DRAFT FINAL

ECOLOGY TOXICS CLEANUP PROGRAM
EPA BROWNFIELDS PROGRAM

QUALITY ASSURANCE PROJECT PLAN

Little Squalicum Park
Remedial Investigation/Feasibility Study
Bellingham, WA

Prepared for

City of Bellingham
Parks & Recreation Department
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Bellingham, WA 98225

Prepared by

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SECTION A: PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN
LITTLE SQUALICUM PARK
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
BELLINGHAM, WASHINGTON

Quality Assurance Project Plan Approvals

Ecology Project Coordinator:	Mary O'Herron		Date:	
EPA Project Coordinator:	Ravi Sanga		Date:	
EPA QA Manager:	Ginna Grepo-Grove		Date:	
City of Bellingham Project Mgr:	Tim Wahl		Date:	
Integral Project Manager:	Mark Herrenkohl		Date:	
Integral Project QA Manager:	Maja Tritt		Date:	
ARI Project Manager:	Sue Dunnihoo		Date:	
ARI QA Manager:	Dave Mitchell		Date:	
STL Project Manager:	Jill Kellmann		Date:	
STL QA Manager:	Pam Schemmer		Date:	
NAS Project Manager:	Gerald Irissarri		Date:	
NAS QA Manager:	Linda Nemeth		Date:	

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
ARI	Analytical Resources Inc.
BTC	Bellingham Technical College
CFR	Code of Federal Regulations
COC	chain-of-custody
Creek	Little Squalicum Creek
CVAA	cold vapor atomic absorption spectrometry
DQO	data quality objective
DRO	diesel-range organic hydrocarbons
EDD	electronic data deliverable
EIM	electronic information management
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon screen
EQuIS™	Environmental Quality Information System
FCR	field correction record
FID	flame ionization detector
GC	gas chromatography
GC/ECD	electron capture detector
GC/MS	gas chromatography with mass spectrometry
GPC	gel permeation chromatography
GRO	gasoline-range organic hydrocarbons
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high density polyethylene
HRGC/HRMS	high-resolution gas chromatography with high-resolution mass spectrometry
ICP/MS	inductively coupled plasma/mass spectrometry
ICP/OES	inductively coupled plasma-optical emission spectrometry
LCS	laboratory control sample
LIMS	laboratory information management system
mg/kg	milligrams per kilogram
µg/kg	micrograms per kilogram
MQO	measurement quality objective
MDL	method detection limit
MRL	method reporting limit
MTCA	Model Toxic Control Act
NAS	Northwest Aquatics Sciences, Inc.
NWTPH	Northwest total petroleum hydrocarbons
PARCC	precision, accuracy or bias, representativeness, completeness, and comparability
Park	Little Squalicum Park

PCB	polychlorinated biphenyl
PID	photo-ionization detector
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RPD	relative percent difference
SAP	sampling and analysis plan
SMS	Sediment Management Standards
SOP	standard operating procedure
STL	Severn Trent Laboratories, Inc.
SVOCs	semivolatile organic compounds
TOC	total organic carbon
TSS	total suspended solids
WISHA	Washington Industrial Safety and Health Act
WMG	wide mouth glass

A3 DISTRIBUTION LIST

Ecology Project Coordinator:	Mary O'Herron
EPA Project Coordinator:	Ravi Sanga
EPA QA Manager:	Ginna Grepo-Grove
City of Bellingham Project Manager:	Tim Wahl
Integral Project Manager:	Mark Herrenkohl
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STL QA Manager:	Pam Schemmer
NAS Project Manager:	Gerald Irissarri
NAS QA Manager:	Linda Nemeth

A4 INTRODUCTION AND PROJECT AND TASK ORGANIZATION

This quality assurance project plan (QAPP) describes quality assurance/quality control (QA/QC) procedures that will be used to complete a remedial investigation/feasibility study (RI/FS) for the Little Squalicum Park (the Park) site located in Bellingham, Washington. This QAPP has been prepared in accordance with EPA guidance for the preparation of QAPPs (USEPA 2002a).

The Park consists of 32 acres located within the Birchwood Neighborhood and lies adjacent to Bellingham Technical College (BTC) and the junction of Marine Drive, Eldridge Avenue and Lindbergh Avenue. Little Squalicum Creek (the Creek) flows through the middle of the park and discharges into Bellingham Bay. The field effort will include collection of surface water, surface sediment, and sediment borings from the Creek. Soil and groundwater samples will also be collected at selected stations within the park boundaries as part of this characterization. Samples from each media will be analyzed for conventional parameters (e.g., total organic carbon, hardness), physical tests (e.g., grain size), heavy metals, petroleum hydrocarbons, semivolatile organic compounds (SVOCs), and dioxins/furans. Selected soil samples will also be analyzed for chlorinated pesticides and PCB Aroclors. Selected surface sediment samples may also be evaluated for toxicity using a suite of freshwater bioassay tests. Details are provided in the *Sampling and Analysis Plan* (SAP) which accompanies this document.

Integral Consulting Inc. (Integral) is conducting this work under contract to the City of Bellingham, Parks and Recreation Department (City), with direction from both the Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency, Region 10 Brownfields program (EPA). The organizational structure for this project is illustrated in Figure A-1. Contact information is provided in Table A-1. Project and quality assurance responsibilities are described in detail in Section 4 of the accompanying Work Plan. Responsibilities are included for the following project roles:

- Project managers for Ecology, EPA, the City of Bellingham, Integral, and subcontractor laboratories
- Quality assurance managers for EPA, Integral, and the laboratories
- Task managers for the field effort and subcontractors supporting the sample collection effort.

A5 PROBLEM DEFINITION AND BACKGROUND

The Whatcom County Health and Human Services completed a site hazard assessment (SHA) of the Park site in February 2004, as required under the Model Toxics Control Act (MTCA). The site's hazard ranking, an estimation of the potential threat to human health and/or the environment relative to other Washington State sites assessed at that time, was determined to be a 1, where 1 represents the highest relative risk and 5 the lowest

(Ecology 2004). Based on the results of the SHA, Ecology has determined that a RI/FS should be developed pursuant to WAC 173-340-350 and WAC 173-204-560 for the Park site. Ecology has negotiated an *Agreed Order* (dated March 22, 2005) with the City to conduct an RI/FS on the Park site. The RI/FS is intended to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup action alternative for the site.

The primary objective of the Park RI/FS is to provide critical data necessary to understand the nature and magnitude of environmental problems at the site, to determine if cleanup actions are required, and to determine how these actions may be accomplished as part of specific wildlife enhancement and park development actions. This objective will be met by sampling surface water, groundwater, soil and sediments and evaluating the results in concert with other existing data. A complete list of the project objectives are presented in the Work Plan.

Several historical studies of the Park have been completed, as described in Section 3.0 of the SAP. The overall sampling strategy for the Park is to place a greater density of sampling locations in areas for which little or no historical data are available and to limit the analyte list in well-studied areas by applying a tiered sampling and testing approach. An adequate volume of sample will be archived to allow analysis of all analytes for a given medium (including toxicity testing), if necessary. Section 4 of the SAP presents the sampling design and rationale for a tiered approach to complete the Park RI field and testing investigation.

A6 TASK DESCRIPTION

The tasks to be completed for this project include fieldwork, laboratory analyses, data quality evaluation, data management, data analysis, and report preparation. Tasks that will be completed in the field, including related documentation and QA/QC activities, are described in detail in Section 5.0 of the SAP. The following activities are addressed in the SAP:

- Horizontal and vertical control methods
- Sampling equipment and methods
- Sample identification
- Sample processing methods
- Documentation of sample information and field activities
- Sample handling and shipping procedures
- Chain-of-custody (COC) procedures
- Decontamination procedures
- Handling and disposal of investigation-derived wastes.

Integral will collect surface water, groundwater, soil, and sediment and prepare samples for delivery to the laboratories. Eron Dodak or Susan Fitzgerald of Integral will serve as Field Coordinator and will assume custody of samples as they are collected. A list of samples and analyses is provided in Table A-2. Sample locations are provided in Figures 4-1 through 4-4 of the SAP.

Samples will be analyzed by Analytical Resources, Inc. (ARI) of Tukwila, Washington for the following:

- Conventional parameters [total sulfides, ammonia, total solids, total organic carbon (TOC), total suspended solids (TSS), and hardness];
- Physical parameters (grain size, Atterberg limits, specific gravity, and moisture content/bulk density);
- Northwest total petroleum hydrocarbons (NWTPH) – diesel-range organic hydrocarbons (DRO) and gasoline-range organic hydrocarbons (GRO), volatile petroleum hydrocarbon screen (VPH), and extractable petroleum hydrocarbon screen (EPH);
- Total metals;
- SVOCs; and
- Chlorinated pesticides and PCB Aroclors.

ARI will subcontract the dioxins/furans analysis to Severn Trent Laboratories' (STL) facility located in Sacramento, California. A complete analyte list is provided in Tables A-3 through A-6. Analyses will be completed using EPA and Puget Sound Estuary Program (PSEP) methods (USEPA 2005, PSEP 1986, 1997a,b), as indicated in Table A-7. Full laboratory data reports will be provided in hard copy and electronic data deliverables (EDDs) will be provided in spreadsheet format as required for importing into the database. The Environmental Quality Information System (EQuIS™) database application will be used to manage the field and laboratory data. Data will also be submitted electronically to Ecology and EPA in SEDQUAL and EIM formats as required.

Bioassays will be conducted to determine whether anthropogenic contaminants of concern are present at concentrations which are toxic to biota. Biological testing will be conducted on selected sediment samples collected in the Creek based on the chemistry results (tiered sampling approach). The following freshwater sediment toxicity bioassays (2 acute and 1 chronic tests) will be conducted on each selected sample:

- 10-day Amphipod (*Hyalella azteca*)
- Microtox® Sediment Porewater (*Vibrio fischeri*)
- 20-day Midge Larvae (*Chironomus tentans*).

Northwest Aquatics Sciences, Inc. (NAS) of Newport, Oregon, an accredited laboratory by Ecology, will conduct the bioassay testing for this project.[1]

Data verification will be completed by Integral for data generated in the field and by ARI, STL, and NAS for data generated at the laboratories. The completeness of the final database will be verified by Integral. Data validation and data quality assessment will be completed by an independent validation firm, which will be selected at a later date. The validation firm will also complete data verification (i.e., verifying that analytical procedures and calculations were completed correctly and checking transcriptions of the laboratory data) for the first data package for each analysis as part of the full validation that will be completed for these packages. The validation firm will also verify the accuracy of the laboratory EDDs.

The start date for field sampling will be determined following Ecology and EPA approval of the project Work Plans. Currently, it is anticipated that field sampling will begin in October 2005. Sample analysis and data validation are each expected to require 4 to 6 weeks for completion, for a total of 8 to 12 weeks from the time analysis is authorized until finalization of the database. The field and reporting schedules are discussed further in Section 3.3 of the Work Plan.

Samples for conventional analyses, geotechnical, and bioassay testing will be stored under refrigeration (4±2° C). Bioassay samples will also be stored in the dark with sediment bottles either purged with nitrogen gas or with no headspace. Samples for analysis of metals and organic compounds will be stored under refrigeration for immediate analyses, and frozen (-20° C) when initiation of analysis will be delayed or samples archived. Samples will be analyzed or archived according to criteria described in Section 4 of the SAP.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Although data have been collected at the study site during previous investigations, data gaps were identified during a review of existing data (refer to SAP). These data gaps described in Section 3.8 of the SAP will be addressed in this study. A tiered sampling design will be used for the sampling. The sampling design is described in Section 4.0 of the SAP.

Data Quality Objectives (DQOs) were developed for the Park RI/FS using EPA's DQO process (USEPA 2000a) to describe data and data quality needs for the project. Data quality indicators such as the PARCC parameters (i.e., precision, accuracy or bias, representativeness, completeness, comparability) (USEPA 2002a) and analytical sensitivity will be used to assess conformance of data with quality control criteria. DQOs and quality control criteria are described in this section.

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[1] Microtox testing will be subcontracted to CH_2M Hill in Corvallis, Oregon, an Ecology accredited lab.

A7.1 The Data Quality Objective Process

As part of the development of the sampling strategy, data needs were evaluated for assessing chemical distributions and developing remedial alternatives for the Park soil and sediments. The seven-step DQO process (USEPA 2000a) was used to identify the adequacy of existing data and the need for additional data, to develop the overall approach to each study element, and ultimately to develop the field sampling plan. The DQO processes for the various aspects of the site characterization are provided in 3 of the SAP.

Reporting limits for this study should ideally be below the screening benchmarks selected for each analyte and sample type. Selection of screening benchmark levels for soil, groundwater, surface water and pore water, and sediment are provided in Section 3.5 of the SAP. Although method reporting limits (MRLs) are below screening levels for most of the analytes, MRLs are above the screening levels in several cases. Screening levels and MRLs for the various sample types are provided in Tables A-3 through A-6. Analytical sensitivity is discussed further in the following section.

A7.2 Data Quality Indicators

The overall DQO for this project is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality. The QA procedures and measurements that will be used for this project are based on EPA, Ecology, and PSEP guidance (USEPA 2002a, 2005; Ecology 1997, 2003; PSEP 1986, 1997a,b). PARCC parameters are commonly used to assess the quality of environmental data. Measurement quality objectives (MQOs) for the quantitative PARCC parameters, bias, precision, and completeness, are provided in Table A-8.

Bias represents the degree to which a measured concentration conforms to the reference value. The results for matrix spikes, laboratory control samples, field blanks, and method blanks will be reviewed to evaluate bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

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

$\%R$ = percent recovery
M = measured concentration in the spiked sample
U = measured concentration in the unspiked sample
C = concentration of the added spike

The following calculation is used to determine percent recovery for a laboratory control sample or reference material:

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

%R = percent recovery
M = measured concentration in the reference material
C = established reference concentration

Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Any analytes detected in field or method blanks will be evaluated as potential indicators of bias.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of matrix spike duplicates, laboratory duplicates, field splits, and field replicates. Precision is expressed in terms of the relative standard deviation for three or more measurements and the relative percent difference (RPD) for two measurements. The following equation is used to calculate the RPD between measurements:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

C_1 = first measurement
C_2 = second measurement
RPD = relative percent difference

The relative standard deviation is the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage.

Completeness will be calculated as the ratio of usable data (i.e., unqualified data and J-qualified data) to requested data, expressed as a percentage.

Additional laboratory QC procedures will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects.

QC samples and procedures are specified in each method protocol (Table A-7). All QC requirements will be completed by the laboratories as described in the protocols, including the following (as applicable to each analysis):

- Instrument tuning
- Initial calibration

- Initial calibration verification
- Continuing calibration
- Calibration or instrument blanks
- Method blanks
- Laboratory control samples
- Internal standards
- Surrogate spikes
- Serial dilutions
- Matrix spikes
- Matrix spike duplicates or laboratory duplicates.

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet control limits. Laboratory control limits for the methods that will be used for this site investigation are provided in Appendix K of ARI's quality assurance plan (Attachment 1 of this QAPP) and, for STL, in Attachment 2 of this QAPP. Data validation criteria and procedures are described in Sections D1 and D2 of this QAPP.

MRLs reflect the sensitivity of the analysis. The methods and modifications selected for this study will incorporate modifications recommended by PSEP (1997a,b) to optimize MRLs. Target MRLs for this study are summarized in Tables A-3 through A-6. Method modifications are described in Section B4.

Method detection limits (MDLs) have been determined by ARI and STL for each analyte, as required by EPA (2003). MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix with 99 percent confidence that a false positive result has not been reported. ARI and STL have established MRLs at levels above the MDLs for the project analytes. These values are based on the laboratories' experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system. The concentration of the lowest standard in the initial calibration curve for each analysis is at the level of the MRL. This allows reliable quantification of concentrations to the MRL. Analyte concentrations for this site investigation will be reported to the MDL. Analytes detected at concentrations between the MRL and the MDL will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MRL. The MRL will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference. For dioxin analyses, STL will determine and report sample-specific detection limits as described in EPA method 1613B.

Representativeness and comparability are qualitative QA/QC parameters. Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design, by the selection of sampling sites and sample collection procedures. In the laboratory, representativeness will be ensured by the proper handling and storage of samples and initiation of analysis within holding times.

Comparability is the qualitative similarity of one data set to another (i.e., the extent to which different data sets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by EPA and PSEP and are commonly used for sediment studies.

The overall quality objective for the toxicity testing is to produce data that meet EPA's and Ecology's acceptability criteria for the 10-day acute *H. azteca*, the Microtox® sediment porewater (*V. fischeri*), and the 20-day chronic *C. tentans* sediment toxicity tests. The toxicity data will be generated to address the objectives listed in Section B1. Acceptance criteria for the bioassay testing methods that will be used for this site investigation are summarized in Section IX of NAS's quality assurance plan (Attachment 3 of this QAPP). Details are provided in each toxicity test method protocol (USEPA 2000b, Ecology 2003).

A8 SPECIAL TRAINING/CERTIFICATION

The City has assembled a project team with the requisite experience and technical skills to successfully complete the RI/FS for the Park. All consultant team personnel involved in sample collection have extensive environmental sampling experience. Minimum training and certification requirements for laboratory personnel are described in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. In response to this requirement, the U.S. Occupational Safety and Health Administration developed regulation 29 CFR§1910.120, the "Hazardous Waste Operations and Emergency Response" standard (HAZWOPER). This standard includes requirements for workers engaged in hazardous waste operations to complete a 40-hour training course and annual 8-hour refresher courses. The training provides employees with knowledge and skills that enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary. Training is also consistent with the requirements of the Washington Industrial Safety and Health Act (WISHA). Documentation of course completion will be maintained in personnel files.

A9 DOCUMENTS AND RECORDS

Records will be maintained documenting all activities and data related to field sampling, chemical, and biological analysis at the laboratories. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section. The components of field documentation are discussed in Sections 5.5 and 5.6 of the SAP.

The SAP, QAPP, and the health and safety plan (HASP), will be provided to every project participant listed in Section A3. Any revisions or amendments to any of the documents that comprise the SAP will also be provided to these individuals.

A9.1 Field Documentation

The Integral project manager will ensure that the field team receives the final approved version of the SAP (including the HASP and this QAPP) prior to the initiation of field activities. Field records that will be maintained include:

- Field log books
- Photo documentation
- Boring and test pit logs
- Field data and sample collection information forms
- Field change request forms (as needed)
- Sample tracking/chain of custody forms.

The content and use of these documents are described in Section 5.6 of the SAP.

A9.2 Laboratory Documentation

All activities and results related to sample analysis will be documented at each laboratory. Internal laboratory documentation procedures are described in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

<u>The chemistry laboratories</u> will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program package. It will contain all information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from standard operating procedures (SOPs) and this QAPP
- Chain-of-custody and cooler receipt forms

- A summary of analyte concentrations (to two significant figures, unless otherwise justified), method reporting limits, and method detection limits
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, extraction, dilution, and cleanup logs
- Instrument tuning data
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including surrogate spikes, internal standards, laboratory control samples (LCSs), matrix spike samples, matrix spike duplicate samples, and laboratory duplicate or triplicate samples
- Original data quantification reports for all analyses and samples
- All laboratory worksheets and standards preparation logs.

The biological testing laboratory will be responsible for internal checks on sample handling and toxicity data reporting and will correct errors. The laboratory data package will include the following:

- A cover letter or case narrative that identifies the procedures used and discusses any problems encountered and any deviations from the referenced test method, SOPs, and this QAPP
- Chain-of-custody and cooler receipt forms
- A description of the source and composition of water used for the tests
- Detailed information about the test organisms, including source and acclimation or culture conditions
- A description of the experimental design and test chambers
- Data related to water quality measurements and any aeration that may have been required
- Definition of the effect criteria and any other observations
- Responses in the control treatment
- Tabulation and statistical analysis of measured responses
- A description of statistical methods used

- Results associated with the reference toxicant tests.
- Photocopies of all the raw data generated by the laboratory.

Data will be delivered in both hardcopy and electronic format to the Integral laboratory coordinator, who will be responsible for oversight of data verification and validation and for archiving the final data and data quality reports in the project file. Electronic data deliverables will be compatible with Integral's EQuIS™ database.

A9.3 Data Quality Documentation

The first data package generated for each chemical analysis type will be fully validated.[2] If no problems are encountered, validation for the remaining data will be based on review of the summary forms for sample and QC data. Based on the total number of samples to be collected for this investigation (Table A-2), it is anticipated that approximately 25 percent (a minimum of 20 percent) of the data will be fully validated. Data validation reports will be prepared by the contracted validation firm and provided to the Integral laboratory coordinator.

The biological testing laboratory will perform the first data reduction by calculating average survival and biomass for each test sediment and the negative controls. An internal review of the data will be performed by the NAS QA/QC officer. For the external review process the laboratory will provide both the reduced and raw data. The data will be generated in a form amenable to review and evaluation. The raw (replicate) and reduced data will be reviewed and validated by Integral staff.

Results of the validation reports will be summarized in the RI report. Any limitations to the usability of the data will also be discussed in this report.

All database entries provided by the laboratories will be verified against the validated hard-copy data in the data package. All changes to the database will be recorded in the database change log. Any data tables prepared from the database for data users will include all qualifiers that were applied by the laboratories and during data validation.

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[2] A copy of the first data package that is fully validated will be provided to the EPA QA managers upon receipt from the laboratory.

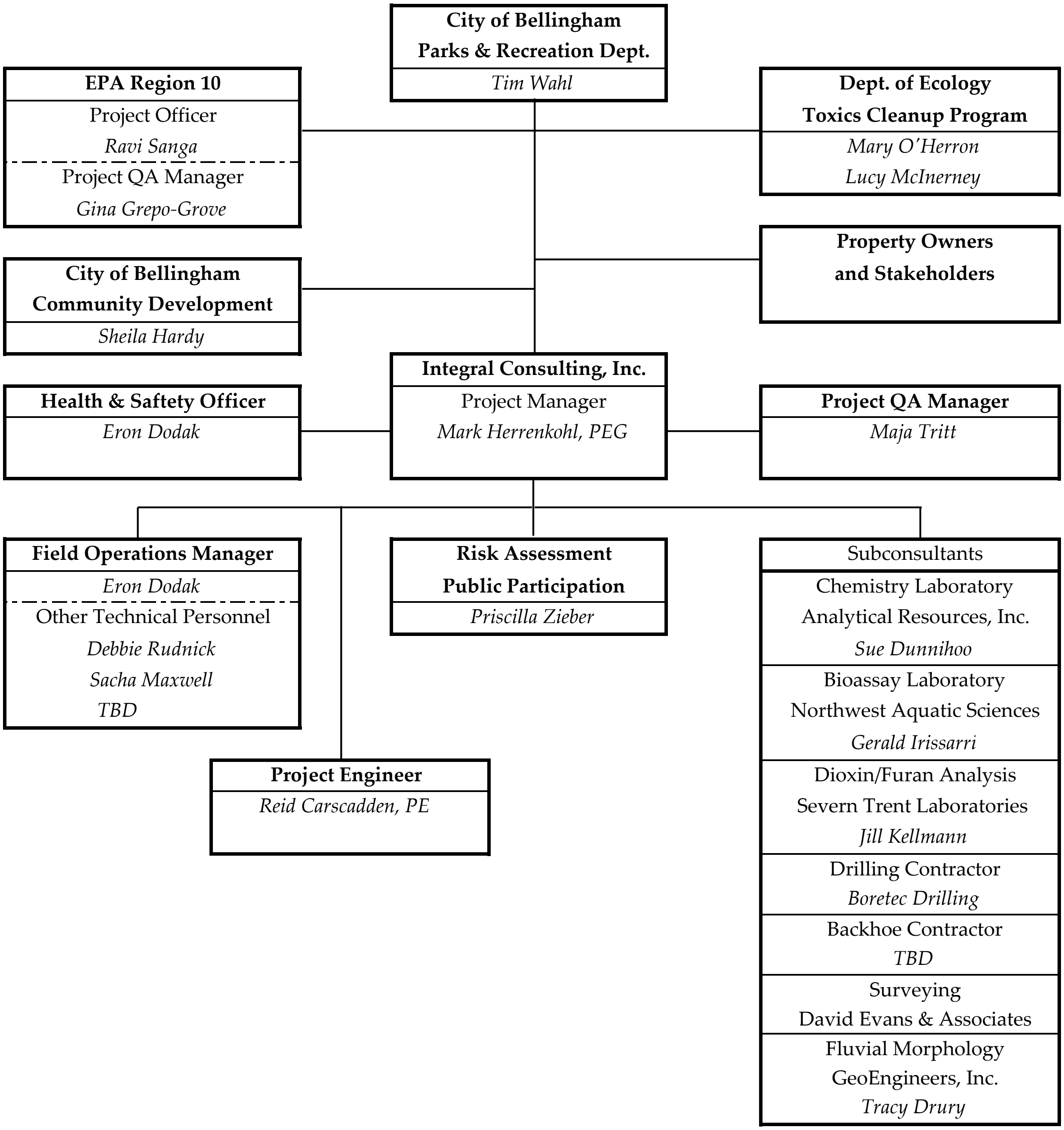

Figure A-1. Program Organization Structure

Table A-1. Project Team Contact Information.

Name	Project Role	Phone	Fax	Email
City of Bellingham				
Tim Wahl	Project Manager	360-676-6985	360-647-6367	twahl@cob.org
Sheila Hardy	Planning & Community Development	360-676-6880	360-738-7431	shardy@cob.org
EPA Region 10				
Ravi Sanga	Project Coordinator	206-553-4092	206-553-0124	Sanga.Ravi@epamail.epa.gov
Ginna Grepo-Grove	Quality Assurance Manager	206-553-1632	206-553-8210	Grepo-Grove.Gina@epamail.epa.gov
Department of Ecology				
Mary O'Herron	Ecology Project Coordinator	360-738-6246	360-738-6253	mohe461@ecy.wa.gov
Lucy McInerney	Toxics Cleanup Program	425-649-7272	na	lpeb461@ecy.wa.gov
Common Consultants				
Mark Herrenkohl (Integral)	Project Manager	360-756-9296 x10	360-756-9296	mherrenkohl@integral-corp.com
Maja Tritt (Integral)	Project QA Coordinator	206-230-9600 x21	206-230-9601	mtritt@integral-corp.com
Eron Dodak (Integral)	Heealth & Safety Officer	503-284-5545 x14	503-284-5755	edodak@integral-corp.com
Susan FitzGerald (Integral)	Field Manager	206-230-9600 x18	206-230-9601	sfitzgerald@integral-corp.com
Priscilla Zieber (Integral)	Risk Assessment/Public Participation	425-820-1739		pzieber@integral-corp.com
Reid Carscadden (Integral)	Project Engineer	206-230-9600 x29	206-230-9601	rcarscadden@integral-corp.com
Chemical Laboratories				
Sue Dunnihoo (Analytical Resources, Inc.)	Laboratory Project Manager	206-695-6207	206-695-6201	sued@arilabs.com
Dave Mitchell (Analytical Resources, Inc.)	Laboratory QA Manager	206-695-6205	206-695-6201	davem@arilabs.com
Jill Kellmann (STL/Sacramento)	Laboratory Project Manager	916-374-4402	916-372-1059	jkellmann@stl-inc.com
Pam Schemmer (STL/Sacramento)	Laboratory QA Manager	916-374-4441	916-372-1059	pschemmer@stl-inc.com
Bioassay Laboratory				
Gerald Irissarri (Northwest Aquatic Service	Laboratory Project Manager	541-265-7225	541-265-2799	girissarri@nwaquatic.com
Linda Nemeth (Northwest Aquatic Services	Laboratory QA Manager	541-265-7225	541-265-2799	lnemeth@intew.net

Table A-2. Summary of Samples and Analyses.

	Number of Samples			
Analysis	**Field Samples**	**Field Replicates[1]**	**Equipment Rinse Blanks[2]**	**Total**
Soil Samples				
TOC	21	2	2	25
Metals	21	2	2	25
NWTPH-Gx	5	1	1	7
VPH[3]	≤5	≤1	0	≤6
NWTPH-Dx	21	2	2	25
EPH[4]	≤21	≤2	0	≤23
Physical testing	33	2	0	35
Pesticides	7	1	1	9
PCB Aroclors	7	1	1	9
SVOCs[5]	≤21	≤2	≤2	≤25
Dioxins/Furans	≤21	≤2	≤2	≤25
Archive (total)	65	0	0	65
Groundwater Samples				
Round 1				
Hardness	4	1	1	6
TSS	4	1	1	6
TOC	4	1	1	6
Metals (unfiltered)	4	1	1	6
Metals (filtered)	4	1	1	6
NWTPH-Gx	4	1	1	6
VPH[3]	≤4	≤1	0	≤5
NWTPH-Dx	4	1	1	6
EPH[4]	≤4	≤1	0	≤5
SVOCs	4	1	1	6
Dioxins/Furans	4	1	1	6
Round 2				
Hardness	4	1	1	6
TSS	4	1	1	6
TOC	4	1	1	6
Metals (unfiltered)	4	1	1	6
Metals (filtered)	4	1	1	6
NWTPH-Gx	4	1	1	6
VPH[3]	≤4	≤1	0	≤5
NWTPH-Dx	4	1	1	6
EPH[4]	≤4	≤1	0	≤5

Table A-2. Summary of Samples and Analyses. (continued)

Analysis	**Number of Samples** **Field Samples**	**Field Replicates**[1]	**Equipment Rinse Blanks**[2]	**Total**
Ground water Samples				
Round 1				
SVOCs	4	1	1	6
Dioxins/Furans	4	1	1	6
Surface Water Samples				
Round 1				
Hardness	7	1	1	9
TSS	7	1	1	9
TOC	7	1	1	9
Metals (unfiltered)	7	1	1	9
NWTPH-Gx	7	1	1	9
VPH[3]	≤7	≤1	0	≤8
NWTPH-Dx	7	1	1	9
EPH[4]	≤7	≤1	0	≤8
SVOCs	7	1	1	9
Dioxins/Furans	3	1	1	5
Round 2				
Hardness	7	1	1	9
TSS	7	1	1	9
TOC	7	1	1	9
Metals (unfiltered)	7	1	1	9
NWTPH-Gx	7	1	1	9
VPH[3]	≤7	≤1	0	≤8
NWTPH-Dx	7	1	1	9
EPH[4]	≤7	≤1	0	≤8
SVOCs	7	1	1	9
Dioxins/Furans	3	1	1	5
Sediment Samples				
Chemical Analysis				
TOC	31	2	2	35
TS, Sulfides, Ammonia	7	1	1	9
Metals	31	2	2	35
NWTPH-Dx	31	2	2	35

Table A-2. Summary of Samples and Analyses. (continued)

	Number of Samples			
Analysis	**Field Samples**	**Field Replicates[1]**	**Equipment Rinse Blanks[2]**	**Total**
Sediment Samples				
Chemical Analysis				
EPH[4]	≤31	≤2	0	≤33
Physical testing	46	3	0	49
SVOCs	≤31	≤2	2	≤35
Dioxins/Furans	≤31	≤2	2	≤35
Archive (total)	127	3	0	130
Toxicity testing[7]				
10-day Amphipod Mortality	≤7	NA	NA	≤7
21-Day Midge Mortality and Growth	≤7	NA	NA	≤7
Pore Water Microtox®	≤7	NA	NA	≤7

Notes:

[1] The collection frequency for field replicates and splits is 5% of natural samples.

[2] A field rinsate blank will be collected once for each sampling method.

[3] VPH analyses will be complete if screening levels are exceeded for TPH-GRO or, at a minimum, 20 percent of total samples will be analyzed.

[4] EPH analyses will be complete if screening levels are exceeded for TPH-DRO or, at a minimum, 20 percent of total samples will be analyzed.

[5] SVOCs will be analyzed for samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples will be analyzed.

[6] Dioxins/Furans will be analyzed in samples with pentachlorophenol concentrations exceeding SL.

[7] Toxicity tests will be completed on samples where concentrations exceed SLs.

Table A-3. Screening Benchmarks and MRLs for Soil Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Dioxins					
1,2,3,4,6,7,8-HpCDD	ng/Kg	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDD	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDD	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,4,6,7,8-HxCDF	ng/Kg	--	NV	50	--
2,3,4,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,7,8-TCDD	ng/Kg	--	NV	10	--
2,3,7,8-TCDF	ng/Kg	--	NV	10	--
OCDD	ng/Kg	--	NV	100	--
OCDF	ng/Kg	--	NV	100	--
Total HpCDD	ng/Kg	--	NV	--	--
Total HpCDF	ng/Kg	--	NV	--	--
Total HxCDD	ng/Kg	--	NV	--	--
Total HxCDF	ng/Kg	--	NV	--	--
Total PeCDD	ng/Kg	--	NV	--	--
Total PeCDF	ng/Kg	--	NV	--	--
Total TCDD	ng/Kg	--	NV	--	--
Total TCDF	ng/Kg	--	NV	--	--
TEQ (ND=0.5 DL)	ng/Kg	site-specific background/Puget Sound Background	49.77/19	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	mg/kg	Ecology SQS	0.38	0.02	--
Acenaphthene	mg/kg	Ecology SQS	0.16	0.02	--
Acenaphthylene	mg/kg	Ecology LAET	0.47	0.02	--
Anthracene	mg/kg	Ecology LAET	1.23	0.02	--
Benzo(a)anthracene	mg/kg	site-specific background/MTCA Method B	0.377/0.137	0.02	--
Benzo(a)pyrene	mg/kg	site-specific background/MTCA Method B	0.455/0.137	0.02	--
Benzo(b)fluoranthene	mg/kg	site-specific background/MTCA Method B	0.663/0.137	0.02	--
Benz[e]acephenanthrylene	mg/kg	MTCA Method B	0.14	0.02	--
Benzo(g,h,i)perylene	mg/kg	site-specific background/Ecology SQS	0.422/0.31	0.02	--
Benzo(k)fluoranthene	mg/kg	site-specific background/MTCA Method B	0.241/0.137	0.02	--
Chrysene	mg/kg	site-specific background/MTCA Method B	0.628/0.137	0.02	--
Dibenzo(a,h)anthracene	mg/kg	site specific background/Ecology SQS	0.376/0.12	0.02	--
Fluoranthene	mg/kg	Ecology SQS	1.6	0.02	--
Fluorene	mg/kg	Ecology SQS	0.23	0.02	--
Indeno(1,2,3-cd)pyrene	mg/kg	site-specific background/MTCA Method B	0.612/0.137	0.02	--
Naphthalene	mg/kg	Ecology LAET	0.53	0.02	--
Phenanthrene	mg/kg	Ecology SQS	1	0.02	--
Pyrene	mg/kg	Ecology LAET	8.79	0.02	--
Other					--
1,2,3-Trichlorobenzene	mg/kg	MTCA TEE soil	20.00	0.02	--
1,2,4-Trichlorobenzene	mg/kg	Ecology SQS	0.81	0.02	--
1,2-Dichlorobenzene	mg/kg	Ecology SQS	0.02	0.02	--
1,3-Dichlorobenzene	mg/kg	MTCA Method B	16.00	0.02	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Other					
1,4-Benzenediamine	mg/kg	MTCA Method B	15200.00	20 (estimated)	--
1,4-Dichlorobenzene	mg/kg	Ecology SQS	0.03	0.02	--
2,4,5-Trichlorophenol	mg/kg	MTCA TEE plant	4.00	0.1	--
2,4,6-Trichlorophenol	mg/kg	EPA Region 9 PRG	0.20	0.1	--
2,4-Dichlorophenol	mg/kg	EPA Region 9 PRG	1.00	0.1	--
2,4-Dimethylphenol	mg/kg	Ecology SQS	0.029	0.02	--
2,4-Dinitrophenol	mg/kg	EPA Region 9 PRG	0.30	0.2	--
2,4-Dinitrotoluene	mg/kg	EPA Region 9 PRG	0.0008	0.1	0.00386
2,6-Dinitrotoluene	mg/kg	EPA Region 9 PRG	0.0007	0.1	0.00666
2-Chloronaphthalene	mg/kg	MTCA Method B	4900.00	0.02	--
2-Chlorophenol	mg/kg	EPA Region 9 PRG	4.00	0.2	--
2-Methylphenol	mg/kg	Ecology SQS	0.063	0.02	--
2-Nitroaniline	mg/kg	MTCA Method B	1.70	0.1	--
3,3'-Dichlorobenzidine	mg/kg	EPA Region 9 PRG	0.007	0.1	0.0236
4-Chloroaniline	mg/kg	EPA Region 9 PRG	0.70	0.1	--
4-Methylphenol	mg/kg	Ecology SQS	0.67	0.02	--
4-Nitrophenol	mg/kg	MTCA TEE soil	7.00	0.1	--
Aniline	mg/kg	MTCA Method B	175.00	0.02	--
Benzidine	mg/kg	MTCA Method B	0.00435	0.2	tbd
Benzoic acid	mg/kg	Site-specific background/Ecology SQS	2.03/0.65	0.2	--
Benzyl alcohol	mg/kg	Ecology SQS	0.057	0.02	--
bis(2-chloroisopropyl)ether	mg/kg	MTCA Method B	3200.00	0.02	--
bis(2-Chloroethyl)ether	mg/kg	EPA Region 9 PRG	0.0004	0.02	0.00599
bis(2-Ethylhexyl)phthalate	mg/kg	Ecology SQS	0.47	0.02	--
Butylbenzylphthalate	mg/kg	Ecology SQS	0.049	0.02	--
Carbazole	mg/kg	EPA Region 9 PRG	0.60	0.02	--
Dibenzofuran	mg/kg	Ecology SQS	0.15	0.02	--
Diethylphthalate	mg/kg	Ecology SQS	0.61	0.02	--
Dimethylphthalate	mg/kg	Ecology LAET	0.311	0.02	--
di-n-Butylphthalate	mg/kg	Ecology LAET	0.1	0.02	--
di-n-Octylphthalate	mg/kg	Ecology LAET	0.01	0.02	0.00392
Hexachlorobenzene	mg/kg	Ecology SQS	0.004	0.2	0.00604
Hexachlorobutadiene	mg/kg	Ecology SQS	0.04	0.02	--
Hexachlorocyclopentadiene	mg/kg	MTCA TEE plant	10.00	0.1	--
Hexachloroethane	mg/kg	EPA Region 9 PRG	0.50	0.02	--
Isophorone	mg/kg	EPA Region 9 PRG	0.50	0.02	--
Nitrobenzene	mg/kg	EPA Region 9 PRG	0.10	0.02	--
n-Nitrosodimethylamine	mg/kg	MTCA Method B	0.0196	0.1	0.0338
n-Nitroso-di-n-propylamine	mg/kg	EPA Region 9 PRG	0.00005	0.1	0.00838
N-nitrosodiphenylamine	mg/kg	Ecology SQS	0.11	0.02	--
Pentachlorophenol	mg/kg	EPA Region 9 PRG	0.03	0.1	0.01925
Phenol	mg/kg	Ecology SQS	0.42	0.02	--
Pyridine	mg/kg	MTCA Method B	80.00	0.1	--
Retene	mg/kg	Ecology LAET	6.02	0.04 (estimated)	--
Tetrachlorophenols	mg/kg	MTCA TEE soil	20	0.1	--
VPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C13 Aromatics	mg/kg	--	NV	5	--
C5-C6 Aliphatics	mg/kg	--	NV	5	--
C6-C8 Aliphatics	mg/kg	--	NV	5	--
C8-C10 Aliphatics	mg/kg	--	NV	5	--
C8-C10 Aromatics	mg/kg	--	NV	5	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
EPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C16 Aliphatics	mg/kg	--	NV	2	--
C12-C16 Aromatics	mg/kg	--	NV	2	--
C16-C18 Aliphatics	mg/kg	--	NV	2	--
C16-C18 Aromatics	mg/kg	--	NV	2	--
C18-C21 Aliphatics	mg/kg	--	NV	2	--
C18-C21 Aromatics	mg/kg	--	NV	2	--
C21-C28 Aliphatics	mg/kg	--	NV	2	--
C21-C28 Aromatics	mg/kg	--	NV	2	--
C28-C36 Aliphatics	mg/kg	--	NV	2	--
C28-C36 Aromatics	mg/kg	--	NV	2	--
Estimated Total EPH+VPH	mg/kg	MTCA TEE soil	200.00	59	--
TPH Screen					
TPH	mg/kg	MTCA TEE soil	200.00	20	--
Pesticides					
4,4'-DDD	ug/kg	MTCA TEE	0.75	2	0.095
4,4'-DDE	ug/kg	MTCA TEE	0.75	2	0.125
4,4'-DDT	ug/kg	MTCA TEE	0.75	2	0.199
Aldrin	ug/kg	MTCA Method B direct contact	0.06	1	0.044
alpha-BHC	ug/kg	MTCA Method B direct contact	0.16	2	0.051
alpha-Chlordane	ug/kg	MTCA TEE	1.00	1	--
beta-BHC	ug/kg	MTCA Method B direct contact	0.56	1	0.091
delta-BHC	ug/kg	MTCA TEE	6.00	1	--
Dieldrin	ug/kg	MTCA Method B direct contact	0.06	2	0.085
Endosulfan I	ug/kg	MTCA Method B direct contact	480.00	1	--
Endosulfan II	ug/kg	MTCA Method B direct contact	480.00	2	--
Endosulfan Sulfate	ug/kg	MTCA Method B direct contact	480.00	2	--
Endrin	ug/kg	MTCA TEE	0.20	2	0.082
Pesticides					
Endrin Aldehyde	ug/kg	MTCA TEE	0.20	2	0.184
Endrin Ketone	ug/kg	MTCA TEE	0.20	2	0.187
gamma-BHC (Lindane)	ug/kg	MTCA Method B direct contact	0.77	2	0.09
gamma-Chlordane	ug/kg	MTCA TEE	1.00	1	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Pesticides					
Heptachlor	ug/kg	MTCA Method B direct contact	0.22	1	0.073
Heptachlor Epoxide	ug/kg	MTCA Method B direct contact	0.11	1	0.054
Methoxychlor	ug/kg	MTCA Method B direct contact	400.00	10	--
Toxaphene	ug/kg	MTCA Method B direct contact	0.91	100	tbd
PCBs					
Aroclor 1016	ug/kg	MTCA Method B direct contact	5.6	33	NV
Aroclor 1221	ug/kg		NV	33	--
Aroclor 1232	ug/kg		NV	33	--
Aroclor 1242	ug/kg		NV	33	--
Aroclor 1248	ug/kg		NV	33	--
Aroclor 1254	ug/kg	MTCA Method B direct contact	1.6	33	NV
Aroclor 1260	ug/kg		NV	33	--
Total PCBs	ug/kg	MTCA TEE	0.65	--	--
Metals					
Arsenic	mg/kg	Sound Background	9.09/7	5	--
Cadmium	mg/kg	Ecology LAET	2.39	0.2	--
Chromium	mg/kg	site-specific background	98.2/83	0.5	--
Copper	mg/kg	MTCA TEE soil	50.00	0.2	--
Lead	mg/kg	MTCA TEE plant	50.00	2	--
Mercury	mg/kg	MTCA TEE soil	0.10	0.05	--
Silver	mg/kg	Ecology LAET	0.545	0.3	--
Zinc	mg/kg	MTCA TEE plant	86.00	0.6	--
Conventionals					
<Sieve 200	percent	--	NV	0.1	--
Sieve 0.25	percent	--	NV	0.1	--
Sieve 0.5	percent	--	NV	0.1	--
Sieve 004	percent	--	NV	0.1	--
Sieve 010	percent	--	NV	0.1	--
Sieve 020	percent	--	NV	0.1	--
Sieve 040	percent	--	NV	0.1	--
Sieve 060	percent	--	NV	0.1	--
Sieve 140	percent	--	NV	0.1	--
Sieve 200	percent	--	NV	0.1	--
TOC	mg/kg	Ecology LAET	98200	100	--

[a] When a "/" is used to separate two values, the first value is for surface soil and the second is for subsurface soil.

[b] Detected COIs will be reported to the MDL with J qualifiers applied below the MRL.

[c] The MDL will be used as the reporting limit for non-detects when the MRL is above the screening benchmark. The MDL is below the screening benchmark for the following analytes: 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 3,3'-Dichlorobenzidine, bis(2-Chloroethyl)ether, Hexachlorobenzene, n-Nitrosodimethylamine, n-Nitroso-di-n-propylamine, and Dieldrin. The MDLs for benzidine and toxaphene are also expected to be greater than the screening benchmark.

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

NV = no value

tbd = to be determined

-- = not applicable

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	pg/L	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	pg/L	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	pg/L	--	NV	50	--
1,2,3,4,7,8-HxCDD	pg/L	--	NV	50	--
1,2,3,4,7,8-HxCDF	pg/L	--	NV	50	--
1,2,3,6,7,8-HxCDD	pg/L	--	NV	50	--
1,2,3,6,7,8-HxCDF	pg/L	--	NV	50	--
1,2,3,7,8,9-HxCDD	pg/L	--	NV	50	--
1,2,3,7,8,9-HxCDF	pg/L	--	NV	50	--
1,2,3,7,8-PeCDD	pg/L	--	NV	50	--
1,2,3,7,8-PeCDF	pg/L	--	NV	50	--
2,3,4,6,7,8-HxCDF	pg/L	--	NV	50	--
2,3,4,7,8-PeCDF	pg/L	--	NV	50	--
2,3,7,8-TCDD	pg/L	EPA Region 5 ESL	0.003	10	--
2,3,7,8-TCDF	pg/L	--	NV	10	--
OCDD	pg/L	--	NV	100	--
OCDF	pg/L	--	NV	100	--
Total HpCDD	pg/L	--	NV	--	--
Total HpCDF	pg/L	--	NV	--	--
Total HxCDD	pg/L	--	NV	--	--
Total HxCDF	pg/L	--	NV	--	--
Total PeCDD	pg/L	--	NV	--	--
Total PeCDF	pg/L	--	NV	--	--
Total TCDD	pg/L	--	NV	--	--
Total TCDF	pg/L	--	NV	--	--
TEQ (ND=0.5 DL)	pg/L	Site-specific background	18.26	--	--
VPH					--
C5-C6 Aliphatics	ug/L	--	NV	50	--
C6-C8 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aromatics	ug/L	Site-specific background	36	50	NV[d]
Methyl tert-Butyl Ether	ug/L	EPA Region 6	11070	5	--
Benzene	ug/L	MTCA GW Method B	0.80	5	--
Ethylbenzene	ug/L	Tier II	7.30	5	--
m&p-Xylene	ug/L	Tier II	13	5	--
o-Xylene	ug/L	Tier II	13	5	--
Toluene	ug/L	Tier II	9.80	5	--
EPH					
C10-C12 Aliphatics	ug/L	Site-specific background	24	40	NV[d]
C10-C12 Aromatics	ug/L	Site-specific background	36	40	NV[d]
C12-C16 Aliphatics	ug/L	Site-specific background	24	40	NV[d]
C12-C16 Aromatics	ug/L	Site-specific background	24	40	NV[d]
C16-C21 Aliphatics	ug/L	--	NV	40	--
C16-C21 Aromatics	ug/L	Site-specific background	47	40	--
C21-C34 Aliphatics	ug/L	--	NV	40	--
C21-C34 Aromatics	ug/L	Site-specific background	47	40	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
SVOCs					
Routine and Detected					
2,4-Dimethylphenol	ug/L	EPA Region 5	100.17	1	--
2-Methylnaphthalene	ug/L	EPA Region 5	329.55	1	--
2-Methylphenol	ug/L	Tier II	13	1	--
Benzoic acid	ug/L	Tier II	42	10	--

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Benzyl alcohol	ug/L	Tier II	8.6	5	--
Dibenzofuran	ug/L	Tier II	3.70	1	--
Diethylphthalate	ug/L	Tier II	210	1	--
di-n-Octylphthalate	ug/L	EPA Region 6	22	1	--
Pentachlorophenol	ug/L	Site-specific background	0.39	5	0.3
Other					
1,2,4-Trichlorobenzene	ug/L	MTCA GW Method B	35	1	--
1,2-Dichlorobenzene	ug/L	Tier II	14	1	--
1,2-Diphenylhydrazine[c]	ug/L	EPA NAWQC	0.036	1	0.395
1,3-Dichlorobenzene	ug/L	Tier II	71	1	--
1,4-Dichlorobenzene	ug/L	MTCA GW Method B	1.82	1	--
1-Methylnaphthalene	ug/L	Tier II	2.1	1	--
2,4,5-Trichlorophenol	ug/L	EPA Region 6	64	5	--
2,4,6-Trichlorophenol	ug/L	EPA NAWQC	1.4	5	0.202
2,4-Dichlorophenol	ug/L	EPA Region 5	11	5	--
2,4-Dinitrophenol	ug/L	EPA Region 5	19	10	--
2,4-Dinitrotoluene	ug/L	EPA NAWQC	0.11	5	--
2,6-Dinitrotoluene	ug/L	MTCA GW Method B	16	5	--
2-Chloronaphthalene	ug/L	EPA Region 5	0.396	1	0.396
2-Chlorophenol	ug/L	EPA Region 5	24	1	--
2-Nitrophenol	ug/L	EPA Region 6	1920	5	--
3,3'-Dichlorobenzidine	ug/L	EPA NAWQC	0.021	5	0.897
4-Bromophenyl-phenylether	ug/L	Tier II	1.5	1	--
4-Methylphenol	ug/L	EPA Region 6	543	1	--
4-Nitrophenol	ug/L	Tier II	300	5	--
7,12-Dimethylbenz(a)anthracen	ug/L	EPA Region 5	0.55	2 (estimated)	NV
Aniline	ug/L	EPA Region 5	4.1	1	--
Benzidine	ug/L	MTCA Method B	0.00032	10	4.22
bis(2-Chloroethyl)ether	ug/L	EPA NAWQC	0.03	1	0.440
bis(2-chloroisopropyl)ether	ug/L	MTCA GW Method B	320	1	--
bis(2-Ethylhexyl)phthalate	ug/L	Site-specific background	16.60	1	--
Butylbenzylphthalate	ug/L	Tier II	19	1	--
Dimethylphthalate	ug/L	EPA Region 6	330	1	--
di-n-Butylphthalate	ug/L	Tier II	35	1	--
di-n-Octylphthalate	ug/L	EPA Region 5	30	1	--
Hexachlorobenzene	ug/L	Region 5	0.0003	1	0.209
Hexachlorobutadiene	ug/L	Region 5	0.053	1	0.540
Hexachlorocyclopentadiene	ug/L	EPA MCL	50	5	--
Hexachloroethane	ug/L	EPA NAWQC	1.4	1	--
Isophorone	ug/L	EPA NAWQC	35	1	--
Nitrobenzene	ug/L	MTCA GW Method B	8	1	--
n-Nitrosodimethylamine	ug/L	EPA NAWQC	0.00069	5	0.245
n-Nitroso-di-n-propylamine	ug/L	EPA NAWQC	0.0005	5	0.410
N-nitrosodiphenylamine	ug/L	EPA NAWQC	3.3	1	--
Phenol	ug/L	EPA Region 5	180	1	--
Pyridine	ug/L	MTCA GW Method B	16	2	--
Tetrachlorophenols	ug/L	EPA Region 5	1.2	10	tbd
Acenaphthene	ug/L	Region 5	38	1	--
Acenaphthylene	ug/L	EPA Region 5	4840	1	--

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit**[a]	**Method Detection Limit**[b]
Anthracene	ug/L	Tier II	0.73	1	0.297
Fluorene	ug/L	Tier II	3.9	1	--
Naphthalene	ug/L	Tier II	12	1	--
Phenanthrene	ug/L	EPA Region 5	3.6	1	--
Benzo(a)anthracene	ug/L	Site-specific background	0.014	1	0.331
Benzo(a)pyrene	ug/L	Site-specific background	0.0076	1	0.303
Benzo(b)fluoranthene	ug/L	Site-specific background	0.015	1	0.252
Benzo(k)fluoranthene	ug/L	MTCA GW Method B	0.01	1	0.475
Benzo(g,h,i)perylene	ug/L	Tier II	7.64	1	--
Chrysene	ug/L	Site-specific background	0.017	1	0.398
Dibenzo(a,h)anthracene	ug/L	EPA NAWQC	0.0038	1	0.219
Fluoranthene	ug/L	EPA Region 5	1.9	1	--
Indeno(1,2,3-cd)pyrene	ug/L	EPA NAWQC	0.0038	1	0.257
Pyrene	ug/L	EPA Region 5	0.3	1	0.341
Petroleum Hydrocarbons					
Diesel	ug/L	--	NV	250	--
Gasoline	ug/L	--	NV	250	--
Motor Oil	ug/L	--	NV	500	--
Metals					
Arsenic	ug/L	Site-specific background	3.5	0.5	--
Cadmium	ug/L	EPA NAWQC	0.25	0.2	--
Calcium	ug/L	--	NV	50	--
Chromium	ug/L	EPA NAWQC	74	0.5	--
Copper	ug/L	Site-specific background	9.7	0.5	--
Lead	ug/L	Site-specific background	2.53	1	--
Magnesium	ug/L	Site-specific background	16200	50	--
Mercury	ug/L	WA State	0.012	0.1	--[e]
Silver	ug/L	Tier II	0.36	0.5	--[e]
Zinc	ug/L	WA State	104.5	4	--
Conventionals					
Hardness	mg/L	--	NV	-	--
TOC	mg/L	--	NV	1.5	--
TSS	mg/L	--	NV	0.1	--

[a] Detected COIs will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the screening benchmark. The MDL is at or below the screening benchmark for the following analytes: anthracene, pentachlorophenol, 2,4,6-Trichlorophenol, 2-Chloronaphthalene, and Pyrene. The MDL for the tetrachlorophenols is also expected to be greater than the screening benchmark.

[c] 1,2-Diphenylhydrazine cannot be separated from azobenzene.

[d] Determination of MDLs is not required for VPH and EPH methodology. However, the methodology is expected to be sufficiently sensitive to allow detection of the hydrocarbon series if the analytes are present at the level of the screening benchmark.

[e] The reporting limits for metals were established by ARI based on their experience with these analyses. The reporting limits for mercury and silver are greater than the screening benchmarks.

NV = no value

tbd = to be determined

-- = not applicable

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	pg/L		NV	50	
1,2,3,4,6,7,8-HpCDF	pg/L		NV	50	
1,2,3,4,7,8,9-HpCDF	pg/L		NV	50	--
1,2,3,4,7,8-HxCDD	pg/L		NV	50	--
1,2,3,4,7,8-HxCDF	pg/L		NV	50	--
1,2,3,6,7,8-HxCDD	pg/L		NV	50	--
1,2,3,6,7,8-HxCDF	pg/L		NV	50	--
1,2,3,7,8,9-HxCDD	pg/L		NV	50	--
1,2,3,7,8,9-HxCDF	pg/L		NV	50	--
1,2,3,7,8-PeCDD	pg/L		NV	50	--
1,2,3,7,8-PeCDF	pg/L		NV	50	--
2,3,4,6,7,8-HxCDF	pg/L		NV	50	--
2,3,4,7,8-PeCDF	pg/L		NV	50	--
2,3,7,8-TCDD	pg/L	Region 5 ESL	0.003	10	--
2,3,7,8-TCDF	pg/L		NV	10	--
OCDD	pg/L		NV	100	--
OCDF	pg/L		NV	100	--
Total HpCDD	pg/L		NV	--	--
Total HpCDF	pg/L		NV	--	--
Total HxCDD	pg/L		NV	--	--
Total HxCDF	pg/L		NV	--	--
Total PeCDD	pg/L		NV	--	--
Total PeCDF	pg/L		NV	--	--
Total TCDD	pg/L		NV	--	--
Total TCDF	pg/L		NV	--	--
TEQ (ND=0.5 DL)	pg/L	Region 5 ESL	0.003	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	ug/L	EPA Region 5 ESL	330	1	--
Acenaphthene	ug/L	EPA Region 5 ESL	38	1	--
Acenaphthylene	ug/L	EPA Region 5 ESL	4840	1	--
Anthracene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.73	1	0.297
Benzo(a)anthracene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.027	1	0.331
Benzo(a)pyrene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.014	1	0.303
Benzo(b)fluoranthene	ug/L	MTCA Method B	2.96E-02	1	0.252
Benzo(k)fluoranthene	ug/L	MTCA Method B	2.96E-02	1	0.475
Benzo(g,h,i)perylene	ug/L	EPA Region 5 ESL	7.64	1	--
Chrysene	ug/L	MTCA Method B	2.96E-02	1	0.398
Dibenzo(a,h)anthracene	ug/L	EPA Region 6	5	1	--
Fluoranthene	ug/L	EPA Region 5 ESL	1.9	1	--
Fluorene	ug/L	Tier II SCV (Suter and Tsao 1996)	3.9	1	--
Indeno(1,2,3-cd)pyrene	ug/L	EPA Region 5 ESL	2.96E-02	1	0.257
Naphthalene	ug/L	Tier II SCV (Suter and Tsao 1996)	12	1	--
Phenanthrene	ug/L	EPA Region 5 ESL	3.6	1	--
Pyrene	ug/L	EPA Region 5 ESL	0.3	1	0.341
Other					
1,2,4-Trichlorobenzene	ug/L	Tier II SCV (Suter and Tsao 1996)	110	1	--
1,2-Dichlorobenzene	ug/L	MTCA Method B	14	1	--
1,2-Diphenylhydrazine[c]	ug/L	MTCA Method B	0.325	1	0.395
1,3-Dichlorobenzene	ug/L	Tier II SCV (Suter and Tsao 1996)	71	1	--
1,4-Dichlorobenzene	ug/L	MTCA Method B	4.86	1	--
2,4,5-Trichlorophenol	ug/L	EPA Region 6	64	1	--

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit[a]**	**Method Detection Limit[b]**
2,4,6-Trichlorophenol	ug/L	EPA Region 5 ESL	4.9	5	0.202
2,4-Dichlorophenol	ug/L	EPA Region 5 ESL	11	5	--
2,4-Dimethylphenol	ug/L	EPA Region 5 ESL	100.17	1	--
2,4-Dinitrophenol	ug/L	EPA Region 5 ESL	19	10	--
2,4-Dinitrotoluene	ug/L	EPA Region 5 ESL	44	5	--
2,6-Dinitrotoluene	ug/L	EPA Region 5 ESL	81	5	--
2-Chloronaphthalene	ug/L	EPA Region 5 ESL	0.396	1	0.433
2-Chlorophenol	ug/L	EPA Region 5 ESL	24	1	--
2-Methylphenol	ug/L	Tier II SCV (Suter and Tsao 1996)	13	1	--
2-Nitrophenol	ug/L	EPA Region 6	1920	5	--
3,3'-Dichlorobenzidine	ug/L	EPA Region 5 ESL	4.5	5	0.897
4-Bromophenyl-phenylether	ug/L	Tier II SCV (Suter and Tsao 1996)	1.5	1	--
4-Chloroaniline	ug/L	EPA Region 5 ESL	231.97	5	--
4-Methylphenol	ug/L	EPA Region 6	543	1	--
4-Nitrophenol	ug/L	Tier II SCV (Suter and Tsao 1996)	300	5	--
Dimethylbenz(a)anthracene	ug/L	EPA Region 5 ESL	0.548	2 (estimated)	NV
Aniline	ug/L	EPA Region 5 ESL	4.1	1	--
Benzidine	ug/L	MTCA Method B	3.22E-04	10	4.22
Benzoic acid	ug/L	Tier II SCV (Suter and Tsao 1996)	42	10	--
Benzyl alcohol	ug/L	Tier II SCV (Suter and Tsao 1996)	8.6	5	--
bis(2-Chloroethyl)ether	ug/L	MTCA Method B	8.54E-01	1	0.440
bis(2-Ethylhexyl)phthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	3	1	--
Butylbenzylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	19	1	--
Dibenzofuran	ug/L	Tier II SCV (Suter and Tsao 1996)	3.7	1	--
Diethylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	210	1	--
Dimethylphthalate	ug/L	EPA Region 5 ESL	73	1	--
di-n-Butylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	35	1	--
di-n-Octylphthalate	ug/L	EPA Region 5 ESL	30	1	--
Hexachlorobenzene	ug/L	EPA Region 5 ESL	0.0003	1	0.209
Hexachlorobutadiene	ug/L	EPA Region 5 ESL	0.053	1	0.540
Hexachlorocyclopentadiene	ug/L	EPA Region 5 ESL	77.04	5	--
Hexachloroethane	ug/L	MTCA Method B	5.33	1	--
Isophorone	ug/L	EPA Region 5 ESL	920	1	--
Nitrobenzene	ug/L	EPA Region 5 ESL	220	1	--
n-Nitrosodimethylamine	ug/L	EPA Region 5 ESL	4.89	5	0.245
n-Nitroso-di-n-propylamine	ug/L	MTCA Method B	0.82	5	0.410
N-nitrosodiphenylamine	ug/L	MTCA Method B	9.73	1	--
Pentachlorophenol	ug/L	MTCA Method B	4.91	5	0.914
Phenol	ug/L	EPA Region 5 ESL	180	1	--
Pyridine	ug/L	EPA Region 5 ESL	2380	0	--
Tetrachlorophenols	ug/L	EPA Region 5 ESL	1.2	10 (estimated)	tbd
Petroleum Hydrocarbons					
Gas-Range	mg/L		NV	0.25	--
Diesel-Range	mg/L		NV	0.5	--
VPH					
C5-C6 Aliphatics	ug/L		NV	50	--
C6-C8 Aliphatics	ug/L		NV	50	--

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes. (continued)

Analyte		Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
	C8-C10 Aliphatics	ug/L		NV	50	--
	C8-C10 Aromatics	ug/L		NV	50	--
EPH						
	C8-C10 Aliphatics	ug/L		NV	50	--
	C10-C12 Aliphatics	ug/L		NV	40	--
	C10-C12 Aromatics	ug/L		NV	40	--
	C12-C16 Aliphatics	ug/L		NV	40	--
	C12-C16 Aromatics	ug/L		NV	40	--
	C16-C21 Aliphatics	ug/L		NV	40	--
	C16-C21 Aromatics	ug/L		NV	40	--
	C21-C34 Aliphatics	ug/L		NV	40	--
	C21-C34 Aromatics	ug/L		NV	40	--
Metals						
	Arsenic	ug/L	MTCA Method B	9.82E-02	0.5	--[e]
	Cadmium	ug/L	CCC (EPA 2002)	0.25	0.2	--
	Calcium		--	NV	50	--
	Chromium	ug/L	CCC (EPA 2002)	74	0.5	--
	Copper	ug/L	CCC (EPA 2002)	9.00	0.5	--
	Lead	ug/L	Ecology (WAC 173-201A-040)	2.50	1	--
	Magnesium	ug/L	EPA Region 6	647	50	--
	Mercury	ug/L	Ecology (WAC 173-201A-040)	0.012	0.1	--[e]
	Silver	ug/L	Tier II SCV (Suter and Tsao 1996)	0.36	0.5	--[e]
	Zinc	ug/L	Ecology (WAC 173-201A-040)	104.50	4	--
Conventionals						
	Hardness	mg/L	--	NV	-	--
	TOC	mg/L	--	NV	1.5	--
	TSS	mg/L	--	NV	0.1	--

[a] Detected COIs will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the screening benchmark. The MDL is below the screening benchmark for the following analytes: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Indeno(1,2,3-cd)pyrene, Pyrene, 1,2-Diphenylhydrazine, 2-Chloronaphthalene, Benzidine, Hexachlorobenzene, and Hexachlorobutadiene. The MDL for the tetrachlorophenols is also expected to be greater than the screening benchmark.

[c] 1,2-Diphenylhydrazine cannot be separated from azobenzene.

[d] Determination of MDLs is not required for VPH and EPH methodology. However, the methodology is expected to be sufficiently sensitive to allow detection of the hydrocarbon series if the analytes are present at the level of the screening benchmark.

[e] The reporting limits for metals were established by ARI based on their experience with these analyses. The reporting limits for arsenic, mercury, and silver are greater than the screening benchmarks.

NV = no value
tbd = to be determined
-- = not applicable

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	ng/Kg	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDD	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDD	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,4,6,7,8-HxCDF	ng/Kg	--	NV	50	--
2,3,4,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,7,8-TCDD	ng/Kg	--	NV	10	--
2,3,7,8-TCDF	ng/Kg	--	NV	10	--
OCDD	ng/Kg	--	NV	100	--
OCDF	ng/Kg	--	NV	100	--
Total HpCDD	ng/Kg	--	NV	--	--
Total HpCDF	ng/Kg	--	NV	--	--
Total HxCDD	ng/Kg	--	NV	--	--
Total HxCDF	ng/Kg	--	NV	--	--
Total PeCDD	ng/Kg	--	NV	--	--
Total PeCDF	ng/Kg	--	NV	--	--
Total TCDD	ng/Kg	--	NV	--	--
Total TCDF	ng/Kg	--	NV	--	--
TEQ (ND=0.5 DL)	ng/Kg	Puget Sound Background	19	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	mg/kg	Ecology SQS	0.38	0.02	--
Acenaphthene	mg/kg	Ecology SQS	0.16	0.02	--
Acenaphthylene	mg/kg	Ecology LAET	0.47	0.02	--
Anthracene	mg/kg	Ecology LAET	1.23	0.02	--
Benzo(a)anthracene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(a)pyrene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(b)fluoranthene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(g,h,i)perylene	mg/kg	Ecology SQS	0.31	0.02	--
Benzo(j)fluoranthene	mg/kg	--	NV	0.02	--
Benzo(k)fluoranthene	mg/kg	MTCA Method B	0.137	0.02	--
Chrysene	mg/kg	MTCA Method B	0.137	0.02	--
Dibenzo(a,h)anthracene	mg/kg	Ecology SQS	0.12	0.02	--
Fluoranthene	mg/kg	Ecology SQS	1.6	0.02	--
Fluorene	mg/kg	Ecology SQS	0.23	0.02	--
Indeno(1,2,3-cd)pyrene	mg/kg	MTCA Method B	0.137	0.02	--
Naphthalene	mg/kg	Ecology LAET	0.529	0.02	--
Phenanthrene	mg/kg	Ecology SQS	1	0.02	--
Pyrene	mg/kg	Ecology LAET	8.79	0.02	--
Other					
1,2,4-Trichlorobenzene	mg/kg	Ecology SQS	0.0081	0.02	0.00626
1,2-Dichlorobenzene	mg/kg	Ecology SQS	0.023	0.02	--
1,2-Diphenylhydrazine	mg/kg	MTCA Method B	1.25	0.02	--
1,3-Dichlorobenzene	mg/kg	MTCA Method B	16	0.02	--

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit**[a]	**Method Detection Limit**[b]
1,4-Dichlorobenzene	mg/kg	Ecology SQS	*0.031*	0.02	--
2,4,5-Trichlorophenol	mg/kg	MTCA TEE plant	4	0.1	--
2,4,6-Trichlorophenol	mg/kg	Region 9 Leaching	0.2	0.1	--
2,4-Dichlorophenol	mg/kg	Region 9 Leaching	1	0.1	--
2,4-Dimethylphenol	mg/kg	Ecology SQS	0.029	0.02	--
2,4-Dinitrophenol	mg/kg	Region 9 Leaching	0.3	0.2	--
2,4-Dinitrotoluene	mg/kg	Region 9 Leaching	0.0008	0.1	0.00386
2,6-Dinitrotoluene	mg/kg	Region 9 Leaching	0.0007	0.1	0.00666
2-Chloronaphthalene	mg/kg	MTCA Method B	4900	0.02	--
2-Chlorophenol	mg/kg	Region 9 Leaching	4	0.2	--
2-Methylphenol	mg/kg	Ecology SQS	0.063	0.02	--
2-Nitroaniline	mg/kg	MTCA Method B	1.7	0.1	--
3&4-Methylphenol	mg/kg	MTCA Method B	310	0.02	--
3,3'-Dichlorobenzidine	mg/kg	Region 9 Leaching	0.007	0.1	0.02362
4-Chloroaniline	mg/kg	Region 9 Leaching	0.7	0.1	--
4-Methylphenol	mg/kg	Ecology SQS	0.67	0.02	--
4-Nitrophenol	mg/kg	MTCA TEE soil	7	0.1	--
Aniline	mg/kg	MTCA Method B	175	0.02	--
Benz[e]acephenanthrylene	mg/kg	MTCA Method B	0.137	0.02	--
Benzidine	mg/kg	MTCA Method B	0.00435	0.2	tbd
Benzoic acid	mg/kg	Ecology SQS	0.65	0.2	--
Benzyl alcohol	mg/kg	Ecology SQS	0.057	0.04	--
bis(2-Chloroethyl)ether	mg/kg	Region 9 Leaching	0.0004	0.02	0.00599
bis(2-chloroisopropyl)ether	mg/kg	MTCA Method B	3200	0.02	--
bis(2-Ethylhexyl)phthalate	mg/kg	Ecology SQS	0.47	0.02	--
Butylbenzylphthalate	mg/kg	Ecology SQS	0.049	0.02	--
Carbazole	mg/kg	Region 9 Leaching	0.6	0.02	--
Dibenzofuran	mg/kg	Ecology SQS	0.15	0.02	--
Diethylphthalate	mg/kg	Ecology SQS	0.61	0.02	--
Dimethylphthalate	mg/kg	Ecology LAET	0.311	0.02	--
di-n-Butylphthalate	mg/kg	Ecology LAET	0.103	0.02	--
di-n-Octylphthalate	mg/kg	Ecology LAET	0.011	0.02	0.00392
Hexachlorobenzene	mg/kg	Ecology LAET	0.004	0.02	0.00604
Hexachlorobutadiene	mg/kg	Ecology LAET	0.039	0.02	--
Hexachlorocyclopentadiene	mg/kg	MTCA TEE plant	10	0.1	--
Hexachloroethane	mg/kg	Region 9 Leaching	0.5	0.02	--
Isophorone	mg/kg	Region 9 Leaching	0.5	0.02	--
Nitrobenzene	mg/kg	Region 9 Leaching	0.1	0.02	--
n-Nitrosodimethylamine	mg/kg	MTCA Method B	0.0196	0.02	0.0338
n-Nitroso-di-n-propylamine	mg/kg	Region 9 Leaching	0.00005	0.1	0.00838
N-nitrosodiphenylamine	mg/kg	Ecology SQS	0.11	0.02	--
Pentachlorophenol[a]	mg/kg	Region 9 Leaching	0.03	0.1	0.01925
Phenol	mg/kg	Ecology SQS	0.42	0.02	--
Pyridine	mg/kg	MTCA Method B	80	0.1	--
Retene	mg/kg	Ecology LAET	6.02	0.04 (estimated)	--
Tetrachlorophenols	mg/kg	MTCA TEE soil	20	0.1	--

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
EPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C16 Aliphatics	mg/kg	--	NV	2	--
C12-C16 Aromatics	mg/kg	--	NV	2	--
C16-C18 Aliphatics	mg/kg	--	NV	2	--
C16-C18 Aromatics	mg/kg	--	NV	2	--
C18-C21 Aliphatics	mg/kg	--	NV	2	--
C18-C21 Aromatics	mg/kg	--	NV	2	--
C21-C28 Aliphatics	mg/kg	--	NV	2	--
C21-C28 Aromatics	mg/kg	--	NV	2	--
C28-C36 Aliphatics	mg/kg	--	NV	2	--
C28-C36 Aromatics	mg/kg	--	NV	2	--
Petroleum Hydrocarbons					
TPH	mg/kg	MTCA TEE soil	200	20	--
Metals					
Arsenic	mg/kg	Puget Sound Bkgd	7	0.2	--
Cadmium	mg/kg	LAET	2.39	0.2	--
Chromium	mg/kg	Puget Sound Bkgd	48	0.5	--
Copper	mg/kg	MTCA TEE soil	50	0.2	--
Lead	mg/kg	MTCA TEE plant	50	2	--
Mercury	mg/kg	MTCA TEE soil	0.1	0.05	--
Silver	mg/kg	LAET	0.545	0.3	--
Zinc	mg/kg	MTCA TEE plant	86	0.6	--
Conventionals			NV		
<Sieve 200	percent	--	NV	0.1	--
Sieve 0.25	percent	--	NV	0.1	--
Sieve 0.5	percent	--	NV	0.1	--
Sieve 004	percent	--	NV	0.1	--
Sieve 010	percent	--	NV	0.1	--
Sieve 020	percent	--	NV	0.1	--
Sieve 040	percent	--	NV	0.1	--
Sieve 060	percent	--	NV	0.1	--
Sieve 140	percent	--	NV	0.1	--
Sieve 200	percent	--	NV	0.1	--
TOC	mg/kg	LAET	98200	100	--

[a] Detected COIs will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the screening benchmark. The MDL is below the screening benchmark for the following analytes: 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 3,3'-Dichlorobenzidine, bis(2-Chloroethyl)ether, Hexachlorobenzene, n-Nitrosodimethylamine, and n-Nitroso-di-n-propylamine. The MDL for benzidine is also expected to be greater than the screening benchmark.

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

NV = no value

tbd = to be determined

-- = not applicable

Table A-7. Laboratory Methods.

Analytes	Laboratory	Sample Preparation		Quantitative Analysis	
		Protocol	Procedure	Protocol	Procedure
Soil and sediment samples					
Conventional Analyses	ARI				
Total sulfides[a]		EPA 376.2	Distillation	EPA 376.2	Colorimetry
Ammonia[a]		EPA 350.1 (Plumb)	KCl extraction	EPA 350.1	Colorimetry
Total organic carbon		Plumb 1981	Acid pretreatment	Plumb 1981	Combustion
Metals	ARI				
Arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc		EPA 3050	Strong acid digestion	EPA SW 6010	ICP
Mercury		EPA 7471A	Acid digestion/oxidation	EPA 7471A	CVAA
Petroleum hydrocarbons	ARI				
Gasoline-range hydrocarbons[b]		NWTPH-Gx	Methanol extraction	NWTPH-Gx	GC/FID
			Purge and trap		
Diesel- and oil-range hydrocarbons		EPA 3545B or 3550B	ASE or Sonication	NWTPH-Dx	GC/FID
			Acid and Silica gel cleanup		
Volatile petroleum hydrocarbons[b]		WDOE VPH	Methanol extraction	WDOE VPH	GC/PID and FID
			Purge and trap		
Extractable petroleum hydrocarbons		WDOE EPH	Sonication	WDOE EPH	GC/FID
			Silica gel fractionation		
Organochlorine pesticides[b]	ARI	EPA 3550B	Sonication	EPA 8081A	Dual column GC/ECD
		EPA 3630C	Silica Gel Cleanup		
		EPA 3660B	Sulfur cleanup		
PCB Aroclors[b]	ARI	EPA 3550B	Sonication	EPA 8082	Dual column GC/ECD
		EPA 3665A	Sulfuric acid cleanup		
		EPA 3630C	Silica Gel Cleanup		
		EPA 3660B	Sulfur cleanup		
Semivolatile organic compounds	ARI	EPA 3550B	Sonication	EPA 8270C	GC/MS
		EPA 3640A	Gel permeation chromatography		

Table A-7. Laboratory Methods. (continued)

Analytes	Laboratory	Sample Preparation		Quantitative Analysis	
		Protocol	Procedure	Protocol	Procedure
Chlorinated dioxins and furans	STL	EPA 1613B	Soxhlet/Dean Stark extraction	EPA 1613B	HRGC/HRMS
			Sulfuric acid cleanup		
			Silica/carbon column cleanup		
Toxicity tests [a]	NAS				
Microtox® test of sediment pore water		Ecology 2003	Pore water extraction	Ecology 2003	*V. fisheri* luminescence
Amphipod 10-day bioassay (*Hyalella azteca*)		Ecology 2003	--	ASTM 2000	10-d mortality
Midge 21-day bioassay (*Chironomus tentans*)		Ecology 2003	--	ASTM 2000	21-d mortality and growth
Geotechnical characteristics	ARI				
Grain Size		NA	--	ASTM-D422-63	Sieve/Hydrometer
Atterberg Limits		NA	--	ASTM-D4318-00	Wet method; moisture determination
Specific Gravity		NA	--	ASTM-D854-02	Water pycnometer
Moisture Content		NA	--	ASTM-D-2216	Gravimetric
Groundwater and surface water samples					
Conventional Analyses	ARI				
Total organic carbon		EPA 415.1	Acid pretreatment	EPA 415.1	Combustion
Total Suspended Solids		EPA 160.2	Filtration and drying	EPA 160.2	Gravimetric
Hardness (Ca, Mg)		--	--	SM 2340B	Calculation
Metals	ARI				
Cadmium, chromium, copper, lead, nickel, silver, zinc		EPA 3005	Acid digestion	EPA 200.8	ICP/MS
Calcium, magnesium		EPA 3005	Acid digestion	EPA 6010B	ICP/OES
Mercury		EPA 7470	Acid digestion/oxidation	EPA 7470	CVAA
Petroleum hydrocarbons	ARI				
Gasoline-range hydrocarbons		NWTPH-Gx	Purge and trap	NWTPH-Gx	GC/FID

Table A-7. Laboratory Methods. (continued)

Analytes	**Laboratory**	**Sample Preparation**		**Quantitative Analysis**	
		Protocol	**Procedure**	**Protocol**	**Procedure**
Diesel- and oil-range hydrocarbons		EPA 3520C	Liquid-Liquid	NWTPH-Dx	GC/FID
Volatile petroleum hydrocarbons		WDOE VPH	Purge and trap	WDOE VPH	GC/PID and FID
Extractable petroleum hydrocarbons		WDOE EPH	Separatory Funnel or Liquid-Liquid	WDOE EPH	GC/FID
			Silica gel fractionation		
Semivolatile Organic Compounds	ARI	EPA 3510C	Separatory Funnel	EPA 8270C	GC/MS
Chlorinated dioxins and furans	STL	EPA 1613B	Extraction	EPA 1613B	HRGC/HRMS
			Sulfuric acid cleanup		
			Silica/carbon column cleanup		

[a] Will be analyzed in sediment samples only.

[b] Will be analyzed in selected soil samples only.

Table A-8. Measurement Quality Objectives.

Analysis	**Bias (percent)**	**Precision (RPD)**	**Completeness (percent)**
Soil and sediment samples			
Conventional analytes	75–125	±35	95
Physical charactersitics	NA	±35	95
Metals	75–125	±35	95
Organic compounds			
Petroleum hydrocarbons	50–150	±50	95
Semivolatile organic compounds	30-150	±50	95
Pesticides	30-150	±50	95
PCB Aroclors	30-150	±50	95
Dioxins and furans	50–150	±50	95
Groundwater and surface water samples			
Conventional analytes	75–125	±35	95
Metals	75–125	±35	95
Organic compounds			
Petroleum hydrocarbons	50–150	±50	95
Semivolatile organic compounds	30–150	±50	95
Dioxins and furans	50–150	±50	95

NA - not applicable
RPD - relative percent difference

SECTION B: DATA GENERATION AND ACQUISITION

B1 SAMPLING PROCESS DESIGN

This section presents the sampling design for a tiered approach to complete the Park RI field investigation (Section 4.0 in the SAP). The design is based on Integral's understanding of historical site data and professional judgment. Specific issues related to sampling methods and sample handling procedures are addressed in Section 5.0 of the SAP.

A total of 12 test pits are planned for excavation within the Park site boundary. The test pits will allow collection of soil samples at depth in the areas of historical landfill and gravel mining operations, which might have disturbed soils and distributed contamination throughout a depth range up to several feet. In each test pit, a sample collected from surface to 1 ft below ground surface (bgs) will be submitted for analyses. Additional samples will be collected at 1-2 ft bgs, 2-3 ft bgs, and the bottom of the test pit for archiving. Selected soil samples will be analyzed for TOC, grain size, Atterberg limits, specific gravity, moisture content/bulk density, metals, and NWTPH-DRO and -GRO. Depending on the results, archive samples may be analyzed for VPH/EPH, SVOCs and dioxins/furans.

Soil samples will also be collected at 9 locations using a hand auger. Hand augering is proposed for these locations because it is less intrusive than test pits. Soil samples will be collected at 0-1 ft bgs and 1-2 ft bgs. Selected soil samples will be analyzed for TOC, grain size, Atterberg limits, specific gravity, moisture content/bulk density, metals, chlorinated pesticides, PCBs, and NWTPH-DRO. Depending on the results, archive samples may be analyzed for EPH, SVOCs and dioxins/furans.

Surface water samples will be collected at 7 designated locations (including one background location) using either a peristaltic pump or grab sampling equipment (e.g., sampled directly into bottles). Integral will collect two rounds of surface water samples, both during the wet season. Surface water samples will be analyzed for hardness, total suspended solids (TSS), TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, and SVOCs. Selected surface water samples may also be analyzed for VPH/EPH and dioxins/furans.

Surface sediment samples will be collected from 7 locations at a depth of 0 to 10 cm using a stainless steel, hand-held coring device or large spoon. After surface samples have been collected, sediment borings will be drilled along transects across the creek bed at six locations, evenly spaced over the length of the creek. The borings will be advanced using a track-mounted, portable, hollow stem auger to collect samples at depth. For each transect of 3 to 5 borings, sediment samples will be collected from 0-1 ft bgs, 1-2 ft, 2-3 ft bgs, 3-4 ft bgs, and 4-5 ft bgs. Site surface (0-10 cm) and the 0-1 ft and 1-

2 ft boring sediment samples will be analyzed for TOC, metals, and NWTPH-DRO. Surface sediments (0-10 cm) will also be analyzed for total sulfides and ammonia to assist in evaluating the bioassay tests, if required. Physical testing (grain size, Atterberg limits, specific gravity, moisture/bulk density) will also be analyzed for the surface (0-10 cm – grain size only), and 0-1 ft and 2-3 ft samples at depth from selected borings representative of each transect. Site surface (0-10 cm), 0-1 ft, and 1-2 ft sediment samples will be archived for possible EPH, SVOC, and dioxin/furan analyses, depending on the DRO results. Additional samples collected at depth may be analyzed for these chemical groups pending the results of shallow sediment samples.

Based on the chemical results of the surface sediment samples we will perform toxicity testing at those locations where concentrations exceed corresponding SLs. The proposed tests are:

- Amphipod (*Hyalella azteca*) 10-day mortality test (USEPA 2000b; Test Method 100.1)
- Microtox® Sediment Porewater (*Vibrio fischeri*) (Ecology 2003)
- Midge (*Chironomus tentans*) 20-day mortality and growth test (USEPA 2000b; Test Method 100.2 modified).

Groundwater samples will be collected at three wells in the Park and a background location (MW-06D[3]) using either a peristaltic pump or bailer. Integral will collect two rounds of groundwater samples, one during the dry season and the other during the wet season. Groundwater samples will be analyzed for hardness, TSS, TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, SVOCs, and dioxins/furans. Depending on the results of the NWTPH method, VPH/EPH may be analyzed.

Field replicates will be collected and analyzed at a frequency of 5 percent of samples. Equipment rinse blanks will be collected and analyzed once per sampling method. Field QC samples are described in Section 4.6 of the SAP.

B2 SAMPLING METHODS

Field sampling methods are described in Section 5.0 of the SAP and include the following activities:

- Horizontal and vertical control methods (utility survey and sample locations)
- Sampling equipment (test pits, hand augers, surface water sampling, surface sediment sampling, sediment borings, and groundwater sampling)

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[3] MW-06D is a background well located northeast of the OESER site near Cedarwood Avenue.

- Sample identification
- Sample containers and labels (sample labels, custody seals, sample summary log, sample custody/tracking procedures)
- Field documentation and procedures (field logbooks, photo documentation, sample collection form, field change request form, sample tracking form, chain-of-custody form)
- Decontamination procedures
- Investigation-derived wastes.

Standard operating procedures (SOPs) for each sampling method are provided in Appendix A of the SAP.

Soil samples will be collected from test pits excavated using a backhoe to a depth of 4 ft bgs. SOP-1 presents the procedures planned for test pit excavations in the Park.

Soil samples will be collected using a stainless steel hand auger or equivalent to a depth of 2 ft bgs. SOP-2 presents the procedures planned for sampling with a hand auger in the Park.

Groundwater will be collected from each well using either a portable peristaltic pump equipped with Teflon-lined tubing or disposable bailer. Refer to SOP-3 in the SAP.

Surface water will be collected from below the water surface using either a portable peristaltic pump equipped with Teflon-lined tubing or direct filling of sample bottles. See SOP-4.

Surface sediment samples (0 to 10 cm) will be collected from the Creek using a stainless steel shovel, spoon or trowel following methods described in SOP-5.

Sediment borings will be advanced using a portable, track-mounted, hollow-stem auger drill rig as described in SOP-6. A 2-ft long, 3-inch diameter split spoon will be used (or equivalent) to collect sediment samples at each sediment boring location.

Requirements for sample containers, sample preservation, storage temperature, and holding times are summarized in Table B-1. All sample containers will have screw-type lids to ensure adequate sealing of the bottles. Lids of the glass containers will have Teflon inserts to prevent sample reaction with the plastic lid and to improve the quality of the seal. When required, preservative will be added to containers at the laboratory prior to shipment to the sampling site.

Commercially available, pre-cleaned jars will be used, and the laboratory will maintain a record of certification from the suppliers. The bottle shipment documentation will record batch numbers for the bottles. With this documentation, bottles can be traced to the supplier, and bottle rinse blank results can be reviewed. The bottle documentation from the laboratory will be included in the Integral project file.

B3 SAMPLE HANDLING AND CUSTODY

The principal documents used to identify samples and to document possession will be field logbooks and chain-of-custody (COC) records. Custody will be documented for all samples at all stages of the analytical or transfer process. COC procedures for core and sample handling prior to delivery to the laboratories are outlined in Section 5.5 of the SAP.

Upon receipt of samples at each laboratory, the sample manager will check for physical integrity of the containers and seals and inventory the samples by comparing sample labels to those on the COC forms. The laboratory will include the COC and cooler receipt forms in the data package. Any breaks in the COC or non-conformances will be noted and reported in writing to the Integral laboratory coordinator within 24 hours of receipt of the samples. Each laboratory QA plan (Attachments 1 through 3 to this QAPP) includes procedures used for accepting custody of samples and documenting samples at the laboratory. The laboratory project manager will ensure that a sample-tracking record is maintained that follows each sample through all stages of sample processing at the laboratory.

All samples submitted to ARI for archival will be stored at -20° C. Sediment for toxicity testing will be stored in the dark for a maximum of 8 weeks. Sample bottles for toxicity testing will be stored either with no headspace or headspace purged with nitrogen gas. Each laboratory will maintain COC documentation and documentation of proper storage conditions for the entire time that the samples are in its possession. The chemical laboratories will store the excess samples for a minimum of 6 months following completion of data validation.

The laboratories will not dispose of the samples for this project until authorized to do so by the Integral laboratory coordinator. The laboratories will dispose of samples, as appropriate, based on matrix, analytical results, and information received from the client. If determined to be hazardous, remaining samples will enter the appropriate laboratory waste streams.

B4 ANALYTICAL METHODS

Samples of all matrix types collected for this study will be analyzed for chemical constituents. Toxicity tests will additionally be conducted for selected sediment and sediment pore water samples. Sediment and soil samples will also be tested for geotechnical characteristics. The laboratory methods that will be used to complete the chemical, biological, and geotechnical testing are described below.

B4.1 Chemical Analyses

Soil, groundwater, surface water, and sediment samples will be analyzed for metals, organic compounds, and conventional analytes. Detailed analyte lists and method reporting limits are provided in Tables A-3 through A-6, respectively, for each sample type. Method reporting limits are equivalent to the concentration of the lowest calibration standard (i.e., the practical quantitation limit) and represent the low end of the calibration range. Analytes that are detected at concentrations below the reporting limit will be reported, but will be qualified as estimated (a "J" qualifier will be applied to the result by the laboratory).

ARI will complete analyses for metals, organic compounds (except dioxins and furans), conventional analytes, and geotechnical characteristics. STL will complete analyses for dioxins and furans. Laboratory methods for sample preparation and analysis are summarized in Table A-7 and described in the following sections. Sample containers, preservation, and holding times are provided in Table B-1.

B4.1.1 Metals

Sediment and soil samples will be analyzed for metals by EPA Method 6010 and for mercury by EPA Method 7471A. Strong acid digestion with nitric acid and hydrogen peroxide will be used to prepare samples for analysis of metals other than mercury. Analysis will be completed by inductively coupled plasma/mass spectrometry (ICP/MS). Mercury samples will be digested with aqua regia and oxidized using potassium permanganate. Analysis will be completed by cold vapor atomic absorption spectrometry (CVAA).

Three methods will be used to analyze groundwater and surface water samples for total metals. Digestion with nitric and hydrochloric acids will be used to prepare samples for analysis of metals other than mercury. Analysis for these metals will be completed by ICP/MS. Calcium and magnesium analyses will be completed by inductively coupled plasma-optical emission spectrometry (ICP-OES). Calcium and magnesium concentrations will be used to calculate water hardness. Mercury samples will be digested with aqua regia, oxidized using potassium permanganate, and analyzed by CVAA.

B4.1.2 Petroleum Hydrocarbons

Soil, groundwater, sediment, and surface water samples will be analyzed for diesel- and oil- range petroleum hydrocarbons. These samples will additionally be analyzed for EPH if screening levels are exceeded. Soil, groundwater, surface water samples will also be analyzed for gasoline-range petroleum hydrocarbons (GRO). These samples will be analyzed for VPH if screening levels are exceeded. Details regarding the decision to analyze samples for VPH or EPH are provided in Section 4.0 of the SAP.

GRO and VPH will be extracted from soil samples using methanol, followed by purge and trap with a carbon-based trap. Groundwater and surface water samples will be purged directly without prior extraction. The contents of the trap will be analyzed by gas chromatography (GC) with a flame ionization detector (FID) for NWTPH-GRO. Samples for VPH will be analyzed using both FID and a photo-ionization detector (PID). The FID detects both aliphatic and aromatic hydrocarbons, whereas the PID detects only the aromatic hydrocarbons. The aliphatic hydrocarbons are calculated as the difference between the FID and PID responses.

For diesel- and oil-range petroleum hydrocarbons, samples will be extracted with methylene chloride and solvent-exchanged into hexane. Silica gel chromatography will be used to separate the aliphatic and aromatic hydrocarbons in the samples. The fractions will be analyzed separately by GC/FID.

B4.1.3 Semivolatile Organic Compounds

SVOCs in sediment and soil samples will be analyzed by EPA SW-846 Method 8270C, with modifications recommended by PSEP (1997a,b) to allow lower reporting limits. Modifications will include the use of a larger sample volume, corresponding to 50 g of dry sediment and a final extract volume of 0.5 mL. Samples will be extracted by sonication. Gel permeation chromatography will be used to clean up the sample extracts. Samples will be analyzed by gas chromatography with mass spectrometry (GC/MS).

Continuous liquid-liquid extraction will be used to extract SVOCs from groundwater and surface water samples. SVOCs will be analyzed by GC/MS with a large-volume injector to enhance sensitivity. TICs will not be reported for this study.

B4.1.4 Dioxins and Furans

Chlorinated dioxins and furans in sediment and soil samples will be extracted with toluene in a Soxhlet/Dean Stark extractor. Water samples will be extracted with methylene chloride. Cleanup procedures will include sulfuric acid cleanup and silica/carbon column cleanup. Additional cleanup procedures will be used if necessary to remove interferences. Samples will be analyzed by high-resolution gas chromatography with high-resolution mass spectrometry (HRGC/HRMS). EPA Method 1613B requires isotopically labeled analogs of target analytes to be spiked into each sample before extraction. Target analytes are quantified relative to the labeled analog and therefore their calculated concentration compensates for extraction and cleanup efficiencies.

As described in EPA Method 1613B, detection limits are calculated on an individual compound and sample basis and depend on the signal-to-background ratio for the specific labeled isomer. Concentrations will be reported to the sample-specific MDLs.

B4.1.5 Pesticides

Chlorinated pesticides in soil samples will be analyzed using EPA SW-846 Method 8081A. Samples will be extracted by sonication extraction. Gel permeation chromatography (GPC) will be used to remove large organic interferents, and sulfur cleanup will be completed if necessary using tetrabutylammonium sulfite. Samples will be analyzed by gas chromatography with an electron capture detector (GC/ECD).

B4.1.6 PCBs

PCB Aroclors in soil samples will be analyzed using EPA SW-846 Method 8082 with modifications recommended by PSEP (1997a) to allow lower reporting limits. Modifications will include the use of a larger sample volume, corresponding to 25 g of dry sediment, and a final extract volume of 5 mL. Samples will be extracted by sonication. Extracts will be cleaned using sulfuric acid cleanup, silica gel cleanup, and sulfur cleanup. Samples will be analyzed by GC/ECD.

B4.1.7 Conventional Analyses

Conventional analyses of sediment samples will include total solids, total sulfides, ammonia, and TOC. Soil samples will be analyzed for total solids and TOC. EPA and PSEP methods will be used as shown in Table A-7.

Total solids in soil and sediment samples will be determined according to PSEP (1986). These results will be used to calculate analyte concentrations on a dry-weight basis and will also be reported in the database.

Total sulfide analysis in sediment samples will include distillation of the sulfide into a sodium hydroxide trap and analysis by colorimetry (EPA 376.2).

Ammonia in sediment samples will be analyzed by EPA Method 350.1. The method, originally developed for use in water samples, will be modified for sediment samples by adding an extraction with a potassium chloride solution. Colorimetry will be used to determine ammonia concentrations.

TOC in sediment and soil samples will be analyzed as described in EPA Method SW 9060 (Ecology modified). Samples will be pretreated with hydrochloric acid to remove inorganic carbon, dried at 70° C, and analyzed by combustion in an induction furnace.

Conventional analyses of surface water samples will include total suspended solids, total organic carbon, and hardness. EPA methods will be used as shown in Table A-7.

For TSS determination, water samples will be filtered through a pre-weighed glass fiber filter. The filter will be dried and weighed and the TSS determined by difference.

Total organic carbon in surface water samples will be analyzed by EPA Method 415.1. Organic carbon in the samples will be oxidized and the evolved CO_2 will be analyzed using an infrared detector. Samples will be pretreated with hydrochloric acid to remove inorganic carbon.

The hardness of the water samples will be calculated using the results for calcium and magnesium which will be obtained by ICP/OES as described for metals.

B4.2 Biological Testing

Bioassays will be conducted on selected sediment samples to determine whether anthropogenic contaminants of concern are present at concentrations which are toxic to biota. The following freshwater sediment toxicity bioassays (2 acute tests and 1 chronic test) will be conducted:

- 10-day Amphipod (*Hyalella azteca*)
- Microtox® Sediment Porewater (*Vibrio fischeri*)
- 20-day Midge Larvae (*Chironomus tentans*).

Biological testing will be in compliance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment Associated Contaminants with Freshwater Invertebrates* (USEPA 2000b), ASTM Guideline E 1706-95b (ASTM 1997, 2000), and the *Sediment Sampling and Analysis Plan Appendix – Subappendicies C and D* (Ecology 2003) following requirements presented in the *Phase 1 Freshwater Sediment Quality Values in Washington State* (Ecology 2002). NAS, an accredited laboratory by Ecology, will conduct the bioassay testing for this project.

All samples for bioassay testing will be stored in 1-liter amber jars, at 4^{o}C, with no headspace (or headspace purged with nitrogen gas) until analysis by the laboratory. Toxicity tests will be initiated within 8 weeks of sample collection.

B4.3 Geotechnical Testing

A suite of physical tests are used to evaluate excavation, filling and capping methods, and capacity of existing soils and sediments to provide foundation support for filling/capping material. The following tests will be completed for selected samples collected in the cores (Table A-2).

B4.3.1 Grain Size

Grain size will be analyzed by the hydrometer and sieve method following ASTM Method D422-63 (ASTM 2003), and will provide information on site geologic character and engineering properties of soil/sediment proposed for remediation.

B4.3.2 Atterberg Limits

Atterberg limits will be determined for selected samples of soil and sediment samples in accordance with ASTM D4318-00 (includes organic determination). Atterberg limits, which include the liquid limit, plastic limit, and the plasticity index, are used to define plasticity characteristics of clays and other cohesive sediments.

B4.3.3 Specific Gravity

Specific gravity will be measured on samples selected for engineering properties in accordance with ASTM D854-02. The specific gravity of soil/sediment samples is used to determine sediment removal and the bed consolidation after filling/capping.

B4.3.4 Moisture Content

Moisture content will be measured on selected samples analyzed for engineering properties in accordance with ASTM D-2216. Moisture content is used to determine the initial *in situ* void ratio of the soil/sediment and to estimate the short-term bulking (or increase in volume) during excavation activities.

B5 QUALITY CONTROL

Quality control samples will be prepared in the field and at the laboratories to monitor the bias and precision of the sample collection and analysis procedures.

B5.1 Field Quality Control Samples

Field QC samples for this study will include field replicates and equipment rinse blanks. These field QC samples will minimally be collected for each type of sample at a frequency of 5 percent of the sample total. The procedures for preparing field duplicates and rinse blanks are presented in Section 4.6 and Appendix A of the SAP. Validation criteria and procedures for field QC samples are described in Sections D1 and D2 of this QAPP.

B5.2 Laboratory Quality Control

Extensive and detailed requirements for laboratory QC procedures are provided in the EPA and PSEP protocols that will be used for this study (Table A-8). Every method protocol includes descriptions of QC procedures, and many incorporate additional QC requirements by reference to separate QC chapters. QC requirements include control limits and requirements for corrective action in many cases. QC procedures will be completed by the laboratories, as required in each protocol and as indicated in this QAPP.

The frequency of analysis for laboratory control samples, matrix spike samples, matrix spike duplicates or laboratory duplicates, and method blanks will be one for every 20 samples or one per extraction batch, whichever is more frequent. Surrogate spikes and internal standards will be added to every field sample and QC sample, as required. Calibration procedures will be completed at the frequency specified in each method description. As required for EPA SW-846 methods, performance-based control limits have been established by the laboratories. These and all other control limits specified in the method descriptions will be used by the laboratories to establish the acceptability of the data or the need for reanalysis of the samples. Laboratory control limits for recoveries of surrogate compounds, matrix spikes, and laboratory control samples, and for relative percent difference of matrix spike duplicates and laboratory duplicates, are provided in Appendix K of ARI's QA manual (Attachment 1 to this QAPP) and in Appendix 2 for STL.

Test acceptability for bioassays is based on the source and sensitivity of the test organisms and on the control of physical and chemical conditions in the culture chambers while the test is in progress. Quality control procedures will include negative and positive controls for the toxicity tests; acceptance conditions for the test organisms; and chemical monitoring of the overlying water in the culture chambers. Water quality monitoring for the various toxicity tests will include ammonia, hardness, alkalinity, conductivity, dissolved oxygen, pH, and temperature. Control criteria and procedures are described in Section IX of the QA/QC Manual for NAS (Appendix 3 of this QAPP). Details are provided in each testing protocol (Table A-7).

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by the laboratories in accordance with the requirements identified in the laboratories' SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup and tuning, and critical operating parameters. Instrument maintenance and repair will be documented in maintenance log or record books.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Laboratory instruments will be properly calibrated, and the calibration will be verified with appropriate check standards and calibration blanks for each parameter before beginning each analysis. Instrument calibration procedures and schedules will conform to analytical protocol requirements and descriptions provided in the laboratories' QA plans.

All calibration standards will be obtained from either the EPA repository or a commercial vendor, and the laboratories will maintain traceability back to the National Institute of Standards and Technology. Stock standards will be used to make intermediate standards and calibration standards. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and prevention of contamination. Documentation relating to the receipt, mixing, and use of standards will be recorded in a laboratory logbook. All calibration and spiking standards will be checked against standards from another source.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and quality control purposes.

During sample collection, solvents of appropriate, documented purity will be used for decontamination. Solvent containers will be dated and initialed when they are opened. The quality of laboratory water used for decontamination will be documented at the laboratory. As discussed in Section B2, cleaned and documented sample containers will be provided by the laboratory. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA plans. All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by Integral (i.e., for supplies used in the field) or the laboratory.

B9 NON-DIRECT MEASUREMENTS

Existing chemical data from previous investigations in the Park will be used for this investigation. All historical data were reviewed for quality assurance. Details are provided in section 3.1 of the SAP.

B10 DATA MANAGEMENT

Data for this project will be generated in the field and at the laboratories. The final repository for sample information for the sample collection efforts described in the SAP will be an EQuIS™ database. Procedures to be used to transfer data from the point of generation to the EQuIS™ database are described in this section. Final data will be combined with historical data and summary tables will be created using EQuIS™.

B10.1 Field Data

Data that are generated during sediment collection and sample preparation will be manually entered into the field logbook, core logs, and COC forms. Data from these sources will be entered into the EQuIS™ database directly from the field logbook and core logs. These data include station location coordinates, station names, sampling dates, sample identification codes, and additional station and sample information (e.g., water depth, sample type, field replicate number). All entries will be reviewed for accuracy and completeness by a second individual, and any errors will be corrected before the data are approved for release to data users.

B10.2 Laboratory Data

A variety of manually entered and electronic instrument data are generated at the laboratories. Data are manually entered into:

- Standard logbooks
- Storage temperature logs
- Balance calibration logs
- Instrument logs
- Sample preparation and analysis worksheets
- Maintenance logs
- Individual laboratory notebooks
- Results tables for conventional analyses (e.g., grain-size distribution, total solids).

All manual data entry into the laboratory information management system (LIMS) is proofed at the laboratory. All data collected from each laboratory instrument, either manually or electronically, are reviewed and confirmed by analysts before reporting. At ARI, the sample information is electronically loaded to temporary files in LIMS and submitted for further review. Forms IV-X for validated data packages are generated in the laboratory and reviewed for correctness in interpretation, conformance with QA requirements, and completeness. Once the data have been accepted, the final results are released to the LIMS for reporting. The LIMS is used to generate the EDD as well as Forms I-III for the data package, providing a single source for reporting of chemical data. The EDD is further spot-checked against the hard copy to ensure that the correct data set is reported for both. A detailed description of procedures for laboratory data management and data review and verification are provided in the laboratory QA plans (Attachments 1 through 3).

Laboratory data will be entered directly into the EQuIS™ database from the EDD. A database printout will be used to verify database entries against the hard-copy laboratory data packages. Electronic data will also be provided to Ecology and EPA in SEDQUAL and EIM import formats, as required.

Table B-1. Required Sample Containers, Preservatives, and Holding Times.[1]

Analysis Type	**Matrix**	**Container Size**	**Holding Time[1]**	**Preservation**
NWTPH-GRO	Soil/Sediment	4 oz glass with Teflon coated/Septum lid	14 days extraction/analysis	Ice (4°C)
NWTPH-DRO	Soil/Sediment	4 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4°C) Frozen (-18°C)
SVOCs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4°C) Frozen (-18°C)
Pesticides/PCBs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4°C) Frozen (-18°C)
Dioxins/Furans	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4°C) Frozen (-18°C)
Metals	Soil/Sediment	4 oz glass	6 months/28 days* 2 years until analysis (except mercury)	Ice (4°C) Frozen (-18°C)
TOC	Soil/Sediment	4 oz glass	14 days 6 months	Ice (4°C) Frozen (-18°C)
Total Sulfides/Ammonia	Soil/Sediment	4 oz glass (zero headspace)	7 days	Ice (4°C)
Grain size	Soil/Sediment	16 oz glass	6 months	Ice (4°C)
Atterburg Limits	Soil/Sediment	Inc.	NA	Ice (4°C)
Specific Gravity	Soil/Sediment	Inc.	NA	Ice (4°C)
Moisture Content/Bulk Density	Soil/Sediment	Inc.	NA	Ice (4°C)
NWTPH-GRO	Water	Two 40-mL glass with Teflon lined Septum lid	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4°C)
NWTPH-DRO	Water	One 1-liter amber glass	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4°C)
SVOCs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4°C)
Pesticides/PCBs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4°C)
Dioxins/Furans	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4°C)
Metals	Water	One 1-liter HDPE	6 months/28 days*	Ice (4°C), HNO_3 pH<2

Table B-1. Required Sample Containers, Preservatives, and Holding Times. (continued)

Analysis Type	**Matrix**	**Container Size**	**Holding Time**[1]	**Preservation**
TOC	Water	One 500-mL HDPE	28 days	Ice (4°C), H_2SO_4 pH<2
TSS	Water	One 1-liter HDPE	--	Ice (4°C)
Hardness	Water	One 1-liter HDPE	--	Ice (4°C)
Bioassays	Sediment	Three 1-liter amber glass	8 weeks	Ice (4°C) No Headspace or Purged with Nitrogen Gas

[1] Storage temperatures and maximum holding times for physical/chemical analyses and sediment toxicity tests (PSEP 1997a,b, Ecology 2003)

* Holding time for mercury is 28 days. Holding time for the other metals is 6 months.

Note: All holding times are from the date of sampling. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis without being qualified.

SECTION C: ASSESSMENT AND OVERSIGHT

This project will rely heavily on the knowledge and experience of the project team. The field team and laboratories will stay in close verbal contact with the Integral project manager and QA manager during all phases of the project. This level of communication will serve to keep the management team appraised of activities and events, and will allow for informal but continuous project oversight. Few scheduled assessment activities are planned for this project because the scope of the sampling and analysis effort and the size of the project team are relatively small.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities will include readiness reviews prior to sampling and prior to release of the final data to the data users, and internal review while work is in progress. An informal technical systems audit may be conducted if problems are encountered during any phase of this project.

Readiness reviews are conducted to ensure that all necessary preparations have been made for efficient and effective completion of each critical phase of project work. The first readiness review will be conducted prior to field sampling. The field coordinator will verify that all field equipment is ready for transfer to the site. The field coordinator will also verify that the field team and subcontractor have been scheduled and briefed and that the contract for the subcontractor has been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed before final data are released for use. The data manager will verify that all results have been received from the laboratories, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the data manager, the Integral QA manager, or their designee. Data will not be released for final use until all data have been verified and validated. No report will be prepared in conjunction with the readiness reviews. However, the project manager and data users will be notified when the data are ready for use.

Technical review of intermediate and final work products generated for this project will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the Integral and City of Bellingham project managers. Ecology and EPA will be notified of any problems that may affect the final outcome of the project.

The laboratories have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Each phase of work is reviewed by a supervisor before it is approved for release. Details are provided in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. If completed, these audits will be conducted by the Integral QA manager or designee or by the ARI, STL, or NAS QA manager. These audits may consist of onsite reviews of any phase of field or laboratory activities or data management. Results of any audits will be provided in the RI report.

Any project team member who discovers or suspects a non-conformance is responsible for reporting the non-conformance to the project manager, the Integral QA manager, or the laboratory project or QA manager, as applicable. The project manager will ensure that no additional work dependent on the non-conforming activity is performed until a confirmed non-conformance is corrected.

C2 REPORTS TO MANAGEMENT

Corrective actions will be required if deviations from the methods or QA requirements established in the SAP or this QAPP are encountered. When a non-conformance is identified, corrective action will be taken immediately, if possible. The project manager will be contacted and, if necessary, will provide assistance in resolving the issue. A formal corrective action plan is not likely to be required for a project of this limited scope. However, any non-conformance issue that ultimately affects the quality of the data or results in a change of scope in the work described in the SAP, including this QAPP, will be documented in the field log or field correction record (FCR) to the project manager. This documentation will serve as a Corrective Action Report. A description of the non-conformance issue, the attempted resolution, and any effects on data quality or usability will be provided in the RI report.

The laboratories have implemented routine systems of reporting non-conformance issues and their resolution. These procedures are described in the laboratory QA plans (Attachment 1 through 3 to this QAPP). Laboratory non-conformance issues will also be described in the RI report if they affect the quality of the project data.

SECTION D: DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the RI report.

D1 CRITERIA FOR DATA REVIEW, VERIFICATION, AND VALIDATION

Field and laboratory data for this project will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification and validation for organic compounds and metals will be completed according to methods described in the EPA Region 10 SOP for validation of dioxins and furans (USEPA 1996) and in the functional guidelines for organic and inorganic data review (USEPA 1999, 2002b). Data will be qualified as estimated as necessary if results for laboratory control samples, matrix spike samples, and matrix spike or laboratory duplicates do not meet measurement quality objectives provided in Table A-8 or if control limits for any other QC sample or procedure do not meet performance-based control limits. Performance-based control limits are established periodically by the laboratories. Current values are provided in Appendix K of the laboratory QA plan (Attachment 1 to this QAPP) and, for STL, in Attachment 2 of this QAPP.

No guidelines are available for validation of data for TOC, grain size, Atterberg limits, and specific gravity. These data will be validated using procedures described in the functional guidelines for inorganic data review (USEPA 2002b), as applicable. The MQOs for accuracy (Table A-8) will be used as control limits for matrix spike recovery, and the MQO for precision will be used as the control limit for laboratory duplicate or triplicate analyses. Performance-based control limits will be used to qualify these data if results for other quality control samples do not meet control limits.

Results for field duplicates will be evaluated using the MQOs provided in Table A-8. Data will not be qualified as estimated if the MQOs are exceeded, but RPD results will be tabulated, and any exceedances will be discussed in the RI report. Equipment rinse blanks will be evaluated and data qualifiers will be applied in the same manner as method blanks, as described in the functional guidelines for data review (USEPA 1996, 1999, 2002b).

Data will be rejected if control limits for acceptance of data are not met, as described in EPA (1996, 1999, 2002b).

D2 VERIFICATION AND VALIDATION METHODS

Field data will be verified during preparation of samples and COCs. Field data and COCs will be reviewed by the field coordinator after the field effort is complete. After field data are entered into the project database, 100 percent verification of the entries will be completed to ensure the accuracy and completeness of the database. Any discrepancies will be resolved before the final database is released for use.

Procedures for verification and validation of laboratory data and field QC samples will be completed as described in the functional guidelines and SOP for data validation (USEPA 1996, 1999, 2002b) and summarized in Section D1, above. The accuracy and completeness of the database will be verified at the laboratory when the EDDs are prepared and again as part of data validation. All entries to the database from the laboratory EDDs will be checked against the hard-copy data packages. Data validation will be completed by a subcontracted data validation firm.

In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

Method reporting limit goals for this project are provided in Tables A-3 through A-7. Reporting limits for non-detects will be compared to the method reporting limit goals to evaluate method sensitivity for each sample. Any exceedance of actual MRLs over the target MRLs will be discussed in the RI report.

D3 RECONCILIATION WITH USER REQUIREMENTS

The goal of data validation is to determine the quality of each data point and to identify data points that do not meet the project MQOs. Nonconforming data may be qualified as estimated or rejected as unusable during data validation if criteria for data quality are not met. Rejected data will not be used for any purpose. An explanation of the rejected data will be included in the RI report.

Data qualified as estimated will be used to evaluate the site and will be appropriately qualified in the final project database. These data are less precise or less accurate than unqualified data. The data users, in cooperation with the Integral project manager and QA manager, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses for this study. The data quality discussion in the RI report will include all available information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. The RI report will also include a discussion of data limitations and their effect on data interpretation activities.

SECTION E: REFERENCES

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ATTACHMENTS 1 - 3

Analytical Resources, Inc.
Quality Assurance Plan

Severn Trent Laboratories, Inc.
Quality Assurance Plan

Northwest Aquatic Sciences, Inc.
Quality Assurance Plan

(Attached CD)