry
SIM – selective ion monitoring
SOP – standard operating procedure
SVOC – semivolatile organic compound

High salinity interferes with metals analysis (except mercury), so dilution of samples may be necessary to remove these interferences. Because chloride interferences may occur with arsenic or copper analysis even at low salinities, metals may be analyzed using alternate test methods.

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Tables 3-4 and 3-5 list specific DQIs for the laboratory and field analyses. These parameters are discussed in more detail in the following subsections. Target MDLs and RLs are presented in Appendix D. Interferences in individual samples may result in an increase in the reported quantitation limits. To achieve the required low quantitation limits, some modifications to the methods may be necessary.

Table 3-4. Summary of DQIs for laboratory analyses

Parameter	Precision[a]	Accuracy[b]	Completeness
Mercury	±25%	75 – 125%	95%
Metals	±25%	75 – 125%	95%
SVOCs including PAHs	±30%	laboratory control charted limits	95%
PCB congeners	±30%	50 – 150%	95%
TBT	±30%	laboratory control charted limits	95%
Dissolved organic carbon	±20%	75 – 125%	95%
Total organic carbon	±20%	75 – 125%	95%
Total suspended solids	±20%	75 – 125%	95%
Salinity	±20%	75 – 125%	95%
Turbidity	±20%	75 – 125%	95%

[a] Precision is assessed by laboratory duplicate analyses (duplicate samples, MSDs, LCS duplicates).
[b] Accuracy is assessed by the percent recoveries of MS and LCS analyses.
DQI – data quality indicator
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TBT – tributyltin

Table 3-5. Summary of DQIs for water quality field analyses

PARAMETER	PRECISION[a]	ACCURACY[b]	COMPLETENESS
Temperature	20%	±0.10 °C	95%
Specific conductance	20%	± 1% of reading ±0.001 mS/cm	95%
pH	20%	± 0.2 pH unit	95%
Dissolved oxygen	20%	± 0.2 mg/L	95%

Note: Water quality measurements will be made using a Hydrolab water quality meter.

[a] Precision is assessed by duplicate field measurements.

[b] Accuracy is as reported for Hydrolab instrument specifications.

C – centigrade

DQI – data quality indicator

3.4.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as an RPD when duplicate analyses are performed and as %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed by laboratory duplicate analyses (i.e., laboratory replicate samples, MS/MSD, LCS duplicates) for all parameters except when reference materials are not available or spiking of the matrix is inappropriate. In these cases, precision is assessed by laboratory triplicate analyses. Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Table 3-4). The equations used to express precision are as follows:

$$\text{RPD} = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc}) \div 2} \times 100 \qquad \textbf{Equation 1}$$

$$\%\text{RSD} = (\text{SD}/\text{D}_{\text{ave}}) \times 100 \qquad \textbf{Equation 2}$$

where:

$$\text{SD} = \sqrt{\left(\frac{\left(\sum \text{Dn} - \text{D}_{\text{ave}}\right)^2}{(\text{n}-1)}\right)}$$

SD = standard deviation

D = sample concentration

D_{ave} = average sample concentration

n = number of samples

3.4.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage recovery for MS

and LCS analyses. The DQI for accuracy varies, depending on the analyte (Table 3-4). The equation used to express accuracy for spiked samples is as follows:

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{unspiked sample result}}{\text{amount of spike added}} \times 100 \qquad \textbf{Equation 3}$$

3.4.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.2. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

3.4.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. Sample collection and chemical and physical testing will adhere to the most recent Puget Sound Estuary Program (PSEP) QA/QC procedures (1997) and EPA and PSEP analysis protocols.

3.4.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100 \qquad \textbf{Equation 4}$$

The DQI for completeness for all components of this project is 95%. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

3.4.6 Sensitivity

Analytical sensitivity is the minimum concentration of an analyte above which a data user can be reasonably confident that the analyte was reliably detected and quantified. MDLs and RLs are compared to risk-based ACGs in Appendix D. Six analytes were identified with ACGs derived for the protection of human health that were lower than either the MDL or the RL. Two analytes had ACGs below the RL and above the MDL (3,3'-dichlorobenzidine and hexachlorobenzene). For these analytes the laboratory can do an additional evaluation to determine whether or not the compound is present at a concentration above the MDL and below the RL, these concentrations are then reported as detected with J qualification. The remaining four analytes (benzidine, bis(2-chloroethyl)ether, n-nitrosodimethylamine, n-nitrosodi-n-propylamine) had ACG values that were below the MDL. Therefore, non-detected results for these chemicals

are difficult to interpret relative to potential risk. These results will be discussed in the uncertainty discussion in the HHRA.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

The QA/QC criteria for the laboratory analyses are described below. Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate MDLs for each analyte in each matrix type, and establish an initial calibration curve for all analytes. The laboratory must demonstrate their continued proficiency through participation in inter-laboratory comparison studies and through repeated analyses of SRMs, calibration checks, method blanks, and spiked samples.

3.5.1 Determination of MDLs

The MDL is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. The laboratories determine MDLs using standard procedures outlined in 40CFR136, in which seven or more replicate samples are fortified at 1 to 5 times (but not to exceed 10 times) the expected MDL concentration. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by the Student's t-factor (e.g., 3.14 for seven replicates).

3.5.2 Sample delivery group

Project- and/or method-specific QC measures such as MS/MSD or laboratory replicate samples will be analyzed per sample delivery group (SDG), preparatory batch, or analytical batch, as specified in Table 3-6. An SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. Although an SDG may span 2 weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

Table 3-6. Laboratory quality control sample analysis summary

Analysis Type	Initial Calibration	Second Source Initial Calibration Verification	Continuing Calibration Verification	Laboratory Control Sample	Laboratory Replicate Sample	Matrix Spike	Matrix Spike Duplicate	Method Blank	Standard Reference Material[a]	Surrogate Spike
PCB congeners	prior to analysis	after initial calibration	prior to 12-hr analytical batch	1 per prep batch	na	na	na	1 per prep batch	na	each sample
Mercury	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	each batch or SDG	na
Other metals	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	each batch or SDG	na
SVOCs, including low-level PAHs	prior to analysis	after initial calibration	every 10 to 20 analyses or 12 hrs	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Butyltins	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
TOC and DOC	daily prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	na	na
Salinity and turbidity	daily prior to analysis	na	every 10 samples	na	1 per batch or SDG	na	na	1 per prep batch	na	na
Total suspended solids	na	na	na	na	1 per batch or SDG	na	na	1 per prep batch	na	na

Note: A batch is a group of samples of the same matrix analyzed or prepared at the same time, not to exceed 20 samples.

[a] An LCS may be used to assess accuracy when SRM is unavailable.

na – not applicable
PCB – polychlorinated biphenyl
PAH – polycyclic aromatic hydrocarbon
SDG – sample delivery group
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TOC – total organic carbon

3.5.3 Laboratory quality control criteria

The analyst will review results of QC analyses (described below) from each analytical batch immediately after the samples have been analyzed. The QC sample results will be evaluated to determine whether control limits have been exceeded. If control limits are exceeded, then appropriate corrective action must be initiated, such as recalibration followed by reprocessing of the affected samples, before a subsequent group of samples is processed. The project QA/QC coordinator must be contacted immediately by the laboratory PM if satisfactory corrective action to achieve the DQIs outlined in this QAPP is not possible. All laboratory corrective action reports relevant to the analysis of project samples must be included in the data deliverable packages.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable, commercial sources. The accuracy of the standards should be verified through comparison with an independent standard. Laboratory QC standards are verified a multitude of ways. Second-source calibration verifications (i.e., same chemicals manufactured by two different vendors) are analyzed to verify initial calibrations. New working standard mixes (e.g., calibrations, spikes) should be verified against the results of the original solution before being put into use and be within 10% of the true value. Newly purchased standards should be verified against current data. Any impurities found in the standard must be documented. The following sections summarize the procedures that will be used to assess data quality throughout sample analysis. Table 3-6 summarizes the QC procedures to be performed by the laboratory. The associated control limits for precision and accuracy are summarized in Table 3-6.

Laboratory Replicate Samples

Laboratory replicate samples provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory replicates are subsamples of the original sample that are prepared and analyzed as a separate sample, assuming sufficient sample matrix is available. A minimum of one laboratory replicate sample will be analyzed for each SDG or for every 20 samples, whichever is more frequent, for inorganic and conventional parameters.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of one MS/MSD pair will be analyzed for each SDG, when sufficient sample volume is available, except for PCB congeners. MS/MSD will not be performed for PCB congener analysis. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is available.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for each extraction/digestion batch or for every 20 samples, whichever is more frequent. Sample results will not be adjusted for detected concentrations found in the method blanks (i.e., results will not be blank-subtracted).

Standard Reference Material

SRMs are samples of similar matrix and of known analyte concentration that are processed through the entire analytical procedure and used as an indicator of method accuracy. A minimum of one SRM will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

Surrogate Spikes

All samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods.

Laboratory Control Samples

LCSs are prepared from a clean matrix similar to the project samples and are spiked with known amounts of the target compounds. The recoveries of the compounds are used as a measure of the accuracy of the test methods.

Internal Standard Spikes

Internal standard spikes may be used for calibrating and quantifying organic compounds and metals by means of inductively coupled plasma-mass spectrometry (ICP-MS). If internal standards are used, all calibration, QC, and project samples will be spiked with the same concentration of the selected internal standard(s). Internal standard recoveries and retention times must be within method and/or laboratory criteria.

Method of Standard Additions

If matrix interferences are found to be present during metals analysis, it may be necessary to compensate for the interferences by performing a method of standard additions (MSA). The MSA technique involves adding known amounts of standard to one or more aliquots of the sample digest. If MSA is performed, a different MSA curve must be generated for each sample. An MSA curve generated for a single sample must not be applied to other samples unless it can be clearly demonstrated that all samples exhibit the same matrix effect.

Field Replicate Samples

Field replicate samples will be collected to evaluate variability attributable to sample handling and are useful in assessing potential sample heterogeneity and matrix effects. Field replicate samples are collected from immediately following the original sample

and are submitted to the laboratory and analyzed as a discrete, separate sample. A minimum of one field replicate will be analyzed for each SDG or for every 20 samples, whichever is more frequent, except for low-level mercury. Field replicate samples will be collected and analyzed for every 10 samples for low-level mercury.

Field Rinsate Blank Samples

Field rinsate blank samples will be collected to evaluate the potential for chemical contamination during the sampling process. Rinsate blank samples will be collected at a rate of one per 20 samples for chemistry analyses, except for low level mercury. Field rinsate blank samples will be collected and analyzed for every 10 samples for low-level mercury. Field rinsate blank samples will be analyzed for total metals, SVOCs, low-level PAHs, and butyltins.

Field Atmospheric Blank Samples

Atmospheric blanks will be used to determine if airborne mercury is introduced to samples during collection. These field blanks will be collected by pouring reagent grade water supplied by Brooks Rand into a pre-cleaned bottle. One atmospheric blank sample will be collected during each sampling event and analyzed for total mercury.

3.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. All equipment used, including the DGPS unit and digital camera will be tested for use before leaving for the field event.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring that laboratory equipment testing, inspection, and maintenance requirements are met. The methods used in calibrating the analytical instrumentation are described in Section 3.7.

3.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Multipoint initial calibrations will be performed on each instrument prior to sample analysis, after each major interruption to the analytical instrument, and when more than one continuing calibration verification sample does not meet the specified criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration verifications will be performed daily for organic analyses, once every 10 samples for the inorganic analyses and with every sample batch for conventional parameters to ensure proper instrument performance.

Gel permeation chromatography calibration verifications will be performed at least once every 7 days, and corresponding raw data will be submitted by the laboratory with the data package. In addition, florisil performance checks will be performed for every florisil lot, and the resulting raw data will be submitted with the data package, when applicable.

The calibration of analytical equipment used for chemical analysis includes instrument blanks or continuing calibration blanks, which provide information on the stability of the instrument's baseline. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification at a frequency of one blank for every 10 samples analyzed for metals analyses and one blank for every 12 hours for organic analyses. If the continuing calibration blank does not meet the specified criteria, the analysis must be discontinued. The analysis may be resumed after corrective actions have been taken to meet the method specifications. All project samples analyzed by an instrument found to be out of compliance must be reanalyzed. None of the field equipment requires calibration.

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leaders for each sampling event will have a checklist of supplies required for each day in the field (see Section 3.2.3). The FC will gather and check these supplies daily for satisfactory conditions before each field event. Batteries used in the DGPS unit and digital camera will be checked daily and recharged as necessary. Supplies for field sampling will be inspected upon delivery and accepted if the condition of the supplies is satisfactory. For example, jars will be inspected to ensure that they are of the correct size and quantity and have not been damaged in shipment.

3.9 DATA MANAGEMENT

All field data will be recorded on field forms (see Appendix B), which will be checked for missing information by the FC at the end of each field day and amended as necessary. After sampling has been completed, all data from field forms will be entered into a Microsoft Excel® spreadsheet for import into the project database. A secondary QC check will be done to ensure that 100% of the data were properly transferred from the field forms to the spreadsheet. This spreadsheet will be kept on the Windward network server, which is backed up daily. Field forms will be archived in the Windward library. All photographs will be transferred to the secure network or a CD at the end of the sampling effort.

Field sampling and analytical information will be submitted to the EPA's Analytical Services Tracking System (ANSETS) no later than the 15th of the month after sampling activities have occurred and the sampling compositing and analysis scheme have been approved. The project QA/QC coordinator will be responsible for the submitting the required information to ANSETS.

Analytical laboratories are expected to submit data in an electronic format as described in Section 2.5.2. The laboratory PM will contact the project QA/QC coordinator prior to data delivery to discuss specific format requirements.

A library of routines will be used to translate typical electronic output from laboratory analytical systems and to generate data analysis reports. The use of automated routines ensures that all data are consistently converted into the desired data structures and that

operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure such translations are correctly applied.

Written documentation will be used to clarify how field and analytical laboratory duplicates and QA/QC samples were recorded in the data tables and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that project team members who use the data will have appropriate documentation. Data management files will be stored on a secure computer.

4 Assessment and Oversight

4.1 Compliance Assessments and Response Actions

EPA or other management agencies may observe field activities during each sampling event, as needed. If situations arise in which there is an inability to follow QAPP methods precisely, the Windward PM will determine the appropriate actions or consult EPA if the issue is significant.

4.1.1 Compliance assessments

Laboratory and field performance assessments consist of EPA-conducted onsite reviews of QA systems and equipment for sampling, calibration, and measurement. EPA personnel may conduct a laboratory audit prior to sample analysis. Any pertinent laboratory audit reports will be made available to the project QA/QC coordinator upon request. Analytical laboratories are required to have written procedures that address internal QA/QC; these procedures will be submitted for review by the project QA/QC coordinator upon request to ensure compliance with the QAPP. All laboratories and QA/QC coordinators are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

4.1.2 Response actions for field sampling

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout field sampling and for resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms (Appendix B) will be completed.

4.1.3 Corrective action for laboratory analyses

Analytical laboratories are required to comply with their current written standard operating procedures, laboratory QA plan, and analytical methods. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data. Laboratory personnel will identify and correct any anomalies before continuing with sample analysis. The laboratory PMs will be responsible for ensuring

that appropriate corrective actions are initiated, as required, for conformance with this QAPP.

The project QA/QC coordinator will be notified immediately if any QC parameter exceeds the project DQIs outlined in this QAPP (Table 3-4) and cannot be resolved through standard corrective action procedures. A description of the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package using the case narrative or corrective action form.

4.2 REPORTS TO MANAGEMENT

Progress reports will be prepared by the FC for submittal to the EWG following each sampling event. The project QA/QC coordinator will also prepare progress reports after the sampling is completed and samples have been submitted for analysis, when information is received from the laboratory, and when analyses are complete. The status of the samples and analyses will be indicated with emphasis on any deviations from the QAPP. A data report will be written after validated data are available for each sampling event, as described in Section 2.6.4.

5 Data Validation and Usability

5.1 DATA VALIDATION

The laboratory analyst is responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within the acceptable limits. The data validation process begins at the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The project QA/QC coordinator is responsible for ensuring that all analyses performed by the laboratories are correct, properly documented, and complete, and that they satisfy the project DQOs specified in this QAPP.

Data are not considered final until validated. Data validation will be conducted following EPA guidance (1995, 1996, 1999, 2004, 2005). Independent third-party data review and summary validation of the analytical chemistry data will be conducted by EcoChem. A minimum of 20% of sample results or a single SDG will undergo full data validation. Full data validation parameters include:

- Quality control analysis frequencies
- Analysis holding times
- Laboratory blank contamination
- Instrument calibration
- Surrogate recoveries

- LCS recoveries
- MS recoveries
- MS/MSD RPDs
- Compound identifications
- Compound quantitations
- Instrument performance checks (i.e., tune ion abundances)
- Internal standard areas and retention time shifts

If no discrepancies are found between reported results and raw data in the set that undergoes full data validation, validation can proceed as a summary-level data validation on the rest of the data using all the QC forms submitted in the laboratory data package. QA review of the surface water chemistry data will be performed in accordance with the QA requirements of the project; the technical specifications of the analytical methods indicated in Tables 3-3 and 3-4; and EPA guidance for organic and inorganic data review (EPA 1995, 1996, 1999, 2004, 2005). The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. The project QA/QC coordinator should be informed of all contacts with the laboratories during data validation. Review procedures used and findings made during data validation will be documented on worksheets. The data validator will prepare a data validation report that will summarize QC results, qualifiers, and possible data limitations. Only validated data with appropriate qualifiers will be released for use in the EW SRI/FS. Rejected data will not be used for any purpose.

5.2 Reconciliation with Data Quality Objectives

Data quality assessment will be conducted by the project QA/QC coordinator. The results of the third-party independent review and validation will be reviewed, and cases where the projects DQOs were not met will be identified. The usability of the data will be determined in terms of the magnitude of the DQO exceedance.

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APPENDIX A

Health and Safety Plan

EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY
HEALTH AND SAFETY PLAN
SURFACE WATER COLLECTION AND CHEMICAL ANALYSIS

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

August 18, 2008

Prepared by: Windward environmental LLC

200 West Mercer Street, Suite 401 • Seattle, Washington • 98119

Health and Safety Plan

By their signature, the undersigned certify that this health and safety plan is approved and that it will be used to govern health and safety aspects of fieldwork described in the quality assurance project plan to which it is attached.

Susan McGroddy	August 18, 2008
Project Manager	Date
Tad Deshler	August 18, 2008
Corporate Health and Safety Manager	Date
Thai Do	August 18, 2008
Field Coordinator/Health and Safety Officer	Date

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Acronyms

CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
EW	East Waterway
FC	field coordinator
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	health and safety manager
HSO	health and safety officer
HSP	health and safety plan
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	project emergency coordinator
PFD	personal flotation device
PPE	personal protective equipment
PM	project manager
QAPP	quality assurance project plan
USCG	US Coast Guard

1 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites and for handling potentially hazardous materials or waste products. This HSP covers elements as specified in 29CFR1910§120. The goal of the HSP is to establish procedures for safe working practices for all field personnel.

This HSP addresses all activities associated with the collection and handling of surface water samples in the East Waterway (EW). During site work, this HSP will be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the corporate health and safety manager (HSM) and the project manager (PM).

All personnel involved in fieldwork on this project are required to comply with this HSP. The content of this HSP reflects the types of activities that are anticipated to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. The HSP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

2 Site Description and Project Scope

2.1 Site Description

The sampling area is in the EW (see Figure 2-2 in the quality assurance project plan [QAPP] to which this HSP is attached). The QAPP provides complete details of the sampling program.

2.2 Scope and Duration of Work

This section summarizes the types of work that will be performed during field activities. Specific tasks to be performed are as follows:

- Collection of surface water samples using a peristaltic pump
- Collection of water quality parameters
- Sample handling, processing, and shipping

The surface water samples will be collected during five separate events, beginning in September 2008, as described in the QAPP.

3 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HSP.

Project Manager – The PM has overall responsibility for the successful outcome of the project. The PM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The PM, in consultation with the HSM, makes final decisions concerning the implementation of the HSP.

Field Coordinator/Health and Safety Officer – Because of the limited scope and duration of fieldwork, the FC and HSO will be the same individual. The FC/HSO will direct field sampling activities, coordinate the technical components of the field program with health and safety components, and ensure that work is performed according to the QAPP. The FC/HSO will implement this HSP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FC/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC/HSO or his designee will be present during sampling operations.

Corporate Health and Safety Manager – The HSM has overall responsibility for the preparation, approval, and revision of this HSP. The HSM will not necessarily be present during fieldwork but will be readily available, if required, for consultation regarding health and safety issues.

Field Crew – All field crew members must be familiar and comply with the information in this HSP. They also have the responsibility to immediately report any potentially unsafe or hazardous conditions to the FC/HSO.

4 Hazard Evaluation and Control Measures

This section discusses potential physical and chemical hazards that may be associated with the proposed project activities and presents control measures for addressing these hazards. The activity hazard analysis (Section 4.4) lists the potential hazards associated with each site activity and the recommended site control. Confined space entry will not be necessary for this project. Therefore, hazards associated with this activity are not discussed in this HSP.

4.1 PHYSICAL HAZARDS

For this project, it is anticipated that physical hazards present a greater risk of injury than do chemical hazards.

4.1.1 Slips, trips, and falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, sampling from a boat or other floating platform requires careful attention to minimize the risk of falling down or falling overboard. Slips can

be minimized through the use of boots that have good treads made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat or in cluttered work areas. Personnel will keep work areas as free as possible from obstacles that could interfere with walking.

Falls can also be a hazard. Personnel can avoid falls by working as far from exposed edges as possible, erecting railings, and using fall protection when working on elevated platforms. For this project, no work that would present a fall hazard is anticipated.

4.1.2 Sampling equipment

No sampling equipment other than a peristaltic pump will be used for the surface water collection. Before sampling activities begin, all personnel will attend a training session to discuss the equipment that will be onboard the sampling vessel.

4.1.3 Falling overboard

All sampling activities will be done from a boat. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn by all personnel while working from the boat.

4.1.4 Manual lifting

Equipment and samples must be lifted and carried. Back strain can result if lifting is done improperly. During any manual lifting tasks, personnel should lift with the load supported by their legs, not their backs. For heavy loads, an adequate number of people, or if possible, a mechanical lifting/handling device, will be used.

4.1.5 Heat stress, hypothermia, or frostbite

Sampling operations and conditions that might result in heat stress, hypothermia, or frostbite are not anticipated. Sampling will occur during a time of year when extreme weather conditions are not expected.

4.1.6 Weather

In general, field team members will be equipped for the normal range of weather conditions. The FC/HSO will be aware of current weather conditions and of the potential for those conditions to pose a hazard to the field crew. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

4.1.7 Sharp objects

Sharp objects are not expected to be encountered during surface water collection activities.

4.2 VESSEL HAZARDS

Because of the high volume of vessel and barge traffic on the EW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt vessel traffic. Potential vessel emergency hazards and responses are presented in Table 1.

Table 1. Potential vessel emergency hazards and responses

POTENTIAL EMERGENCY OR HAZARD	RESPONSE
Fire or explosion	If manageable, personnel should attempt to put out a small fire with a fire extinguisher. Otherwise, personnel should call the USCG or 911 and evacuate the area (by rescue boat or swimming) and meet at a designated area. The FC/HSO will take roll call to make sure everyone evacuated safely. Emergency meeting places will be determined in the field during the daily safety briefing.
Medical emergency or injury	At least one person with current first aid and CPR training will be aboard the vessel at all times. This person will attempt to assess the nature and severity of the injury, immediately call 911, and perform CPR if necessary. Personnel should stop work and wait for medical personnel to arrive. Once the emergency has passed, the FC/HSO should fill out a site accident report.
Person overboard	All personnel aboard the sampling vessel will wear PFDs at all times. If someone should fall overboard, one person should keep an eye on that individual and shout the distance (in boat lengths) and direction (o'clock) of the individual from the vessel. Personnel should stop work and use the vessel to retrieve the individual in the water.
Sinking vessel	Personnel should call the USCG immediately. If possible, personnel should wait for a rescue boat to arrive to evacuate vessel personnel. See fire or explosion (above) for emergency evacuation procedures. The FC/HSO will take roll call to make sure that everyone evacuated safely.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazard, personnel should stop work immediately. The vessel operator and FC/HSO will assess the hazard and, if necessary, send out periodic horn blasts to communicate the vessel's location to other vessels that may be in the area, move to a secure location (i.e., berth), and wait for the visibility to clear.
Loss of power	Personnel should stop work and call the USCG for assistance. Personnel should use oars to move the vessel towards the shoreline. Other vessel personnel should watch for potential collision hazards and notify the vessel operator if hazards exist. Personnel should secure the vessel to a berth, dock, or mooring as soon as possible.
Collision	Personnel should stop work and call the USCG for assistance. The FC/HSO and vessel operator will assess damages and potential hazards. If necessary, the vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
FC – field coordinator
HSO – health and safety officer
PFD – personal flotation device
USCG – US Coast Guard

4.3 CHEMICAL HAZARDS

Previous investigations have shown that some chemicals are present at higher-than-background concentrations in the sampling area. For the purpose of a discussion on potential exposure to these chemicals in water, the chemicals of concern are metals,

tributyltin, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

4.3.1 Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Exposure will be minimized by using safe work practices and by wearing the appropriate personal protective equipment (PPE). Further discussion of PPE requirements is presented in Section 7.

Inhalation – Inhalation is not expected to be an important route of exposure for this project.

Dermal exposure – Dermal exposure to hazardous substances associated with surface water or equipment decontamination will be controlled through the use of PPE and adherence to detailed sampling and decontamination procedures.

Ingestion – Ingestion is not considered a major route of exposure for this project. Accidental ingestion of surface water is possible. However, careful handling of equipment and containers aboard the boat should prevent water splashing or spilling during sample collection and handling activities.

4.3.2 Chemical hazards

Metals and tributyltin – Exposure to metals can occur via ingestion or skin contact. As mentioned above, neither is a likely exposure route for this project. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of water would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the metals into the body.

Polycyclic aromatic hydrocarbons – Exposure to PAHs can occur via ingestion or skin contact. The most important human health exposure pathway (inhalation) for this group of chemicals is not expected to be significant at this site. Animal studies have shown that PAHs can cause harmful effects on skin, body fluids, and the ability to fight disease after both short- and long-term exposure, but these effects have not been documented in people. Some PAHs may reasonably be expected to be carcinogens. Large amounts of water would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the compounds into the body.

Polychlorinated biphenyls – Prolonged skin contact with PCBs can cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat can also occur. Acute and chronic exposure can damage the liver and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen. Skin absorption can substantially contribute to the uptake of PCBs. Momentary skin contact allows little, if any, opportunity for the passage of any

of these compounds into the body. Large amounts of water would need to be ingested for any detrimental effects to occur.

4.4 ACTIVITY HAZARD ANALYSIS

The activity hazard analysis summarizes the field activities to be performed during the project, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the risk of the hazard. Table 2 presents the activity hazard analysis for sampling from a boat.

Table 2. Activity hazard analysis

ACTIVITY	HAZARD	CONTROL
Sampling from a boat	falling overboard	Use care in boarding and departing from vessel. Wear a PFD.
	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	back strain	Use appropriate lifting techniques when transporting equipment and supplies to or from the boat or seek assistance.

PFD – personal flotation device
PPE – personal protective equipment

5 Work Zones and Shipboard Access Control

During sampling and sample handling activities, work zones will be established to identify where sample collection and processing are actively occurring. The intent of the zone is to limit the migration of sample material out of the zone and to restrict access to active work areas by defining work zone boundaries.

5.1 WORK ZONE

The work zones on the boat will encompass the areas where sample collection and handling activities are being performed. The FC/HSO will delineate the work zone as a particular area on the boat. Only persons with appropriate training, PPE, and authorization from the FC/HSO will be allowed to enter the work zone while work is in progress.

5.2 DECONTAMINATION STATION

Sediment accumulation will not likely occur during surface water sampling. However, in the event that any sampling equipment becomes soiled, a decontamination station will be set up. The station will have the buckets, brushes, soapy water, and rinse water. Plastic bags will be provided for expendable and disposable materials. If necessary, decontamination of the boat will also be completed at the end of each work day. Cockpit and crew areas will be rinsed down with site water to minimize the accumulation of incidental sediment.

5.3 ACCESS CONTROL

Boat security and access control will be the responsibility of the FC/HSO and boat captain. Boat access will be granted only to essential project personnel and authorized visitors. Any security or access control problems will be reported to the PM or appropriate authorities.

6 Safe Work Practices

Following common sense rules will minimize the risk of exposure or accident at the work site. The general safety rules listed below will be followed onsite:

- Do not climb over or under obstacles of questionable stability.
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone.
- Work only in well-lighted spaces.
- Never enter a confined space without the proper training, permits, and equipment.
- Make eye contact with equipment operators when moving within range of their equipment.
- Be aware of the movements of shipboard equipment when not in the operator's range of vision.
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
- Use the established sampling and decontamination procedures.
- Always use the buddy system.
- Be alert to your own and other workers' physical condition.
- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if directed to do so by a supervisor.

7 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. In addition, PFDs will be required for all personnel while working aboard the boat. Prior to donning PPE, personnel will inspect their PPE for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed in Sections 7.1 and 7.2. Situations that would require PPE beyond modified Level D are

not anticipated. Should the FC/HSO determine that PPE beyond modified Level D is necessary, the HSM will be notified, and alternative PPE will be selected.

7.1 LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Individuals performing general activities during which skin contact with contaminated materials is unlikely will wear Level D PPE. Level D PPE includes the following:

- Cotton overalls or lab coats
- Chemical-resistant steel-toed boots
- Chemical-resistant gloves
- Safety glasses

7.2 MODIFIED LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Individuals performing activities during which skin contact with contaminated materials is possible but inhalation risks are not expected will be required to wear an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Impermeable outer garb, such as rain gear or waders
- Chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

7.3 SAFETY EQUIPMENT

In addition to the above-identified PPE, basic emergency and first aid equipment will also be provided. Equipment for the field team will include:

- A copy of this HSP
- First aid kit adequate for the number of personnel in the field crew
- Emergency eyewash

The FC/HSO will ensure that the safety equipment is available. Equipment will be checked daily to ensure its readiness for use.

8 Monitoring Procedures for Site Activities

A monitoring program that addresses potential site hazards will be implemented. For this project, air, dust, and noise monitoring will not be necessary. No volatile organic compounds have been identified among the expected contaminants, the sampled media will be wet and will not pose a dust hazard, and none of the equipment emits high-amplitude (i.e., > 85 dBA) noise. For this project, the

monitoring program will consist of all individuals monitoring themselves and their co-workers for signs of potential physical stress or illness.

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental conditions during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Symptoms of heat stress
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Shivering
- Blue lips or fingernails

If any of these conditions develop, work will be halted immediately, and the affected person(s) will be evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the direct result of sample collection or handling activities, procedures will be modified to address the problem.

9 Decontamination

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following subsections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Long-handled scrub brushes
- Clean water sprayers

- Alconox® or similar decontamination solution

9.1 MINIMIZATION OF CONTAMINATION

The first step in addressing contamination is to prevent or minimize exposure to existing contaminated materials and the spread of those materials. During field activities, the FC/HSO will enforce the following rules:

Personnel

- Do not walk through areas of obvious or known contamination.
- Do not handle, touch, or smell contaminated materials directly.
- Make sure PPE has no cuts or tears prior to use.
- Fasten all closures on outer clothing, covering with tape if necessary.
- Protect and cover any skin injuries.
- Stay upwind of airborne dusts and vapors.
- Do not eat, drink, chew tobacco, or smoke in the work zones.

Sampling equipment and boat

- Place clean equipment on a plastic sheet or aluminum foil to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Clean boots before entering the boat.

9.2 PERSONNEL DECONTAMINATION

The FC/HSO will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform decontamination procedures, as appropriate, before eating lunch, taking a break, or leaving the work location. Decontamination procedures for field personnel include:

1. Rinse off the outer suit if it is heavily soiled.
2. Wash and rinse outer gloves and boots with water.
3. Remove and inspect outer gloves and discard them if damaged.
4. Wash hands if taking a break.
5. Don necessary PPE before returning to work.
6. Dispose of soiled, disposable PPE before leaving for the day.

9.3 SAMPLING EQUIPMENT DECONTAMINATION

Equipment decontamination will not be necessary during this sampling event because used tubing will be disposed of between samples.

9.4 VESSEL DECONTAMINATION

Sampling will be conducted from a boat. Care will be taken to minimize the amount of water spilled on the vessel. Although sediment is not expected to be a source of contamination, the vessel deck will be hosed off regularly to remove any sediment from the cockpit and crew areas to minimize slipping hazards and the transport of sediment on boots through work zones.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE, decontamination fluids, and excess sample material. These contaminated materials will be disposed of as an integral part of the project.

10.1 PERSONAL PROTECTIVE EQUIPMENT

Gross surface contamination will be removed from PPE. All disposable sampling materials and PPE, such as disposable coveralls, gloves, and paper towels used in the sample processing, will be placed in heavyweight garbage bags. Filled garbage bags will be placed in a normal refuse container for disposal as solid waste.

10.2 EXCESS SAMPLE MATERIALS

At each sampling location, all excess water will be returned to the collection site.

11 Training Requirements

Individuals who perform work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. It is not anticipated that hazardous concentrations of contaminants will be encountered in sampled material, so training will consist of site-specific instruction for all personnel and the oversight of inexperienced personnel by an experienced person for one working day. The following subsections describe the training requirements for this fieldwork.

11.1 PROJECT-SPECIFIC TRAINING

In addition to Hazardous Waste Operations and Emergency Response (HAZWOPER) training, as described in Section 2.6 of the QAPP, field personnel will undergo training specifically for this project. All personnel must read this HSP and be familiar with its contents before beginning work. Personnel will acknowledge that

they have read the HSP by signing the Field Team HSP Review form (Attachment 1). The completed form will be kept in the project files.

The boat captain and FC/HSO or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers arrive. Field personnel will not be allowed to begin work until project-specific training has been completed and documented by the FC/HSO. Training will address the HSP and all health and safety issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards and actions to control the hazard
- Ship access control and procedure
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment
- Vessel safety practices
- Emergency evacuation and emergency procedures

11.2 Daily Safety Briefings

The FC/HSO or a designee and the boat captain will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, address any specific concerns associated with the work location, and review emergency procedures and routes. The FC/HSO or designee will document safety briefings in the logbook.

11.3 First Aid and CPR

At least one member of the field team must have first aid and cardiopulmonary resuscitation (CPR) training. Documentation identifying which individuals possess first aid and CPR training will be kept in the project health and safety files.

12 Medical Surveillance

A medical surveillance program that conforms to the provisions of 29CFR1910§120(f) will not be necessary for field team members because they do not meet any of the four criteria outlined in the regulations for the implementation of a medical surveillance program:

- Employees who are or may be exposed to hazardous substances or health hazards at or above permissible exposure levels for 30 days or more per year (1910.120(f)(2)(i)
- Employees who must wear a respirator for 30 days or more per year (1910.120(f)(2)(ii))
- Employees who are injured or become ill due to possible overexposures involving hazardous substances or health hazards from an emergency response or hazardous waste operation (1910.120(f)(2)(iii))
- Employees who are members of HAZMAT teams (1910.120(f)(2)(iv))

As described in Section 8, employees will monitor themselves and each other for any deleterious changes in their physical or mental condition during the performance of all field activities.

13 Reporting and Record Keeping

Each member of the field crew will sign the Field Team HSP Review form (see Attachment 1). If necessary, accident/incident report forms and Occupational Safety and Health Administration (OSHA) Form 200s will be completed by the FC/HSO.

The FC/HSO or a designee will maintain a health and safety field logbook that records health-and-safety-related details of the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety field logbook will not be required. The logbook must be bound, and the pages must be numbered consecutively. Entries will be made with indelible blue ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel onboard
- Weather conditions
- Type of fieldwork being performed

The individual maintaining the entries will initial and date the bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous workday's entries.

14 Emergency Response Plan

As a result of the hazards and the conditions under which operations will be conducted, the potential exists for an emergency situation to occur. Emergencies may include personal injury, exposure to hazardous substances, fire, explosion, or the

release of toxic or non-toxic substances (i.e., spills). OSHA regulations require that an emergency response plan be available to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations. The local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying emergency situations, providing first aid, if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following subsections identify the individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions for getting from any sampling location to a hospital.

14.1 PRE-EMERGENCY PREPARATION

Before the start of field activities, the FC/HSO will ensure that preparation has been made in anticipation of potential emergencies. This preparation includes the following:

- Meeting with equipment handlers concerning emergency procedures to be followed in the event of an injury
- Conducting a training session to inform all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures
- Conducting a training session (led by senior staff responsible for operating field equipment) to apprise field personnel of operating procedures and specific risks associated with field equipment
- Ensuring that field personnel are aware of the existence of the emergency response plan in the HSP and ensuring that a copy of the HSP accompanies the field team

14.2 PROJECT EMERGENCY COORDINATOR

The FC/HSO will serve as the project emergency coordinator (PEC) in the event of an emergency. He will designate a replacement for times when he is not available or is not serving as the PEC. The designation will be noted in the logbook. The PEC will be notified immediately when an emergency is recognized. The PEC will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing onboard interim actions before the arrival of emergency response units. The PEC will notify the HSM and the PM as soon as possible after initiating an emergency response action. The PM will have responsibility for notifying the client.

14.3 EMERGENCY RESPONSE CONTACTS

All personnel must know whom to notify in the event of an emergency situation, even though the FC/HSO has primary responsibility for notification. Table 3 lists the names and phone numbers for emergency response services and individuals.

Table 3. Emergency response contacts

CONTACT	TELEPHONE NUMBER
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
US Coast Guard Office Emergency General information	 (206) 286-5400 (206) 442-5295 UHF Channel 16
National Response Center	(800) 424-8802
US Environmental Protection Agency	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Project Management Emergency Contacts	
Susan McGroddy, Project Manager	(206) 812-5421
Tad Deshler, Corporate Health and Safety Manager	(206) 812-5406
Thai Do, Field Coordinator/ Health and Safety Officer	(206) 353-9346 (site cellular telephone)

14.4 RECOGNITION OF EMERGENCY SITUATIONS

Emergency situations will generally be recognizable through observation. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first-aid techniques.

14.5 DECONTAMINATION

In the case of evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. If an injured individual is heavily contaminated and must be transported by emergency vehicle, the emergency response team will be informed of the type of contamination. To the extent possible, contaminated PPE will be removed but only if doing so does not exacerbate the injury. Plastic sheeting will be used to reduce the potential for spreading contamination to the inside of the emergency vehicle.

14.6 FIRE

Field personnel will attempt to control only small fires. If an explosion appears likely, personnel will follow evacuation procedures specified during the training session. If a fire cannot be controlled with the onboard fire extinguisher that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the site as specified during the training session.

14.7 PERSONAL INJURY

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

- Administer first aid, if qualified.
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit.
- Notify the PEC of the incident, the name of the individual, the location, and the nature of the injury.

The PEC will immediately do the following:

- Notify the boat captain, the FC/HSO, and the appropriate emergency response organization.
- Assist the injured individual.
- Follow the emergency procedures for retrieving or disposing of equipment and leave the site and proceed to the predetermined land-based emergency pick-up.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs (i.e., injury in which death is imminent without immediate treatment), the FC/HSO or boat captain will call 911 and arrange to meet the emergency responder at the nearest accessible location or dock. For injuries or emergencies that are not life-threatening (e.g., broken bones, minor lacerations), the PEC will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location if that would be more expedient.
- Notify the HSM and the PM.

If the PEC determines that emergency response is not necessary, he or she may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions to the hospital are provided in Section 14.10.

If a worker leaves the site to seek medical attention, another worker should accompany him or her to the hospital. When in doubt about the severity of an injury

or exposure, always seek medical attention as a conservative approach and notify the PEC.

The PEC will be responsible for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

14.8 Overt Personal Exposure or Injury

If an overt exposure to toxic materials occurs, the first responder to the victim will initiate actions to address the situation. The following actions should be taken, depending on the type of exposure.

14.8.1 Skin contact

- Wash/rinse the affected area thoroughly with copious amounts of soap and water.
- If eye contact has occurred, rinse eyes for at least 15 minutes using the eyewash that is part of the onboard emergency equipment.
- After initial response actions have been taken, seek appropriate medical attention.

14.8.2 Inhalation

- Move victim to fresh air.
- Seek appropriate medical attention.

14.8.3 Ingestion

- Seek appropriate medical attention.

14.8.4 Puncture wound or laceration

- Seek appropriate medical attention.

14.9 Spills and Spill Containment

No bulk chemicals or other materials subject to spillage are expected to be used during this project. Accordingly, no spill containment procedure is required for this project.

14.10 Emergency Route to the Hospital

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

Harborview Medical Center
325 Ninth Avenue
Seattle, WA
(206) 323-3074

Directions from the vicinity of EW to Harborview Medical Center are as follows:

1. Dock the vessel at the First Avenue S boat launch.
2. Drive east on S River Street.
3. Turn left on Occidental Avenue S.
4. Turn left on E Marginal Way S.
5. Turn right on S Michigan Street.
6. Look for the entrance ramps to I-5 northbound.
7. Head north on I-5.
8. Take the James Street exit.
9. Head east on James Street to Ninth Avenue.
10. Turn right on Ninth Avenue.
11. Emergency entrance will be two blocks south on the right.

15 References

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Final Report. Prepared for the U.S. Environmental Protection Agency, Seattle, Washington, and the Puget Sound Water Quality Action Team, Olympia, WA.

ATTACHMENT 1. FIELD TEAM HEALTH AND SAFETY PLAN REVIEW

Attachment 1. Field Team Health and Safety Plan Review

I have read a copy of the health and safety plan, which covers field activities that will be conducted to investigate potentially contaminated areas in the EW. I understand the health and safety requirements of the project, which are detailed in this health and safety plan.

Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date

APPENDIX B

Field Collection Forms

SURFACE WATER COLLECTION FORM

Project Name: _____ **Project no.** _____

Date: _____ **Time:** _____ **WW crew:** _____

Weather: _____ **Other crew:** _____

Latitude (y): _____ **Longitude (x):** _____ **Tide:** ____flood ____ebb ___slack

Location ID: _____ **Bottom depth:** _____m

Sample ID:		**Sample time:**
***In situ* measurements** Temp: _____˚C DO: _____mg/L	pH: _____ Conductivity: _____µS/cm	**Sample collection depth** __ U: Upper (1m below surface) ___ L: Lower (1m above bottom)
Notes (i.e., other unmeasured water quality characteristics, presence of sheen, odor, field duplicate, rinsate blank)**:**		

Sample ID:		**Sample time:**
***In situ* measurements** Temp: _____˚C DO: _____mg/L	pH: _____ Conductivity: _____µS/cm	**Sample collection depth** __ U: Upper (1m below surface) ___ L: Lower (1m above bottom)
Notes (i.e., other unmeasured water quality characteristics, presence of sheen, odor, field duplicate, rinsate blank)**:**		

Sample ID:		**Sample time:**
***In situ* measurements** Temp: _____˚C DO: _____mg/L	pH: _____ Conductivity: _____µS/cm	**Sample collection depth** __ U: Upper (1m below surface) ___ L: Lower (1m above bottom)
Notes (i.e., other unmeasured water quality characteristics, presence of sheen, odor, field duplicate, rinsate blank)**:**		

PROTOCOL MODIFICATION FORM

Project Name and Number: _____

Material to be Sampled: _____

Measurement Parameter: _____

Standard Procedure for Field Collection & Laboratory Analysis (cite reference):

Reason for Change in Field Procedure or Analysis Variation: _____

Variation from Field or Analytical Procedure: _____

Special Equipment, Materials or Personnel Required: _____

Initiator's Name: _____ Date: _____

Project Officer: _____ Date: _____

QA Officer: _____ Date: _____

APPENDIX C

Data Management

Appendix C Data Management

AVERAGING LABORATORY REPLICATE SAMPLES

Chemical concentrations obtained from the analysis of laboratory replicate samples (two or more analyses of the same sample) will be averaged for a closer representation of the "true" concentration as compared to the result of a single analysis. Averaging rules are dependent on whether the individual results are detected concentrations or reporting limits (RLs) for undetected chemicals. If all concentrations are detected for a single chemical, the values are simply averaged arithmetically for the sample and its associate laboratory replicate sample(s). If all concentrations are undetected for a given parameter, the minimum RL is selected. If the concentrations are a mixture of detected concentrations and RLs, any two or more detected concentrations are averaged arithmetically and RLs ignored. If there is a single detected concentration and one or more RLs, the detected concentration is reported. The latter two rules are applied regardless of whether the RLs are higher or lower than the detected concentration.

LOCATION AVERAGING

Results of chemical concentrations of discrete samples collected at a single sampling location that are submitted to the laboratory as individual samples and analyzed separately will be averaged for the purposes of mapping a single concentration per location. The averaging rules used for location averaging are the same as for laboratory replicate samples described above. This type of averaging is performed when multiple sediment samples are collected from the same location at the same time. For example: a sample and its field duplicate sample, often referred to as a split sample (PSEP 1997).

SIGNIFICANT FIGURES AND CALCULATIONS

Analytical laboratories report results with various numbers of significant figures depending on the laboratory's standard operating procedures, the instrument, the chemical, and the reported chemical concentration relative to the RL. The reported (or assessed) precision of each result is explicitly stored in the project database by recording the number of significant figures. Tracking of significant figures is used when calculating analyte sums and performing other data summaries. When a calculation involves addition, such as totaling PCBs, the calculation can only be as precise as the least precise number that went into the calculation. For example:

> 210 + 19 = 229 would be reported as 230 because although 19 is reported to 2 significant digits, the trailing zero in the number 210 is not significant.

When a calculation involves multiplication or division, the final result is rounded at the end of the calculation to reflect the value used in the calculation with the fewest significant figures. For example:

59.9 × 1.2 = 71.88 would be reported as 72 because there are two significant figures in the number 1.2.

When rounding, if the number following the last significant figure is less than 5, the digit is left unchanged. If the number following the last significant figure is equal to or greater than 5, the digit is increased by 1.

Many of the Washington State Sediment Management Standards (SMS) chemical criteria are in units normalized to the TOC content in the sediment sample (i.e., milligrams per kilogram organic carbon [mg/kg OC]). Only samples with TOC concentrations greater than or equal to 0.5% or less than or equal to 4.0% are considered appropriate for OC normalization. Samples with TOC concentrations less than 0.5% or greater than 4.0% are compared to dry weight chemical criteria. Chemical concentrations originally in units of micrograms per kilogram (µg/kg) dry weight were converted to mg/kg OC using the following equation:

$$\frac{(C_{\mu g/kg\ dry\ weight}) \times (0.001\ mg/\mu g)}{TOC}$$

Where:

C	=	the chemical concentration
TOC	=	the percent total organic carbon on a dry weight basis, expressed as a decimal (e.g., 1% = 0.01)

BEST RESULT SELECTION FOR MULTIPLE RESULTS

In some instances, the laboratory generates more than one result for a chemical for a given sample. Multiple results can occur for several reasons, including: 1) the original result did not meet the laboratory's internal quality control (QC) guidelines, and a reanalysis was performed; 2) the original result did not meet other project data quality objectives, such as a sufficiently low RL, and a reanalysis was performed; or 3) two different analytical methods were used for that chemical. In each case, a single best result is selected for use. The procedures for selecting the best result differ depending on whether a single or multiple analytical methods are used for that chemical.

For the same analytical method, if the results are:

- Detected and not qualified, then the result from the lowest dilution is selected, unless multiple results from the same dilution are available, in which case, the result with the highest concentration is selected.
- A combination of estimated and unqualified detected results, then the unqualified result is selected. This situation most commonly occurs when the original result is outside of calibration range, thus requiring a dilution.
- All estimated, then the "best result" is selected using best professional judgment in consideration of the rationale for qualification. For example, a result qualified

based on laboratory replicate results outside of QC objectives for precision would be preferred to a qualified result that is outside the calibration range.

- A combination of detected and undetected results, then the detected result is selected. If there is more than one detected result, the applicable rules for multiple results (as discussed above) are followed.
- All undetected results, then the lowest RL is selected.

For detected concentrations analyzed by the SVOC full-scan and selective ion monitoring (SIM) methods (i.e., PAHs), the highest detected concentration is selected. If the result by one method is detected and the result by the other method is not detected, then the detected result is selected for reporting, regardless of the method. If results are reported as non-detected by both methods, the undetected result with the lowest RL is selected. The SIM method is more analytically sensitive than the full-scan SVOC method, and the undetected results are generally reported at a lower RL by the SIM method than by the full-scan method. Therefore, the SIM method is selected for non-detected results unless an analytical dilution or analytical interferences elevated the SIM RL above the SVOC full-scan RL.

CALCULATED TOTALS

Total PCB congeners and total PAHs are calculated by summing the detected values for the individual components available for each sample. For individual samples in which none of the individual components is detected, the total value is given a value equal to the highest RL of an individual component, and assigned the same qualifier (U or UJ), indicating an undetected result. Concentrations for the analyte sums are calculated as follows:

- **Total PCB congeners** are calculated using only detected values for the 209 individual congeners. For individual samples in which none of the 209 congeners are detected, total PCB congeners are given a value equal to the highest RL of the individual congener and assigned a U-qualifier indicating the lack of detected concentrations. PCB congeners that do not meet minimum method requirements for qualitative determination (i.e., estimated maximum possible concentrations) are treated as non-detected values when calculating the total PCB congener sums.
- **Total low-molecular-weight PAHs (LPAHs), high-molecular-weight PAHs (HPAHs), PAHs, and benzofluoranthenes** are calculated in accordance with the methods of the SMS. Total LPAHs are the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs are the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes are the sum of the b (i.e., benzo(b)fluoranthene), j, and k isomers. Because the j isomer is rarely quantified,

this sum is typically calculated with only the b and k isomers. For samples in which all individual compounds within any of the three groups described above are undetected, the single highest RL for that sample represents the sum.

CALCULATION OF PCB CONGENER TEQS

PCB congener toxic equivalents (TEQs) are calculated using the World Health Organization (WHO) consensus toxic equivalency factor (TEF) values for fish, birds (Van den Berg et al. 1998), and mammals (Van den Berg et al. 2006) as presented in Table E-1. The TEQ is calculated as the sum of each congener concentration multiplied by the corresponding TEF value. When the congener concentration is reported as non-detected, then the TEF is multiplied by half the RL.

Table C-1. PCB Congener TEF Values

PCB CONGENER NUMBER	TEF VALUE FOR FISH (unitless)	TEF VALUE FOR BIRDS (unitless)	TEF VALUE FOR MAMMALS (unitless)
77	0.0001	0.05	0.0001
81	0.0005	0.1	0.0003
105	<0.000005	0.0001	0.00003
114	<0.000005	0.0001	0.00003
118	<0.000005	0.00001	0.00003
123	<0.000005	0.00001	0.00003
126	0.005	0.1	0.1
156	<0.000005	0.0001	0.00003
157	<0.000005	0.0001	0.00003
167	<0.000005	0.00001	0.00003
169	0.00005	0.001	0.03
189	<0.000005	0.00001	0.00003

PCB – polychlorinated biphenyl
TEF – toxic equivalency factor

CALCULATION OF CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS

Carcinogenic polycyclic aromatic hydrocarbons (cPAH) values are calculated using TEF values (California EPA 1994; Ecology 2001) based on the individual PAH component's relative toxicity to benzo(a)pyrene. TEF values are presented in Table E-3. The cPAH is calculated as the sum of each individual PAH concentration multiplied by the corresponding TEF value. When the individual PAH component concentration is reported as non-detected, then the TEF is multiplied by half the RL.

Table C-2. cPAH TEF Values

cPAH	TEF VALUE (unitless)
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Dibenz(a,h)anthracene	0.4
Chrysene	0.01
Indeno(1,2,3-cd)pyrene	0.1

cPAH – carcinogenic polycyclic aromatic hydrocarbon
TEF – toxic equivalency factor

REFERENCES

California EPA. 1994. Health effects of benzo(a)pyrene. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Berkeley, CA.

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APPENDIX D

Analytical Concentration Goals

Appendix D Analytical Concentration Goals

This appendix addresses the question of whether the analytical methods proposed for the chemical analyses of surface water are sufficiently sensitive to meet the needs of the East Waterway (EW) ecological risk assessment (ERA) and human health risk assessment (HHRA). To answer this question, standard reporting limits (RLs) and method detection limits (MDLs) for surface water analytes were compared to analytical concentration goals (ACGs).

For evaluating risk to humans, an ACG for a particular chemical is defined as the concentration of that chemical in surface water that has been identified as having an acceptable risk level (e.g., excess cancer risk no higher than 10^{-6} or hazard quotient [HQ] less than 0.1 for non-cancer risk). US Environmental Protection Agency (EPA) Region 6 has developed screening levels for the ingestion of tap water (EPA 2007). These levels are based on an ingestion rated of 2 L/day. Because water from the EW is not used for drinking, the application of these screening levels without modification would not be appropriate. However, with modification, they can form the basis for health-protective ACGs.

The EW HHRA will include a swimming scenario that incorporates the incidental ingestion of water and dermal contact with surface water. EPA has not developed screening levels for dermal contact with surface water or incidental water ingestion during swimming. For the purpose of developing ACGs, the EPA screening levels for drinking water ingestion were adjusted to account for a swimming scenario. Although the exposure parameters for the swimming scenario have not been developed, it is likely they will be equivalent to those used for the swimming scenario in the HHRA conducted by King County as part of a water quality assessment (WQA) (King County 1999), which included the EW. The relevant exposure parameters for the highest-exposure scenario from that assessment were an exposure frequency of 24 events/yr, an exposure duration of 2.6 hrs per event, and an incidental water ingestion rate of 0.075 L/hr. In order to compare these results to the drinking water ingestion rate of 2 L/day that forms the basis for the EPA Region 6 water screening level (EPA 2007), the incidental water ingestion rate used in the King County WQA was normalized to 365 days/yr because the drinking water scenario used by EPA is based on 365 days/yr. Using the exposure parameters described above, the incidental water ingestion rate for a swimming scenario, expressed on the basis of everyday exposure (i.e., 365 days/yr) would be 0.013 L/day.[1]

An incidental water ingestion rate of 0.013 L/day is approximately 150 times lower than the drinking water ingestion rate of 2 L/day assumed in the EPA Region 6 screening levels. Because a screening level that is based only on incidental water ingestion does not account for dermal contact with water, the EPA Region 6 water screening level was

[1] 2.6 hr/event × 24 events/yr × 0.075 L/hr × 1 yr/365 days.

multiplied by a factor of 10, which is functionally equivalent to an incidental water ingestion rate of 0.2 L/day. This hypothetical water ingestion rate is approximately 15 times greater than the actual incidental surface water ingestion rate that is likely to be used for the EW HHRA. For the purposes of ACG derivation, this 15-fold difference is adequately protective of the dermal exposure route for the swimming exposure pathway in the EW. In addition, for risk levels based on non-cancer endpoints, the EPA Region 6 screening values were divided by 10 because they are based on an HQ of 1; whereas EPA Region 10 guidance (1996) indicates that screening values based on non-cancer endpoints should be based on an HQ of 0.1. ACGs were calculated for individual PCB congeners with dioxin-like properties by dividing the modified EPA Region 6 ACG (as described above) for 2,3,7,8-TCDD by the toxic equivalency factor for the respective congener (Van den Berg et al. 2006).

For evaluating risk to fish in the ERA, an ACG is defined as the concentration of a chemical in surface water to which fish are exposed and that is associated with an acceptable risk level. As discussed in Section 2.2 of the main document, risk to fish from surface water exposure will be evaluated for metals and polycyclic aromatic hydrocarbons (PAHs); other chemicals will be evaluated using a critical tissue-residue approach.

ACGs were not derived for wildlife receptors because the contribution to risk from incidental surface water ingestion is expected to be very low and will not drive the risk assessment conclusions. For example, in the Lower Duwamish Waterway ERA, the proportion of the risk to wildlife receptors from the incidental ingestion of polychlorinated biphenyls (PCBs) in surface water was less than 0.01% of the total risk from all ingestion pathways combined (Windward 2007). Therefore, the contribution to risk is expected to be insignificant at chemical concentrations equal to or below the analytical RLs.

The human health and fish ACGs were compared with target RLs and MDLs (Table D-1). The target RLs for 66 of the 72 chemicals with ACGs were less than the ACGs; thus, the specified methods are sufficiently sensitive for the risk assessments for those chemicals. However, the RLs for six other chemicals were higher than the ACGs derived for the protection of human health, and the MDLs for four of these chemicals were higher than the human health ACGs. The target RLs and MDLs in Table D-1 are the lowest that can be reasonably obtained using standard EPA-approved analytical methods. The chemicals with RLs higher than ACGs are six semivolatile organic compounds (i.e., 3,3'-dichlorobenzidine, benzidine, bis(2-chloroethyl) ether, hexachlorobenzene, n-nitrosodimethylamine, n-nitrosodi-n-propylamine). The chemicals with MDLs higher than ACGs are benzidine, bis(2-chloroethyl) ether, n-nitrosodimethylamine, and n-nitrosodi-n-propylamine. Therefore, there may be a level of uncertainty with the assessment of risk for these chemicals in the HHRA if they are not detected using the standard methods. For undetected chemicals with RLs above the ACGs, the ramifications for the HHRA will be discussed in the uncertainty assessment.

The laboratories will make all reasonable efforts to achieve the target MDLs and RLs for all chemicals. Additional efforts may include using modified extraction techniques (e.g., extracting a higher sample volume or adjusting the final extract volume), a lower concentration for the lowest standard in the initial calibration, or by adjusting the amount of extract injected into the instrument.

Table D-1. Comparison of target detection limits and ACGs

Analyte by Method	Detection Limit (µg/L)[a]		Human Health ACG (µg/L)	Fish ACG (µg/L)[b]	Type of ACG Lower than MDL
	MDL	RL			
PAHs by EPA Method 8270D-SIM					
Acenaphthene	0.0050	0.010	365	na	
Anthracene	0.0028	0.010	1,825	na	
Benzo(a)anthracene	0.0041	0.010	0.29	0.11	
Benzo(a)pyrene	0.0031	0.010	0.029	11	
Benzo(b)fluoranthene	0.0029	0.010	0.29	0.2	
Benzo(k)fluoranthene	0.0034	0.010	2.9	0.2	
Benzo(g,h,i)perylene	0.0048	0.010	na	0.05	
Chrysene	0.0035	0.010	29	11	
Dibenzo(a,h)anthracene	0.0023	0.010	0.029	0.2	
Fluoranthene	0.0061	0.010	1,460	0.8	
Fluorene	0.0027	0.010	243	na	
Indeno(1,2,3-cd)pyrene	0.0031	0.010	0.29	0.05	
Naphthalene	0.0036	0.010	6.2	na	
Phenanthrene	0.0040	0.010	na	4.6	
Pyrene	0.0056	0.010	183	2.1	
Other SVOCs by EPA Method 8270D					
1,2,4-Trichlorobenzene	0.24	1.0	8	nd	
1,2-Dichlorobenzene	0.21	1.0	49	nd	
1,3-Dichlorobenzene	0.22	1.0	14	nd	
1,4-Dichlorobenzene	0.23	1.0	4.7	nd	
2,4,5-Trichlorophenol	1.6	5.0	3,650	nd	
2,4,6-Trichlorophenol	1.7	5.0	61	nd	
2,4-Dichlorophenol	1.7	5.0	110	nd	
2,4-Dimethylphenol	0.30	1.0	730	nd	
2,4-Dinitrophenol	2.4	10	73	nd	
2,4-Dinitrotoluene	0.92	5.0	73	nd	
2,6-Dinitrotoluene	1.2	5.0	37	nd	
2-Chloronaphthalene	0.23	1.0	487	nd	
2-Chlorophenol	0.32	1.0	30	nd	
2-Methylphenol	0.32	1.0	1,825	nd	
2-Nitroaniline	1.3	5.0	110	nd	
3,3'-Dichlorobenzidine	1.1	**5.0**	1.5	nd	human health

Analyte by Method	Detection Limit (µg/L)[a]		Human Health ACG (µg/L)	Fish ACG (µg/L)[b]	Type of ACG Lower than MDL
	MDL	RL			
4-Chloroaniline	1.0	5.0	146	nd	
4-Methylphenol	0.22	1.0	183	nd	
4-Nitrophenol	0.90	5.0	292	nd	
Aniline	0.12	1.0	118	nd	
Benzidine	**5.2**	**10**	0.00094	nd	human health
Benzoic acid	3.1	10	146,000	nd	
Benzyl alcohol	0.88	5.0	10,950	nd	
Bis(2-chloroethyl) ether	**0.31**	**1.0**	0.098	nd	human health
Bis(2-ethylhexyl) phthalate	0.53	1.0	48	nd	
Bis-chloroisopropyl ether	0.29	1.0	2.7	nd	
Butyl benzyl phthalate	0.24	1.0	7,300	nd	
Carbazole	0.24	1.0	34	nd	
Di-ethyl phthalate	0.41	1.0	29,200	nd	
Dimethyl phthalate	0.20	1.0	365,000	nd	
Di-n-butyl phthalate	0.21	1.0	3,650	nd	
Hexachlorobenzene	0.24	**1.0**	0.42	nd	human health
Hexachlorobutadiene	0.24	1.0	8.6	nd	
Hexachloroethane	0.27	1.0	48	nd	
Isophorone	0.25	1.0	708	nd	
Nitrobenzene	0.30	1.0	3.4	nd	
n-Nitrosodimethylamine	**0.71**	**5.0**	0.0042	nd	human health
n-Nitrosodi-n-propylamine	**1.1**	**5.0**	0.10	nd	human health
n-Nitrosodiphenylamine	0.29	1.0	137	nd	
Pentachlorophenol	0.99	5.0	5.6	nd	
Phenol	0.14	1.0	10,950	nd	
PCBs by EPA Method 1668A					
PCB congeners (total PCBs)[c]	2.4×10^{-6} – 13.3×10^{-6}	8.0×10^{-6} – 51×10^{-6}	0.34	nd	
PCB-77[d]	3.4×10^{-6}	19×10^{-6}	0.045	nd	
PCB-81[d]	2.4×10^{-6}	19×10^{-6}	0.015	nd	
PCB-105[d]	5.6×10^{-6}	13×10^{-6}	0.15	nd	
PCB-114[d]	4.2×10^{-6}	13×10^{-6}	0.15	nd	
PCB-118[d]	13.0×10^{-6}	12×10^{-6}	0.15	nd	
PCB-123[d]	4.1×10^{-6}	13×10^{-6}	0.15	nd	
PCB-126[d]	5.2×10^{-6}	14×10^{-6}	0.000045	nd	
PCB-156[d]	4.3×10^{-6}	15×10^{-6}	0.15	nd	
PCB-157[d]	4.3×10^{-6}	15×10^{-6}	0.15	nd	
PCB-167[d]	3.8×10^{-6}	11×10^{-6}	0.15	nd	
PCB-169[d]	5.4×10^{-6}	12×10^{-6}	0.00015	nd	
PCB-189[d]	4.9×10^{-6}	17×10^{-6}	0.15	nd	

Analyte by Method	Detection Limit (µg/L)[a]		Human Health ACG (µg/L)	Fish ACG (µg/L)[b]	Type of ACG Lower than MDL
	MDL	RL			
Metals by EPA Method 1640 (modified)					
Antimony	0.004	0.012	15	na	
Arsenic	0.03	0.10	0.45	36.0	
Cadmium	0.003	0.010	18	9.3	
Chromium	0.08	0.30	110	50.0	
Cobalt	0.02	0.10	730	na	
Copper	0.03	0.10	1,356	3.1	
Lead	0.036	0.150	150	8.1	
Nickel	0.03	0.10	730	8.2	
Selenium	0.05	0.20	183	71.0	
Silver	0.005	0.020	183	1.9	
Thallium	0.003	0.010	25.6	na	
Vanadium	0.024	0.080	183	na	
Zinc	0.08	0.25	11	81.0	
Metals by EPA Method 1631					
Mercury	0.000015	0.00040	0.63	0.025	
TBT by Krone (1989)					
Tri-n-butyltin	0.10	0.20	11	nd	

Note: Actual RLs and MDLs will vary based on the amount of sample volume used for each analysis, matrix interferences, and the analytical dilution.

[a] RLs and MDLs are from Analytical Resources, Inc., Brooks Rand Labs LLC, and Analytical Perspectives.

[b] For metals, ACGs are based on Washington State marine chronic WQS, with the exception of silver, which is an acute WQS because no chronic value is available. For PAHs, ACGs are based on TRVs presented in the aquatic risk assessment conducted by King County (1999).

[c] RLs and MDLs for calculated totals are the highest of the RLs and MDLs for the individual congeners.

[d] Dioxin-like PCB and dioxin/furan congeners will be evaluated as toxic equivalents (TEQs) in the risk assessments, rather than as individual congeners. However, because TEQs are calculated, rather than measured by the laboratory, RBCs for individual congeners are presented to facilitate comparison with RLs for those congeners. In reality, risks will be assessed based on sums of these congeners (normalized per their relative toxicity to TCDD), and thus comparison to RLs on a congener-specific basis is somewhat uncertain.

[e] The RLs and MLs for metals are achieved using EPA Method 1640 (modified) for reductive precipitation.

ACG – analytical concentration goal

EPA – US Environmental Protection Agency

MDL – method detection limit

na – not available

nd – not determined (risk to fish from these chemicals will be evaluated using a critical tissue-residue approach)

PCB – polychlorinated biphenyl;

RL – reporting limit

SVOC – semivolatile organic compound

TBT – tributyltin

TRV – toxicity reference value

WQS – water quality standard

Bold identifies MDLs and RLs that exceeded an ACG.

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