QUALITY-ASSURANCE PROJECT PLAN

Assessing Sediment and Toxic Chemical Loads from the Green River, WA to the Lower Duwamish Waterway

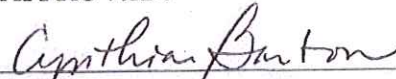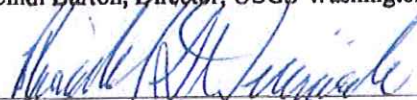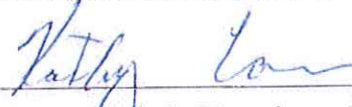PREPARED FOR THE WASHINGTON STATE DEPARTMENT OF ECOLOGY

January 3, 2013
Prepared by

U.S. GEOLOGICAL SURVEY
WASHINGTON WATER SCIENCE CENTER

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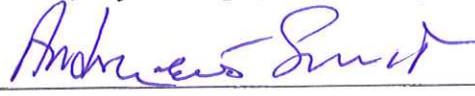
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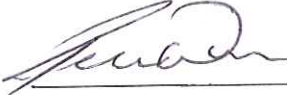
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QUALITY ASSURANCE PROJECT PLAN

Assessing Sediment and Toxic Chemical Loads from the Green River, WA to the Lower Duwamish Waterway

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Background

The Lower Duwamish Waterway (LDW) in Seattle, Washington is the site of intense current and historical anthropogenic influence, including numerous industrial, commercial, and residential uses. The land uses in the drainage basin include: residential (35 percent) such as the towns of South Park and Georgetown; industrial (18 percent) and commercial (11 percent) including marinas, boat manufacturing, concrete manufacturing, food processing, and airplane parts manufacturing; rights-of-way (18 percent) such as roads and highways; and open or undeveloped areas (17 percent) including parks. Decades of intense anthropogenic activities have resulted in contaminated sediments in the LDW. In 2001-2002, the U.S. Environmental Protection Agency (USEPA) and the Washington State Department of Ecology (Ecology) required remedial investigations and feasibility studies on the 5-mile, 441-acre LDW under the federal Superfund law and Washington's Model Toxics Control Act due to concern over human health risks from exposure to contaminated sediments. The main contaminants of concern for human health include polychlorinated biphenyls (PCBs), dioxins and furans, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and arsenic. The final Feasibility Study was completed October 31, 2012, and it proposes a number of cleanup alternatives, including dredging, capping, and/or natural recovery. The draft preferred USEPA cleanup plan for the LDW is scheduled to be released for public comment in March 2013.

To support the implementation of a cleanup plan of contaminated sediments in the LDW, it is necessary to evaluate the sediment recovery potential. "Anthropogenic background" or "area background" concentrations that are higher than cleanup concentrations will result in insufficient recovery at the site. Three major sources of sediment to the LDW have been identified: upstream sources that are transported by the Green River to the LDW, lateral sources from land adjacent to the LDW, and re-suspended bed sediment within the LDW. The Sediment Transport Model (STM), developed for the LDW, predicts that every year more than 185,000 MT of sediment enters the LDW, and greater than 99 percent of that originates from upstream sources while approximately 0.5 percent originates from lateral sources and 0.2 percent originates from bed sediment within the LDW (LDWG 2008). In addition, the STM predicts that approximately 90 percent of the total bed area in the LDW receives 10 cm of new sediment within 10 years or less. Therefore, the sediment and contaminant transport and loading dynamics from the Green River to the LDW will determine, in large part, the sediment recovery potential of remediated areas in the LDW.

Research Problem and Objectives

Limited field data are available regarding sediment and contaminant transport and loading dynamics from the Green River to the LDW. The STM estimated suspended and bed sediment loading into the LDW from upstream sources using grain size information and a flow-rating curve for the Green River based on discharge data from 1960-1980 and 1996-1998. That physical model was then coupled with contaminant concentration data to create a Bed Composition Model (BCM). The upstream contaminant data was extrapolated from five historic data sets from King County, Ecology, and the U.S. Army Corps of Engineers. Only one of those

data sets (Gries and Sloan, 2009) measured contaminants on suspended sediment (the other studies measured surface sediment or whole water). However, the sample size of the Gries and Sloan data set was relatively small (n=7) and none of the samples were collected during the rising limb of high flow events. The upstream data that were used in the BCM primarily originated from surface bed-sediment data, and it was acknowledged that those values were probably estimates of actual contaminant concentrations because the suspended sediment fraction was not fully incorporated. Typically the suspended sediment fraction is comprised of smaller particles with higher organic carbon content than surface bed-sediment particles. Hydrophobic contaminants such as PCBs and PAHs preferentially sorb to organic carbon, so it is expected that the majority of the contaminant load is transported with the fine suspended fraction of sediment. Therefore, better estimates of annual sediment loading and toxic chemical loading from suspended sediment in the Green River to the LDW are needed.

The objective of this project is to quantify sediment and toxic chemical loads associated with upstream sources in the Green River to the LDW, with a focus on high flow/high turbidity events that may contribute more to the annual loading than average flow conditions. These improved measurements will aid in assessing the potential for future re-contamination of remediated sediment in the LDW.

Organization and Timeline

The roles and responsibilities of key personnel involved in this project are provided in this section.

Ron Timm and Andrew Smith, Washington State Department of Ecology. Provide technical management of the project to ensure that activities are conducted in accordance with Department of Ecology guidelines and standards.

Robert Black and Kathy Conn, USGS Washington Water Science Center. Implement project objectives including coordination of field sampling, processing, transport of samples for physical and chemical analysis, and data retrieval. Analyze data and provide preliminary findings to Ecology. Ensure that the project is conducted according to USGS guidelines and standards.

Patrick Moran, USGS Washington Water Science Center's Interim Water Quality Specialist. Review sampling plan and data for adherence to USGS quality assurance and control standards.

Contract Laboratories and Consultants:
The USGS will contract with two Washington State accredited laboratories for analytical chemistry services and one USGS laboratory for physical sediment analysis. Coordination with these laboratories is the responsibility of the USGS and is included in the overall contract to the agency.

USGS Washington Water Science Center (WaWSC)
Bob Black, Supervisory Hydrologist
Kathy Conn, Hydrologist

934 Broadway, Suite 300
Tacoma, WA 98402
Phone: (253) 552-1600
Information Officer: (253) 552-1635
Fax: (253) 552-1581

The WaWSC will be responsible for overseeing the collection, transport, shipping, payment and interpretation of all physical and chemistry data related to this project. This includes water, suspended sediment, and bed sediment samples. USGS analytical guidelines and quality parameters will be reviewed and compared for compliance and a data quality evaluation (see Wagner and others, 2007) will also be the responsibility of the WaWSC. In addition, the publication and transmittal of all final reports will be the primary responsibility of the WaWSC.

USGS Cascades Volcano Observatory Sediment Laboratory (CVO)
Dan Gooding, Laboratory Chief
1300 SE Cardinal Court,
Building 10, Suite 100
Vancouver, WA 98683
Phone: (360) 993-8917
FAX: (360) 993-8980
dgooding@usgs.gov
URL: http://vulcan.wr.usgs.gov/Projects/SedLab/framework.html

The CVO will be responsible for the analysis of water samples for physical characterization of suspended sediment, including particle size distribution (PSD) and suspended sediment concentration (SSC). SSC is a measure of the amount of sediment in a given volume of water, reported as milligrams per liter (mg/L). Water samples collected using two techniques will be compared: (1) from the bridge using depth- and width-integrated techniques that ensure the sample is representative of the river's entire cross-section (as the samples for water chemistry will be collected) and (2) from the bank using a pump from a point source (as the samples for suspended sediment chemistry will be collected). See the Field Sampling section and Table 2 for more details.

Analytical Resources, Inc. (ARI)
Mark Harris, Project Manager
4611 S. 134th Place
Suite 100
Tukwila, WA 98168-3240
Phone: (206) 695-6200
FAX: (206) 695-6201
URL: http://www.arilabs.com/

ARI will be responsible for the analytical chemistry analysis of water, suspended sediment, and bed sediment samples for all analytes listed in Appendix A, with the exception of the dioxins, furans, and PCB congeners, which will be subcontracted to AXYS Analytical. ARI is responsible

for coordinating the subcontract with AXYS. ARI will provide bottles, coolers, preservatives, and chain of custody forms for each sampling event. They will provide an EPA Level 2 deliverable of all data to the USGS, which includes a summary narrative and results from all analyses (conducted at both ARI and AXYS). The data will be transmitted in two formats – one that is compatible with Ecology's Environmental Information Management (EIM) database and one that is compatible with USGS's National Water Information System (NWIS) database.

AXYS Analytical Services LTD (AXYS)
Devin Mitchell, Project Manager
2045 Mills Road
Sidney BC V8L 5X2
Phone: (250) 655-5800
FAX: (250) 655-5811
URL: http://www.axysanalytical.com/

AXYS will be responsible for the analysis of water, suspended sediment, and bed sediment samples for dioxins, furans, and PCB congeners through a subcontract with ARI. They will receive samples from ARI and will provide results back to ARI that meet AXYS' quality assurance standards.

The timeline for the project is shown in Table 1.

Table 1. Timeline of project tasks.

Task	Federal Fiscal Year (FY) 2013					
	Jan	Feb	Mar	Apr	May	June
Study Design	■					
Method Development	■					
Field Sampling	■	■	■	■	■	
Data Review and Analysis			■	■	■	■
Report Preparation						■

Data Quality Objectives

The overall data quality objective is to ensure that data of known and acceptable quality are generated. To achieve this goal, data must be reviewed for 1) precision, 2) accuracy (or bias), 3) representativeness, 4) completeness, 5) comparability, and 6) sensitivity.

Precision- is a measure of mutual agreement among individual measurements of the same property, under prescribed similar conditions. For this project, sampling precision from field samples will be addressed by collecting and submitting for analysis sequential replicate samples obtained during the same sampling event. One field replicate of water and one field replicate of bed sediment will be collected for chemical analysis. A field replicate will not be collected for suspended sediment because of the mass limitations. Due to the high risk of contamination by VOCs, a trip blank (a sample of deionized water filled at ARI and transported in the cooler to and from the site during field sampling) will be included in each of the five sampling events. Results from the field replicate samples will be included in the final report.

Both analytical laboratories will conduct laboratory blank, replicate, and matrix spike analyses according to their quality assurance and control plan (with every batch of approximately 20 samples). Laboratory replicates will be prepared by splitting a sample in the laboratory, and carrying the subsamples through the entire analytical process. Precision is expressed as the relative percent difference (RPD). The control limits for laboratory matrix spike and replicate samples are given in Appendix A. The replicate RPD typically is ≤ 40. The control limits for matrix spike recoveries are calculated for each individual compound. Control limits of $30 - 160$ are default limits used where there is insufficient data to calculate historic control limits.

Accuracy- is a measure of the bias of a system or measurement. It is the closeness of agreement between an observed measurement value to the expected value or to the most-probable value. For this project, accuracy will be assessed through matrix spikes and continuing calibration data generated by each laboratory. When isotopes or standard reference materials are available, they will be incorporated into the sampling plan for trace organic analysis. For example, a sediment standard reference material for low-level dioxins and PCBs is available through Ecology, and will be provided to AXYS for analysis. When isotope dilution methods are available, they will be used, from which analyte concentrations are adjusted based on the extraction recovery and analytical performance of its isotope.

Representativeness- expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. For this project, representativeness will be determined by the site selection, timing of the sampling events, sample collection methods, acceptance criteria, and sample handling and storage. To ensure samples are representative, they will be collected:

- From a location in the Green River that is close to the LDW but far enough upstream to minimize potential tidal affects determined during previous studies (Embrey and Frans 2003).
- During low tide conditions, to maximize collection of sediment being transported downstream from upstream sources, and minimize potential backwater tidal effects that could re-suspend and transport downstream sediment up into the sampling area.
- During a range of flow conditions, focusing on high-flow events.
- From one or more locations within the water column at the sampling site that represents average conditions, as determined by water quality parameters (specific conductance, turbidity, pH, dissolved oxygen), flow, and visual observations.

- Using USGS field sampling protocols for representative samples when available and appropriate (Mueller and Wagner, 2009; U.S. Geological Survey, variously dated; Wilde and others, 2004; Davis and the Federal Interagency Sedimentation Project, 2005; Shelton 1997; Edwards and Glysson, 1999; Radke and others, 2005), as well as protocols used throughout the region (for example, Ecology, 2008).

Specifically, samples of water and suspended sediment (for physical parameters) will be flow-weighted (in other words, collected from multiple stations in the river cross-section) and depth-integrated, and will be collected using samplers (nozzles, bottles, and bags) that have been tested for non-biased sampling (the velocity through the nozzle into the sampler is the same as the velocity of the river, so as not to bias the water or sediment representation). Water samples will be composited in a Teflon churn prior to bottle filling to minimize sample variability between bottles. Bed sediment samples will be targeted from areas with a high deposition of fine sediment material in order to aptly represent the presence of fine material.

The USGS has been developing a protocol for the collection and concentration of suspended sediment using a flow-through centrifuge. For this project, suspended sediment samples collected for chemistry will initially be pumped from a point source in the river, though modifications and improvements to the sampling design may be considered during the study. See the Field Sampling section and Table 2 for more details.

Completeness- is a measure of the amount of acceptable analytical data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Target completeness values are 90% for chemical analyses of water and sediment.

Comparability-expresses the confidence with which one data set can be compared to another. For this project, comparability will be achieved through the use of standard EPA-approved laboratory methods. In addition, standard techniques to collect and analyze representative samples will be used. This will allow comparison to previous (for example, Gries and Sloan 2009) and ongoing (for example, ongoing USGS study on large Puget Sound rivers) data sets.

Sensitivity- is a measure of the analytical capability of the methods to meet the project objectives. The analytical limit of quantitation (LOQ) goals for ARI are presented in Appendix A. The analytical goals for AXYS, including typical sample specific detection level (SDL) and lower method calibration limit (LMCL) are presented in Appendix B. The contract analytical laboratories were specifically selected because of their ability to detect analytes at low level concentrations (for example, ng/L and less). In addition, one water sample field blank will be collected for chemical analysis. An equipment-blank associated with the five suspended sediment samples will be tested by passing a slurry of clean sediment and deionized water through entire sampling set up including the pump tubing, Teflon-lined bucket, peristaltic pump setup, and centrifuge. Results from the field and equipment blanks will indicate if the equipment cleaning, sampling collection, handling, and processing procedures introduce contamination that could increase the low reporting level.

Sampling Design

Approach: Between January and June 2013, the USGS Washington Water Science Center will collect representative samples of water, suspended sediment, and bed sediment from a single strategically-located site on the Green River, WA during five hydrologic events ranging in flow conditions. Samples will be analyzed by Washington State-accredited laboratories for a large suite of compounds, including PAHs and other semivolatile compounds, PCB aroclors and the full suite of 209 congeners, volatile compounds, metals including arsenic, dioxins and furans, pesticides, tributyltin, and total organic carbon. Concurrent with the chemistry sampling, we will measure SSC and PSD. From these and already available stream flow data, we will calculate preliminary estimates of toxic chemical loads from the Green River to the Lower Duwamish Waterway.

Site Description: The lower Duwamish/Green River basin is nearly flat and the tidal influence extends year-round more than 12 miles upstream from the river mouth (Figure 1, "D") and during low-flow conditions at least 17 miles upstream (Figure 1, "G"). Sampling at a location upstream of tidal influence will not capture effects from all potential sources upstream of the LDW. However, sampling near the upstream boundary of the LDW (River Mile, RM, 5) will be in estuarine conditions with very strong tidal influences. Because the primary goal of this project is to assess toxic loads on suspended sediment originating from upstream sources, it is of singular importance to select a site where sampling protocols can be modified to minimize collection of suspended sediment that originates from the LDW and has been re-suspended and transported upstream during high tides.

The single sampling location selected is USGS 12113390 – Duwamish River at Golf Course at Tukwila, WA (Figure 1, "C" and Figure 2). The site is located at approximately RM 10.4. Between 1995 and 2004, samples were collected approximately monthly at this site as part of the USGS National Water Quality Assessment (NAWQA) program. Discharge, specific conductance, nutrients, metals, pesticides and organics in water and a limited number of bed sediment samples were measured. Instantaneous discharge values ranged from 230 to 13,200 cubic feet per second (cfs), with a median value of 1390 cfs (n=116). The highest measured instantaneous discharges were recorded during large storm events in the late winter season (January through April) in 1996 and 1997 (note that this is an instantaneous, not continuous, discharge record). Elevated SSC values were often measured concurrently with elevated discharge. SSC ranged from 3 to 787 mg/L (n=114), with a median value of 19 mg/L. During all NAWQA sampling events, which were targeted during low tide conditions, specific conductance values were less than 200 µS/cm, suggesting that the salinity influence at this site is negligible. The cross section promotes good mixing of the water column as the bridge supports are on the bank and there are no large bridge abutments or other disruptions to flow and mixing in the water (Figure 2). In addition, the site location provides safe sampling access because it is a wide bridge with limited golf cart and foot traffic only. After hours, the bridge can only be accessed through a locked gate (for which the USGS has a key), providing heightened security compared to other sites.
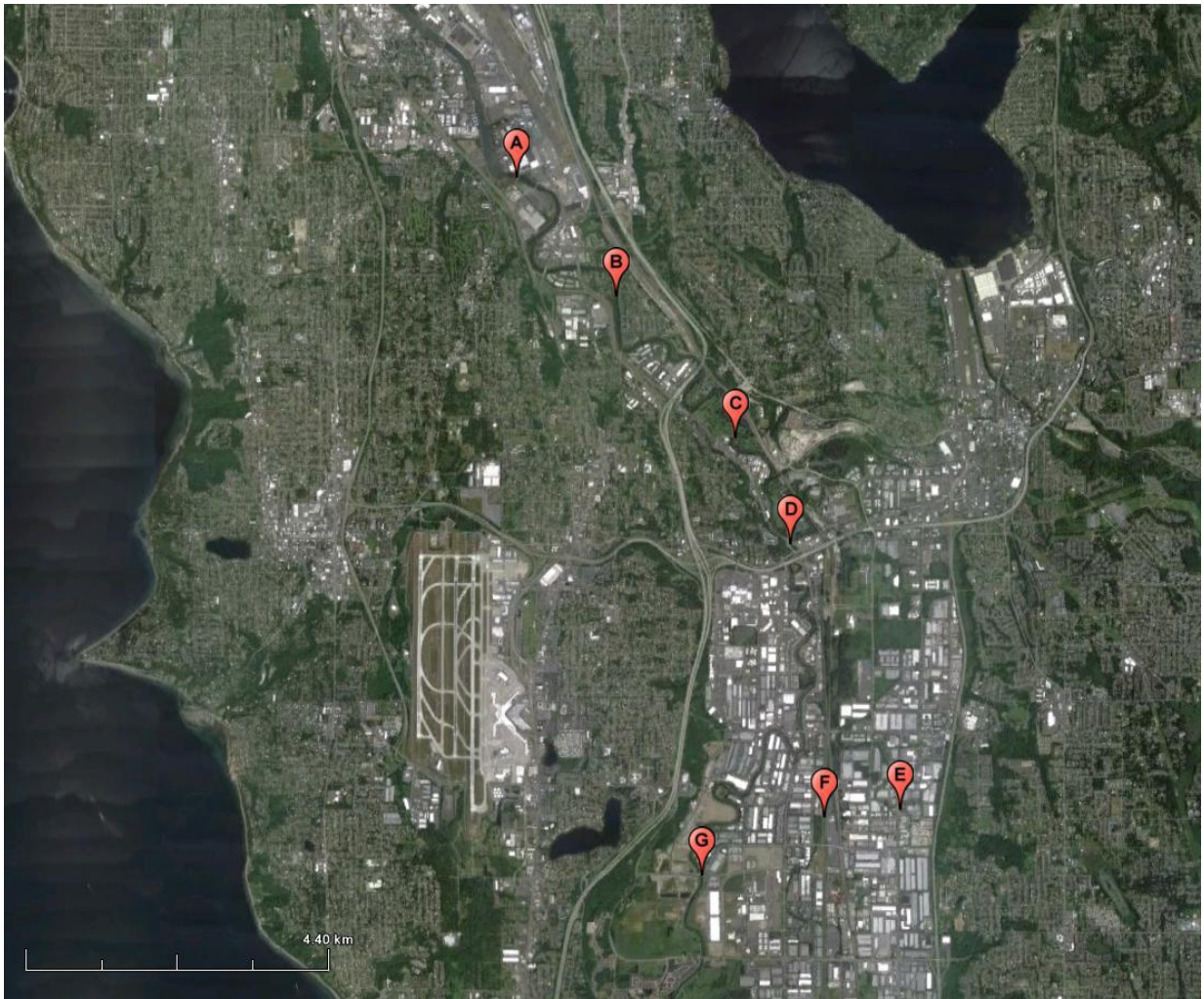
Figure 1. Map of relevant locations on the Green River upstream of the Lower Duwamish Waterway Superfund Site in Seattle, WA.

A: Approximate upstream boundary of the Lower Duwamish Waterway Sediment Cleanup Site (River Mile, RM, 5)

B: Ecology Location Name LDWRRUN0 (RM 6.7); location of previous suspended sediment sampling (Gries and Sloan 2009)

C: USGS 12113390 – Duwamish River at Golf Course at Tukwila, WA; site of historic NAWQA sampling and selected sampling location for this study (RM 10.4)

D: USGS 12113350 – Green River at Tukwila, WA; stage-only gage (RM 12.4)

E: USGS 12113346 – discharge gage accounting for Springbrook Creek input to Green River

F: USGS 12113349 – discharge gage accounting for Mill Creek input to Green River

G: USGS 12113344 – Green River at 200th Street at Kent, WA; discharge gage, flow rating is under development (RM 17)

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Figure 2. Photo of the selected site, USGS 12113390 – Duwamish River at Golf Course at Tukwila, WA, located at River Mile 10.4.

We considered the site of the previous suspended sediment investigation (Gries and Sloan, 2009) - Ecology Location Name LDWRRUN0 (RM 6.7). This site is approximately 3 to 4 miles closer to the upstream boundary of the LDW (Figure 1, "B"); however, it is located in more estuarine conditions. During the previous study, the salinity gradient was often present, with salinity values around 20 ppt at the bottom of the water column and occasionally exceeding 3 ppt (a common freshwater/saltwater threshold) at the mid-column sampling point during August sampling events (Gries and Sloan, 2009, Appendix D). The vertical bridge supports have large wood abutments extending into the water, increasing the difficulty in obtaining a well-mixed, representative sample of the cross-section. Also, the footbridge is accessible by the public 24 hours a day, increasing safety concerns and limiting the ability to effectively use appropriate USGS equipment including a bridge crane, reel, and sampler (Figure 3).

Figure 3. Photo of example USGS sampling equipment, including a crane, reel, and sampler for representative collection of depth- and width-integrated samples.

Development along the river between the USGS site (RM 10.4) and the Ecology site (RM 6.7) includes the golf course, a small commercial complex, and residential properties. The contaminant contributions to the river from this reach are expected to be minimal, primarily consisting of stormwater outfalls. The sampling design will include a comparison of samples collected at both sites for water quality parameters such as SSC, PSD, specific conductance, and turbidity to assess data comparability between sites.

The selected USGS site meets the criteria of: (1) capturing and representing the majority of upstream sources to the LDW while minimizing tidal influence, (2) providing data that can be compared to historic data, and (3) providing safe sampling access using appropriate equipment.

Real-time stage and discharge measurements from nearby upstream stations will be used to inform sampling. This includes the following stations (Figure 1, "D", "E", "F", and "G", respectively): 12113350 (Green River at Tukwila, WA, RM 12.4, stage only due to tidal influence), 12113346 (Springbrook discharge contribution, typically <2%), 12113349 (Mill Creek discharge contribution, typically less than 5%), and 12113344 (Green River at 200th Street in Kent, WA, RM 17, discharge rating under development, low-flow tidal influence). A minimum stage threshold of 10 ft. at USGS 12113350 (Green River at Tukwila, WA) is ideal,

which would have resulted in 5 sampling events between January 1 and June 30, 2012. Sampling events may occur during lower flow conditions so as not to bias the results. In addition, a conductivity data logger and pressure transducer to monitor river stage will be installed onsite at the sampling location over the duration of the project. We will use the conductivity information and the continuous river stage data at the site to calibrate flow and stage data from upstream sources to assess the tidal influence at the site. Based on historic data, we expect the tidal influence to be variable backwater conditions during most times of the year. To minimize tidal backwater effects (that could transport sediment upstream), samples will be collected during a 6-hour window surrounding low tide.

Field Sampling Methods

During each of the five proposed sampling events, six tasks will occur to measure the following parameters: 1) instantaneous discharge, 2) general water quality, 3) water chemistry, 4) suspended sediment physical parameters, 5) suspended sediment chemistry, and 6) bed sediment chemistry. A summary of these tasks is contained in Table 2 and a more detailed description is provided below.

Task 1) Instantaneous discharge. Discharge will be measured using an acoustic Doppler current profiler (ADCP) following standard USGS protocols (Mueller and Wagner, 2009).

Task 2) General water quality. Water quality parameters including water temperature, pH, dissolved oxygen, specific conductance, and turbidity will be measured using a multiparameter sonde (YSI Inc., Yellow Springs, OH) and/or other hand-held devices such as the Analite turbidity sensor (McVan Instruments, Victoria, Australia).

Task 3) Water chemistry. Based on the discharge measurements and stream width, the river cross-section will be divided into equal discharge increments (EDI) or equal width increments (EWI) for water chemistry analysis and suspended sediment physical parameter analysis (see Task 4) using standard USGS protocols (U.S. Geological Survey, variously dated) including those specific for sampling of trace organic chemicals (Wilde and others, 2004). This sampling technique collects a depth- and width-integrated isokinetic sample that is representative of the entire river cross-section at that sampling site. Briefly, a sampler is lowered at a consistent transit rate from the surface to the bottom and back to the surface of the water column at each station. The process is repeated as necessary to obtain sufficient sample. Water samples will be collected from each cross-section station in Teflon bottles or bags using an approved sampler, such as the D-96 (Davis and the Federal Interagency Sedimentation Project, 2005). The water samples will be composited in a 14-L Teflon churn and immediately processed in an on-site mobile laboratory (see Sample Processing). Volatile organic compounds (VOCs) will be collected separately using a USGS tested and designed hand-held sampler to avoid losses due to sample pouring, transferring, and churning (Shelton 1997). The sampler, containing four 40 mL glass vials will be lowered to a mid-point in the vertical water column at a single station in the centroid of flow. Water fills the bottles slowly from the bottom to avoid turbulence and head space that could results in analyte losses. A complete list of analytes being characterized in all water samples is contained in Appendix A and B.

Table 2 (continued on next page). Summary of field collection tasks, parameters collected, collection methods, references, and laboratories completing each task. Task numbers correspond to the task numbers discussed in the text.

Task No.	Task Description	Parameter Collected	Collection Method	Published Collection Methods	Laboratory	Notes
1	Instantaneous discharge	River discharge (ft^3/sec)	Acoustic Doppler Current Profiler (ADCP)	Muller and Wagner, 2009.	USGS-Tacoma	-
2	General water quality (field parameters)	Water temperature (^{0}C), pH, dissolved oxygen (mg/L), specific conductance (µS/cm), turbidity (NTU)	Teledyne YSI multiparameter sonde; Analite turbidity sensor	USGS National Field Manual for the Collection of Water-Quality Data (NFM), variously dated.	USGS-Tacoma	-
3	Water chemistry	Dioxins, Furans, PCB Aroclors and 209 congeners, Semivolatile Compounds, PAHs, Pesticides, Tributyl tin, Trace Elements (metals) including mercury and hexavalent chromium, total organic carbon. See Appendix A and B for complete list of analytes.	Depth- and width-integrated isokinetic sample representative of entire river cross-section using Teflon samplers. Sample transferred to Teflon churn in on-site mobile lab for complete homogenization prior to sample processing.	Wilde and others, 2004; Davis and the Federal Interagency Sedimentation Project, 2005; USGS NFM, variously dated.	Analytical Resources, Inc. (ARI), Tukwila, WA and AXYS Analytical Services LTD (AXYS), British Columbia, Can.	-
3	Water chemistry (VOCs)	Volatile Organic Compounds (VOCs) (µg/l). See Appendix A and B for complete list of analytes.	USGS hand-held VOC sampler designed to minimize chemical loss. Sample collected at 60% of depth at the centroid of flow.	Shelton, 1997.	ARI	-
4	Suspended sediment physical parameters	Characterization of abundance of suspended sediment in a volume of water, expressed as suspended sediment concentration (SSC, mg/L). Characterization of size distribution of suspended sediment particles, expressed as a particle size distribution (PSD).	Depth- and width-integrated isokinetic sample representative of entire river cross-section. This cross-section sample will be collected immediately after the water chemistry cross-section sample using USGS suspended sediment sampling protocol.	Edwards and Glysson, 1999; Radke and others, 2005.	USGS Cascades Volcano Observatory Sediment Laboratory (CVO), Vancouver, WA	No chemical analyses will be conducted on these samples. Results will be interpreted with the suspended sediment chemistry sampling results (Task 5) to assess potential load of suspended sediment-bound chemicals.

Table 2 (continued from previous page). Summary of field collection tasks, parameters collected, collection methods, references, and laboratories completing each task. Task numbers correspond to the task numbers discussed in the text.

Task No.	Task Description	Parameter Collected	Collection Method	Published Collection Methods	Laboratory	Notes
5	Suspended sediment chemistry	Dioxins, Furans, PCB Aroclors and 209 congeners, Semivolatile Compounds, PAHs, Pesticides, Tributyl tin, Trace Elements (metals) including mercury and hexavalent chromium, VOCs, total organic carbon. See Appendix A and B for complete list of analytes.	Concurrent with water chemistry sampling, 1000-2000 liters of sediment-laden river water will be pumped at 60% of depth at centroid of flow through a Teflon tube into Teflon-lined buckets. Suspended sediment will be separated the from water by flow-through centrifuge for chemical analysis.	Sample collection methods developed as part of this project. Sediment handling methods: Shelton and Capel, 1994.	ARI and AXYS	An additional 5-10 liters of water will be pumped to compare SSC and PSD in the pumped sample to SSC and PSD in the depth- and width-integrated sample (Task 4). Also, the centrifuge effluent water will be analyzed for SSC and PSD to determine efficiency rates and the size distribution of un-captured sediment.
6	Bed sediment chemistry	Dioxins, Furans, PCB Aroclors and 209 congeners, Semivolatile Compounds, PAHs, Pesticides, Tributyl tin, Trace Elements (metals) including mercury and hexavalent chromium, VOCs, total organic carbon. See Appendix A and B for complete list of analytes. Also grain size.	The top 10 cm of sediment from a minimum of 10 depositional areas containing fine-grained particles located within 1000 m up- or down-stream of site will be collected and composited with Teflon and glass sampling equipment. All samples sieved to <2 mm. Trace element and mercury samples sieved with nylon sieve. Organic samples sieved with stainless steel sieve.	Radke and others, 2005; Shelton and Capel, 1994; Ecology, 2008.	ARI and AXYS	If excess sediment is collected, additional sample may be wet sieved through a 63 μm sieve to assess differences in sediment chemistry between the fine fraction (<63 μm) and the sand fraction (63 μm < x < 2mm).

Task 4) Suspended sediment physical parameters. After completing one cross-section of depth- and width-integrated isokinetic sampling for water chemistry, a second cross-section of depth- and width-integrated isokinetic sampling will be completed to characterize the abundance and size distribution of suspended sediment using standard USGS protocols (Edwards and Glysson 1999, Radke and others, 2005). Again, approved samplers, nozzles, bags, and bottles will be used. The volume of water collected will depend on current sediment conditions, and is expected to range between 5 and 50 L. The samples will be stored until transport to CVO for analysis of SSC and PSD. These samples will not receive any chemical analyses, but will be used to characterize the abundance and size distribution of suspended sediment at the time of concurrent suspended sediment chemistry sampling (see below). An accurate representation of the abundance and size distribution of suspended sediment will be combined with the suspended sediment chemistry sampling results (see Task 5) to help assess the potential load of suspended sediment-bound chemicals being transported downstream.

Task 5) Suspended sediment chemistry. Concurrent with tasks 3) and 4), a separate team will pump river water from a point source through Teflon tubing into sequential 5-gallon buckets lined with Teflon bags for suspended sediment chemistry analysis. An ISCO pump (Teledyne ISCO, Lincoln, Nebraska) or similar non-screened, high-flow pumping device will be used. The point-sampling location will be located at a depth approximately 0.6 times the main channel depth in a section favoring fine particulates as determined based on ADCP data during each sampling trip. The volume of water collected will depend on the current river turbidity and sediment conditions, and will likely be between 1000 and 2000 liters (50 to 100 5-gallon buckets). The sample-filled Teflon bags will be closed, sealed in their bucket, labeled, and transported to the Washington Water Science Center for concentration of suspended sediment using flow-through centrifuges (see Sample Processing). Sediment collected from the centrifuge will be analyzed for those compounds listed in Appendix A and B. A sample of pumped water will also be collected into a large container for analysis of SSC and PSD at CVO to compare to the results from the representative samples collected in Task 4. During low-flow/low-turbidity sampling events, a follow-up site visit to collect additional water for centrifugation may be necessary, and will occur during the next feasible low tide condition.

Task 6) Bed sediment chemistry. A bed sediment sample will be collected during five non-storm events, which may occur on the same day as Tasks 1 - 5 or during lower flow conditions preceding or succeeding the other sampling activities. Samples will be collected according to Ecology and USGS protocols (Ecology, 2008; Radke and others, 2005; Shelton and Capel, 1994) for the same suite of chemical parameters as the suspended sediment samples (Appendix A and B) and grain size analysis. Depending on the conditions, the samples will be collected from the bridge, bank, or boat. Samples (0-10 cm depth) from multiple locations near the site will be composited into a single sample. Locations will be selected to focus on areas with a high deposition of fine material. The composited sample immediately will be processed in an on-site mobile laboratory (see Sample Processing).

Sample Processing

Dissolved Water Chemistry Sample Processing (see Task 3 above)
In the mobile laboratory, the composited water sample will be churned according to USGS protocols (U.S. Geological Survey, variously dated) to ensure sample homogenization prior to bottle filling. Pre-acidified bottles will be used for samples requiring preservation (See Table 3). Labels will be completed and samples will be stored on ice until transportation within 6 hours to ARI for analysis.

Suspended Sediment Chemistry Sample Processing (see Task 5 above)
At the Washington Water Science Center Field Services Unit located in Tacoma, WA, water from the 5-gallon Teflon bags will be pumped into a continuous flow-through centrifuge (CFC Express, Scientific Methods, Inc., Granger, IN) to concentrate the suspended sediment (Figure 4). The centrifuge runs at a fixed speed of 10,000 revolutions per minute, and preliminary testing suggests that the inflow rate be no more than 300 mL/min to ensure sediment capture efficiencies greater than 90 % (by weight). Water samples will be pumped from the buckets using Teflon tubing, C-FLEX, and a peristaltic pump into the centrifuge. At a flow rate of 300 mL/min, approximately one bucket per hour can be centrifuged. With two flow-through centrifuge units running in parallel, approximately 25 to 50 hours of centrifugation will be required for each sampling event. Pre-centrifuged water in buckets will be kept at 4 °C until centrifugation. Periodically, concentrated sediment from the centrifuge bowl will be composited in a pre-tared glass jar and stored quiescently at 4 °C. Excess overlying water will be decanted by pipette. The total wet weight of the sediment will be recorded. In addition, SSC of centrifuge influent and effluent will be compared to determine sediment capture efficiency. Finally, the PSD of un-captured sediment in the centrifuge effluent will be determined during each sampling event.

If sufficient suspended sediment is collected exceeding the mass requirements for the methods listed in Table 3 (approximately 100-150 g), a subset of the sediment sample will be separated by size fraction (sand and fine) by wet sieving. Using a 63 µm Viton mesh supported by a Teflon ring, the sediment will be wet sieved into a fines fraction (<63 µm) and a sand fraction (63 µm to 2 mm). Each size fraction will be sent to ARI for chemical analysis (see Analytical Methods section below). Contaminant concentrations associated with each size fraction will be compared to results from the whole (un-sieved) sediment sample to assess the proportion of contaminants associated with each size fraction. This information may inform the analytical scheme for future projects regarding the need to analyze all size fractions or focus on one size fraction, such as the fines less than 63 µm in diameter.

Table 3. Method, sample container, minimum sediment required, preservative, and holding time of each parameter group.

Analytical Parameter	EPA Method	Sample Container		Min. Sed. Required (dry weight)	Preservative	Holding Time	
		Water	Sediment			Water	Sediment
Dioxins, Furans, and 209 PCB congeners	1613/1668	2 x 500 mL AG	8 oz. WMG (amber)	10 g	Cool ≤ 6 °C	7 d	14 d
Semivolatile Compounds	8270D	2 x 500 mL AG	8 oz. WMG	15 g	Cool ≤ 6 °C	7 d	14 d
Polycyclic Aromatic Hydrocarbons (PAHs)	8270-SIM LL	2 x 500 mL AG	8 oz. WMG	15 g	Cool ≤ 6 °C	7 d	14 d
Polychlorinated biphenyls (PCBs)	8082 LL	2 x 500 mL AG	8 oz. WMG	15 g	Cool ≤ 6 °C	7 d	14 d
Pesticides	8081	2 x 500 mL AG	8 oz. WMG	15 g	Cool ≤ 6 °C	7 d	14 d
Tributyl tin	Krone	2 x 500 mL AG	8 oz. WMG	5 g	Cool ≤ 6 °C	7 d	14 d
Trace Elements (metals)	200.8	500 mL HDPE	4 oz. WMG	2 g	2.5 mL 1:1 HNO3[1]	6 mo	6 mo
Mercury	7470-LL	500 mL HDPE	4 oz. WMG	2 g	5 mL 1:1 HNO3[1]	28 d	28 d
Hexavalent Chromium	7196	500 mL HDPE	4 oz. WMG	5 g	Cool ≤ 6 °C	24 hr	28 d
Volatile Organic Compounds	8260	3 x 40 mL vial, no headspace	2 oz. WMGS (no headspace)	5 g	Cool ≤ 6 °C	7 d	14 d
Total organic carbon	415.1	250 mL AG	-	-	Cool ≤ 6 °C + pH <2 w/ 2mL H2SO4	28 d	-
Total organic carbon	Plumb 1981	-	4 oz. WMG	1 g	Cool ≤ 4 °C	-	14 d
Total solids		-	4 oz. WMG	5 g	Cool ≤ 6 °C	-	14 d
Grain size	PSEP	-	16 oz. WMP	50 g	Cool ≤ 6 °C	-	14 d

[1] Preservation for water samples only
AG = amber glass Boston round bottle
HDPE = high-density polypropylene
WMG = wide-mouth glass jar
WMGS = wide-mouth glass jar with septa
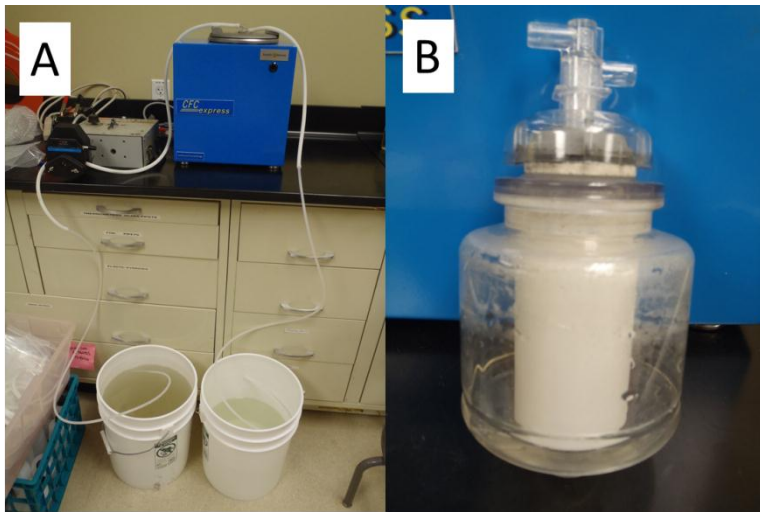
Figure 4. Flow-through centrifuge set-up (*a*) and centrifuge bowl (*b*).

Bed Sediment Chemistry Sample Processing (see Task 6 above)
The bed sediment sample will be composited and homogenized using a Teflon spatula in the mobile laboratory immediately after sample collection. All sediment will be wet sieved through a 2 mm diameter sieve prior to jar filling. Samples for metals analysis will be processed through a plastic sieve (cleaned in soap, water, dilute hydrochloric acid, and methanol), and samples for all other analyses will be processed through a stainless steel sieve (cleaned in soap, water, and methanol). Similar to the suspended sediment processing described in the previous paragraph, if sufficient bed sediment is collected, a wet sieving technique will be tested to separate the sample into a fines fraction (<63 μm) and a sand fraction (63 μm to 2 mm) for analysis. Standard USGS protocol (Shelton and Capel 1994) describes analysis of organic compounds on sediment <2 mm in diameter, and analysis of trace elements on sediment <63 μm in diameter. We will test the feasibility of applying this protocol to the current site during the first bed sediment sampling events.

Analytical Methods

Samples of water (Task 3), suspended sediment (Task 5), and bed sediment (Task 6) will be analyzed for a suite of over 200 chemical parameters (Appendix A), TOC, and total solids and grain size (sediment samples only) at ARI. ARI is a Washington State-accredited laboratory providing low-level organic and inorganic analyses. The parameters groups and EPA Method are listed in Table 3. Found in Appendix A, for both water and sediment, are all the ARI analytes listed individually with the following information:

- EPA Method number,
- Detection Limit (DL) – the lowest result that can be reliably distinguished from a blank with a false positive rate ≤ 1%,
- Limit of Detection (LOD) - the lowest result that can be reliably distinguished from a blank based on historical method blank detections, according to NELAP certification requirements,
- Expected Limit of Quantitation (LOQ) – the smallest detectable concentration of analyte greater than the LOD that meets specific criteria with respect to precision and accuracy based upon method performance of samples spiked at or near the LOQ with a false negative rate ≤ 5%,
- Control limits for laboratory matrix spikes (as percent recovery), and

- Control limits for laboratory replicates (as RPD).

ARI's results will be reported to the LOQ with J-flagging down to the LOD. ARI's Quality Assurance Plan, which includes information such as continuing calibration data for each method, can be found at: http://www.arilabs.com/portal/index.php?option=com_remository&Itemid=51&func=fileinfo&parent=category&filecatid=16.

ARI's Data Reporting Qualifiers can be found at: http://www.arilabs.com/portal/index.php?option=com_remository&Itemid=51&func=fileinfo&parent=category&filecatid=87.

In addition, samples will be analyzed for dioxins, furans, and the full suite of 209 PCB congeners through a subcontract to AXYS Analytical Services Ltd. (AXYS), located in British Columbia, Canada (http://www.axysanalytical.com/). AXYS also is a Washington State-accredited laboratory specializing in ultra-trace analysis of persistent organic pollutants and emerging contaminants. Found in Appendix B, for both water and sediment, are the AXYS analytes listed individually with the following information:

- EPA Method number,
- Typical Sample-specific Detection Limit (SDL) – the concentration equivalent to 3 times the estimated chromatographic noise height, determined individually for every sample analysis run,
- Lower Method Calibration Limit (LMCL) – determined by prorating the concentration of the lowest calibration limit for sample size and extract volume. The following equation is used: ((lowest level calibration standard) x (extract volume))/sample size,
- On-going precision and recovery (OPR) for laboratory matrix spikes (as percent recovery), and
- Control limits for replicates (as RPD).

AXYS results will be reported to the LMCL and J-flagged down to the SDL, as consistent with standard State of Washington protocols.

A minimum of 100 to 150 g of sediment is required to complete the chemical analyses. During low-turbidity sampling events, even with consecutive days of water collection, there may be insufficient sediment concentrated from the centrifuge to complete all 11 methods. In these cases, a priority list of analytical methods will be followed (with #1 being the top priority):

1. Total solids (always completed; needed to report a dry weight concentration)
2. Total organic carbon
3. Dioxins/Furans/PCB Congeners (a single co-extraction by AXYS)
4. PCB Aroclors
5. PAHs
6. Metals (including mercury)
7. Semivolatile compounds
8. Pesticides
9. Hexavalent Chromium
10. Tributyl tin
11. Volatile organic compounds

The VOCs are the lowest priority because, based on their volatility and the turbulent sampling techniques (pumping and centrifuging), analyte losses during sediment collection are likely. All efforts will be made to collect

sufficient sediment to complete all 11 methods, and it is expected that there will be sufficient sediment to analyze the priority methods (#1-6) in all situations.

Quality Control Procedures

USGS quality assurance procedures for surface-water measurements and water-quality sampling and analysis will be followed (Wagner and others, 2007; U.S. Geological Survey, variously dated). This includes the proper equipment selection, cleaning procedures, and sampling protocols for low level organic compounds, VOCs, and metals. Sampling equipment for chemical analyses will be Teflon and will be pre-cleaned with phosphate-free soap, rinsed three times with tap water, soaked in 5% hydrochloric acid, rinsed with deionized water, rinsed with high purity methanol, and air dried. Field sampling techniques include various measures to avoid sample contamination including the "clean hands, dirty hands" technique and processing of water samples in a clean mobile laboratory. Hydrologists and hydrological technicians on this project have been trained at the National Training Center in the collection of water quality samples, including samples for trace organic and low level mercury analyses.

The field folder will include copies of the QAPP and the protocols referenced within. Deviations from the QAPP will be noted on the field sheet. Detections of parameters above the reporting level in the field and/or equipment blank indicate the introduction of contamination during the cleaning, sampling, handling, and processing of the environmental samples. Data will be qualified as described in the USGS Office of Water Quality Technical Memorandum 2012.01 (http://water.usgs.gov/admin/memo/QW/) which states that detections less than 3 times the blank concentration be given a "<" qualifier ("less than" the detected concentration) while detections between 3 and 10 times the blank concentration be given an "E" code (for "estimated"). Detections greater than 10 times the blank concentration will not be qualified. The water and bed sediment field replicates will be reviewed as an indication of field variability.

Results from laboratory quality assurance samples (a blank, replicate, and matrix spike per batch of 20 samples) will be reviewed by laboratory personnel. If values exceed control limits (Appendix A and B) then laboratory personnel will take appropriate corrective actions such as re-runs and re-extractions and/or discuss modifications to the protocol with the principal investigator.

While both analytical laboratories (ARI and AXYS) are State-accredited, they are not associated with the USGS's National Water Quality Laboratory and do not perform the same QA/QC procedures necessary to permit immediate inclusion in the USGS's national and publically accessible database. Therefore, some additional project resources will be used to perform the necessary quality assurance examination of the data that will allow the USGS to include the results in its database. A Laboratory Evaluation Program (LEP) will be conducted by project personnel according to the guidance provided by the USGS Branch of Quality Systems (http://devbqs.cr.usgs.gov/LEP/index.php) and in accordance with USGS Office of Water Quality Technical Memorandum 2007.01.

Data Management, Verification, and Validation

A field form, modified from the standard USGS Surface Water Quality Notes, will be completed during each sampling event. Field parameters recorded will include date, time, sampling team, field conditions, sampler types, sampling methods, meter and probe serial numbers and calibration information, number and type of quality assurance samples collected, and any deviations from the sampling protocol.

Field parameters, including water temperature, specific conductance, dissolved oxygen, pH, and turbidity will be compiled on the field form and reviewed by one of the USGS principal investigators prior to entry into the USGS National Water Information System (NWIS). The instantaneous discharge record during each sampling event will be worked up according to standard USGS protocols (Mueller and Wagner, 2009), which includes verification and validation by secondary and tertiary reviewers, prior to entry into NWIS. Quality-assurance procedures used by the Washington Water Science Center for activities related to the collection, processing, storage, analysis, and publication of surface-water data are described in detail by Kresch and Tomlinson (2004).

Quality assurance procedures utilized by USGS sediment laboratories for analysis of suspended-sediment concentration are provided by Knott and others (1992; 1993) and Matthes and others (1992). Prior to sending samples to the laboratory, analytical services requests for determination of suspended-sediment concentration and particle-size analysis and sample site and other information are entered into the Sediment Laboratory Environmental Data System (SLEDS). The laboratory results are also entered into the system. Documentation of SLEDS is available online at http://eris.wr.usgs.gov/SedLab/framework.html.

All analytical results from AXYS and ARI will be compiled and transmitted to the USGS Washington Water Science Center. The Level 2 deliverable includes a hard-copy written narrative and tables of results including quality assurance information. The data will also be delivered electronically in two formats – one that is compatible for entry into Ecology's Environmental Information Management (EIM) database and one that is compatible for entry into USGS's NWIS. New parameter codes and/or method codes specific to this project will be requested as necessary for the water quality database of NWIS.

All data, including the field parameters, physical sediment results, and analytical chemistry results, will be reviewed and validated by Washington Water Science Center project personnel, equivalent to an EPA Level 3 data package. Subsequently, the Center's Water Quality Specialist will review the data as a 3rd-party independent reviewer, comparable to an EPA Level 4 data package. Data qualifiers or flags may be applied to data by either laboratory or project personnel pending review of quality assurance data and the Center's Water Quality Specialist. Common data qualifiers include, but are not limited to:

B   Analyte detected in method blank
J   Estimated concentration is less than established reporting limits
E   Estimated concentration above the valid instrument calibration range

Data that has been flagged or qualified by the laboratory or during the USGS review process will be reported as measured with the qualifier, unless an alternative reporting method is deemed necessary. The USGS review process follows the USGS' Fundamental Science Practices (http://www.usgs.gov/fsp/default.asp) to provide unbiased, objective, and impartial scientific information. Reviewed data will be entered into both Ecology and USGS database systems for long-term storage and access.

Reporting

Tidal exchange information at the site (for example, discrete measurements of stage, discharge, and SSC compared to nearby continuous measurements of stage and discharge) will be combined with chemistry data to determine preliminary estimates of net downstream loading of sediment, sediment-bound contaminants, and dissolved contaminants. A draft of the data report, in the form of a USGS Data Series Publication, will be prepared with the available data in early summer 2013 and submitted to Ecology by June 30, 2013. The draft will contain tables of concentration results for all analytes and other parameters in water, suspended sediment, and bed sediment for each of the five sampling events. The concentrations will be compared to published criteria, when

available. Preliminary loading calculations will be presented based on discharge and dissolved concentrations (for dissolved loading) and discharge, SSC, and particulate-bound contaminants (for particulate-bound loading). For analytes that are not detected during the study, a loading calculation will be calculated based on the reporting limit and reported as "less than" the calculated value. For analytes that are detected during some, but not all, sampling events, a value of one half of the reporting level will be used for the non-detects to calculate the loading, and the data will be qualified. The results from this 5-month study will provide preliminary information about the types of toxic chemicals that have the potential to reach the LDW from the Green River, and will inform future investigations for improving these loading estimates.

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Appendix A. List of analytes, methods, detection limit (DL), limit of detection (LOD), limit of quantitation (LOQ), control limits for laboratory control samples (LCS) matrix spikes (MS), as percent recovery, and control limits for laboratory replicate samples (as relative percent difference, RPD), from Analytical Resources, Inc. for water, suspended sediment, and bed sediment samples.

LOD, LOQ and Control Limits Summary
GC - MS – SVOA Analysis of Aqueous Samples
EPA Method 8270D
ARI Analysis: BANWLI & BANWSI

Continuous Liquid-Liquid (EPA Method 3520C, Bench Sheet 3006F) or Separatory Funnel (EPA method 3510C, Bench Sheet 3010F) extraction using 500mL sample concentrated to 0.5 mL final extract volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS, MS Recovery[2,3]	Replicate RPD[4]
Phenol	0.445	0.5	1	26 – 112	≤ 40
Bis(2-Chloroethyl)ether	0.257	0.5	1	51 – 100	≤ 40
2-Chlorophenol	0.246	0.5	1	50 – 100	≤ 40
1,3-Dichlorobenzene	0.499	0.5	1	27 – 100	≤ 40
1,4-Dichlorobenzene	0.470	0.5	1	29 – 100	≤ 40
1,2-Dichlorobenzene	0.436	0.5	1	32 – 100	≤ 40
Benzyl alcohol	0.409	1.0	2	10 - 128	≤ 40
2,2'-oxybis(1-Chloropropane)	0.221	0.5	1	39 - 101	≤ 40
2-Methylphenol	0.329	0.5	1	47 – 100	≤ 40
Hexachloroethane	0.610	1.0	2	19 – 100	≤ 40
N-Nitroso-di-n-propylamine	0.365	0.5	1	46 – 100	≤ 40
4-Methylphenol	0.536	1.0	2	46 – 100	≤ 40
Nitrobenzene	0.490	0.5	1	46 – 103	≤ 40
Isophorone	0.258	0.5	1	62 – 105	≤ 40
2-Nitrophenol	0.979	1.5	3	32 – 116	≤ 40
2,4-Dimethylphenol	0.627	1.5	3	15 – 100	≤ 40
Bis(2-Chloroethoxy)methane	0.252	0.5	1	44 – 100	≤ 40
2,4-Dichlorophenol	1.109	1.5	3	35 – 114	≤ 40
1,2,4-Trichlorobenzene	0.495	0.5	1	34 – 100	≤ 40
Naphthalene	0.326	0.5	1	48 – 100	≤ 40
Benzoic acid	8.647	10	20	10 - 172	≤ 40
4-Chloroaniline	1.733	2.5	5	10 - 153	≤ 40
2,6-Dinitrotoluene	1.300	1.5	3	32 – 129	≤ 40
Hexachlorobutadiene	0.604	1.5	3	22 – 100	≤ 40
4-Chloro-3-methylphenol	0.919	1.5	3	33 – 123	≤ 40
Hexachlorocyclopentadiene	1.862	2.5	5	10 – 100	≤ 40
2,4,6-Trichlorophenol	1.235	1.5	3	37 – 120	≤ 40
2,4,5-Trichlorophenol	1.706	2.5	5	37 – 124	≤ 40
2-Chloronaphthalene	0.340	0.5	1	49 – 100	≤ 40
2-Nitroaniline	0.784	1.5	3	18 – 140	≤ 40
Acenaphthylene	0.274	0.5	1	47 – 110	≤ 40
Dimethylphthalate	0.264	0.5	1	60 – 106	≤ 40
Acenaphthene	0.347	0.5	1	55 – 101	≤ 40

LOD, LOQ and Control Limits Summary
GC - MS – SVOA Analysis of Aqueous Samples
EPA Method 8270D
ARI Analysis: BANWLI & BANWSI

Continuous Liquid-Liquid (EPA Method 3520C, Bench Sheet 3006F) or Separatory Funnel (EPA method 3510C, Bench Sheet 3010F) extraction using 500mL sample concentrated to 0.5 mL final extract volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS, MS Recovery[2,3]	Replicate RPD[4]
3-Nitroaniline	1.140	1.5	3	**10** – 208	≤ 40
2-Methylnaphthalene	0.241	0.5	1	38 – **100**	≤ 40
2,4-Dinitrophenol	5.474	10	20	**10** – 224	≤ 40
Dibenzofuran	0.198	0.5	1	46 – 108	≤ 40
4-Nitrophenol	2.895	5.0	10	**10** – 103	≤ 40
2,4-Dinitrotoluene	1.277	1.5	3	33 – 134	≤ 40
Fluorene	0.266	0.5	1	59 – 108	≤ 40
4-Chlorophenyl-phenylether	0.342	0.5	1	54 – 104	≤ 40
Diethylphthalate	0.407	0.5	1	60 - 108	≤ 40
4-Nitroaniline	1.366	1.5	3	13 – 144	≤ 40
4,6-Dinitro-2-methylphenol	4.928	5.0	10	**10** – 190	≤ 40
N-Nitrosodiphenylamine	0.392	0.5	1	39 – 100	≤ 40
4-Bromophenyl-phenylether	0.262	0.5	1	56 – 105	≤ 40
Hexachlorobenzene	0.335	0.5	1	54 – 108	≤ 40
Pentachlorophenol	2.746	5.0	10	25 – 144	≤ 40
Phenanthrene	0.283	0.5	1	64 – 115	≤ 40
Anthracene	0.303	0.5	1	59 – 107	≤ 40
Carbazole	0.251	0.5	1	36 – 123	≤ 40
Di-n-butylphthalate	0.304	0.5	1	62 – 110	≤ 40
Fluoranthene	0.290	0.5	1	63 – 119	≤ 40
Pyrene	0.379	0.5	1	57 – 117	≤ 40
Butylbenzylphthalate	0.402	0.5	1	49 – 118	≤ 40
Benzo(a)anthracene	0.373	0.5	1	61 – 113	≤ 40
3,3'-Dichlorobenzidine	1.553	2.5	5	**10** – 151	≤ 40
Chrysene	0.397	0.5	1	62 – 115	≤ 40
bis(2-Ethylhexyl)phthalate	1.050	1.5	3	47 – 127	≤ 40
Di-n-octylphthalate	0.331	0.5	1	60 – 106	≤ 40
Benzo(b)fluoranthene	0.298	0.5	1	61 – 120	≤ 40
Benzo(k)fluoranthene	0.487	0.5	1	59 – 120	≤ 40
Benzo(a)pyrene	0.425	0.5	1	46 – 105	≤ 40
Indeno(1,2,3-cd)pyrene	0.435	0.5	1	42 – 134	≤ 40
Dibenzo(a,h)anthracene	0.437	0.5	1	46 – 132	≤ 40
Benzo(g,h,i)perylene	0.464	0.5	1	33 – 135	≤ 40
N-Nitrosodimethylamine	1.209	1.5	3	17 - 106	≤ 40

LOD, LOQ and Control Limits Summary GC - MS – SVOA Analysis of Aqueous Samples EPA Method 8270D ARI Analysis: BANWLI & BANWSI					

Continuous Liquid-Liquid (EPA Method 3520C, Bench Sheet 3006F) or Separatory Funnel (EPA method 3510C, Bench Sheet 3010F) extraction using 500mL sample concentrated to 0.5 mL final extract volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS, MS Recovery[2,3]	Replicate RPD[4]
Aniline	**0.470**	**0.5**	**1**	**10** – 113	≤ 40
1-methylnaphthalene	**0.199**	**0.5**	**1**	43 – **100**	≤ 40
Azobenzene (1,2-DP-Hydrazine)	**0.214**	**0.5**	**1**	52 – 111	≤ 40
Benzofluoranthenes, Total	**2.317**	**2.5**	**5**	60 – 130[5]	≤ 40
Surrogate Standard Recovery			**MB / LCS**	**Samples**	**RPD**
2-Fluorophenol			33 – 100	23 – **100**	≤ 40
Phenol-d_5			15 - 121	16 – 106	≤ 40
2-Chlorophenol-d_4			46 – 102	33 – 100	≤ 40
1,2-Dichlorobenzene-d_4			40 – **100**	27 – **100**	≤ 40
Nitrobenzene-d_5			50 – **100**	34 – 101	≤ 40
2-Fluorobiphenyl			51 – **100**	38 – **100**	≤ 40
2,4,6-Tribromophenol			46 – 125	31 – 128	≤ 40
p-Terphenyl-d_{14}			54 – 117	27 – 122	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ) are defined in ARI SOP 1018S
(2) Control limits calculated using all data from 8/1/10 through 7/31/11.
(3) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(4) Relative Percent Difference between analytes in replicate analyzes.   If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O + C_D}{2}} x100$$

(5) 30 – 160 are default limits used when there is insufficient data to calculate historic control limits.

DL[1] LOD[1], LOQ[1] and Control Limits Summary
GC - MS – SVOA Analysis of Sediment EPA
Method 8270 Full Scan & SIM

Microwave Extraction (EPA Method 3546, Bench Sheet 3093F) - 10 g sample with extract concentrated to 1 mL final volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	Full Scan Analysis			SIM Analysis			LCS,MS Control Limits (%)	RPD[2]
	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)		
Phenol	8.65	10	**20**	2.56	5	**5**	30 – 160	≤ 40
bis-(2-Chloroethyl)ether	3.35	10	**20**	--	--	--	30 – 160	≤ 40
2-Chlorophenol	2.39	10	**20**	--	--	--	30 – 160	≤ 40
1,3-Dichlorobenzene	2.63	10	**20**	1.31	2.5	**5**	30 – 160	≤ 40
1,4-Dichlorobenzene	2.86	10	**20**	1.19	2.5	**5**	30 – 160	≤ 40
1,2-Dichlorobenzene	2.50	10	**20**	1.10	2.5	**5**	30 – 160	≤ 40
Benzyl alcohol	6.09	10	**20**	7.04	10	**20[3]**	30 – 160	≤ 40
2,2'-oxy-*bis*-(1-Chloropropane)	3.76	10	**20**	--	--	--	30 – 160	≤ 40
2-Methylphenol	5.25	10	**20**	1.81	2.5	**5**	30 – 160	≤ 40
Hexachloroethane	2.94	10	**20**	--	--	--	30 – 160	≤ 40
N-Nitroso-di-n-propylamine	3.36	10	**20**	9.48	10	**12[3]**	30 – 160	≤ 40
4-Methylphenol [6]	6.63	10	**20**	2.52	5	**10**	30 – 160	≤ 40
Nitrobenzene	4.06	10	**20**	--	--	--	30 – 160	≤ 40
Isophorone	2.86	10	**20**	--	--	--	30 – 160	≤ 40
2-Nitrophenol	38.7	50	**100**	--	--	--	30 – 160	≤ 40
2,4-Dimethylphenol	3.46	20	**40**	2.89	10	**20**	30 – 160	≤ 40
bis-(2-Chloroethoxy)methane	2.00	10	**20**	--	--	--	30 – 160	≤ 40
2,4-Dichlorophenol	21.5	100	**200**	--	--	--	30 – 160	≤ 40
1,2,4-Trichlorobenzene	3.48	10	**20**	1.86	2.5	**5**	30 – 160	≤ 40
Naphthalene	2.76	10	**20**	--	--	--	30 – 160	≤ 40
Benzoic acid	101	200	**400[5]**	--	--	--	30 – 160	≤ 40
4-Chloroaniline	22.3	135	**270[4]**	--	--	--	30 – 160	≤ 40
Hexachlorobutadiene	4.57	10	**20**	0.96	2.5	**5**	30 – 160	≤ 40
4-Chloro-3-methylphenol	15.1	50	**100**	--	--	--	30 – 160	≤ 40
2-Methylnaphthalene	3.06	10	**20**	--	--	--	30 – 160	≤ 40
Hexachlorocyclopentadiene	66.4	200	**400[4]**	--	--	--	30 – 160	≤ 40
2,4,6-Trichlorophenol	22.4	50	**100**	--	--	--	30 – 160	≤ 40
2,4,5-Trichlorophenol	21.4	50	**100**	--	--	--	30 – 160	≤ 40
2-Chloronaphthalene	2.64	10	**20**	--	--	--	30 – 160	≤ 40
2-Nitroaniline	18.4	50	**100**	--	--	--	30 – 160	≤ 40
Acenaphthylene	5.71	10	**20**	--	--	--	30 – 160	≤ 40
Dimethylphthalate	2.90	10	**20**	1.34	2.5	**5**	30 – 160	≤ 40
2,6-Dinitrotoluene	30.6	50	**100**	--	--	--	30 – 160	≤ 40
Acenaphthene	3.28	10	**20**	--	--	--	30 – 160	≤ 40
3-Nitroaniline	22.5	50	**100**	--	--	--	30 – 160	≤ 40

DL[1] LOD[1], LOQ[1] and Control Limits Summary
GC - MS – SVOA Analysis of Sediment
EPA Method 8270 Full Scan & SIM

Microwave Extraction (EPA Method 3546, Bench Sheet 3093F) - 10 g sample with extract concentrated to 1 mL final volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	Full Scan Analysis			SIM Analysis			LCS,MS Control Limits (%)	RPD[2]
	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)		
2,4-Dinitrophenol	111	425	850[4]	--	--	--	30 – 160	≤ 40
Dibenzofuran	4.10	10	20	--	--	--	30 – 160	≤ 40
4-Nitrophenol	34.7	50	100	--	--	--	30 – 160	≤ 40
2,4-Dinitrotoluene	19.5	50	100	--	--	--	30 – 160	≤ 40
Fluorene	4.35	10	20	--	--	--	30 – 160	≤ 40
4-Chlorophenyl-phenylether	5.29	10	20	--	--	--	30 – 160	≤ 40
Diethylphthalate	36.6	50	50[3]	3.26	5.0	5.0	30 – 160	≤ 40
4-Nitroaniline	37.9	50	100	--	--	--	30 – 160	≤ 40
4,6-Dinitro-2-methylphenol	21.2	100	200	--	--	--	30 – 160	≤ 40
N-Nitrosodiphenylamine	5.39	10	20	1.38	10	20	30 – 160	≤ 40
4-Bromophenyl-phenylether	5.03	10	20	--	--	--	30 – 160	≤ 40
Hexachlorobenzene	4.29	10	20	1.26	2.5	5	30 – 160	≤ 40
Pentachlorophenol	48.5	100	200[4]	14.3	25	50	30 – 160	≤ 40
Phenanthrene	3.64	10	20	--	--	--	30 – 160	≤ 40
Anthracene	4.50	10	20	--	--	--	30 – 160	≤ 40
Carbazole	2.69	10	20	--	--	--	30 – 160	≤ 40
Di-n-butylphthalate	8.16	10	20	--	--	--	30 – 160	≤ 40
Fluoranthene	2.91	10	20	--	--	--	30 – 160	≤ 40
Pyrene	1.94	10	20	--	--	--	30 – 160	≤ 40
Butylbenzylphthalate	6.14	10	20	2.89	5.0	5	30 – 160	≤ 40
Benzo(a)anthracene	3.29	10	20	--	--	--	30 – 160	≤ 40
3,3'-Dichlorobenzidine	17.8	75	150[4]	--	--	--	30 – 160	≤ 40
Chrysene	3.75	10	20	--	--	--	30 – 160	≤ 40
bis-(2-Ethylhexyl)phthalate	14.6	20	25[3]	--	--	--	30 – 160	≤ 40
Di-n-octylphthalate	5.84	10	20	--	--	--	30 – 160	≤ 40
Benzo(b)fluoranthene [7]	3.47	10	20	--	--	--	30 – 160	≤ 40
Benzo(k)fluoranthene [7]	4.18	10	20	--	--	--	30 – 160	≤ 40
Benzofluoranthene-Total [8]	6.67	20	40	--	--	--	30 – 160	≤ 40
Benzo(a)pyrene	5.45	10	20	--	--	--	30 – 160	≤ 40
Indeno(1,2,3-cd)pyrene	4.68	10	20	--	--	--	30 – 160	≤ 40
Dibenzo(a,h)anthracene	4.31	10	20	2.02	2.5	5	30 – 160	≤ 40
Benzo(g,h,i)perylene	4.40	10	20	--	--	--	30 – 160	≤ 40
N-Nitrosodimethylamine	14.1	50	100	3.15	13	25	30 – 160	≤ 40
Aniline	40.0	270	540[4]	--	--	--	30 – 160	≤ 40
Pyridine	32.7	75	150[4]	--	--	--	30 – 160	≤ 40
1-Methylnaphthalene	2.68	10	20	--	--	--	30 – 160	≤ 40

DL[1] LOD[1], LOQ[1] and Control Limits Summary
GC - MS – SVOA Analysis of Sediment
EPA Method 8270 Full Scan & SIM

Microwave Extraction (EPA Method 3546, Bench Sheet 3093F) - 10 g sample with extract concentrated to 1 mL final volume

LOD Spike level = LOQ (unless otherwise noted)

Analyte	Full Scan Analysis			SIM Analysis			LCS,MS Control Limits (%)	RPD[2]
	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)	DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)		
Azobenzene (1,2-DP-Hydrazine)	2.98	10	**20**	--	--	--	30 – 160	≤ 40
Surrogate Standards						**MB / LCS**	**Samples**	**RPD**
2-Fluorophenol						30 – 160	30 – 160	≤ 40
Phenol-d$_5$						30 – 160	30 – 160	≤ 40
2-Chlorophenol-d$_4$						30 – 160	30 – 160	≤ 40
1,2-Dichlorobenzene-d$_4$						30 – 160	30 – 160	≤ 40
Nitrobenzene-d$_5$						30 – 160	30 – 160	≤ 40
2-Fluorobiphenyl						30 – 160	30 – 160	≤ 40
2,4,6-Tribromophenol						30 – 160	30 – 160	≤ 40
p-Terphenyl-d$_{14}$						30 – 160	30 – 160	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD), Limit of Quantitation (LOQ) are defined in ARI SOP 1018S

(2) Relative Percent Difference between analytes in replicate analyzes.   If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O + C_D}{2}} x100$$

(3) Spiked at 5 ppb
(4) Spiked at 100 ppb
(5) Spiked at 200 ppb
(6) 3-Methylphenol (not calibrated) co-elutes with 4-Methylphennol (calibrated)
(7) Benzo(b)fluoranthene and Benzo(k)fluoranthene are reported as separate analytes only when the height of the valley between the isomer peaks is less than than 50% of the average of the two peak heights, otherwise total Benzofluoranthenes are reported.
(8) Benzo(b)fluoranthene + Benzo(j)fluoranthene + Benzo(k)fluoranthene (only the b & k isomers are calibrated)

LOD[1], LOQ[2] and Control Limits Summary
Analysis of Water Samples for Low Concentration PNA
EPA Method 8270 – SIM
ARI Analysis: PNLWSL

Separatory Funnel Extraction (EPA Method 3510C) using 500 mL sample with extract concentrated to 0.5 mL final volume. Silica gel cleanup performed on extract prior to analysis. ARI bench Sheet 3071F

DL, LOD & LOQ units are nanograms per liter (ng/L) = parts-per-trillion (ppt). LOD Spike level = LOQ

Analyte	DL[1] ng/L	LOD[1] ng/L	LOQ[1] ng/L	LCS Control Limit [2]	Replicate RPD [3]
Naphthalene	0.85	**5**	**10**	37 – 90	≤ 40
2-Methylnaphthalene	0.72	**5**	**10**	39 – 90	≤ 40
Acenaphthylene	0.81	**5**	**10**	35 – 95	≤ 40
Acenaphthene	0.83	**5**	**10**	38 – 94	≤ 40
Dibenzofuran	0.94	**5**	**10**	36 – 94	≤ 40
Fluorene	1.41	**5**	**10**	41 – 102	≤ 40
Phenanthrene	1.01	**5**	**10**	41 – 101	≤ 40
Anthracene	0.58	**5**	**10**	28 – 101	≤ 40
Fluoranthene	0.92	**5**	**10**	49 – 114	≤ 40
Pyrene	0.70	**5**	**10**	42 - 114	≤ 40
Benzo(a)anthracene	1.27	**5**	**10**	42 – 111	≤ 40
Chrysene	1.57	**5**	**10**	46 – 106	≤ 40
Benzo(b)fluoranthene	2.54	**5**	**10**	39 – 119	≤ 40
Benzo(k)fluoranthene	0.85	**5**	**10**	50 – 117	≤ 40
Benzo(j)fluoranthene	1.65	**5**	**10**	30 – 160 [4]	≤ 40
Benzo(a)pyrene	1.14	**5**	**10**	20 – 99	≤ 40
Indeno(1,2,3-cd)pyrene	1.82	**5**	**10**	32 – 113	≤ 40
Dibenz(a,h)anthracene	0.97	**5**	**10**	30 – 113	≤ 40
Benzo(g,h,i)perylene	1.87	**5**	**10**	27 – 113	≤ 40
1-Methylnaphthalene	0.88	**5**	**10**	38 – 95	≤ 40
Perylene	3.21	**5**	**10**	30 – 160 [4]	≤ 40
Surrogate Standard Recovery			**MB / LCS**	**Samples**	**RPD**
2-Methylnapthalene-d$_{10}$			40 – 93	35 – 94	≤ 40
Dibenzo(a,h)anthracene-d$_{14}$			31 – 115	26 – 115	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ)are defined in ARI SOP 1018S

(2) Control limits calculated using data from all samples prepared between 4/1/11 through 3/31/12.

(3) Relative Percent Difference between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_o - C_D|}{\frac{C_O - C_D}{2}} x100$$

(4) Default limits pending generation of historic limits for Benzo(j)fluoranthene.

PNA Analysis of Soil / Sediment Samples
LOD[1], LOQ[2] and Control Limits Summary
EPA Method 8270D-SIM

10 gram sample to 0.5 mL final volume – Microwave extraction (EPA Method 3546) with Silica Gel Clean-up

	DL[1,2] μg/kg	LOD[1] μg/kg	LOQ[1] μg/kg	LCS % Recovery[3]	Replicate RPD[4]
Naphthalene	0.413	0.50	**0.6**	30 – 160	≤ 40
2-Methylnaphthalene	0.087	0.25	**0.5**	30 – 160	≤ 40
Acenaphthylene	0.133	0.25	**0.5**	30 – 160	≤ 40
Acenaphthene	0.141	0.25	**0.5**	30 – 160	≤ 40
Dibenzofuran	0.105	0.25	**0.5**	30 – 160	≤ 40
Fluorene	0.129	0.25	**0.5**	30 – 160	≤ 40
Phenanthrene	0.204	0.25	**0.5**	30 – 160	≤ 40
Anthracene	0.132	0.25	**0.5**	30 – 160	≤ 40
Fluoranthene	0.236	0.25	**0.5**	30 – 160	≤ 40
Pyrene	0.287	0.50	**0.5**	30 – 160	≤ 40
Benzo(a)anthracene	0.208	0.25	**0.5**	30 – 160	≤ 40
Chrysene	0.266	0.50	**0.5**	30 – 160	≤ 40
Benzo(b)fluoranthene	0.164	0.25	**0.5**	30 – 160	≤ 40
Benzo(k)fluoranthene	0.153	0.25	**0.5**	30 – 160	≤ 40
Benzo(j)fluoranthene	0.104	0.25	**0.5**	30 – 160	≤ 40
Benzo(a)Pyrene	0.097	0.25	**0.5**	30 – 160	≤ 40
Indeno(1,2,3-cd)Pyrene	0.154	0.25	**0.5**	30 – 160	≤ 40
Dibenz(a,h)Anthracene	0.178	0.25	**0.5**	30 – 160	≤ 40
Benzo(g,h,i)Perylene	0.166	0.25	**0.5**	30 – 160	≤ 40
1-Methylnaphthalene	0.190	0.25	**0.5**	30 – 160	≤ 40
Perylene	0.118	0.25	**0.5**	30 – 160	≤ 40
Surrogate Standard Recovery			**MB/LCS**	**Samples**	**RPD**
2-Methylnapthalene-d$_{10}$			30 – 160	30 – 160	≤ 40
Dibenzo(a,h)anthracene-d$_{14}$			30 – 160	30 – 160	≤ 40
Fluoranthene-d$_{10}$			30 – 160	30 – 160	≤ 40

(1) DetectionLimit (DL),Limit of Detection (LOD) and Limit of Quantitation (LOQ) as defined in ARI SOP 1018S.
(2) Spike concentration used to calculate the DL is 0.5 ng/kg.
(3) 30 – 160 are default values used when there is insufficient data to calculate historic control limits.
(4) Relative Percent Difference between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O + C_D}{2}} x100$$

DL[1] LOD[1], LOQ[1] and Control Limits Summary for VOA Analysis of Water 10 mL Purge Volume (EPA Method 8260C)

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS Recovery[2,4]	Replicate RPD[3]
Chloromethane	0.095	0.25	**0.5**	77 – 122	≤ 40
Vinyl Chloride	0.057	0.1	**0.2**	74 – 123	≤ 40
Bromomethane	0.252	0.5	**1.0**	68 – 130	≤ 40
Chloroethane	0.086	0.1	**0.2**	68 – 133	≤ 40
Trichlorofluoromethane	0.037	0.1	**0.2**	74 – 135	≤ 40
Acrolein	2.476	2.5	**5.0**	60 – 124	≤ 40
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.043	0.1	**0.2**	76 – 124	≤ 40
Acetone	2.057	2.5	**5.0**	64 – 125	≤ 40
1,1-Dichloroethene	0.054	0.1	**0.2**	74 – 120	≤ 40
Bromoethane	0.041	0.1	**0.2**	77 – 122	≤ 40
Iodomethane (Methyl Iodide)	0.227	0.5	**1.0**	76 – 123	≤ 40
Methylene Chloride	0.485	0.5	**1.0**	71 – 125	≤ 40
Acrylonitrile	0.604	1.0	**1.0**	76 – 123	≤ 40
Carbon Disulfide	0.037	0.1	**0.2**	77 – 124	≤ 40
trans-1,2-Dichloroethene	0.048	0.1	**0.2**	75 – 120	≤ 40
Vinyl Acetate	0.069	0.1	**0.2**	74 – **120**	≤ 40
1,1-Dichloroethane	0.053	0.1	**0.2**	80 – 120	≤ 40
2-Butanone	0.814	2.5	**5.0**	73 – 123	≤ 40
2,2-Dichloropropane	0.052	0.1	**0.2**	72 – 133	≤ 40
cis-1,2-Dichloroethene	0.043	0.1	**0.2**	78 – 120	≤ 40
Chloroform	0.027	0.1	**0.2**	**80 – 120**	≤ 40
Bromochloromethane	0.061	0.1	**0.2**	**80 – 120**	≤ 40
1,1,1-Trichloroethane	0.041	0.1	**0.2**	79 – 124	≤ 40
1,1-Dichloropropene	0.034	0.1	**0.2**	**80 – 120**	≤ 40
Carbon Tetrachloride	0.044	0.1	**0.2**	71 – 139	≤ 40
1,2-Dichloroethane	0.072	0.1	**0.2**	**80** – 121	≤ 40
Benzene	0.027	0.1	**0.2**	**80 – 120**	≤ 40
Trichloroethene	0.049	0.1	**0.2**	**80** – 120	≤ 40
1,2-Dichloropropane	0.035	0.1	**0.2**	**80 – 120**	≤ 40
Bromodichloromethane	0.051	0.1	**0.2**	**80** – 122	≤ 40
Dibromomethane	0.145	0.2	**0.2**	**80 – 120**	≤ 40
2-Chloroethylvinyl Ether	0.250	0.5	**1.0**	62 – 130	≤ 40
4-Methyl-2-Pentanone	0.974	2.5	**5.0**	**80** – 125	≤ 40

DL[1] LOD[1], LOQ[1] and Control Limits Summary for VOA Analysis of Water

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS Recovery[2,4]	Replicate RPD[3]
cis 1,3-dichloropropene	0.061	0.1	0.2	80 – 127	≤ 40
Toluene	0.040	0.1	0.2	80 – 120	≤ 40
trans 1,3-Dichloropropene	0.081	0.1	0.2	79 – 132	≤ 40
2-Hexanone	0.902	2.5	5.0	80 – 129	≤ 40
1,1,2-Trichloroethane	0.129	0.2	0.2	80 – 120	≤ 40
1,3-Dichloropropane	0.062	0.1	0.2	80 – 120	≤ 40
Tetrachloroethene	0.047	0.1	0.2	80 – 120	≤ 40
Dibromochloromethane	0.048	0.1	0.2	80 – 120	≤ 40
1,2-Dibromoethane (Ethylene Dibromide)	0.075	0.1	0.2	80 – 120	≤ 40
Chlorobenzene	0.023	0.1	0.2	80 – 120	≤ 40
Ethyl Benzene	0.037	0.1	0.2	80 – 120	≤ 40
1,1,1,2-Tetrachloroethane	0.040	0.1	0.2	80 – 128	≤ 40
m,p-xylene	0.052	0.2	0.4	80 – 120	≤ 40
o-Xylene	0.035	0.1	0.2	80 – 120	≤ 40
Styrene	0.045	0.1	0.2	80 – 121	≤ 40
Bromoform	0.062	0.1	0.2	62 – 149	≤ 40
1,1,2,2-Tetrachloroethane	0.060	0.1	0.2	80 – 120	≤ 40
1,2,3-Trichloropropane	0.131	0.25	0.5	80 – 120	≤ 40
trans-1,4-Dichloro 2-Butene	0.324	0.5	1.0	47 – 147	≤ 40
n-Propyl Benzene	0.023	0.1	0.2	80 – 120	≤ 40
Bromobenzene	0.060	0.1	0.2	80 – 120	≤ 40
iso-propyl Benzene	0.021	0.1	0.2	80 – 120	≤ 40
2-Chloro Toluene	0.024	0.1	0.2	80 – 120	≤ 40
4-Chloro Toluene	0.016	0.1	0.2	80 – 120	≤ 40
tert-Butyl Benzene	0.026	0.1	0.2	80 – 121	≤ 40
1,3,5-Trimethyl Benzene	0.015	0.1	0.2	80 – 120	≤ 40
1,2,4-Trimethylbenzene	0.024	0.1	0.2	80 – 122	≤ 40
sec-Butyl Benzene	0.024	0.1	0.2	80 – 121	≤ 40
4-Isopropyl Toluene	0.026	0.1	0.2	80 – 124	≤ 40
1,3-Dichlorobenzene	0.036	0.1	0.2	80 – 120	≤ 40
1,4-Dichlorobenzene	0.040	0.1	0.2	80 – 120	≤ 40
n-Butyl Benzene	0.025	0.1	0.2	80 – 125	≤ 40
1,2-Dichlorobenzene	0.036	0.1	0.2	80 – 120	≤ 40

DL[1] LOD[1], LOQ[1] and Control Limits Summary for VOA Analysis of Water 10 mL Purge Volume (EPA Method 8260C)

Analyte	DL[1] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS Recovery[2,4]	Replicate RPD[3]
1,2-Dibromo 3-Chloropropane	0.366	0.5	**0.5**	79 – 129	≤ 40
1,2,4-Trichlorobenzene	0.107	0.25	**0.5**	77 – 127	≤ 40
Hexachloro-1,3-Butadiene	0.073	0.25	**0.5**	80 – 135	≤ 40
Naphthalene	0.118	0.25	**0.5**	**80** – 128	≤ 40
1,2,3-Trichlorobenzene	0.110	0.25	**0.5**	**80** - 125	≤ 40
Dichlorodifluoromethane	0.052	0.1	**0.2**	68 – 133	≤ 40
Methyl-*tert*-butyl ether	0.073	0.25	**0.5**	79 – 121	≤ 40
Surrogate Standards			**MB / LCS**	**Samples**	**RPD**
1,2-Dichloroethane-d$_4$			**80 – 120**	**80** – 130	≤ 40
1,2-Dichlorobenzene-d$_4$			**80 – 120**	**80 – 120**	≤ 40
Toluene-d$_8$			**80 – 120**	**80 – 120**	≤ 40
4-Bromofluorobenzene			**80 – 120**	**80 – 120**	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ) are defined in ARI SOP 1018S

(2) Control limits calculated using all data from 1/1/12 through 5/31/12.

(3) Relative Percent Difference between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O - C_D}{2}} x100$$

(4) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that:

    a. ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit or

    b. Control limits for analyzes with no separate preparation procedure are adjusted to reflect the minimum uncertainty in the calibration of the instrument allowed by the referenced analytical method.

DL[1] LOD[1], LOQ[1] and Control Limits Summary
VOA Analysis of Soil (EPA Method 8260C)

Analyte	DL[1,5] µg/kg	LOD[1] µg/kg	LOQ[1] µg/kg	LCS Recovery[2,4]	Replicate RPD[3]
Dichlorodifluoromethane	0.207	0.5	**1.0**	67 – 142	≤ 40
Chloromethane	0.263	0.5	**1.0**	65 – 129	≤ 40
Vinyl Chloride	0.235	0.5	**1.0**	74 – 134	≤ 40
Bromomethane	0.187	0.5	**1.0**	40 – 172	≤ 40
Chloroethane	0.462	0.5	**1.0**	53 – 154	≤ 40
Trichlorofluoromethane	0.266	0.5	**1.0**	57 – 161	≤ 40
Acrolein*	3.809	25	**50.0**	60 – 130	≤ 40
Acetone*	0.482	2.5	**5.0**	48 – 132	≤ 40
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.287	1.0	**2.0**	72 – 142	≤ 40
1,1-Dichloroethene	0.336	0.5	**1.0**	73 – 138	≤ 40
Bromoethane	0.440	1.0	**2.0**	74 – 132	≤ 40
Iodomethane (Methyl Iodide)	0.215	0.5	**1.0**	34 – 181	≤ 40
Methylene Chloride	0.635	1.0	**2.0**	61 – 128	≤ 40
Carbon Disulfide	0.559	1.0	**1.0**	72 – 146	≤ 40
Acrylonitrile	1.026	2.5	**5.0**	59 – 124	≤ 40
Methyl-t-butyl ether (MTBE)	0.231	0.5	**1.0**	68 – 124	≤ 40
trans-1,2-Dichloroethene	0.266	0.5	**1.0**	73 – 131	≤ 40
Vinyl Acetate	0.381	2.5	**5.0**	54 – 138	≤ 40
1,1-Dichloroethane	0.203	0.5	**1.0**	65 – 139	≤ 40
2-Butanone*	0.513	2.5	**5.0**	64 – 120	≤ 40
2,2-Dichloropropane	0.292	0.5	**1.0**	77 – 137	≤ 40
cis-1,2-Dichloroethene	0.240	0.5	**1.0**	75 – 124	≤ 40
Chloroform	0.234	0.5	**1.0**	75 – 126	≤ 40
Bromochloromethane	0.323	0.5	**1.0**	69 – 133	≤ 40
1,1,1-Trichloroethane	0.226	0.5	**1.0**	78 – 133	≤ 40
1,1-Dichloropropene	0.312	0.5	**1.0**	80 – 123	≤ 40
Carbon Tetrachloride	0.213	0.5	**1.0**	76 – 136	≤ 40
1,2-Dichloroethane	0.191	0.5	**1.0**	77 – **120**	≤ 40
Benzene	0.296	0.5	**1.0**	80 – **120**	≤ 40
Trichloroethene	0.212	0.5	**1.0**	80 – 120	≤ 40
1,2-Dichloropropane	0.162	0.5	**1.0**	74 – **120**	≤ 40
Bromodichloromethane	0.254	0.5	**1.0**	80 – 122	≤ 40
Dibromomethane	0.147	0.5	**1.0**	80 – **120**	≤ 40

DL[1] LOD[1], LOQ[1] and Control Limits Summary VOA Analysis of Soil (EPA Method 8260C)					
Analyte	**DL[1,5] µg/kg**	**LOD[1] µg/kg**	**LOQ[1] µg/kg**	**LCS Recovery[2,4]**	**Replicate RPD[3]**
2-Chloroethyl Vinyl Ether	0.276	2.5	**5.0**	20 – 157	≤ 40
4-Methyl-2-Pentanone*	0.420	2.5	**5.0**	70 – 124	≤ 40
cis-1,3-Dichloropropene	0.226	0.5	**1.0**	80 – 124	≤ 40
Toluene	0.151	0.5	**1.0**	78 – **120**	≤ 40
trans-1,3-Dichloropropene	0.216	0.5	**1.0**	80 – 126	≤ 40
1,1,2-Trichloroethane	0.286	0.5	**1.0**	77 – **120**	≤ 40
1,2-Dibromoethane (Ethylene Dibromide)	0.176	0.5	**1.0**	79 – **120**	≤ 40
2-Hexanone*	0.439	2.5	**5.0**	62 – 128	≤ 40
1,3-Dichloropropane	0.209	0.5	**1.0**	77 – **120**	≤ 40
Tetrachloroethene	0.257	0.5	**1.0**	76 – 131	≤ 40
Dibromochloromethane	0.266	0.5	**1.0**	77 – 123	≤ 40
Chlorobenzene	0.219	0.5	**1.0**	80 – **120**	≤ 40
1,1,1,2-Tetrachloroethane	0.233	0.5	**1.0**	80 – **120**	≤ 40
Ethyl Benzene	0.202	0.5	**1.0**	**80** – **120**	≤ 40
m,p-Xylene	0.392	0.5	**1.0**	**80** – 123	≤ 40
o-Xylene	0.224	0.5	**1.0**	**80** – **120**	≤ 40
Styrene	0.138	0.5	**1.0**	**80** – 122	≤ 40
Bromoform	0.297	0.5	**1.0**	63 – **120**	≤ 40
Isopropyl Benzene	0.233	0.5	**1.0**	77 – 127	≤ 40
1,1,2,2-Tetrachloroethane	0.253	0.5	**1.0**	71 – **120**	≤ 40
1,2,3-Trichloropropane	0.517	1.0	**2.0**	75 – **120**	≤ 40
trans-1,4-Dichloro-2-Butene	0.437	2.5	**5.0**	62 – 127	≤ 40
n-Propyl Benzene	0.272	0.5	**1.0**	76 – 126	≤ 40
Bromobenzene	0.153	0.5	**1.0**	75 – **120**	≤ 40
1,3,5-Trimethylbenzene	0.254	0.5	**1.0**	77 – 126	≤ 40
2-Chlorotoluene	0.300	0.5	**1.0**	76 – 120	≤ 40
4-Chlorotoluene	0.277	0.5	**1.0**	75 – 121	≤ 40
t-Butylbenzene	0.306	0.5	**1.0**	77 – 125	≤ 40
1,2,4-Trimethylbenzene	0.230	0.5	**1.0**	77 – 125	≤ 40
s-Butylbenzene	0.240	0.5	**1.0**	77 – 127	≤ 40
4-Isopropyl Toluene	0.236	0.5	**1.0**	78 – 131	≤ 40
1,3-Dichlorobenzene	0.227	0.5	**1.0**	76 – 120	≤ 40
1,4-Dichlorobenzene	0.232	0.5	**1.0**	75 – **120**	≤ 40

Analyte	DL[1,5] µg/kg	LOD[1] µg/kg	LOQ[1] µg/kg	LCS Recovery[2,4]	Replicate RPD[3]
DL[1] LOD[1], LOQ[1] and Control Limits Summary **VOA Analysis of Soil (EPA Method 8260C)**					
n-Butylbenzene	0.262	0.5	**1.0**	75 – 134	≤ 40
1,2-Dichlorobenzene	0.293	0.5	**1.0**	77 – **120**	≤ 40
1,2-Dibromo-3-Chloropropane	0.586	2.5	**5.0**	61 – 128	≤ 40
1,2,4-Trichlorobenzene	0.332	2.5	**5.0**	75 – 130	≤ 40
Hexachloro-1,3-Butadiene	0.410	2.5	**5.0**	72 – 135	≤ 40
Naphthalene	0.429	2.5	**5.0**	71 – 122	≤ 40
1,2,3-Trichlorobenzene	0.305	2.5	**5.0**	76 – 122	≤ 40
Surrogate Standards			**MB / LCS**	**Samples**	**RPD**
1,2-Dichloroethane-d$_4$			**80** – 122	**80** – 149	≤ 40
1,2-Dichlorobenzene-d$_4$			**80** – **120**	**80** – **120**	≤ 40
Toluene-d$_8$			**80** – **120**	77 – **120**	≤ 40
4-Bromofluorobenzene			**80** – **120**	**80** – **120**	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ) are defined in ARI SOP 1018S

(2) Control limits calculated using all data from 1/1/12 through 5/31/12.

(3) Relative Percent Difference between analytes in replicate analyzes. If C$_O$ and C$_D$ are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O - C_D}{2}} x100$$

(4) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that:

    a. ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit or

    b. Control limits for analyzes with no separate preparation procedure are adjusted to reflect the minimum uncertainty in the calibration of the instrument allowed by the referenced analytical method.

(5) MDL study QD19 – 3/8/10

Quality Control Parameters for Metals Analysis ICP-MS EPA Methods 200.8 or 6020A

Analyte	Mass	Aqueous Samples[2] DL[1] µg/L	Aqueous Samples[2] LOD[1] µg/L	Aqueous Samples[2] LOQ[1] µg/L	Spike Recovery Matrix Spike	Spike Recovery LCS	RPD[3]	Solids[2] LOQ[1] mg/kg
Aluminum	27	1.601	10	20.0	75 – 125	80 – 120	≤ 20	20.0
Antimony	121	0.010	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
	123	0.011	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Arsenic #1	75	0.048	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Arsenic #2	75	0.092	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Barium	135	0.020	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
	137	0.019	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Beryllium	9	0.021	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Cadmium	111	0.010	0.05	0.1	75 – 125	80 – 120	≤ 20	0.1
	114	0.005	0.05	0.1	75 – 125	80 – 120	≤ 20	0.1
Calcium	43	3.983	25	50.0	75 – 125	80 – 120	≤ 20	50.0
Chromium	52	0.045	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
	53	0.118	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Cobalt	59	0.011	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Copper	63	0.158	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
	65	0.236	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Iron	54	5.753	10	20.0	75 – 125	80 – 120	≤ 20	20.0
	57	3.876	10	20.0	75 – 125	80 – 120	≤ 20	20.0
Lead	208	0.046	0.05	0.1	75 – 125	80 – 120	≤ 20	0.1
Magnesium	24	0.297	10	20.0	75 – 125	80 – 120	≤ 20	20.0
Manganese	55	0.022	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Molybdenum	98	0.013	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Nickel	60	0.079	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
	62	0.089	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
Potassium	39	2.944	10	20.0	75 – 125	80 – 120	≤ 20	20.0
Selenium	82	0.127	0.25	0.5	75 – 125	80 – 120	≤ 20	0.5
	78	0.324	0.25	2.0	75 – 125	80 – 120	≤ 20	2.0
Silver	107	0.008	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Sodium	23	2.833	50	100.0	75 – 125	80 – 120	≤ 20	100.0
Thorium [4]	232	0.013	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Thallium	205	0.004	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Uranium [4]	238	0.003	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Vanadium	51	0.043	0.1	0.2	75 – 125	80 – 120	≤ 20	0.2
Zinc	66	0.497	2	4.0	75 – 125	80 – 120	≤ 20	4.0
	67	0.531	2	4.0	75 – 125	80 – 120	≤ 20	4.0
	68	0.524	2	4.0	75 – 125	80 – 120	≤ 20	4.0

(1) Detection Limit (DL), Limit of Detection Limit (LOD) and Limit of Quantitation (LOQ) as defined in ARI SOP 1018S

(2) 50 mL sample and 50 mL final volume Solids LOQ based on 100% solids using 1.0 g sample 100 mL final volume.

(3) Relative Percent Difference in replicate analyzes. $RPD = \dfrac{C_O - C_D}{\dfrac{C_O + C_D}{2}} x100$ where C_O=Original, C_D=Duplicate

(4) ARI has no accreditation for these elements.

Quality Control Parameters for Mercury Analysis using CVAA
EPA Methods 7470A or 245.1 for Aqueous Samples
EPA Methods 7471B or 245.5 for Solid Samples

	Aqueous Samples[2]			Spike Recovery		RPD [5]
	DL [1] µg/L	LOD [1] µg/L	LOQ [1] µg/L	Matrix Spike	LCS	
Mercury	0.0069	0.05	0.10 [2]	75 – 125	80 – 120	≤ 20
Mercury (low level)	0.0026	0.01	0.02 [2]	75 – 125	80 – 120	≤ 20
	Soil / Sediment Samples			Spike Recovery		RPD [5]
	DL [1] mg/kg	LOD [1] mg/kg	LOQ [1] mg/kg	Matrix Spike	LCS	
Mercury	0.0021	0.0125	0.025 [3]	75 – 125	80 – 120	≤ 20
	Tissue Samples			Spike Recovery		RPD [5]
	DL [1] mg/kg	LOD [1] mg/kg	LOQ [1] mg/kg	Matrix Spike	LCS	
Mercury	0.0021	0.0125	0.005 [4]	75 – 125	80 – 120	≤ 20

(1) Detection Limit (DL), Limit of Detection Limit (LOD) and Limit of Quantitation (LOQ) as defined in ARI SOP 1018S
(2) 20 mL sample with 20 mL final volume
(3) 0.2 g sample with 50 mL final volume assuming 100% dry weight. Soil and sediment are reported on a dry weight basis.
(4) Tissue LOQ is 0.005 mg/kg as received (wet weight) based on 1 g sample with 50 mL final volume.
(5) Relative Percent Difference between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O + C_D}{2}} \, x100$$

DL[1], LOD[1], LOQ[1] and Control Limits Summary
Analysis of Water Samples for Chlorinated Pesticides
EPA Method 8081B

Separatory Funnel (EPA Method 3510C) Extraction using 500 mL sample with extract concentrated to 5 mL final volume. ARI Bench Sheet 3038F

LOD Spike level = LOQ Concentration

Analyte	DL[1,2] µg/L	LOD[1] µg/L	LOQ[1] µg/L	LCS Control Limit [3,4]	Replicate RPD [5]
alpha-BHC	0.0085	0.025	**0.05**	51 – 120	≤ 40
beta-BHC	0.0098	0.025	**0.05**	44 – 134	≤ 40
gamma-BHC (Lindane)	0.0159	0.025	**0.05**	59 – 131	≤ 40
delta-BHC	0.0087	0.025	**0.05**	44 – 156	≤ 40
Heptachlor	0.0113	0.025	**0.05**	47 – 110	≤ 40
Aldrin	0.0103	0.025	**0.05**	47 – 106	≤ 40
Heptachlor Epoxide	0.0079	0.025	**0.05**	62 – 121	≤ 40
trans-Chlordane (*beta*-Chlordane, *gamma*-Chlordane)	0.0082	0.025	**0.05**	63 – 125	≤ 40
cis-Chlordane (*alpha*-chlordane)	0.0082	0.025	**0.05**	62 – 123	≤ 40
Endosulfan I	0.0089	0.025	**0.05**	**10** – 110	≤ 40
4,4'-DDE	0.0184	0.05	**0.10**	61 – 138	≤ 40
Dieldrin	0.0168	0.05	**0.10**	64 – 123	≤ 40
Endrin	0.0167	0.05	**0.10**	53 – 127	≤ 40
Endosulfan II	0.0139	0.05	**0.10**	23 – 102	≤ 40
4,4'-DDD	0.0186	0.05	**0.10**	53 – 133	≤ 40
Endrin Aldehyde	0.0163	0.05	**0.10**	28 – 107	≤ 40
4,4'-DDT	0.0169	0.05	**0.10**	49 – 127	≤ 40
Endosulfan Sulfate	0.0235	0.05	**0.10**	49 – 121	≤ 40
Endrin Ketone	0.0151	0.05	**0.10**	45 – 126	≤ 40
Methoxychlor	0.0744	0.25	**0.50**	48 – 118	≤ 40
Hexachlorobutadiene	0.0123	0.05	**0.10**	23 – **100**	≤ 40
Hexachlorobenzene	0.0101	0.05	**0.10**	44 – 101	≤ 40
Surrogate Standard Recovery			**MB / LCS**	**Samples**	**RPD**
Tetrachloro-*m*-xylene (TCMX)			38 – 103	30 – 105	≤ 40
Decachlorobiphenyl			37 – 125	11 – 144	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation as defined in ARI SOP 1018S.
(2) MDL study QD48

DL[1], LOD[1], LOQ[1] and Control Limits Summary
Analysis of Soil/Sediment Samples for Chlorinated Pesticides
EPA Method 8081B

Microwave (EPA Method 3546) Extraction using 12.5g (dry weight) sample with extract concentrated to 2.5 mL final volume. ARI Bench Sheet 3046F

LOD Spike level = LOQ Concentration

Analyte	DL[1,2] µg/kg	LOD[1] µg/kg	LOQ[1] µg/kg	LCS Control Limit [3,4]	Replicate RPD [5]
alpha-BHC	0.081	0.25	**0.5**	68 – 115	≤ 40
beta-BHC	0.139	0.25	**0.5**	60 – 126	≤ 40
gamma-BHC (Lindane)	0.048	0.25	**0.5**	68 – 134	≤ 40
delta-BHC	0.082	0.25	**0.5**	71 – 154	≤ 40
Heptachlor	0.132	0.25	**0.5**	66 – 115	≤ 40
Aldrin	0.055	0.25	**0.5**	66 – 115	≤ 40
Heptachlor Epoxide	0.085	0.25	**0.5**	65 – 127	≤ 40
trans-Chlordane (*beta*-Chlordane, *gamma*-Chlordane)	0.077	0.25	**0.5**	73 – 136	≤ 40
cis-Chlordane (*alpha*-chlordane)	0.051	0.25	**0.5**	77 – 124	≤ 40
Endosulfan I	0.072	0.25	**0.5**	28 – **100**	≤ 40
4,4'-DDE	0.124	0.5	**1.0**	71 – 149	≤ 40
Dieldrin	0.100	0.5	**1.0**	74 – 131	≤ 40
Endrin	0.215	0.5	**1.0**	72 – 135	≤ 40
Endosulfan II	0.116	0.5	**1.0**	37 – 110	≤ 40
4,4'-DDD	0.135	0.5	**1.0**	76 – 137	≤ 40
Endrin Aldehyde	0.218	0.5	**1.0**	38 – 109	≤ 40
4,4'-DDT	0.192	0.5	**1.0**	58 – 144	≤ 40
Endosulfan Sulfate	0.192	0.5	**1.0**	47 – 148	≤ 40
Endrin Ketone	0.119	0.5	**1.0**	29 – 165	≤ 40
Methoxychlor	0.698	2.5	**5.0**	65 – 123	≤ 40
Hexachlorobutadiene	0.138	0.5	**1.0**	43 – 104	≤ 40
Hexachlorobenzene	0.094	0.5	**1.0**	62 – 119	≤ 40
Surrogate Standard Recovery			**MB / LCS**	**Samples**	**RPD**
Tetrachloro-*m*-xylene (TCMX)			47 – 124	34 – 169	≤ 40
Decachlorobiphenyl			60 – 149	36 – 182	≤ 40

(1) Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation as defined in ARI SOP 1018S.
(2) MDL study QZ38

Quality Control Summary for Butyl Tin Compounds
EPA Methods 8270D – SIM

Analyte	DL[1]	LOD[1]	LOQ[1]	Spike Recovery Limits (%)[2,3]			RPD[4]
				LCS	MB/LCS Surrogate	Sample Surrogate	
TBTWSI – Aqueous Samples (Separatory Funnel Extraction – 100 to 0.5 mL) EPA Method 3510C – ARI Benchsheet TBT#1 – 3043F							
Tributyl Tin Ion[5]	0.043 µg/L	0.096 µg/L	0.193 µg/L	30-160	--	--	≤ 40
Dibutyl Tin Ion[5]	0.096 µg/L	0.216 µg/L	0.433 µg/L	30-160	--	--	≤ 40
Butyl Tin Ion[5]	0.108 µg/L	0.153 µg/L	0.306 µg/L	30-160	--	--	≤ 40
Tripentyl Tin	--	--	--	--	30-160	30-160	≤ 40
Tripropyl Tin	--	--	--	--	30-160	30-160	≤ 40
TBTWSI – Pore Water Samples (Separatory Funnel Extraction – 150 to 0.5 mL) EPA Method 3510C – ARI Benchsheet TBT #3 – 3047F							
Tributyl Tin Ion[6]	--	--	0.0052 µg/L	30-160	--	--	≤ 40
Dibutyl Tin Ion[6]	--	--	0.0077µg/L	30-160	--	--	≤ 40
Butyl Tin Ion[6]	--	--	0.0054 µg/L	30-160	--	--	≤ 40
Tripentyl Tin	--	--	--	--	30-160	30-160	≤ 40
Tripropyl Tin	--	--	--	--	30-160	30-160	≤ 40
TBTSMI – Soil / Sediment Samples (Microwave Extraction – 5g dry wt to 0.5mL) EPA Method 3546 – ARI Benchsheet TBT#4 – 3064F							
Tributyl Tin Ion	1.52 µg/kg	1.93 µg/kg	3.86 µg/kg	40 – 144	--	--	≤ 40
Dibutyl Tin Ion	3.72 µg/kg	4.33 µg/kg	5.78 µg/kg	34 – 115	--	--	≤ 40
Butyl Tin Ion	2.95 µg/kg	3.06 µg/kg	4.08 µg/kg	**10** – 111	--	--	≤ 40
Tripentyl Tin	--	--	--	--	35 – 130	25 – 140	≤ 40
Tripropyl Tin	--	--	--	--	28 – 106	32 – 104	≤ 40

(1) Detection Limit (DL), limit of detection (LOD) and limit of quantation (LOQ) as defined in ARI SOP 1018S.
(2) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(3) 30 – 160 are default, advisory control limits used when there is insufficient data to calculate historic control limits. These limits are not used as the sole reason to reject data from a batch of of analyzes.
(4) Acceptance criteria for the relative percent difference (RPD) between analytes in replicate analyzes.   If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O - C_D}{2}} x100$$

(5) DL from ARI MDL study QD32
(6) ARI does not report concentrations below the LOQ (low calibration standard concentration) and does not, therefore, determine a DL or LOD for butyl tin analysis in interstitial (pore) water.

Quality Control Criteria for Analysis of Aqueous Samples for Aroclors (Polychlorinated Biphenyls – PCB) - EPA Method 8082B

Analysis Code	Extraction	DL[1]	LOD[1]	LOQ[1]	Analyte	Spike Recovery Control Limits (%) [2,3]			RPD[4]
						LCS	MB/LCS Surrogate	Sample Surrogate	
Aqueous Samples (Separatory Funnel Extraction – EPA Method 3510C)									
PCBWSI 01-3018F	500 to 5 mL	0.130 µg/L	0.5 µg/L	1 µg/L	Aroclor 1016	45 – 121	--	--	≤ 40
		0.147 µg/L	0.5 µg/L	1 µg/L	Aroclor 1260	54 – 129	--	--	
		--	--	--	TCMX	--	40 – 118	38 – 118	
		--	--	--	DCBP	--	41 – 111	29 – 118	
PCBWSM 02-3021F	500 to 1 mL	0.0175 µg/L	0.05 µg/L	0.1 µg/L	Aroclor 1016	36 – **100**	--	--	≤ 40
		0.0174 µg/L	0.05 µg/L	0.1 µg/L	Aroclor 1260	41 – 113	--	--	
		--	--	--	TCMX	--	29 – **100**	25 – **100**	
		--	--	--	DCBP	--	39 – 116	**10** – 128	
PCBWLS	1000 to 0.5 mL [5]	0.00248 µg/L	0.005 µg/L	0.01 µg/L	Aroclor 1016	44 – 117	--	--	≤ 40
		0.00276 µg/L	0.005 µg/L	0.01 µg/L	Aroclor 1260	46 – 131	--	--	
		--	--	--	TCMX	--	31 – **100**	21 – **100**	
		--	--	--	DCBP	--	32 – 108	19 – 111	
TCLP Extract (Separatory Funnel Extraction – EPA Method 3510C)									
PCBWST	100 to 10 mL	0.130 µg/L [8]	5 µg/L	10 µg/L	Aroclor 1016	30 – 160	--	--	≤ 40
		0.147 µg/L [8]	5 µg/L	10 µg/L	Aroclor 1260	30 – 160	--	--	
		--	--	--	TCMX	--	30 – 160	30 – 160	
		--	--	--	DCBP	--	30 – 160	30 – 160	
Tissue Samples (Tissuemizer / Blender Extraction – EPA Method 3550C Modified) – Concentrations in µg/kg as received (wet weight)									
PCBUZI 09-3029F	10 g to 5 mL	2.92 µg/kg [6]	25 µg/kg	50 µg/kg	Aroclor 1016	30 – 160			≤ 40
		3.91 µg/kg [6]	25 µg/kg	50 µg/kg	Aroclor 1260	30 – 160			
		--	--	--	TCMX		30 – 160	30 – 160	
		--	--	--	DCBP		30 – 160	30 – 160	
PCBUZM 10-3027F	25 g to 5 mL	2.37 µg/kg [7]	10 µg/kg	20 µg/kg	Aroclor 1016	30 – 160			≤ 40
		1.06 µg/kg [7]	10 µg/kg	20 µg/kg	Aroclor 1260	30 – 160			
		--	--	--	TCMX		30 – 160	30 – 160	
		--	--	--	DCBP		30 – 160	30 – 160	
PCBUZL 11-3030F	25 g to 1 mL	2.37 [7] µg/kg	2 µg/kg	4 µg/kg	Aroclor 1016	30 – 160			≤ 40
		1.06 [7] µg/kg	2 µg/kg	4 µg/kg	Aroclor 1260	30 – 160			
		--	--	--	TCMX		30 – 160	30 – 160	
		--	--	--	DCBP		30 – 160	30 – 160	

(1) Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ) are defined in ARI SOP 1018S.

(2) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.

(3) 30 – 160 are default limits used when there is insufficient data to calculate historic control limits

(4) Acceptance criteria for the relative percent difference (RPD) between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O + C_D}{2}} x100$$

(5) Low level extraction solvent is hexane instead of Methylene Chloride.

(6) LOD Study SM10

(7) MDL Study QZ25

(8) Based on PCBWSI until sufficient TCLP data is collected to calculate LOD.

Quality Control Criteria for Analysis of Solid Matrix Samples for Aroclors (Polychlorinated Biphenyls – PCB) EPA Method 8082B

Analysis Code	Extrac-tion	DL[1] (ppb)	LOD[1] (ppb)	LOQ[1] (ppb)	Analyte	Spike Recovery Control Limits (%) [2,3,8]			RPD[4]
						LCS	MB/LCS Surrogate	Sample Surrogate	
Soil / Sediment Samples (Microwave Extraction – EPA Method 3546)									
PCBSMI 15-3067F	12g to 4 mL	9.83	17	33	Aroclor 1016	55 – 109	--	--	≤ 40
		7.06	17	33	Aroclor 1260	50 – 125	--	--	
PCBSCI 08-3025F		--	--	--	TCMX	--	53 – 108	39 – 122	
		--	--	--	DCBP	--	49 – 126	31 – 140	
PCBDMP20 05-3017F	12.5 g to 2.5 mL[6]	9.33	10	20[6]	Aroclor 1016	46 – 110	--	--	≤ 40
		10.82	15	20[6]	Aroclor 1260	47 – 124	--	--	
PCBDCP20 06-3026F		--	--	--	TCMX	--	43 – 107	34 – 109	
		--	--	--	DCBP	--	48 – 123	24 – 127	
PCBDMP10 05-3017F	12.5 g to 2.5 mL[6]	0.759	5	10[6]	Aroclor 1016	46 – 110	--	--	≤ 40
		1.066	5	10[6]	Aroclor 1260	47 – 124	--	--	
PCBDCP10 06-3026F		--	--	--	TCMX	--	43 – 107	34 – 109	
		--	--	--	DCBP	--	48 – 123	24 – 127	
PCBDMP4 05-3017F	12.5 g to 2.5 mL[6]	0.577	2	4[6]	Aroclor 1016	46 – 110	--	--	≤ 40
		0.610	2	4[6]	Aroclor 1260	47 – 124	--	--	
PCBDCP4 06-3026F		--	--	--	TCMX	--	43 – 107	34 – 109	
		--	--	--	DCBP	--	48 – 123	24 – 127	
Soil / Sediment Samples Medium Level (Vortex Extraction – EPA Method 3546)									
PCBSVX 12-3019F	5 g to 40 mL	109[7]	400	800	Aroclor 1016	30 – 160	--	--	≤ 40
		192[7]	400	800	Aroclor 1260	30 – 160	--	--	
		--	--	--	TCMX	--	30 – 160	30 – 160	
		--	--	--	DCBP	--	30 – 160	30 – 160	

(1) Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ) are defined in ARI SOP 1018S.

(2) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.

(3) 30 – 160 are default limits used when there is insufficient data to calculate historic control limits

(4) Acceptance criteria for the relative percent difference (RPD) between analytes in replicate analyzes. If C_O and C_D are the concentrations of the original and duplicate respectively then

$$RPD = \frac{|C_O - C_D|}{\frac{C_O - C_D}{2}} x100$$

(6) LOQ determined by lowest concentration used to calibrate the GC-ECD instrument.

(7) MDL Study PC66 6/24/09

(8) Control Limits calculated using all data generated between 1/1/11 and 11/30/11

Appendix B. List of analytes, methods, typical sample specific detection level (SDL), lower method calibration limit (LMCL), on-going precision and recovery (OPR), and replicate relative percent difference (Rep. RPD) from AXYS Analytical Services Ltd. for water, suspended sediment, and bed sediment samples.

Analyte	Method	Water				Sediment			
		SDL	LMCL	OPR	Rep. RPD	SDL	LMCL	OPR	Rep. RPD
Dioxins		(pg/L)	(pg/L)	(%)	(%)	(pg/L)	(pg/L)	(%)	(%)
2,3,7,8-TCDD	1613B	0.5	10.0	70-130	≤ 20	0.05	1.0	70-130	≤ 20
1,2,3,7,8-PECDD	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
1,2,3,4,7,8-HXCDD	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
1,2,3,6,7,8-HXCDD	1613B	1.0	50.0	76-130	≤ 20	0.10	5.0	76-130	≤ 20
1,2,3,7,8,9-HXCDD	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
1,2,3,4,6,7,8-HPCDD	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
OCDD	1613B	5.0	100.0	78-130	≤ 20	0.50	10.0	78-130	≤ 20
Furans									
2,3,7,8-TCDF	1613B	0.5	10.0	75-130	≤ 20	0.05	1.0	75-130	≤ 20
1,2,3,7,8-PECDF	1613B	1.0	50.0	80-130	≤ 20	0.10	5.0	80-130	≤ 20
2,3,4,7,8-PECDF	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
1,2,3,4,7,8-HXCDF	1613B	1.0	50.0	72-130	≤ 20	0.10	5.0	72-130	≤ 20
1,2,3,6,7,8-HXCDF	1613B	1.0	50.0	84-130	≤ 20	0.10	5.0	84-130	≤ 20
1,2,3,7,8,9-HXCDF	1613B	1.0	50.0	78-130	≤ 20	0.10	5.0	78-130	≤ 20
2,3,4,6,7,8-HXCDF	1613B	1.0	50.0	70-130	≤ 20	0.10	5.0	70-130	≤ 20
1,2,3,4,6,7,8-HPCDF	1613B	1.0	50.0	82-122	≤ 20	0.10	5.0	82-122	≤ 20
1,2,3,4,7,8,9-HPCDF	1613B	1.0	50.0	78-130	≤ 20	0.10	5.0	78-130	≤ 20
OCDF	1613B	5.0	100.0	70-130	≤ 20	0.50	10.0	70-130	≤ 20

Analyte	Method	Water				Sediment			
		SDL	LMCL	OPR	Replicate RPD	SDL	LMCL	OPR	Replicate RPD
PCB Congeners		(pg/L)	(pg/L)	(%)	(%)	(pg/L)	(pg/L)	(%)	(%)
CL1-PCB-1	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL1-PCB-2	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL1-PCB-3	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL2-PCB-4	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-5	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-6	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20

CL2-PCB-7	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-8	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-9	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-10	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-11	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-12/13	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-14	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL2-PCB-15	1668C	2.0	20.0	60-135	≤ 20	0.2	2.0	60-135	≤ 20
CL3-PCB-16	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-17	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-19	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-21/33	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-22	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-23	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-24	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-25	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-26/29	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-27	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-28/20	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-30/18	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-31	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-32	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-34	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-35	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-36	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-37	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-38	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL3-PCB-39	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-41/40/71	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-42	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-43	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-44/47/65	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-45/51	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-46	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-48	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-50/53	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-52	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-54	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-55	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-56	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-57	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-58	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-59/62/75	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20

CL4-PCB-60	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-61/70/74/76	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-63	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-64	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-66	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-67	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-68	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-69/49	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-72	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-73	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-77	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-78	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-79	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-80	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL4-PCB-81	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-82	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-83/99	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-84	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-88/91	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-89	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-92	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-94	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-95/100/93/102/98	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-96	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-103	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-104	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-105	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-106	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-**108**/124	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-**109**/119/86/97/125/87	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-107	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-110/115	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-111	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-112	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-113/90/101	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-114	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-117/116/85	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-118	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-120	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-121	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-122	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20

CL5-PCB-123	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-126	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL5-PCB-127	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-128/166	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-130	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-131	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-132	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-133	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-134/143	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-136	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-137	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-138/163/129/160	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-139/140	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-141	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-142	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-144	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-145	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-146	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-147/149	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-148	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-150	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-151/135/154	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-152	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-153/168	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-155	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-156/157	1668C	1.0	40.0	60-135	≤ 20	0.1	4.0	60-135	≤ 20
CL6-PCB-158	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-159	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-161	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-162	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-164	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-165	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-167	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL6-PCB-169	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-170	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-171/173	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-172	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-174	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-175	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-176	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-177	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-178	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20

CL7-PCB-179	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-180/193	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-181	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-182	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-183/185	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-184	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-186	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-187	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-188	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-189	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-190	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-191	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL7-PCB-192	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-194	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-195	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-196	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-197/200	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-198/199	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-201	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-202	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-203	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-204	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL8-PCB-205	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL9-PCB-206	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL9-PCB-207	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL9-PCB-208	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20
CL10-PCB-209	1668C	1.0	20.0	60-135	≤ 20	0.1	2.0	60-135	≤ 20