Final Work Plan
Supplemental Sediment Investigation

R.G. Haley Site
Bellingham, Washington

for
City of Bellingham

August 21, 2015

GeoEngineers
Earth Science + Technology

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R.G. Haley Site
Bellingham, Washington

File No. 0356-114-06

August 21, 2015

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1.0 INTRODUCTION

This work plan for supplemental sediment investigation (Work Plan) has been prepared on behalf of the City of Bellingham (City) for the R.G. Haley Site (Site). The supplemental sediment investigation is being conducted in accordance with Washington State Department of Ecology (Ecology) Agreed Order No. DE2186 (the Order), as amended. The Haley Site as identified in the Order is shown in Figure 1. The Site includes an upland area (upland unit) and adjacent aquatic lands (marine unit) in Bellingham Bay as described in the draft Remedial Investigation (RI) and draft Feasibility Study (FS) reports (GeoEngineers, 2015a). Two adjacent Model Toxics Cleanup Act (MTCA) cleanup sites overlap the Haley Site: the Cornwall Avenue Landfill site (Cornwall) to the south[1] and the Whatcom Waterway site to the west and northwest.

The sediment area potentially requiring remediation is defined based on exceedances of Sediment Management Standards (SMS) chemical and biological criteria for the protection of the benthic invertebrate community and bioaccumulation-based criteria derived for the protection of people and ecological receptors that may consume seafood. Contaminants of concern for the marine unit are polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH) and the bioaccumulative compounds carcinogenic PAHs (cPAHs), pentachlorophenol and dioxins/furans. The area of greatest risk to human and ecological receptors is associated with the area closest to the shoreline (i.e., adjacent intertidal/shallow subtidal areas) where both benthic- and bioaccumulation-based criteria are exceeded in surface sediment. Chemical concentrations in surface sediment generally decrease with distance from the shoreline and increasing deposition of clean sediment from the Nooksack River. Benthic risks decrease accordingly, thus the bayward extent of benthic risks is relatively well-defined; however, the lateral extent of benthic risks (along the shoreline) represents a data gap. The extent of bioaccumulative risks along the shoreline also needs to be refined because of the limited number of sediment samples analyzed for cPAHs and dioxins/furans near the northern and southern boundaries of the upland unit. The bayward extent of bioaccumulative risks has not yet been established for the project.

This Work Plan presents the objectives, scope, sampling and analytical testing program, permitting and proposed schedule for the supplemental sediment investigation that will be performed in accordance with MTCA Cleanup Regulation (Washington Administrative Code [WAC] Chapter 173-340), the Washington State Sediment Management Standards (SMS; WAC 173-204) and related guidance. Site background information, results of previous investigations, and a conceptual site model for the Haley Site are presented in the draft RI Report (GeoEngineers, 2015a).

2.0 OBJECTIVES

As indicated in the draft RI and FS reports (GeoEngineers, 2015a), additional sediment data are needed to evaluate the Site boundary to address human health risks from site-related bioaccumulative compounds in the marine unit and to refine the lateral extent of contamination and associated risks in the intertidal/shallow nearshore areas. These data will also be used to refine the extent of remedial technologies (e.g., monitored natural recovery [MNR], enhanced natural recovery [ENR], and

[1] Cardinal directions are referenced to "project north" in this document; see Figure 1.

removal/capping) that are components of the preferred cleanup action alternative identified in the draft FS report (GeoEngineers, 2015a) for the marine unit.

The objectives of the supplemental sediment investigation are therefore to collect the data needed to:

- Establish the outer (bayward) boundary of the Haley Site marine unit, based in part on the extent of bioaccumulative compounds in surface sediment exceeding preliminary cleanup levels (CULs) identified in the draft FS. The estimated areas where surface sediment dioxin/furan and cPAH concentrations exceed bioaccumulative screening levels, based on existing sediment sample data, are indicated in Figures 2 and 3, respectively.
- Confirm the northern and southern extent of benthic community and human health risks in surface sediment in the intertidal portion of the Site.
- Characterize the vertical extent of contamination in the northern and southern intertidal areas of the marine unit.
- Collect data that will support refining the areas where removal/capping, MNR and ENR may be implemented under the preferred sediment remedy (GeoEngineers, 2015a).

3.0 SCOPE

The supplemental sediment investigation will consist of the following general tasks:

- Assess the presence of forage fish eggs along the intertidal beach prior to collecting surface sediment samples or cores.
- Collect seven intertidal surface sediment grab samples that will be used in conjunction with existing surface sediment data to confirm the northern and southern extent of benthic risks in the intertidal portion of the marine unit.
- Collect seven intertidal subsurface sediment core samples that will be used to refine the assessment of the extent of contamination, design/placement of remedial technologies under the preferred alternative, and human health risks.
- Collect 11 subtidal surface (0 to 12 centimeters [cm]) sediment samples that will be used in conjunction with existing surface sediment data to evaluate the marine unit Site boundary, based in part on the extent of site-related bioaccumulative compounds (dioxins/furans and cPAHs) exceeding preliminary CULs.
- Analyze three recently collected surface (0 to 10 cm) subtidal surface sediment samples[2] in the vicinity of the Cornwall Landfill Site (Landau, 2015) for dioxins/furans to support the Site boundary evaluation and the human health risks in the southern subtidal portion of the marine unit.

[2] Landau collected five surface sediment samples as part of the pre-design sampling effort in June 2015. The samples were located in the area proposed for thin-layer capping in the vicinity of the Cornwall Avenue Landfill for the purpose of conducting bioassays and limited chemical analyses. On behalf of the City, GeoEngineers requested that three of the sediment samples (CL-SG-1, CL-SG-3 and CL-SG-4) be analyzed for dioxins/furans to help refine the extent of these bioaccumulative compounds in the marine unit. Additional excess sample volume was not available for other analyses.

- Conduct laboratory analyses and confirmatory biological testing of the collected sediment samples.
- Validate and submit the data to Ecology's Environmental Information Management (EIM) system.
- Prepare a supplemental sediment investigation data report that will include a summary of field activities, descriptions of any deviations from the Work Plan or quality assurance project plan (QAPP), and tabular and graphical presentations of the data.

4.0 SAMPLING AND ANALYTICAL TESTING PROGRAM

This section describes the sampling and analytical testing program for the supplemental sediment investigation. The sampling and analytical testing program is summarized in Table 1. The proposed supplemental sediment sampling locations are shown in Figure 4 (intertidal portion of the marine unit) and Figure 5 (subtidal portion of the marine unit). Appendix A describes sediment sampling field procedures, Appendix B contains the QAPP, and Appendix C contains the Site Health and Safety Plan.

4.1. Intertidal Sediment Sampling and Analysis

Sample collection in the intertidal zone will be preceded by a forage fish egg survey within 48 hours of the field effort to ascertain if forage fish are spawning in the intertidal zone of the project area (a portion of Pine Street Beach/Cornwall Cove within the area of investigation is mapped as a potential spawning area for both Pacific sand lance [*Ammodytes hexapterus*] and surf smelt [*Hypomesus pretiosus*] [WDFW 2015]). Survey protocol with follow those established by the Washington State Department of Fish and Wildlife (WDFW) (Moulton and Pentilla, 2001) and be performed by WDFW-trained biologists.

The locations where surface sediment meets SMS benthic criteria are not fully delineated in the intertidal zone near the northern and southern boundaries of the Haley upland unit (the bayward extent has been defined based on benthic toxicity tests). Concentrations of bioaccumulative compounds are also not well documented in these intertidal areas north and south of the Haley upland unit. Subsurface conditions (e.g., chemical concentrations, sediment characteristics, etc.) that inform the extent of contamination and may affect the extent of the preferred remedy to the northern and southern boundaries are also not fully characterized.

To meet the supplement sediment investigation objectives, both surface and subsurface sampling will be conducted in the intertidal zone adjacent to the upland unit. The biologically active zone for benthic invertebrates has been identified for Bellingham Bay as the top 12 cm of the surface sediment and will be used as the sampling depth to evaluate benthic risks. The point of compliance for protection of human health is represented by the depth to which recreational clamming may take place (defined in the draft FS as 0 to 45 cm [18 inches]). For the purpose of this supplemental sediment investigation, this compliance depth will be represented by the 0 to 2 feet sample interval. Subsurface conditions will be evaluated to a depth of 8 feet below mudline; this depth was selected based on the depth of site-specific contamination in nearby sediment core samples that were collected during prior phases of the RI.

The seven proposed intertidal surface sediment grab sampling locations (locations SSI-SS-01 through SSI-SS-07) are shown in Figure 4. Four locations are proposed in the Pine Street beach area (also known as Cornwall Cove), north of the Haley upland property, and three locations are proposed south of the Haley property in or near the Haley-Cornwall sediment cap overlap area (Figure 4). Seven sediment core samples (SSI-SC-01 through SSI-SC-07) will also be collected from within the intertidal area and will be co-located

with the surface sediment samples. Intertidal (surface and subsurface) sediment samples will be collected during one field event. A global positioning system (GPS) will be used to navigate to the proposed sampling locations. Details of navigation, sample collection and handling procedures are provided in Appendix A (Sediment Sampling Field Procedures).

4.1.1. Surface Sediment Samples – Benthic Risk

Intertidal surface sediment samples for the evaluation of benthic chemical and biological criteria exceedances will be obtained from a depth of 0 to 12 cm below the sediment surface using a Van Veen (or similar) grab sampling device deployed from a sampling vessel. Some intertidal sampling locations may be accessed from the upland at low tide, and samples at these locations may be obtained using hand tools if a low tide with sufficient amplitude occurs during field sampling. Sufficient sample volume will be obtained for both initial chemical analytical testing and potential follow-up bioassay testing if needed (see below for a discussion of tiering sample analyses).

The surface (0 to 12 cm) sediment samples for evaluating risks to the benthic community will be analyzed for conventional parameters and the SMS suite of chemicals of concern except for metals, pesticides and polychlorinated biphenyls (PCBs)[3]. Surface sediment samples closest to the previously characterized intertidal area (i.e., SSI-SS-02, -03, -04 and -05) will also be analyzed for TPH; other surface sediment samples further north or south may be analyzed for TPH depending on the outcome of the initial analyses. A summary of the analytical suite is provided below and in Table 1.

- SMS suite of semivolatile organic compounds (SVOCs)
- Chlorinated phenolic compounds
- Total petroleum hydrocarbons (selected samples)
- Total organic carbon
- Grain size
- Total solids

Bioassays may also be conducted depending on the results of the initial chemical analyses and will include:

- 10-day adult amphipod mortality test (acute toxicity)
- Sediment bivalve or echinoderm larval test (acute toxicity)
- 20-day juvenile polychaete growth test (chronic toxicity)

Based on the potential presence of wood and wood debris in the intertidal zone, bioassays will be conducted under ultraviolet light protocol per Sediment Cleanup Users Manual guidance (Ecology 2015a).

[3] Metals, pesticides and PCBs are not site-specific contaminants of concern. Historically, they have either not been detected or detected at low concentrations in the vicinity of the Haley Site.

4.1.2. Sediment Cores – Human Health Risk and Subsurface Sediment Conditions

A vibracore or similar equipment will be used to collect sediment cores to a depth of approximately 8 feet below mudline (or refusal). Cores will be subsectioned every 2 feet to create up to four discrete sediment samples for potential chemical analyses. The top 2-foot section will be used to evaluate human exposure to site-specific bioaccumulative contaminants during potential clam digging; all subsections may be used to characterize sediment for the purpose of refining the extent of contamination and extent of the preferred alternative.

Initially, the top two sediment core sample intervals (0 to 2 feet and 2 to 4 feet) will be analyzed. Subsurface core intervals 4 feet below the mudline or deeper will be archived. Subsequent intervals of archived subsurface samples may be analyzed based on the adjacent interval sample results exceeding preliminary CULs.

The top two sediment core sample intervals (0 to 2 feet and 2 to 4 feet) will only be analyzed for site-specific bioaccumulative contaminants of concern (pentachlorophenol, dioxins/furans and cPAHs), other PAH indicators of hazardous substances, and conventional parameters to allow refinement of the extent of contamination and human health risks under current and post-remedy scenarios (i.e., the proposed remedy would remove 2 feet of material in the intertidal areas outside of the smear zone, leaving a new sediment surface that will be capped and armored). Subsequent intervals, if analyzed, would include the same chemical and conventional parameter suite. As with the surface sediment analytical approach, TPH will be analyzed in the top two core intervals at the locations immediately adjacent to the previously characterized area (i.e., SSI-SC-02 -03, -04 and -05). TPH may be analyzed in deeper core intervals or adjacent cores depending on the outcome of the overlying core interval or co-located surface sample.

Sample preparation and analytical methods are specified in the quality assurance project plan (QAPP) in Appendix B.

4.2. Subtidal Sediment Sampling and Analysis

Existing data presented in the draft RI report (GeoEngineers, 2015a) showed that the two bioaccumulative contaminants of concern with the largest footprint of preliminary CUL exceedances in sediment are dioxins/furans and cPAHs. The sediment preliminary CULs for dioxins/furans (15 nanograms per kilogram [ng/kg] TEQ) and cPAHs (86 micrograms per kilogram [µg/kg] TEQ) are based on the regional background concentrations established by Ecology for these compounds in Bellingham Bay sediments (Ecology, 2015b).

The 11 proposed subtidal surface sediment sampling locations (locations SSI-SS-08 through SSI-SS-18) are shown in Figure 5. These proposed sampling locations were selected based on the interpolated distribution[4] of dioxins/furans and cPAHs shown in Figures 2 and 3; proposed sample locations are intended to provide reasonable interpolation of the concentrations of these bioaccumulative compounds in areas between existing data points. Surface sediment samples will be obtained from a depth interval of 0 to 12 cm at each subtidal sample location using a Van Veen (or similar) grab sampling device deployed

[4] The extent was estimated from existing sediment data using inverse distance-weighted interpolation among known sample concentrations.

from a sampling vessel. Details regarding navigation, sample collection and handling procedures are provided in Appendix A (Sediment Sampling Field Procedures).

Five of the proposed subtidal surface sediment samples will initially be analyzed; the remaining six samples may be analyzed depending on the outcome of the first six subtidal surface sample analyses (Figure 5 and Table 1). If the detected concentrations in any of the initial samples exceed the regional background-based preliminary CULs, adjacent archived samples will be analyzed to support evaluation of the marine unit Site boundary and human health risks. Subtidal (initial or follow-up) samples will be analyzed for the following parameters:

- Dioxins/furans
- cPAHs
- Total organic carbon
- Grain size
- Total solids

The City requested analysis of dioxins/furans in two subtidal surface sediment samples collected by Landau Associates (Landau) offshore of the Cornwall upland in June 2015 (locations CL-SG-3 and CL-SG-4; Figure 2). Landau collected these samples at these locations for bioassay testing as part of the Cornwall pre-design characterization (Landau Associates, 2015). The dioxin/furan concentrations detected in these samples were 25.2 ng/kg TEQ (CL-SG-3) and 52.2 ng/kg TEQ (CL-SG-4). On behalf of the City, GeoEngineers also requested that surface sediment sample CL-SG-1 also be submitted for analysis of dioxins/furans to support the evaluation of the southern extent of this contaminant.

5.0 PERMITS AND AUTHORIZATIONS

Under Revised Code of Washington (RCW) 70.105D.090, remedial actions conducted under a consent decree, order, or agreed order are exempt from the procedural requirements of Chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW, and the procedural requirements of any laws requiring or authorizing local government permits or approvals for the remedial action. However, exempted remedial actions still must comply with the substantive requirements of these laws. These exemptions apply to the proposed supplemental sediment investigation sampling activities. Washington State Department of Natural Resources (DNR) has indicated that no authorization is necessary from DNR for sediment sampling conducted on state-owned land under a MTCA investigation if the work will not disturb the environment (DNR, 2015).

The City has determined that under WAC 197-11-800(17), the proposed sampling activities are categorically exempt from State Environmental Policy Act (SEPA) review. The City has further determined that under RCW 77.55.061, the proposed sampling activities are exempt from the procedural requirements of Chapter 77.55 RCW (Construction Projects in State Waters). In particular, the proposed sampling will not require a hydraulic project approval/permit from the Washington Department of Fish and Wildlife (WDFW). Ecology will review this Work Plan for compliance with the substantive requirements of Chapter 77.55 RCW.

However, exemptions do not apply to federal permits; sediment investigations typically fall under the Nationwide Permit #6, which governs survey activities. Because of the federal nexus, a biological evaluation

will likely be required to allow consideration of potential impacts to protected species and critical habitats. Accordingly, the Joint Aquatic Resource Permit Application (JARPA) will be completed to allow state agencies to identify substantive requirements for the supplemental sampling event and to comply with federal regulations under the Clean Water Act and Endangered Species Act.

6.0 SCHEDULE

The proposed sediment sampling activities are scheduled to occur in late summer or early fall of 2015 within agency-approved in-water work windows (July 16, 2015 through October 14, 2016). Field work will be completed within one week of the forage fish egg survey, per WDFW requirements (see Section 4.1). It is anticipated that a draft technical memorandum summarizing the results and conclusions of the supplemental sediment investigation will be completed in December 2015 or early 2016.

7.0 REFERENCES

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TABLES

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Table 1

Supplemental Sediment Sampling and Analysis

R.G. Haley Site

Bellingham, Washington

Sample Location Description	Analytical Tier	Station ID	Expected Exploration Depth	Sampling Method	Proposed Analysis								
					Dioxins/ Furans	Total Organic Carbon (TOC)	Total Solids	Grain Size	SVOCs	PAHs	Chlorophenols	TPH (Diesel- and Heavy Oil-Range)	Bioassay
					EPA Method 1613 Mod	Plumb 1981, Standard Method 5310B or SW846 Method 9060	PSEP 1986	PSEP 1986 or ASTM D-422 Mod	EPA 8270	EPA 8270 SIM low level	EPA 8041	NWTPH-Dx with acid/ silica gel cleanup	PSEP 1995[3]
Intertidal Sediment	Initial	SSI-SS-1	0-12 cm	Grab	NA; see SSI-SC-1	X	X	X	X	X	X	A[1]	X[2]
	Initial	SSI-SC-1	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	A[1]	NA
	Initial	SSI-SC-1	2-4 ft		X	X	X	X	NA	X	X	A[1]	
	Follow-up	SSI-SC-1	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-1	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-2	0-12 cm	Grab	NA; see SSI-SC-2	X	X	X	X	X	X	X	X[2]
	Initial	SSI-SC-2	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	X	NA
	Initial	SSI-SC-2	2-4 ft		X	X	X	X	NA	X	X	X	
	Follow-up	SSI-SC-2	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-2	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-3	0-12 cm	Grab	NA; see SSI-SC-3	X	X	X	X	X	X	X	X[2]
	Initial	SSI-SC-3	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	X	NA
	Initial	SSI-SC-3	2-4 ft		X	X	X	X	NA	X	X	X	
	Follow-up	SSI-SC-3	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-3	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-4	0-12 cm	Grab	NA; see SSI-SC-4	X	X	X	X	X	X	X	X[2]
	Initial	SSI-SC-4	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	X	NA
	Initial	SSI-SC-4	2-4 ft		X	X	X	X	NA	X	X	X	
	Follow-up	SSI-SC-4	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-4	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-5	0-12 cm	Grab	NA; see SSI-SC-5	X	X	X	X	X	X	X	X[2]
	Initial	SSI-SC-5	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	X	NA
	Initial	SSI-SC-5	2-4 ft		X	X	X	X	NA	X	X	X	
	Follow-up	SSI-SC-5	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-5	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-6	0-12 cm	Grab	NA; see SSI-SC-6	X	X	X	X	X	X	A[1]	X[2]
	Initial	SSI-SC-6	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	A[1]	NA
	Initial	SSI-SC-6	2-4 ft		X	X	X	X	NA	X	X	A[1]	
	Follow-up	SSI-SC-6	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-6	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Initial	SSI-SS-7	0-12 cm	Grab	NA; see SSI-SC-7	X	X	X	X	X	X	A[1]	X[2]
	Initial	SSI-SC-7	0-2 ft	Vibracorer	X	X	X	X	NA	X	X	A[1]	NA
	Initial	SSI-SC-7	2-4 ft		X	X	X	X	NA	X	X	A[1]	
	Follow-up	SSI-SC-7	4-6 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
	Follow-up	SSI-SC-7	6-8 ft		A[1]	A[1]	A[1]	A[1]	NA	A[1]	A[1]	A[1]	
Subtidal Sediment	Initial	SSI-SS-8	0-12 cm	Grab	X	X	X	X	NA	NA[4]	NA	NA	NA
	Initial	SSI-SS-9	0-12 cm		NA[5]	X	X	X	NA	X	NA	NA	
	Initial	SSI-SS-10	0-12 cm		X	X	X	X	NA	X	NA	NA	
	Initial	SS-SSI-11	0-12 cm		X	X	X	X	NA	X	NA	NA	
	Initial	SSI-SS-12	0-12 cm		X	X	X	X	NA	X	NA	NA	
	Follow-up	SSI-SS-13	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	NA[4]	NA	NA	
	Follow-up	SSI-SS-14	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	A[1]	NA	NA	
	Follow-up	SSI-SS-15	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	A[1]	NA	NA	
	Follow-up	SSI-SS-16	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	NA[6]	NA	NA	
	Follow-up	SSI-SS-17	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	A[1]	NA	NA	
	Follow-up	SSI-SS-18	0-12 cm		A[1]	A[1]	A[1]	A[1]	NA	NA[6]	NA	NA	
	Initial	CL-SG-1	0-10 cm		X	NA	X	X	NA	NA	NA	NA	X (completed)
	Initial	CL-SG-3	0-10 cm		X (completed)	X (completed)	X (completed)	NA	NA	NA	NA	NA	
	Initial	CL-SG-4	0-10 cm										

Notes

[1]Analysis pending results of initial or adjacent samples or sample intervals (in the case of cores).

[2]Pending chemical analytical results. Sediment samples found to exceed SMS benthic chemical criteria will be submitted for benthic toxicity (bioassay) testing.

[3]Benthic PAH toxicity will be evaluated with exposure to ultraviolet (UV) light according to the SCUM II 2015 Appendic C.

[4]Existing cPAH data are available to represent this area.

[5]Existing dioxin data are available to represent this area.

[6]cPAHs will not be analyzed at these locations; locations well beyond area predicted to be above regional background.

A = archive

cm = centimeters

EPA = Environmental Protection Agency

ft = feet

NA = not analyzed

SMS = Sediment Management Standards

PAHs = polycyclic aromatic hydrocarbons

SVOCs = semivolatile organic compounds

PSEP = Puget Sound Estuary Program

TPH = total petroleum hydrocarbons

FIGURES

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Legend

Haley Site per Agreed Order, Exhibit 1

Project North

2,000 0 2,000

Feet

Reference: Whatcom County GIS, City of Bellingham GIS, Aerial from Esri, 2013.

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Projection: NAD 1983 UTM Zone 10N

Vicinity Map

R.G. Haley Site
Bellingham, Washington

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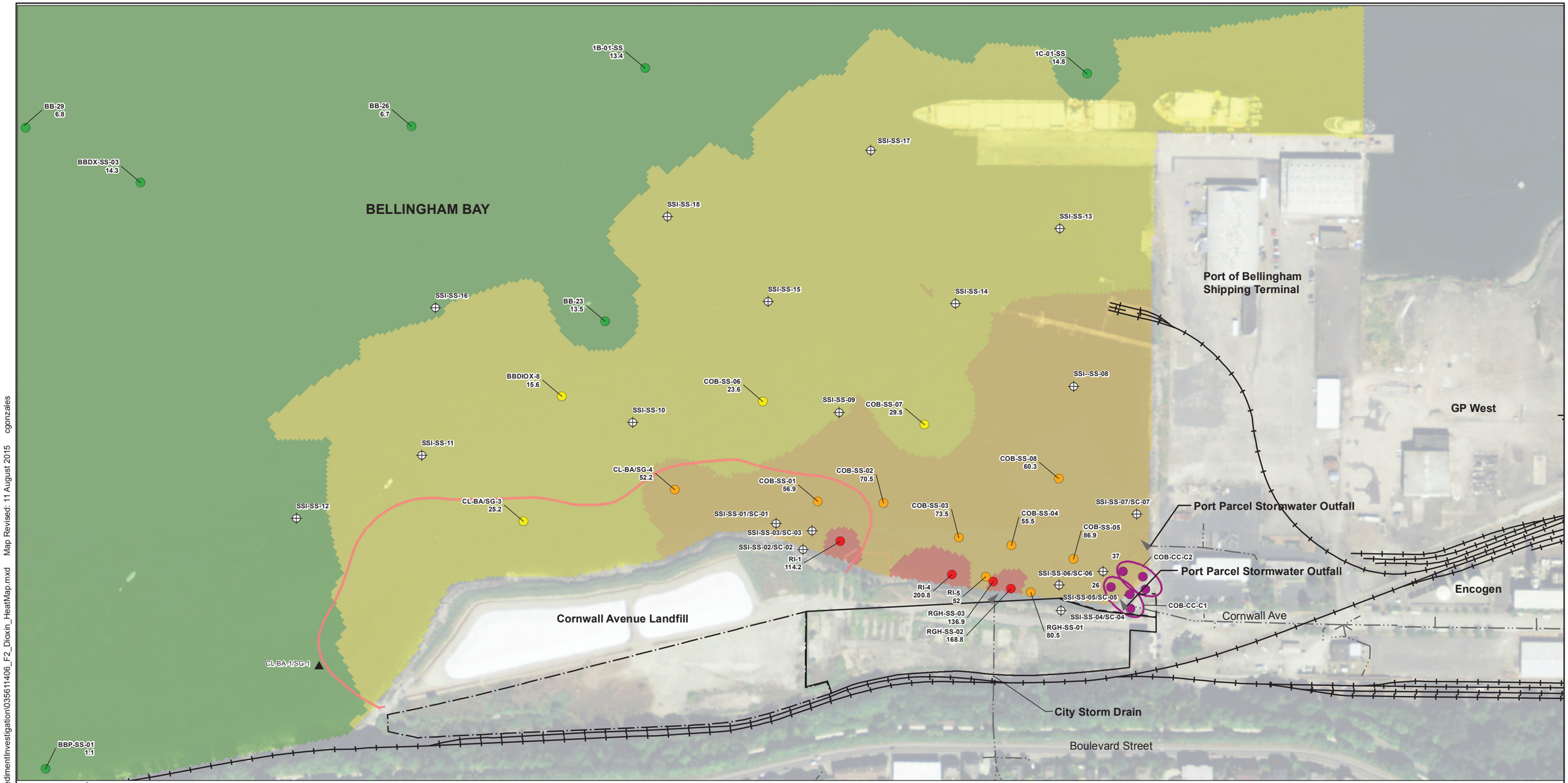
Figure 1

Path: \\sea\projects\00356114\GIS\MXDs\SupplementalSedimentInvestigation\0356114406_F1_VicinityMap.mxd Map Revised: 14 July 2015 cgonzales



W True North S N E Project North

0 150 300

Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Historic overwater structures in the Site area are shown in Figure 2-3 of Draft RI Report

Surface Sediment Dioxin Concentration (ng/kg)

- <15
- 15-45
- 45-100
- >100
- Composite Samples
- Cornwall Pre-Design Sediment Sample Location

Regional background concentration established by Ecology = 15 ng/kg

- Proposed Sample Location (Surface and Subsurface Sediment)
- Storm Drain Pipe
- City Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property
- BNSF Railroad
- Thin Layer Sediment Cap

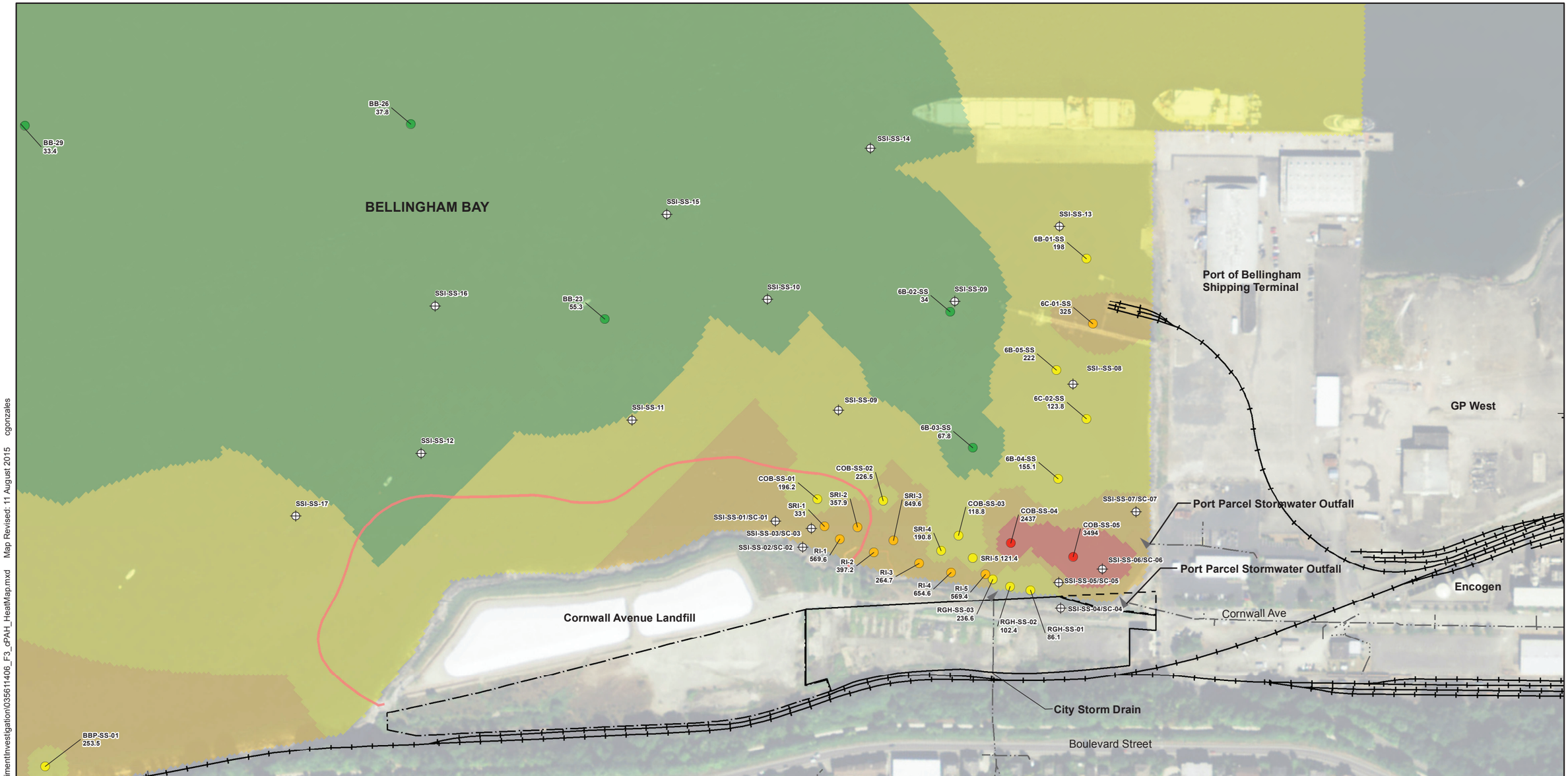
Interpolated Dioxin Distribution Map
Existing Surface Sediment Data

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 2

Path: \\sea\projects\0\0356114\GIS\MXDs\SupplementalSedimentInvestigation\0356114406_F2_Dioxin_HeatMap.mxd Map Revised: 11 August 2015 cgonzales



W True North S N E

Project North

0 150 300

Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
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3. Historic overwater structures in the Site area are shown in Figure 2-3 of Draft RI Report

Surface Sediment cPAH Concentration (µg/kg)
- <86
- 86-260
- 260-1,000
- >1,000

Proposed Sample Location (Surface and Subsurface Sediment)
Storm Drain Pipe
City Owned Property, Former R.G. Haley
Cornwall Property
Port of Bellingham Property
BNSF Railroad
Thin Layer Sediment Cap

Regional background concentration established by Ecology = 86 µg/kg

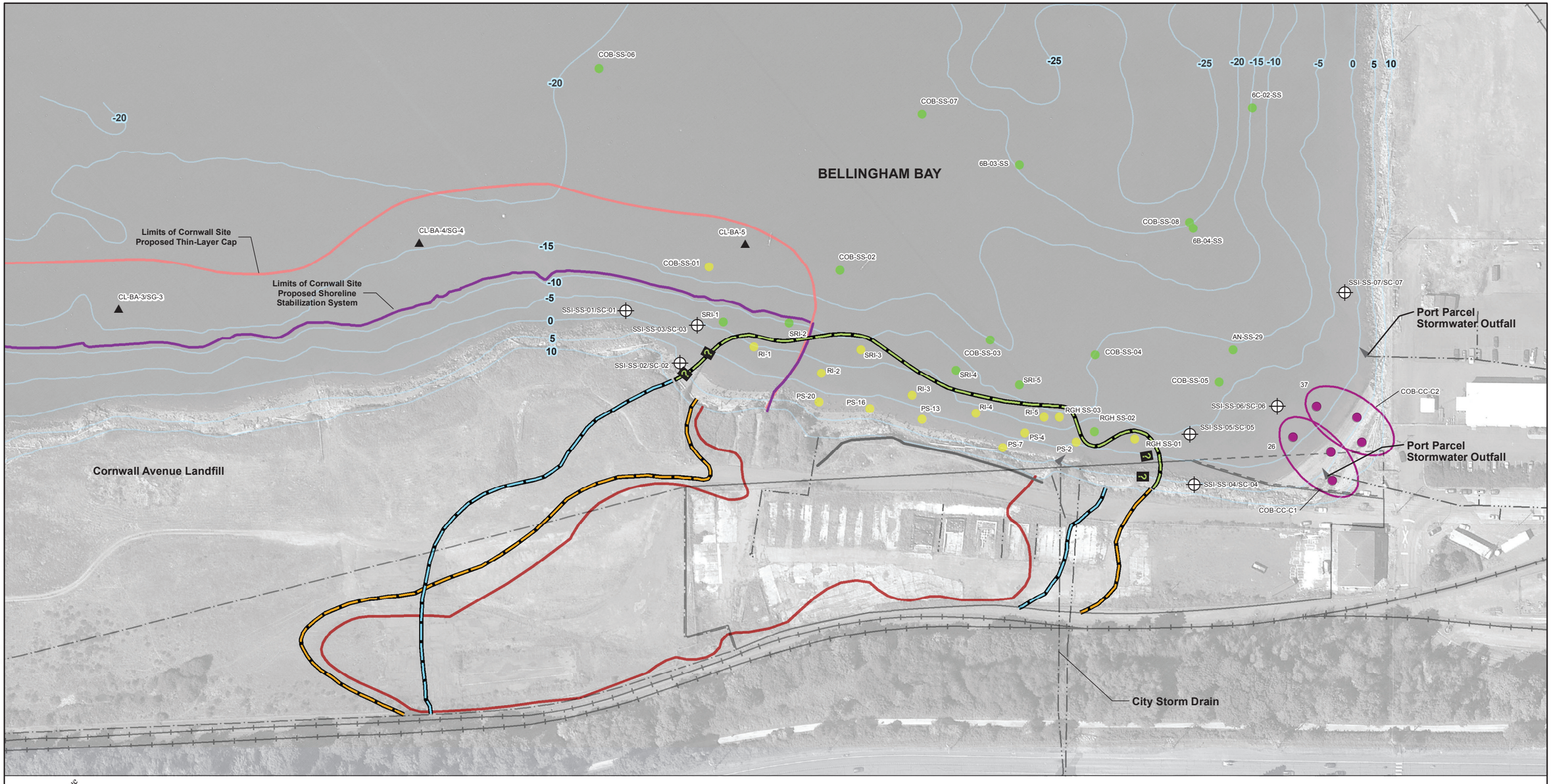
Interpolated cPAH Distribution Map
Existing Surface Sediment Data

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 3

Path: \\sea\projects\0\0356114\GIS\MXDs\SupplementalSedimentInvestigation\0356114O6_F3_cPAH_HeatMap.mxd Map Revised: 11 August 2015 cgonzales



W True North S N Project North E

0 75 150

Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

- Proposed Intertidal Sampling Location (Surface Sediment and Cores)
- Cornwall Pre-Design Sediment Sample Location
- Surface Sediment that Exceeds SMS Benthic Chemical and/or Toxicity Criteria
- Surface Sediment that Meets SMS Benthic Chemical and/or Toxicity Criteria
- Composite Sample
- Sheet Pile Wall
- Storm Drain Pipe
- Boundary of Haley Soil Exceedances
- Boundary of Haley Groundwater Exceedances
- Boundary of Haley Sediment SMS Benthic Chemical and/or Toxicity Exceedances
- Boundary of Smear Zone
- City-Owned Property, Former R.G. Haley
- Cornwall Avenue Landfill
- Port of Bellingham Property

Proposed Intertidal Supplemental Sediment Investigation Sampling Locations

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 4

Path: \\sea\projects\0\0356114\GIS\MXDs\SupplementalSedimentInvestigation\0356114_F4_ProposedIntertidalSupplementalSe

Map Revised: 11 August 2015

cgonzales

BB-29
BB-26
BBDX-SS-03
1B-01-SS
1C-01-SS
SSI-SS-17
SSI-SS-18
SSI-SS-16
SSI-SS-15
SSI-SS-14
SSI-SS-13
SSI-SS-08
SSI-SS-09
SSI-SS-10
SSI-SS-11
SSI-SS-12
BB-23
BBDIOX-8
6B-01-SS
6B-02-SS
6B-03-SS
6B-04-SS
6B-05-SS
6C-01-SS
6C-02-SS
COB-SS-01
COB-SS-02
COB-SS-03
COB-SS-04
COB-SS-05
COB-SS-06
COB-SS-07
CL-BA-1/SG-1
CL-BA-2
CL-BA-3/SG-3
CL-BA-4/SG-4
CL-BA-5
SRI-1
SRI-2
SRI-3
SRI-4
SRI-5
RI-1
RI-2
RI-3
RI-4
RI-5
RGH-SS-01
RGH-SS-02
RGH-SS-03
BBP-SS-01

BELLINGHAM BAY

Limits of Cornwall Site
Proposed Thin-Layer Cap

Limits of Cornwall Site
Proposed Shoreline
Stabilization System

Cornwall Avenue Landfill

Port Parcel
Stormwater Outfall

Port Parcel
Stormwater Outfall

City Storm Drain

-35 -30 -25 -20 -15 -10 -5 0 5 10

W True North N
S Project North E
0 150 300
Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to
NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

- Interpolated Boundary of Dioxin Concentrations > 15 ng/kg
- Interpolated Boundary of cPAH Concentrations > 86 µg/kg
- Proposed Subtidal Surface Sediment Sampling Location
- Proposed Archived Surface Sediment Sample
- Existing Sample Location
- Cornwall Pre-Design Sediment Sample Location
- Sheet Pile Wall
- Storm Drain Pipe
- City-Owned Property, Former R.G. Haley
- Cornwall Avenue Landfill
- Port of Bellingham Property
- Boundary of Haley Soil Exceedances
- Boundary of Haley Groundwater Exceedances
- Boundary of Haley Sediment SMS Benthic Chemical and/or Toxicity Exceedances
- Boundary of Smear Zone

Proposed Subtidal Supplemental Sediment Investigation Sampling Locations

R.G. Haley Site
Bellingham, Washington

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Figure 5

APPENDICES

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APPENDIX A
Sediment Sampling Field Procedures

Table of Contents

APPENDIX A.
SEDIMENT SAMPLING FIELD PROCEDURES

1.0 INTRODUCTION

This appendix describes field procedures for the supplemental sediment sampling that will be conducted at the R.G. Haley Site (Site). The purpose and objectives of the sediment investigation are discussed in the Supplemental Sediment Investigation Work Plan (Work Plan). The purpose of this appendix is to describe field activities, sampling and navigation equipment, sampling locations and procedures that will be used during this investigation. Equipment and methods will be consistent with current guidance regarding implementation of sediment investigations under the Sediment Management Standards (SMS).

This field procedures appendix will be used in conjunction with the Work Plan and appendices including the Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HASP). The QAPP identifies quality assurance/quality control (QA/QC) procedures that will be implemented during sampling activities and laboratory analyses.

Site conditions may make it necessary to modify the procedures described in this sampling plan. Any significant variations or modifications that become necessary during the field investigation will be communicated to and discussed with the City of Bellingham, the Washington State Department of Ecology (Ecology), and other involved parties as appropriate. Variations or modifications implemented during the investigation and the reason for the modification will be documented in field records.

2.0 SAMPLING OBJECTIVE AND GENERAL APPROACH

The objective of sediment sampling at the Site is to further characterize the extent of contamination, biological impacts, and human health risks resulting from site-related contaminants in in the vicinity of the Site. Information will be used to evaluate the outer-most boundary of the marine unit based on human health risks from bioaccumulative contaminants of concern and refine the extent of and risks associated with contamination in the intertidal portion of the marine unit. These data will be used to refine the preferred remedy during remedial design.

Contaminants identified in Site sediment during previous investigations that are to be further characterized using the procedures specified in this Sampling and Analysis Plan (SAP) include:

- Diesel- and oil-range petroleum hydrocarbons,
- Polycyclic aromatic hydrocarbons (PAHs),
- Pentachlorophenol, and
- Dioxins/furans.

The sediment investigation will be conducted as a single field effort in intertidal and subtidal areas within and near the Site. A tiered analytical approach will be used for sediment sampling and analysis, as described in the Work Plan.

Surface sediment samples will be collected using a Van Veen sampler or similar grab sampler deployed from a vessel (i.e., boat and/or barge). Some intertidal surface sediment samples may be collected from land using hand-held equipment, if the low tide duration is adequate when sampling is scheduled to be performed; otherwise, intertidal samples will be collected from a boat during a high tide. Subsurface sediment samples will be collected using a small barrel vibracorer deployed from a vessel with minimal draft. Specific details of sample collection are provided in Section 4.

Details on sample handling, processing and analyses are presented in the QAPP including preliminary cleanup levels, recommended sample preparation, chemical analytical methods, biological testing methods, sediment sample volumes and containers for conventional and chemical analyses, and storage temperatures and holding times.

3.0 PERSONNEL AND RESPONSIBILITIES

The following GeoEngineers personnel will have key roles and responsibilities for sediment sampling and analysis activities:

Project Management: Dana Carlisle will be the project manager responsible for the overall quality assurance for sediment sampling and analysis on this project to ensure that it meets technical requirements.

Task Management: Nancy Musgrove will be the task manager for sediment sampling and analysis tasks and will have responsibility for implementation of the sediment sampling and analysis program and data evaluation.

Field Coordinator: The Field Coordinator will be a GeoEngineers geologist, environmental scientist or engineer who will be responsible for performing sediment sample collection in accordance with the methods and procedures described in the Work Plan and appendices. Duties will include coordination of field sampling efforts and sample delivery to the laboratory. Responsibilities will also include complying with the site-specific HASP.

Quality Assurance Leader: Mark Lybeer will be the GeoEngineers QA Leader. The QA Leader is responsible for coordinating with the laboratory regarding all issues related to sample analyses and supporting the evaluation and reporting of all results to the project team. Specific responsibilities include:

- Serves as GeoEngineers' official contact for laboratory data QA concerns.
- Reviews and approves the laboratory QA Plan for laboratories subcontracted to GeoEngineers.
- Responds to laboratory data QA needs, answers laboratory requests for guidance and assistance, and helps resolve analytical issues or other related concerns.
- Monitors laboratory compliance with data quality requirements.
- Ensures that appropriate sampling, testing, and analytical procedures are followed and that proper QC checks are implemented.
- Reviews the implementation of the QAPP and the overall quality of the analytical data generated.
- Maintains the authority to implement corrective actions as necessary.

- Ensures proper implementation of the QAPP.
- Provides oversight of the data development and review process and of subcontracting laboratories.
- Conducts laboratory audits, as necessary, and data validation activities.
- Ensures that the electric data deliverable (EDD) from the laboratory is properly prepared and accurate.
- Processes data and loads data into GeoEngineers internal data management system.
- Enters data into Ecology's Environmental Information Management (EIM) system.

Analytical Laboratory Manager (Subcontractor): The subcontracted laboratories conducting sample analyses and potential biological testing for this project are required to obtain approval from the QA Leader before the initiation of sample analysis/testing to assure that the laboratory QA plan complies with the project QA objectives. The Laboratory Manager administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of the Laboratory Manager include:

- Ensures implementation of the Laboratory QA Plan.
- Serves as the laboratory point of contact.
- Activates corrective action as necessary.
- Issues the final laboratory QA/QC report.
- Administers QA sample analysis, where required.
- Complies with the specifications established in the project plans as related to laboratory services.
- Participates in QA audits and compliance inspections.

The laboratories' QA Managers will be determined once the specific Ecology-accredited laboratories to be used for the project are confirmed.

4.0 FORAGE FISH/EELGRASS ASSESSMENT

4.1. Forage Fish

The Washington State Department of Fish and Wildlife (WDFW) has identified the northwestern arm of Pine Street Beach/Cornwall Cove as sand lance and surf smelt spawning habitat. According to the terms of the Hydraulic Project Approval (HPA), the potential for developing forage fish eggs to be present in the intertidal areas proposed for sediment sampling must be assessed prior to beginning the supplemental sediment investigation.

A qualified[1] GeoEngineers biologist will perform the forage fish spawning survey following the WDFW protocols. The survey will be conducted within 48 hours prior to commencing the supplement sediment investigation and the intertidal portion of this investigation will be completed within 7 days of the forage fish spawning survey. The survey will consist of collecting and processing small (<4 liters) composite

[1] WDFW-trained and certified.

samples of beach sediment using methods described by Moulton and Penttila (2001)[2] to detect the presence or absence of forage fish spawn on the beach. Should forage fish eggs be found, no work below the Ordinary High Water Mark (OHWM) will occur until additional surveys demonstrate that no eggs are present. Depending on the location and methods of the sampling, some intertidal sample collection may be approved by the WDFW area habitat biologist. GeoEngineers will also comply with any other terms of the HPA to avoid disturbing forage fish spawning or egg development during the supplemental sediment investigation.

4.2. Eelgrass

A benthic habitat survey was performed in September 2012 for the RG Haley Site. The survey relied upon side-scan sonar and scuba diving observations to assess the occurrence and density of eelgrass in the intertidal and shallow subtidal areas of the marine unit of the Site. Eelgrass was generally distributed between -2.5 feet and -12.5 feet (NAVD88), with the greatest densities occurring at an elevation of approximately -6.5 feet. The eelgrass distribution generally ran parallel to the shoreline.

The subtidal sampling locations have been selected to avoid the known areas with eelgrass. However, eelgrass may occur in other areas due to its ability to rapidly colonize available substrate in the vicinity of established beds. To ensure that eelgrass beds are not disturbed by sampling equipment, the presence of eelgrass will be assessed using an underwater video camera, prior to deploying the grab or core sampling device at a given location. The presence and location of eelgrass in the intertidal zone will be assessed as part of the forage fish survey, for the portion of the beach that is exposed at the time of the survey.

5.0 SAMPLE COLLECTION AND HANDLING

5.1. Navigation and Positioning

Sample locations will be documented in the field (North American Datum of 1983) using a hand-held or boat-mounted differential global positioning system (DGPS) or real-time kinetic global positioning system (RTK-GPS). Location control accuracy for the samples is to be within +/- 1 meter of the planned sampling locations. The location where samples are collected will be recorded either on the field logs or using the GPS software to the nearest 0.1 second.

Where over-water sampling is performed, water depths at sediment sampling locations will be measured directly using a lead-line and converted to mudline elevations using National Oceanic and Atmospheric Administration (NOAA) tide information for Bellingham Bay.

5.2. Collection Methods

Prior to sample collection, all field staff and subcontractors assisting with field collection will read and become familiar with the sediment sampling field procedures and the QAPP.

---

[2] Moulton, L. L. and Penttila, D. E. (2001) San Juan County Forage Fish Assessment Project, Field Manual for Sampling Forage Fish Spawn in Intertidal Shore Regions, First Edition, March 2001. Washington Department of Fish and Wildlife, La Conner, Washington http://wdfw.wa.gov/publications/01209/wdfw01209.pdf

5.2.1. Surface Sediment

Surface sediment samples are anticipated to be collected using a modified Van Veen or power grab sediment sampler deployed from a vessel. All sampling equipment will be decontaminated before sampling and in between sampling locations. The general procedure for collecting surface sediment samples is as follows:

1. Maneuver the sampling vessel to the proposed sampling location, steady the vessel, and verify location using the GPS.
2. Record the location coordinates of the sample.
3. Prepare the sampler for deployment.
4. Deploy the sampler through the water column to the mudline, descending at approximately 1 foot per second (fps). Verify that the sampler cable is approximately perpendicular to the water line.
5. Record the sampling time and the depth to mudline below the water surface using the lead-line.
6. Raise the grab to the vessel at approximately 1 fps to prevent sediment from potentially washing out.
7. Place the sampler on the work surface of the vessel; block the sides, if necessary, to prevent overlying water from sloshing or being lost (i.e., minimize disturbance of sediment surface in grab).
8. Examine the sample for the following sediment acceptance criteria:
    a. The sampler jaw is closed, with no significant leakage.
    b. The sampler is not overfilled so that the sediment surface presses against the top of the sampler.
    c. Minimal leakage has occurred, as evidenced by overlying water on the sediment surface.
    d. Minimal sample disturbance has occurred, as evidenced by limited turbidity in the overlying water.
    e. A penetration of at least 13 centimeters (cm) has been achieved; this depth is greater than the target penetration depth to allow subsampling of sediment that has not come into contact with the side of the sampler.
    f. If any of the sediment acceptance criteria are not achieved the sample will be rejected and the location resampled. If the proposed sampling location cannot be achieved after four deployments, notify the Project and Task Managers to determine an appropriate alternative location.
9. Gently siphon off standing water from the surface of the sediment using a hose primed with Site seawater. Do not disturb the surface of the sediment.
10. Visually classify sediment in accordance with ASTM International (ASTM) D2488 methods and the Unified Soil Classification System (ASTM D2487) and record on the field form. In addition to the visual classification, sediment samples will be field screened for odor, sheen or other evidence of contamination (see Section 4.3). Qualitative descriptions that will be recorded include presence of biota, debris, wood, shell hash, and other observations of sample condition.

11. Photograph the sediment sample. Include in the camera's field of view and a sheet of paper or white board with the sample name written in large black print; use care not to touch the sediment with the paper/whiteboard.
12. Collect the upper 12 cm of sediment from the sampler using a decontaminated stainless steel spoon. Do not collect sediment that has been in contact with the sides of the sampler. Place the sediment into a decontaminated stainless steel homogenization bowl. Cover the bowl with a new sheet of aluminum foil until all sample material has been collected (dispose foil after use).
13. Thoroughly rinse the interior of the sampler with Site seawater until all loose sediment has been washed off. Excess sediment will be returned to the bay at the approximate location where the sample was collected.
14. If sufficient sample volume is not collected, repeat the sampling process until sufficient volume is achieved. Successive deployments will be within an approximate 10-foot radius of the initial deployment.
15. Homogenize the final sediment volume in the stainless steel bowl using the stainless steel spoon until the sediment appears generally uniform in color and texture.
16. Distribute the sample to sample containers identified in the QAPP, including any field duplicates and ensure that the samples are properly labeled and tightly closed.
17. Clean the exterior of the sample containers, confirm label information is correction, place container inside a sealable bag (e.g., Ziploc™) and store containers in a cooler with ice.
18. Decontaminate all equipment as described in Section 4.4.
19. Double check that field collection forms are completely filled out.

5.2.2. Subsurface Sediment Core Collection

Subsurface sediment cores will be obtained using a small-barrel (~4-inch diameter) vibracorer. Continuous cores will be advanced through the sediment to depths of approximately 8 feet below mudline. Subsurface sediment samples will be collected continuously in 2-foot intervals and submitted to the laboratory for analysis or archival. If additional volume is needed than is available in the 2-foot interval then additional cores may be completed to obtain more volume.

The procedures for collecting subsurface sediment samples are as follows:

1. Maneuver the sampling vessel to the proposed sampling location, steady the vessel, and verify location control using the GPS.
2. Record the location of the sample.
3. Record the sampling time and depth to mudline below the water surface using a lead-line.
4. Drive the sampler into the sediment surface to the target depth or until refusal.
5. Collect a continuous core to the specified target depth or until refusal.
6. For each core interval, record the penetration depth on the field form.
7. Extract the core barrel, extract and cap the liner, and examine the core relative to the following acceptance criteria:

- Overlying water is present and the surface is intact.
- Calculated linear compaction is not greater than 25 percent.
- The core tube appears intact without obstructions or blockage.
- If any of the sediment acceptance criteria are not achieved, the sample will be rejected and the location resampled. If the proposed sampling location cannot be achieved after four deployments, notify the Project Manager. Ecology will be contacted for required review and approval of an appropriate alternative location.
- If the core meets the acceptance criteria then proceed with core processing. If core processing is not performed in the field, the cores will be labeled and kept at approximately 4°C during storage and shipment.

8. Open the core with a decontaminated core-opening device.
9. Visually classify sediment in accordance with ASTM D2488 methods and the Unified Soil Classification System (ASTM D2487) and record on the field form. In addition to the visual classification, sediment samples shall be observed and field-screened (see Section 4.3). Qualitative descriptive parameters including biota, debris, and presence of product/staining will also be recorded.
10. Photograph the sample. Include in the camera's field of view a sheet of paper or whiteboard with the sample name written in large black print; use care not to touch the sediment with the paper/whiteboard or with gloved hands in contact with whiteboards, pens or with whiteboard ink. It is likely several photos will be necessary to record the entire length of the core sample. Include the depth interval on the paper/whiteboard.
11. Collect sediment from the liner using a decontaminated stainless steel spoon. Do not collect sediment that has been in contact with the sides of the core liner, or the core-opening device. Place the sediment into a decontaminated stainless steel homogenization bowl. Cover the container with a new sheet of aluminum foil and dispose after use.
12. Homogenize the sediment in the stainless steel bowl using the stainless steel spoon until the sediment appears generally uniform in color and texture.
13. Distribute the sample to appropriate sample containers and ensure that the samples are properly labeled and tightly closed.
14. Clean the exterior of the sample containers, confirm label information is correction, place container inside a sealable bag (e.g., Ziploc™) and store containers in a cooler with ice.
15. Decontaminate all equipment as described in Section 4.5.
16. Double check that field collection forms are completely filled out.

If adequate sample volume cannot be obtained in a particular interval(s) in cores, an adjacent core will be attempted within a 10-foot radius of the original core.

5.3. Field Screening

Sediment samples will be field-screened for evidence of possible contamination. Field screening results will be recorded on the field logs. The following field screening methods will be used: (1) visual/olfactory screening and (2) water sheen screening.

5.3.1. Visual/Olfactory Screening

The sediment will be observed for unusual colors, staining or odor that may be indicative of contamination.

5.3.2. Water Sheen Screening

This is a qualitative field screening method that can help identify the presence or absence of petroleum hydrocarbons. A portion of the sediment sample will be placed in a pan containing distilled water. The water surface will be observed for signs of sheen. The following sheen classifications will be used:

- No sheen (NS) – No visible sheen on the water surface
- Slight sheen (SS) – Light, colorless, dull sheen; spread is irregular, slow; sheen dissipates rapidly
- Moderate sheen (MS) – Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface
- Heavy sheen (HS) – Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen

5.4. Equipment Decontamination

Field sampling equipment, including the sediment samplers as well as stainless steel bowls and spoons, will be cleaned prior to sampling and between each sampling location. Equipment for reuse will be decontaminated according to the procedure below:

1. Seawater will be sprayed over equipment to dislodge and remove any sediment (deionized water will be used for the samples collected by hand).
2. Surfaces of grab, bowls and spoons that contacted sample material will be scrubbed with a brush using an Alconox solution.
3. Cleaned equipment will be rinsed with seawater (grab sampler on vessel) or deionized water.

Solvents (i.e., acetone and hexane) may be used during sample collection activities performed by hand if petroleum or other oily materials are encountered in a sample; however, they will not be used aboard the vessel because the use of solvents on the congested deck of a vessel may pose a safety hazard to the crew. In addition, disposal and spillage of solvents during field activities aboard the vessel pose an environmental concern. If it is necessary to use solvents, solvents would only be used in the designated waste storage area on the Haley property, and only after step 3 above. In these cases, an additional rinse with deionized water will be required. Deionized water used in cleaning/rinsing steps will be collected and stored on the Haley property in the investigative waste storage area pending future transport off-site for permitted disposal.

Field personnel will limit cross-contamination by changing gloves between individual sample collection activities.

5.5. Field Documentation

Sample documentation will be recorded on sample forms. In addition, field reports will be completed on field report forms. Field sample forms and reports will become part of the project files at the conclusion of this field exploration.

At a minimum, the following information will be recorded during the collection of each sample:

- Sample location.
- Sampler's name(s).
- Date and time of sample collection.
- Water depth (for over-water samples); estimate of tidal elevation for intertidal samples, if collected from shore.
- Sampling equipment penetration, sample material recovery depth, and/or sample interval.
- Gross characteristics of the sediment including:
  - Presence or absence of layering/stratification,
  - Texture,
  - Color,
  - Presence of biota or biological structures,
  - Presence of debris including wood,
  - Presence of petroleum or oily substances, and
  - Field screening results (see Section 4.3).
- Description of wood presence (type and quantity of wood), if observed, including:
  - Type of wood (e.g., sawdust, bark, processed lumber, stick), and
  - Location of wood (e.g., on the surface, beneath the surface, in a layer, mixed throughout).
- Gross characteristics of the vertical profile including:
  - Presence of a redox layer and redox layer thickness, if present, and
  - Changes in material characteristics.

The following information also will be recorded in the field log for each day of sampling:

- Deviations from the WP, HASP or QAPP.
- Decontamination procedures (i.e., whether solvents were used and where).
- Calibration readings for any equipment used.

The handling, use and maintenance of field log books are the Field Coordinator's responsibilities.

5.6. Sample Containers and Labeling

Sediment samples obtained during this study will be placed in appropriate laboratory-prepared containers. Sample container type and size along with any use of preservatives are listed in the QAPP.

Sample containers will be labeled with the following information at the time of collection:

- Project name and/or number;
- Sample name;
- Analysis being requested, and
- Date and time of collection.

Sample naming conventions will be as follows:

Surface Sediment Sample

SSI-SS-##, where SSI indicates "supplemental sediment investigation," SS indicates surface sediment, and ## indicates the two-digit location code as designated in the Work Plan. An example is as follows: SSI-SS-08.

Subsurface Sediment Sample

SSI-SC-##-#-#, where SSI indicates "supplemental sediment investigation," SC indicates sediment core, the first number field refers to the two-digit location code as designated in the Work Plan and the second and third number fields refer to the core interval in feet. An example follows: SSI-SC-05-0-2 (core location 5; top 2-foot interval).

The sample collection activities will be noted on the field forms. The Field Coordinator will monitor consistency between the SAP, sample containers/labels, field log books and the chain-of-custody.

5.7. Sample Storage and Shipping

Samples will be placed in a cooler with wet ice or "blue ice" immediately after they are collected. Excess space will be filled with non-compressible material. The original chain-of-custody record will be signed by a member of the field team. Chain-of-custody forms will be placed inside a large sealable bag and placed inside the cooler; field personnel will retain a copy. The chain-of-custody forms will accompany the samples during transit to the laboratory. Coolers will be sealed with packing tape to prevent loss, if tipped or dropped.

The samples will be transported and delivered to the laboratories in coolers. Transport and delivery may be performed by one of the following methods:

- Field personnel may transport and deliver samples that are being submitted to a local laboratory for analysis.
- Field personnel may transfer the samples to a courier service. Custody seals will be attached to coolers.
- Field personnel may have the samples shipped to the laboratory via a commercial express mailing service. Custody seals will be attached to coolers.

Upon transfer of sample possession, the chain-of-custody will be signed by the person relinquishing the samples (typically field personnel) and by the party receiving the samples (typically laboratory personnel).

Holding times will be observed during sample handling and storage. Holding times for the project analyses are summarized in the QAPP.

5.8. Field Instrumentation

Proper calibration of equipment and instrumentation facilitates accurate and reliable field measurements. Field and laboratory equipment used on the project will be calibrated and adjusted in general accordance with the manufacturer's recommendations. Methods and intervals of calibration and maintenance will be based on the type of equipment, stability characteristics, required accuracy, intended use, and environmental conditions.

5.9. Field Measurement Evaluation

Field data will be reviewed at the end of each day by following the quality control checks outlined below and procedures in the QAPP. Field data documentation will be checked against the applicable criteria as follows:

- Correct sample collection information.
- Correct field instrumentation and calibration.
- Correct sample collection protocol.
- Correct sample containers, preservation and volume.
- Field QC samples collected at the frequency specified.
- Sample documentation and chain-of-custody protocols performed correctly and completely.
- Location (GPS) data are transferred to database and/or are recorded on field forms.

5.10.Disposal of Investigation-Derived Waste

All disposable sampling material and personal protective equipment (i.e., disposable coveralls, gloves, and paper towels) used in sample processing will be placed in appropriate containers in the designated investigation-derived waste storage area at the Haley Site. Decontamination water and/or solvents will be placed in (separate) drums that will be labeled, secured and properly stored on-site in the designated waste storage area.

5.11.Sample Analyses

Sample analyses, reporting limit and detection limit goals are outlined in the Work Plan, Table 1 and QAPP.

6.0 HEALTH AND SAFETY

A site-specific HASP is presented as an appendix to the Work Plan. GeoEngineers field staff will conduct a safety meeting each morning before beginning daily field activities. The field staff have “stop work” authority for any activity deemed to be unsafe or not in accordance with the HASP.

APPENDIX B
Quality Assurance Project Plan

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APPENDIX B
QUALITY ASSURANCE PROJECT PLAN

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared for the R.G. Haley Site as an appendix to the Supplemental Sediment Sampling Work Plan (Work Plan). The supplemental sediment investigation is being conducted to support the delineation of the marine unit Site boundary and the extent and location of elements of the preferred remedy within the marine unit of the Site including removal/capping, enhanced natural recovery and monitored natural recovery. This QAPP presents the procedures, organization, and specific quality assurance/quality control (QA/QC) activities designed to achieve the data quality objectives (DQOs) established for the project.

The QAPP has been developed based on guidelines specified in the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation (Chapter 173-340 of the Washington Administrative Code [WAC 173-340]) and Washington State Department of Ecology (Ecology) guidance contained in Ecology Publication #04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Ecology 2004). The QAPP also has been developed in general accordance with the Sediment Management Standards (SMS) portion of the WAC 173, Chapter 204-100 to 204-620 and the *Sediment Cleanup Users Manual II* (Ecology 2015).

Throughout the project, environmental measurements will be conducted to produce data that are scientifically valid, of known and acceptable quality, and meet established objectives. QA/QC procedures will be implemented so that the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data generated meet the specified DQOs to the maximum extent possible.

2.0 SAMPLE COLLECTION, HANDLING, AND CUSTODY

The sample collection, handling, and custody procedures are explained in Appendix A Field Procedures.

3.0 CHEMICAL ANALYSES/METHODS

Sediment samples from intertidal and subtidal areas will be collected during field activities. Intertidal surface sediment samples will be analyzed for the SMS suite of chemicals of concern (except for pesticides, metals and polychlorinated biphenyls [PCBs]) and conventional parameters (grain size, total organic carbon [TOC], total solids). Additionally, total petroleum hydrocarbons (TPH) will be analyzed in selected surface samples. Intertidal subsurface samples will be analyzed for bioaccumulative contaminants of concern for the Site, including carcinogenic polycyclic aromatic hydrocarbons (cPAHs), dioxin/furans and chlorinated phenols (specifically pentachlorophenol). Selected subsurface samples will be analyzed for TPH. Subtidal surface sediment will be analyzed for dioxins/furans, cPAHs, grain size and TOC. Analytes and analytical methods are listed below and summarized in Table 1 of the Work Plan.

- Dioxins/furans (17 congeners) [EPA Method 1613 Modified (low level)];

- TOC (Standard Method 5310B or SW-846 Method 9060 [see Bragdon-Cook 2002 for clarification on use])
- Total solids (Standard Method 2540G)
- Grain size (PSEP 1997)
- Semi-volatile organic compounds (SVOCs), analyzed by US Environmental Protection Agency (EPA) Methods 8270D and 8270-SIM;
- Polycyclic aromatic hydrocarbons (PAHs) by EPA Methods 8270-SIM;
- Chlorinated phenols by EPA Method 8041;
- TPH (Northwest Total Petroleum Hydrocarbons – Diesel Extended [NWTPH-Dx] with and without silica gel cleanup);

3.1. Sample Preservation, Container, and Holding Times

Samples subject to laboratory analyses will be prepared, containerized, and preserved in the field according to the guidelines described above and those detailed in Table B-1. Samples will be kept on ice in coolers while at the site. The samples will be preserved and hand-delivered by the GeoEngineers' field representative to the laboratory. In cases where hand-delivery is not possible (inclement weather, after-hours sampling, etc.), the samples will be kept at 4°C until the next day. The samples will remain in a safe, refrigerated state upon delivery to the laboratory, and at the laboratory, until analyzed.

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a recommended holding time for analysis only. For many methods, recommended holding times may be extended by sample preservation techniques in the field. If a sample exceeds a recommended holding time, then the results may be biased low. For example, if the extraction holding time for volatile analysis of soil samples is exceeded, then the possibility exists that some of the organic constituents may have volatilized from the sample or degraded. Results for that analysis would be qualified as estimated to indicate that the reported results may be lower than actual site conditions. Recommended holding times are presented in Table B-1.

4.0 DATA QUALITY OBJECTIVES

The quality assurance objectives for technical project data are to collect environmental sampling data of known, acceptable, and documentable quality. The specific objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting to ensure consistency and thoroughness of data generated.
- Achieve the level of QA/QC required to produce scientifically valid analytical data of known and documented quality. This will be accomplished by establishing criteria for data precision, accuracy, representativeness, completeness, and comparability, and by evaluating project data against these criteria.

The sampling design, field procedures, useable laboratory procedures, and QC procedures established for this project were developed to provide defensible data. Specific data quality factors that may affect data usability include quantitative factors (precision, bias, accuracy, completeness, and reporting limits) and

qualitative factors such as representativeness and comparability. The specific DQOs associated with these data quality factors are discussed below. Method-specific DQOs for chemical laboratory analyses are presented in Table B-2.

4.1. Analytical Sensitivity

Analytical methods have qualitative limitations regarding the level at which an analyte can be theoretically detected with a given statistical level of confidence that are often expressed as the method detection limit (MDL). These same methods also have quantitative thresholds at which an analyte can be quantified that are typically represented by the lowest point of a 5-to-7 point calibration curve (linear, response factors, (1/a) weighted, etc.) that is conducted prior to field sample analysis. In all cases, these latter real-world measurements are always greater (3 to 5 times) than the MDLs and are often expressed as the method reporting limits (MRLs).

When compounds are positively identified (i.e., detected) at concentrations greater than the MDLs, but less than the MRLs the detected concentration is identified as an estimate (i.e., "J" flagged). The contract laboratory will provide numerical results for all analytes that are positively identified and report them as detected above the MRL or detected below the MRL but above the MDL.

Achieving a stated detection limit for a given analyte is helpful in providing statistically useful data. Intended data uses, such as comparison to numerical criteria or risk assessments, typically dictate specific project target reporting limits (RLs) necessary to fulfill stated objectives. The target RLs are presented in Table B-2. These target RLs will serve as the laboratory MRLs for this project. It may be possible to achieve MRLs less than the targets under ideal conditions. However, the target RLs presented in Table B-2 are considered targets because several factors may influence final MRLs. First, moisture and other physical conditions of sediment samples can affect MRLs. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect of this is that other analytes could be reported as not detected, but at a laboratory-adjusted MRL significantly higher than a specified target RL. Data users must be aware that elevated MRLs can bias statistical data summaries, and careful interpretation is required when using data sets with MRLs exceeding targets.

4.2. Precision

Precision is the measurement of reproducibility among duplicate measurements of an analyte from the same sample and applies to split samples (from lab or field), replicate analyses of the same sample, and duplicate spiked environmental samples (matrix spike duplicates). The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision is expressed as the relative percent difference (RPD) of spike sample and field split sample comparisons of various matrices. The RPD is calculated as:

Where

$$RPD\,(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} X\ 100,$$

D_1 = Concentration of analyte in primary sample.

D_2 = Concentration of analyte in the split sample/aliquot.

The RPD will be calculated for samples and compared to the project RPD QC control limits. The RPD QC control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the MRL. For results less than 5 times the MRL, the difference between the primary and duplicate samples should be less than 2 times the MRL for sediment samples.

4.3. Accuracy and Bias

Accuracy is a measure of bias in the analytical process. The closer the measurement value is to the true value, the greater the accuracy. Accuracy is typically evaluated by adding a known concentration (a "spike") of a target or surrogate compound to a sample prior to analysis. The detected concentration or percent recovery (%R) of the spiked compound reported in the sample provides a quantitative measure of analytical accuracy. Since most environmental data collected represent single points spatially and temporally rather than an average, accuracy is generally more important than precision in assessing the data. In general, if %R values are low, non-detect results may be reported for compounds of interest when in fact these compounds are present (i.e., false negative results), and results for detected compounds may be biased low. The reverse is true when %R values are high. In this case, non-detect values are considered accurate, whereas detected values may be higher than true values.

For this project, accuracy will be expressed as the %R of a known surrogate spike, matrix spike, or laboratory control sample (blank spike) concentration:

$$Recovery\,(\%R) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentration}\ X\ 100$$

Accuracy (%R) criteria and precision criteria for laboratory control samples (Laboratory Control Samples OR Ongoing Precision and Recovery Samples) are presented in Table B-2.

4.4. Representativeness, Completeness, and Comparability

Representativeness expresses the degree to which data accurately and precisely represent the actual site conditions. Representativeness of the data will be evaluated by:

- Comparing actual sampling procedures to those specified in this QAPP.
- Reviewing analytical results for field duplicates (i.e., second sample collected from the same parent sample) to determine the precision in the analytical results.
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative in nature. Only representative data will be used in subsequent data reduction, validation, and reporting activities.

Completeness establishes whether a sufficient number of valid measurements were obtained to meet project objectives. The number of samples and results expected establishes the comparative basis for completeness. The completeness goal is 90 percent useable data for the samples/analyses planned. If the completeness goal is not achieved, an evaluation will be performed to determine if the data are adequate to meet study objectives. The following equation is used to calculate completeness:

% Completeness =Number of valid results x 100/Number of possible results

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, the following items are evaluated when assessing data comparability:

- Whether two data sets or batches contain the same set of parameters.
- Whether the units used for each data set are convertible to a common metric scale.
- Whether similar analytical procedures and quality assurance were used to collect data for both data sets.
- Whether the analytical instruments used for both data sets have approximately similar detection levels.
- Whether samples within data sets were selected and collected in a similar manner.

A statement on comparability will be prepared to assess overall usefulness of data sets generated during the project, following the evaluation of precision and accuracy.

5.0 QUALITY CONTROL SAMPLES AND PROCEDURES

QC samples will be analyzed to ensure the precision, accuracy, representativeness, comparability, and completeness of the data. Table B-3 summarizes the types and frequency of QC samples to be analyzed during the investigation, including both field QC and laboratory QC samples.

5.1. Field Quality Control Samples

Field QC samples serve as a control and check mechanism to monitor the consistency of sampling methods and potential influence of off-site factors on environmental samples. Examples of potential off-site factors include airborne VOCs and potable water used in drilling activities. As shown in Table B-3, field QC samples will consist of field duplicates. Description of this type of QC sample are provided in the following subsections.

5.1.1. Field Duplicates

Field duplicates serve as measures for precision. They are created by placing aliquots of a homogenized sample in separate containers, and identifying one of the aliquots as the primary or parent sample and the other as the duplicate sample. Field duplicates measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sample processing techniques used by field personnel and/or the relative homogeneity of sample matrices. The duplicate sample is submitted to gain precision information on sample homogeneity, handling, shipping, storage and preparation, and analysis. Field duplicates will be analyzed for the same parameters as the associated primary samples.

One field duplicate will be collected for every 20 sediment samples (i.e., a frequency of 5 percent).

5.1.2. Other QC Samples

According to the *National Functional Guidelines for Organic Data Review* (EPA 2008), "The purpose of laboratory (or field) blank analysis is to assess the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples….." Field blanks will be used at the discretion of the QA Leader if there is a reason to suspect

contamination introduced by ambient conditions in the field. Field blanks are samples of distilled water poured directly into sample containers in the field. Field blanks are analyzed for the same parameters as the associated project samples.

Analytical results for QC blanks will be interpreted in general accordance with EPA's *National Functional Guidelines for Organic and Inorganic Data Review* and professional judgment.

5.2. Chemical Laboratory Quality Control

The analytical laboratories will follow standard analytical method procedures that include specified QC monitoring requirements. These requirements will vary by method, but generally include:

- Method blanks;
- Internal standards;
- Instrument calibrations;
- Matrix spikes/matrix spike duplicates (MS/MSDs);
- Laboratory control samples/laboratory control sample duplicates (LCS/LCSDs);
- Laboratory replicates or duplicates; and
- Surrogate spikes.

5.2.1. Laboratory Blanks

Laboratory procedures employ the use of several types of blanks but the most commonly used blanks for QA/QC assessments are method blanks. Method blanks are laboratory QC samples that consist of either a soil-like material that has undergone a contaminant destruction process, or a sample of reagent water. Method blanks are extracted and analyzed with each batch of environmental samples undergoing analysis. Method blanks are particularly useful during volatiles analysis since VOCs can be transported in the laboratory through the vapor phase. If a substance is found in the method blank, it indicates that one (or more) of the following occurred:

- Measurement apparatus or containers were not properly cleaned and contained contaminants.
- Reagents used in the analytical process were contaminated with a substance(s) of interest.
- Contaminated analytical equipment was not properly cleaned.
- Volatile substances in the air with high solubility or affinities toward the sample matrix contaminated the samples during preparation or analysis.

It is difficult to determine which of the above scenarios took place if method blank contamination occurs. However, it is assumed that the conditions that affected the blanks also likely affected the project samples. If method blank contamination occurs, validation guidelines assist in determining which substances detected in associated project samples are likely truly present in the samples and which ones are likely attributable to the analytical process.

5.2.2. Matrix Spike/Matrix Spike Duplicates

MS/MSDs are used to assess influences or interferences caused by the physical or chemical properties of the sample itself. For example, extreme pH can affect the results of SVOC analyses. Or, the presence of a particular analyte in a sample may interfere with accurate quantitation of another analyte. MS/MSD data are reviewed in combination with other QC monitoring data to evaluate matrix effects. In some cases, matrix effects cannot be determined due to dilution and/or high levels of related substances in the sample. An MS is created by spiking a known amount of one or more of the target analytes into a project sample, ideally at a concentration at least 5 to 10 times higher than the concentration in the unspiked sample. Percent recovery value is calculated by subtracting the unspiked sample result from the spiked sample result, dividing by the spike amount, and multiplying by 100.

The samples designated for MS/MSD analysis should be obtained from a sampling location that is suspected to not be highly contaminated. A sample from an area of low-level contamination is needed because the objective of MS/MSD analyses is to assess possible matrix interferences, which can best be achieved with low levels of contaminants. For the supplemental investigation, additional sample volume will be collected for MS/MSD analysis for every 20 primary sediment samples, or as determined as necessary by the analytical laboratory.

5.2.3. Laboratory Control Spikes/ Laboratory Control Spike Duplicates

Also known as blank spikes, laboratory control spikes (LCS) and laboratory control spike duplicates (LCSDs) are similar to MS/MSD samples in that a known amount of one or more of the target analytes is spiked into a prepared medium and the percent recovery is calculated for the spiked substance(s). The primary difference between an MS and LCS is that the LCS spike medium is considered “clean” or contaminant-free. For example, reagent water is typically used for LCS water analyses. The purpose of an LCS is to help assess the overall accuracy and precision of the analytical process including sample preparation, instrument performance, and analyst performance. LCS data must be reviewed in context with other laboratory QC data to determine if corrective action is necessary for laboratory control limit exceedances.

5.2.4. Laboratory Replicates/Duplicates

Laboratories often utilize MS/MSDs, LCS/LCSDs, and/or laboratory replicates to assess precision. Replicates are a second analysis of a field-collected environmental sample. Replicates can be split at varying stages of the sample preparation and analysis process, but most commonly consist of a second analysis on the extracted media.

5.2.5. Surrogate Spikes

Surrogate spikes are used to verify the accuracy of the analytical instrument and extraction procedures used. Surrogates are substances similar to the target analytes. A known concentration of surrogate is added to each project sample and passed through the instrument, noting the surrogate recovery. Each surrogate used has an acceptable range of percent recovery. If a surrogate recovery is low, sample results may be biased low, and, depending on the percent recovery, a possibility of false negatives may exist. Conversely, when surrogate recoveries are above the specified range of acceptance, a possibility of false positives exists, although non-detected results are considered accurate.

5.3. Calibration Procedures

5.3.1. Field Instrumentation

Field instrument calibration and calibration checks facilitate accurate and reliable field measurements. The calibration of the instruments will be checked and adjusted as necessary in general accordance with manufacturers' recommendations. Methods and frequency of calibration checks and instrument maintenance will be based on the type of instrument, stability characteristics, required accuracy, intended use, and environmental conditions. The basic calibration check frequencies are described below.

5.3.2. Laboratory Instrumentation

Several types of instrument calibrations are used, depending on the method, to determine whether the methodology is 'in control' by verifying the linearity of the calibration curve and to assure that the sample results reflect accurate and precise measurements. This is done by verifying that the percent relative standard deviations (%RSD) and/or the correlation coefficients are within the control limits specified in the validation documents. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification.

For chemical analytical testing, calibration procedures and their appropriate chemical standards are to comply with the specific methods within EPA SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, 3rd Edition, December 1996 and the laboratory's Standard Operating Procedures (SOPs). Calibration documentation will be retained at the laboratory for a minimum period of 6 months.

5.4. Bioassay Laboratory Quality Control

Sediment toxicity tests will incorporate standard QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls, reference sediment samples, lab replicates, and measurements of water quality during testing. All biological testing will be in strict compliance with standard protocols established by ASTM and EPA. In addition, tests will be conducted under full spectrum lighting as directed by Ecology for sites impacted by PAHs per SCUM II guidance (Ecology 2015). General biological testing procedures and specific procedures for each sediment bioassay are summarized in the following sections.

5.4.1. Negative Controls

Negative control sediment is used in bioassays to check laboratory performance. Negative control sediment are clean sediments in which the test organism normally lives and which are expected to produce low mortality, and thus are collected from the organism collection site for the bioassay.

In the amphipod and juvenile polychaete bioassay tests, control mortality over the exposure period should be less than or equal to 10 percent. This represents a generally accepted level of mortality of test organisms under control conditions, where the bioassay (in terms of test organism health) is still considered a valid measure of effects of the test treatments. If control mortality is greater than 10 percent, the bioassay test will generally have to be repeated. The control must also achieve a mean growth rate of 0.38 mg/individual/day in the juvenile polychaete bioassay. Determination for repeating these tests will be in consultation with the QA Leader (Field Procedures Appendix). For the sediment larval test, the performance standard for the seawater negative control combined endpoint (mortality + abnormality) is 30 percent or less.

5.4.2. Reference Sediment

Bioassay reference sediment that closely matches the grain-size characteristics (represented as percent fines) of the field sediment samples will be used for test comparison and interpretations. The reference sediment will be used to account for physical effects of the test sediment. The collection area will be determined based on sample physical characteristics and in coordination with the QA Leader. The reference sample will be analyzed for total solids, TOC and grain size.

The wet-sieving protocol will be used in the location of the appropriate reference station. Wet-sieving will be conducted using a 63-micron (number 230) sieve and graduated cylinder; 100 mL (milliliters) of sediment is placed in the sieve and washed until the water runs clear. The volume of sand and gravel remaining is then washed into the graduated cylinder and measured as the coarse fraction. The percent fines are determined by subtracting the coarse fraction from 100.

5.4.3. Replication

Five laboratory replicates of test sediment, reference sediment, and negative controls will be run for each marine water bioassay (per ASTM and EPA guidance).

5.4.4. Positive Controls

A positive control will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and provide an indication of the sensitivity of the particular organisms used in a bioassay.

5.4.5. Water Quality Monitoring

Water quality monitoring will be conducted for the amphipod, larval, and juvenile polychaete bioassays and reference toxicant tests. This consists of daily measurements in each test replicate of salinity, temperature, pH, and dissolved oxygen (DO) for the amphipod and larval tests. These measurements will be made every three days for the juvenile polychaete bioassay, with the exception of DO, which will be measured daily. Ammonia and sulfides in the overlying water will be determined at test initiation and termination for all three tests. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls).

5.4.6. Interpretation

Test interpretation consists of endpoint comparisons of test sediments to the measurements observed in the controls and in reference sediments on an absolute percentage basis, as well as statistical comparison between the test and reference endpoints, where appropriate. Test interpretation will follow SMS requirements. The QA Leader will be contacted immediately in the event that the control or references don't meet performance standards.

5.4.7. Bioassay Retest

Any bioassay retests will be fully coordinated with the QA Leader.

5.4.8. Data Deliverables

The bioassay laboratory for this study will be required to report results that include all information recommended by PSEP protocols for quality assurance review, as follows:

- A description of any deviations from the methodology or problems with the process and procedures of analyses.
- Test methods used for bioassay testing and statistical analyses.

- Results for survival, growth, reburial, abnormalities, water quality parameters, reference toxicant, and statistical analyses. A reference toxicant control chart will be submitted for each test organism showing the temporal changes in the mean and the 95 percent confidence interval or positive and negative 2 standard deviations and include the LC_{50}s at each of 12 previous reference toxicant tests to be acceptable.
- Original data sheets for water quality, survival, growth, reburial, abnormalities, reference toxicant, and statistics.

6.0 LABORATORY DATA REPORTING AND DELIVERABLES

Laboratories will report data in formatted hardcopy and electronic form to the Project Manager and QA Leader. Upon completion of analyses, the laboratory will prepare electronic deliverables for data packages in accordance with the specifications in the agreed-upon *Special Conditions for Lab Analysis (rev 05162014)* document. The laboratory will provide electronic data deliverables (EDDs) within 2 business days after GeoEngineers' receipt of printed-copy analytical results, including the appropriate QC documentation. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the client/field sample identification, the laboratory sample identification, reporting units, analytical methods, analytes tested, analytical results, extraction and analysis dates, quantitation limits, and data qualifiers. Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues.

GeoEngineers will establish EDD requirements with the contract laboratories, as part of subcontracting.

7.0 DATA REDUCTION AND ASSESSMENT PROCEDURES

This section describes the process for generating and checking data, as well as the process for producing reports for field and analytical laboratory data.

7.1. Data Reduction

Data reduction involves the conversion or transcription of field and analytical data to a useable format. The laboratory personnel will reduce the analytical data for review by the QA Leader and Task Manager. This will involve both hard-copy forms and EDDs. Both forms of data will be compared with each other to verify that the data are reliable and error-free.

7.2. Review of Field Documentation and Laboratory Receipt Information

Documentation of field sampling data will be reviewed periodically for conformance with project QC requirements described in this QAPP. At a minimum, field documentation will be checked for proper documentation of the following:

- Sample collection information (date, time, location, matrices, etc.);
- Field instruments used and calibration data;
- Sample collection protocol;
- Sample containers, preservation, and volume;
- Field QC samples collected at the frequency specified;

- Chain-of-custody protocols; and
- Sample shipment information.

Sample receipt forms provided by the laboratories will be reviewed for QC exceptions. The final laboratory data package will describe (in the case narrative) the effects that any identified QC exceptions have on data quality. The laboratories will review transcribed sample collection and receipt information for correctness prior to delivering the final data package.

7.3. Chemical Data Verification/Validation

Project decisions, conclusions, and recommendations will be based upon verified (validated) data. The purpose of data verification is to ensure that data used for subsequent evaluations and calculations are scientifically valid, of known and documented quality, and legally defensible. Field data verification will be used to eliminate data not collected or documented in accordance with the protocols specified in the SAP. Laboratory data verification will be used to eliminate data not obtained using prescribed laboratory procedures.

The QA Leader will validate data collected during the supplemental investigation to ensure that the data are valid and usable. Data will be validated in general conformance with EPA functional guidelines for data validation (EPA, 2004, 2005, and 2008). At a minimum, the following items will be reviewed to verify the data as applicable:

- Documentation that a final review of the data was completed by the Laboratory QA Coordinator;
- Documentation of analytical and QC methodology;
- Documentation of sample preservation and transport;
- Sample receipt forms and case narratives; and
- The following QC parameters:
  - Holding times and sample preservation
  - Method blanks
  - MS/MSDs
  - LCS/LCSDs
  - Surrogate spikes
  - Duplicates/replicates

When sample analytical data are received from the analytical laboratory, they will undergo a QC review by the QA Leader. The accuracy and precision achieved will be compared to the laboratory's analytical control limits. Example control limits are presented in Table 1. Calculations of RPDs will follow standard statistical conventions and formulas as presented in Section 2.0. Additional specifications and professional judgment by the QA Leader may be incorporated when appropriate data from specific matrices and field samples are available.

A data quality assessment will be prepared to document the overall quality of the data relative to the DQOs. The major components of the data quality assessment are as follows:

- **Data Validation Summary.** Summarizes the data validation results for all sample delivery groups by analytical method. The summary identifies any systematic problems, data generation trends, general conditions of the data, and reasons for any data qualification.
- **QC Sample Evaluation.** Evaluates the results of QC sample analyses, and presents conclusions based on these results regarding the validity of the project data.
- **Assessment of DQOs.** An assessment of the quality of data measured and generated in terms of accuracy, precision, and completeness relative to objectives established for the project.
- **Summary of Data Usability.** Summarizes the usability of data, based on the assessment performed in the three preceding steps.

The data quality assessment will help to achieve an acceptable level of confidence in the decisions that are to be made based upon the project data. The project analytical data will be submitted to Ecology's EIM system after the data quality assessment is completed.

8.0 REFERENCES

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Table B-1

Test Methods, Sample Containers, Preservation and Holding Times

R.G. Haley Site

Bellingham, Washington

Analysis	Method [1]	Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]
Dioxins/furans	EPA 1613 Modified	100 g	8 oz. WM Amber Glass with Teflon™-lined lid	Freeze -18°C	1 year until extraction
Total organic carbon (TOC)	Plumb 1981 (if TOC above 2%); Standard Method 5310B or SW846 Method 9060 (if TOC below 2%)	25 g	8 oz. WM Glass with Teflon™-lined lid	Cool 0 to 6ºC or Freeze -18°C	14 days (fresh sample) or 6 months (frozen)
Total solids	Standard Method 2540G	25 g	8 oz. WM Glass with Teflon™-lined lid (share jar with TOC)	Cool 0 to 6ºC or Freeze -18°C	14 days (fresh sample) or 6 months (frozen)
Grain size	PSEP 1997	300 g	16 oz. HDPE or Ziploc™ bag	Cool 0 to 6°C	6 months
Semi-volatile organic compounds (SVOCs)	EPA 8270 and EPA 8270-SIM (Low Level)	150 g	2 x 8 oz. or a 16 oz. WM Glass with Teflon™-lined lid	Cool 0 to 6ºC or Freeze -18°C	14 days to extraction, 1 year if frozen, 40 days from extraction to analysis
Polycyclic aromatic hydrocarbons (PAHs)	EPA (8270-SIM) low level	30 g	2 x 8 oz. or a 16 oz. WM Glass with Teflon™-lined lid (share jar with SVOC)	Cool 0 to 6ºC or Freeze -18°C	14 days to extraction, 1 year if frozen, 40 days from extraction to analysis
Chlorinated phenols	EPA 8041	150 g	2 x 8 oz. or a 16 oz. WM Glass with Teflon™-lined lid (share jar with SVOC)	Cool 0 to 6ºC or Freeze -18°C	14 days to extraction, 1 year if frozen, 40 days from extraction to analysis
Diesel- and heavy oil-range petroleum	Ecology NWTPH-Dx with acid/silica gel cleanup	25 g	8 oz. WM Glass with Teflon™-lined lid	Cool 0 to 6°C	14 days to extraction

Analysis	Method [1]	Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]
Bioassays	PSEP 1995[3]	8 L	5 x 1L WM Glass or Polyethylene	Cool, 0 to 4°C, nitrogen atmosphere	8 weeks
Ammonia	EPA Method 350.1 Modified	20 g	4 oz. WM Glass with Teflon-lined lid	Cool 0 to 6°C	7 days to extraction, 48 hours to analysis (28 days with preservative) to analysis
Total sulfides	PSEP 1986	20 g	4 oz. WM Glass with Teflon-lined lid (no headspace)	Cool 0 to 6ºC, 1N Zinc Acetate	7 days
Total volatile solids	PSEP 1986	20 g	4 oz. WM Glass with Teflon™-lined lid (no headspace)	Cool 0 to 6ºC	14 days

Notes:

[1]Target practical quantitation limits are listed in QAPP Table B-2.

[2]Holding times are based on elapsed time from date of sample collection.

[3]Benthic PAH toxicity will be evaluated with exposure to ultraviolet (UV) light according to the SCUM II 2015 Appendix C.

g = gram

HDPE = high density polyethylene

L = liter

oz. = ounce

PSEP = Puget Sound Estuary Program

SVOCs = semivolatile organic compounds

WM = wide mouth

Table B-2

Target Reporting Limits (RLs) and Quality Control Limits for Sediment Samples

R.G. Haley Site

Bellingham, Washington

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]	Target EDL/MDL[5]	LCS/LCSD or OPR Sample Quality Control Limits	
				RPD	% R
Petroleum Hydrocarbons (mg/kg)					
Diesel-range hydrocarbons	--	10	--	0-30	50-150
Heavy oil-range hydrocarbons	--	10	--	0-30	50-150
Total TPH	200 [4]	50	--	NA	NA
Total LPAHs (µg/kg)					
Total LPAH	5,200	140	--	NA	NA
Naphthalene	2,100	20	--	0-30	27 - 107
Acenaphthylene	1,300	20	--	0-30	26 - 102
Acenaphthene	500	20	--	0-30	31 - 100
Fluorene	540	20	--	0-30	33 - 106
Phenanthrene	1,500	20	--	0-30	38 - 108
Anthracene	960	20	--	0-30	30 - 117
2-Methylnaphthalene	670	20	--	0-30	38 - 108
Total HPAHs (µg/kg)					
Total HPAH	12,000	240	--	NA	NA
Fluoranthene	1,700	20	--	0-30	43 - 119
Pyrene	2,600	20	--	0-30	36 - 122
Benzo(a)anthracene	1,300	20	--	0-30	36 - 125
Chrysene	1,400	20	--	0-30	42 - 115
Total benzofluoranthenes	3,200	40	--	0-30	42 - 124
Benzo(a)pyrene	1,600	20	--	0-30	33 - 122
Indeno(1,2,3-c,d)pyrene	600	20	--	0-30	29 - 126
Dibenzo(a,h)anthracene	230	20	--	0-30	30 - 128
Benzo(g,h,i)perylene	670	20	--	0-30	27 - 107
Carcinogentic PAHs (µg/kg)					
cPAHs	86	20	--	NA	NA
Chlorinated Hydrocarbons (µg/kg)					
1,2-Dichlorobenzene	35	5	--	0-30	36 - 100
1,3-Dichlorobenzene	170	5	--	0-30	33 - 100
1,4-Dichlorobenzene	110	5	--	0-30	34 - 100
1,2,4-Trichlorobenzene	31	5	--	0-30	34 - 100
Hexachlorobenzene	22	5	--	0-30	34 - 100
Phthalates (µg/kg)					
Dimethyl phthalate	71	20	--	0-30	46 - 103
Diethyl phthalate	200	50	--	0-30	44 - 108
Di-n-butyl phthalate	1,400	20	--	0-30	47 - 115
Butyl benzyl phthalate	63	20	--	0-30	35 - 122
Bis(2-ethylhexyl) phthalate	1,300	25	--	0-30	48 - 124
Di-n-octyl phthalate	6,200	20	--	0-30	49 - 107

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]	Target EDL/MDL[5]	LCS/LCSD or OPR Sample Quality Control Limits	
				RPD	% R
Miscellaneous Extractables (µg/kg)					
Dibenzofuran	540	20	--		
Hexachlorobutadiene	11	5	--	0-30	33 - 100
N-Nitrosodiphenylamine	28	20	--	0-30	27 - 162
Benzyl alcohol	57	20	--	0-30	10 - 100
Benzoic acid	650	400	--		
Phenols (µg/kg)					
Phenol	420	20	--	0-30	41 - 100
2-Methylphenol	63	20	--	0-30	37 - 100
4-Methylphenol	670	40	--	0-30	37 - 100
2,4-Dimethylphenol	29	20	--	0-30	34 - 100
Pentachlorophenol	360	200	--	0-30	10 - 162
Dioxins and Furans (ng/kg)					
2,3,7,8-TCDD	--	0.5	0.0184	N/A	67 - 158
1,2,3,7,8-PeCDD	--	2.5	0.0275	N/A	70 - 142
1,2,3,4,7,8-HxCDD	--	2.5	0.0314	N/A	70 - 164
1,2,3,6,7,8-HxCDD	--	2.5	0.0335	N/A	70 - 134
1,2,3,7,8,9-HxCDD	--	2.5	0.0296	N/A	64 - 162
1,2,3,4,6,7,8-HpCDD	--	2.5	0.0492	N/A	70 - 140
OCDD	--	5	0.136	N/A	78 -144
2,3,7,8-TCDF	--	0.5	0.0211	N/A	75 - 158
1,2,3,7,8-PeCDF	--	2.5	0.0235	N/A	80 -134
2,3,4,7,8-PeCDF	--	2.5	0.0247	N/A	68 - 160
1,2,3,4,7,8-HxCDF	--	2.5	0.0251	N/A	72 - 134
1,2,3,6,7,8-HxCDF	--	2.5	0.0235	N/A	84 - 130
1,2,3,7,8,9-HxCDF	--	2.5	0.032	N/A	78 - 130
2,3,4,6,7,8-HxCDF	--	2.5	0.0271	N/A	70 -156
1,2,3,4,6,7,8-HpCDF	--	2.5	0.028	N/A	82 -122
1,2,3,4,7,8,9-HpCDF	--	2.5	0.0359	N/A	78 - 138
OCDF	--	5	0.0531	N/A	63 -170

Notes:

[1] Screening criteria are Sediment Management Standards (SMS) Lowest Apparent Effects Threshold (LAET) unless otherwise noted.

[2] Target PQLs and RLs obtained from Analytical Resources, Inc. of Tukwila, Washington.

[3] The laboratory analytical reports for dioxin/furan analyses will report the Effective Detection Limit (EDL) in addition to the target RL. The EDL is generally an order of magnitude less than the RL. However, the EDL is compound- and sample-specific and therefore, will vary. The EDL will be used as the limit of detection for evaluating dioxin/furan concentrations.

[4] Numerical criteria for sediment do not currently exist for petroleum hydrocarbons under SMS. A screening level for petroleum hydrocarbons of 200 mg/kg was used by Ecology to screen petroleum hydrocarbon results collected as part of a study in Bellingham Bay performed by Hart Crowser in 2009. The petroleum hydrocarbon screening level used by Ecology (i.e., 200 mg/kg) is being used in this study.

[5] Target MDLs are used for only for High Resolution/Mass Spectometry analyses.

HPAHs = High molecular weight polycyclic aromatic hydrocarbons

LPAHs = Low molecular weight polycyclic aromatic hydrocarbons

µg/kg = micrograms per kilogram

mg/kg = milligrams per kilogram

ng/kg = nanograms per kilogram

PQL = Practical quantitation limit

RPD = relative percent difference

RL = Reporting limit

TPH = Total petroleum hydrocarbons

%R = percent recovery

-- No screening criteria available

Table B-3

Field and Laboratory Quality Control Samples for Chemical Testing
Type and Minimum Frequency

R.G. Haley Site

Bellingham, Washington

Parameter	Field QC Samples		Laboratory QC Samples			
	Field Duplicates	Equipment Rinsate Blanks	Method Blanks	LCS or OPR	MS/MSD	Lab Duplicates
Dioxins/Furans	1 per 10 sediment samples	1 per 20 sediment samples (1 per day minimum)	1 per batch*	1 per batch*	NA	NA
Semi-volatile organic compounds			1 per batch*	1 per batch*	1 per batch*	NA
Metals			1 per batch*	1 per batch*	1 per batch*	1 per batch*
Diesel- and heavy oil-range with acid/silica gel cleanup			1 per batch*	1 per batch*	1 per batch*	NA
Ammonia			1 per batch*	1 per batch*	1 per batch*	1 per batch*
Sulfides			1 per batch*	NA	NA	1 per batch*

Notes:

*An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and MS/MSD (or MS and lab duplicate). No more than 20 field samples are contained in one batch.

LCS = Laboratory control sample

MS = Matrix spike

MSD = Matrix spike duplicate

NA = Not applicable

OPR = Ongoing precision and recovery

Table B-4

Biological Toxicity Test and Performance Standards[1]

R.G. Haley Site

Bellingham, Washington

Test Species	Holding Times	Test Procedures					Control Samples			Control Performance Standards	Reference Performance Standards
		Dissolved Oxygen (mg/L)	Temp (°C)	Salinity (ppt)	pH	Total Ammonia Acceptable Range (mg/L)	Negative Control	Positive Control	Reference Sediment		
10-Day Adult Amphipod Mortality Test (Acute Toxicity)											
Rhepoxynius abronius[2]	≤8 weeks (56 days)	>5.1	15±1	28±1	7 - 9	40.8 - 232.6	Clean sediment	Reference toxicant in seawater	Yes	Control ≤ 10% mortality (SMS)	Control ≤ 25% mortality (SMS) (relative to Control)
Sediment Bivalve or Echinoderm Larval Test (Acute Toxicity)											
Crassostrea gigas[3]	≤8 weeks (56 days)	>5.0	20±1	28±1	7 - 9	0.41 - 10.2	Clean seawater	Reference toxicant in seawater	Yes	Control normal survival ≥ 70%	Reference normal survival relative to control ≥ 65%
20-Day Juvenile Polychaete Growth Test (Chronic Toxicity)											
Neanthes arenaceodentata	≤8 weeks (56 days)	>4.6	20±1	28±2	7 - 9	56.9 - 240.5	Clean sediment	Reference toxicant	Yes	Control ≤ 10% mortality Mean growth rate ≥ 0.72 mg/ind/day Minimum growth rate ≥ 0.38 mg/ind/day	Mortality ≤ 20% $MIG_{Reference}/MIG_{Control} \geq 80\%$

Notes:

[1]Test methods follow PSEP 1995, including any SMARM updates, and SCUM II 2015 and performance standards follow WAC 173-204-315(2).

[2]Test species are selected based on interstitial salinity and grain size; salinity greater than 25 parts per thousand and grain size less than 60% fines are anticipated for intertidal/nearshore locations proposed for sampling.

[3]Test species vary by time of year and are selected based on available stock and condition. Test species may include the mussel *Mytilus edulis*, the oyster *Crassostrea gigas*, the urchins *Strongylocentrotus purpuratus* or *S. droebachiensis* or the sand dollar *Dendraster excentricus*. Typically, oyster larvae are used for late summer/fall testing.

L = liter

MIG = mean individual growth

mg = milligram

mg/ind/day = milligram per individual per day

ppt = parts per thousand

SMS = Sediment Management Standards

APPENDIX C
Site Health and Safety Plan

Have we delivered World Class Client Service?

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