Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

BASELINE FISH AND CRAB TISSUE COLLECTION AND CHEMICAL ANALYSES - QUALITY ASSURANCE PROJECT PLAN

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

July 19, 2017

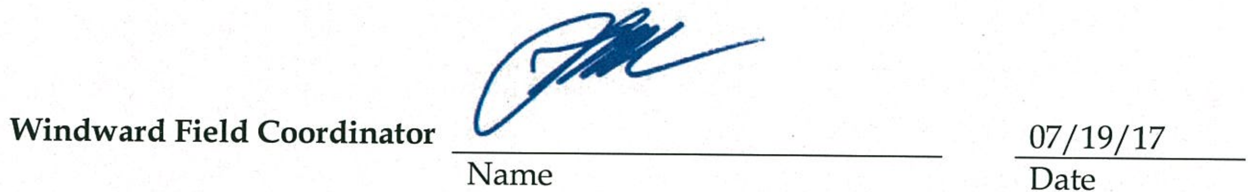
Prepared by:

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

Title and Approval Page
Fish and Crab Tissue Collection and Chemical Analyses
Quality Assurance Project Plan

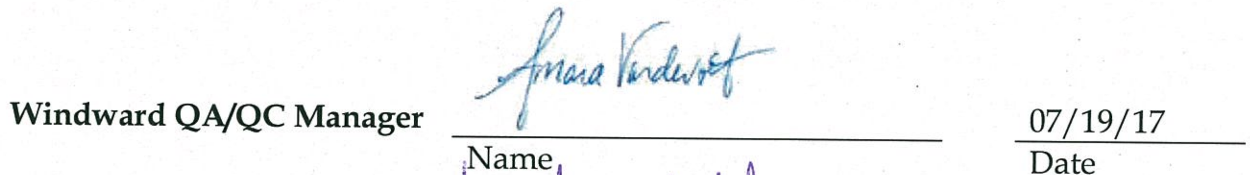
Windward Project Manager ______________ 07/19/17

Name Date



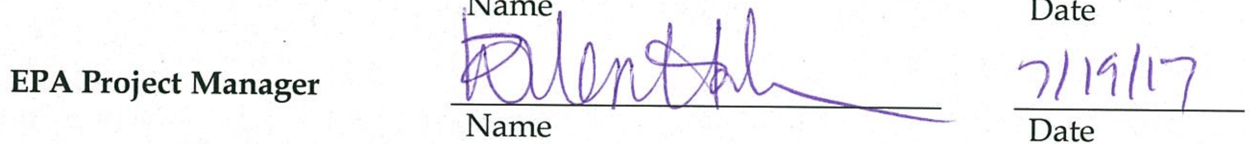
Windward Field Coordinator ______________ 07/19/17

Name Date



Windward QA/QC Manager ______________ 07/19/17

Name Date



EPA Project Manager ______________ 7/19/17

Name Date

EPA Task Manager N/A ______________

Name Date

EPA QA/QC Manager ______________ 7/19/17

Name Date

Distribution List

This list identifies all individuals who will receive a copy of the approved quality assurance project plan, either in hard copy or electronic format, as well as any subsequent revisions.

- Elly Hale, EPA Project Manager
- Kathy Godtfredsen, Windward Project Manager
- Susan McGroddy, Windward Task Manager
- Thai Do, Windward Field Lead
- Donald Brown, EPA QA/QC Manager
- Amara Vandervort, Windward QA/QC Manager

Chemistry Project Managers:

- Sue Dunnihoo (Analytical Resources, Inc.)
- Elizabeth Madonick (Brooks Applied Labs)
- Georgina Brooks (Axys Analytical Services, Ltd.)
- Jeff Grindstaff (ALS Environmental-Kelso)
- Andrew Schauer (Isolab University of Washington)

Lower Duwamish Group:

- Brian Anderson, Joe Flaherty (The Boeing Company)
- Dave Schuchardt, Allison Crowley, Pete Rude (City of Seattle)
- Jeff Stern, Debra Williston (King County)
- Joanna Florer (Port of Seattle)

Table of Contents

Distribution List ii
Table of Contents iii
Tables v
Figures v
Maps v
Acronyms vi
1 Introduction 1
2 Project Objectives and Description 3
2.1 Data Quality Objectives 3
2.2 Project Description and Schedule 5
3 Project Organization and Responsibility 7
3.1 Project Management 9
3.2 Field Coordination 9
3.2.1 Boat captains 10
3.3 Quality Assurance/Quality Control 10
3.4 Laboratory Responsibilities 11
3.5 Data Management 13
3.6 Special Training/Certification 13
3.7 Documentation and Records 14
3.7.1 Field observations 14
3.7.2 Laboratory records 15
3.7.3 Data reduction 17
3.7.4 Data report 17
3.7.5 Data storage and backup 18
4 Data Generation and Acquisition 19
4.1 Sampling Design 19
4.1.1 Targeted species 19
4.1.2 Sampling areas 19
4.1.3 Number of composite samples 26
4.1.4 Compositing scheme 28
4.1.5 Targeted organism size 29
4.2 Sampling Methods 29
4.2.1 Sample identification 29
4.2.2 Sampling methods 30
4.2.3 Field sample processing 33
4.3 Sample Handling and Custody Requirements 34

4.3.1 Sample handling procedures 34
4.3.2 Sample custody procedures 35
4.3.3 Shipping requirements 36
4.3.4 Decontamination procedures 38
4.3.5 Field-generated waste disposal 38
4.4 Laboratory Methods 39
4.4.1 Laboratory sample handling 39
4.4.2 Analytical methods 40
4.5 Analytical Data Quality Objective and Criteria 45
4.5.1 Precision 46
4.5.2 Accuracy 46
4.5.3 Representativeness 46
4.5.4 Comparability 47
4.5.5 Completeness 47
4.5.6 Sensitivity 47
4.6 Quality Assurance/Quality Control 51
4.6.1 Field quality control samples 51
4.6.2 Laboratory quality control 51
4.7 Instrument/Equipment Testing, Inspection, and Maintenance 56
4.8 Instrument/Equipment Calibration and Frequency 56
4.9 Inspection/Acceptance of Supplies and Consumables 57
4.10 Non-direct Measurements 57
4.11 Data Management 57

5 Assessment and Oversight 59
5.1 Compliance Assessments and Response Actions 59
5.1.1 Compliance assessments 59
5.1.2 Response actions for field sampling 59
5.1.3 Corrective action for laboratory analyses 59
5.2 Reports to Management 60

6 Data Validation and Usability 61
6.1 Data Validation 61
6.2 Reconciliation with Data Quality Objectives 62

7 References 63

Appendix A. Health and Safety Plan

Appendix B. Field Forms

Appendix C. Standard Operating Procedures for Tissue Processing

Appendix D. Analytical Methods and Reporting Limits

Tables

Table 2-1.	Fish and crab QAPP DQOs	3
Table 3-1.	Permits required for sampling	14
Table 4-1.	LDW tissue sampling design for fish and crabs	21
Table 4-2.	Summary of level of effort and catch totals for target species in previous LDW tissue sampling events	24
Table 4-3.	Level of effort for trawling in 2004, 2005, and 2007 LDW sampling events	25
Table 4-4.	Procedures to be conducted at each analytical laboratory	41
Table 4-5.	Analytical methods and sample handling requirements	42
Table 4-6.	Numbers of composite samples per LDW sampling area to be analyzed for each analyte group	45
Table 4-7.	Data quality indicators for tissue analyses	47
Table 4-8.	Summary of fish and crab tissue analytes, methods, and RL goals for each analyte	49
Table 4-9.	Tissue mass required per sample type	51
Table 4-10.	Laboratory quality control sample analysis summary	53

Figures

Figure 3-1.	Project organization and team responsibilities	8
Figure 4-1.	Sample shipping and handling process	37

Maps

Map 2-1. Conceptual sampling reaches for baseline English sole and crab tissue collection

Map 2-2. Conceptual sampling subreaches for baseline shiner surfperch tissue collection

Acronyms

%RSD	percent relative standard deviation
95UCL	95% upper confidence limit for the mean
ALS	ALS Environmental-Kelso
AOC	Administrative Order on Consent
ARI	Analytical Resources, Inc.
Axys	Axys Analytical Services Ltd.
BEHP	bis[2-ethylhexyl] phthalate
BHC	benzene hexachloride
Brooks Applied	Brooks Applied Labs
CFR	Code of Federal Regulations
COC	chain of custody
COPC	contaminant of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CV	coefficient of variation
DBT	dibutyltin
DCM	dichloromethane
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DGPS	differential global positioning system
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture detector
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
FC	field coordinator
GC/MS	gas chromatography/mass spectrometry
GPC	gel permeation chromatography

GPS	global positioning system
HG-AFS	hydride generation-atomic fluorescence spectrometry
HpCDD	heptachlorodibenzo-*p*-dioxin
HpCDF	heptachlorodibenzofuran
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
HSP	health and safety plan
HxCDD	hexachlorodibenzo-*p*-dioxin
HxCDF	hexachlorodibenzofuran
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
Isolab	Isolab at University of Washington
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MDD	minimum detectable difference
MDL	method detection limit
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
NMFS	National Marine Fisheries Service
OCDD	octachlorodibenzo-*p*-dioxin
OCDF	octachlorodibenzofuran
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
PM	project manager
PPE	personal protective equipment

PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAO	remedial action objective
RI/FS	remedial investigation/feasibility study
RL	reporting limit
RM	river mile
RME	relative margin of error
ROD	Record of Decision
RPD	relative percent difference
RTK	Real Time Kinematic
SDG	sample delivery group
SIM	select ion monitoring
SOP	standard operating procedure
SRM	standard reference material
SVOC	semivolatile organic compound
TBT	tributyltin
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	toxic equivalent
TM	task manager
TTL	target tissue level
UCT-KED	universal cell technology-kinetic energy discrimination
USFWS	US Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife
Windward	Windward Environmental LLC
ww	wet weight

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for collecting fish and crab tissue from the Lower Duwamish Waterway (LDW) for chemical analyses. As described in the *Pre-Design Studies Work Plan* (Windward and Integral 2017b), hereafter referred to as the Work Plan, baseline fish and crab tissue data will be collected and analyzed to address the third amendment to the Administrative Order on Consent (AOC), Tasks 3, 4, and 5 (EPA 2016c).

Section 3.2.2 of the Work Plan presents the data quality objectives (DQOs) and preliminary study design for fish and crab tissue collection and associated chemical analyses (Windward and Integral 2017b). This QAPP includes these DQOs and presents the fish and crab tissue study design, including details on project organization, field data collection, laboratory analyses, and data management.

US Environmental Protection Agency (EPA) guidance for QAPPs was followed in preparing this project plan (EPA 2002). The remainder of this plan is organized into the following sections:

- Section 2 – Project Objectives and Description
- Section 3 – Project Organization and Responsibilities
- Section 4 – Data Generation and Acquisition
- Section 5 – Assessment and Oversight
- Section 6 – Data Validation and Usability
- Section 7 – References

Appendix A to this QAPP is a health and safety plan (HSP) designed to protect on-site personnel from physical, chemical, and other hazards posed by the field sampling effort. Field collection forms are included as Appendix B. Standard operating procedures (SOPs) for laboratory tissue processing are included as Appendix C. Analytical methods and reporting limits (RLs) are included as Appendix D.

2 Project Objectives and Description

EPA issued a Record of Decision (ROD) for the LDW Superfund site on November 21, 2014 (EPA 2014b). The ROD described the selected sediment remedy for the LDW, and identified monitoring activities, including baseline sampling of LDW media, for comparison to post-remedial data. This QAPP is focused on baseline sampling of fish and crab tissue.

2.1 Data Quality Objectives

Two DQOs have been established for the fish and crab effort. These DQOs are summarized in Table 2-1.

Table 2-1. Fish and crab QAPP DQOs

DQO Step	DQO 1	DQO 2
STEP 1: State the problem	Site-wide tissue concentrations of human health risk drivers have not been measured since 2007 and data are needed to establish current site-wide 95UCL concentrations in tissue to serve as baseline conditions before the site-wide sediment remedy.	The baseline mean concentrations of the RAO 1 risk drivers need to be established before the site-wide remedy in order to assess concentration trends following remediation.
STEP 2: Identify the goals of the study	The goal of DQO 1 is to establish current site-wide 95UCL concentrations for comparison to TTLs from the ROD.	The goal of DQO 2 is to establish current site-wide mean tissue concentrations for assessing trends.
STEP 3: Identify the information inputs	Existing tissue data from the LDW and associated statistics (e.g., variance) were used to determine the appropriate sample sizes needed to achieve the statistical power of the sampling design necessary to establish baseline and evaluate trends.	
STEP 4: Define the boundaries of the study	The boundary of the study has been defined by the ROD and divided into reaches that are based on the sampling and analysis conducted for the RI. Reach 1 extends from RM 0.0 to RM 2.9, and Reach 2 extends from RM 2.9 to RM 5.0. Crab and English sole will be collected from the two reaches, and shiner surfperch will be collected from two subreaches within each of the two reaches (for a total of four subreaches each of which will be approximately one-quarter of the LDW).	
STEP 5: Develop the analytical approach	All samples will be analyzed for risk drivers (PCBs, dioxins/furans, inorganic arsenic and cPAHs[a]). Each sample will be a composite of 5 to 15 individuals, depending on the species. In addition to analyzing all samples for risk drivers, a subset of samples will be analyzed for other COPCs as specified in the ROD. These analytes will include BEHP, PCP, TBT, vanadium, and organo-chlorine pesticides.	
STEP 6: Specify performance or acceptance criteria	Performance or acceptance criteria are described in Section 4.6, including field quality control samples and laboratory quality control. Data quality indicators for laboratory analyses (precision, accuracy, representativeness, completeness, and comparability) will be met, as described in Section 4.5.	
STEP 7: Develop the detailed plan for obtaining data	Following approval of this QAPP, fish and crab will be collected in August or September 2017 using two methods. Crab traps will be used to target Dungeness crab, and a high-rise otter trawl will be used to target both crab and fish (English sole and shiner surfperch). If sufficient numbers of the target species cannot be collected, alternate target species (starry flounder and graceful crab) will be collected, as discussed in Section 4.1. If graceful crab are collected, stable isotope analysis of both crab species will be conducted to assess their relative trophic levels.	

[a] Because of the ability of fish to metabolize cPAHs (Collier et al. 2013), fish will not be analyzed for cPAHs. Thus, only crab samples will be analyzed for cPAHs.

95UCL – 95% upper confidence limit for the mean
BEHP – bis[2-ethylhexyl] phthalate
COPC – contaminant of potential concern
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DQO – data quality objective
LDW – Lower Duwamish Waterway
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
QAPP – quality assurance project plan
RAO – remedial action objective
RI – remedial investigation
RM – river mile
ROD – Record of Decision
TBT – tributyltin
TTL – target tissue level

The first DQO for the collection of and analysis of baseline fish and crab tissue samples is:

- To establish baseline site-wide 95% upper confidence limit for the mean (95UCL) concentrations of risk drivers for comparison to target tissue levels (TTLs) [1] for remedial action objective (RAO) 1

RAO 1 establishes sediment cleanup objectives for human health risk associated with the consumption of resident seafood. The baseline site-wide 95UCL is the statistic selected in the ROD for comparison to TTLs to measure progress toward achieving RAO 1 (EPA 2014b). TTLs are not cleanup levels; rather, they will be used for informational purposes to assess ongoing risks associated with the consumption of resident LDW fish and shellfish (EPA 2014b).

TTLs have been developed for English sole (fillet and whole body), shiner surfperch, Dungeness crab (edible meat and whole body), and Eastern softshell clam. There are TTLs for fish, crab and clam for polychlorinated biphenyls (PCBs) and dioxin/furans, and for clams for carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and inorganic arsenic. The purpose of this investigation is to generate a baseline site-wide dataset for English sole, shiner surfperch, and Dungeness crab. The study design for the baseline dataset for Eastern softshell clam will be provided in a separate QAPP.

In order to develop the fish and crab study design, a targeted relative margin of error (RME) for the site-wide mean concentration for fish and crab tissues in the LDW was established as 25%. The RME was calculated to be the width of the LDW-wide 95UCL as a percent of the mean.

As presented in Appendix A to the Work Plan (Windward and Integral 2017a), data from several LDW tissue sampling efforts (included in the RI/FS dataset) were evaluated to develop the study design. Distributional characteristics of individual tissue concentrations and site-wide patterns of mean concentrations were used to identify the best statistical model to identify the sample sizes expected to achieve the targeted RME for the first DQO.

The sampling design provides a robust site-wide 95UCL for each of the target tissue types that will be compared to the TTLs.

[1] TTLs are specified in ROD Table 21, titled *LDW resident fish and shellfish target tissue concentrations* (EPA 2014b).

In addition to the risk drivers, a subset of samples (as noted in Section 4.4.2) will be analyzed for the chemicals listed in ROD Tables 14 and 18.[2] In combination, these contaminants of potential concern (COPCs) include bis[2-ethylhexyl] phthalate (BEHP), pentachlorophenol (PCP), tributyltin (TBT), vanadium, and organo-chlorine pesticides. A smaller subset of samples will be analyzed for these chemicals because they are not risk drivers.

The second DQO is:

- To establish baseline site-wide mean concentrations to assess trends following sediment remediation for contaminants with TTLs

The baseline data collected to calculate site-wide 95UCLs will also be used to establish baseline site-wide mean concentrations to assess trends following implementation of the sediment remedy. A preliminary power analysis was conducted to calculate the minimum detectable difference (MDD) for each of the target species based on the sampling design and the variance observed in the 2007 tissue data, as described in Appendix A of the Work Plan (Windward and Integral 2017b). The results of this analysis indicate a 90% probability of being able to detect a temporal decrease of 50% in the baseline mean concentration for English sole, 35% in the baseline mean concentration for shiner surfperch, and 30% in the baseline mean concentration for Dungeness crab edible meat. The 2007 results for whole-body Dungeness crab could not be evaluated due to small sample size and outliers, but the sampling design is expected to be powerful enough to detect temporal decreases that are comparable to the expected analytical variance.

In addition to addressing the DQOs, fish and crab tissue sampling will support health risk communication related to human consumption of resident seafood (RAO 1) (EPA 2014b).

2.2 Project Description and Schedule

Baseline fish and crab tissue will be collected between river mile (RM) 0 and RM 5 of the LDW. The sampling area will be divided into two reaches for English sole and Dungeness crab collection and four subreaches for shiner surfperch collection. Reach and subreach boundaries are shown in Maps 2-1 and 2-2.

Tissue samples will be analyzed for the four contaminants of concern associated with RAO 1: cPAHs, PCBs, inorganic arsenic, and dioxins/furans. In addition, a subset of samples will be analyzed for other contaminants that were not selected as

[2] Spotted sandpiper-related chemicals listed in ROD Table 18, titled *Rationale for selection of contaminants as COCs for ecological risk,* will not be analyzed in fish and crab tissue, because only benthic invertebrate tissue and sediment analyses are relevant to the spotted sandpiper. Also, the benthic invertebrate-related chemicals listed in ROD Table 18 will not be analyzed in fish and crab tissue, because these chemicals are only applicable in sediment analyses (EPA 2014b). Cadmium will not be analyzed in fish tissue because it was assessed using a dietary approach for fish.

contaminants of concern, including selected semivolatile organic compounds (SVOCs), vanadium, TBT, and selected organochlorine pesticides. Specific sample analyses to be performed are summarized in Section 4.

Fish and crab tissue sampling in the LDW will take place in August/September 2017. Fish and crab will be collected using a high-rise otter trawl. In addition, crab will be collected using crab traps, which will be deployed during the same time period.

Chemical analysis of the samples will be performed after compositing and homogenization have been completed and will require approximately four weeks to perform.[3] Data validation will be completed approximately three weeks after receipt of the chemistry data. EPA will be notified when the final data validation report has been received.

A draft data report will be submitted to EPA 21 days after receipt of the validated analytical results. A draft final data report will be submitted to EPA 30 days after receipt of EPA's comments on the draft report.

[3] The stable isotope analysis of crab tissues will require more than four weeks to complete. This dataset will be provided as a supplement to the data report.

3 Project Organization and Responsibility

The overall project organization and the individuals responsible for the various tasks required for the tissue sample collection and analysis are shown in Figure 3-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following sections.

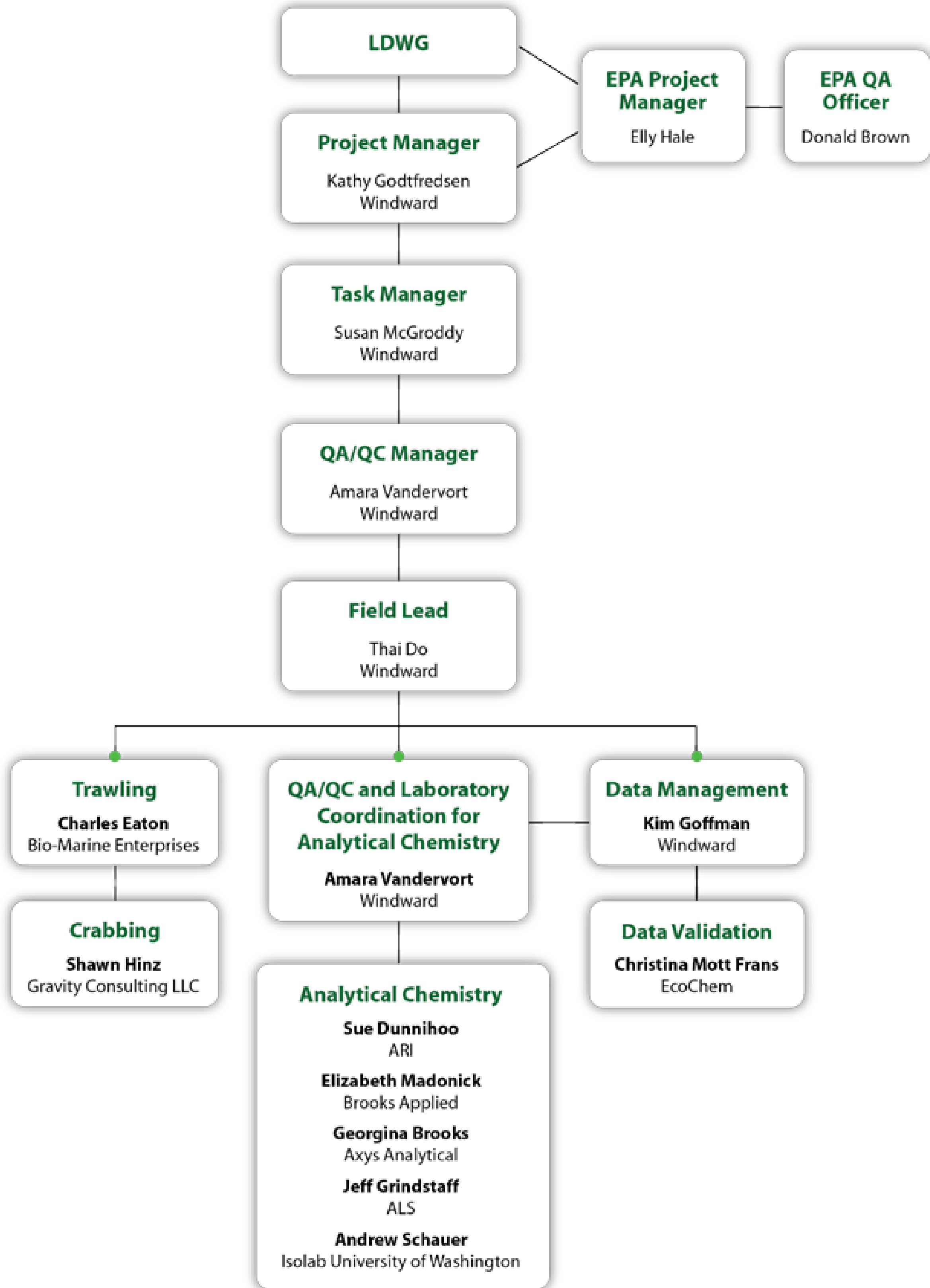


Figure 3-1.Project organization and team responsibilities

3.1 PROJECT MANAGEMENT

Both the Lower Duwamish Waterway Group (LDWG) and EPA are involved in all aspects of this project, including discussion, review, and approval of this QAPP, and interpretation of the results of the investigation. Elly Hale is the EPA PM for the pre-design studies (EPA 2016c).

Kathy Godtfredsen will serve as the Windward Environmental LLC (Windward) PM. In this capacity, she will be responsible for overall project coordination, and for providing oversight for 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 LDWG and EPA on schedule, deliverables, and other administrative details. Dr. Godtfredsen can be reached as follows:

Dr. Kathy Godtfredsen
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.206.577.1283
E-mail: kathyg@windwardenv.com

Susan McGroddy will serve as the Windward monitoring task manager (TM), as TM she will be responsible for communicating with the Windward PM on the progress of project tasks, conducting detailed planning and coordination, and monitoring and communicating any deviations from the QAPP. Significant deviations from the QAPP will be further reported to representatives of LDWG and EPA. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5421
E-mail: susanm@windwardenv.com

3.2 FIELD COORDINATION

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

Mr. Thai Do
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5407
Email: thaid@windwardenv.com

3.2.1 Boat captains

Charlie Eaton will serve as the trawl boat captain. He will be responsible for operating the boat and for decisions pertinent to the operation of the trawl. The boat captain will coordinate closely with the FC to ensure that samples are collected in keeping with the methods and procedures presented in this QAPP. Mr. Eaton can be reached as follows:

Mr. Charles Eaton
Bio-Marine Enterprises
2717 3rd Avenue North
Seattle, WA 98109
Telephone: 206.282.4945
Mobile: 206.714.1055
Email: cmeaton@msn.com

Shawn Hinz will serve as the crabbing boat captain. He will be responsible for operating the boat and will coordinate closely with the FC to ensure that samples are collected in keeping with the methods and procedures presented in this QAPP. Mr. Hinz can be reached as follows:

Mr. Shawn Hinz
Gravity Consulting LLC
32617 Southeast 44th Street
Fall City, WA 98024
Mobile: 425.281.1471
Email: shawn@gravity.com

3.3 Quality Assurance/Quality Control

Amara Vandervort will be the Windward QA/QC coordinator for the project. In this capacity, she will oversee coordination of the field sampling and laboratory programs, and will supervise data validation and project QA coordination, including coordination with the analytical laboratories and the EPA QA officer, Donald Brown. Ms. Vandervort will also maintain the official approved QAPP and ensure that the appropriate parties receive updated versions of the QAPP. Ms. Vandervort can be reached as follows:

Ms. Amara Vandervort
Windward Environmental LLC
200 West Mercer Street, Suite 401

Seattle, WA 98119
Telephone: 206. 812.5415
Email: amarav@windwardenv.com

Mr. Brown can be reached as follows:

Mr. Donald Brown
US Environmental Protection Agency, Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: 206.553.0717
Email: brown.donaldm@epa.gov

Independent third-party chemical data review and validation will be provided by Ecochem. The PM at Ecochem can be reached as follows:

Ms. Christina Mott Frans
Ecochem
1011 Western Avenue, Suite 1006
Seattle, WA 98104
Telephone: 206. 508. 2110
Email: cmfrans@ecochem.net

3.4 Laboratory Responsibilities

Amara Vandervort of Windward will serve as the laboratory coordinator for the analytical chemistry laboratories. Analytical Resources, Inc. (ARI) will perform all chemical analyses on the tissue samples, with the exception of analyses for PCB congeners, dioxins/furans, inorganic arsenic, and organochlorine pesticides. Axys Analytical Services Ltd. (Axys) will perform PCB congener and dioxin/furan analyses, Brooks Applied Labs (Brooks Applied) will perform inorganic arsenic analyses, and ALS Environmental-Kelso (ALS) will perform organochlorine pesticide analyses. Isolab at University of Washington (Isolab) will perform stable isotope analysis of crab tissue on an as-needed basis.

The laboratory PM at ARI can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 South 134th Place
Tukwila, WA 98168-3240
Telephone: 206.695.6207
Facsimile: 206. 695.6201
Email: limsadm@arilabs.com

The laboratory PM at Axys can be reached as follows:

Ms. Georgina Brooks
Axys Analytical Services Ltd.

2045 West Mills Road
Sidney, British Columbia V8L 5X2
Canada
Telephone: 250.655.5801
Facsimile: 250.655.5811
Email: gbrooks@axys.com

The laboratory PM at Brooks Applied can be reached as follows:

Ms. Elizabeth Madonick
Brooks Applied Labs
18804 North Creek Parkway, Suite 100
Bothell, WA 98011
Telephone: 206.753.6141; ext. 129
Facsimile: 206.632.6017
Email: elizabeth@brooksapplied.com

The laboratory PM at ALS can be reached as follows:

Jeff Grindstaff
ALS Environmental- Kelso
1317 13th Avenue South
Kelso, WA 98626
Telephone: 360.577.7222
Facsimile: 360.636.1068
Email: Jeff.Grindstaff@alsglobal.com

The laboratory PM at Isolab can be reached as follows:

Andrew Schauer
Earth and Space Sciences
Johnson Hall, Room 303A
UW Mailbox 351310
Seattle, WA 98195
Telephone: 206.543.6327
Email: isolab@uw.edu

The laboratories will meet the following requirements:

- 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.

3.5 DATA MANAGEMENT

Kim Goffman of Windward will oversee data management, and will ensure that analytical data are incorporated into the LDW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the pre-design studies. Ms. Goffman can be reached as follows:

Ms. Kim Goffman
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5414
Email: kimg@windwardenv.com

3.6 SPECIAL TRAINING/CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations through the Occupational Safety and Health Administration (OSHA) providing health and safety standards and guidelines for workers engaged in hazardous waste operations. Accordingly, 29 Code of Federal Regulations (CFR) 1910.120 requires that employees be given the training necessary to provide them with the knowledge and skills to enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hr HAZWOPER training course and 8-hr refresher courses, as necessary, to meet OSHA regulations.

Other regulations relevant to this project involve collection permits. Three fish sampling permits are needed for the sampling described in this QAPP (Table 3-1). The Washington State Department of Fish and Wildlife (WDFW) requires a permit for any scientific collection of organisms, and the service agencies (National Marine Fisheries Service [NMFS] and US Fish and Wildlife Service [USFWS]) require permits for the incidental take of threatened fish species (i.e., chinook salmon and bull trout). The FC or leader of each sampling team will be in possession of a copy of each permit, as required by the permits. Copies of permits will be available upon request.

Also, ARI, Axys, Brooks Applied, and ALS laboratories have current environmental laboratory accreditation from the Washington State Department of Ecology (Ecology).

Table 3-1. Permits required for sampling

Permit	Contact Person/Permit Holder	Permit Number
USFWS incidental take permit for threatened and endangered species (bull trout); required even though this species is not targeted for collection because they may be caught incidentally in the sampling gear	Thai Do, Windward	Threatened Species Permit TE088853-0 (pending renewal)
NMFS incidental take permit for threatened and endangered species (chinook salmon); required even though this species is not targeted for collection because they may be caught incidentally in the sampling gear	Thai Do, Windward	Scientific Research Permit (pending)
WDFW scientific collection permit	Thai Do, Windward	Scientific Collection Permit (pending)

NMFS – National Marine Fisheries Service
USFWS – US Fish and Wildlife Service
WDFW – Washington Department of Fish and Wildlife
Windward – Windward Environmental LLC

3.7 Documentation and Records

All field activities and laboratory analyses will be documented following the protocols described in this section. In addition, data reduction rules and data report formats are provided herein.

3.7.1 Field observations

All field activities will be recorded in a field logbook maintained by the FC. The field logbook will provide a description of all sampling activities, conferences between the FC and EPA oversight personnel associated with field sampling activities, sampling personnel, and weather conditions, as well as 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, and all entries will be made in indelible ink. Photographs, taken with a digital camera, will provide additional documentation of the fish and crab tissue collection activities. 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 collection sheets, included as Appendix B, will also be used to record pertinent information after sample collection:

- Target Species Tally Form
- Non-target Species Tally Form
- Protocol Modification Form
- Composite Sample Form

3.7.2 Laboratory records

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. The laboratory data packages 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 sample analyses. The summary will include, but not be limited to, discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory will be documented, as will their resolutions. In addition, operating conditions for instruments used for the analysis of each suite of analytes and definitions of laboratory qualifiers will be provided.
- **Records**: Legible copies of the chain of custody (COC) 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, as applicable:
    - Field sample identification (ID) code and the corresponding laboratory ID code
    - Sample matrix
    - Date of sample extraction/digestion
    - Date and time of analysis
    - Weight and/or volume used for analysis
    - Final dilution volumes or concentration factor for the sample
    - Percent solids and percent lipids in the samples
    - Identification of the instruments used for analysis
    - Method detection limits (MDLs) and RLs as applicable
    - 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 required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are as follows:
    - 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 to indicate 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/matrix spike duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included. The RPD for all MS and MSD analyses will be reported.
- The matrix duplicate summary will report the RPD for all matrix duplicate analyses. The QC limits for each compound or analyte will be listed.
- The standard reference material (SRM) analysis summary will report the results of the SRM analyses and compare these results to published concentration ranges for the SRMs.
- The laboratory control sample (LCS) analysis summary will report the results of the analyses of LCSs. The QC limits for each compound or analyte will be included.
- 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 extraction/digestion, preparation, and cleanup logs
  - Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
  - Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, LCSs, and SRMs
  - Enhanced and unenhanced spectra of target compounds detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all gas chromatography/mass spectrometry (GC/MS) analyses

- Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MS/MSD, laboratory replicates, LCSs, 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 are 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 (as applicable), 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.

3.7.3 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 analysis of the data. 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 and reduction by the laboratory PM, the Windward PM, the QA/QC coordinator, and independent 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.

3.7.4 Data report

A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples, as specified in Task 5 of the third amendment to the AOC (EPA 2016c). At a minimum, the following information will be included in the data report:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- Trawl start and end points recorded using a Trimble NT300D differential global positioning system (DGPS) with 1- to 2-m accuracy. When the trawl is deployed on the bottom of the LDW, global positioning system (GPS) and clock readings will be taken to mark the starting point of the trawl. Final GPS and clock readings will be made when net retrieval begins.
- Catch data for all target and non-target species

- Summary of the chemical data QA/QC review
- Results from the analyses of field samples, included as summary tables in the main body of the report, data forms submitted by the laboratories, and cross-tab tables produced from Windward's database
- Copies of field logs and photographs (appendix)
- Copies of COC forms (appendix)
- Data validation report (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 two formats: one that is compatible with Ecology's Environmental Information Management System, and one that is compatible with EPA's Scribe database.

3.7.5 Data storage and backup

All electronic files related to the project will be stored on a secure server on Windward's network. The server contents are backed up on an hourly basis, and a copy of the backup is uploaded nightly to a secure off-site facility.

4 Data Generation and Acquisition

Fish and crab tissue will be collected, processed, and analyzed according to the procedures described in this section. In addition, QA/QC, instrument maintenance and calibration, non-direct measurement, and data management information are provided.

4.1 Sampling Design

Sampling design components—including targeted species, sampling reaches and subreaches, number of composite samples per reach or subreach, compositing scheme, and target sizes for collected fish and crabs—are detailed in the following sections.

4.1.1 Targeted species

Based on the species sampled as part of the RI (Windward 2010), the results of the fishers study (Windward 2016), and the species with TTLs listed in Table 21 of the ROD (EPA 2014b), three target species of fish and crab (English sole [*Parophrys vetulus*], shiner surfperch [*Cymatogaster aggregate*], and Dungeness crab [*Metacarcinus magister*]) will be collected to establish LDW baseline conditions.[4]

4.1.2 Sampling areas

English sole and Dungeness crab samples will be collected from two reaches of the LDW: Reach 1 (RM 0.0 to RM 2.9) and Reach 2 (RM 2.9 to RM 5.0) (Table 4-1, Map 2-1). Reach 1 includes all areas where surveyed fishers reported fishing for resident species (Windward 2016). Individual fish and crab collected from within each reach will be composited, and the data across reaches will be combined to calculate 95UCL concentrations across the LDW for comparison to TTLs.

[4] Per request of public health agencies, as many as 25 (5 composites with 5 fish each) sand sole (*Psettichthys melanostictus*) (> 20 cm) will be retained if they are incidentally caught during trawling. These fish will be archived by WDFW or King County; analysis (if occurs) would be by an entity other than LDWG. Note that as part of their toxics monitoring program for Puget Sound, WDFW archived 4 sand sole caught during their recent sampling in the LDW.

Shiner surfperch samples will be collected from four subreaches of the LDW. Shiner surfperch collected for the RI had more spatial variability in their tissue concentrations than other fish species.[5] Each subreach comprises one-fourth of the LDW: Reach 1a (RM 0.0 to RM 1.25), Reach 1b (RM 1.25 to RM 2.5), Reach 2a (RM 2.5 to RM 3.75), and Reach 2b (RM 3.75 to RM 5.0) (Table 4-1, Map 2-2). Each of these reaches includes one of the four areas sampled as part of the RI (Areas T1, T2, T3, and T4) (Windward 2010): Reach 1a contains Area T1, Reach 1b contains Area T2, Reach 2a contains Area T3, and Reach 2b contains Area T4.

[5] As stated in the RI (Windward 2010), means of wet weight PCB concentrations in shiner surfperch were higher in Areas T2 and T3 and lower in Areas T1 and T4 in 2004, 2005, and 2007, as well as averaged over all years. Significant relationships between tissue and surface sediment were also identified for shiner surfperch on a subarea basis using 2004 data; PCB concentrations in surface sediment explained more than 50% of the variance in concentrations in tissue. Using 2005 data for shiner surfperch, the relationship was significant but less strong, explaining 29% of the variance. For English sole and Dungeness crab, regression relationships were not significant on an area basis using either 2004 or 2005 data, and PCB homolog patterns were consistent across the entire LDW.

Table 4-1. LDW tissue sampling design for fish and crabs

<table>
<tr><th rowspan="2">Species</th><th rowspan="2">Sample Type</th><th rowspan="2">Target Size[a] (cm)</th><th rowspan="2">Target No. of Fish or Crab per Composite</th><th rowspan="2">Target No. of Fish or Crab per Reach</th><th rowspan="2">Total No. of Individuals</th><th colspan="4">No. of Composite Samples by Reach[b]</th><th rowspan="2">Notes</th></tr>
<tr><th colspan="2">1</th><th colspan="2">2</th></tr>
<tr><td rowspan="2">English sole</td><td>remainder[c]</td><td>≥ 20</td><td>10</td><td>60[d]</td><td>120</td><td colspan="2">6</td><td colspan="2">6</td><td rowspan="2">none</td></tr>
<tr><td>fillet</td><td>≥ 20</td><td>10</td><td>60[d]</td><td>120</td><td colspan="2">6</td><td colspan="2">6</td></tr>
<tr><td rowspan="2">Starry flounder</td><td>remainder[c]</td><td>≥ 20</td><td>10</td><td>no target</td><td>no target</td><td colspan="2">no target</td><td colspan="2">no target</td><td rowspan="2">If sufficient English sole cannot be caught within a reach, starry flounder will serve as an alternate benthic fish.</td></tr>
<tr><td>fillet</td><td>≥ 20</td><td>10</td><td>no target</td><td>no target</td><td colspan="2">no target</td><td colspan="2">no target</td></tr>
<tr><td rowspan="2">Shiner surfperch</td><td rowspan="2">whole body</td><td rowspan="2">≥ 8</td><td rowspan="2">15</td><td rowspan="2">45[d]</td><td rowspan="2">180</td><td>1a</td><td>1b</td><td>2a</td><td>2b</td><td rowspan="2">Shiner surfperch will be collected from four subreaches (rather than two reaches) due to more spatial differentiation for shiner surfperch than for other fish and crab species analyzed in the RI (Windward 2010).</td></tr>
<tr><td>3</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td rowspan="2">Dungeness crab[e,f]</td><td>edible meat</td><td>≥ 9</td><td>5</td><td>30[d]</td><td>60</td><td colspan="2">6</td><td colspan="2">6</td><td rowspan="2">none</td></tr>
<tr><td>hepato-pancreas</td><td>≥ 9</td><td>10</td><td>30[d]</td><td>60</td><td colspan="2">3</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Graceful crab[e,f]</td><td>edible meat</td><td>≥ 9</td><td>7[g]</td><td>30[d]</td><td>60</td><td colspan="2">6</td><td colspan="2">6</td><td rowspan="2">If sufficient Dungeness crab cannot be caught within a reach, graceful crab will serve as an alternate crab species.</td></tr>
<tr><td>hepato-pancreas</td><td>≥ 9</td><td>14[g]</td><td>30[d]</td><td>60</td><td colspan="2">3</td><td colspan="2">3</td></tr>
</table>

Note: All target and alternate fish collected will be archived frozen for 1 year from collection.

a Total length for fish and carapace width for crabs.

b Reaches and subreaches are defined as follows: Reach 1 (RM 0.0 to RM 2.9), Reach 2 (RM 2.9 to RM 5.), Subreach 1a (RM 0.0 to RM 1.25), Subreach 1b (RM 1.25 to RM 2.5), Subreach 2a (RM 2.5 to RM 3.75), and Subreach 2b (RM 3.75 to RM 5.0).

c The remainder sample is all the tissue remaining after the fillet has been removed. The whole-body concentrations will be calculated mathematically based on the fraction of the whole body represented by each tissue type (Section 4.1.1).

d If available, additional fish will be archived to create as many as 2 additional composites per reach for English sole (10 additional English sole per reach) and 1 additional composite per subreach for shiner surfperch (15 additional shiner surfperch per subreach). If available, additional crabs will be archived to create as many as 2 additional composites per reach (10 additional crabs per reach). These archived samples will be analyzed if needed to meet the target RME because the observed site-wide variance is greater than anticipated.

e Male crabs will be collected and used in compositing in order to be consistent with fishing regulations. Both male and female Dungeness crabs were collected for the LDW RI (Windward 2010) in order to characterize consumption by wildlife. However,81% of the collected crabs during the RI were male.

f The concentration for whole-body crab will be calculated mathematically by combining the edible meat and hepatopancreas concentrations based on the fraction of the whole body represented by each tissue type (Section 4.1.1).

g In the event that graceful crabs are collected as an alternate for Dungeness crab, the edible meat composites will be made up of 7 crabs; 14 crabs will be combined in the hepatopancreas composites in order to ensure sufficient mass in the analytical samples.

EPA – US Environmental Protection Agency
LDW – Lower Duwamish Waterway
RI – remedial investigation
RM – river mile
RME - relative margin of error

Starry flounder (*Platichthys stellatus*) will be collected as a potential alternate species for English sole in the event that a sufficient quantity of English sole of acceptable size cannot be collected in a given reach. Starry flounder is a flatfish species with a trophic status similar to or higher than that of English sole (Fresh et al. 1979; Windward 2004b). Starry flounder also has greater freshwater tolerance (Eschmeyer et al. 1983) and thus can be more abundant in the upper reach of the LDW. English sole and starry flounder will be composited and analyzed separately.

In case a sufficient quantity of Dungeness crabs of acceptable size cannot be collected in a given reach, graceful crab (*Metacarcinus gracilis*, also known as slender crab) will be retained as an alternate species. Graceful crab have sufficient abundance in the LDW to serve as an alternate species and have the same general feeding strategy (i.e., predators and scavengers that consume a large variety of mollusks, crustaceans, and fish) (Dethier 2006). Dungeness crabs and graceful crabs will be composited and analyzed separately.

If graceful crabs are used as an alternate species because insufficient numbers of Dungeness crab are available, the trophic similarity of the two species will be evaluated chemically through stable isotope analysis. Carbon and nitrogen stable isotopes have a wide range of ecological uses and are commonly employed in toxicity and food web studies to investigate trophic dynamics. Stable nitrogen isotopic signatures supply information about the trophic position and diet of consumers (Peterson and Fry 1987; Fry 1988; Peterson et al. 1985), while stable carbon isotopic signatures are useful for distinguishing among food webs based on different types of primary producers or the location in which consumers feed along a salinity gradient (e.g., Stewart et al. 2004; France 1995). For example, stable carbon and nitrogen isotopes were used to discern the feeding patterns of consumers in two food webs with differing selenium uptake in San Francisco Bay (Stewart et al. 2004). In the LDW, stable isotope plots will be used to show the similarity between the feeding habits of Dungeness and graceful crabs collected from the same reach. These data will enable decisions to be made regarding whether to combine sample data from the two species in trend analysis. The need to analyze alternate species will be determined in consultation with EPA based on feasibility and catch-per-unit-effort.

If sufficient numbers of English sole are collected for a given reach, starry flounder will be disposed of and no additional starry flounder will be collected. Similarly, both Dungeness and graceful crab will be counted and composited separately during the field effort. If a sufficient number of Dungeness crab are collected in a given reach, graceful crab will be disposed of and no additional graceful crab will be collected.

The catch totals of target species for previous sampling events are summarized in Table 4-2. The catch results are summarized for the RI sampling areas T1, T2, T3, and T4. For English sole and Dungeness crab, RI areas T1 and T2 are within Reach 1, and RI areas T3 and T4 are within Reach 2 for the baseline sampling effort (Map 2-1). For the shiner surfperch, each of the RI areas is contained within a subreach. T1 is contained within Subreach 1a, T2 is contained within Subreach 1b, T3 is contained within Subreach 2a, and T4 is contained within Subreach 2b (Map 2-2).

Table 4-2. Summary of level of effort and catch totals for target species in previous LDW tissue sampling events

Target Species	2017 Sampling Areas	RI Sampling Areas	2004 (actual)	2004 Target	2005 (actual)	2005 Target	2007 (actual)	2007 Target	2017 Target
English sole	Reach 1	T1	83	30	30	30	46	30	60
		T2	66	30	37	30	45	30	
	Reach 2	T3	40	30	30	30	45	30	60
		T4	45[a]	30	16	15	**5[b]**	**15**	
Dungeness crab	Reach 1	T1	33	30	6	5	**4[c]**	**15**	30
		T2	**1[c]**	**30**	23	5	**0[c]**	**15**	
	Reach 2	T3	**16[c]**	**30**	11	5	16	15	30
		T4	**6[c]**	**30**	20	5	**1[c]**	**5**	
Shiner surfperch	Subreach 1a	T1	79	30	60	60	63	60	45
	Subreach 1b	T2	111	30	62	60	60	60	45
	Subreach 2a	T3	157	30	70	60	60	60	45
	Subreach 2b	T4	121	30	45	40	40	40	45

Bold text in shaded cells indicates that the target number of individual organisms was not collected for the study.

[a] Although more than 30 English sole were collected in T4, an insufficient number was collected within each of the five subareas in T4. Therefore, starry flounder composites were also analyzed to supplement the numbers in T4 subareas without sufficient English sole. The number of starry flounder analyzed is not included in the English sole total shown here.

[b] Starry flounder were analyzed as an alternate species for this area.

[c] Graceful crab were analyzed as an alternate species for this area, because the target number of Dungeness crab was not attained.

LDW – Lower Duwamish Waterway

RI – remedial investigation

With respect to Reaches 1 and 2, sufficient English sole were collected to meet the target numbers in 2004 and 2005. In 2007, there were insufficient English sole collected in the T4 sampling area (within Reach 2). In general, collecting sufficient English sole in T4 was difficult, and therefore, the English sole target number for T4 was reduced in 2005 and 2007. Starry flounder have been identified as an alternate species in the event that collecting sufficient English sole is an issue in 2017.

Based on past sampling events, collecting sufficient numbers of Dungeness crab in specific areas within the LDW has been difficult (Table 4-2). Dungeness crabs do not appear to be evenly distributed throughout the waterway, so it may be difficult to collect sufficient individuals to achieve the 2017 target numbers (30 crabs per reach). The only previous sampling events that targeted similar numbers of crabs were those in 2004 and 2007, and these were only partially successful (Table 4-2). Graceful crab will be collected as an alternate species in the event that insufficient Dungeness crabs are available.

Collecting sufficient numbers of shiner surfperch has not been an issue, so no alternate species has been identified for shiner surfperch.

The levels of effort required for the sampling events in 2004, 2005, and 2007 are provided in Table 4-3. The 2004 and 2007 sampling events, which were similar in scope to the baseline sampling event and conducted in the same time of year, were completed in seven days.

Table 4-3. Level of effort for trawling in 2004, 2005, and 2007 LDW sampling events

Year	Month	Total Trawls	Trawl Days	Trawls per Day
2004	August	121	7	17
2005	August/September	93	6	16
2007	September	109	7	16

LDW – Lower Duwamish Waterway

The existing data suggest that the greatest difficulty will be in collecting sufficient numbers of English sole and Dungeness crab in Reach 2. Therefore, the effort will begin in Reach 2 with three days of sampling in order to estimate the potential total level of effort that could be required to achieve the target numbers in this reach. Sampling will then be conducted in Reach 1 until sampling is complete (no more than three days),[6] while the Reach 2 results are assessed by LDWG and EPA to determine whether alternate species will be needed to achieve the target number of composites in Reach 2. Following the completion of Reach 1 sampling, Reach 2 sampling will be completed in accordance with the decisions made based on the assessment of the data from the

[6] If Reach 1 sampling has not been completed after three days, the results will be assessed to determine whether alternate species are needed. If necessary, Reach 1 sampling will resume after Reach 2 sampling is complete.

initial three-day sampling effort. The baseline sampling will have a maximum level of effort of eight days. EPA will be kept informed throughout the sampling event. In the event that target numbers cannot be reached with reasonable effort, EPA will be consulted.

4.1.3 Number of composite samples

Individual organisms will be collected within the targeted reaches or subreaches of the LDW, as described above, and multiple tissue composite samples will be constructed for a given reach or subreach. Composite samples will be combined to estimate the site-wide mean and its 95UCL using stratified estimates. The stratified design will account for possible differences of mean and variability in composite tissue concentrations across reaches and subreaches.

A total of 12 composite samples will be created for English sole (whole-body minus fillet; referred to as remainder),[7] English sole (fillet), Dungeness crab (edible meat), and Dungeness crab (hepatopancreas), 6 from each of the 2 reaches shown in Map 2-1 (Table 4-1). The numbers of composite samples are based on a statistical evaluation of data from several LDW tissue sampling efforts (included in the RI/FS dataset). Distributional characteristics of individual tissue concentrations and site-wide patterns of mean concentrations were used to identify the best statistical design to determine the sample sizes expected to achieve the targeted RME of 25%,[8] as described in Appendix A of the Work Plan (Windward and Integral 2017b).

Each English sole composite sample will include 10 fish for a total of 60 fish per reach, a total of 120 fish for both reaches combined. The same fish will be used for fillet and remainder samples, and whole-body concentrations in each fish will be determined by mathematically combining the results based on the fraction of the whole body represented by each tissue type.

Reconstituted whole-body English sole concentrations will be calculated using the following equation:

$$C_{WB} = \left(\mathrm{C}_{\mathrm{fillet}} \times \mathrm{F}_{\mathrm{fillet}}\right) + \left(\mathrm{C}_{\mathrm{remainder}} \times \mathrm{F}_{\mathrm{remainder}}\right) \qquad \textbf{Equation 1}$$

Where:

C_{WB}	=	estimated whole-body tissue concentration
C_{fillet}	=	fillet tissue concentration

[7] The English sole remainder and fillet data will be used to calculate whole-body concentrations.

[8] An RME of 25% or less is expected for this sampling design when the coefficient of variation (CV) is < 0.48. Data for all species and tissue types met this CV threshold, with one exception. A single elevated hepatopancreas sample increased variability for the Dungeness crab whole-body estimates, resulting in a CV of 0.6 and an RME of approximately 30% for the mean using this sampling design. Without this single sample, the CV was < 0.15.

F_{fillet}	=	average fraction of whole-body weight that is fillet (average fillet weight fraction of individual English sole that are included in composite sample)
$C_{remainder}$	=	remainder tissue concentration
$F_{remainder}$	=	average fraction of whole-body weight that is remainder (average remainder fraction of individual English sole that are included in composite sample)

If sufficient English sole cannot be caught within a specific reach, starry flounder will be considered as an alternate species (see Section 4.1.1). Composite samples will not mix the two species. Extra English sole (and starry flounder) will be retained and archived for the potential analysis of as many as two additional composite samples per reach, if sufficient fish of the target size are available. These extra composite samples will only be analyzed if the site-wide CV is approximately 0.5 or higher, 0.5 being the CV threshold used to establish the number of composites needed to achieve the target RME (Windward and Integral 2017b).

Dungeness crab edible meat composite samples will include edible meat from five individuals. Dungeness crab hepatopancreas tissue samples will also be analyzed; equal contributions from 10 crabs will be needed for each of the hepatopancreas samples to obtain sufficient mass for analysis. Thus, in total, 30 crabs (6 composite samples with 5 crabs each) will be collected in each reach to produce 6 edible meat composites and 3 hepatopancreas composites. Each hepatopancreas composite will contain hepatopancreas tissue from the 10 crabs represented in the corresponding 2 edible meat composites.

To calculate the concentrations in whole-body Dungeness crab for comparison to the TTLs (ROD Table 21 (EPA 2014b)), the edible meat concentrations and the hepatopancreas concentrations will be mathematically combined based on the fraction of the whole body represented by each tissue type. Each hepatopancreas sample will be combined with the two corresponding edible meat samples to generate two whole-body samples.

Reconstituted whole-body crab tissue concentrations will be calculated using the following equation:

$$C_{WB} = \left(C_{hepatopancreas} \times F_{hepatopancreas}\right) + \left(C_{edible\ meat} \times F_{edible\ meat}\right) \quad \textbf{Equation 2}$$

Where:

C_{WB}	=	estimated whole-body tissue concentration
$C_{hepatopancreas}$	=	hepatopancreas tissue concentration (mg/kg ww)
$F_{hepatopancreas}$	=	average fraction of whole-body weight that is hepatopancreas (average hepatopancreas weight fraction of individual crab that are included in composite sample)

$C_{edible\ meat}$	=	edible meat concentration
$F_{edible\ meat}$	=	average fraction of whole-body weight that is edible meat (average edible meat fraction of individual crab that are included in composite sample)

If sufficient Dungeness crabs cannot be caught within a specific reach, graceful crab will be collected as an alternate species (see Section 4.1.2). If both species are analyzed, they will be analyzed in separate composite samples. Extra Dungeness crab (and graceful crab) will be retained and archived for the potential analysis of as many as two additional composite samples per reach, if sufficient crabs of the target size are available. These extra composite samples will only be analyzed if the site-wide CV is approximately 0.5 or higher, 0.5 being the CV threshold used to establish the number of composites needed to achieve the target RME (Windward and Integral 2017b).

For shiner surfperch, 3 composite samples will be collected per subreach (i.e., Reaches 1a, 1b, 2a, and 2b) for a total of 12 composite samples site wide (Table 4-1). Each shiner surfperch composite sample will include 15 fish for a total of 45 fish per subreach and 180 fish site wide. Extra shiner surfperch will be retained and archived for the potential analysis of one additional composite sample per subreach. These extra composite samples will only be analyzed if the CV is higher than the maximum site-wide CV of 0.4 observed in the 2007 dataset (Work Plan Appendix A), which was used to establish the number of composites needed to achieve the target RME (Windward and Integral 2017b). Sufficient shiner surfperch are expected to be collected, so an alternate species is not needed.

4.1.4 Compositing scheme

Table 4-1 presents the number of organisms required per composite sample for all tissues. At the conclusion of the sampling event, all individuals will be archived frozen, and a compositing memorandum will be prepared for EPA review.

To determine which individual fish or crabs of a given species from a given sampling area will be composited, consideration will be given to length, mass, and the location of collection within a reach (or subreach). After each day of trawling and crab trapping, the locations and catch will be summarized and shared with LDWG and EPA. Using this information, the trawl plan for the next day will be devised to ensure coverage of the reach, to the extent feasible.

Using this compositing approach, the concentration variance of a given chemical among samples from a given sampling area will be minimized to the extent possible, resulting in a reasonable estimate of the true population mean concentration for each sampling area and the LDW as a whole. Following the completion of the field effort, a compositing memorandum will be prepared to identify the individuals selected for each composite. In order to create representative composites, the individuals within the

composites will be balanced in terms of the size of the fish and crab, locations, and genders that were collected.

4.1.5 Targeted organism size

Target sizes for this QAPP are consistent with those of the LDW RI tissue dataset and represent reasonable size ranges for seafood consumed by humans. The target size range for English sole is ≥ 20 cm total length.[9] The target size for starry flounder, a potential alternate for English sole, is also ≥ 20 cm total length.

The target size range for both Dungeness and graceful crabs is ≥ 9 cm total length, which is consistent with the target size range used in the LDW RI (Windward 2010). Collecting crabs in this size range will maximize the likelihood of collecting sufficient numbers of crabs for chemical analyses; it also considers the need to collect crabs large enough to be consumed by humans. Additionally, crabs in this size range are mostly adults that may have been exposed to LDW sediments for a longer period of time than juvenile crabs.

The targeted size range for shiner surfperch is ≥ 8 cm total length. Weitkamp and Campbell (1980) identified 8- to 14-cm shiner surfperch captured in the LDW as adult fish. Fish of this size were also collected for the LDW RI (Windward 2010).

4.2 SAMPLING METHODS

Sample ID, sampling methods for each target organism, and field processing methods will be performed following the protocols described in this section. Contingencies may arise during field activities that require modification of the general procedures outlined below. Such modifications will be at the discretion of the FC after consultation with the Windward TM and PM, the boat captain, and the EPA representative in the field, if applicable. LDWG and EPA will be consulted if significant deviations from the sampling design are required. All modifications will be recorded in the protocol modification form.

4.2.1 Sample identification

Unique alphanumeric ID numbers will be assigned to each individually wrapped fish or crab specimen in the field and recorded on the target fish and crab species form.[10] For the WDFW permit, organisms other than the targeted or alternate species will be recorded on the non-target species collection form, but no specimen ID will be assigned. The first five characters of the ID number will be LDW17 to identify the

---

[9] Fish that are > 17 but < 20 cm in length will be archived in case there are not sufficient fish ≥ 20 cm in length. If insufficient fish are available, the number of fish in this size range will be considered in alternate-species decisions.

[10] The sample ID schematic has been simplified from the one used in the RI to maintain the uniqueness of each individual specimen or composite sample, and to minimize the risk of compositing and data entry errors.

project area and sampling year (2017). The next two characters will identify the specific tissue sampling area, including subarea, if applicable: R1 or R2 for English sole, starry flounder, Dungeness crab, and graceful crab; R1A, R1B, R2A, or R2B for shiner surfperch. The next five characters include a two-letter species code (ES, SF, SS, DC, or GC, representing English sole, starry flounder, shiner surfperch, Dungeness crab, or graceful crab, respectively) and a three-digit number indicating the sequential number of the specimen captured during the sampling event. For example, the 11th English sole captured in Reach 1 would be identified as LDW17-R1-ES011. All relevant information for each individually wrapped and labeled target specimen—including specimen ID, length, weight, external abnormalities, sample date, sample time, and location number—will be recorded on the target fish and crab species collection form (Appendix B) and included as an appendix in the final data report. Therefore, all pertinent data associated with each individual fish or crab specimen will be tracked.

Composite samples will be identified using a similar convention. In place of the individual's three-digit sequential number, a two-letter tissue type code (WB, FL, RM, EM, or HP for whole body, skin-on fillet, remainder [after removal of the fillet], edible meat, or hepatopancreas samples, respectively) will be indicated. Finally, the ID will be appended by "comp" and a two-digit sequential composite number. For example, the second fillet English sole composite sample collected from Reach 1, would be identified as LDW17-R1-ESFL-comp02.

4.2.2 Sampling methods

Fish and crabs will be collected from the LDW primarily using a high-rise otter trawl. Crab traps will also be deployed concurrently to supplement the sampling effort.

4.2.2.1 High-rise otter trawl

Trawling methods, described in this section, are designed to systematically sample reaches and subreaches. Based on previous levels of effort needed during the RI, the expected maximum daily effort is approximately 16 trawls, depending on site conditions and number of fish and crab processed (Table 4-3). Trawling will be conducted using the vessel *R/V Kittiwake*, captained by Charlie Eaton of Bio-Marine Enterprises.

The high-rise otter trawl consists of a 25-ft (7.6-m) headrope and 29-ft (8.8-m) footline, side panels with 1.5-in. mesh that open to 5 ft at the wing tips, and 24- x 36-in. V-shaped galvanized steel trawl doors. The footline consists of 0.5-in. combination poly/wire with 5.33-oz seine leads interspersed with 2-in. rubber discs, and the headrope has eight 5-in. plastic floats. The 1.25-in. mesh codend also has a knotless nylon codend liner with 0.25-in. mesh.

Each trawl line will be conducted within the bounding coordinates of the reaches or subreaches. Trawling will not be conducted in waters shallower than 6 ft deep (at the time of trawling), because the high-rise otter trawl is impractical in shallower areas (Eaton 2004). The specific trawl line and order in which the reaches or subreaches will

be sampled will be determined by the boat captain and FC based on logistical considerations. Subsequent trawls may follow the first trawl line or a different trawl line.

The trawl will be deployed to the bottom using a winch. When the trawl reaches the bottom, the "dog" of the winch will be set (stopping the release of cable from the winch), and the vessel will begin the trawl. The trawl will progress upstream at a constant speed of 2.5 knots. The spread of the trawl will be approximately 4.7 m, with a rise of approximately 1.5 m. When the vessel reaches the end of each trawl line, the dog of the winch will be released and the trawl will be hauled aboard, allowing the captured species to be processed. The date, time, and location of the trawl will be recorded on the fish and crab tissue collection form (Appendix B) after each trawl is hauled out of the water.

Trawl start and end points will be recorded using a Trimble NT300D DGPS with 1- to 2-m accuracy. When the trawl is deployed on the bottom, GPS and clock readings will be taken to mark the starting point of the trawl. Final GPS and clock readings will be made when net retrieval begins. The length of the line out from the trawl will also be recorded to correct for the final trawl length and endpoint.

Trawling will be conducted from aboard the *R/V Kittiwake* using a live sampling technique, which will minimize the number of non-target species mortalities through species sorting and processing prioritization. Upon completion of an individual trawl, the catch will be hauled aboard and immediately emptied into a large plastic tub filled with site water. Field technicians will sort the catch by species and size into numerous smaller tubs, also containing site water. Target species will be separated from non-target species and processed as described in Section 4.2.3. Non-target species will be identified to the lowest practical taxon and their numbers estimated, and the fish will be returned to the LDW as quickly as possible (without weighing). For target species, any prey in the fish's mouth will be assumed to have been consumed in the trawl and will be removed from the fish's mouth before processing.

The order in which reaches and subreaches will be trawled over the course of the project and in a given day will follow the general scheme outlined in Section 4.1.2, but will be determined by both the FC and the boat captain based on logistical considerations. Leaving this decision to the discretion of the field personnel maximizes their ability to respond to field conditions, and to exercise their professional judgment on fishing conditions. The trawl results will be reported daily to the Windward TM and PM, who will provide input on priorities for the subsequent day's sampling effort. In the event that there are issues with sufficient catch, LDWG and EPA will be consulted as well.

Trawling will be discontinued in a given reach or subreach when the target numbers of fish and crabs have been collected through either traps or trawls. All fish and crab of target sizes will be archived pending compositing (see Section 4.1.3).

4.2.2.2 Crab traps

Crab traps will be deployed daily at maximally dispersed locations outside of the navigation channel within a reach. Traps will be placed at locations where they will not interfere with vessel navigation, and where they will remain submerged during the entire time they are in the LDW.[11] Up to 12 traps per day is a feasible effort based on Windward's experience in quarterly crab and shrimp sampling (Windward 2004a). Fewer or more traps may be set in a given reach depending on the success of the trawling effort during the first few days of sampling. Only one reach will be sampled each day.

The specific reach to be sampled using traps will be determined primarily based on crab targets and sampling logistics related to the concurrent trawl effort. If trawl target numbers are met in a given reach, trap sampling will focus on the other reach until targets are met for both reaches, or until the maximum level of effort (eight days) is met (see Section 4.1.2).

Trap sample locations will be recorded using a Trimble SPS461 (with Real Time Kinematic [RTK]) DGPS with 10-cm accuracy. Coordinates will be taken at the deployment location for each trap. The FC will ensure that specimens are collected within the specified tissue reaches (Map 2-1).

Crabs will be collected using Ladner© 30-in. stainless steel rubber-wrapped crab traps. Each trap will be deployed on an individual float at the chosen sampling location. Crab bait, a mixture of fish scraps and squid, will be placed in mesh bait bags and tied to the inside of the trap so that the bag cannot be opened and its contents consumed. All traps will soak for a minimum of two hours before retrieval.[12] All traps will be retrieved in the same order they were deployed. The field crew will monitor the traps, to the extent possible, when deployed in areas of high vessel traffic. Any trap(s) determined by the FC to be a hazard to navigation will be moved to a new location within the same sampling subarea away from vessel traffic. Any traps lost during sampling will be replaced, and all traps will be outfitted with a degradable latch to ensure that escape holes will open if the trap is lost. The degradable latch will ensure that lost traps will not continue to catch indefinitely, thereby harming local crab or fish. The date, time, and location of the trap will be recorded during both deployment and retrieval.

During the trap retrieval phase, captured organisms will be sorted by species into decontaminated bins filled with LDW water. All non-target species will be identified to the lowest practical taxon and their number estimated.

---

[11] Traps will generally be placed in locations deeper than -2 ft mean lower low water (MLLW); however, traps may be placed in shallower water if high tides coincide with sampling.

[12] The quarterly crab/shrimp surveys used a 4-hr soak time as a standard for assessing relative abundance at different locations, but a 2-hr soak time should be sufficient to capture the target specimens and still provide the field crew with enough flexibility for multiple deployments of the same trap during a single day. If catch rates are low, increased soak times may be considered; overnight soaks will not be used due to potential loss from vessel traffic and the possibility of trap theft.

Deploying crab traps will be discontinued in a given reach when the target numbers of crab have been collected through either traps or trawls. All crabs of target size will be retained, with the goal of achieving the requisite number of composite samples per reach (see Section 4.1.3).

4.2.3 Field sample processing

All species captured using the methods outlined above will be placed in decontaminated bins filled with LDW water. Target species fish and crabs of similar size will be preferentially selected and visually sorted. Specimens of target species that do not meet size requirements will be counted and returned to the LDW. Specimens of non-target species will be identified to the lowest practical taxon and their numbers estimated. Special care will be taken to ensure that non-target organisms are returned to the LDW quickly, with minimal handling.

4.2.3.1 Fish

Individual fish of the selected target species will be rinsed in LDW water to remove any foreign material from the external surface. Large target fish will be killed using the method outlined by EPA (2000) (i.e., by a sharp blow to the base of the skull with a metal rod or club). This method will be used solely for the purpose of killing fish, and care will be taken to keep the wooden club or metal rod reasonably clean to prevent sample contamination. Small fish will be killed by placing them in a clean bag on ice, as recommended by EPA (2000). Individual specimens of the target species will be visually grouped by species and general size class, and placed in clean holding trays to prevent contamination. All fish will be inspected carefully to ensure that their skin has not been damaged by the sampling equipment. The FC will discard any specimens with broken skin. Each fish within the selected target species will be measured to determine total length (nearest mm) and weight (nearest 0.5 g).

For English sole, the gender of the fish will be determined. If fish weights are to be determined in the field, fish will be weighed using a handheld scale suited to the weight of the species (PesolaÒ 100 g × 1 g, PesolaÒ 300 g × 2 g, and PesolaÒ 1000 g × 10 g). To be consistent with the convention used by most fisheries biologists in the United States, total length will be measured as the distance from the anterior-most part of the fish to the tip of the longest caudal fin ray (when the lobes of the caudal fin are compressed dorsoventrally) (Anderson and Gutreuter 1983). Additional information regarding fish collected for chemical analysis will include general observations of individual specimen health, such as any visible signs of morphological abnormalities, external lesions, parasites, or fin erosion. If time allows, photographs of external abnormalities will also be taken. If sampling conditions do not allow adequate time for sample processing in the field, individual specimens of the same species from a particular sampling area and gear deployment (i.e., a single trawl) will be kept together in one large, resealable plastic bag with the date, time, effort number, species, and collection method recorded on the outside in indelible ink. All

other pertinent information will be traceable through the field notebook and collection forms (Appendix B). The bagged and iced fish will be transported in coolers to the laboratory for final processing. Fillets will be prepared in the laboratory, not in the field.

4.2.3.2 Crabs

Crabs will be inspected to ensure that their exoskeletons have not been cracked or damaged during the sampling process; damaged crabs will be discarded (EPA 2000). The sex of the crab will be determined and only male crabs will be retained for additional processing. Female crabs will be counted and returned to the LDW as quickly as possible (without measuring). Captured crabs will be rinsed with LDW water, and individual specimens will be grouped by species and placed in clean holding trays to prevent contamination. Target crab specimens will be identified to species, measured to the nearest 1 mm, and weighed to the nearest 0.5 g. Crabs may be weighed and measured in the field or in the laboratory at the discretion of the FC. Prior to processing, crabs will be placed on dry ice; dry ice will be used rather than water ice because it is a more humane way to kill the crabs. Crab carapace width measurements will be obtained using stainless steel calipers. Crabs will be weighed using a handheld scale suited to the weight of the species (PesolaÒ 100 g × 1 g, PesolaÒ 300 g × 2 g, and PesolaÒ 1000 g × 10 g). In keeping with EPA guidance, crab carapace width measurements will be made laterally across the carapace from tip of spine to tip of spine (EPA 2000). If sampling conditions do not allow adequate time for sample processing in the field, individual specimens of the same species from a particular sampling area and gear deployment (i.e., a single trap) will be kept together in one large, resealable plastic bag with the date, time, effort number, species, and collection method recorded on the outside in indelible ink. All other pertinent information will be traceable through the field notebook and collection forms (Appendix B). The bagged and iced crabs will be transported in coolers to the laboratory for final processing. The edible meat and hepatopancreas will be removed from the crabs in the laboratory, not in the field.

4.3 Sample Handling and Custody 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 analyses, to delivery of the sample results to the recipient. Procedures to be followed for sample handling, custody, and shipping are detailed in this section. In addition, procedures for decontamination of equipment and disposal of field-generated waste are described.

4.3.1 Sample handling procedures

Fish and crab processing will be conducted either in the field or off-site. Field processing is described in Section 4.2.3. Fish or crabs from each sampling effort (i.e., a single trawl or crab trap from a given reach or subreach) will be kept separate from one

another and processed one at a time to ensure that individual specimens are tracked properly. Each target species will be individually wrapped in heavy-duty aluminum foil; enclosed in individual, resealable plastic bags with an ID label (also enclosed in a resealable bag); and immediately stored in coolers with wet ice. Crabs will be double wrapped in heavy-duty aluminum foil to minimize punctures in the aluminum foil or plastic bag. If processing occurs off-site, specimens transported to the facility will be unpacked from coolers, measured as described in Section 4.2.3, and weighed using an analytical scale accurate to 0.5 g.

The FC will be responsible for reviewing count, length, weight, gender, and external abnormality information for all species recorded on the field collection forms (Appendix B), and will correct any improperly recorded information. All fish and crabs will be placed on ice, packed into coolers, and sent to ARI to be held, frozen. Specimen labels will be included with each shipment.

Sample labels will contain the project number, sampling personnel, date, time, specimen ID, and comments (Appendix B). All of the pertinent information about the specimen, including the specific trawl or trap the specimen came from and the specific reach or subreach, will be traceable through the sample label. A complete sample label will be affixed to each individual sample as described above.

The specimens included in each composite sample will be tracked using a composite sample form (Appendix B). This form will include the composite sample ID, the individual sample ID of each specimen included in the composite, and the length and weight of each specimen.

At each laboratory, a unique sample identifier will be assigned to each sample (termed either project ID or laboratory ID). The laboratory 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 type of analysis being performed.

4.3.2 Sample custody procedures

Samples are considered to be in custody if they are: 1) in the custodian's possession or view; 2) in a secured place (under lock) with restricted access; or 3) in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures will be used for all samples throughout the collection, transportation, and analytical processes, and for all data and data documentation whether in hard copy or electronic format. Custody procedures will be initiated during sample collection. A COC form will accompany all samples to the analytical laboratory. Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. Minimum documentation of sample handling and custody will include:

- Sample location, project name, and unique sample ID number

- Sample collection date and time
- Any special notations on sample characteristics or problems
- Name of the person who initially collected the samples
- Date sample was sent to the laboratory
- Shipping company name and waybill number

In the field, the FC will be responsible for all sample tracking and custody procedures. The FC will also 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 sample transfer, COC entries will be made for all samples. Information on the sample labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms, which will accompany all samples, will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to QA/QC reports and data reports. Tissue samples will be shipped in sealed coolers.

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 forms. The laboratories will contact the FC and project QA/QC coordinator immediately if discrepancies are discovered between the COC forms and the sample shipment upon receipt.

4.3.3 Shipping requirements

A sample shipping and handling flow chart is provided in Figure 4-1. ARI will ship individual crab and fish samples that have been organized into composite sample groups to Axys for homogenization and compositing, as described in Section 4.4, after EPA and LDWG have agreed on the final compositing scheme. The final compositing scheme will be sent to Axys prior to the delivery of the samples. Axys will ship the homogenized subsamples to the other laboratories for analyses.

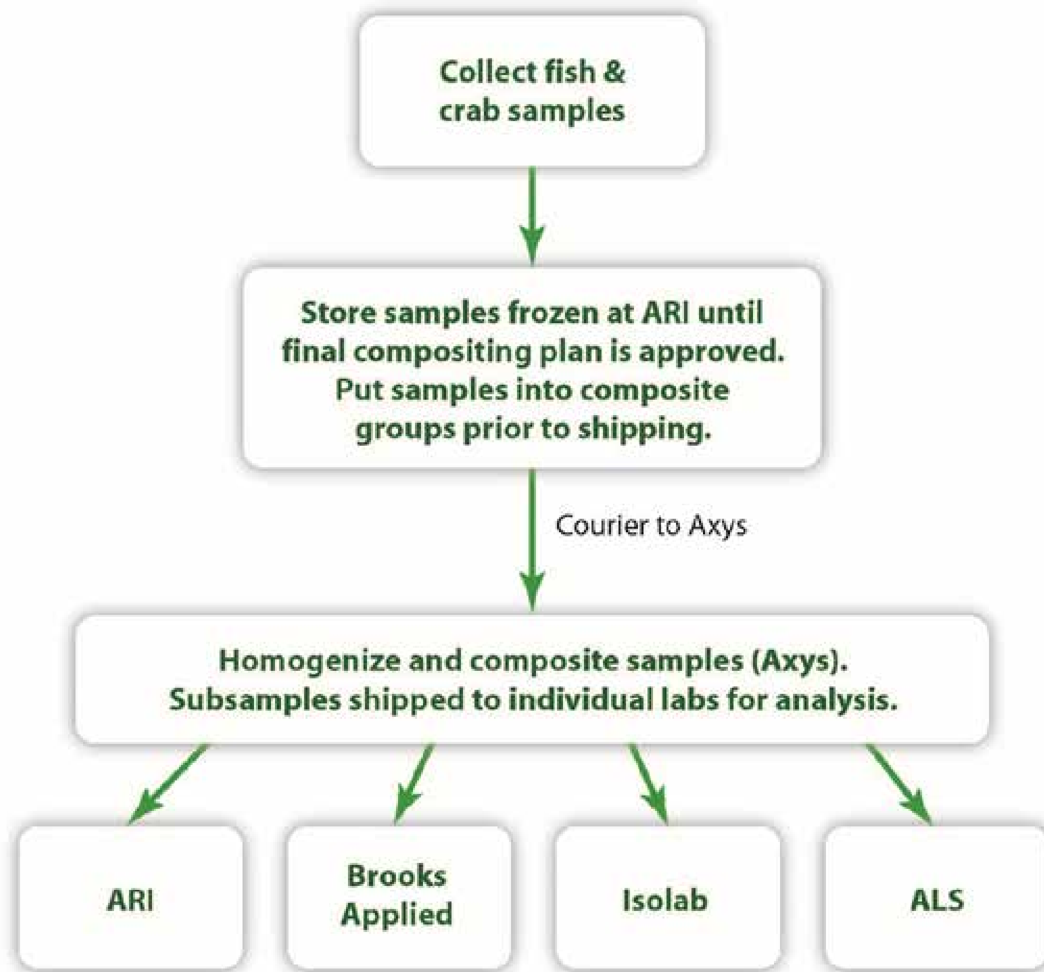


Figure 4-1.Sample shipping and handling process

Samples will be stored, frozen, at ARI, and will remain frozen while they are organized into composite groups. The samples will be transported, frozen, by courier in coolers from ARI to Axys. Prior to shipping, sample containers will be wrapped in bubble wrap and securely packed inside a cooler with ice packs. The original signed COC forms will be placed in a sealed plastic bag and taped to the inside lid of the cooler. Fiber tape will be wrapped completely around the cooler. On each side of the cooler, a *This Side Up* arrow label will be attached; a *Handle with Care* label will be attached to the top of the cooler, and the cooler will be sealed with a custody seal in two locations.

The temperature inside the cooler(s) containing the tissue samples will be checked by Axys upon receipt of the samples. The laboratory will specifically note any coolers that do not contain ice packs, or that are not sufficiently cold (≤ 6°C) upon receipt. All samples will be handled so as to prevent contamination or sample loss. Samples will be stored frozen until compositing. After composite samples are created, all remaining tissue samples will be disposed upon receipt of written notification by the Windward PM. Samples may be held up to 1 year, depending on when decisions are made

regarding analysis. Once composite samples are homogenized and frozen, Axys will ship subsamples to the other analytical laboratories. Shipment of subsamples will follow the same procedure as noted above.

4.3.4 Decontamination procedures

Sources of extraneous tissue contamination include sampling gear, grease from ship winches or cables, spilled engine fuel (gasoline or diesel), engine exhaust, dust, ice chests, and ice used for cooling. All potential sources of contamination in the field will be identified by the FC, and appropriate steps will be taken to minimize or eliminate contamination. For example, during retrieval of sampling gear, the boat will be positioned, when feasible, so that engine exhaust does not fall on the deck. Ice chests will be scrubbed clean with detergent and rinsed with distilled water after use in each sampling area to prevent potential cross-contamination. To avoid contamination from melting ice, samples will be placed in waterproof plastic bags (EPA 2000), and the crushed wet ice will be placed in separate plastic bags. Sampling equipment that has obviously been contaminated by oils, grease, diesel fuel, or gasoline will not be used, unless it can be thoroughly decontaminated using detergent and distilled water. All utensils or equipment that will be used directly in handling fish or crab (e.g., fish measuring board or calipers) will be cleaned in the laboratory prior to each sampling trip, and stored in aluminum foil until use (EPA 2000). Between sampling areas, the field collection team will clean each measurement device with Alconox® detergent, rinse it with ambient water, and wrap it in aluminum foil to prevent contamination. The high-rise otter trawl and crab traps cannot be practically decontaminated using the same protocol as other sampling equipment due to their large size, so they will be manually cleaned of all visible debris and washed in LDW water during deployment. All fish and crabs caught by trawl or trap will be placed in a decontaminated container with LDW water for a few minutes to rinse them before processing.

In summary, the following practices will be followed to minimize sample contamination:

- Fish and crab processing will only occur on only clean surfaces, such as aluminum foil.
- Ice chests will be scrubbed with Alconox® detergent and rinsed with deionized water prior to any sampling activities.
- Samples will be placed in resealable, waterproof plastic bags to avoid contamination from melting ice.
- Sampling equipment will be kept free from contaminants such as oils, grease, and fuels.

4.3.5 Field-generated waste disposal

Excess fish or crabs, generated equipment rinsates, and decontamination water will be returned to each sampling location after sampling has been completed for that location.

All disposable sampling materials and personal protective equipment (PPE) used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal as solid waste.

4.4 Laboratory Methods

Laboratories will meet the sample handling requirements and follow the procedures described in this section. In addition, analytical methods and data quality indicator (DQI) criteria are provided herein.

4.4.1 Laboratory sample handling

Samples will be stored initially at ARI and held, frozen at -10°C, until all fish or crabs have been collected. Individual tissue samples will remain frozen and will be organized into composite groups by Windward personnel. The individual fish or crabs included in each composite sample will be determined based on the compositing scheme described in Sections 4.1.3 and 4.1.4, as well as any required modifications determined in consultation with EPA. Fish and crabs selected for each composite sample will be grouped into labeled, resealable plastic bags. Fish and crabs will remain frozen and will be delivered to Axys via courier (Figure 4-2).

Tissue homogenization will be conducted by Axys. The laboratory SOP for tissue homogenization is presented in Appendix C. During the compositing and homogenization process, fish and crab specimens from each trawl, trap, or sampling location will be kept separate from one another and processed one at a time to ensure that individual specimens are tracked properly.

4.4.1.1 Fish composites

For English sole fillet samples, partially thawed whole fish will be filleted with the skin on. A lengthwise cut will be made along the dorsal region adjacent to the spine using a solvent-rinsed scalpel or pre-cleaned razor blade. The muscle tissue will be carefully separated from the ribs until the entire muscle fillet has been removed, including all tissue behind the gill flap to the tail fin (as much as is reasonably possible). Care must be taken to not puncture any internal organs during this process.

The weight of the fillet and the remainder of each individual fish will be measured prior to compositing. The fillet composite and the remainder composite will be comprised of the same 10 fish.

Whole shiner surfperch will be partially thawed prior to processing. Equal aliquots of individually homogenized fish will be combined and homogenized to create each composite sample. Homogenized composites will be stored frozen.

4.4.1.2 Crab composites

Crab samples will be at least partially thawed before processing. The hepatopancreas tissue and edible meat tissue will be dissected and separated into respective samples using surgical scalpels, forceps, shears, picks, and/or razor blades. The shell will be removed from the belly of the crab by pulling up on the back end of the shell, thereby exposing the crab's internal organs. The hepatopancreas tissue, which is typically yellow, will be removed, ensuring its separation from all other tissue (e.g., white, spongy gill tissue). All edible meat tissue (as much as is reasonably possible) will be removed from the crab's upper body, legs, and claws. The weight of the edible meat and hepatopancreas will be measured for each individual crab prior to compositing. Equal aliquots of homogenized edible meat or hepatopancreas will be combined and homogenized to create each composite. Homogenized composites will be stored frozen.

4.4.1.3 Homogenization

Individual fish and crab specimens will be homogenized using a blender, chopper, and/or meat grinder following Axys SOPs. Solvent-rinsed knives or razor blades may be used to cut the tissue into smaller pieces (i.e., 3-in. slices) prior to chopping or blending to ensure that the tissue is homogenized into a creamy paste with no discernable bits remaining (e.g., no large pieces of bones or fins). Then, equal aliquots from each individual homogenate will be combined to create a composite sample. The composited, homogenized tissue subsample selected for extraction or analysis must be representative of the entire composite sample. The final compositing scheme will be determined in consultation with EPA.

Recommended container materials, storage temperatures, and holding times are provided in Section 4.4.2. Any remaining homogenates (either of individual fish included in composite samples or of the composited samples themselves) will be archived.

Whole fish and crabs not homogenized will be archived, frozen for up to 1 year from collection. Homogenized fish and crabs will be archived, frozen, for up to 1 year from collection; after that time, the samples will be discarded because they will be outside of their analytical holding times (Section 4.4.2).

Axys will ship frozen subsamples of selected tissue sample homogenates to ARI, Brooks Applied, and ALS laboratories for chemical and conventional, total and inorganic arsenic, and organochlorine pesticide analyses, as presented in Section 4.4.2. Frozen crab sample homogenates will be shipped to Isolab in the event that graceful crabs are used as an alternate crab species.

4.4.2 Analytical methods

Chemical analyses of the tissue samples will be conducted at five different laboratories. Analyses to be conducted at each laboratory are presented in Table 4-4. Analytical

methods and laboratory sample handling requirements for all measurement parameters are presented in Table 4-5.

Table 4-4. Procedures to be conducted at each analytical laboratory

Axys	ARI	Brooks Applied	ALS	Isolab
· Compositing · Homogenization · Storage · Dioxins/furans congeners · PCB congeners	· PCB Aroclors · cPAHs · SVOCs · vanadium · TBT · lipids · percent solids	· inorganic arsenic	· organochlorine pesticides	· stable isotope analysis[a]

[a] Supplemental analysis to be performed for all edible meat crab samples in the event that graceful crabs are used as a crab alternate species.

ALS – ALS Environmental-Kelso
ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services Ltd.
Brooks Applied – Brooks Applied Labs
cPAH – carcinogenic polycyclic aromatic hydrocarbon
Isolab – Isolab at University of Washington
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TBT – tributyltin

Table 4-5. Analytical methods and sample handling requirements

Parameter	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Sample Holding Time	Container	Preservative
PCB Aroclors[a]	GC/ECD	EPA 3350-C Mod EPA 8082A	DCM/acetone	GPC (optional) acid	ARI	1 year to extract; extract within 14 days of thawing; analyze within 1 year of extraction	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
PCB congeners	HRGC/HRMS	soxhlet extraction EPA 1668C	DCM	biobead multi-layered acid/base silica alumina florisil	Axys	1 year to extract; extract within 14 days of thawing; analyze within 1 year of extraction if extracts are stored in the dark at < -10°C	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Inorganic arsenic	HG-AFS	EPA 1632	na	na	Brooks Applied	1 year	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
cPAHs[b]	GC/MS	EPA 3350-C Mod EPA 8270D-SIM	DCM/acetone	GPC (optional) silica gel (manual)	ARI	1 year to extract; extract within 14 days of thawing; analyze within 40 days of extraction	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Dioxins/furans[c] 17 congeners	HRGC/HRMS	soxhlet extraction EPA 1613B	DCM/hexane	biobead multi-layered acid/base silica florisil alumina carbon/celite	Axys	1 year to extract; extract within 14 days of thawing; analyze within 1 year of extraction if extracts are stored in the dark at < -10°C	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Selected SVOC[d]	GC/MS	EPA 3350-C Mod EPA 8270D	DCM/acetone	GPC	ARI	1 year to extract; extract within 14 days of thawing; analyze within 40 days of extraction	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C

Parameter	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Sample Holding Time	Container	Preservative
TBT, DBT, monobutyltin (as ions)	GC/MS	EPA 3350-C Mod EPA 8270-SIM	0.10% tropolone/DCM	hexylMgBr in diethyl ether alumina or silica gel	ARI	1 year to extract; extract within 14 days of thawing; analyze within 40 days of extraction	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Vanadium	ICP-MS	EPA 6020A UCT-KED	na	na	ARI	6 months	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Selected organochlorine pesticides[e]	GC/MS	EPA 3541 EPA 8270D/1699 Mod	DCM	GPC carbon	ALS	1 year to extract; extract within 14 days of thawing; analyze within 40 days of extraction	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Lipids	gravimetric extraction	Bligh and Dyer (mod)	DCM/acetone	na	ARI	1 year	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Percent solids	drying oven	PSEP (1997)	na	na	ARI	6 months	aluminum foil (whole fish) glass jar (homogenate)	freeze to ≤ -10°C
Solid $\delta^{13}C$, $\delta^{15}N$	isotope ratio mass spectrometer	IsoLab (2017)	na	na	Isolab	indefinitely	glass jar with screw-top lid	freeze to ≤ -10°C

[a] PCB Aroclors include Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268.

[b] cPAH components include benzo(a)anthracene, benzo(a)pyrene, total benzofluoranthenes, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

[c] Dioxin/furan congeners include 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF.

[d] Selected SVOCs are bis(2-ethylhexyl) phthalate, PCP, carbazole, and hexachlorobenzene.

[e] Selected organochlorine pesticides are: Aldrin, alpha-BHC, beta-BHC, total chlordane, total DDTs, dieldrin, gamma-BHC, heptachlor, and heptachlor epoxide.

ALS – ALS Environmental-Kelso
ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services Ltd.
BHC – benzene hexachloride
HG-AFS – hydride generation-atomic fluorescence spectrometry
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
OCDF – octachlorodibenzofuran
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
PeCDD – pentachlorodibenzo-*p*-dioxin

Brooks Applied – Brooks Applied Labs
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DBT – dibutyltin
DCM – dichloromethane
DDT – dichlorodiphenyltrichloroethane
ECD – electron capture detector
EPA – US Environmental Protection Agency
GC/MS – gas chromatography/mass spectrometry
GPC – gel permeation chromatography
HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
ICP-MS – inductively coupled plasma-mass spectrometry
Isolab – Isolab at University of Washington
na – not applicable
OCDD – octachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
PSEP – Puget Sound Estuary Program
SIM – select ion monitoring
SVOC – semivolatile organic compound
TBT – tributyltin
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
UCT-KED – universal cell technology-kinetic energy discrimination

All samples will be analyzed for PCBs, dioxins/furans, and inorganic arsenic. All crab samples will be analyzed for cPAHs. A subset of samples (Table 4-6) will also be analyzed for the chemicals listed in ROD Table 14 and the appropriate chemicals listed in ROD Table 18.[13] The COPCs include selected SVOCs (bis(2-ethylhexyl) phthalate, PCP, carbazole, and hexachlorobenzene), TBT, vanadium, and selected organo-chlorine pesticides. The methods for these analytes are listed in Table 4-5.

Table 4-6. Numbers of composite samples per LDW sampling area to be analyzed for each analyte group

Analyte	English Sole		Shiner Surfperch	Dungeness Crab	
	Remainder	Fillet	Whole Body	Edible Meat	Hepatopancreas
PCBs Aroclors	12	12	12	12	6
PCB congeners	6[a]	6[a]	8[a]	8[a]	4[a]
Inorganic arsenic	12	12	12	12	6
cPAHs	na[b]	na[b]	na[b]	12	6
Dioxins/furans congeners	12	12	12	12	6
Selected SVOCs	2	2	2	2	1
TBT	2	2	2	2	1
Vanadium	2	2	2	2	1
Selected organochlorine pesticides	2	2	2	2	1
Solid $\delta^{13}C$, $\delta^{15}N$[c]	na	na	na	TBD	na

a In addition to these samples, any tissue sample without at least one Aroclor detected will be analyzed for PCB congeners.

b cPAHs are not analyzed in fish tissue because they are metabolized (Collier et al. 2013).

c Supplemental analysis to be performed for all crab edible meat samples in the event that graceful crabs are used as a crab alternate species.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
LDW – Lower Duwamish Waterway
na – not applicable
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TBD – to be determined
TBT – tributyltin

If sufficient Dungeness crab cannot be collected, stable isotope analysis will be performed on all edible meat crab composite samples to compare the trophic levels of Dungeness and graceful crab tissues collected from the same reach. The results of this analysis will be provided as an addendum to the final report when it is available.

4.5 Analytical Data Quality Objective and Criteria

The analytical DQO for the collection of fish and crab tissue 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.

[13] See Section 2.1.

These parameters are discussed below, and specific DQIs for tissue laboratory analyses are presented in Section 4.5.6.

4.5.1 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; it is expressed as a RPD when duplicate analyses are performed, and as a %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed by laboratory duplicate analyses (e.g., duplicate samples, MSDs, and LCS duplicates) for all parameters. Precision measurements can be affected by the nearness of a chemical concentration to the detection limit, whereby the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Section 4.5.6). The equations used to express precision are as follows:

$$RPD = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc}) \div 2} \times 100$$ **Equation 3a**

$$\%RSD = (SD/D_{ave}) \times 100$$

Where:

$$SD = \sqrt{\left(\frac{\sum (D_n - D_{ave})^2}{(n-1)}\right)}$$ **Equation 3b**

D	=	sample concentration
D_{ave}	=	average sample concentration
n	=	number of samples
SD	=	standard deviation

4.5.2 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 (Section 4.5.6). The equation used to express accuracy for spiked samples is as follows:

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{unspiked sample result}}{\text{amount of spike added}} \times 100$$ **Equation 4**

4.5.3 Representativeness

Representativeness is an expression of the degree to which data accurately and precisely represent an environmental condition. The sampling approach in the Work Plan (Windward and Integral 2017b) was designed to address the specific objectives

described in Section 2.1. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

4.5.4 Comparability

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

4.5.5 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:

$$Completeness = \frac{number\ of\ valid\ measurements}{total\ number\ of\ data\ points\ planned} \times 100 \qquad \textbf{Equation 5}$$

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.

4.5.6 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. For this study, the MDL[14] will be used as the measure of sensitivity for each measurement process. MDLs and RLs are compared to the TTLs listed in the ROD in this section.

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Tables 4-7 and 4-8 list specific DQIs for tissue analyses.

Table 4-7. Data quality indicators for tissue analyses

Parameter	Units	Precision[a]	Accuracy		Completeness
			SRM/LCS[a,b]	Spiked Samples[a]	
PCB Aroclors[c,d]	µg/kg ww	± 35%	na	30–150%	90%
PCB congeners	ng/kg ww	± 50%	40–145%	10–145%	90%
Inorganic Arsenic	mg/kg ww	± 35%	na	65–135%	90%

[14] The term MDL includes other types of detection limits such as EDL values calculated for PCB congeners and dioxin and furan congeners. Recent revisions to EPA SW846 methods no longer require the calculation of MDLs.

Parameter	Units	Precision[a]	Accuracy		Completeness
			SRM/LCS[a,b]	Spiked Samples[a]	
cPAHs[e]	µg/kg ww	± 35%	20–130%	20–130%	90%
Dioxins/furans congeners[f]	ng/kg ww	± 50%	70–130%	17–130%	90%
SVOCs[g]	µg/kg ww	± 35%	na	20–130%	90%
TBT	µg/kg ww	± 35%	na	20–130%	90%
Vanadium	mg/kg ww	± 30%	na	75–125%	90%
Organochlorine pesticides[h]	µg/kg ww	± 50%	30–150%	30–150%	90%
Lipids	% ww	± 30%	na	na	90%
Percent solids	% ww	± 20%	na	na	90%
Solid $\delta^{13}C$, $\delta^{15}N$	per mil	TBD	± 0.1 (13C) and 0.2 (15N)	na	90%

[a] Values listed are performance-based limits provided by the laboratories.

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

[c] If a sample has no detected PCB Aroclors, then the sample will be submitted for analysis of PCB congeners by Method 1668C with an estimated RL of 0.004 µg/kg.

[d] PCB Aroclors include Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268.

[e] cPAH components include benzo(a)anthracene, benzo(a)pyrene, total benzofluoranthenes, chrysene, dibenzo(a,h)anthracene, and ideno(1,2,3-cd)pyrene.

[f] Dioxin/furan congeners include 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF.

[g] Target SVOCs include bis(2-ethylhexyl) phthalate, PCP, carbazole, and hexachlorobenzene.

[h] Target organochlorine pesticides include aldrin, alpha-BHC, beta-BHC, total chlordane, total DDTs, dieldrin, gamma-BHC, heptaochlor, and heptachlor epoxide.

BHC – benzene hexachloride
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DDT – dichlorodiphenyltrichloroethane
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
na – not applicable
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
RL – reporting limit
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
SRM/LCS – standard reference material/laboratory control sample
SVOC – semivolatile organic compound
TBD – to be determined
TBT – tributyltin
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
ww – wet weight

The laboratory MDL and RL values for each analytical method are compared to their respective TTL values in Table 4-8. All of the analytical methods are sufficiently sensitive, with the exception of the PCB Aroclor method. The PCB congener method will be used for all samples that do not have at least one detected Aroclor, so the combination of these methods will ensure that the PCB concentrations are sufficiently sensitive relative to the PCB TTL.

Table 4-8. Summary of fish and crab tissue analytes, methods, and RL goals for each analyte

Analyte	Method	Laboratory MDL	RL	TTL (ROD Table 21)
ROD COCs				
PCBs Aroclors (µg/kg ww)	EPA 8082A	2.37[a]	4[b,c]	12 (benthic fish, fillet) 1.8 (pelagic fish, whole body) 1.1 (crab, edible meat) 9.1 (crab, whole body)
PCB congeners (sum) (µg/kg ww)	EPA 1668C	0.0002[d]	0.0004[e]	12 (benthic fish, fillet) 1.8 (pelagic fish, whole body) 1.1 (crab, edible meat) 9.1 (crab, whole body)
cPAH (µg TEQ/kg ww)	EPA 8270D-SIM	0.9[f]	4.5[g]	na
Dioxins/furans (ng TEQ/kg ww)	EPA 1613B	0.025[h]	0.1[i]	0.35 (benthic fish, whole body) 0.53 (crab, edible meat) 2.0 (crab, whole body)
Inorganic arsenic (mg/kg ww)	EPA 1632	0.004	0.010	na
Metals and Organometals				
TBT (µg/kg ww)	EPA 8270D-SIM	0.450	3.86	na
Vanadium (mg/kg ww)	EPA 6020A	na[j]	0.004	na
SVOCs				
BEHP (µg/kg ww)	EPA 8270D	28.0[a]	50.0[b]	na
Carbazole (µg/kg ww)	EPA 8270D	7.37[a]	20.0[b]	na
Hexachlorobenzene (µg/kg ww)	EPA 8270D	4.74[a]	20.0[b]	na
PCP (µg/kg ww)	EPA 8270D	31.3[a]	100[b]	na
Organochlorine Pesticides				
Aldrin (µg/kg ww)	EPA 8270D/ 1699 Mod	0.22	1.0	na
alpha-BHC (µg/kg ww)	EPA 8270D/ 1699 Mod	0.26	1.0	na
beta-BHC (µg/kg ww)	EPA 8270D/ 1699 Mod	0.4	1.0	na
Dieldrin (µg/kg ww)	EPA 8270D/ 1699 Mod	0.22	1.0	na
gamma-BHC (µg/kg ww)	EPA 8270D/ 1699 Mod	0.17	1.0	na
Heptaclor (µg/kg ww)	EPA 8270D/ 1699 Mod	0.09	1.0	na
Heptachlor epoxide (µg/kg ww)	EPA 8270D/ 1699 Mod	0.061	1.0	na
Total chlordane[k] (µg/kg ww)	EPA 8270D/ 1699 Mod	0.13	2.0	na
Total DDTs[l] (µg/kg ww)	EPA 8270D/ 1699 Mod	0.46	2.5	na
Conventionals				
Lipids (%)	PSEP 1986	0.040	na	na
Percent solids (%)	SM 2450G 1997	0.010	na	na

Analyte	Method	Laboratory MDL	RL	TTL (ROD Table 21)
Stable Isotope				
Solid $\delta^{13}C$, $\delta^{15}N$ (permil)	isotope ratio mass spectrometer	$\delta^{13}C$–0.1 $\delta^{15}N$–0.2	na	na

[a] SW846 no longer requires MDL values. The laboratories have the option to use these values to assess sensitivity for EPA 8000 series methods. ARI has continued to maintain MDL studies for these analytes.

[b] RL values are consistent with the LLOQ values required under EPA SW846

[c] If a sample has no detected PCB Aroclors, then the sample will be submitted for analysis of PCB congeners by Method 1668C with an estimated RL of 0.004 µg/kg.

[d] The PCB congener EDL is based on the laboratory-estimated detection limit from Axys and represents the value for an individual PCB congener. Individual congener EDLs are listed in Appendix D. EDL is a sample-specific detection limit. The value provided is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis.

[e] The PCB congener LMCL is based on the laboratory minimum calibration level from Axys and represents the value for an individual PCB congener. Individual congener LMCLs are listed in Appendix D. LMCL is Axys's lowest calibration limit. Detected values below the LMCL will be J-qualified. The reported LMCL will be adjusted based on the sample mass of each sample.

[f] The MDL cPAH TEQ value was calculated using one-half the MDL for each of the cPAH compounds and appropriate TEF values (California EPA 2009).

[g] The RL cPAH TEQ value was calculated using one-half the RL for each of the cPAH compounds and appropriate TEF values (California EPA 2009).

[h] The dioxin/furan EDL is based on the laboratory-estimated detection limit from Axys for 2,3,7,8-TCDD and the mammal TEF value (Van den Berg et al. 2006) for this congener. Individual congener EDLs are listed in Appendix D. The value provided is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis.

[i] The dioxin/furan LMCL is based on the laboratory minimum calibration level from Axys for 2,3,7,8-TCDD and the mammal TEF value (Van den Berg et al. 2006) for this congener. Individual congener LMCLs are listed in Appendix D. LMCL is Axys's lowest calibration limit. Detected values below the LMCL will be J-qualified. The reported LMCL will be adjusted based on the sample mass of each sample.

[j] SW 846 no longer requires MDL values.

[k] The components of total chlordane include alpha-Chlordane, cis-Nonachlor, gamma-Chlordane, oxychlordane, and trans-Nonachlor. Individual component MDLs and RLs are listed in Appendix D.

[l] The components of total DDT include 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Individual component MDLs and RLs are listed in Appendix D.

Axys – Axys Analytical Services Ltd.
BEHP – bis(2-ethylhexyl) phthalate
BHC – benzene hexachloride
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
EDL – estimated method detection limit
EPA – US Environmental Protection Agency
LMCL – lower method calibration limit
MDL – method detection limit
na – not available
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
PSEP – Puget Sound Estuary Program
RL – reporting limit
ROD – Record of Decision
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TBT – tributyltin
TCDD – tetrachlorodibenzo-*p*-dioxin
TEF – toxic equivalency factor
TEQ – toxic equivalent
TTL – target tissue level
ww – wet weight

Standard tissue mass requirements are specified to meet RLs for each particular analytical method. Table 4-9 summarizes the tissue mass needed for each sample type. The masses listed include the mass required for QC samples. Mass required for standard analyses is 87 g for crab tissue and 77 g for fish tissue.

Table 4-9. Tissue mass required per sample type

Analyte	Tissue Mass (g) for Crabs[a, b]	Tissue Mass (g) For Fish
PCB Aroclors[b]	37.5	37.5
PCB congeners and dioxins/furans	40	40
Inorganic arsenic	3.5	3.5
cPAHs	30	na
selected SVOCs[b]	37.5	37.5
TBT	15	15
Vanadium[c]	7.5	7.5
selected organochlorine pesticides[d]	10	10
Lipids and percent solids	taken from SVOC extract[c]	taken from SVOC extract[c]
Solid $\delta^{13}C$, $\delta^{15}N$	0.5	0.5
Total Mass	**181.5**	**151.5**

[a] Separate tissue mass will be collected for edible meat and for hepatopancreas.

[b] In the event that there is not sufficient hepatopancreas mass to perform all QC analyses on a single hepatopancreas composite, QC for some analytes may be performed on a separate hepatopancreas composite.

[c] PCB congeners, selected SVOCs, TBT, vanadium, and selected organochlorine pesticides will be analyzed in a subset of samples, as described in the text of this section.

[d] Solvent extraction with acetone/DCM for both SVOCs and PCB Aroclors.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
DCM – dichloromethane
na – not available
PCB – polychlorinated biphenyl
QC - quality control
SVOC – semivolatile organic compound
TBT – tributyltin

4.6 Quality Assurance/Quality Control

The types of samples analyzed and the procedures conducted for QA/QC in the field and laboratory are described in this section.

4.6.1 Field quality control samples

Field QA/QC samples, such as field duplicates and rinsate blanks, are generally used to evaluate the efficiency of field decontamination procedures and the variability attributable to sample handling. For the fish and crab tissue sampling, rinsate blanks will not be relevant. Field duplicate fish composite samples will not be collected, although matrix replicates of homogenized tissue samples will be analyzed as described in the following section.

4.6.2 Laboratory quality control

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate RLs for each analyte in each matrix of interest as applicable, and establish an initial calibration curve for all analytes. The laboratory must also demonstrate its continued proficiency by participation in inter-laboratory

comparison studies, and by repeated analysis of certified reference materials, calibration checks, laboratory reagent and rinsate blanks, and spiked samples.

4.6.2.1 Sample delivery group

Project- and/or method-specific QC measures, such as MSs and MSDs or laboratory duplicates, will be analyzed per sample delivery group (SDG) preparatory batch, or per analytical batch as specified in Table 4-9. A SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. Although a SDG may span two weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

4.6.2.2 Laboratory quality control samples

The analyst will review results of QC analyses from each sample group immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine whether control limits have been exceeded.

If control limits have been exceeded, then appropriate corrective action, such as recalibration followed by reprocessing of the affected samples, must be initiated 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. Standards will be validated to determine their accuracy by comparing them to an independent standard. Laboratory QC standards are verified a multitude of ways: second-source calibration verifications (i.e., same standard, two different vendors) are analyzed to verify initial calibrations; new working standard mixes (calibrations, spikes, etc.) are verified against the results of the original solution and must be within 10% of the true value; newly purchased standards are verified against current data. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis. Table 4-10 summarizes the QC procedures to be performed by the laboratory. The associated control limits for precision and accuracy are summarized in Table 4-7.

Table 4-10. Laboratory quality control sample analysis summary

Analysis Type	Initial Calibration	Initial Calibration Verification (second source)	Continuing Calibration Verification	SRM or LCS[a]	Laboratory Replicates	MSs	MSDs	Method Blanks	Surrogate Spikes
PCBs Aroclors	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	na	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
PCB congeners	prior to analysis	after initial calibration	every 12 hours	1 per prep batch[c]	1 per batch or SDG	na	na	1 per prep batch	each sample
Inorganic arsenic	prior to analysis	after initial calibration	every 10 samples	na	1 per batch or SDG	1 per batch or SDG	1 per batch or SDG	1 per prep batch	na
cPAHs	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch[d]	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
Dioxins/furans congeners	prior to analysis	after initial calibration	every 12 hours	1 per prep batch[c]	1 per batch or SDG	na	na	1 per prep batch	each sample
SVOCs	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	na	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
TBT	prior to analysis	after initial calibration	every 10 samples	na	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
Vanadium	prior to analysis	after initial calibration	every 10 samples	na	1 per batch or SDG	1 per batch or SDG	1 per batch or SDG	1 per prep batch	na
Organochlorine pesticides	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch[d]	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
Percent solids	na	na	na	na	1 per 20 samples or per batch	na	na	na	na
Lipids	na	na	na	na	1 per 20 samples or per batch	na	na	na	na

Analysis Type	Initial Calibration	Initial Calibration Verification (second source)	Continuing Calibration Verification	SRM or LCS[a]	Laboratory Replicates	MSs	MSDs	Method Blanks	Surrogate Spikes
Solid $\delta^{13}C$, $\delta^{15}N$[e]	prior to analysis	na	na	19 per analytical run[f]	1 per 30 samples or per analytical run	na	na	3 per analytical run	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 an SRM is unavailable.

[b] An LCS will be used to assess accuracy.

[c] CARP-2 will be used to assess accuracy for PCB congeners and dioxin/furans.

[d] SRM 1974c will be used to assess accuracy for cPAHs and organochlorine pesticides.

[e] Analytical batch size for solid $\delta^{13}C$, $\delta^{15}N$ is 30 samples.

[f] GA1, GA2, and salmon will be used to assess accuracy for solid $\delta^{13}C$, $\delta^{15}N$.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
LCS – laboratory control sample
MS – matrix spike
MSD – matrix spike duplicate
na – not applicable or not available
PCB – polychlorinated biphenyl
SDG – sample delivery group
SRM – standard reference material
SVOC – semivolatile organic compound
TBT – tributyltin

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of 1 method blank will be analyzed for each extraction/digestion batch or for every 20 samples, whichever is more frequent.

Standard Reference Material

SRMs are samples of similar matrix and known analyte concentration, processed through the entire analytical procedure and used as an indicator of method accuracy. A minimum of 1 SRM will be analyzed for each sample group or for every 20 samples, whichever is more frequent. An LCS sample can be used to assess accuracy if an appropriate SRM is not available.

Laboratory Control Samples

LCSs are prepared from a clean matrix, similarly to the project samples that 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.

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 1 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 1 MS/MSD pair will be analyzed for each SDG or for every 20 samples, whichever is more frequent, when sufficient sample mass is available, with the exception of PCB congeners and dioxins/furans. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample mass is available.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Internal Standard Spikes

Internal standards may be used for calibrating and quantifying organic compounds and metals using MSs. 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.

4.7 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 differential GPS 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 laboratory equipment testing, inspection, and maintenance requirements are met. The methods used in calibrating the analytical instrumentation are described in the following section.

4.8 Instrument/Equipment Calibration and Frequency

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

In addition, if an Aroclor is detected in a sample, then the standard for that Aroclor must be analyzed in the continuing calibration within 72 hrs of the original detection of the Aroclor. Gel permeation chromatography (GPC) calibration verifications will be performed at least once every seven 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.

Calibration of analytical equipment used for chemical analysis includes the use of instrument blanks or continuing calibration blanks, which provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification, at a frequency of 1 blank for every 10 samples analyzed for inorganic analyses and 1 blank every 12 hours for organic analyses. If the continuing calibration does not meet the specified criteria, the analysis must stop. Analysis may resume 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.

A Trimble NT300D or SPS461 GPS receiver unit will be employed for the various sampling methods outlined in this QAPP. The GPS receiver will be calibrated daily to ensure it is accurately recording positions from known benchmarks and functioning within the individual unit's factory specifications.

Analytical scales will be used in the field and in the laboratory for weighing fish and crabs. The scales will be calibrated using the scale's internal calibration before weighing samples at each sampling event. Scales will be tared before each sample is weighed.

4.9 Inspection/Acceptance of Supplies and Consumables

The FC will gather and check field supplies daily for satisfactory conditions before each field event. Batteries used in the digital camera will be checked daily and recharged as necessary. Supplies and consumables for the field sampling effort will be inspected upon delivery and accepted if the condition of the supplies is satisfactory.

4.10 Non-direct Measurements

Tide stage data will be obtained from the Harbor Tides website,[15] which provides daily tide tables for a station at the Lockheed Shipyard on Harbor Island in Seattle, Washington.

4.11 Data Management

All field data will be recorded on field forms, which the FC will check for missing information at the end of each field day and amend as necessary. A QC check will be done to ensure that all data were transferred accurately from the field forms to the database. Field forms will be archived in the Windward library.

The analytical laboratories are expected to submit data in an electronic format, as described in Section 3.4. 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 will ensure that all data are consistently converted to 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. All data management files will be secured on the Windward network. Data management procedures outlined in Appendix C of the Work Plan will be followed (Windward and Integral 2017b).

---

[15] https://tidesandcurrents.noaa.gov/tide_predictions.html.

5 Assessment and Oversight

5.1 COMPLIANCE ASSESSMENTS AND RESPONSE ACTIONS

EPA or its designees may observe field activities during each sampling event, as needed. If situations arise wherein there is a significant inability to follow the QAPP methods precisely, the Windward PM will determine the appropriate actions, or consult EPA if the issue is significant.

5.1.1 Compliance assessments

Laboratory and field performance assessments will consist of on-site reviews conducted by EPA 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 will be required to have written procedures addressing internal QA/QC. All laboratories and QA/QC coordinators will be required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

5.1.2 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 this QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

5.1.3 Corrective action for laboratory analyses

Analytical laboratories will be required to comply with their current written SOPs, laboratory QA plan, and analytical methods. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data. The analysts 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 sample exceeds the DQIs outlined in this QAPP (Table 4-7) and the exceedance 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.

5.2 REPORTS TO MANAGEMENT

The FC will prepare a daily summary for submittal to LDWG and EPA following each sampling day. The project QA/QC coordinator will also prepare progress reports for submittal to LDWG 1) after sampling has been completed and samples have been submitted for analysis, 2) when information is received from the laboratory, and 3) when analyses are complete. The status of the samples and analyses will be indicated with emphasis on any deviations from this QAPP. A data report will be written after validated data are available, as described in Section 2.2.

6 Data Validation and Usability

6.1 DATA VALIDATION

The data validation process will begin in the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The laboratory analyst will be responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within acceptable limits. The project QA/QC coordinator will be 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 will not be considered final until validated. Data validation will be conducted following EPA guidance (EPA 2016b, a, 2014a).

Independent third-party data review and summary validation of the analytical chemistry data will be conducted by Ecochem or a suitable alternative. Stable isotope analysis data will be considered ancillary and will not be validated. A minimum of 10% or a single sample delivery group will undergo full data validation. Full data validation parameters will include:

- QC analysis frequencies
- Analysis holding times
- Laboratory blank contamination
- Instrument calibration
- Surrogate recoveries
- LCS recoveries
- MS recoveries
- MS/MSD RPDs
- Compound identifications—verification of raw data with the reported results (10% of analytes)
- Compound quantitations—verification of calculations and RLs (10% of analytes)
- Instrument performance check (tune) ion abundances
- Internal standard areas and retention time shifts

If no discrepancies are found between reported results and raw data in the dataset that undergoes full data validation, then a summary validation on the rest of the data can proceed using all of the QC forms submitted in the laboratory data package. QA review of the tissue chemistry data will be performed in accordance with the QA

requirements of the project, the technical specifications of the analytical methods indicated in Table 4-6, and EPA guidance for organic and inorganic data review (EPA 2016a, b). 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 issuance of 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. This data validation report will be appended to the tissue data report. Only validated data with appropriate qualifiers will be released for general use.

6.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data QA will be conducted by the project QA/QC coordinator in accordance with EPA guidelines (EPA 2016a, b). The results of the third-party independent review and validation will be reviewed, and cases wherein the project DQOs were not met will be identified. The usability of the data will be determined in terms of the magnitude of the DQO exceedance.

7 References

Anderson RO, Gutreuter SJ. 1983. Length, weight, and associated structural indices. In: Nielson LA, Johnson DL, eds, Fisheries techniques. American Fisheries Society, Bethesda, MD.

California EPA. 2009. Technical support document for cancer potency factors: methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. Air Toxicology and Epidemiology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.

Collier TK, Anulacion BF, Arkoosh MR, Dietrich JP, Incardona JP, Johnson LL, Ylitalo GM, Myers MS. 2013. Effects on fish of polycyclic aromatic hydrocarbons (PAHs) and naphthenic acid exposures. In: Tierney KB, Farrell AP, Brauner CJ, eds, Organic Chemical Toxicology of Fishes. Vol 33. Fish Physiology. pp 195-255.

Dethier MN. 2006. Native shellfish in nearshore ecosystems of Washington State. Puget Sound Nearshore Partnership report no. 2006-04. Seattle District, US Army Corps of Engineers, Seattle, WA.

Eaton C. 2004. Personal communication (LDWG, EPA and Ecology fish tissue experts meeting: discussion of English sole, shiner perch, pacific staghorn sculpin, and rockfish in the LDW with Matt Luxon, Windward Environmental). LDWG, Seattle, WA. 3/31/04.

EPA. 2000. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 1: Fish sampling and analysis, 3rd edition. EPA 823-B-00-007. Office of Water, US Environmental Protection Agency, Washington, DC.

EPA. 2002. Guidance for quality assurance project plans. QA/G-5. EPA/240/R-02/009. Office of Environmental Information, US Environmental Protection Agency, Washington, DC.

EPA. 2014a. R10 data validation and review guidelines for polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran data (PCDD/PCDF) using Method 1613B, and SW846 Method 8290A. EPA-910-R-14-003. US Environmental Protection Agency, Region 10 Office of Environmental Assessment, Seattle, WA.

EPA. 2014b. Record of Decision. Lower Duwamish Waterway Superfund Site. US Environmental Protection Agency.

EPA. 2016a. National functional guidelines for inorganic Superfund methods data review. OLEM 9355.0-133. EPA 540-R-2016-001. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency, Washingon, D.C.

EPA. 2016b. National functional guidelines for Superfund organic methods data review. OLEM 9355.0-134. EPA-540-R-2016-002. Office fo Superfund Remediation and Technology Innovation, US Environmental Protection Agency, Washington, D C.

EPA. 2016c. Third Amendment to the Administrative Order on Consent for remedial investigation/feasibility study (AOC) for the Lower Duwamish Waterway (LDW), CERCLA-10-2001-0055. US Environmental Protection Agency, Region 10, Olympia, WA.

Eschmeyer WN, Herald ES, Hammann H. 1983. Pacific coast fishes. Peterson Field Guide Series. Houghton Mifflin, Boston, MA.

France RL. 1995. Carbon-13 enrichment in benthic compared to planktonic algae: foodweb implications. Mar Ecol Prog Ser 124:307-312.

Fresh KL, Rabin D, Simenstad CA, Salo EO, Garrison K, Matheson L. 1979. Fish ecology studies in the Nisqually Reach area of southern Puget Sound, Washington. FRI-UW-7904. Prepared for Weyerhauser Company. Fisheries Research Institute, University of Washington, Seattle, WA.

Fry B. 1988. Food web structure on Georges Bank from stable C, N, and S isotopic compositions. Limnol Oceanogr 33(5):1182-1190.

IsoLab. 2017. Analysis of Solid $\delta^{13}C$, $\delta^{15}N$ [online]. University of Washington, Seattle, WA. Available from: http://isolab.ess.washington.edu/isolab/sample-prep-analysis/solid-cn.

Peterson BJ, Fry B. 1987. Stable isotopes in ecosystem studies. Annual Review of Ecology and Systematics 18:293-320.

Peterson BJ, Howarth RW, Garritt RH. 1985. Multiple stable isotopes used to trace the flow of organic matter in estuarine food webs. Science 227(4692):1361-1363.

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Prepared for the Puget Sound Estuary Program, US Environmental Protection Agency, Region 10. King County (METRO) Environmental Laboratory, Seattle, WA.

Stewart AR, Luoma SN, Schlekat CE, Doblin MA, Heib KA. 2004. Food web pathway determines how selenium affects aquatic ecosystems: a San Francisco Bay case study. Environ Sci Tech 38:4519-4526.

Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicol Sci 93(2):223-241.

Weitkamp DE, Campbell RF. 1980. Port of Seattle Terminal 107 fisheries study. Parametrix, Inc., Bellevue, WA.

Windward. 2004a. Lower Duwamish Waterway remedial investigation. Crab and shrimp survey second quarterly report. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2004b. Lower Duwamish Waterway remedial investigation. Task 8: Phase 2 RI work plan. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2010. Lower Duwamish Waterway remedial investigation. Remedial investigation report. Final. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2016. Lower Duwamish Waterway fishers study data report. Final. Windward Environmental LLC, Seattle, WA.

Windward, Integral. 2017a. Pre-design studies work plan. Appendix A. Statistical support for sampling designs. Lower Duwamish Waterway Superfund site. Draft. Prepared for the Lower Duwamish Waterway Group for submittal to EPA Region 10. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

Windward, Integral. 2017b. Pre-design studies work plan. Lower Duwamish Waterway Superfund site. Draft. Prepared for the Lower Duwamish Waterway Group for submittal to EPA Region 10. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

Harbor I.

Baseline Tissue Reach 1

Baseline Tissue Reach 2

T1

T2

T3

T4

Slip 1

Slip 2

Slip 3

Slip 4

Slip 6

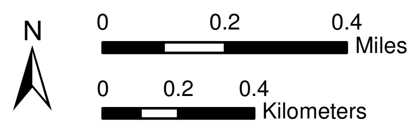
Upper Turning Basin

0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
5.1
5.2
5.3

Baseline Tissue Reach 1
Baseline Tissue Reach 2
Reach boundary
RI tissue sampling area (T1, T2, T3, T4)
Early Action Area
Road
Navigation Channel
River mile

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company



Map 2-1. Conceptual sampling reaches for baseline English sole and crab tissue collection

Prepared by craigh, 7/14/2017; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Fish and Crab\Map 2-1 6520 Crab-sole sampling plan.mxd

Harbor I.

Baseline Tissue Subreach 1a

Baseline Tissue Subreach 1b

Baseline Tissue Subreach 2a

Baseline Tissue Subreach 2b

T1

T2

T3

T4

Slip 1

Slip 2

Slip 3

Slip 4

Slip 6

Upper Turning Basin

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3

- Baseline Tissue Subreach 1a
- Baseline Tissue Subreach 1b
- Baseline Tissue Subreach 2a
- Baseline Tissue Subreach 2b
- Subreach boundary
- RI tissue sampling area
- Early Action Area
- Road
- Navigation Channel
- River mile

Windward environmental LLC

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Map 2-2. Conceptual sampling subreaches for baseline shiner surfperch tissue collection

Prepared by craigh, 7/14/2017; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Fish and Crab\Map 2-2 6520 Shiner surfperch sampling plan.mxd

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Baseline Fish and Crab Tissue Collection and Chemical Analyses - Quality Assurance Project Plan: Appendix A: Health and Safety Plan

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

July 19, 2017

Prepared by:

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

Health and Safety Plan

Title and Approval Page: LDW Tissue Sampling 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.

7/19/17

Name
Project Manager

Date

7/19/17

Name
Corporate Health and Safety Manager

Date

7/19/17

Name
Field Coordinator/Health and Safety Officer

Date

Table of Contents

Tables A-iii

Figures A-iii

Acronyms A-iv

1 Introduction A-1

2 Site Description and Project Scope A-3

2.1 Site Description A-3

2.2 Scope of Work A-3

3 Health and Safety Personnel A-5

4 Hazard Evaluation and Control Measures A-7

4.1 Physical Hazards A-7

4.1.1 Slips, trips, and falls A-7

4.1.2 Sampling equipment deployment A-7

4.1.3 Falling overboard A-7

4.1.4 Manual lifting A-8

4.1.5 Heat stress A-8

4.1.6 Hypothermia or frostbite A-8

4.1.7 Weather A-9

4.1.8 Vessel traffic A-9

4.2 Chemical Hazards A-9

4.2.1 Exposure routes A-9

4.2.2 Description of chemical hazards A-10

4.3 Activity Hazard Analysis A-11

5 Work Zones and Shipboard Access Control A-13

5.1 Work Zone A-13

5.2 Decontamination Station A-13

5.3 Access Control A-13

6 Safe Work Practices A-15

7 Personal Protective Equipment and Safety Equipment A-17

7.1 Level D Personal Protective Equipment A-17

7.2 Modified Level D Personal Protective Equipment A-17

7.3 Safety Equipment A-17

8 Monitoring Procedures for Site Activities A-19

9 Decontamination A-21

9.1 Minimization of Contamination A-21

9.2 Personnel Decontamination A-22

9.3 Sampling Equipment Decontamination A-22

10 Disposal of Contaminated Materials A-23

10.1 Personal Protective Equipment A-23

10.2 Excess Sample Materials A-23

11 Training Requirements A-25

11.1 Project-specific Training A-25

11.2 Daily Safety Briefings A-25

11.3 First Aid and CPR A-26

12 Medical Surveillance A-27

13 Reporting and Record Keeping A-29

14 Emergency Response Plan A-31

14.1 Pre-emergency Preparation A-31

14.2 Project Emergency Coordinator A-31

14.3 Emergency Response Contacts A-32

14.4 Recognition of Emergency Situations A-32

14.5 Decontamination A-33

14.6 Fire A-33

14.7 Personal Injury A-33

14.8 Overt Personal Exposure or Injury A-34

14.8.1 Skin contact A-34

14.8.2 Inhalation A-34

14.8.3 Ingestion A-34

14.8.4 Puncture wound or laceration A-34

14.9 Spills and Spill Containment A-35

14.10 Boating Hazards A-35

14.11 Emergency Routes to the Hospital A-36

Attachment 1. Health and Safety Plan Acknowledgment Form A-39

Tables

Table 1. Activity hazard analysis A-11

Table 2. Emergency response contacts A-32

Table 3. Potential boat emergency hazards and responses A-35

Figures

Map 1. Emergency routes to Harborview Medical Center A-37

Acronyms

CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
FC	field coordinator
HSM	health and safety manager
HSO	health and safety officer
HSP	health and safety plan
LDW	Lower Duwamish Waterway
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PFD	personal flotation device
PM	project manager
PPE	personal protective equipment
QAPP	quality assurance project plan
TBT	tributyltin
TCDD	tetrachlorodibenzo-*p*-dioxin
USCG	US Coast Guard
Windward	Windward Environmental LLC

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/waste products. This HSP covers elements specified in 29 Code of Federal Regulations (CFR) 1910§120. The procedures and guidelines contained herein are based on generally recognized health and safety practices. Any changes or revisions to this HSP will be made by a written amendment that will become a permanent part of this document. The goal of this HSP is to establish procedures for safe working practices for all field personnel and visitors.

This HSP addresses all activities associated with the collection and handling of biological specimens from the Lower Duwamish Waterway (LDW) for the preparation of tissue samples for chemical analyses. During site work, this HSP is to be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the Windward Environmental LLC (Windward) health and safety manager (HSM) and the Windward project manager (PM).

All personnel involved in fieldwork on this project are required to comply with this HSP. The contents of this HSP reflect anticipation of the types of activities to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. This 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 LDW (see Maps 2-1 and 2-2 in the quality assurance project plan [QAPP]). The QAPP to which this HSP is appended provides complete details of the sampling program. This section summarizes the types of work that will be performed during field activities.

2.2 Scope of Work

Specific tasks to be performed are as follows:

- Collection of biological specimens from a boat using a high-rise otter trawl
- Collection of biological specimens from a boat using crab traps
- Sample handling, processing, and shipping

Additional details on sampling design and methods are provided in Section 4 of 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; they will be responsible for informing all individuals who are assigned to work on the site, or who visit the site, of the contents of this plan, and for ensuring that each person signs the Health and Safety Plan Acknowledgment Form (Attachment 1). By signing the Health and Safety Plan Acknowledgment Form, individuals recognize the site health and safety hazards, known or suspected, and agree to adhere to the protocols required to minimize exposure to such hazards.

Project Manager: The PM will have 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. In consultation with the HSM, the PM will make final decisions concerning implementation of the HSP.

Field Coordinator/Health and Safety Officer: Because of the limited scope and duration of fieldwork for this project, the FC and HSO will be the same person. 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 will also have 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 and operations.

Corporate Health and Safety Manager: The HSM will have overall responsibility for preparation, approval, and revisions 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 during fieldwork.

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

4 Hazard Evaluation and Control Measures

This section covers 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 4.3, lists the potential hazards associated with each site activity and the recommended site control to be used to minimize each potential hazard.

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 will present a greater risk of injury than chemical hazards. Physical hazards are identified and discussed below.

4.1.1 Slips, trips, and falls

As with all field work, 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 overboard. The same care should be used in rainy conditions or on the shoreline where slick rocks are found. Slips can be minimized by wearing boots with good tread, made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat, in a cluttered work area, or in the intertidal zone where uneven substrate is common. Personnel will keep work areas as free as possible from items that interfere with walking.

Falls may be avoided by working as far from exposed edges as possible, by erecting railings, and by using fall protection when working on elevated platforms. For this project, open hatches may present a fall hazard, so hatches will remained closed when not being accessed for storage. Personnel should be aware of the area around any open hatches and use extra caution when accessing them.

4.1.2 Sampling equipment deployment

A high-rise otter trawl and crab traps will be used to collect tissue samples, as described in Section 4.2.2 of the QAPP. Before sampling activities begin, there will be a training session for all field personnel for the equipment that will be onboard the sampling vessel.

4.1.3 Falling overboard

Sampling activities will be conducted from a boat. As with any work from a floating platform, there is a chance of falling overboard. US Coast Guard-approved Type II or III personal flotation devices (PFDs) will be worn while working on the deck of 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 handling tasks, personnel should lift with the load supported by their legs and not their backs. For heavy loads, an adequate number of people will be used, or if possible, a mechanical lifting/handling device will be used.

4.1.5 Heat stress

Heat stress could be an issue during summer. Heat-related problems include heat rash, heat cramps, heat exhaustion, and heat stroke if the person does not ingest sufficient fluids. Heat rash can occur when sweat is not allowed to evaporate, leaving the skin wet most of the time and making it subject to irritation. Heat cramps are painful spasms of the muscles from excessive salt loss associated with sweating. Excessive sweating can also lead to heat exhaustion, resulting in moist, clammy skin. Physical signs and symptoms of heat exhaustion include headache, nausea, vertigo, weakness, thirst, and giddiness. Heat exhaustion may progress to heat stroke if a worker is unable to cool and re-hydrate his or her body. The primary signs and symptoms of heat stroke are confusion, irrational behavior, loss of consciousness, convulsions, a lack of sweating, hot dry skin, and an abnormally high body temperature. Workers should be aware of the key differences between the signs and symptoms of heat stroke and those of heat exhaustion, such as the lack of sweating, the color of the skin (red), and the rise in body temperature associated with the former. Heat stroke is a medical emergency that requires immediate medical attention.

A person exhibiting any of the signs of heat stress should be removed from the work area to a shaded area. Immediate steps that can be taken to reduce the symptoms include using a fan or soaking with water to increase cooling and promote evaporation, rehydrating with electrolyte replacement fluids, and removing outer layers of clothing.

4.1.6 Hypothermia or frostbite

Hypothermia occurs when the body's core temperature falls below 95°F. The sampling will occur during the time of year when cold and wet weather conditions may occur, making hypothermia a concern. Hypothermia is also a risk when someone becomes wet from falling overboard. The FC/HSO will monitor all crew members for early symptoms of hypothermia (e.g., shivering, muscle incoordination, mild confusion). If such symptoms are observed, the FC/HSO will take immediate steps to reduce heat loss by providing extra layers of clothing, or by temporarily moving the affected crew member to a warmer environment.

All personnel will wear protective clothing appropriate for the weather conditions and physical activity. A person exhibiting any of the signs of hypothermia should be removed from the work area to a warmer environment. Immediate steps that can be taken to reduce the symptoms of hypothermia include minimizing exposure to cold and wet conditions, limiting sitting or standing still for long periods, rehydration with

warm fluids, and the removal of any wet outer layers of clothing to permit sweat evaporation during rest periods in a warm environment.

Sampling operations and conditions that might result in the occurrence of frostbite are not anticipated. The sampling will take place during the time of year (i.e., August/September) when extreme weather conditions are not expected to occur.

4.1.7 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.

4.1.8 Vessel traffic

Because of the high volume of vessel traffic on the LDW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt such traffic. As practical, the field boat will stay out of the navigation channel.

4.2 CHEMICAL HAZARDS

Previous investigations have shown that some chemicals are present at higher-than-background concentrations in the sampling area. For the purposes of discussing the potential exposure of individuals to chemicals in sediments, the chemicals of concern are metals, tributyltin (TBT), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

4.2.1 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.

4.2.1.1 Inhalation

Inhalation is not expected to be an important route of exposure.

4.2.1.2 Dermal exposure

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

4.2.1.3 Ingestion

Incidental ingestion of sediment or surface water 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 while onboard the boat should prevent water from splashing or spilling during sample collection and handling activities.

4.2.2 Description of chemical hazards

4.2.2.1 Metals and tributyltin

Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is a likely exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for metals to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.2.2.2 Petroleum hydrocarbons and polycyclic aromatic hydrocarbons

Exposure to petroleum hydrocarbons and PAHs may occur via ingestion or skin contact. Inhalation, the most important human health exposure pathway for this group of chemicals, is not expected to occur at this site. Animal studies have also shown that PAHs can have harmful effects on the skin, body fluids, and the ability to fight disease after both short- and long-term exposure, but these effects have not been observed in humans. Some PAHs may reasonably be expected to be carcinogens. However, large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.2.2.3 Polychlorinated biphenyls

Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may 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 may contribute substantially to the uptake of PCBs. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.2.2.4 Dioxins/furans

Prolonged skin contact with dioxins/furans may cause acne-like symptoms known as chloracne. Other effects on the skin, such as red skin rashes, have been reported to occur in people following exposure to high concentrations of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). Acute and chronic exposure can damage the liver, increase the risk of diabetes and abnormal glucose tolerance, and possibly increase the risk for reproductive and developmental effects. 2,3,7,8-TCDD is a possible human carcinogen, and a mixture of dioxins/furans with six chlorine atoms (four of the six chlorine atoms at the 2-, 3-, 7-, and 8-positions) is a probable human carcinogen. Skin

absorption may substantially contribute to the uptake of dioxins/furans. Large amounts of sediment 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. Field procedures require the immediate washing of sediments from exposed skin.

4.3 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 occurring.

Table 1 presents the activity hazard analysis for tissue sampling from a boat.

Table 1. Activity hazard analysis

Activity	Hazard	Control
Sampling from a boat	falling overboard	Use care in boarding/departing from the vessel. Deploy and recover the net or traps from the back deck of the boat. Wear a PFD.
	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	back strain	Use appropriate lifting technique when deploying and retrieving pots, or seek help.
	overhead hazards	Use caution and be aware of overhead and gear hazards such as trawl nets and doors. Wear a hard hat and modified Level D PPE when working on deck.
	open hatches	Keep hatches closed when not being accessed. Be aware around hatch area and use caution when entering/exiting hatch.
	heat stress	Monitor crew members for signs/symptoms of heat stress. Remove person to cool area and remove extra layers of clothing. Promote evaporative cooling and rehydrate with electrolytic fluids.
	hypothermia	Monitor crew members for signs/symptoms of hypothermia. Minimize prolonged exposure to wet and cold conditions. Remove person to warm area and remove wet clothing. Rehydrate with warm fluids.

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 zones is to limit the migration of sample material out of its zone, and to restrict unauthorized access to active work areas by defining work zone boundaries.

5.1 Work Zone

A work zone will encompass the area where sample collection and handling activities are being performed. The FC/HSO will delineate the work zone as a particular area onboard the collection vessel. 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

A decontamination station where personnel will clean soiled boots and/or PPE prior to leaving the work zone will be set up. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zone. Plastic bags will be provided for expendable and disposable materials. If the sampling location does not allow for the establishment of a decontamination station, the FC/HSO will provide alternatives to prevent the spread of contamination.

Decontamination of the boat will be completed at the end of each work day. Cockpit and crew areas will be rinsed down with water to minimize the accumulation of sediment.

5.3 Access Control

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

6 Safe Work Practices

Following common sense will minimize the risk of exposure or accidents at a work site. The following general safety rules will be adhered to on-site:

- 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 the 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 conditions.
- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

7 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. In addition, a PFD will be required when working onboard the boat. Prior to donning PPE, the field crew 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 requiring 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 an alternative selected.

New personnel or visitors will be informed of PPE requirements during their initial site briefing (see Section 3).

7.1 Level D Personal Protective Equipment

Workers 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

Workers performing activities during which skin contact with contaminated materials is possible, and during which 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
- Waterproof and chemical-resistant steel-toed boots
- Chemical-resistant outer gloves
- Heavy-duty waterproof gloves
- Hard hats

7.3 Safety Equipment

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will be provided. Equipment for the field team will include:

- A copy of this HSP

- A first aid kit adequate for the number of personnel
- Emergency eyewash
- Sunscreen

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

8 Monitoring Procedures for Site Activities

A monitoring program that addresses the potential site hazards will be maintained. 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 will emit high-amplitude (> 85 dBA) sound. For this project, the monitoring program will consist of all workers monitoring themselves and their co-workers for signs that might indicate 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 condition 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 personnel develop any of these conditions, work will be halted immediately and the affected person(s) 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 sections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Rinse buckets
- Long-handled scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- 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 measures:

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 the following decontamination procedures, as appropriate, before eating lunch, taking a break, or leaving the work location:

1. If outer suit is heavily soiled, rinse it off.
2. Wash and rinse outer gloves and boots with water.
3. Remove outer gloves; inspect and discard if damaged.
4. Wash hands.

Before returning to work, personnel will re-don all necessary PPE. If leaving for the day, personnel will dispose of soiled, expendable PPE.

9.3 SAMPLING EQUIPMENT DECONTAMINATION

Sampling equipment will be decontaminated, as described in Section 4.3.4 of the QAPP, to minimize sample contamination and worker exposure to contamination from samples. The following practices will be followed:

- All utensils or equipment used directly in handling fish (e.g., such as measuring boards, calipers, and scales) will be scrubbed with Alconox® detergent, rinsed with deionized water, and stored wrapped in aluminum foil until use.
- Sample processing surfaces will be cleaned and lined with aluminum foil to prevent direct contact with samples.
- Ice chests will be scrubbed with Alconox® detergent and rinsed with deionized water prior to any sampling activities.
- Wet ice used for sample storage during field activities will be contained in separate plastic bags, and samples will be placed in resealable, waterproof plastic bags to avoid contamination from melting ice.
- Sampling equipment will be free from contaminants such as oils, grease, and fuels.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE 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 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, excess or unwanted specimens collected for tissue samples will be returned to the water.

11 Training Requirements

Individuals performing 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 oversight of inexperienced personnel by an experienced person for one working day. The following sections describe the training requirements for this fieldwork.

11.1 PROJECT-SPECIFIC TRAINING

In addition to HAZWOPER training, as described in Section 3.6 of the QAPP, field personnel will undergo training specifically for this project. All personnel and visitors must read this HSP and be familiar with its contents before beginning work or providing oversight. They must acknowledge reading the HSP by signing the HSP review form in Attachment 1. The signed form will be kept in the project files.

The boat captain and FC/HSO will also be required to have the US Coast Guard (USCG) Auxiliary Boating Safety certification. The boat captain 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 exposure to chemicals
- Activities that pose physical hazards, and actions to control the hazards
- Ship access control and procedures
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment on the vessel
- Vessel safety practices
- Vessel 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 all safety briefings in the logbook.

11.3 First Aid and CPR

At least two members of the field team must have first aid and cardiopulmonary resuscitation (CPR) training. Documentation of 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 conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members on this project, because they do not meet any of the following four criteria outlined in the regulations for 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 as a result of 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 conditions during the performance of all field activities.

13 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (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 with records of health- and safety-related details for the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety 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 person 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 onboard the sampling vessels 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 release of toxic or non-toxic substances (spills). OSHA regulations require that an emergency response plan be available for use onboard to guide actions in emergency situations.

Onshore organizations will be relied upon to respond to emergency situations. Given the location of the site, the local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying an emergency situation, 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; otherwise, all personnel will rely on outside emergency response resources.

The following sections identify the onboard 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 and a map 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 emergencies. Preparatory actions include the following:

- Meeting between the FC/HSO and equipment handlers concerning emergency procedures in the event that a person is injured
- A training session given by the FC/HSO informing all field personnel of emergency procedures, locations of emergency equipment and its uses, and proper evacuation procedures
- A training session given by senior staff on operating field equipment to apprise field personnel of operating procedures and specific risks associated with that 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 in the event of an emergency. He will designate his replacement during those times when he is not onboard or is not serving as the project emergency coordinator; the designation will be

noted in the logbook. The project emergency coordinator will be notified immediately when an emergency is recognized. The project emergency coordinator will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing interim actions onboard before the arrival of emergency response units. The project emergency coordinator will notify the HSM and the Windward PM as soon as possible after initiating an emergency response action. The Windward PM will have responsibility for notifying the client.

14.3 EMERGENCY RESPONSE CONTACTS

All onboard personnel must know whom to notify in the event of an emergency situation, even though the FC/HSO has primary responsibility for notification. Table 2 lists the names and phone numbers for emergency response services and individuals.

Table 2. Emergency response contacts

Contact	Telephone Number
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	206.323.3074
Emergency Responders	
US Coast Guard Emergency General information	 206.286.5400 206.442.5295 UHF Channel 16
National Response Center	800.424.8802
US Environmental Protection Agency	800.424.8802
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	206.649.7000
Emergency Contacts	
Windward Project Manager	
Kathy Godtfredsen	206.812.5413
Windward Corporate Health and Safety Manager	
Susan McGroddy	206.812.5421
Field Coordinator/ Field Health and Safety Officer	
Thai Do	206.812.5407

14.4 RECOGNITION OF EMERGENCY SITUATIONS

Emergency situations will generally be recognizable by 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 also 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 from the injured individual, 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, should they occur. 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 boat as specified in 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:

- Designate an individual to call 911 and 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 project emergency coordinator of the incident, the name of the injured individual(s), the location of the individual, and the nature of the injury.

The project emergency coordinator will immediately do the following:

- Notify the boat captain and the appropriate emergency response organization.
- Assist the injured individual(s).
- Follow the emergency procedures for retrieving or disposing of equipment reviewed in the training session, and leave the site en route to the predetermined land-based emergency pickup.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs (i.e., injury where death is imminent without immediate treatment), the FC/HSO or boat captain will call 911 and arrange to meet the ambulance unit at the nearest accessible dock.

- If a non-life-threatening emergency occurs (i.e., broken bones, minor lacerations, etc.), the project emergency coordinator will follow the procedures outlined above and proceed to the Harbor Island Marina, or to an alternative location of his choice if that would be more expedient.
- Notify the HSM and the PM.

If the project emergency coordinator determines that an emergency response is not necessary, he may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions showing the route to the hospital are in Section 14.11.

If a worker leaves the boat to seek medical attention, another worker should accompany him 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 project emergency coordinator.

The project emergency coordinator 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 the 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 Boating Hazards

Emergency responses to boating hazards are described in Table 3.

Table 3. Potential boat emergency hazards and responses

Potential Emergency Hazard	Response
Fire or explosion	If manageable, attempt to put out a small fire with a fire extinguisher. Otherwise, call the USCG or 911, evacuate the area (by life rafts, rescue boat, or swimming), and meet at a designated location. The HSO will take roll call to make sure everyone has evacuated safely. Emergency meeting locations will be determined in the field during the daily safety briefings.
Medical emergency/ personal injury	At least two people with current first aid and CPR training will be onboard the vessel at all times. This person will attempt to assess the nature and critical path of the injury, call 911 immediately, and apply first aid/CPR if necessary. Stop work and wait for medical personnel to arrive. Fill out a site accident report.
Falling into an open hatch	Stop work and rescue the person, if safe and necessary. Assess the nature of the injury, and follow the response for medical emergency/personal injury.
Person overboard	Immediately throw a life ring to the person in the water. Have one onboard person keep an eye on the victim and shout the distance (boat lengths) and direction (o'clock) of the victim from the vessel. Stop work and use the vessel to retrieve the person in the water.
Sinking vessel	Call the USCG immediately. If possible, wait for a rescue boat to arrive to evacuate vessel personnel. See fire/explosion section (above) for emergency evacuation procedures. The HSO will take roll call to make sure everyone has evacuated safely.
Hydraulic oil spill or leak	If the leak/spill is small, immediately apply absorbent pads to control the leak and continue work. If the leak/spill is uncontainable, stop work, call 911 immediately, and wait for assistance. The vessel operator will assess the personal safety hazard associated with the leak/spill and begin evacuation procedures if necessary.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, stop work immediately. The vessel operator and HSO will assess the hazard and, if necessary, send out periodic horn blasts to notify other vessels potentially in the area of the sampling vessel's location. Move to a secure location (i.e., berth) and wait for visibility to clear.
Loss of power	Stop work and call the USCG for assistance. Vessel personnel should watch for potential collision hazards and notify vessel operator if hazards exist. Secure vessel to a berth, dock, or mooring as soon as possible.
Collision	Stop work and call the USCG for assistance. HSO and vessel operator will assess damage and potential hazards. If necessary, vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
HSO – health and safety officer
USCG – US Coast Guard

14.11 EMERGENCY ROUTES 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 - 9th Avenue
Seattle, WA
206.323.3074

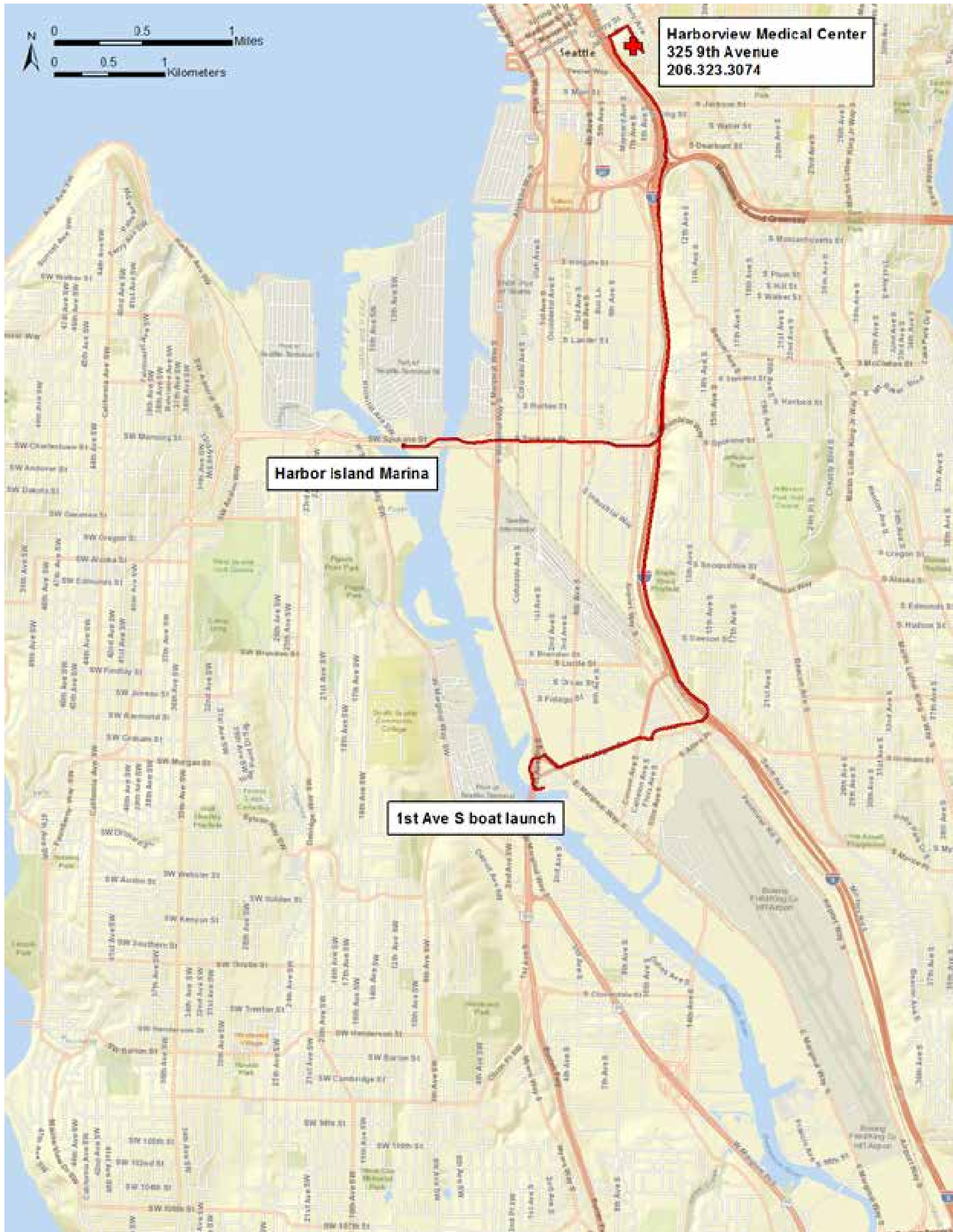
Directions from the vicinity of the LDW to Harborview Medical Center are as follows (Figure 1):

From the 1st Avenue South boat launch:

- Drive east on South River Street.
- Turn left on Occidental Avenue South.
- Turn left on East Marginal Way South.
- Turn right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From the Harbor Island Marina:

- From marina parking lot, turn sharp right onto Klickitat Way Southwest.
- Turn slight right onto Southwest Spokane Street
- Turn slight left to take the ramp toward WA-99 N/I-5/Columbian Way.
- Keep left at the fork in the ramp.
- Stay straight to go onto West Seattle Bridge.
- Merge onto I-5 North via the ramp on the left.
- Take the James Street exit.
- Head east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.



Map 1. Emergency routes to Harborview Medical Center

Attachment 1. Health and Safety Plan Acknowledgment Form

I have read a copy of the Health and Safety Plan (HSP), which covers field activities that will be conducted to investigate potentially contaminated areas in the Lower Duwamish Waterway (LDW). I understand the health and safety requirements of the project, which are detailed in this HSP.

Signature	Date
Signature	Date
Signature	Date
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 FORMS

This appendix contains the following forms that will be used, as necessary, during this study:

- Target Species Tally Form
- Non-target Species Tally Form
- Protocol Modification Form
- Specimen Label
- Composite Sample Form

TARGET SPECIES TALLY FORM

Project Name: **Location:**

Date: **Field Crew Initials:**

Target Species:

Collection Method:

COLLECTION TIME	SPECIMEN ID NO.	LENGTH (mm)	WEIGHT (g)	COMMENTS

NON-TARGET SPECIES TALLY FORM

Project Name: **Location:**

Date: **Field Crew Initials:**

Collection Method:

COLLECTION TIME	SPECIES	COUNT	COMMENTS

PROTOCOL MODIFICATION FORM

Project Name/Task 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 Manager: ______________________ Date: __________

QA Manager: ______________________ Date: __________

SPECIMEN LABEL

Windward Environmental LLC 200 W. Mercer St., Suite 401, Seattle, WA 98119 Tel: 206.378.1364 Fax: 206.973.3048	
Project/Task #:	Sampler:
Collection date:	Collection time:
Location:	Method:
Species:	
Specimen ID:	
Length (mm):	Weight (g)

COMPOSITE SAMPLE FORM

Project Name:		Task #:
Date composited:	Species:	Area/Subarea:
Composite mass:	Tissue type: (circle one) whole-body fillet remainder edible meat hepatopancreas	
Composite sample ID:		Number of individuals:

SPECIMEN ID	LENGTH (mm)	WEIGHT (g)	COMMENTS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Appendix C. Standard Operating Procedures for Tissue Processing

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

AXYS Analytical Services Ltd.
Standard Operating Procedure

Title: Procedures for Homogenization of Solids and Tissues
Area: Laboratory Procedures

SOP #: SLA-013
Rev. No.: 4
Date: 11-Sep-2003

Purpose:

To homogenize samples thoroughly to enable a representative sub-sample to be taken for analysis.

Scope:

Good accuracy of results requires that the sub-sample analyzed is representative of the larger sample being studied. In order to do this, the sample must be thoroughly homogenized before it can be subsampled. Chemists working in the Lab Services group are responsible for the homogenization of the following matrices.

1. animal tissue,
2. plant tissue,
3. pulps,
4. sediment and soils, and
5. sludges.

This SOP describes the homogenizing procedures for the above matrices. Prior to homogenizing, samples may have to be dissected (i.e., animal tissue) or composited. These procedures are described in SOPs SLA-011 and SLA-012 respectively.

Aqueous samples are homogenized according to procedures described in SOPs SLA-084 and SLA-086. These procedures are carried out by a Chemist in the Extraction Lab, just prior to analysis.

Equipment and Reagents:

1. Refer to Table 1 for the equipment used in homogenization procedures. Refer to Table 2 for guidance in selecting the appropriate homogenizing equipment.

2. Wear only gloves that have been approved for use in the lab for homogenization procedures. Minimize the contact between a glove and sample and ensure that solvents do not come in contact with the gloves.

3. Clean all equipment between each use according to SOPs SLA-037 of SLA-038.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

4. Solvents must be high purity, distilled in glass, either HPLC grade or pesticide residue grade. Each lot number of solvent must be checked for impurities by performing a solvent proof prior to use.

5. Only the dull side of aluminium foil may come in contact with a sample as the shiny side has a chemical coating that may be a source on contamination.

6. When transferring a sample to a new jar, use a baked jar with a foil-lined lid if the sample is going to be analyzed for organic compounds only. If the sample is to be analyzed for organic compounds and trace metals, use a trace-metal certified pre-cleaned glass jar with Teflon-lined lid (ICHEM or equivalent). Refer to the LIMS to determine which analyses have been requested for the sample.

Table 1

Inventory No.	*Item*	*Manufacturer*	*Model No. (Serial No.)*
G01	Grinder	OMAS ½ hp	TS8
G02	Grinder	Berkel 2 hp	unknown
G03	Grinder	Butcher Boy 3 hp	10A32
G04	Grinder	Butcher Boy 0.75 hp	TCA12
B06	Blender	Osterizer	B888
B07	Blender	Waring	35BL49
V10	Blender	Virtis	302968
V11	Blender	Virtis	302968
Glass jars Spatulas Scoopulas Scissors Forceps Sieve Knives Stainless steel bowls			

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

CONFIDENTIAL

Procedures:

1. INITIAL INSTRUCTIONS

1. Do not proceed with homogenization until the Project Chemist has released samples. Review the project notes before starting homogenization as the Project Chemist may have provided written instructions.

2. Request the samples for homogenization from the Sample Receiving Chemist, according to procedures described in SOP SLA-004 "Sample Control Procedures"

3. Check the sample jars for any cracks. If any samples have broken jars, immediately notify the Lab Services Manager who will determine whether the sample has been compromised and what course of action to take to recover the sample. Report compromised or lost samples the Project Chemist who notifies the client. Carry out the following procedures on samples with damaged containers.

   a) Thaw samples in damaged containers during the workday. As soon as a sample has thawed just enough to permit removal from the jar, transfer it to a clean, baked jar.

   b) Label the new jar with the transfer information, including the date of transfer and the initials of the Chemist performing the transfer. Transfer the original sample label and AXYS ID label to the new jar. Complete a Sample Transfer Form (FWO-030) documenting the damage, the losses and the action taken.

   c) If a moisture analysis had been done and a significant amount of standing water has been lost, repeat the moisture determination for subsequent analyses. (SOP SLA-015)

2. RECORD KEEPING

A Sample Preparation Record (FWO-104) must be completed by a Lab Chemist for every sample homogenized, at the time the sample is homogenized. The record is completed as described below.

1. Cross-reference the AXYS ID jar label and the Client jar label against the LIMS Chain of

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

Custody. If there are any discrepancies immediately notify Sample Receiving; do not start the homogenization procedures until these are resolved.

2. On the Sample Preparation Record, record the LIMS ID and contract number from the AXYS ID label, and the entire Client ID from client label.

3. Record the name of the person filling out the record. The person preparing the sample must initial the record and fill in the time that the preparation procedure started.

4. Record the sample type (Solid, Soil, Sediment, etc) and sample description (colour, texture, smell, amount of water, vegetation, foreign materials, condition, etc).

5. Record the equipment used in the preparation and a brief description of the procedure used.

6. Record whether the sample is a single sample or a composite sample.

7. Record the weight of the sample before preparation (if the sample is a composite record the weight of the individual samples) and the weight of any clear water decanted. Record the final weight of the sample after preparation.

8. Record the number and types of jars into which the sample is placed.

3. HOMOGENIZING ANIMAL TISSUE

Three types of equipment are used to homogenize animal tissue: the Virtis mixer, the Oster blender, and the commercial meat grinder(s). The type of blender used depends on the quantity of sample.

<u>*Procedure: (Virtis Mixer)*</u>

1. Allow the samples to thaw at room temperature until pliable. Visually inspect the sample and write a description of it (i.e., type or species of animal, colour, texture, condition, etc.) on the Sample Preparation Record. If the sample requires dissection or shucking (mussels, clams, oysters), do this while the sample is still frozen. To shuck the sample use solvent-rinsed shucking tools and wear gloves. The dissection procedure is described in SLA-012, "Dissection of Samples".

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

2. Wash the removable blade from the Virtis blender with detergent and water, rinse with Seastar water and then solvent-rinse using acetone, toluene, hexane, and dichloromethane (three times with each solvent).

3. If necessary, chop the sample into small pieces, using solvent rinsed stainless steel tools such as scissors, scalpels or knives. Select the tool most appropriate to the type of tissue. Cut the tissue on a foil-covered surface.

4. Transfer the sample to a clean, baked jar using either a solvent-rinsed spatula or forceps. Allow the sample to thaw completely. It may be possible to homogenize some samples in the original jar.

5. Lower the blade into place. Place foil over top of jar to avoid sample loss. Turn on the Virtis for about 30 seconds.

6. Raise the blade out of the jar and with a solvent rinsed spatula scrape the sample off the blade back into the jar.

7. Lower the blade and turn on the mixer again for 20-30 seconds. Repeat if necessary until the sample is completely homogenized.

8. Return the sample to its original labelled sample jar. If the sample had previously been in a plastic bag or wrapped in aluminum foil, or some other type of packaging, obtain a clean, baked, glass jar (see Equipment and Reagents, Pt 6) for the homogenized sample. If possible remove the original label from the plastic bag (or aluminum foil, etc.) and place on the new sample jar. Place an Axys ID label on the new sample jar. The Axys ID label must include (1) an Axys ID number (e.g., L1500-01), (2) the contract number and (3) the original sample ID number, or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

9. Write your initials and the date on the sample label along with the word "homogenized".

10. Homogenize each sample in the batch. Clean all equipment with detergent and water and solvent-rinse thoroughly between each sample.

11. Request the samples be returned to the storage location according to procedures in SOP

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

SLA-004 “Sample Control Procedures”.

12. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

Procedure: (Oster Blender)

1. Allow the samples to thaw completely at room temperature. Large samples may be thawed overnight in the refrigerator. Visually inspect the sample and write a description of it (i.e., type or species of animal, colour, texture, condition, etc.) on the Sample Preparation Record. If sample requires dissection or shucking (mussels, clams, oysters), do this while the sample is still partially frozen. The dissection procedure is described in SLA-012, "Dissection of Samples". To shuck samples, use solvent-rinsed shucking tools and wear gloves. Shuck the samples on a foil-covered surface.

2. Wash the glass blender including blade, base plate and Teflon seals with detergent and water, rinse with Seastar water, and then solvent-rinse using acetone, toluene, hexane, and dichloromethane (three times with each solvent). Do not solvent-rinse the lid of the blender.

3. Transfer the sample to the blender using either a solvent-rinsed spatula or forceps. Place several layers of aluminum foil over the top of the blender and then gently, so as not to tear the foil, place the lid on top of the foil.

4. Turn on the blender for about 30 seconds.

5. Take the lid and foil off and, using a solvent-rinsed spatula, scrape the sample off the sides of the blender and back into the base.

6. Turn on the machine again for 20-30 seconds. Repeat if necessary until the sample is completely homogenized.

7. Return the sample to its labelled sample jar. If the sample had previously been in a plastic bag or wrapped in aluminum foil, or some other type of packaging, obtain a clean, baked, glass jar (see Equipment and Reagents, Pt 6) for the homogenized sample. If possible remove the original label from the plastic bag (or aluminum foil, etc.) and place on the new sample jar. Place an Axys ID label on the new sample jar. The Axys ID label must include (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number, or

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

8. Write your initials and the date on the sample label along with the word "homogenized".

9. Homogenize each sample in the batch. Clean all equipment with detergent and water, rinse with Seastar water and solvent-rinse thoroughly between each sample.

10. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures";

11. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

Procedure: (Commercial Meat Grinder)

1. It is not necessary to let samples thaw completely when using the meat grinder for homogenizing. Visually inspect the sample and write a description of it (i.e., type or species of animal, colour, texture, condition, etc.) on the Sample Preparation Record. If sample requires dissection, do this while the sample is still frozen. The dissection procedure is described in SLA-012, "Dissection of Samples".

2. Disassemble the grinder and thoroughly wash all parts of the grinder that come into contact with the sample. Wash first with detergent and water, rinse with Seastar water, and then solvent-rinse using acetone, toluene, hexane, and dichloromethane (three times with each solvent). Re-assemble the grinder. Also wash and solvent-rinse a stainless steel mixing bowl.

3. Using a clean, solvent-rinsed knife, cut up the frozen sample into pieces small enough to feed through the meat grinder. Wear polyethylene gloves at all times while handling the sample.

4. Transfer the sample to the top of the grinder using solvent rinsed tongs or a spoon. Turn on the grinder and push the sample through the grinder with the stainless steel column. Collect the ground sample in the mixing bowl.

5. After the entire sample has gone through the grinder, turn off the motor. Mix the ground tissue using a solvent rinsed spoon. Transfer the ground sample back into the top of the grinder and repeat two more times.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

6. After the sample has been processed through the grinder three times, carefully disassemble the grinder and scrape out any tissue remaining in the inside (UNLESS TRACE METALS ARE BEING DONE).

7. Return the sample to its labelled sample jar. If the sample had previously been in a plastic bag or wrapped in aluminum foil, or some other type of packaging, obtain a clean, baked, glass jar (see Equipment and Reagents, Pt 6) for the homogenized sample. If possible, remove the original label from the plastic bag (or aluminum foil, etc.) and place on the new sample jar. Place an Axys ID label on the new sample jar. The Axys ID label must include (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number, or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

8. Write your initials and the date on the sample label along with the word "homogenized".

9. Homogenize each sample in the batch. Clean all equipment with detergent and water, rinse with Seastar water and solvent-rinse thoroughly between each sample.

10. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures".

11. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

4. HOMOGENIZING PLANT TISSUE

1. It is not necessary to let samples thaw before homogenizing. Visually inspect the sample and write a description of it (i.e., type or species of plant tissue, colour, texture, condition, etc.) on the Sample Preparation Record.

2. If the sample is grass, leaves or thin woody stalks, use scissors for homogenizing. Wear gloves while handling the sample. Cut the sample up while it is still frozen using solvent-rinsed scissors. Cut the sample into one-centimetre long pieces. Woody stems should also be cut in half with the grain of the wood. Collect the cut sample on a piece of aluminum foil. If possible, homogenize the cut material using the blender.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

3. Homogenize very large quantities of grass or vegetation using the meat grinders. Wear gloves while handling the sample.

   Note: If large pieces of wood require homogenizing, use a drill. Clean and solvent-rinse a large-gauge drill bit. Securely clamp the wood and drill random holes in the wood making sure to choose drill sites that best represent the composition of the submitted wood sample. Collect the sawdust on aluminum foil.

4. Transfer the sample to a clean jar (see Equipment and Reagents, Pt 6). If possible retain the original label and place on the plastic bag. An Axys ID label is also placed on the plastic bag. The Axys ID label must include two pieces of information (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number, or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label. If vegetation has been homogenized with the meat grinder, transfer to a baked glass jar.

5. Write your initials and the date on the sample label along with the word "homogenized".

6. Homogenize each sample in the batch. Clean all equipment with detergent and water, rinse with Seastar water and solvent-rinse thoroughly between each sample.

7. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures".

8. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

CONFIDENTIAL

5. HOMOGENIZING PULPS

If air-drying is permitted prior to homogenization refer to SLA-039 for details.

1. Visually inspect the sample and write a description of it on the Sample Preparation Record.

2. Wash the Waring stainless steel blender including blade with detergent and water, rinse with Seastar water, and then solvent-rinse using acetone, toluene, hexane, and dichloromethane (three times with each solvent).

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

3. In the fumehood, transfer pulp to the blender. Place several layers of aluminum foil over the top of the blender.

4. Turn on the blender and blend the pulp until it is reduced to a very fine "fluff". Repeat until the entire sample has been treated.

5. Return the sample to its labelled sample jar. If the sample had previously been in some other type of packaging, obtain a clean, baked, glass jar (see Equipment and Reagents, Pt 6) for the homogenized sample and transfer the original label to the new sample jar. Place an Axys ID label on the new sample jar. The Axys ID label must include two pieces of information (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number, or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

6. Cut sheet pulp and paper samples into pieces approximately 1 cm square using solvent-rinsed scissors or shears. Wear gloves while handling the sample. (Prepare only a representative subsample.) Place sample in a labelled, clean baked jar.

7. Re-wrap the original sample in aluminum foil. If the sample had previously been wrapped in aluminum foil, reuse this package. If possible, retain the original label on the foil and add the Axys ID label as outlined in Step 3.

8. Write your initials and the date on the sample label along with the word "homogenized".

9. Homogenize each sample in the batch. Clean all equipment with detergent and water, rinse with Seastar water and solvent-rinse thoroughly between each sample.

10. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures".

11. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

6. HOMOGENIZING SEDIMENTS/SOILS

1. Thaw samples that are to be homogenized immediately at room temperature. Thaw smaller samples that are to be homogenized the following day overnight in the refrigerator. Thaw larger sediment or soil samples to be homogenized the next day at room temperature. Wrap jars containing samples thawing at room temperature in aluminum foil to prevent jar breakage.

2. Visually inspect the sample and write a description of it (i.e., colour, texture, particle size, water content, rocks/plant matter, etc.) on the Sample Preparation Record. Include any transfer information from the jar label to the Sample Preparation Record.

3. Consult the Project Notes for specific instructions for homogenization and subsampling. These may include decantation of standing water, procedures for sieving, removal of rocks, vegetation, and 'foreign' matter.

4. If a client has requested the removal of standing water, use the following procedures as appropriate:

   a) Settling/Decantation:

   Allow the sample to thaw completely and, without disturbing the fine particulate matter, inspect the free water for evidence of suspended or floating particles. If these are observed, consult the Lab Services Manager for permission to proceed.

   If chlorophenol analysis is required, test the pH of the water using pH paper. If the pH is greater than 6.0 adjust it to between 5.0 and 6.0 using reagent grade hydrochloric acid. This step is to ensure that acidic analytes such as phenols are not discarded with the free water. It is important that the pH not be adjusted lower than 5.0 since this may lead to destruction of surrogate compounds added to the sample at a later stage.

   The decantation procedure must not result in loss of fine particulate matter, as the bulk of the contaminants may be concentrated here. Decant carefully, removing only as much free water as can be separated without disturbing the final material.

   b) Centrifugation/Decantation:

   Samples in which the fine particles cannot be removed from the free water by settling

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

are centrifuged prior to decantation as follows:

If required, adjust the pH of the water for chlorophenol analysis, as described in Step 4 a).

Decant standing water into a 50 mL centrifuge tube. Load into IEC DPR-6000 centrifuge and spin at 3000 RPM for 10 min. Decant the standing water from the particulate and combine the particulate in the centrifuge tube with the original sediment sample. Discard the standing water..

5. If sieving is required pass the sample through the appropriate sieve, into a clean bowl (washed with detergent and water, rinsed with Seastar water, and then solvent-rinsed using acetone, toluene, hexane, and dichloromethane - three times with each solvent). While wearing gloves break up clumps with a clean spatula. Ensure that the sample is not within 1" of the sides of the sieve in order to prevent sample loss. Discard material retained on the sieve. Sieves must be thoroughly cleaned and proofed before being used or reused. **If samples are oily or greasy or smell of hydrocarbons consult the Project Chemist before sieving**

6. If vegetation is present and is required to be retained, cut it up into pieces no larger than 1 cm and return it to the sample.

7. If required by the client, remove rocks more than 0.4 cm and foreign particles using a solvent rinsed stainless steel spatula or forceps.

8. Where possible, homogenize the sample by manual mixing with a solvent rinsed stainless steel spatula or scoopula, within the original sample container. The container should be no more than ¾ full to ensure room for mixing.

9. If it is impractical to mix the sample within its container, empty the sample contents into a larger pre-cleaned glass jar (see Equipment and Reagents, Pt 6. Transfer the labelling from the original jar to the larger sample container. Mix sample thoroughly with a stainless steel spatula or scoopula. Be sure to stir from the bottom to the top and in a circular motion along the sides of the jar. The homogenized sample should be even in colour with no layers present. Make a reasonable effort to break particles to less than 1mm using the spatula or scoopula and pressing against the side of the container.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

10. Grinding the sample in a mortar and pestle may be required to ensure that particle size is less than an estimated 1mm diameter. This must be employed where porous and pulverizable materials are observed at greater than 5% of the total sample mass as estimated by eye. Consult the Lab Services Manager for instructions and authorization. After grinding, stir the sample using a solvent-rinsed spatula until it is completely homogeneous. **After completion of this step the mortar and pestle must be isolated and identified as potentially high level contaminated – it will require special cleaning and proofing prior to being returned to service.**

11. Following any grinding or sieving return the sample to its labelled sample jar. The sample jar must have an original label on it as well as an Axys ID label. The Axys ID label must include two pieces of information (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

12. Write your initials and the date on the sample label along with the word "homogenized".

13. Homogenize each sample in the batch. Clean all equipment with detergent and water, rinse with Seastar water, and solvent-rinse thoroughly between each sample.

14. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures".

15. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

7. HOMOGENIZING SLUDGES

1. If air-drying is permitted prior to homogenization refer to SLA-039 for details.

2. Visually inspect the sample and write a description of it on the Sample Preparation Record.

3. Gummy, fibrous or oily material not amenable to mixing should be cut or otherwise reduced in size to allow mixing and maximum exposure to the sample surfaces for extraction.

4. Wash the Waring stainless steel blender, including blade, with detergent and water, followed by rinsing with Seastar water, then solvent-rinsing using acetone, toluene, hexane and

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

dichloromethane (wetting the entire surface three times with each solvent).

5. Transfer the sludge very carefully to the clean blender, place several layers of foil over the top of the blender and blend sludge until homogeneous in appearance. Don't overload the blender; i.e., a large amount of sample should be done in several portions.

6. Return the sample to its labelled sample jar (the jar should be air-dried with the sample). If the sample had previously been in some other type of packaging, obtain a clean, baked glass jar (see Equipment and Reagents, Pt 6) for the homogenized sample. If possible, place the original label on the new sample jar. Place an Axys ID label on the new sample jar. The Axys ID label must include two pieces of information: (1) an Axys ID number (e.g., L2880-01), (2) the contract number and (3) the original sample ID number, or sample information. Make sure that the original sample information on the Axys sample label matches the information from the original label.

7. Write your initials and the date on the sample label along with the word "homogenized".

8. Clean all equipment with detergent and water, rinse with Seastar water and solvent-rinse thoroughly between each sample. Clean area used to homogenize sludge thoroughly as sludges are generally higher in contaminants than most samples. If there is a possibility that cleaning brushes are contaminated, discard them.

9. Request the samples be returned to the storage location according to procedures in SOP SLA-004 "Sample Control Procedures".

10. Update the LIMS to indicate that samples have been homogenized and are available for analysis.

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

Table 2: Uses of Homogenization Equipment

SAMPLE TYPE		*Prehomogenizing Preparation*	*Homogenizing\ Equipment Used*
Fish (whole or fillets)	under 75 g	cut into small pieces, place in jar, thaw thoroughly	Virtis large blade
Fish (whole or fillets)	over 75 g under 1500 g	cut into small pieces, sample remains partially frozen	Small grinder (G01)
Fish (whole or fillets)	over 1500 g	cut into small pieces, sample remains partially frozen	Large grinder (G03)
Bivalves	under 150 g	shuck, place in jar, thaw thoroughly	Virtis large blade
Bivalves	over 150 g	shuck, thaw sufficiently to allow blending	Blender (Oster B06)
Crab muscle		partially thaw, remove muscle tissue from shell, place in jar	Virtis large blade
Crab hepatopancreas		thaw slightly, remove hepato pancreas from body, place in jar	Virtis large blade
Plants (soft or woody stem)	under 75 g	cut leaves off stems, cut stems into small pieces, place in jar	Virtis large blade
Plants (soft or woody stem)	over 75 g	cut leaves off stems, cut stems into small pieces	Blender (Oster B06)
Plants (grass any amount)		cut into small pieces, place in jar	Virtis large blade
Mice and voles	1 to 2 whole animal(s)	while partially frozen, cut into very small pieces, place in jar, thaw	Virtis large blade
Mice and voles	over 2 whole animals	while partially frozen, cut into very small pieces, remain partially frozen	Blender (Oster B06)
Other Mammals	whole	use same guidelines as fish	same rules as with fish
Liver	under 15 g	place in jar, thaw thoroughly	Virtis stator blade
Liver	over 15 g under 100g	partially thaw, chop into small pieces, place in jar, thaw thoroughly	Virtis large blade
Liver	over 100 g	partially thaw, chop into small pieces	Blender (Oster B06)
Adipose	under 75g	partially thaw, chop into small pieces, place in jar, thaw thoroughly	Virtis large blade
Adipose	over 75g	partially thaw, chop into small pieces	Blender (Oster B06)
Insects	under 3 g	partially thaw	Virtis micro blade
Insects	over 3 g	partially thaw	Virtis large blade
Egg		thaw slightly, remove shell, place in jar, thaw thoroughly	Virtis stator blade
Soil and Sediments	wet or dry	thaw thoroughly	4 mm sieve and scissors
Paper and Pulp	dry sheets	none	scissors
Pulp	wet, loose	dry thoroughly	Blender (Waring B07)
Sludge		dry thoroughly	Blender (Waring B07)
Ash	dry	none	Blender (Waring B07)

This document is the property of Axys Analytical Services Ltd and contains proprietary and confidential information.
It may not be reproduced or distributed without the written permission of the owner. Copyright 11-Sep-2003.
AXYS Analytical Services Ltd, PO Box 2219, Sidney, BC, Canada, V8L 3S8. Tel. (250) 656-0881 FAX (250) 656-4511

References:

FWO-030 Sample Transfer Form
FWO-104 Sample Preparation Record
SLA-011 Compositing Samples
SLA-012 Dissection of Samples
SLA-014 Thawing of Samples
SLA-015 Moisture Determine
SLA-037 Cleaning of Sample Preparation Equipment - Metals and Organic Samples
SLA-038 Cleaning of Sample Preparation Equipment - Organic Samples
SLA-039 Air Drying of Wet Pulp and Sludge Samples
SLA-084 Homogenization and Subsampling of Aqueous Samples Originating from a Single Bottle
SLA-086 Preparation of Composite Aqueous Samples

Approval:

Ron McLeod, Chief Operations Officer	Date
Dale Hoover, Quality Manger	Date
Coreen Hamilton, Technical Director	Date

CONFIDENTIAL

Axys Analytical Services Ltd.
Standard Operating Procedure

Title:	Dissection of Samples	**SOP #:**	LAB-12
Area:	Laboratory Procedures	**Rev. No.:**	2
		Date:	June 13/96
		Page:	1 of 2

CONFIDENTIAL

Purpose:

To excise the appropriate tissue or organ(s) from an animal sample.

Scope:

Dissection procedures are used when a whole animal has been submitted, although only a certain tissue type (e.g., muscle) or a particular organ (e.g., liver, hepatopancreas, gonads) is to be analyzed. The organism must be dissected prior to homogenizing. Dissections are generally performed while the organisms are still partially frozen.

The dissection of samples is generally carried out by the Sample Preparation Technician.

This SOP describes the procedure for dissecting a fish. (The basic procedure for dissecting other organisms is the same except for the obvious differences in the location of the cuts.)

Procedure:

1. Remove the sample(s) from the freezer. If required, weigh the sample. Record the weight in the homogenizing logbook, along with the sample ID.

2. Begin the dissection before the organism thaws. Wear polyethylene gloves at all times while handling the organism and performing the dissection. Place the organism on a clean, solvent-rinsed glass cutting board.

   <u>To remove all muscle tissue from a fish (e.g., fillet):</u> Make a lengthwise cut along the dorsal region just to the right of the spine. Use a solvent-rinsed scalpel. Separate the muscle tissue from the ribs. Make another lengthwise cut along the dorsal region, this time just to the left of the spine, and again remove the muscle from the bone. Using clean, solvent-rinsed forceps, pick additional muscle from the bones of the ribs and spine. Carefully separate the muscle from the skin using the scalpel. Continue working until all the muscle tissue has been removed.

To remove organs such as liver, hepatopancreas, and gonads from a fish: Make an incision along the posterior, ventral region (belly) using a solvent-rinsed scalpel. Locate the appropriate organ(s) and excise it using the scalpel.

3. If required, determine the sex of the organism. Record the gender in the homogenizing logbook.

4. If required, weigh the excised tissue or whole excised organs. Record the weight in the homogenizing logbook. Your supervisor will let you know if the unused portions of the sample (e.g., bones, skin) should be discarded or saved. Record this information in the logbook (i.e., "bones and skin discarded" or "bones and skin saved, WIF 4C").

5. The dissected tissue or organ(s) is now ready to be homogenized as per SOP LAB-13.

6. If tissue is not homogenized immediately, place the dissected tissue in a clean jar with the original sample label information and store in a freezer.

Approval: ______________________

____

CONFIDENTIAL

APPENDIX D. ANALYTICAL METHODS AND REPORTING LIMITS

Tables

Table 1. Methods and RL goals for PCB Aroclors, cPAHs, metals, TBT, organochlorine pesticides, SVOCs, and conventionals 1
Table 2. RL goals for dioxins/furan congeners 4
Table 3. RL goals for PCB congeners 5

Table 1. Methods and RL goals for PCB Aroclors, cPAHs, metals, TBT, organochlorine pesticides, SVOCs, and conventionals

Analyte	Method	Unit	MDL	RL
PCBs as Aroclors				
Aroclor 1016	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1221	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1232	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1242	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1248	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1254	EPA 8082A	µg/kg ww	2.37[a]	4.00[b]
Aroclor 1260	EPA 8082A	µg/kg ww	1.06[a]	4.00[b]
Aroclor 1262	EPA 8082A	µg/kg ww	1.06[a]	4.00[b]
Aroclor 1268	EPA 8082A	µg/kg ww	1.06[a]	4.00[b]
cPAHs				
Benzo(a)anthracene[c]	EPA 8270D-SIM	µg/kg ww	0.537	5.00
Benzo(a)pyrene[c]	EPA 8270D-SIM	µg/kg ww	0.915	5.00
Total benzofluoranthenes[c]	EPA 8270D-SIM	µg/kg ww	1.00	10.0
Chrysene[c]	EPA 8270D-SIM	µg/kg ww	0.488	5.00
Dibenzo(a,h)anthracene[c]	EPA 8270D-SIM	µg/kg ww	1.53	5.00
Indeno(1,2,3-cd)pyrene[c]	EPA 8270D-SIM	µg/kg ww	0.575	5.00
Metals				
Inorganic Arsenic	EPA 1632	mg/kg ww	0.004	0.010
Vanadium	EPA 6020A	mg/kg ww	na[d]	0.004
TBT	EPA 8270D-SIM	µg/kg ww	0.450	3.86
Organochlorine Pesticides				
Aldrin	EPA 8270D/1699 Mod	µg/kg ww	0.22	1.0

Table 1. Methods and RL goals for PCB Aroclors, cPAHs, metals, TBT, organochlorine pesticides, SVOCs, and conventionals

Analyte	Method	Unit	MDL	RL
alpha-BHC	EPA 8270D/1699 Mod	µg/kg ww	0.26	1.0
beta-BHC	EPA 8270D/1699 Mod	µg/kg ww	0.4	1.0
Carbazole	EPA 8270D/1699 Mod	µg/kg ww	7.37	20.0
Dieldrin	EPA 8270D/1699 Mod	µg/kg ww	0.22	1.0
gamma-BHC	EPA 8270D/1699 Mod	µg/kg ww	0.17	1.0
Heptachlor	EPA 8270D/1699 Mod	µg/kg ww	0.09	1.0
Heptachlor epoxide	EPA 8270D/1699 Mod	µg/kg ww	0.061	1.0
alpha-Chlordane[e]	EPA 8270D/1699 Mod	µg/kg ww	0.12	1.0
cis-Nonachlor[e]	EPA 8270D/1699 Mod	µg/kg ww	0.13	1.0
gamma-Chlordane[e]	EPA 8270D/1699 Mod	µg/kg ww	0.13	1.0
Oxychlordane[e]	EPA 8270D/1699 Mod	µg/kg ww	0.77	2.5
trans-Nonachlor[e]	EPA 8270D/1699 Mod	µg/kg ww	0.094	1.0
2,4'-DDD[f]	EPA 8270D/1699 Mod	µg/kg ww	0.31	2.5
2,4'-DDE[f]	EPA 8270D/1699 Mod	µg/kg ww	0.42	2.5
2,4'-DDT[f]	EPA 8270D/1699 Mod	µg/kg ww	0.46	1.0
4,4'-DDD[f]	EPA 8270D/1699 Mod	µg/kg ww	0.13	1.0
4,4'-DDE[f]	EPA 8270D/1699 Mod	µg/kg ww	0.7	2.5
4,4'-DDT[f]	EPA 8270D/1699 Mod	µg/kg ww	0.35	1.0
SVOCs				
BEHP	EPA 8270D	µg/kg ww	28.0 [a]	50.0 [b]
PCP	EPA 8270D	µg/kg ww	31.3 [a]	100 [b]
Hexachlorobenzene	EPA 8270D	µg/kg ww	4.74 [a]	20.0 [b]
Conventionals				

Table 1. Methods and RL goals for PCB Aroclors, cPAHs, metals, TBT, organochlorine pesticides, SVOCs, and conventionals

Analyte	Method	Unit	MDL	RL
Total solids	PSEP 1986	% dw	na	0.040
Lipids	Bligh and Dyer (mod)	% ww	na	0.010

[a] SW 846 no longer requires MDL values. The laboratories have the option to use these values to assess sensitivity for EPA 8000 series methods. ARI has continued to maintain MDL studies for these analytes.

[b] RL values are consistent with the LLOQ values required under EPA SW 846

[c] Components of cPAH sum.

[d] SW 846 no longer requires MDL values.

[e] Components chlordane sum.

[f] Components of total DDx sum.

BEHP – bis(2-ethylhexyl) phthalate
BHC – benzene hexachloride
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
EPA – US Environmental Protection Agency
MDL – method detection limit
na – not available
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
PSEP - Puget Sound Estuary Program
RL – reporting limit
SIM – selective ion monitoring
SVOC – semivolatile organic compounds
TBT – tributyltin
total DDx – DDT isomers (2,4′-DDD, 4,4′-DDD, 2,4′-DDE, 4,4′-DDE, 2,4′-DDT and 4,4′-DDT)
ww – wet weight

Table 2. RL goals for dioxins/furan congeners

Analyte	EPA Method 1613B Tissue (ng/kg ww) based on 10g sample	
	EDL[a]	LMCL[b]
2,3,7,8-TCDD	0.05	0.20
1,2,3,7,8-PeCDD	0.05	1.00
1,2,3,4,7,8-HxCDD	0.05	1.00
1,2,3,6,7,8-HxCDD	0.05	1.00
1,2,3,7,8,9-HxCDD	0.05	1.00
1,2,3,4,6,7,8-HpCDD	0.05	1.00
OCDD	0.05	2.00
2,3,7,8-TCDF	0.05	0.20
1,2,3,7,8-PeCDF	0.05	1.00
2,3,4,7,8-PeCDF	0.05	1.00
1,2,3,4,7,8-HxCDF	0.05	1.00
1,2,3,6,7,8-HxCDF	0.05	1.00
1,2,3,7,8,9-HxCDF	0.05	1.00
2,3,4,6,7,8-HxCDF	0.05	1.00
1,2,3,4,6,7,8-HpCDF	0.05	1.00
1,2,3,4,7,8,9-HpCDF	0.05	1.00
OCDF	0.05	2.00

[a] EDL is a sample-specific DL. The value provided here is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis

[b] LMCL is Axys's lowest calibration limit. Detected values below the LMCL are J-qualified. The reported LMCL will be adjusted based on the sample mass of each sample.

Axys – Axys Analytical Services Ltd.
DL – detection limit
EPA – US Environmental Protection Agency
EDL – estimated detection limit
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
J – estimated concentration
LMCL – lower method calibration limit
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
RL – reporting limit
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
ww – wet weight

Table 3. RL goals for PCB congeners

Analyte	EPA Method 1668C Tissue (ng/kg ww) based on 10g sample	
	EDL[a]	LMCL[b]
PCB-1	0.1	0.4
PCB-2	0.1	0.4
PCB-3	0.1	0.4
PCB-4	0.2	0.4
PCB-5	0.2	0.4
PCB-6	0.2	0.4
PCB-7	0.2	0.4
PCB-8	0.2	0.4
PCB-9	0.2	0.4
PCB-10	0.2	0.4
PCB-11	0.2	0.4
PCB-12/13	0.2	0.4
PCB-14	0.2	0.4
PCB-15	0.2	0.4
PCB-16	0.1	0.4
PCB-17	0.1	0.4
PCB-19	0.1	0.4
PCB-21/33	0.1	0.4
PCB-22	0.1	0.4
PCB-23	0.1	0.4
PCB-24	0.1	0.4
PCB-25	0.1	0.4
PCB-26/29	0.1	0.4
PCB-27	0.1	0.4
PCB-28/20	0.1	0.4
PCB-30/18	0.1	0.4
PCB-31	0.1	0.4
PCB-32	0.1	0.4
PCB-34	0.1	0.4
PCB-35	0.1	0.4
PCB-36	0.1	0.4
PCB-37	0.1	0.4
PCB-38	0.1	0.4

Table 3. RL goals for PCB congeners

Analyte	EPA Method 1668C Tissue (ng/kg ww) based on 10g sample EDL[a]	LMCL[b]
PCB-39	0.1	0.4
PCB-41/40/71	0.1	0.4
PCB-42	0.1	0.4
PCB-43	0.1	0.4
PCB-44/47/65	0.1	0.4
PCB-45/51	0.1	0.4
PCB-46	0.1	0.4
PCB-48	0.1	0.4
PCB-50/53	0.1	0.4
PCB-52	0.1	0.4
PCB-54	0.1	0.4
PCB-55	0.1	0.4
PCB-56	0.1	0.4
PCB-57	0.1	0.4
PCB-58	0.1	0.4
PCB-59/62/75	0.1	0.4
PCB-60	0.1	0.4
PCB-61/70/74/76	0.1	0.4
PCB-63	0.1	0.4
PCB-64	0.1	0.4
PCB-66	0.1	0.4
PCB-67	0.1	0.4
PCB-68	0.1	0.4
PCB-69/49	0.1	0.4
PCB-72	0.1	0.4
PCB-73	0.1	0.4
PCB-77	0.1	0.4
PCB-78	0.1	0.4
PCB-79	0.1	0.4
PCB-80	0.1	0.4
PCB-81	0.1	0.4
PCB-82	0.1	0.4
PCB-83/99	0.1	0.4
PCB-84	0.1	0.4

Table 3. RL goals for PCB congeners

Analyte	EPA Method 1668C Tissue (ng/kg ww) based on 10g sample	
	EDL[a]	LMCL[b]
PCB-88/91	0.1	0.4
PCB-89	0.1	0.4
PCB-92	0.1	0.4
PCB-94	0.1	0.4
PCB-95/100/93/102/98	0.1	0.4
PCB-96	0.1	0.4
PCB-103	0.1	0.4
PCB-104	0.1	0.4
PCB-105	0.1	0.4
PCB-106	0.1	0.4
PCB-108/124	0.1	0.4
PCB-109/119/86/97/125/87	0.1	0.4
PCB-107	0.1	0.4
PCB-110/115	0.1	0.4
PCB-111	0.1	0.4
PCB-112	0.1	0.4
PCB-113/90/101	0.1	0.4
PCB-114	0.1	0.4
PCB-117/116/85	0.1	0.4
PCB-118	0.1	0.4
PCB-120	0.1	0.4
PCB-121	0.1	0.4
PCB-122	0.1	0.4
PCB-123	0.1	0.4
PCB-126	0.1	0.4
PCB-127	0.1	0.4
PCB-128/166	0.1	0.4
PCB-130	0.1	0.4
PCB-131	0.1	0.4
PCB-132	0.1	0.4
PCB-133	0.1	0.4
PCB-134/143	0.1	0.4
PCB-136	0.1	0.4
PCB-137	0.1	0.4

Table 3. RL goals for PCB congeners

Analyte	EPA Method 1668C Tissue (ng/kg ww) based on 10g sample	
	EDL[a]	LMCL[b]
PCB-138/163/129/160	0.1	0.4
PCB-139/140	0.1	0.4
PCB-141	0.1	0.4
PCB-142	0.1	0.4
PCB-144	0.1	0.4
PCB-145	0.1	0.4
PCB-146	0.1	0.4
PCB-147/149	0.1	0.4
PCB-148	0.1	0.4
PCB-150	0.1	0.4
PCB-151/135/154	0.1	0.4
PCB-152	0.1	0.4
PCB-153/168	0.1	0.4
PCB-155	0.1	0.4
PCB-156/157	0.1	0.4
PCB-158	0.1	0.4
PCB-159	0.1	0.4
PCB-161	0.1	0.4
PCB-162	0.1	0.4
PCB-164	0.1	0.4
PCB-165	0.1	0.4
PCB-167	0.1	0.4
PCB-169	0.1	0.4
PCB-170	0.1	0.4
PCB-171/173	0.1	0.4
PCB-172	0.1	0.4
PCB-174	0.1	0.4
PCB-175	0.1	0.4
PCB-176	0.1	0.4
PCB-177	0.1	0.4
PCB-178	0.1	0.4
PCB-179	0.1	0.4
PCB-180/193	0.1	0.4
PCB-181	0.1	0.4

Table 3. RL goals for PCB congeners

Analyte	EPA Method 1668C Tissue (ng/kg ww) based on 10g sample	
	EDL[a]	LMCL[b]
PCB-182	0.1	0.4
PCB-183/185	0.1	0.4
PCB-184	0.1	0.4
PCB-186	0.1	0.4
PCB-187	0.1	0.4
PCB-188	0.1	0.4
PCB-189	0.1	0.4
PCB-190	0.1	0.4
PCB-191	0.1	0.4
PCB-192	0.1	0.4
PCB-194	0.1	0.4
PCB-195	0.1	0.4
PCB-196	0.1	0.4
PCB-197/200	0.1	0.4
PCB-198/199	0.1	0.4
PCB-201	0.1	0.4
PCB-202	0.1	0.4
PCB-203	0.1	0.4
PCB-204	0.1	0.4
PCB-205	0.1	0.4
PCB-206	0.1	0.4
PCB-207	0.1	0.4
PCB-208	0.1	0.4
PCB-209	0.1	0.4

[a] EDL is a sample-specific DL. The value provided here is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis.

[b] LMCL is Axys's lowest calibration limit. Detected values below the LMCL are J-qualified. The reported LMCL will be adjusted based on the sample mass of each sample.

Axys – Axys Analytical Services Ltd.
DL – detection limit
EPA – US Environmental Protection Agency
EDL – estimated detection limit
J – estimated concentration
LMCL – lower method calibration limit
PCB – polychlorinated biphenyl
RL – reporting limit
ww – wet weight