Revised- Generalized Quality Assurance Project Plan (QAPP) for:

Columbia River Mainstem Fish Tissue and Sediment Quality Monitoring Program

August 2025

A. PROJECT MANAGEMENT

A1. APPROVAL PAGE

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A4. REVISED BACKGROUND- LESSONS LEARNED

This revised and generalized QAPP is updated with SOPs specific for the Columbia River-Reservoir system. It incorporates and communicates lessons learned after two previous EPA Columbia River Restoration Program grants were implemented and completed. New appendices have been added here that outline both juvenile and adult resident fish collection and dissection. Adult anadromous salmon were collected in partnership with Columbia River Tribes, and that mechanism was efficient, seems mutually beneficial and is encouraged going forward. Overall, the implementation of this QAPP and the sampling efforts were as expected and successful, but were delayed from the original timeline. Two particular areas for improvement, fish collection permitting/ collection methods and laboratory contracting and funding transfers, are discussed in more detail below.

Fish permitting for collecting fish in and around adult salmon is, understandably, very particular. The NOAA permitting process and final permits are very specific about time of year, river conditions and ESA listed salmon encounter rates. This was known before the project started, but the permit requirements to exhaust other, safer approaches first, was an additional time commitment not fully understood nor budgeted for. The permit rules for ESA listed fish in the Columbia appear to be changing. Perhaps in accordance with stock assessment, the collection and handling restrictions are becoming more narrow. This pilot study implemented a variety of sample collection techniques, prior to implementing boat electro-fishing. This method is considered a method of last resort. However, electrofishing was also by far the most efficient collection method. More research and piloting of alternative collection methods, ie. hook and line, baited slinky pots or long-line or bottom line sets, specific to the Columbia river reservoirs, is needed for more efficient study of Columbia River fishes. Experience in fish collection in the reservoir also appears paramount for efficient and successful collections. Careful planning and additional staff time may be needed for this task in the future until efficient collection methods can be demonstrated. Permitting fish collection work goes hand in hand with collection methods and seasonal timing and intended information need and/or scientific value. All are reviewed and considered in the permitting process. All these topics should therefore be planned well in advance, with at least 1 year's lead time, in order for successful and efficient permitting and collections to occur.

Laboratory analysis for low level pollutant quantification is typically expensive and possible by a relatively small number of laboratories. The administrative and inter-

agency challenges of paying a specific laboratory with targeted capabilities for its services are not trivial. Funding transfers can be problematic and subject to various overhead rates and sometimes an agency's requirements for fair and open contractor competition. This causes delays and erodes dollars ultimately available for scientific results. Demonstrated and proven efficiencies to contract and pay for laboratory services should be discussed and pursued early in the planning process. Centralized and shared laboratory services and/or contracting should be considered and has clear benefits towards consistent and comparable datasets.

A5. BACKGROUND

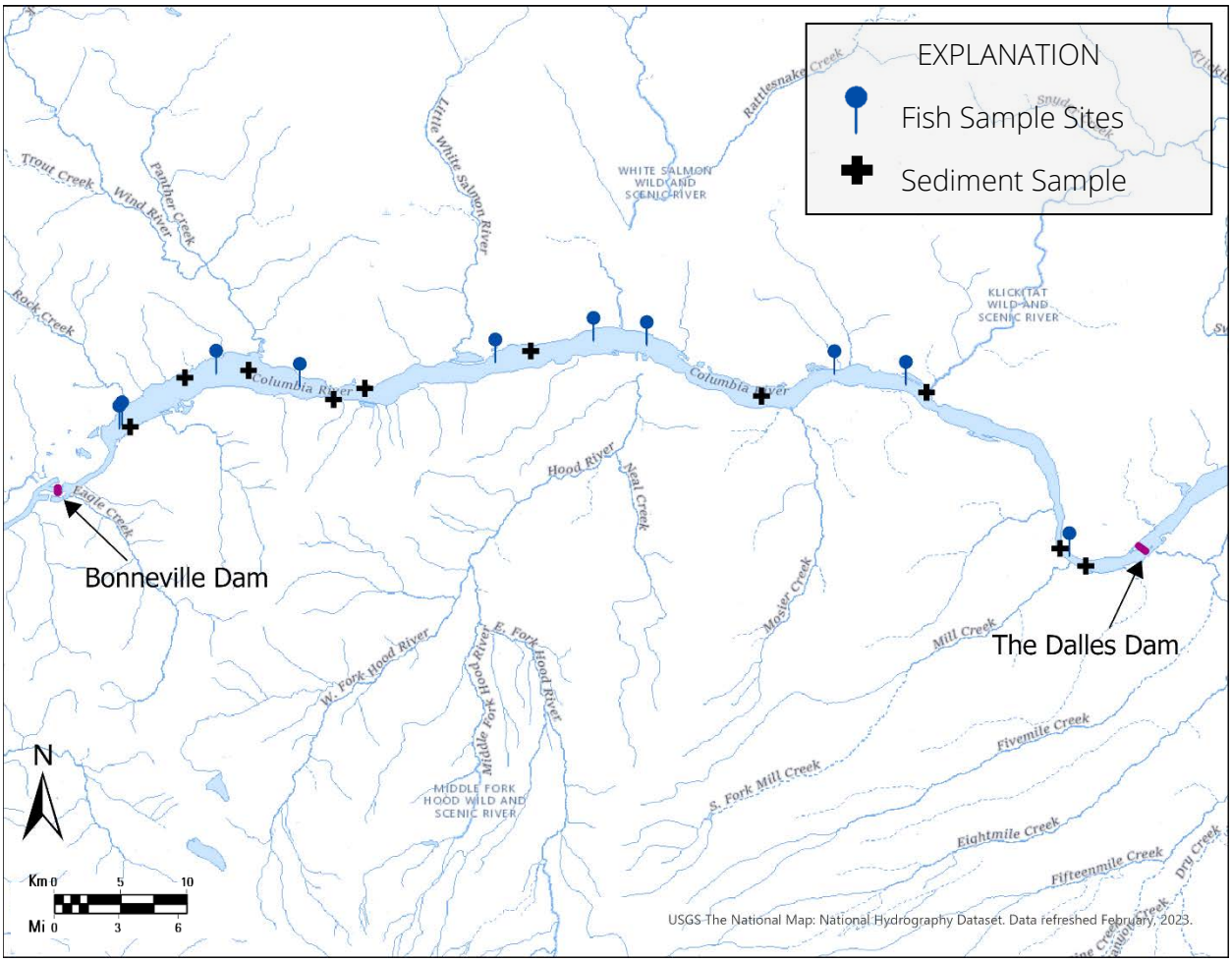
Concern about the health of the aquatic ecosystem of the Columbia River Basin and the potential risk to human health exists due to the exposure of toxic contaminants found in fish, wildlife, and sediment (USEPA, 2009). Several federally listed and tribally important species and their designated critical habitat and essential fish habitat supported by the Columbia River are affected. Past studies have measured key contaminants in Columbia River fish which have included polychlorinated biphenyls (PCBs), dioxins, furans, arsenic, mercury, and organochlorine pesticides (USEPA, 2009). The Columbia River mainstem from the Bonneville Dam to the Canadian border is affected by several site- and species- specific Fish Consumption Advisories issued by the Washington Department of Health (WDOH, 2023). According to fish consumption surveys of tribes (CRITFC, 1994; Polissar and others, 2016), tribal members have relied extensively on fish resources and fishing activities throughout time. These surveys highlight that Tribal fish harvesting and high use and consumption of fish historically, in comparison to the average consumer, is of concern due to toxic accumulation in fish tissue putting tribal members at higher health risk. The advisories result in a reduction of access to healthy food and treaty reserved resources. Despite concerns regarding the effects of contaminants on fish and wildlife and human health; efforts to address the pollution by toxic chemicals in the Columbia River have been limited. The lack of a dedicated contaminant monitoring program in the Columbia River mainstem impedes evaluation and decision making regarding the health of the river. These concerns were recognized in the Columbia River Basin Toxics Reduction Action Plan established in 2010 (USEPA, 2010). The Action Plan identified 61 actions organized into 5 Initiatives that would help achieve the goal of reducing human and ecosystem exposure to toxic contaminants in the Columbia River Basin. Initiatives 3 (Conduct monitoring to identify sources and then reduce toxics) and 4 (Develop a regional, multi-agency research and monitoring program) of the Action Plan address the importance of, and need for,

various monitoring actions to help realize the plan's goal. Recently, as a part of their freshwater fish monitoring program, Washington Department of Ecology (Ecology) has begun sampling the mainstem of the Columbia River, beginning with the downstream location below Bonneville dam (Bednarek 2024) and has plans to continue that sampling upstream to the Canadian Border.

A6. PROJECT DESCRIPTION

EPA awarded funds to the Confederated Tribes and Bands of the Yakama Nation, who have partnered with the U.S. Geological Survey (USGS), Columbia River Inter-Tribal Fish Commission, Washington State Department of Ecology, and Oregon Department of Environmental Quality to develop a monitoring program aimed at tracking the status and trends of contaminants in fish and sediments in the Columbia River mainstem from Bonneville Dam to near the Dalles Dam (Fig. 1). This long-term monitoring design and rationale was recently published as a "Framework for the Development of the Columbia River Mainstem Fish Tissue and Water Quality Monitoring Program" in 2023 (Counihan et al 2022). The contaminants of interest include mercury (total and methylmercury (in sediments only)), organochlorine (OC) pesticides, polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (PBDEs). This quality assurance project plan (QAPP) will focus on and Phase 2 of a three-phase, multi-year program that will develop a plan to establish a long-term monitoring program. This is an important first step in developing and implementing the materials developed in Phase 1.

Figure 1. Example map of the study reach and sampling sites.



The following provides a brief outline of the three phases:

- In Phase 1 (year 1 and 2), a Monitoring Framework to guide formation of a long-term monitoring program to assess the status and trends of contaminants in fish and sediments in the Middle and Upper Columbia River mainstem was developed and completed in December of 2022. Phase I included reviewing relevant and existing datasets, soliciting feedback on research needs and priorities from key stakeholders, formulating a written conceptual design and distributing it for stakeholder review, and addressing stakeholder comments to produce a Monitoring Framework and an Outreach Messaging Framework.
- Phase 2 (2023-2024) is an implementation of a pilot study of the Columbia River Monitoring Framework. The work in this phase will cover the following EPA's Columbia River Basin Restoration Program (CRBRP) project categories and priorities (RFA Section 1.B.): Category 4) Monitoring to evaluate trends; Category 7) Promoting citizen engagement or knowledge; Priority 1) Increased monitoring and access to data; and Priority 3) Promoting citizen engagement or education. Phase 2 will be an implementation of stakeholder engagement process that supports the larger vision

for the monitoring program: A multi-phased approach with dependency on collaboration during all phases including work towards developing a widely available database and document repository.

- Phase 3 will implement the monitoring program developed in Phase 1 and 2. The monitoring program will continue annually including data management and community engagement and outreach activities.

A7. PROJECT OBJECTIVES

The primary purpose of this project is to pilot implement the Framework by the collection, process, and analysis of fish and sediment samples from .....an XY-mile reach of the Columbia River. This monitoring approach was piloted in a previous study lead by the Yakama Fisheries and USGS in the Bonneville pool in 2023 and 2024. That study and others listed above in the background, will provide information needed to inform and instruct aquatic monitoring in a large river like the Columbia. The main goal is to further develop a collaborative monitoring program through field sampling, analytical measurements, and reporting effort to the public. This work will directly inform the development of the monitoring program by providing on the ground information to refine media specific QAPPs, field and lab SOPs, Health and Safety Plans (HASPs), Invasive Species Spread and Prevention Plan (ISSPP), laboratory contracting, performance plan and data review, and other plans and permits required to fully implement the Columbia River Mainstem Fish Tissue and Sediment Quality Monitoring Program (i.e., Phase 3).

A8. PROJECT ORGANIZATION

This QAPP covers the study design for sample collection and describes the quality assurance and quality control (QA/QC) methods and procedures that will be used for the collection of fish tissue and sediment samples. This QAPP was prepared according to guidance presented in the 2002 EPA document of Requirements for Quality Assurance Project Plans (USEPA 2002a). Reference to the QAPP elements described in the guidance document are included in this document. Organization of the project team provides the framework for conducting the sample collection tasks to meet study objectives. The organizational structure and function also facilitate project performance and adherence to QA/QC procedures and requirements. Critical roles will be fulfilled by those responsible for ensuring the collection and processing of data and for routinely assessing the data for precision and accuracy, as well as the persons responsible for approving and accepting final deliverables. The project staff include staff from.....TBD..

The Field Sampling Coordinator, or her designee, will supervise the assigned project staff to provide for their efficient operation by directing their efforts either directly or indirectly. The project leads will also have the following responsibilities:

- providing oversight for study design, site selection, and adherence to design objectives,
- reviewing and approving the project work plan, QAPP, and other materials developed
- to support the project.

The Project Leads, will be responsible for performing evaluations to ensure that QA/QC protocols are maintained throughout the sample collection and preparation processes for the length of the study. The evaluations will include reviewing all required documentation for completeness and documenting and addressing any problems encountered outside normal operating conditions and verifying all other QA/QC procedures identified in the QAPP are followed.

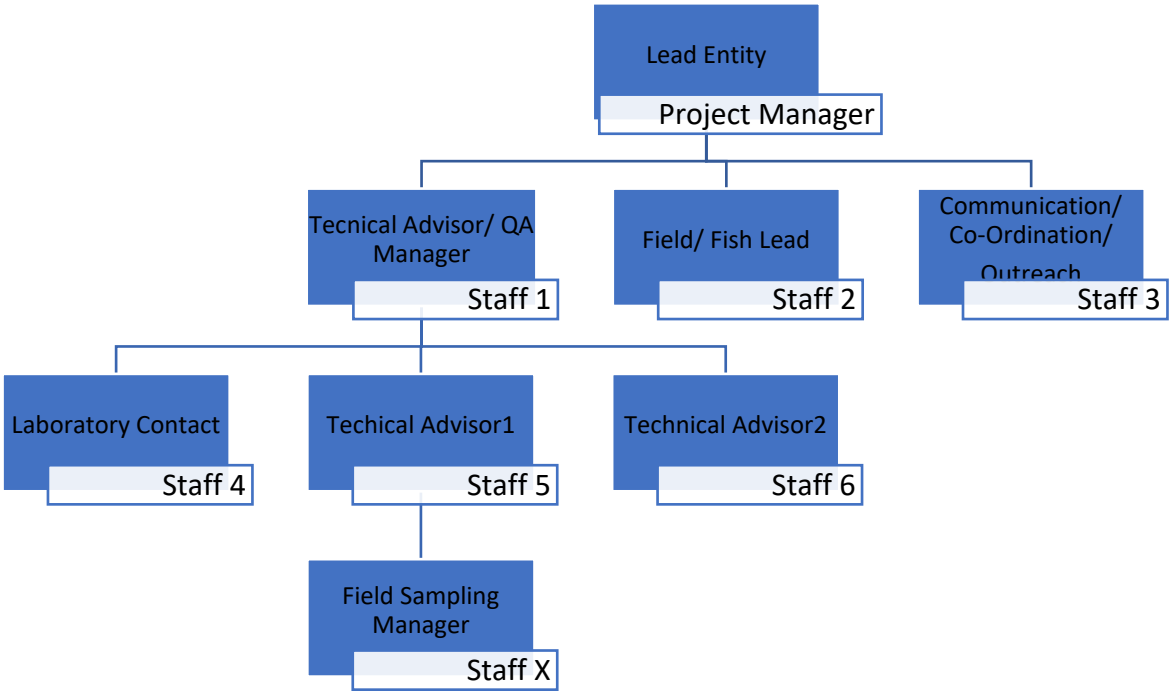
Field Sampling Teams will be composed of:

TBD

Field staff are responsible for performing the field work, including collection, preparation, and shipment of samples and completion of field sampling records. The Field Sampling Teams will include scientific staff with specialization and technical competence in field sampling activities to perform the required work effectively and efficiently. All work must be performed in adherence with the project work plan and QAPP. Field Sampling Teams will be responsible for:

- receiving and inspecting the sample containers
- completing and signing appropriate field records
- assigning tracking numbers to each sample
- verifying proper handling and storage of the samples
- verifying completeness and accuracy of shipment information
- controlling and monitoring access to samples while in their custody
- initiating shipment of the samples to appropriate destinations.

Figure 2. Conceptual Project Organizational Chart.


Lead Entity
Project Manager
Tecnical Advisor/ QA Manager
Staff 1
Field/ Fish Lead
Staff 2
Communication/ Co-Ordination/ Outreach
Staff 3
Laboratory Contact
Staff 4
Techical Advisor1
Staff 5
Technical Advisor2
Staff 6
Field Sampling Manager
Staff X

B. DATA ACQUISITION

B1. SAMPLING PROCESS

Sample Type

To meet the study objectives under this QAPP, sample type will include composite sampling of fish fillets and whole fish composites, as well as composite sediment samples. In addition, biofilm samples from large flat rock surfaces will be collected adjacent to the fish sampling sites as budget and time allow. (More details on sample type is described below.)

Sampling Period

Field sampling will be conducted during the summer of 2023. The primary sampling window will be between July and August 2023 (table 1). If the fish collection methods are not fully successful during this time, boat-based electrofishing may occur in the late October to November time frame *when water temperatures have cooled to below 64 degrees F, as per the NOAA Fish Collection permit*.

Site Selection

Sites for sample collection from X to Y locations will be selected using the linear Generalized Random Tessellation Stratified (GRTS) method. The GRTS method is designed to produce a probability sample with design-based variance estimators. It provides a spatially balanced, random selection of sites, allowing for unequal probability sampling. If logistical or safety constraints make a site inaccessible, the reason for the site inaccessibility will be recorded and reported, and pre-selected additional randomized sampling sites will be used as a replacement. This GRTS method, as described by Stevens and Olsen (2004) and therein, is analogous to the design approach implemented by the EPA National Streams and Rivers Assessment (NRSA) program, and EPA Office of Research and Development (ORD) scientists were consulted prior to its implementation here.

Sample Frame

Implementation of the field sampling tasks will proceed with several time points, as presented in Table 1. All activities associated with sample collection will be conducted consistent with the requirements and procedures specified in this QAPP.

Table 1. Project timeline associated with fish tissue and sediment sample collection.

Task	Description	Timeline
Project Planning and Monitoring		
Submit QAPP and respond to comments. Plan for field effort.	Plan, task and train staff on appropriate methods. Plan for sample handling (bottles, labels, transport, storage). Schedule. Confirm laboratory contracting.	
Conduct field sampling for fish and sediments.	Document sample collection, locations, collection success, modifications, sample status and proper holding methods and times. Finalize sub-contractor and laboratory payments.	
Fish collections/purchase events with Tribal Fishers for salmon collection	Sample collection and locations for adult salmon will be coordinated with Yakama Fisheries staff and documented with the sample collection and location information.	
Secondary Fish Collection, if needed	Boat electrofishing maybe utilized during this window if catch rates in July and August were insufficient	
Ship samples to the laboratory.	Samples will be shipped in dry ice in the proper shipping container. Document shipping information	09/2023 - 11/2023
Submit post-sampling reporting for Federal and State permits. Prepare Data Release.	Complete reporting requirements for Federal and State permits. Begin data release for review and public notification.	03/2024 - 05/2024
Review Laboratory Data.	Review all project data, including laboratory QA data. Verify method performance and need for laboratory re-runs or clarifications.	02/2024- 03/2024
Laboratory Analysis		
Conduct Quality Assurance checks, data validation and confirmation.	Distribute preliminary dataset and validation package to Team members for additional review.	04/2024 - 05/2024
Archive and distribute data in permanent and publicly available database.	Create data release, submit for peer review, release data via USGS	05/2024 - 08/2024

	ScienceBase or USGS National Water Information System (NWIS).	
Document Pilot sampling efforts, and reference the relevant, aforementioned written products (SOPs, permits, sampling frame, etc)	Produce a Data Summary Report that documents and summarizes overall sampling efforts and observations and supporting materials; including data appendices to the summary report.	01/2024 - 09/2024

B2. SAMPLING METHODS

Field methods described in Hayslip and Herger (2008) will be used for the sampling of fish, as allowed by XY NOAA permits, and field methods described in Counihan and others (2014) will be used for sediment sampling. Field sampling will be conducted during the x-y months. Sampling is planned as a one-time event per site, no scheduled repeat sampling for the base sites. Biofilm samples may also be collected if time and budget allow it. Collection of biofilm samples will follow sampling methods described in Larson and Collyard (2019) and Hobbs (2019). In addition, water temperature and specific conductance readings will be collected at the beginning of each sampling event using a multiparameter meter.

Fish Sampling

The fish collection procedures will follow the methods as outlined by the NOAA and ODFW permit requirements, where this same sampling design request was submitted. Both predatory and prey versions of resident and anadromous salmonids composite samples will be collected.

Adult Salmonids

Returning adult salmon (considered to be >60cm) will be collected from tribal fisherman fishing in Bonneville Reservoir with the assistance of the Yakama Nation or other partner and their fisheries management staff during the active Fall adult fishery. Communication and coordination with Tribal Fisherman has already begun through Yakama Nation or other partner Fisheries managers, and representative from the project will attend and inform and answer questions from Tribal Fishers during the spring or summer planning meetings. Purchased adult salmon from the Tribal fishers will be cleaned thoroughly with DI water and dissected immediately upon receipt. Two,

10-gram skin-on fillet pieces collected from the largest cross section of the fillet (above the lateral line, posterior to the skull and anterior to the dorsal fin) will be collected. Dissection will use stainless steel dissection tools. Duplicate, 3-5 fish skin-on fillet composites, will be collected, (ie. 2 containers), and placed immediately on dry ice. Lengths and weight and sex of each fish at the time of receipt will be recorded. Adults will be scanned for coded wire tags and PIT tags with a PIT Tag wand and scales of adults will be retained for aging.

Juvenile Salmonids

Juvenile salmonids are considered between 12-17 cm in length and out-migrating juveniles will be collected from the Bonneville Fish Collection facility. Depending upon availability, whole body composite samples of 3-5 juvenile salmon of the same species will be created. Five to ten of these single species, whole body juvenile salmonid samples, composited into a single container per sample, will be collected, depending upon availability. Lengths and weight of each fish at the time of receipt will be recorded.

Resident Fish

Resident prey (forage) fish will consist of fish (< 30cm) and resident predatory (> 30cm) fish species from a targeted resident list will be developed to minimize the effect of sampling different species while still obtaining a representative sample across sites (USEPA 2008). Targeted fish species are listed in table 3. Other species not listed may only be considered if an insufficient number of the targeted resident species is collected.

Ten sample sites were selected (fig. 1) by a statistical random (systematic) process determined by a GRTS sampling design which selects the center channel point. Fish sampling will be within a fixed 1000' section along either the left or right banks from the center channel point. The gear types used to collect fish are determined in the permitting process. Sampling will be performed using passive net gear including hoop nets, fyke nets, large minnow nets and hook-n-line. Using passive net sampling gear allows the release of all non-target fish with minimal effects to the fish, as well as for targeted resident species prior to processing. Deployment of gears and collection of fish samples from shoreline areas in XY Reservoir is planned within a fixed location near the shore (approx. within 500'). Boat electrofishing will only be used if various other methods are not effective.

Fish tissue samples will be processed using similar methods to those described in USEPA 2000. Fish will be weighed, measured, sex determined and identified in the field. Composite samples of 5 fish fillets with skin-on of the same species (same species because of the significant species-specific bioaccumulation potential) and of similar size (within 75% total length of the largest fish) will be collected. Whole fish for juvenile fish samples will also be collected (table 2). (Fish for whole body composite analysis may be opened for sex determination.) All samples collected will be analyzed for total mercury, organochlorine (OC) pesticides, PCBs, and PBDEs. Fish samples will be collected in sufficient numbers to provide a 50-g composite homogenate sample of tissue for analysis of recommended target analytes and placed in a borosilicate glass container. All samples will be processed in the field and will be frozen at the sampling site and stored until ready to be shipped on dry ice to the laboratory for analysis.

Table 2. Fish groups and fish size categories

Fish Group	Size Group	Sample Medium	Number of samples per fish group*
Forage fish	<30 cm	Whole fish	10
Predatory fish	>30 cm	Fillets, skin-on	10
Juvenile Salmonids	12-17 cm	Whole fish	5
Adult Salmonids	>60 cm	Fillets, skin-on	5

*Composite of 5 fish fillets or whole fish of the same species equals one sample. QA sample number not included here.

Table 3. Targeted fish species list

Resident Forage Fish	Resident Predatory Fish	Salmonids Juvenile	Salmonids Adults
Speckled Dace	Smallmouth Bass	Coho	Coho
Sculpin	Walleye	Chinook	Chinook
Red Side Shiner	Largemouth Bass		
Largescale Sucker	Northern Pikeminnow		
Chiselmouth			
Peamouth			
Carp			

Sediment Sampling

Sediment samples will be collected in accordance with the permits acquired and this QAPP (table 4). Similar to fish sample sites, up to 7 sample sites were generated to collect sediment samples using a GRTS algorithm that encompasses the Reservoir and contains a grid of sample points at a resolution of 30 m x 30 m (see: https://www.monitoringresources.org/Sites/Master/Detail/2). Sediment samples will be collected along either the left or right banks or the center of the channel within a 30m x 30m grid section. All sediment samples collected will be analyzed for mercury (total and methylmercury), organochlorine (OC) pesticides, PCBs, and PBDEs. In addition, grain size and organic content (loss on ignition) in sediment samples collected will be analyzed.

Sediment samples will be collected from a boat using a standard ponar benthic grab sampler, or a 30 x 30 cm box corer, deployed from a bow-mounted crane and winch (Counihan and others, 2014). Individual ponar grab samples will be collected within a strata and deposited in a stainless steel bin and then composited. Refusal of the ponar or box corer due to hard substrates is possible at some sites and a total of 10 sediment samples may not be collected. Individual samples will be homogenized with

a stainless-steel spoon, subsampled, and transferred to a whirlpak for grain size and loss on ignition (LOI) analysis; the remaining sample portion will then be transferred to a bin set up to be composited. Once the sample is composited, the sample will be homogenized again, and a portion will be transferred to a 500 ml glass jar for contaminant analysis. The individual stainless steel collection bins will be rinsed thoroughly with native water between samples. After the full composite is collected at each site, the bins will be rinsed with native water, cleaned with Liquinox soap and deionized water, rinsed two more times with deionized water, and finally rinsed with methanol from a squirt bottle and rinsed again with deionized water before the next composite sample is collected at the following site. Immediately after collection, samples will be placed in coolers on ice at < 4°C and later freeze until ready to be shipped to analytical laboratory.

Table 4. Criteria and considerations for collecting a representative sample of bottom material

Aspects of Sample Collection	Criteria and Considerations
Equipment	● Sampling equipment penetration must be deep enough to provide a sample mass that meets project objectives ● Sampling equipment must be completely closed after proper penetration ● Weight of sampler
Techniques and methods	● Quantities of bottom material enclosed each time sampling equipment is deployed should be approximately equal ● Speed of sampler through water column ● Consistent depth of sediment per grab (ie. top 10 cm)
Sampling environment	● Depth of water column (ensure adequate cable length to control speed of sampler deployment ● Physical, chemical, and biological character of water column above sample-collection site ● Velocity of water currents (too fast could produce improper deployment of sampler) ● If site is inaccessible, avoid site and move to next site on sample list ● Sampling platform stability (such waves) ● Temperature and conductivity of water at 1m of depth

Biofilm Sampling

Biofilm refers to the mixture of periphyton, microbial biomass, and fine sediments that adheres to solid surfaces in aquatic environments. Periphyton is algae attached to the river bottom, rocks, or debris in freshwater rivers and streams. Standard protocols for sampling attached algae for the collection of biofilm samples will be followed (Larson and Collyard, 2019). Biofilm will be scraped from rocks and collected in the field to confirm that sufficient biomass is retrieved (~10 g wet weight). Samples will be transferred from the collecting bowl to a cleaned glass jar. A sample to assess areal biomass (g dry weight / cm2) will be collected separately. The area scraped from both sample locations for biofilm will be measured by cutting a piece of aluminum foil to trace the sampled area. The area of the aluminum foil is then measured using a 2-D digitizing software (Hobbs, 2019).

Sampling Methods Summary

An overview of the sample types, collection method, parameters, and total number of samples that will be collected for this study are shown in table 5 below. If biofilm samples are collected, dependent on time and budget, these samples will only be analyzed for OC pesticides, PCBs, and PBDEs, with the sample lab method and detection levels as the tissue samples.

Table 5. Sample types and total number of samples planned to be collected, not including QA/QC samples.

Parameter	Sample type	Total number of samples	Collection method
PCBs, PBDE, OC pesticides, total mercury, percent lipids	Fish tissue*	30	Passive net gear
PCBs, PBDE, OC pesticides, total mercury, methylmercury, grain size, loss on ignition	Sediment	10^	Grab sample

*Adult salmonids will be bought from fisherman for analysis. ^Not to exceed number, may be less depending upon sampling success. All juvenile salmonids will be collected from Bonneville Fish Collection Facility for analysis.

B3. QUALITY OBJECTIVES AND CRITERIA FOR DATA COLLECTION

Specific Data Quality Objectives (DQO) generated in this QAPP will help to determine the intended qualitative and quantitative use of the data, define the type of data needed to support the decisions to be made, identify the conditions under which the data should be collected, and specify acceptable limits on the probability of making a decision error due to uncertainty in the data. Laboratory and field methods, contract negotiation and documentation and financial arrangements, and sample preservation and handling documentation will be completed before sample collection begins.

Possible sources of error or uncertainty are listed below:

- Sampling error: The difference between sample values and true values from unknown biases due to collection methods and sampling design
- Measurement error: The difference between sample values and true values associated with the measurement process
- Natural variation: Environmental spatial and temporal variability in population abundance and distribution
- Error sources or biases associated with compositing, sample handling, storage, and preservation

The methods and procedures described in this document are intended to reduce the magnitude of the possible sources of uncertainty listed above, by following the steps listed below:

- use of established and standardized sample collection and handling procedures, and
- use of trained staff to perform the sample collection and sample handling

B4. SAMPLING HANDLING

Sample containers and labels should be prepared before sampling for sample organization and sampling efficiency. Proper labeling of samples is an important quality assurance aspect and all sample containers for each site should be prelabeled prior to sampling. Pre-labeling clean and dry containers helps to ensure that labels adhere properly to the containers. Labels should contain site name, site number, sample date and time, species name (for fish only). Labels should be preprinted on waterproof paper using ink that is resistant to water, and the information should be recorded on the label using a water-resistant pen. Examples of all forms are provided in Appendix B. Sampling crews should be mindful while sampling to prevent contamination of containers, packaging, and sampling equipment used for trace of mercury analysis.

Primary concern with sample handling and processing is to avoid sources of possible tissue contamination including contamination from sampling gear, spilled engine fuel (gasoline or diesel), engine exhaust, dust, ice coolers, and ice used for cooling. All potential sources of contamination in the field should be identified and appropriate steps should be taken to minimize or eliminate them. Wind direction and sources of engine exhaust will be monitored; under some conditions, contact with exhaust may be unavoidable and will be so noted. Ice coolers used should be scrubbed clean with detergent and rinsed with distilled water after each use to prevent contamination. To avoid contamination from melting ice, samples should be placed in waterproof plastic bags. Sampling equipment that has been contaminated by oils, grease, diesel fuel, or gasoline should not be used. All equipment that will be used directly in handling fish (e.g., fish measuring board, scales) should be cleaned in the laboratory prior to each sampling trip, rinsed in acetone and pesticide-grade methanol, and stored in aluminum foil until use. Between sampling sites, each measurement device should be cleaned by rinsing it with ambient water and rewrapping it in aluminum foil to prevent contamination. Similarly, the loss of contaminants is also a concern and can be prevented by ensuring that the sample collected remains intact, i.e., sample collection procedures should be performed with the intention of minimizing the laceration of fish skin. In addition, any sensitive gear such as meters, probes, cameras, rangefinders, and other sensitive gear should be packed to avoid shock, exposure, and other damage during transportation and boat rides.

Individuals of the selected target species will be rinsed in ambient water to remove any foreign material from the external surface. A nine-character composite sample identification number consisting of the two-character state abbreviation, two-number year abbreviation, 3-digit site identification number, and sample type (“BA” for animal tissue sample, “SB” for bed-sediment sample, “BAQ” for animal tissue quality control sample, or “SBQ” for bed-sediment quality control sample) will be assigned by the field teams for each composite collected. The composite sample specimen number and information regarding the fish specimens will be recorded on the field record forms.

A Laboratory Analytical Services Request (ASR) Form will be completed and submitted together with the samples. ASR should include sample date and time, sample type, site number, site name, and analytical schedules being requested. A copy of the ASR form will be kept as a record. Documentation establishing the collection information, sample shipment information (tracking number, ASR), and sample inventory of the contents of each shipment coinciding with information in the field data forms will act as a record.

The information on the field data form is discussed above. No Chain of Custody or signature of the person relinquishing the sample will be required. Any observations regarding the shipment (e.g., torn or damaged packaging, insufficient dry ice) should be documented by the laboratory, however, and should be communicated to USGS project lead.

Sample management, short-term storage, sub-sampling (if needed) and documentation prior to laboratory submittal will primarily be handled by the assigned Project Staff member. Project leads will work with the to ensure proper handling of the field samples and generation of key QA samples at various points along the sampling and shipping progression.

Table 6. Sample Preservation Methods and Holding Times

Analyte Class	Media	Holding Times Field (wet or dry Ice)	Holding Times- Lab	Preservation Container*
PCBs	Tissue & Sediments	24 hours	1 year	Certified Baked Glass
PBDEs	Tissue and Sediment	24 hours	1 year	Certified Baked Glass
Organochlorines	Tissue and Sediment	24 hours	1 year	Certified Baked Glass
Mercury	Tissue and Sediment	24 hours	1 year	Certified Baked Glass

*For larger samples (e.g. large fish) wrapping first in aluminum foil prior to ziplock baging may be needed.

B5. ANALYTICAL METHODS

All laboratories will use EPA or other standard methods which have proven performances in tissue and sediment matrices. The laboratories may use other suitable methods, provided that performance-based measures are achieved. The specific analytical concentration goals (ACGs) were established in a 3-step review process.

1) For the protection of human health, the 2008 Risk Based Concentrations (RBCs) generated by Syracuse Research Corporation for EPA Region 10 in Table B-2 of the "Upper Columbia River Site, Quality Assurance Project Plan for the 2009 Fish Tissue Study" (Parametrix, 2009) were reviewed and considered appropriate ACGs for this study. See Appendix C.
2) For the resident forage fish and for the juvenile salmonids, RBCs for the protection of piscivorous fish and wildlife are rarely defined, but for 5 classes of contaminants (ie. PCBs, PBDEs, DDT, chlordane, dieldrin) were summarized by Batt and others (2017) and deemed suitable ACGs for this study.
3) Factors 1 and 2 were considered, along with laboratory costs, new sample capacity, turnaround time and number of total analytes reported on the method, to arrive at a final decision about which lab and analytical method would be utilized.

The list of laboratory analytes and expected detection limits is shown in Appendix A. With one notable exceptions (eg. PCB-126) the detection limits listed in Appendix A are generally lower than the "Lowest Risk-Based Concentration" reported in Table B-2 of the "Upper Columbia River Site, Quality Assurance Project Plan for the 2009 Fish Tissue Study". Meeting all the lowest risk-based concentration targets in the Table B-2, for such a long list of chemicals is economically unfeasible and was not originally scoped as such.

Tissue

The .....XY Laboratory will analyze for OC pesticides, PCBs, and PBDEs in fish and sediment samples. Total mercury will be analyzed by .....XY Laboratory. Subsamples of all fish samples processed and homogenized by .....XY Laboratory will be sent to .....XY Laboratory for total mercury analysis. Whole fish samples will be retained whole, composited into a single container per sample, frozen in the field and homogenized at .....XY Laboratory. Composite fillet tissues will likewise be weighed and composited into single container, and frozen in the field and homogenized at .....XY Laboratory. The SOPs from both laboratories use appropriate analytical methods to achieve the required measurement quality objectives.

Laboratory method .....XY Laboratory Laboratory will be used for the analytical procedures of the quantitative determination of PCBs congeners by high resolution gas chromatography and mass spectroscopy (HRGC/MS). This method is consistent with EPA method 1668A. Organochlorine (OC) pesticides will be measured by low

resolution gas chromatography/ mass spectrometry (GC/LRMS) analysis Prior to processing tissue samples, whole fish and skin on fish fillets (filleted in the field) composite samples will be homogenized. Prior to sample extraction, isotopically labeled surrogate standards are added to the sample. The initial calibration solutions contain surrogates, recovery standards and native analytes. The concentration of the native analytes in the solutions varies to encompass the working range of the instrument, while the concentrations of the surrogates and recovery standards remain constant.

Laboratory method MLA-033 or equivalent by .....XY Laboratory will be used for the analytical determination of the concentrations of PBDEs, according to the protocols described in EPA Method 1614A, in aqueous, solid, and tissue samples. The method uses isotope dilution, and the analysis is performed using a high-resolution gas chromatography to a high-resolution mass spectrometer (HRGC/HRMS). Fish tissue samples - a 20-g aliquot of sample is homogenized, and a 10-g aliquot is spiked with the labeled compounds. The sample is mixed with anhydrous sodium sulfate, dried for a minimum of 30 minutes, and extracted for 18-24 hours using methylene chloride in a Soxhlet extractor. Samples are spiked with isotopically labeled BDE surrogate standards, solvent extracted, spiked with a cleanup surrogate

Sample specific detection limits (SDLs) reported with the analytical results are determined from the analysis data by converting the minimum detectable signal to a concentration following the same procedures used to convert target peak responses to concentrations. The estimated minimum detectable area is determined as 2.5 times the height of the noise in the m/z channel of interest, converted to an area using the area height ratio of the corresponding labeled surrogate peak. SDLs are prorated depending on sample size, extract dilution/split and final extract volume.

Total mercury analysis in tissues will follow Cold Vapor Atomic Absorption (CVAA) method from Bureau Veritas CAM SOP-0453, with typically a 5 ng/g detection limit in tissues. The entire tissue will be transferred to a digestion vial and weighed, then sample will be freeze-dried and processed on a dry-weight basis with the moisture content determined as part of the process. Composites prepared from multiple samples, sample is homogenized as an entire sample and then digested and analyzed. Samples are typically digested using a mixture of nitric acid, hydrochloric acid, and hydrogen peroxide, which completely dissolves the tissue. The resultant digestate is then analyzed by CVAA (cold vapor atomic absorption) spectrophotometry for total mercury.

Sediment

Sediment samples will be analyzed for same parameters as fish tissue samples, with generally the same methods. ……XY Laboratory will conduct analytical procedures for the determination of PCBs and OC pesticides using method MLA-010, and PBDEs using method MLA-033. Total mercury and methylmercury in sediment samples will be analyzed……..XY Laboratory. In addition, grain size and loss on ignition analyses will be analyzed by ……..XY Laboratory.

Sediment samples for OC pesticides, PCBs, and BDEs analysis will follow the same extraction methods as fish tissue samples. ……..XY Laboratory analytical method for PBDEs will use isotope dilution and internal standard high resolution gas chromatography/high resolution mass spectrometry, HRGC/HRMS. And analytical method for PCBs and OC pesticides will be using gas chromatography/low-resolution mass spectrometry (GC/LRMS) analysis. Solid samples are spiked into a sample containing 10g of solids. The sample is mixed with anhydrous sodium sulfate, dried for a minimum of 30 minutes, and extracted for 18-24 hours using methylene chloride in a Soxhlet extractor. Samples are spiked with isotopically labeled BDE surrogate standards, solvent extracted, spiked with a cleanup surrogate standard and cleaned up on a series of chromatographic columns which may include layered acid/base silica, alumina and Florisil columns.

Sample specific detection limits (SDLs) reported with the analytical results are determined from the analysis data by converting the minimum detectable signal to a concentration following the same procedures used to convert target peak responses to concentrations. The estimated minimum detectable area is determined as 2.5 times the height of the noise in the m/z channel of interest, converted to an area using the area height ratio of the corresponding labeled surrogate peak. SDLs are prorated depending on sample size, extract dilution/split and final extract volume.

Analysis for total mercury in sediment samples will be analyzed by atomic adsorption following direct combustion. Samples will be prepared by room-temperature acid digestion and oxidation with aqua regia. The samples are brought up to volume with a 5% bromine monochloride solution to ensure complete oxidation and heated at 50°C in an oven overnight. Samples are then analyzed with an automated flow injection system incorporating a cold vapor atomic fluorescence spectrometer (CVAFS) (DeWild and others, 2004b) or equivalent by ……..XY Laboratory. These diluted samples are then analyzed according to USEPA Method 1631, Revision E (USEPA, 2002b).

Analysis of methylmercury is conducted by distillation, gas chromatography separation, and speciated isotope dilution mass spectrometry. Prior to analysis, distillation is required to disassociate methylmercury from the sample matrix and reduce matrix interference during analysis. Analysis is conducted via the Brooks-Rand "MERX" automated methylmercury analytical system coupled to the Elan inductively coupled plasma-mass spectrometer (ICPMS). Quantification of methylmercury concentrations in the samples are calculated using isotopic dilution (DeWild and others, 2004a) or equivalent method by .....XY Laboratory. Results are reported on a dry weight basis by dividing the concentration as-processed by the percent dry weight.

Sediment grain size can be used to assess fine-grained particles correlated to concentration of contaminants in sediments. The pipet method is used to determine particle size gradation of fine material. A pipet is used to withdraw fine sediment at known depths over a period of time. These withdrawals are used to determine the concentration of the cylinder at the predetermined depths as a function of settling time. For particle material larger than 0.0625mm, such as sand, the Visual Accumulation (VA) tube method or sieve methods is used by. .....XY Laboratory A breakdown of sand size through this method includes 9 increments from 0.700mm to 0.0625mm. Fine analysis includes six increments from 0.002mm to 0.0625mm. Sand in the 1mm and 2mm size class are sieved prior to using the settling tube.

Loss on ignition analysis will be used to estimate the organic and carbonate content in the sediment samples collected, or equivalent method. At the laboratory, in a first reaction, samples are weighed and heated for two hours at 500-550° C where organic matter is oxidized to carbon dioxide and ash. In a second reaction, carbon dioxide is evolved from carbonate at 900-1000° C, leaving oxide. The weight loss during these reactions is easily measured by weighting the samples before and after heating and is closely correlated to the organic matter and carbonate content of the sediment. The percent of sample mass lost following heating is reported as LOI. This method estimates organic matter based on weight change associated with high temperature oxidation of organic matter.

B6. QUALITY CONTROL AND QUALITY CRITERIA

Field

Quality control data are generated from the collection and analysis of quality-control samples to quantify the magnitude of the bias and variability in the measurement process of obtaining environmental data. At least ten percent of the total fish and

sediment samples will be collected as replicate samples as part of quality control (table 6). The replicate samples will be used to evaluate random variability between samples and analytical results. Fish and sediment replicate samples will consist of a second independently collected sample of the same type (same species for fish) from the same sample site on the same day. The collection process for the replicate sample will follow the same field procedures as the environmental sample. In addition, an equipment blank will be collected for fish and sediment equipment. Equipment blank samples are intended to demonstrate that sample collection and processing equipment and equipment-cleaning procedures are not sources of contamination. A blank solution will be poured through all the equipment used for collecting and processing fish and sediment samples. The blank solution exposed to all the collection and processing equipment will be collected in the sample containers, based on the laboratory analysis, that will be used for fish and sediment samples. Equipment blanks should be collected at least 2 months before beginning of field sampling. Analysis for the replicate samples and equipment blanks will consist of the same as the environmental sample analysis: mercury, OC pesticides, PCBs, and PBDEs.

Laboratory

The laboratory quality control measures include the use of laboratory control standards (LCS), matrix spikes and matrix spike duplicates (MS/MSD), continuing calibration verification (CCV), surrogates, internal standards, laboratory blanks, duplicate analyses, and other method specific quality control activities (table 6). Laboratory control standards in the form of control samples will be used to determine if laboratory equipment and procedures are able to accurately recover a known amount of spiked analyte at an expected range. Laboratory control standards are run alongside of, and in an identical manner as, the sample. Method blanks in the lab will be used to ensure that lab analysis and procedures are not causing contamination to the sample matrix. Matrix spiked samples are used to determine the effect of the matrix on a method's recovery efficiency. For XY Laboratory, samples are analyzed in batches consisting of a maximum of twenty samples, one procedural blank and one spiked matrix (OPR) sample. A duplicate is analyzed, provided there is sufficient sample, with batches containing 7-20 samples. Matrix spike/matrix spike duplicate (MS/MSD) pairs may be analyzed on an individual contract basis. The batch is carried through the complete analytical process as a unit. For sample data to be reportable, the batch QC data must meet the established acceptance criteria presented on the analysis reports. Quality assurance and control objectives for the USGS MRL during the

analytical run with each batch of sediment samples include calibration data, method blanks, duplicates analyses, certified reference material (CRM) samples, matrix spikes, reverse ID check standard recoveries to ensure acceptance criteria are being met (table 6). First level Quality Assurance data will be reported with the environmental data to the public. This includes sample-specific reporting levels (as needed), blank performance, and replicate performance. Second level quality performance data, ie. calibration data, matrix spike recovery, blind CRM performance, will be stored and permanently archived via ….TBD…..and internal Project Folders and Laboratory Evaluation Procedures therein, via electronic server and database.

All laboratory quality controls required to meet project objectives are listed in Appendix B.

Table 7. Field and laboratory Quality Control samples frequency and acceptance criteria

Quality Control Sample	Analysis Type	Analyte	Frequency	Acceptance Criteria
Field				
Replicate	Fish tissue	PBDEs, OC Pesticides, Mercury & PCBs	10% of total samples	±40%
Replicate	Sediment	PBDEs, OC Pesticides, Mercury & PCBs	10% of total samples	±40%
Equipment blank	Fish tissue Sediment	PBDEs, OC Pesticides, Mercury & PCBs	1 sample per analysis type	< MDL
Laboratory				
Blank	Fish tissue Sediment	PCBs, PBDEs & OC Pesticides	Every 20 samples	<10% of analyte value
Duplicate	Fish tissue Sediment	PCBs, PBDEs & OC Pesticides	Every 7-20 samples	≤ 40% of RPD
Matrix spike	Fish tissue Sediment	PCBs, PBDEs & OC Pesticides	Every 20 samples	60-130% recovery
	Fish tissue	Total Mercury		

Instrument purge	Sediment	Methylmercury, Total Mercury	Every 10 samples	<0.005 of peak area
Empty boat blanks	Sediment	Methylmercury, Total Mercury	Every 10 samples	<0.01 of peak area
Reagent blanks	Sediment	Methylmercury, Total Mercury	Every 10 samples	<0.05 ng/boat
Certified reference material	Sediment	Methylmercury, Total Mercury	Every 10 samples	80-120% recovery
Check standards	Sediment	Methylmercury, Total Mercury	Every 10 samples	80-120% recovery

Measurement Performance Criteria and Data Quality Indicators

Measurement performance criteria are based on the quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. These performance criteria are referred to as principal data quality indicators (DQIs). These DQI's are precision, accuracy, representativeness, completeness, and comparability.

Precision

Precision is the degree of mutual agreement among independent measurements from the repeated application of a measurement process under identical conditions. It is the inverse of variability, but unlike variability, precision cannot be directly determined.

Accuracy

Accuracy is commonly defined as the degree of agreement between a measured value and the true or expected value. It is a function of both bias and variability. Bias is the systematic error in a method or measurement process, and variability is random error in independent measurements as the result of repeated application of the process under specific conditions.

Representativeness

Representativeness refers to the degree to which data accurately and precisely represent a
characteristic of a population, parameter, variations at a sampling point, a process condition, or an environmental condition (USEPA 2008).

Completeness

Completeness is defined as the amount or percentage of data obtained compared to the amount that is expected to be obtained under normal conditions. To optimize completeness, every effort is made to avoid missing samples. Accidents during sample storage, transport, or laboratory activities, that may cause the loss of the original sample, will result in lost data, could potentially affect the integrate results and final report. Any samples that fail holding time or preservation requirements, will require to be flagged and any related data will be reconsidered. If laboratory activities may be the cause of a sample loss, the project lead will decide if these samples are salvageable and worth analyzing, and how to flag any related data.

Comparability

Comparability is a measure of the confidence with which one data set can be compared with
another. It is dependent on the proper design of the sampling program and on adherence
to accepted sampling techniques, standard operating procedures, and quality assurance guidelines. Comparability of data will be accomplished by standardizing the field sampling methods and analytical methods, and all samples will be collected and prepared for shipment according to procedures described in this QAPP.

B7. DOCUMENTATION AND RECORDS

The required data to be recorded at each sampling site for each sample medium is identified below. Detailed documentation of all field sample collection and handling methods is necessary for proper sample processing in the laboratory and, eventually, for study results interpretation. Field sample collection and handling will be documented for each sampling site using the following forms:

- Fish Tissue Field Data Sheet (table 7)
- Sediment Field Data Sheet (table 8)
- Analytical Services Request (ASR) Form

All sections in the above forms will be completed for each site, and all entries should be made in permanent ink. The submission of samples to the laboratory will include an ASR Form documenting sampling time and date and information in the ASR forms should be consistent with sample information of the corresponding field data sheet.

Table 8. Explanation of field data sheet sections for fish sampling

Section	Section Description
Sample header	Where and when sample was collected, station description, station name and number, field team member names.
Related sampling activities	Other sampling activities
Physical site conditions	Physical and chemical conditions at the time of the sampling, including specific conductance and water temperature
Sampling information	Sampling methods and effort, and fish specimen data, such as identification, abundance, length, weight, sex and external anomalies

Table 9. Explanation of field data sheet sections for sediment sampling

Section	Section Description
Sample header	Where and when sample was collected, station description, station name and number, field team member names
Related sampling activities	Other sampling activities
Physical site conditions	Physical and chemical conditions at the time of the sampling, including specific conductance and water temperature
Sampling information	Sampling method and device, sample volume
Supporting information	Water depth, velocity, substrate type

Samples will be shipped to the analytical laboratory via priority, overnight express delivery service (table 9).

Table 10. Summary of all sample types for preservation and shipping documentation

Sample Type	Medium	Preservation	Sample destination	Shipping comments
Adult fish	Fish tissue, fillets	Dry Ice		Frozen, will be shipped in batches
Juvenile fish	Fish tissue, whole	Dry Ice		Frozen, will be shipped in batches
Sediment	Sediment	Freeze		Frozen, will be shipped in batches

If any change(s) in this QAPP is(are) required or needed during the study, a memo will be sent to each person on the distribution list describing the change(s), following approval by the Project Lead. All memos announcing changes must be attached to this QAPP.

All documents and records completed for this project will be maintained by USGS during the project and retained for a period of five years after completion of the project.

B8. EQUIPMENT INSPECTION AND MAINTENANCE

All field equipment will be inspected prior to sampling activities to ensure that proper use requirements are met (e.g., boats are operating correctly, nets are without defects, sondes and other meters are properly calibrated). Inspection of field equipment will occur well in advance of the field operation to allow time for replacement or repair of defective equipment, and the field crew will be equipped with proper backup equipment to prevent lost time on site. Inspection of all equipment on an equipment and supply list prior to each sampling event should be conducted.

B9. INSTRUMENT CALIBRATION

All instruments used in the field will be calibrated according to USGS and manufacturer's operating instructions daily before being used. Multiparameter meter for the collection of water temperature and specific conductance, recently calibrated against known NIST standards, will be used to collect water quality conditions at the time of sampling.

B10. FIELD SUPPLIES INSPECTION

A checklist of field supplies will be created, and it will be the responsibility of each field team to gather and inspect the necessary sampling supplies prior to the sampling event and to inspect the sample
packaging and shipping supplies. Defective packaging and shipping supplies (e.g., torn or damaged polyethylene sample tubing) will be discarded.

B11. DATA MANAGEMENT

All observational data and field measurements at the time of sampling will be recorded using field data sheets. Scanned copies of all paper field data documents will be made immediately (at end of the day) and archived electronically. All data will be managed according to the Data Management Plan of the…….. XY program…….. The data sheets will be kept and maintained in an organized file. Field data sheets and other sample documentation will be initially reviewed for transcription errors, precision, completeness, anomalous data, and any other general problems.

Samples will be documented and tracked via Sample Identification Labels, Field Record Forms, and Sample Analytical Services Request Forms. Field team leaders will be responsible for reviewing all completed field forms. Any corrections should be noted, initialed, and dated by the reviewer. Shipment of samples to the laboratory must be conducted by a delivery service that provides constant tracking of shipments (e.g., Federal Express).

C. DATA VALIDATION

C1. DATA REVIEW, VALIDATION, AND VERIFICATION

Data received from the analytical laboratories will be reviewed and validated, and ultimately made publicly available, via a data hosting site such as…….TBD…….[USGS ScienceBase (www.sciencebase.gov) or in the USGS National Water Information System (NWIS) database (https://waterdata.usgs.gov/nwis/). The Project Manager will be responsible to uploading finalized dataset into XY database]. These electronic data releases require USGS peer-review and are intended to remain publicly available in perpetuity. All field data sheets, and sample analysis required forms will be reviewed for completeness by the field sampling teams. Any discrepancies in the records will be verified with the associated field staff and will be reported to the Project Lead.

Sample analysis information will be checked by laboratory upon receiving to ensure that holding times have not been exceeded. Violations of holding times will be

reported (by the laboratory) to the Project Lead. As soon as laboratory results become available and following completion of the sample collection tasks, precision, accuracy, and completeness, measures will be assessed and compared with EPA national recommended aquatic life criteria (USEPA, 2023) for fish samples, and consensus-based sediment quality guidelines (Ingersoll and others, 2000) in sediment samples. This will help determine quantity and quality of the data collected to support the intended use for this project. Any problems encountered in meeting the performance criteria (or uncertainties and limitations in the use of the data) will be discussed with the Project Lead.

C2. REGULATORY CRITERIA AND STANDARDS

Regulatory criteria and standards for both sediment and aquatic biota will be used to assess when toxics are at a level of concern. Washington's sediment management standard criteria will be used to compare the study's sediment screening results.

D. DATA ASSESSMENT

D1. ASSESSMENT AND REPONSE ACTIONS

Assessment and corrective response actions are identified below to ensure that sample
collection activities are conducted as described and the measurement and data quality objectives established by the USGS are met. The essential steps are as follows:

- identify and define the problem
- assign responsibility for investigating the problem
- investigate and determine the cause of the problem
- assign and accept responsibility for implementing appropriate corrective action
- establish effectiveness of and implement the corrective action
- verify that the corrective action has eliminated the problem

Immediate corrective actions form part of normal operating procedures and are noted on project field forms. Problems not solved following these steps will require more formalized, long-term corrective action.

D2. REPORTS TO MANAGEMENT

Annual summary reports will be completed at the end of each fiscal year and will describe activities from the beginning of the year. These summary reports will consist of information on project status, highlights, results of QC audits and internal

assessments. The project personnel are responsible for report production and distribution.

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Appendix A. Laboratory analysis sample detection limits (SDL) and method detection limits (MDL)

(in nanograms per gram (ng/g) for fish tissue and sediment.)

[NA – not available]

Parameter	SEDIMENT		TISSUE*	
	SDL (ng/g)	MDL (ng/g)	SDL (ng/g)	MDL (ng/g)
MERCURY				
Methylmercury	NA	0.08	N/A	0.08
Total Mercury	0.6-6.0	0.3	1.38	0.3
ORGANOCHLORINE PESTICIDES				
Hexachlorobenzene	0.1	0.08	0.1	0.01
HCH, alpha	0.2	0.25	0.2	0.03
HCH, beta	0.2	0.27	0.2	0.03
HCH, gamma	0.2	0.18	0.2	0.07
Heptachlor	0.2	0.17	0.2	0.02
Aldrin	0.5	0.21	0.5	0.04
Chlordane, oxy-	0.5	0.22	0.5	0.14
Chlordane, gamma (trans)	0.1	0.06	0.1	0.02
Chlordane, alpha (cis)	0.1	0.17	0.1	0.04
Nonachlor, trans-	0.1	0.29	0.1	0.03
Nonachlor, cis-	0.1	0.25	0.1	0.04
2,4'-DDD	0.1	0.16	0.1	0.01
4,4'-DDD	0.1	0.08	0.1	0.02
2,4'-DDE	0.1	0.07	0.1	0.01
4,4'-DDE	0.1	0.07	0.1	0.01
2,4'-DDT	0.1	0.06	0.1	0.03
4,4'-DDT	0.1	0.08	0.1	0.02
Mirex	0.1	0.11	0.1	0.03
Technical Toxaphene	15	NA	15	NA
HCH, delta	0.1	0.13	0.1	0.08
Heptachlor Epoxide	0.1	0.02	0.1	0.08
alpha-Endosulphan	0.1	0.04	0.1	0.03
Dieldrin	0.1	0.04	0.1	0.03
Endrin	0.1	0.05	0.1	0.02
beta-Endosulphan	0.1	0.08	0.1	0.03
Endosulphan Sulphate	0.1	0.04	0.1	0.03

Endrin Aldehyde	0.1	0.09	0.1	0.03
Endrin Ketone	0.1	0.05	0.1	0.03
Methoxychlor	0.2	0.09	0.2	0.08
PBDEs				
BR2-DPE-7	1	1.3	1	0.61
BR2-DPE-8/11	1	1.5	1	0.42
BR2-DPE-10	1	0.8	1	2.3
BR2-DPE-12/13	1	2.6	1	0.81
BR2-DPE-15	1	0.54	1	0.7
BR3-DPE-17/25	1	1.2	1	1.1
BR3-DPE-28/33	1	1.4	1	1.2
BR3-DPE-30	1	1.8	1	1
BR3-DPE-32	1	0.85	1	0.6
BR3-DPE-35	1	0.59	1	1.4
BR3-DPE-37	1	0.56	1	0.82
BR4-DPE-47	1	2.8	1	3.9
BR4-DPE-49	1	0.78	1	1.4
BR4-DPE-51	1	0.79	1	0.68
BR4-DPE-66	1	1	1	0.98
BR4-DPE-71	1	0.81	1	0.85
BR4-DPE-75	1	1.7	1	0.86
BR4-DPE-77	1	0.8	1	0.56
BR4-DPE-79	1	1.3	1	1.5
BR5-DPE-85	1	0.47	1	0.91
BR5-DPE-99	1	2.6	1	4.2
BR5-DPE-100	1	0.94	1	0.89
BR5-DPE-105	1	1.3	1	1.8
BR5-DPE-116	1	1.4	1	1.9
BR5-DPE-119/120	1	1.3	1	1.3
BR5-DPE-126	1	0.73	1	0.89
BR6-DPE-128	1	1.3	1	4
BR6-DPE-138/166	1	1.6	1	1.7
BR6-DPE-140	1	1	1	0.94
BR6-DPE-153	1	0.63	1	0.93
BR6-DPE-154	1	0.83	1	0.91
BR6-DPE-155	1	0.68	1	0.98
BR7-DPE-181	2	1	2	1.8

BR7-DPE-183		2	0.52	2	1.5
BR7-DPE-190		2	1.4	2	3.4
BR8-DPE-203		2	2	2	1.4
BR9-DPE-206		10	12.3	10	4.5
BR9-DPE-207		10	11	10	7.9
BR9-DPE-208		10	8.8	10	6.3
BR10-DPE-209		20	124	20	23
PCBs (pg/g based on 10g sample)					
PCB	1	0.1	0.42	0.1	0.13
PCB	2	0.1	0.24	0.1	0.14
PCB	3	0.1	0.28	0.1	0.20
PCB	4	0.2	0.53	0.2	0.27
PCB	5	0.2	0.29	0.2	0.24
PCB	6	0.2	0.41	0.2	0.22
PCB	7	0.2	0.40	0.2	0.35
PCB	8	0.2	0.22	0.2	0.29
PCB	9	0.2	0.39	0.2	0.19
PCB	10	0.2	0.34	0.2	0.29
PCB	11	0.2	0.28	0.2	0.24
PCB	12/13	0.2	0.64	0.2	0.36
PCB	14	0.2	0.37	0.2	0.31
PCB	15	0.2	0.33	0.2	0.14
PCB	16	0.1	0.14	0.1	0.45
PCB	17	0.1	0.25	0.1	0.29
PCB	19	0.1	0.24	0.1	0.27
PCB	21/33	0.1	0.55	0.1	0.57
PCB	22	0.1	0.21	0.1	0.30
PCB	23	0.1	0.21	0.1	0.31
PCB	24	0.1	0.24	0.1	0.34
PCB	25	0.1	0.23	0.1	0.27
PCB	26/29	0.1	0.52	0.1	0.52
PCB	27	0.1	0.26	0.1	0.32
PCB	28/20	0.1	0.75	0.1	0.45
PCB	30/18	0.1	0.40	0.1	0.66
PCB	31	0.1	0.20	0.1	0.20
PCB	32	0.1	0.27	0.1	0.30
PCB	34	0.1	0.22	0.1	0.27
PCB	35	0.1	0.23	0.1	0.31

PCB	36	0.1	0.18	0.1	0.40
PCB	37	0.1	0.28	0.1	0.33
PCB	38	0.1	0.20	0.1	0.30
PCB	39	0.1	0.28	0.1	0.32
PCB	41/40/71	0.1	1.02	0.1	1.33
PCB	42	0.1	0.34	0.1	0.44
PCB	43	0.1	0.30	0.1	0.52
PCB	44/47/65	0.1	1.24	0.1	1.23
PCB	45/51	0.1	0.92	0.1	0.87
PCB	46	0.1	0.39	0.1	0.33
PCB	48	0.1	0.38	0.1	0.43
PCB	50/53	0.1	0.64	0.1	0.72
PCB	52	0.1	0.60	0.1	0.50
PCB	54	0.1	0.17	0.1	0.15
PCB	55	0.1	0.63	0.1	0.42
PCB	56	0.1	0.49	0.1	0.54
PCB	57	0.1	0.34	0.1	0.37
PCB	58	0.1	0.42	0.1	0.26
PCB	59/62/75	0.1	1.04	0.1	1.23
PCB	60	0.1	0.65	0.1	0.51
PCB	61/70/74/76	0.1	2.10	0.1	1.81
PCB	63	0.1	0.60	0.1	0.43
PCB	64	0.1	0.42	0.1	0.36
PCB	66	0.1	0.70	0.1	0.43
PCB	67	0.1	0.61	0.1	0.26
PCB	68	0.1	0.54	0.1	0.32
PCB	69/49	0.1	0.73	0.1	0.85
PCB	72	0.1	0.33	0.1	0.36
PCB	73	0.1	0.51	0.1	0.32
PCB	77	0.1	0.15	0.1	0.17
PCB	78	0.1	0.29	0.1	0.39
PCB	79	0.1	0.28	0.1	0.33
PCB	80	0.1	0.54	0.1	0.44
PCB	81	0.1	0.31	0.1	0.20
PCB	82	0.1	0.51	0.1	0.20
PCB	83/99	0.1	0.71	0.1	0.66
PCB	84	0.1	0.41	0.1	0.50
PCB	88/91	0.1	0.54	0.1	0.91

PCB	89	0.1	0.37	0.1	0.50
PCB	92	0.1	0.28	0.1	0.51
PCB	94	0.1	0.22	0.1	0.51
PCB	95/100/93/102/98	0.1	1.65	0.1	2.19
PCB	96	0.1	0.20	0.1	0.32
PCB	103	0.1	0.21	0.1	0.37
PCB	104	0.1	0.28	0.1	0.10
PCB	105	0.1	0.16	0.1	0.17
PCB	106	0.1	0.31	0.1	0.21
PCB	107/124	0.1	0.55	0.1	0.57
PCB	108/119/86/97/125/87	0.1	2.33	0.1	1.41
PCB	109	0.1	0.48	0.1	0.77
PCB	110/115	0.1	1.39	0.1	0.52
PCB	111	0.1	0.33	0.1	0.21
PCB	112	0.1	0.35	0.1	0.32
PCB	113/90/101	0.1	0.48	0.1	0.43
PCB	114	0.1	0.23	0.1	0.21
PCB	117/116/85	0.1	2.11	0.1	0.68
PCB	118	0.1	0.18	0.1	0.28
PCB	120	0.1	0.45	0.1	0.32
PCB	121	0.1	0.38	0.1	0.53
PCB	122	0.1	0.14	0.1	0.42
PCB	123	0.1	0.42	0.1	0.34
PCB	126	0.1	0.25	0.1	0.17
PCB	127	0.1	0.32	0.1	0.28
PCB	128/166	0.1	0.56	0.1	0.50
PCB	130	0.1	0.37	0.1	0.28
PCB	131	0.1	0.36	0.1	0.41
PCB	132	0.1	0.22	0.1	0.29
PCB	133	0.1	0.16	0.1	0.32
PCB	134/143	0.1	0.50	0.1	0.59
PCB	136	0.1	0.40	0.1	0.32
PCB	137	0.1	0.25	0.1	0.26
PCB	138/163/129/160	0.1	0.71	0.1	1.54
PCB	139/140	0.1	0.46	0.1	1.28
PCB	141	0.1	0.29	0.1	0.35
PCB	142	0.1	0.20	0.1	0.26

PCB	144	0.1	0.32	0.1	0.42
PCB	145	0.1	0.25	0.1	0.42
PCB	146	0.1	0.43	0.1	0.35
PCB	147/149	0.1	0.33	0.1	0.75
PCB	148	0.1	0.43	0.1	0.34
PCB	150	0.1	0.35	0.1	0.26
PCB	151/135/154	0.1	1.17	0.1	1.59
PCB	152	0.1	0.13	0.1	0.37
PCB	153/168	0.1	0.30	0.1	0.92
PCB	155	0.1	0.29	0.1	0.12
PCB	156/157	0.1	0.47	0.1	0.32
PCB	158	0.1	0.10	0.1	0.27
PCB	159	0.1	0.37	0.1	0.36
PCB	161	0.1	0.41	0.1	0.25
PCB	162	0.1	0.30	0.1	0.32
PCB	164	0.1	0.31	0.1	0.30
PCB	165	0.1	0.32	0.1	0.26
PCB	167	0.1	0.28	0.1	0.22
PCB	169	0.1	0.34	0.1	0.15
PCB	170	0.1	0.27	0.1	0.73
PCB	171/173	0.1	0.64	0.1	0.32
PCB	172	0.1	0.23	0.1	0.26
PCB	174	0.1	0.80	0.1	0.58
PCB	175	0.1	0.47	0.1	0.11
PCB	176	0.1	0.31	0.1	0.27
PCB	177	0.1	0.44	0.1	0.41
PCB	178	0.1	0.49	0.1	0.25
PCB	179	0.1	0.40	0.1	0.28
PCB	180/193	0.1	0.78	0.1	1.53
PCB	181	0.1	0.35	0.1	0.34
PCB	182	0.1	0.31	0.1	0.26
PCB	183/185	0.1	0.76	0.1	0.43
PCB	184	0.1	0.24	0.1	0.15
PCB	186	0.1	0.42	0.1	0.25
PCB	187	0.1	0.44	0.1	0.43
PCB	188	0.1	0.27	0.1	0.12
PCB	189	0.1	0.38	0.1	0.28
PCB	190	0.1	0.34	0.1	0.18

PCB	191	0.1	0.37	0.1	0.26
PCB	192	0.1	0.41	0.1	0.19
PCB	194	0.1	0.45	0.1	0.38
PCB	195	0.1	0.22	0.1	0.26
PCB	196	0.1	0.37	0.1	0.35
PCB	197/200	0.1	0.37	0.1	1.34
PCB	198/199	0.1	0.63	0.1	0.45
PCB	201	0.1	0.25	0.1	0.39
PCB	202	0.1	0.23	0.1	0.41
PCB	203	0.1	0.38	0.1	0.22
PCB	204	0.1	0.42	0.1	0.17
PCB	205	0.1	0.28	0.1	0.17
PCB	206	0.1	0.18	0.1	0.31
PCB	207	0.1	0.26	0.1	0.21
PCB	208	0.1	0.27	0.1	0.38
PCB	209	0.1	0.47	0.1	0.31

* If budget and time allow, analysis of biofilm samples collected will follow methods for fish tissue.

Appendix B. Quality Control (QC) acceptance criteria for OC pesticides, PCBs, and PBDEs analysis.

[S:N – Signal-to-Noise; CS – Calibration Standard; RT – Retention Time; CAL-VER – Calibration Verification; RRT – Relative Response Time; RRF – Relative Response Factor; RSD – Relative Standard Deviation; DL – Detection Limit; Ng – Nanograms; Pg – Picograms; µL– microliter]

QC Acceptance Criteria for Analysis of OC Pesticides by GC/MS	
QC Parameter	Specification
Analysis Duplicate	The relative difference must be ≤40%, i.e., the duplicates must agree to within ±20% of the mean (applicable to concentrations >10 times the DL)
Procedural Blank	<10% of analyte value
Instrument Sensitivity	S/N 3:1 for 10 pg HCB, for 10 pg p,p'-DDT and for 20 pg oxychlordane. S/N 2:1 for 2.5 ng of Technical Toxaphene with a minimum of 4 peaks detected
Instrument Linearity	For a minimum 5-point calibration, a relative standard deviation of the RRFs 20% for all compounds, except for $^{13}C_{12}$-pp'-DDT where RSD of RRF ≤25%.
RRF: Bracketing Calibration	RRFs from calibration standards must agree to within ±20% over a 12-hour period, i.e., the relative difference must be ≤40%, which is equivalent to 28.3% RSD.
RRF: Continuing Calibration Verification	RRFs for all compounds from opening/closing calibration standards must be within ±20% of the mean RRFs from the initial calibration.
Chromatogram Quality Max Peak Width: Resolution:	1. Peak width at half height for p,p'-DDT is 5 sec. 2.Valley height between p,p'-DDD and o,p-DDT must be less than 10% the height of the peaks 3. PCB 209 peak must be symmetrical with negligible tailing, ≤20 sec. 4. p,p'-DDT breakdown must be ±15%.
Analyte/Surrogate Ratios	Response must be within the calibrated range of the instrument. IA Chemists may use data from more than one chromatogram to get the responses in the calibrated range.
Retention Time Window for target compounds	RRT must be within ±3 sec of the predicted retention time determined from the calibration standard and adjusted

	relative to the peak retention time reference (labeled surrogate) Authentic compound must elute after its labeled analogue
QC Acceptance Criteria for Analysis of PCB Congeners by GC/MS	
QC Parameter	Specification
Analysis Duplicate	The relative difference must be ≤40%, i.e., the duplicates must agree to within ±20% of the mean (applicable to concentrations >10 times the DL).
Procedural Blank	See above or <10% of analyte value.
Matrix Spike Recovery	See above; PCB 19 must be greater than 55%; PCB 104 must be greater than 60%.
Instrument Sensitivity	S/N ratio 3:1 for 10 pg PCB 118.
Instrument Linearity	Linearity is determined by at least a 5-point calibration with a relative standard deviation of the RRFs ±20%.
RRF: Bracketing Calibration	RRFs from calibration standards must agree to within ±20% over a 12-hour period, i.e., the relative difference must be ≤40%, which is equivalent to 28.3% RSD.
RRF: Continuing Calibration Verification	RRFs from opening/closing calibration standards must be within ±20% of the mean RRFs from the initial calibration for all compounds.
Chromatogram Quality Max. Peak Width: Resolution:	1. PCB 209 peak must be symmetrical with negligible tailing. Peak width should not exceed approximately 20 seconds. 2. Valley height must be 80% of smallest peak height of PCB 28/31 pair.
Analyte/Surrogate Ratios	Response must be within the calibrated range of the instrument. IA Chemists may use data from more than one chromatogram to get the responses in the calibrated range.
Retention Time Window for target compounds	RRT must be within ±3 sec of the predicted retention time determined from the calibration standard and adjusted relative to the peak retention time reference (labeled surrogate).

	Authentic compound must elute after its labeled analogue.
QC Acceptance Criteria for Analysis of BDE by GC/MS	
QC Parameter	Specification
Closing Calibration Verification	Within ±20% of the opening CAL-VER for all natives compounds except BDE 203, 206, 207 and 208. Within ±35% of the opening CAL-VER for BDE 203, 206, 207 and 208. Within ±35% of the opening CAL-VER for ^{13}C-surrogates except ^{13}C-BDE 209. Within ±70% of the opening CAL-VER for ^{13}C-BDE 209.
Analysis Duplicate	Max. 40% RPD (applicable to concentrations ≥10 times the DL)
Analyte/Surrogate Ratios	Response must be within the calibrated range of the instrument. Coders may use data from more than one chromatogram to get the responses in the calibrated range.
Ion Ratios	Ion ratios must fall within ±15% of the theoretical values for positive identification of all targets in the calibration standards and samples.
Sensitivity	Minimum S:N ratio 10:1 for CS1. Minimum absolute response of BDE 209L in the CAL-VER is 5 x 10^6 (Quant. + confirm. ions)
Calibration Verification	Specification for BDE 209L is 25-200% of actual concentration.
Carryover	1st toluene blank: ≥ 90% target compounds ≤ 10 pg/20 µL, BDE 209 ≤ 200 pg/20 µL. 2nd toluene blank: ≤ 5 pg/20 µL, except BDE 209 ≤ 100 pg/20 µL.
Chromatogram Quality	BDE 49 and 71 must be uniquely resolved, valley height ≤ 40% of the shorter peak. Peak tailing ratio of $^{13}C_{12}$-BDE 99 and $^{13}C_{12}$-BDE 77 peaks (baseline peak width back half:front half) ≤ 3:1. RT of BDE 209 must be ≥ 48 min. RT of labeled surrogates in CAL-VER must be within ±15 sec of those of initial calibration.

QC Acceptance Criteria for Analysis of Methylmercury by ICPMS	
QC Parameter	Specification
Instrument Calibration	Mass Bias Calibration Curve - five point calibration curve with MeHg working standard to determine the mass bias correction Reverse ID Calibration Curve - created by adding both MeHg working standard and isotopic MeHg spike used during distillation to determine concentration of isotopic MeHg working standard used for the isotopic spike. Reverse ID Check Standard - used to verify instrument calibration in every eighth position and have a measured mass within 80-120% of its true value Fractionation of the Isotopically Enriched MeHg Standard - enriched MeHg isotopes used to create the reverse ID calibration/check standards and to amend environmental samples is contaminated with small amounts of other isotopes.
Certified Reference Material	Recovery within 75-125% of its certified value. CRM SQC-1238
Precision Analysis	Relative standard deviation for triplicate analyses should be less than 25%
Instrument Carryover	5 non-analytical instrument blanks are analyzed previous to calibration to clear sample train of residual MeHg
Sample Triplicate	Two samples from each batch are set up in triplicate to evaluate the precision of the method. DQOs for replicate analyses are a relative standard deviation of less than 25 %
Method Blank	Analyzed every 10 samples. Part of the distillation

QC Acceptance Criteria for Analysis of Total Mercury by CVAFS	
QC Parameter	Specification
Instrument Calibration	Created with mercury masses appropriate to the measurement mode Calculated with a polynomial best fit equation with while forcing an intercept of zero, Have an r2 value greater than 0.995.

	The mass of mercury in analyzed samples should not exceed the standard curve.
Acid Washing	Done in a 10% HNO_3 solution. Acid washing, equipment to be soaked in mercury-clean water for 24 hours, dried for 3 days, and heated to 550°C for 2 hours before use.
Standard Reference Material	Recovery of the standard reference material must be within 80-120% of its certified value.
Sample Precision	Relative standard deviation of samples analyzed in triplicate should be less than 15%.
Sample Carryover	A purge mass should not exceed 10% of the mass of mercury measured in any previous sample, up to the previous purge.
Instrument Purge	Acceptable when peak area is < 0.005
Empty boat blanks	Acceptable if peak area is < 0.01
Check Standards	Acceptable if recovery is 90 – 110%
Sample Triplicate	RSD < 15%
Reagent Blank	Reagent blanks analyzed in the initial setup of the instrument should be < 0.05 ng/boat.

Appendix C. Human Health Risk-Based Concentrations for Surface Water, Fish Tissue and Sediment, Syracuse Research Memo

Human Health Risk-Based Concentrations for Surface Water, Fish Tissue and Sediment in Support of Sampling and Analysis Plan Development, Memo from Syracuse Research Corporation to EPA Region 10.

See under separate attachment.

Appendix D. Columbia River Field Standard Operating Procedures (SOPs)

D1. Columbia Field SOP: Fish hook and line sampling

PURPOSE:

Hook and line sampling will be used to contact additional target species within the sample sites when time allows. Hook and line sampling is an acceptable method during when water conditions are unacceptable to boat electrofish or when permit take is met.

AREA OF APPLICABILITY:

For WDFW staff collecting fish using angling for the investigation of fish tissue monitoring program, Columbia River.

MATERIALS NEEDED:

- Medium weight rod, reel and monofilament line
- Assortment of fishing lures and or baits
- Landing net
- Cooler with ice or dry ice?
- livewell

PROCEDURES:

1. Times for sampling will be assigned to individuals based on workload.

2. Ensure that all personnel are wearing PFDs.

3. Navigate to selected sample point using a GPS receiver and a laptop equipped with GIS software or a paper map with a list of GPS coordinates.

4. Record the following information on the datasheet before setting the hoop net; Outing Start Date (MM/DD/YYYY), site, Boat Operator and deckhands, Temperature (in Celsius).

5. Identify areas within the designated sites where target fish may potentially inhabit and begin fishing.

6. Record time when fish begins when fish are caught and when fishing ends.

7. Record depth fishing and gear used.

8. After being caught place fish in livewell. If one is unavailable sacrifice fish and place in cooler of ice or dry ice?

9. After fishing is complete transport fish immediately to workup staff.

Trolling: Record start and end waypoints within designated site.

Anchored jigging / casting: Record anchor point coordinates.

Associated LLRT SOP

Boat Operations and Towing

D2. Columbia Field SOP: Use of 'Slinky' or Hoop nets to Capture Fish

PURPOSE:

To provide guidelines for physical capture of fish in Slinky or Hoop nets.

AREA OF APPLICABILITY:

For WDFW staff collecting fish using Slinky or Hoop nets for the investigation of tissue quality monitoring within the Columbia River.

MATERIALS NEEDED:

- Hoop traps/nets
- Boat to deploy net
- GPS receiver
- Livewell
- Data sheets, pens, field notebook
- Timepiece
- Anchors, line and buoys

PROCEDURES:

1. Ensure that all personnel are wearing PFDs.

2. Navigate to selected sample point using a GPS receiver and a laptop equipped with GIS software or a paper map with a list of GPS coordinates.

3. Record the following information on the datasheet before setting the hoop net; Outing Start Date (MM/DD/YYYY), site, Depth, Boat Operator and deckhands, Temperature (in Celsius).

4. Each net will be deployed with anchor weights at both openings to prevent movement or folding. The upstream side of the trap will be attached to a heavy anchor and buoy line. The

downstream portion of the net will have a lighter anchor attached directly to the hoop. Traps will be baited to attract target fish into the trap.

5. Record net deployment and retrieval times. Initially, soak times will be set overnight. However, this sampling regime will be adjusted if needed to reduce impacts to non-target species.

6. Soak time is defined as the time from when the buoy enters the water until the buoy is removed from the water.

7. After the designated soak time, retrieve nets by bringing on board boat.

8. Carefully remove fish from nets. Immediately place fish in livewell and transport fish to designated work-up station.

D3. Field SOP: Use of an Electrofishing Boat to Capture Fish

PURPOSE:

To provide guidelines for physical capture of predatory fish using an electrofishing boat.

AREA OF APPLICABILITY:

For WDFW staff collecting fish using an electrofishing boat for the investigation of tissue quality monitoring program within the Columbia River.

MATERIALS NEEDED:

- Electrofishing boat with live well and depth finder
- GPS receiver
- Fiberglass handled nets, rubber gloves, rubber boots, and PFDs
- Data sheets, pens, field notebook
- Timepiece
- Conductivity meter
- Back-up headlamps
- Marine radio and or cell phone

PROCEDURES:

1. Prior to electrofish boat deployment, alert local enforcement and inform them WDFW boats will be conducting research on the Columbia River.

2. Make sure all personnel onboard the electrofishing boat are wearing rubber boots and PFDs. In addition, netters should wear rubber gloves and use fiberglass handled nets to capture fish.

3. Navigate to selected transect using a GPS receiver and a laptop equipped with GIS software or a paper map with a list of transect coordinates.

    a. Verify that the GPS start point is within the correct site strata and depth strata (less than 3 m depth).

    b. If sample point is not in correct reservoir or site strata, randomly select a different site from the provided list of alternate sample points.

c. If GPS point is onshore or too shallow for electrofishing, move outwards from the GPS start point perpendicular to shore until a depth is reached that can be sampled.

d. If GPS point is too deep for electrofishing, from GPS start point move perpendicular towards shore until a depth is reached that can be sampled.

e. Estimate whether the entire electroshock transect will be within the specified depth strata (less than 3 m). If the entire transect will likely not fit within the specified depth strata, randomly select a different site from the provided list of alternate sample points, such that the entire transect will be within the less than 3 m depth strata. Repeat steps 2a-2d if necessary.

f. If a GPS site is located such that the crew determines the site is not safe to sample, then the safety issue will be recorded, and a different site from the provided list of alternate sample points will be chosen randomly. Repeat as necessary.

4. Record the following information on the datasheet before electrofishing begins; Outing Start Date (MM/DD/YYYY), Reach & Location, Start Date/Time (HH:MM in military time), Assigned UTM coordinates, Assigned Depth Strata, Boat Operator, Netters, Temperature (in Celsius), and Conductivity (in microsiemens per cm).

5. At the start of sampling, using the GPS receiver, record the Actual UTM Start (in UTM zone 10N WGS84) on the datasheet.

6. Moving in an upstream direction in waters between 0.5 - 1.5 m, perform low-power electroshocking using 50-500 volts and 42-48% range at 30 Hz DC, to produce 1-2 amps. Standardize power output of the electrofishing unit based on the conductivity of the water. If fish display severe tetanus, adjust settings to induce taxis and minimize tetanus.

7. Electrofish pedal operations (continuous or intermittent) are at the discretion of the operator, and should be designed to capture the highest number of fish. Use intermittent shocking when approaching structures such as beaver lodges, downed trees, docks and weed patches. Stay off the pedal until close to structure, then hit the pedal.

8. Never cover the same section that you have electrofished over again, as catch rates decrease.

9. Electroshocking is discontinued in any transect where excessive numbers of salmonid juveniles or adults are incidentally shocked. When adult salmon are encountered, temporarily turn off the electric power allowing the adult to swim free and escape. Non-target species should be counted but not netted.
10. Place netted fish in circulating live wells until they can be processed.

11. At the end of the transect (600 electrofishing seconds) record Actual UTM End, End Date/Time, Effort (the actual number of seconds shocked - from the boat's counter), Power (high or low, Hz and % Range), Minimum (Min.) Actual Depth (in meters), and Maximum (Max.) Actual Depth (in meters).

12. Take captured fish to work-up location or keep on ice until they can be picked up.

D4. Sediment Collection SOP – Bonneville Reservoir Pilot Investigation

Site Identification and Verification

Site verification is the process of determining if the randomly selected sites can be sampled in the field. Constraints to sampling a particular site can be accessibility (both physically reaching a site or safety issues), permission (Federal Endangered Species concerns, tribal areas, or wildlife areas may cause restrictions in sampling specific areas), or mapping errors. This section describes the process for selecting sampling locations.

A. Sample Design

Sampling locations were selected from an areal GRTS sample frame for the reservoir that can be accessed here: https://www.monitoringresources.org/Sites/Master/Detail/2.

B. Site Types and Site Replacement

There is a unique set of primary "base" sites and 'oversample' sites. All base sites in the section will eventually be sampled unless the validation processes find them to be either non-target, meaning not located on the Columbia (an unlikely scenario) or unsampleable. If a base site is deemed non-target or unsampleable, an oversample site will be used as a replacement. Field crews will assess the site and decide if it is inherently unsampleable, or if it may become sampleable and is worth revisiting.

C. Site Location

The randomly selected base and oversample sites have coordinates of latitude/longitude in decimal degrees.

D. Site Validation

Site validation is required to determine whether a site can and should be sampled (its "sampling status"). This is an office-based process and, if necessary, a field reconnaissance. Site validation includes an evaluation of the sample locations for position errors, possible safety hazards, and accessibility. Office-based validation and field reconnaissance occur before the sample event.

First, evaluate each site for 'target' or 'non-target' status. If the site is positioned on the

Columbia River Mainstem the site is considered target otherwise it is 'non-target' (e.g., the shore location falls at/in a tributary confluence). Next, evaluate whether each site is sampleable or non-sampleable based on safety and access.

Safety issues:

--Safe to deploy Ponar dredge?

--Safe distance from hazards such as rapids or dams?

--Safe in terms of water level fluctuations?

Note: unsafe conditions on the day of sampling such as weather, high winds or high flow conditions may cause a site that is 'sampleable' to be 'unsampleable' at the time. This would result in a change of status

for the site to 'unsampleable' status, unless the site can be sampled later, within the index period, when conditions are safe.

Access issues:
--Is there a boat ramp from where the site can be reached that is within reasonable proximity? --Are there any restrictions from Federal, State, or Tribal ownership that could result in access denials?

Sediment collection permits:
--Will permits be granted so that sediment can be collected?

E. Site Validation form should be filled out for each site (Figure 1). The information on this form is used to track whether the site is 'target or 'non-target', and 'sampleable' or 'nonsampleable', the reason for non-sampleable status, and whether the site must have a reconnaissance level field visit to make the determination one way or another. This site status information will be added to the project database. Most of the information required on the form is self-explanatory. For the EvalReason entry the choices are "sampleable" (if there are no problems identified or suspected for accessibility, safety, or permitting), "inaccessible" (if the site cannot be sampled because of safety, areas that are restricted such as areas demarcated near dam structures, or where distance from any accessible boat ramp would be prohibitive, etc.), or "no permit" (if a permit to collect sediment was not granted or if an access permit was not granted for sites that lie in portions of the River controlled by Indian tribes). If the status is unknown leave the EvalReason blank until the determination can be made with additional information gathered during the field reconnaissance. If site is deemed unsampleable during office or reconnaissance validation process, then the next site on the 'oversample' list will be evaluated for sampling. If the sample status of a site changes on the day of sampling, a "nearest neighbor" site replacement approach will be used in the field, due to the large project area and limited access points. If a base site must be rejected ***during field operations*****,** the physically nearest available oversample site will be used instead.

Besides site status, the **site validation form** is used to compile important information that will be needed during the field sampling (locations of lodging, local contacts, status, and location of boat ramp etc.). All information that will help inform the field crew about the condition and access of the site should be recorded on the form.

Figure 1. Example of Site Validation Form

XY Reservoir ---Site Validation Form					Initials:		DATE:	
siteID	**panel**	**STATE**		**LAT_DD83**	**LON_DD83**	**EvalStatus**	**Sample? Y/N**	**EvalReason**
CR206637-086	Base	WA		47.99784	-119.63716	Eval	**N**	
Accessible?:								
Hazards?:								
Site Status	**sampleable**			**not sampleable due to safety or permit issue, etc.**			**Unkn status- needs reconn.**	
Nearest boat ramp:								
Ramp location:	**Left or right bank?**			**Upstream or down from X?**			**Nearest town:**	
directions to ramp:								
Sediment/permit contact:								
permit issue/ comment:								
Nearest medical								
follow-up tasks comments:								
contacts (Names, phone #s)								

F. Site Verification: Determining Sampleability During the Sampling Visit

Upon arrival at a site the crew will verify the site location and verify that the site meets the protocols of sampleablity. Information relevant to the site verification or conditions on the day of sampling is entered on the Site Verification Form (Figure 2). Fill out the header information: Site #, site name, date, crew personnel, coordinates for site from Table 1; the crews will use GPS to locate the site. The coordinates from Table 1 will be recorded as the GIS coordinates for the site. The acceptable tolerance goal is that the sampling station be established within the accuracy expected from a properly functioning GPS unit of the caliber that will be used for the study but should be such that there is confidence that the sample is taken within a 30 m x 30m area from the Lon/lat listed in Table 1. The actual latitude/longitude coordinates of the sampling site as indicated on the GPS unit, are also recorded on the data sheet.

The probabilistic sampling design used is unbiased, thus, some of the generated sites can fall in locations that are not amenable to sampling. Regardless, field crews will strictly adhere to the guidelines for locating the station, unless there are substantiated reasons that prevent sampling within that defined area.

Next, determine if the site is 'sampleable' based on the current onsite conditions. Check the appropriate box on the field form which describes if the site is or is not sampleable. Check only one box in this section. If the site cannot be sampled note this in the comments and provide further details. If a base site is deemed non-target (e.g., not underwater) or unsampleable (e.g., because of safety concerns) in the field, the nearest oversample site will be used as a replacement (see: Appendix 2-3).

Complete the rest of the form. Describe the weather conditions by checking the appropriate box. Record the driving directions to get to the site and any information you feel will be useful to another sampling team in relocating this site. Also describe the

Table 1. Sediment sampling locations for pilot in XY Reservoir. Sampling locations are from an areal GRTS sample frame developed for the reservoir that can be referenced here: https://www.monitoringresources.org/Sites/Master/Detail/2. Latitude and longitude are in decimal degrees using the North American Datum of 1983 (NAD83).

Site Name	longitude/latitude	Site ID
Reservoir_1		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		
Reservoir__		

Figure 2. Field Site Verification Form

Reviewed by (initials):_____

XY Reservoir Pilot -SITE VERIFICATION

SITE ID NUMBER: _____ **DATE: / /2023**

SITE NAME: **PERSONNEL:**

RIVER VERIFICATION INFORMATION

SITE VERIFIED BY (X all that apply): NO DS GPS NO DS Map NO DS signs NO DS other:_____ NO DS
Not Verified:_____

COORDINATES	LATITUDE (dd) North	LONGITUDE (dd) West
TARGET (if applicable):	____ ____. ____ ____ ____ ____	____ ____. ____ ____ ____ ____
ACTUAL:	____ ____. ____ ____ ____ ____	____ ____. ____ ____ ____ ____

INDEX SITE STATUS - X ONE BOX ONLY

SAMPLEABLE

NO DS Regular - Boatable

NO DS Other (Explain in Comments)

NON-SAMPLEABLE (NO SAMPLE TAKEN)

NO DS Hazard: (explain in Comments)

NO ACCESS

NO DS Access Permission Denied

NO DS Inaccessible (Unable to Reach Site)

WEATHER CONDITIONS

Cloud Cover	☐<5% ☐5-25% ☐50-75% ☐>75%
Precipitation	☐None ☐Light ☐Moderate ☐ Heavy
Previous Precip. (24 H)	☐None ☐Light ☐Moderate ☐ Heavy
Approx. Air Temp (ºC) : ____ ____	Time: _____ am pm

DIRECTIONS TO RIVER SITE

GENERAL COMMENTS

launch site. For example: Can the boat be launched with a trailer? Are there fees? Is the launch paved or does it consist of soft sand? What landmarks are at the launch? On the back page of the form draw or attach a map of

the site. Also, note whether photos were taken. It is recommended to take pictures of the launch site and upstream and downstream at the X site.

Overview of Field Operations

This section describes the daily field activities. Included are discussion of field-crew configuration and responsibilities, boat operations, the flow of daily operations, collection permits, and general safety considerations.

G. Crew Configuration and Responsibilities

Field operations require a three-or four-person sampling crew. In the field, each crew is supervised by a crew leader, who is responsible for daily operational planning, data quality, and safety. There is one dedicated boat operator.

H. Boat Operations

Each crew requires a boat for sampling. Care must be taken to maintain the boats in good order.

The boat trip from the ramp to the sample site may be many miles and may involve potential hazards. All boats should be equipped with a high-quality dash-mounted GPS/sonar unit with preloaded basemaps. Site location (latitude, longitude) data from Table 1 should also be loaded into the GPS units as waypoints. Crews should also carry navigation charts or an atlas. As part of pre-visit activities, crews should plan their route to make sure they use the closest suitable ramp, and that they are aware of any hazards, including rocks, rapids, and shoals. Also, crew must be aware of hazards associated with water level fluctuations including difficulties of trailering the boat and parking of vehicles out of the inundation zone.

Boating on large rivers presents multiple safety hazards. The river must always be treated with respect to avoid situations that threaten the health and safety of crews.

I. Flow of Daily Operations

After navigating to the sample site, the crew leader evaluates whether the site is safe to sample under the existing conditions (sampleability may be apparent at the boat ramp). If the site is safe to sample, the crew will then deploy the Ponar dredge to collect a sediment sample from the river bottom. When the Ponar is deployed, the latitude and longitude will be recorded. The Ponar is then retrieved, and the sediment sample transferred to the appropriate stainless steel intermediate container for homogenizing and collecting a subsample.

J. Collection Permits

Washington state requires a collecting permit for sediment. In some cases, Tribal permits may be required. Copies of the permits should be carried on boats when sampling. Crews should closely follow the specifications of the permit(s). These specifications may include notification of the permitting agency prior to field sampling, and submission of an annual report listing the sediment collection activities.

K. General Safety Considerations for Field Operations

Field work on large rivers is inherently hazardous and involves significant risks to crew safety and health. Additional resources include the American Red Cross and Handal (1992), Ohio EPA (1990), USCG (1987), and USEPA (1986). Web sites with useful safety information include www.cdc.gov/niosh (occupational safety), www.nws.noaa.gov/safety (weather safety), www.uscgboating.org (boating safety), and www.firstaidguide.net (includes insect bite information). Personnel on field crews should be in sound physical condition, be able to swim, and have a physical exam annually or in accordance with their agency policy. Crew members with "MedicAlert" health conditions (e.g., severe allergies, diabetes, susceptibility to seizures) should make crew leaders and other crew members aware of their condition, the symptoms, and the actions required in a health emergency.

During field activities, crews may observe apparent violations of environmental regulations, may discover improperly disposed hazardous materials, or may observe or cause an accidental spill or release of hazardous materials. In such cases, it is important that the proper actions be taken and that field personnel do not become exposed to harmful substances. Know the location of the nearest hospital, and how to access emergency services such as State Patrol and 911.

Sediment Collection and Processing Protocols

Specific procedures for the deployment of sediment collection gear can be found in AppendixA1.

Once the Ponar is retrieved, and the sediment sample transferred to the appropriate stainless steel intermediate container for homogenizing a subsample of sediment from the container will be collected trying to get the most fine sediment since most contaminants are associated with the fine sediment fraction, while little occurrence of contaminants typical occurs with the coarse grain materials (e.g., fine sand to gravels). We will collect approximately 450 ml in a 500 ml jar to allow for expansion during freezing. We use all stainless steel equipment while using nitrile gloves to transfer the sediment subsample into the jar, which will be labeled with

site information, date, and location.

The sampling team must maintain sample integrity from the time of collection to the shipment and arrival at the laboratory. Sample integrity is maintained by taking precautions to prevent loss of contaminants that might be present in the sample and avoiding possible introduction of contaminants to the sample during handling. Once a sample is collected, sample integrity is maintained through controlled sample handling, storage, and preservation procedures.

Sampling Period

Field sampling will be conducted between late-August and mid-September. This period is preferred because water and wind levels are generally low facilitating safer boating.

Field Recordkeeping

One sediment Field Data/Chain of Custody Form will be completed for each sampling site (Figure 3). Data recorded for this form will be entered on either hardcopy data forms or input into handheld computers. Data will be backed-up daily, either by Xeroxing of hardcopy data sheets or download of handheld computer files to another computer. Also, a field logbook to document any other data that may be useful in evaluating the quality of the data will be maintained by the crew.

Figure 3.

Reservoir Sediment Collection					
SITE ID	**Date**	**Time**	**GPS/Nearest Landmark**	**SAMPLE TYPE (Splits, etc.)**	**Notes**

Appendix A1 -Field Standard Operating Procedure – Ponar dredge

PURPOSE: To collect bottom sediments from Reservoirs for chemical characterization.

AREA OF APPLICABILITY:

For staff collecting sediment samples for contaminants monitoring program pilot implementation in XY Reservoir, Columbia River.

MATERIALS NEEDED:

- Ponar dredge
- Stainless steel vessel to receive sediment from the Ponar dredge
- Stainless steel spoon
- Sample jars with labels
- Data sheets, pens, field notebook
- Timepiece

PROCEDURES:

9. Ensure that all personnel are wearing PFDs.

10. Navigate to sample points using a GPS receiver.

11. Follow data recording protocols outlined in the sediment sampling protocols.

12. Deploy Ponar dredge noting when it contacts the bottom

13. Record the latitude and longitude of actual sample location in decimal degrees in NAD83.

Retrieve the Ponar dredge and transfer the sediment sample to the stainless steel vessel

Appendix 2. Oversample sites for use if base sites are deemed not to be sampleable in the field. Latitude and longitude are in decimal degrees using the North American Datum of 1983 (NAD83).

SITEID	Longitude	Latitude

Appendix 3. Map of oversample sites for sediment sampling.

D5. Field SOP Juvenile Salmon Collection for contaminant assessment

SCOPE: This SOP describes procedures for the collection of dead juvenile salmon at the Bonneville Dam juvenile bypass facility for the purpose of interrogating the specimens for a suite of contaminants that include organochlorine pesticides (like DDT), PCBs, PBDEs, and total mercury. Dead juvenile salmon will be collected by Pacific States Marine Fisheries (PSMFC) staff under the authorities granted in a Determination of Take for Research Purposes from NOAA (FPC-47: APPS 27134) and a Scientific Collection Permit from WDFW (DEHART 22-328).

This activity is part of a larger project that is vetting methods for assessing the status and trends of contaminants in fish, water, and sediment in the Columbia River from Bonneville Dam to the international border with Canada. The U.S. Geological Survey has contracted with the Yakama Nation that has received funding from the U.S. Environmental Protection Agency (Grant # 02J21401) to conduct this work.

AREA OF APPLICABILITY: Columbia River - Bonneville Dam juvenile bypass facility

PRINCIPLE: Juvenile salmon species that are incidental mortalities at the Bonneville Dam juvenile bypass facility will be assessed for condition, collected, placed in labeled sampling containers, and frozen. Samples will subsequently be transferred to USGS staff by PSMFC staff at a location offsite from the collection facility. Because samples are being used for low level chemistry, samples contaminated from non-river sources (e.g. oil, grease, clothing) should be avoided.

Target numbers and types of specimens are:

- Approximate numbers of dead juvenile salmon needed (by species)
    - Chinook
        - CH1 – 15 individual fish
        - CH0 – 15 individual fish
    - Coho – 15 individual fish
- Approximate time frame
    - May – July
- Focal species, run-type (e.g., CH1 and/or CH0), rear-types (e.g., clipped and/or unclipped)
    - CH1, CH0, and Coho

- Clipped or unclipped – Either, but want to avoid collecting fish from the Spring Creek releases

Additional fish can be collected if the number of mortalities that can be collected exceed the target numbers.

MATERIALS NEEDED: Labelled sample containers, nitrile gloves, cooler, and blue ice (provided by USGS); permanent marker pen for filling in information on sample container labels, freezer

PROCEDURES: Put on provided nitrile gloves before handling. Incidental mortalities at the Bonneville Dam juvenile bypass facility will be identified, assessed as to their condition, and placed in a sample container. Relevant fields on the sample container label need to be filled in with a permanent marker and then immediately transferred to a freezer.

The following criteria will be used to assess the condition of the juvenile salmon mortalities:

A-freshly dead; silver, bright, and firm;

B-recently dead; a little darkening but firm;

C-Obvious signs of decay

Only specimens that can be classified into categories A and B should be collected. Our goal is to fill the target sample sizes with freshly dead mortalities but understand that this may not be possible.

Once the specimens are collected, the samples need to be frozen as soon as possible. Samples need to remain frozen for the duration of their storage at the bypass facility.

USGS staff will coordinate with PSMFC staff to arrange a time to pick up the specimens. Specimens will be collected monthly unless freezer space becomes an issue. If needed, samples will be collected more frequently. During the transfer, specimens should be in a cooler with frozen “blue ice” (provided by the USGS).

REFERENCES: NA

APPROVED BY: . **DATE** .

QUALITY ASSURANCE OFFICER

REVIEWED BY: . **DATE** .

LABORATORY SUPERVISOR

D6. Fish Dissection Procedures- see USGS/BRD-1999-0007 (Schmitt 1999)

See citation below under separate cover.

Schmitt, C. J., V. S. Blazer, G. M. Dethloff, D. E. Tillitt, T. S. Gross, W. L. Bryant Jr., L. R. De Weese, S. B. Smith, R. W., Goede, T. M. Bartish, and T. J. Kubiak. 1999. Biomonitoring of Environmental Status and Trends (BEST) Program: field procedures for assessing the exposure offish to environmental contaminants. U.S. Geological Survey, Biological Resources Division, Columbia, (MO): Information and Technology Report USGS/BRD-1999-0007. iv + 35 pp. + appendices.

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(303) 292-4755 fax

MEMORANDUM

To: Monica Tonel, Marc Stifelman (EPA, Region 10)
From: Lynn Woodbury (SRC)
Task: FD052.CF999.842
Date: April 23, 2008
Re: Human Health Risk-Based Concentrations for Surface Water, Fish Tissue and Sediment in Support of Sampling and Analysis Plan Development

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Per your email request on March 28, 2008, SRC has calculated risk-based concentrations (RBCs) for surface water, fish tissue, and sediment to support development of the sampling and analysis plans (SAPs) for these media at the Upper Columbia River (UCR) Site. This memorandum has been revised, as appropriate, based on comments from the Confederated Tribes of the Colville Reservation, the Spokane Tribe of Indians, and the Washington State Department of Ecology.

RBCs were calculated based on the maximally exposed receptor population (i.e., traditional subsistence scenario) from the draft Human Health Risk Assessment (HHRA) Workplan (EPA 2008). RBCs were back-calculated based on target hazard quotient (HQ) of 0.1 for non-cancer and a target cancer risk of 1E-06. When calculating RBCs, the human intake factor (HIF) was based on the child for non-cancer and the time-weighted average (TWA) for cancer.

It is important to note that the RBCs provided in this memorandum are not intended to represent clean-up levels or remediation goals. They have been derived solely for the purposes of establishing target analytical detection limits and selecting appropriate analytical methods in the development of site SAPs in support of the human health risk assessment.

These RBCs should be utilized to ensure that method detection limits for each medium are adequate to calculate meaningful risk estimates for human health. For example, if the RBC for some chemical in sediment was 1 mg/kg, and all of the analytical results were obtained using a method with a detection limit of 5 mg/kg, then it would not be certain that risks from that chemical are below a level of concern even if all of the results were non-detect.

Detection limit adequacy is most important for chemicals with high censoring (i.e., low detection frequency). If a chemical has a high detection frequency, it is possible to calculate meaningful risk estimates, even if the detection limit exceeds the RBC. For example, if the sediment RBC were 1 mg/kg, the detection limit were 5 mg/kg, and the detected results ranged from 10 to 100 mg/kg, the data would be adequate for estimating exposure and risk.

It is recognized that, in some instances, it may not be possible for current analytical methods to achieve method detection limits that are lower than the specified RBCs. As appropriate, samples will be analyzed using the best available techniques and data limitations related to detection limit adequacy will be noted in the uncertainties section of the human health risk assessment.

Surface Water RBCs

Table 1 presents the RBCs for ingestion of chemicals of interest (COIs) in water based on a drinking water ingestion scenario. This table also includes the EPA Maximum Contaminant Levels (MCLs) for drinking water. Details of the calculation of the HIF for drinking water (i.e., body weight, exposure frequency, exposure duration, ingestion rates) are presented in Appendix A. For mercury, the water quality criterion is protective of fish tissue ingestion (EPA 2006). Details of the calculation of the mercury RBC for water are presented in Appendix B. For chemicals identified as having a mutagenic mode of action for carcinogenesis, drinking water RBCs were calculated in accordance with EPA (2005) as shown in Appendix C.

Table 2 presents the RBCs for inhalation of COIs in water during sweat lodge use. As noted in the table, in the case of most metals and perchlorocyclopentadiene, the RBC based on inhalation exposures during sweat lodge use is lower than the RBC based on drinking water ingestion exposures. For these COIs, the Surface Water SAP should establish analytical goals based on the lower RBC (i.e., sweat lodge RBC). Details of the calculation of the HIF for sweat lodge exposures are presented in Appendix D. For chemicals identified as having a mutagenic mode of action for carcinogenesis, water RBCs for sweat lodge use were calculated in accordance with EPA (2005) as shown in Appendix E.

Fish Tissue RBCs

Table 3 presents the RBCs for ingestion of COIs in fish tissue. For arsenic, the fish tissue RBC was calculated based on an assumption that 10% of arsenic in tissue is in a biologically available form. As noted above, the fish tissue residue criterion (TRC) for mercury was calculated in accordance with draft guidance provided in EPA (2006). Details of the calculation of the methylmercury TRC is presented in Appendix B. Details of the calculation of the HIF for fish ingestion exposures are presented in Appendix F. For chemicals identified as having a mutagenic mode of action for carcinogenesis, fish tissue RBCs were calculated in accordance with EPA (2005) as shown in Appendix G.

Sediment RBCs

Although sediment RBCs had been calculated previously in support of the Sediment DQO and Strawman SAP memorandum (SRC 2008), values were derived using a target cancer risk of 1E-05 and the adult HIF. **Table 4** presents revised sediment RBCs for metals based on a target cancer risk of 1E-06 and the TWA HIF for the purposes of maintaining consistency with the surface water and fish tissue RBCs. Details of the calculation of the HIF for incidental ingestion of sediment are presented in Appendix H.

References cited:

Syracuse Research Corporation (SRC). 2008. Memorandum: Proposed Beach Surface Sediment Data Quality Objectives and Sampling Design Recommendations. Provided by: Lynn Woodbury and Bill Brattin (SRC). Provided to: Monica Tonel and Marc Stifelman (EPA, Region 10). March 21, 2008.

U.S. Environmental Protection Agency (EPA). 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-03/003F.

_____. 2006. Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. U.S. Environmental Protection Agency, Office of Science and Technology. EPA 823/B-04/001.

_____. 2008. Workplan for the Human Health Risk Assessment for the Upper Columbia River Site Remedial Investigation and Feasibility Study. U.S. Environmental Protection Agency, Region 10. Prepared by Syracuse Research Corporation. Draft – February 22, 2008.

Attached Tables:

Table 1	Risk-Based Concentrations (RBCs) and Maximum Contaminant Levels (MCLs) for Ingestion of Chemicals of Interest (COIs) in Drinking Water
Table 2	Risk-Based Concentrations (RBCs) for Inhalation of Chemicals of Interest (COIs) in Water During Sweat Lodge Use
Table 3	Risk-Based Concentrations (RBCs) and for Ingestion of Chemicals of Interest (COIs) in Fish Tissue
Table 4	Risk-Based Concentrations (RBCs) and for Incidental Ingestion of Metals in Surface Sediment

Attached Appendices:

Appendix A	Human Intake Factor for Drinking Water (HIF_{dw})
Appendix B	Calculation of Fish Tissue Residue Criterion for Mercury
Appendix C	Calculation of RBCs for Ingestion of Drinking Water for Chemicals with a Mutagenic Mode of Action
Appendix D	Human Intake Factor for Sweat Lodge Use
Appendix E	Calculation of RBC for Inhalation of Benzo(a)pyrene in Water During Sweat Lodge Use
Appendix F	Human Intake Factor for Ingestion of Fish (HIF_{fish})
Appendix G	Calculation of RBCs for Ingestion of Fish Tissue for Chemicals with a Mutagenic Mode of Action
Appendix H	Human Intake Factor for Incidental Ingestion of Surface Sediment (HIF_{sed})

TABLE 1
RISK-BASED CONCENTRATIONS (RBCs) AND MAXIMUM CONTAMINANT LEVELS (MCLs)
FOR INGESTION OF CHEMICALS OF INTEREST (COIs) IN DRINKING WATER

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			EPA Drinking Water MCL (mg/L) [1]	Lowest Water Value (mg/L)	Notes
		Target HQ:		0.1	Target Risk:		1E-06			
		HIF_{dw} (L/kg-d):		1.2E-01	HIF_{TWAdw} (L/kg-d):		5.2E-02			
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
METALS AND METALLOIDS										
Aluminum	7429905	1.0E+00	P	8.6E-01	--		--	--	8.6E-01	
Antimony	7440360	4.0E-04	I	3.4E-04	--		--	6.0E-03	3.4E-04	
Arsenic	7440382	3.0E-04	I	2.6E-04	1.5E+00	I	1.3E-05	1.0E-02	1.3E-05	
Barium	7440393	2.0E-01	I	1.7E-01	--		--	2.0E+00	1.7E-01	
Beryllium	7440417	2.0E-03	I	1.7E-03	--		--	4.0E-03	1.7E-03	
Boron	7440428	2.0E-01	I	1.7E-01	--		--	--	1.7E-01	
Cadmium	7440439	5.0E-04	I	4.3E-04	--		--	5.0E-03	4.3E-04	(a)
Calcium	7440702	--		--	--		--	--	--	
Chromium	7440473	1.5E+00	I	1.3E+00	--		--	1.0E-01	1.0E-01	(b)
Cobalt	7440484	2.0E-02	P	1.7E-02	--		--	--	1.7E-02	
Copper	7440508	4.0E-02	H	3.4E-02	--		--	1.3E+00	3.4E-02	
Fluoride	16984488	6.0E-02	I	5.2E-02	--		--	4.0E+00	5.2E-02	(c)
Iron	7439896	7.0E-01	P	6.0E-01	--		--	--	6.0E-01	
Lead	7439921	--		--	--		--	1.5E-02	1.5E-02	(d)
Magnesium	7439954	--		--	--		--	--	--	
Manganese	7439965	4.7E-02	I	4.0E-02	--		--	--	4.0E-02	(e)
Mercury	7439976	see Appendix B		8.9E-11	--		--	2.0E-03	8.9E-11	(f)
Molybdenum	7439987	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
Nickel	7440020	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
Potassium	7440097	--		--	--		--	--	--	
Selenium	7782492	5.0E-03	I	4.3E-03	--		--	5.0E-02	4.3E-03	
Silica	7631869	--		--	--		--	--	--	
Silver	7440224	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
Sodium	7440235	--		--	--		--	--	--	
Thallium	7440280	7.0E-05	O	6.0E-05	--		--	2.0E-03	6.0E-05	
Tin	7440315	6.0E-01	H	5.2E-01	--		--	--	5.2E-01	
Uranium	7440611	3.0E-03	I	2.6E-03	--		--	3.0E-02	2.6E-03	(g)
Vanadium	7440622	1.0E-03	E	8.6E-04	--		--	--	8.6E-04	
Zinc	7440666	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
OTHER TRACE ELEMENTS										
Bismuth	7440699	--		--	--		--	--	--	
Cerium	7440451	--		--	--		--	--	--	
Cesium	7440462	--		--	--		--	--	--	
Gallium	7440553	--		--	--		--	--	--	
Lanthanum	7439910	--		--	--		--	--	--	
Lithium	7439932	2.0E-02	E	1.7E-02	--		--	--	1.7E-02	
Niobium	7440031	--		--	--		--	--	--	
Rubidium	7440177	--		--	--		--	--	--	
Scandium	7440202	--		--	--		--	--	--	
Strontium	7440246	6.0E-01	I	5.2E-01	--		--	--	5.2E-01	
Thorium	7440291	--		--	--		--	--	--	
Titanium	7440326	--		--	--		--	--	--	
Ytterbium	7440644	--		--	--		--	--	--	
Zirconium	7440677	--		--	--		--	--	--	
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)										
2-Methylnaphthalene	91576	4.0E-03	I	3.4E-03	--		--	--	3.4E-03	
Acenaphthene	83329	6.0E-02	I	5.2E-02	--		--	--	5.2E-02	
Acenaphthylene	208968	--		--	--		--	--	--	
Anthracene	120127	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
Benzo(a)anthracene	56553	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Benzo(a)pyrene	50328	--		--	see Appendix C		1.3E-06	2.0E-04	1.3E-06	MMOA
Benzo(b)fluoranthene	205992	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Benzo(ghi)perylene	191242	--		--	--		--	--	--	
Benzo(k)fluoranthene	207089	--		--	see Appendix C		1.3E-04	--	1.3E-04	MMOA
Chrysene	218019	--		--	see Appendix C		1.3E-03	--	1.3E-03	MMOA
Dibenz(a,h)anthracene	53703	--		--	see Appendix C		1.3E-06	--	1.3E-06	MMOA
Fluoranthene	206440	4.0E-02	I	3.4E-02	--		--	--	3.4E-02	
Fluorene	86737	4.0E-02	I	3.4E-02	--		--	--	3.4E-02	
Indeno(1,2,3-cd)pyrene	193395	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Naphthalene	91203	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
Phenanthrene	85018	--		--	--		--	--	--	
Pyrene	129000	3.0E-02	I	2.6E-02	--		--	--	2.6E-02	

TABLE 1
RISK-BASED CONCENTRATIONS (RBCs) AND MAXIMUM CONTAMINANT LEVELS (MCLs)
FOR INGESTION OF CHEMICALS OF INTEREST (COIs) IN DRINKING WATER

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			EPA Drinking Water MCL (mg/L) [1]	Lowest Water Value (mg/L)	Notes
		Target HQ:		0.1	Target Risk:		1E-06			
		HIF_{dw} (L/kg-d):		1.2E-01	HIF_{TWAdw} (L/kg-d):		5.2E-02			
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
PESTICIDES										
2,4'-DDD	53190	--		--	2.4E-01	I	8.0E-05	--	8.0E-05	(h)
4,4'-DDD	72548	--		--	2.4E-01	I	8.0E-05	--	8.0E-05	
2,4'-DDE	3424826	--		--	3.4E-01	I	5.6E-05	--	5.6E-05	(i)
4,4'-DDE	72559	--		--	3.4E-01	I	5.6E-05	--	5.6E-05	
2,4'-DDT	789026	5.0E-04	I	4.3E-04	3.4E-01	I	5.6E-05	--	5.6E-05	(j)
4,4'-DDT	50293	5.0E-04	I	4.3E-04	3.4E-01	I	5.6E-05	--	5.6E-05	
Aldrin	309002	3.0E-05	I	2.6E-05	1.7E+01	I	1.1E-06	--	1.1E-06	
Atrazine	1912249	3.5E-02	I	3.0E-02	2.2E-01	H	8.7E-05	3.0E-03	8.7E-05	
alpha-BHC	319846	--		--	6.3E+00	I	3.0E-06	--	3.0E-06	
beta-BHC	319857	--		--	1.8E+00	I	1.1E-05	--	1.1E-05	
delta-BHC	319868	--		--	--		--	--	--	
gamma-BHC	58899	3.0E-04	I	2.6E-04	1.3E+00	H	1.5E-05	--	1.5E-05	
alpha-Chlordane	5103719	5.0E-04	I	4.3E-04	3.5E-01	I	5.5E-05	--	5.5E-05	(k)
gamma-Chlordane	5566347	5.0E-04	I	4.3E-04	3.5E-01	I	5.5E-05	--	5.5E-05	(k)
Dieldrin	60571	5.0E-05	I	4.3E-05	1.6E+01	I	1.2E-06	--	1.2E-06	
Endosulfan I	959988	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endosulfan II	33213659	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endosulfan sulfate	1031078	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endrin	72208	3.0E-04	I	2.6E-04	--		--	2.0E-03	2.6E-04	
Endrin aldehyde	7421934	--		--	--		--	--	--	
Endrin ketone	53494705	--		--	--		--	--	--	
Heptachlor	76448	5.0E-04	I	4.3E-04	4.5E+00	I	4.3E-06	4.0E-04	4.3E-06	
Heptachlor epoxide	1024573	1.3E-05	I	1.1E-05	9.1E+00	I	2.1E-06	2.0E-04	2.1E-06	
Hexachlorobenzene	118741	8.0E-04	I	6.9E-04	1.6E+00	I	1.2E-05	1.0E-04	1.2E-05	
Hexachlorobutadiene	87683	1.0E-03	P	8.6E-04	7.8E-02	I	2.5E-04	--	2.5E-04	
Methoxychlor	72435	5.0E-03	I	4.3E-03	--		--	4.0E-02	4.3E-03	
cis-Nonachlor	5103731	--		--	--		--	--	--	
trans-Nonachlor	39765805	--		--	--		--	--	--	
Oxychlordane	27304138	--		--	--		--	--	--	
Toxaphene	8001352	--		--	1.1E+00	I	1.7E-05	3.0E-03	1.7E-05	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)										
1,1'-Biphenyl	92524	5.0E-02	I	4.3E-02	--		--	--	4.3E-02	
1,2,4-Trichlorobenzene	120821	1.0E-02	I	8.6E-03	--		--	7.0E-02	8.6E-03	
1,2-Dichlorobenzene	95501	9.0E-02	I	7.7E-02	--		--	--	7.7E-02	
1,3-Dichlorobenzene	541731	3.0E-03	E	2.6E-03	--		--	--	2.6E-03	
1,4-Dichlorobenzene	106467	3.0E-02	E	2.6E-02	2.4E-02	H	8.0E-04	--	8.0E-04	
2,2'-oxybis(1-chloropropane)	108601	4.0E-02	I	3.4E-02	7.0E-02	H	2.7E-04	--	2.7E-04	
2,4,5-Trichlorophenol	95954	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
2,4,6-Trichlorophenol	88062	1.0E-03	P	8.6E-04	1.1E-02	I	1.7E-03	--	8.6E-04	
2,4-Dichlorophenol	120832	3.0E-03	I	2.6E-03	--		--	--	2.6E-03	
2,4-Dimethylphenol	105679	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
2,4-Dinitrophenol	51285	2.0E-03	I	1.7E-03	--		--	--	1.7E-03	
2,4-Dinitrotoluene	121142	2.0E-03	I	1.7E-03	--		--	--	1.7E-03	
2,6-Dinitrotoluene	606202	1.0E-03	P	8.6E-04	--		--	--	8.6E-04	
2-Chloronaphthalene	91587	8.0E-02	I	6.9E-02	--		--	--	6.9E-02	
2-Chlorophenol	95578	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
2-Methylphenol	95487	5.0E-02	I	4.3E-02	--		--	--	4.3E-02	
2-Nitroaniline	88744	--		--	--		--	--	--	
2-Nitrophenol	88755	--		--	--		--	--	--	
3,3'-Dichlorobenzidine	91941	--		--	4.5E-01	I	4.3E-05	--	4.3E-05	
3-Nitroaniline	99092	--		--	--		--	--	--	
4,6-Dinitro-2-methylphenol	534521	--		--	--		--	--	--	
4-Bromophenyl-phenylether	101553	--		--	--		--	--	--	
4-Chloro-3-methylphenol	59507	--		--	--		--	--	--	
4-Chloroaniline	106478	4.0E-03	I	3.4E-03	--		--	--	3.4E-03	
4-Chlorophenylphenyl ether	7005723	--		--	--		--	--	--	
4-Methylphenol	106445	5.0E-03	H	4.3E-03	--		--	--	4.3E-03	
4-Nitroaniline	100016	--		--	--		--	--	--	
4-Nitrophenol	100027	--		--	--		--	--	--	
Acetophenone	98862	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Benzaldehyde	100527	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Benzoic acid	65850	4.0E+00	I	3.4E+00	--		--	--	3.4E+00	

TABLE 1
RISK-BASED CONCENTRATIONS (RBCs) AND MAXIMUM CONTAMINANT LEVELS (MCLs)
FOR INGESTION OF CHEMICALS OF INTEREST (COIs) IN DRINKING WATER

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			EPA Drinking Water MCL (mg/L) [1]	Lowest Water Value (mg/L)	Notes
		Target HQ: 0.1			Target Risk: 1E-06					
		HIF_{dw} (L/kg-d): 1.2E-01			HIF_{TWAdw} (L/kg-d): 5.2E-02					
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
Benzyl alcohol	100516	5.0E-01	P	4.3E-01	--		--	--	4.3E-01	
bis(2-Chloroethoxy)methane	111911	--		--	--		--	--	--	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	1.7E-05	--	1.7E-05	
Bis(2-ethylhexyl)phthalate	117817	2.0E-02	I	1.7E-02	1.4E-02	I	1.4E-03	--	1.4E-03	
Butyl benzyl phthalate	85687	2.0E-01	I	1.7E-01	--		--	--	1.7E-01	
Caprolactam	105602	5.0E-01	I	4.3E-01	--		--	--	4.3E-01	
Carbazole	86748	--		--	2.0E-02	H	9.6E-04	--	9.6E-04	
Dibenzofuran	132649	1.0E-03	P	8.6E-04	--		--	--	8.6E-04	
Diethylphthalate	84662	8.0E-01	I	6.9E-01	--		--	--	6.9E-01	
Dimethylphthalate	131113	--		--	--		--	--	--	
Di-n-butylphthalate	84742	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Di-n-octylphthalate	117840	--		--	--		--	--	--	
Hexachloroethane	67721	1.0E-03	I	8.6E-04	1.4E-02	I	1.4E-03	--	8.6E-04	
Isophorone	78591	2.0E-01	I	1.7E-01	9.5E-04	I	2.0E-02	--	2.0E-02	
Nitrobenzene	98953	5.0E-04	I	4.3E-04	--		--	--	4.3E-04	
N-Nitrosodi-n-propylamine	621647	--		--	7.0E+00	I	2.7E-06	--	2.7E-06	
N-Nitrosodiphenylamine	86306	--		--	4.9E-03	I	3.9E-03	--	3.9E-03	
Pentachlorophenol	87865	3.0E-02	I	2.6E-02	1.2E-01	I	1.6E-04	1.0E-03	1.6E-04	
Perchlorocyclopentadiene	77474	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	
Phenol	108952	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
POLYBROMINATED DIPHENYLETHERS (PBDEs)										
multiple congeners	--	--		--	--		--	--	--	
POLYCHLORINATED BIPHENYLS (PCBs)										
as Aroclor	--	2.0E-05	I	1.7E-05	2.0E+00	I	9.6E-06	--	9.6E-06	(m)
DIOXIN-LIKE CONGENERS										
as TEQ	--	--		--	1.5E+05	H	1.3E-10	--	1.3E-10	(n)

RBC = risk-based concentration HIF = Human Intake Factor -- = no data MMOA = mutagenic mode of action

[1] Maximum Contaminant Levels (MCLs) for drinking water from http://www.epa.gov/safewater/contaminants/index.html

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Based on toxicity values for water.
(b) Based on toxicity values for Chromium III.
(c) Based on IRIS values for fluorine (CASRN 7782-41-4).
(d) Risk calculations for lead not based on oRfD or oSF approach, RBC not calculated.
(e) Based on toxicity values for non-food.
(f) Criterion is based on fish ingestion scenario, see Appendix B.
(g) Based on toxicity values from IRIS.
(h) Based on toxicity values for 4-4'-DDE.
(i) Based on toxicity values for 4-4'-DDD.
(j) Based on toxicity values for 4-4'-DDT.
(k) Based on toxicity values for Chlordane.
(l) Based on toxicity values for Endosulfan.
(m) Based on toxicity values for Aroclor 1254.
(n) Based on toxicity values for TCDD.

See Appendix A for details on the derivation of the Human Intake Factor (HIF_{dw}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{oSF_{water} * IR_{TWAdw} * EF * ED}$$

IR_{TWAdw} = (IRchild * EDchild + IRadult * EDadult) / EDtotal
= (2 L/d * 4 yrs + 4 L/d * 64 yrs) / 68 yrs
= 3.9 L/d

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Water Ingestion Slope Factor (risk/pCi) [1]	**Drinking Water RBC (pCi/L)**
Radium (88)	Ra-226+D	3.86E-10	**2.7E-02**
Uranium (92)	U-238+D	8.71E-11	**1.2E-01**

[1] http://www.epa.gov/radiation/heast/

See Appendix A for details on the exposure parameters.

TABLE 2
RISK-BASED CONCENTRATIONS (RBCs) FOR INHALATION OF CHEMICALS OF INTEREST (COIs) IN WATER DURING SWEAT LODGE USE

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			Lowest Water RBC (mg/L)	Lower than drinking water RBC?	Notes
		Target HQ: 0.1			Target Risk: 1E-06					
		HIF (L/kg-d): 4.3E-03			HIF_{TWA} (L/kg-d): 4.0E-03					
		iRfD (mg/kg-d)	iRfD Source	RBC (mg/L)	iSF $(mg/kg\text{-}d)^{-1}$	iSF Source	RBC (mg/L)			
METALS AND METALLOIDS										
Aluminum	7429905	1.0E-03	P	2.3E-02	--		--	2.3E-02	yes	
Arsenic	7440382	--		--	1.5E+01	I	1.6E-05	1.6E-05	no	
Barium	7440393	1.4E-04	A	3.3E-03	--		--	3.3E-03	yes	
Beryllium	7440417	5.7E-06	I	1.3E-04	8.4E+00	I	2.9E-05	2.9E-05	yes	
Boron	7440428	5.7E-03	H	1.3E-01	--		--	1.3E-01	yes	
Cadmium	7440439	5.7E-05	E	1.3E-03	6.3E+00	I	3.9E-05	3.9E-05	yes	
Cobalt	7440484	5.7E-06	P	1.3E-04	9.8E+00	P	2.5E-05	2.5E-05	yes	
Manganese	7439965	1.4E-05	I	3.3E-04	--		--	3.3E-04	yes	
Uranium	7440611	8.6E-05	M	2.0E-03	--		--	2.0E-03	yes	(a)
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)										
Benzo(a)pyrene	50328	--		--	see Appendix E		5.5E-05	5.5E-05	no	MMOA
Naphthalene	91203	9.0E-04	I	2.1E-02	--		--	2.1E-02	no	
PESTICIDES										
2,4'-DDT	789026	--		--	3.4E-01	I	7.3E-04	7.3E-04	no	(b)
4,4'-DDT	50293	--		--	3.4E-01	I	7.3E-04	7.3E-04	no	
Aldrin	309002	--		--	1.7E+01	I	1.5E-05	1.5E-05	no	
alpha-BHC	319846	--		--	6.3E+00	I	3.9E-05	3.9E-05	no	
beta-BHC	319857	--		--	1.8E+00	I	1.4E-04	1.4E-04	no	
alpha-Chlordane	5103719	2.0E-04	I	4.7E-03	3.5E-01	I	7.1E-04	7.1E-04	no	(c)
gamma-Chlordane	5566347	2.0E-04	I	4.7E-03	3.5E-01	I	7.1E-04	7.1E-04	no	(c)
Dieldrin	60571	--		--	1.6E+01	I	1.5E-05	1.5E-05	no	
Heptachlor	76448	--		--	4.5E+00	I	5.5E-05	5.5E-05	no	
Heptachlor epoxide	1024573	--		--	9.1E+00	I	2.7E-05	2.7E-05	no	
Hexachlorobenzene	118741	--		--	1.6E+00	I	1.5E-04	1.5E-04	no	
Hexachlorobutadiene	87683	--		--	7.8E-02	I	3.2E-03	3.2E-03	no	
Toxaphene	8001352	--		--	1.1E+00	I	2.2E-04	2.2E-04	no	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)										
1,2-Dichlorobenzene	95501	4.0E-02	H	9.3E-01	--		--	9.3E-01	no	
1,4-Dichlorobenzene	106467	2.3E-01	I	5.3E+00	4.0E-02	O	6.2E-03	6.2E-03	no	
2,2'-oxybis(1-chloropropane)	108601	--		--	3.5E-02	H	7.1E-03	7.1E-03	no	
2,4,6-Trichlorophenol	88062	--		--	1.0E-02	I	2.5E-02	2.5E-02	no	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	2.2E-04	2.2E-04	no	
Hexachloroethane	67721	--		--	1.4E-02	I	1.8E-02	1.8E-02	no	
Nitrobenzene	98953	6.0E-04	A	1.4E-02	--		--	1.4E-02	no	
Perchlorocyclopentadiene	77474	5.7E-05	I	1.3E-03	--		--	1.3E-03	yes	
POLYCHLORINATED BIPHENYLS (PCBs)										
as Aroclor	--	--		--	2.0E+00	I	1.2E-04	1.2E-04	no	(d)
DIOXIN-LIKE CONGENERS										
as TEQ	--	--		--	1.5E+05	H	1.6E-09	1.6E-09	no	(e)

RBC = risk-based concentration HIF = Human Intake Factor -- = no data MMOA = mutagenic mode of action

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Based on toxicity values from IRIS.
(b) Based on toxicity values for 4-4'-DDT.
(c) Based on toxicity values for Chlordane.
(d) Based on toxicity values for Aroclor 1254.
(e) Based on toxicity values for TCDD.

See Appendix D for details on the derivation of the Human Intake Factor (HIF) for sweat lodge use.

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{iSF * IR_{TWAdw} * TF_{water>>air} * EF * ED}$$

$$BR_{TWAdw} = (BRchild * EDchild + BRadult * EDadult) / EDtotal$$
$$= (1\ m^3/d * 4\ yrs + 1\ m^3/d * 64\ yrs) / 68\ yrs$$
$$= 1\ m^3/d$$

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Inhalation Slope Factor (risk/pCi) [1]	**Water RBC (pCi/L)**	Lower than drinking water RBC?
Radium (88)	Ra-226+D	3.86E-10	**7.0E-01**	no
Uranium (92)	U-238+D	8.71E-11	**3.1E+00**	no

[1] http://www.epa.gov/radiation/heast/

See Appendix D for details on the exposure parameters.

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ:		0.1	Target Risk:		1E-06		
		HIF_{fish} (kg ww/kg-d):		3.1E-02	$HIF_{TWAfish}$ (kg ww/kg-d):		1.4E-02		
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
METALS AND METALLOIDS									
Aluminum	7429905	1.0E+00	P	3.2E+00	--		--	3.2E+00	
Antimony	7440360	4.0E-04	I	1.3E-03	--		--	1.3E-03	
Arsenic	7440382	3.0E-04	I	9.7E-03	1.5E+00	I	4.8E-04	4.8E-04	(a)
Barium	7440393	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Beryllium	7440417	2.0E-03	I	6.5E-03	--		--	6.5E-03	
Boron	7440428	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Cadmium	7440439	1.0E-03	I	3.2E-03	--		--	3.2E-03	(b)
Calcium	7440702	--		--	--		--	--	
Chromium	7440473	1.5E+00	I	4.9E+00	--		--	4.9E+00	(c)
Cobalt	7440484	2.0E-02	P	6.5E-02	--		--	6.5E-02	
Copper	7440508	4.0E-02	H	1.3E-01	--		--	1.3E-01	
Fluoride	16984488	6.0E-02	I	1.9E-01	--		--	1.9E-01	(d)
Iron	7439896	7.0E-01	P	2.3E+00	--		--	2.3E+00	
Lead	7439921	--		--	--		--	--	(e)
Magnesium	7439954	--		--	--		--	--	
Manganese	7439965	1.4E-01	I	4.5E-01	--		--	4.5E-01	(f)
Mercury	7439976	see Appendix B		2.4E-04	--		--	2.4E-04	(g)
Molybdenum	7439987	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Nickel	7440020	2.0E-02	I	6.5E-02	--		--	6.5E-02	
Potassium	7440097	--		--	--		--	--	
Selenium	7782492	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Silica	7631869	--		--	--		--	--	
Silver	7440224	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Sodium	7440235	--		--	--		--	--	
Thallium	7440280	7.0E-05	O	2.3E-04	--		--	2.3E-04	
Tin	7440315	6.0E-01	H	1.9E+00	--		--	1.9E+00	
Uranium	7440611	3.0E-03	I	9.7E-03	--		--	9.7E-03	(h)
Vanadium	7440622	1.0E-03	E	3.2E-03	--		--	3.2E-03	
Zinc	7440666	3.0E-01	I	9.7E-01	--		--	9.7E-01	
OTHER TRACE ELEMENTS									
Bismuth	7440699	--		--	--		--	--	
Cerium	7440451	--		--	--		--	--	
Cesium	7440462	--		--	--		--	--	
Gallium	7440553	--		--	--		--	--	
Lanthanum	7439910	--		--	--		--	--	
Lithium	7439932	2.0E-02	E	6.5E-02	--		--	6.5E-02	
Niobium	7440031	--		--	--		--	--	
Rubidium	7440177	--		--	--		--	--	
Scandium	7440202	--		--	--		--	--	
Strontium	7440246	6.0E-01	I	1.9E+00	--		--	1.9E+00	
Thorium	7440291	--		--	--		--	--	
Titanium	7440326	--		--	--		--	--	
Ytterbium	7440644	--		--	--		--	--	
Zirconium	7440677	--		--	--		--	--	
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)									
2-Methylnaphthalene	91576	4.0E-03	I	1.3E-02	--		--	1.3E-02	
Acenaphthene	83329	6.0E-02	I	1.9E-01	--		--	1.9E-01	
Acenaphthylene	208968	--		--	--		--	--	
Anthracene	120127	3.0E-01	I	9.7E-01	--		--	9.7E-01	
Benzo(a)anthracene	56553	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Benzo(a)pyrene	50328	--		--	see Appendix G		5.0E-06	5.0E-06	MMOA
Benzo(b)fluoranthene	205992	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Benzo(ghi)perylene	191242	--		--	--		--	--	
Benzo(k)fluoranthene	207089	--		--	see Appendix G		5.0E-04	5.0E-04	MMOA
Chrysene	218019	--		--	see Appendix G		5.0E-03	5.0E-03	MMOA
Dibenz(a,h)anthracene	53703	--		--	see Appendix G		5.0E-06	5.0E-06	MMOA
Fluoranthene	206440	4.0E-02	I	1.3E-01	--		--	1.3E-01	
Fluorene	86737	4.0E-02	I	1.3E-01	--		--	1.3E-01	
Indeno(1,2,3-cd)pyrene	193395	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Naphthalene	91203	2.0E-02	I	6.5E-02	--		--	6.5E-02	
Phenanthrene	85018	--		--	--		--	--	
Pyrene	129000	3.0E-02	I	9.7E-02	--		--	9.7E-02	

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ:		0.1	Target Risk:		1E-06		
		HIF_{fish} (kg ww/kg-d):		3.1E-02	$HIF_{TWAfish}$ (kg ww/kg-d):		1.4E-02		
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
PESTICIDES									
2,4'-DDD	53190	--		--	2.4E-01	I	3.0E-04	3.0E-04	(i)
4,4'-DDD	72548	--		--	2.4E-01	I	3.0E-04	3.0E-04	
2,4'-DDE	3424826	--		--	3.4E-01	I	2.1E-04	2.1E-04	(j)
4,4'-DDE	72559	--		--	3.4E-01	I	2.1E-04	2.1E-04	
2,4'-DDT	789026	5.0E-04	I	1.6E-03	3.4E-01	I	2.1E-04	2.1E-04	(k)
4,4'-DDT	50293	5.0E-04	I	1.6E-03	3.4E-01	I	2.1E-04	2.1E-04	
Aldrin	309002	3.0E-05	I	9.7E-05	1.7E+01	I	4.2E-06	4.2E-06	
Atrazine	1912249	3.5E-02	I	1.1E-01	2.2E-01	H	3.3E-04	3.3E-04	
alpha-BHC	319846	--		--	6.3E+00	I	1.1E-05	1.1E-05	
beta-BHC	319857	--		--	1.8E+00	I	4.0E-05	4.0E-05	
delta-BHC	319868	--		--	--		--	--	
gamma-BHC	58899	3.0E-04	I	9.7E-04	1.3E+00	H	5.6E-05	5.6E-05	
alpha-Chlordane	5103719	5.0E-04	I	1.6E-03	3.5E-01	I	2.1E-04	2.1E-04	(l)
gamma-Chlordane	5566347	5.0E-04	I	1.6E-03	3.5E-01	I	2.1E-04	2.1E-04	(l)
Dieldrin	60571	5.0E-05	I	1.6E-04	1.6E+01	I	4.5E-06	4.5E-06	
Endosulfan I	959988	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endosulfan II	33213659	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endosulfan sulfate	1031078	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endrin	72208	3.0E-04	I	9.7E-04	--		--	9.7E-04	
Endrin aldehyde	7421934	--		--	--		--	--	
Endrin ketone	53494705	--		--	--		--	--	
Heptachlor	76448	5.0E-04	I	1.6E-03	4.5E+00	I	1.6E-05	1.6E-05	
Heptachlor epoxide	1024573	1.3E-05	I	4.2E-05	9.1E+00	I	7.9E-06	7.9E-06	
Hexachlorobenzene	118741	8.0E-04	I	2.6E-03	1.6E+00	I	4.5E-05	4.5E-05	
Hexachlorobutadiene	87683	1.0E-03	P	3.2E-03	7.8E-02	I	9.3E-04	9.3E-04	
Methoxychlor	72435	5.0E-03	I	1.6E-02	--		--	1.6E-02	
cis-Nonachlor	5103731	--		--	--		--	--	
trans-Nonachlor	39765805	--		--	--		--	--	
Oxychlordane	27304138	--		--	--		--	--	
Toxaphene	8001352	--		--	1.1E+00	I	6.6E-05	6.6E-05	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)									
1,1'-Biphenyl	92524	5.0E-02	I	1.6E-01	--		--	1.6E-01	
1,2,4-Trichlorobenzene	120821	1.0E-02	I	3.2E-02	--		--	3.2E-02	
1,2-Dichlorobenzene	95501	9.0E-02	I	2.9E-01	--		--	2.9E-01	
1,3-Dichlorobenzene	541731	3.0E-03	E	9.7E-03	--		--	9.7E-03	
1,4-Dichlorobenzene	106467	3.0E-02	E	9.7E-02	2.4E-02	H	3.0E-03	3.0E-03	
2,2'-oxybis(1-chloropropane)	108601	4.0E-02	I	1.3E-01	7.0E-02	H	1.0E-03	1.0E-03	
2,4,5-Trichlorophenol	95954	1.0E-01	I	3.2E-01	--		--	3.2E-01	
2,4,6-Trichlorophenol	88062	1.0E-03	P	3.2E-03	1.1E-02	I	6.6E-03	3.2E-03	
2,4-Dichlorophenol	120832	3.0E-03	I	9.7E-03	--		--	9.7E-03	
2,4-Dimethylphenol	105679	2.0E-02	I	6.5E-02	--		--	6.5E-02	
2,4-Dinitrophenol	51285	2.0E-03	I	6.5E-03	--		--	6.5E-03	
2,4-Dinitrotoluene	121142	2.0E-03	I	6.5E-03	--		--	6.5E-03	
2,6-Dinitrotoluene	606202	1.0E-03	P	3.2E-03	--		--	3.2E-03	
2-Chloronaphthalene	91587	8.0E-02	I	2.6E-01	--		--	2.6E-01	
2-Chlorophenol	95578	5.0E-03	I	1.6E-02	--		--	1.6E-02	
2-Methylphenol	95487	5.0E-02	I	1.6E-01	--		--	1.6E-01	
2-Nitroaniline	88744	--		--	--		--	--	
2-Nitrophenol	88755	--		--	--		--	--	
3,3'-Dichlorobenzidine	91941	--		--	4.5E-01	I	1.6E-04	1.6E-04	
3-Nitroaniline	99092	--		--	--		--	--	
4,6-Dinitro-2-methylphenol	534521	--		--	--		--	--	
4-Bromophenyl-phenylether	101553	--		--	--		--	--	
4-Chloro-3-methylphenol	59507	--		--	--		--	--	
4-Chloroaniline	106478	4.0E-03	I	1.3E-02	--		--	1.3E-02	
4-Chlorophenylphenyl ether	7005723	--		--	--		--	--	
4-Methylphenol	106445	5.0E-03	H	1.6E-02	--		--	1.6E-02	
4-Nitroaniline	100016	--		--	--		--	--	
4-Nitrophenol	100027	--		--	--		--	--	
Acetophenone	98862	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Benzaldehyde	100527	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Benzoic acid	65850	4.0E+00	I	1.3E+01	--		--	1.3E+01	
Benzyl alcohol	100516	5.0E-01	P	1.6E+00	--		--	1.6E+00	
bis(2-Chloroethoxy)methane	111911	--		--	--		--	--	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	6.6E-05	6.6E-05	

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ: 0.1			Target Risk: 1E-06				
		HIF_{fish} (kg ww/kg-d): 3.1E-02			$HIF_{TWAfish}$ (kg ww/kg-d): 1.4E-02				
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
Bis(2-ethylhexyl)phthalate	117817	2.0E-02	I	6.5E-02	1.4E-02	I	5.2E-03	5.2E-03	
Butyl benzyl phthalate	85687	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Caprolactam	105602	5.0E-01	I	1.6E+00	--		--	1.6E+00	
Carbazole	86748	--		--	2.0E-02	H	3.6E-03	3.6E-03	
Dibenzofuran	132649	1.0E-03	P	3.2E-03	--		--	3.2E-03	
Diethylphthalate	84662	8.0E-01	I	2.6E+00	--		--	2.6E+00	
Dimethylphthalate	131113	--		--	--		--	--	
Di-n-butylphthalate	84742	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Di-n-octylphthalate	117840	--		--	--		--	--	
Hexachloroethane	67721	1.0E-03	I	3.2E-03	1.4E-02	I	5.2E-03	3.2E-03	
Isophorone	78591	2.0E-01	I	6.5E-01	9.5E-04	I	7.6E-02	7.6E-02	
Nitrobenzene	98953	5.0E-04	I	1.6E-03	--		--	1.6E-03	
N-Nitrosodi-n-propylamine	621647	--		--	7.0E+00	I	1.0E-05	1.0E-05	
N-Nitrosodiphenylamine	86306	--		--	4.9E-03	I	1.5E-02	1.5E-02	
Pentachlorophenol	87865	3.0E-02	I	9.7E-02	1.2E-01	I	6.0E-04	6.0E-04	
Perchlorocyclopentadiene	77474	6.0E-03	I	1.9E-02	--		--	1.9E-02	
Phenol	108952	3.0E-01	I	9.7E-01	--		--	9.7E-01	
POLYBROMINATED DIPHENYLETHERS (PBDEs)									
multiple congeners	--	--		--	--		--	--	
POLYCHLORINATED BIPHENYLS (PCBs)									
as Aroclor	--	2.0E-05	I	6.5E-05	2.0E+00	I	3.6E-05	3.6E-05	(n)
DIOXIN-LIKE CONGENERS									
as TEQ	--	--		--	1.5E+05	H	4.8E-10	4.8E-10	(o)

RBC = risk-based concentration HIF = Human Intake Factor -- = no toxicity data MMOA = mutagenic mode of action

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Assumes 10% of arsenic in tissue is in a biologically available form.
(b) Based on toxicity values for food.
(c) Based on toxicity values for Chromium III.
(d) Based on IRIS values for fluorine (CASRN 7782-41-4).
(e) Risk calculations for lead not based on oRfD or oSF approach, RBC not calculated.
(f) Based on toxicity values for food.
(g) Tissue residue criterion calculated in Appendix B.
(h) Based on toxicity values from IRIS.
(i) Based on toxicity values for 4-4'-DDE.
(j) Based on toxicity values for 4-4'-DDD.
(k) Based on toxicity values for 4-4'-DDT.
(l) Based on toxicity values for Chlordane.
(m) Based on toxicity values for Endosulfan.
(n) Based on toxicity values for Aroclor 1254.
(o) Based on toxicity values for TCDD.

See Appendix F for details on the derivation of the Human Intake Factor (HIF_{fish}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{oSF_{food} * IR_{TWAfish} * EF * ED}$$

$$IR_{TWAfish} = (IRchild * EDchild + IRadult * EDadult) / EDtotal$$
$$= (530\ g/d * 4\ yrs + 1060\ g/d * 64\ yrs) / 68\ yrs$$
$$= 1029\ g/d$$

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Food Ingestion Slope Factor (risk/pCi) [1]	**Fish Tissue RBC (pCi/g)**
Radium (88)	Ra-226+D	5.15E-10	**7.6E-05**
Uranium (92)	U-238+D	1.21E-10	**3.2E-04**

[1] http://www.epa.gov/radiation/heast/

See Appendix F for details on the exposure parameters.

TABLE 4

RISK-BASED CONCENTRATIONS (RBCs) FOR INCIDENTAL INGESTION OF METALS AND RADIONUCLIDES IN SURFACE SEDIMENT

Analyte Name	Non-Cancer			Cancer			Lowest Sediment RBC (mg/kg)	Notes	Sediment Reference Concentration Range (mg/kg) [1]
	Target HQ: 0.1			Target Risk: 1E-06					
	HIF_{sed} (kg/kg-d): 1.7E-05			HIF_{TWAsed} (kg/kg-d): 4.9E-06					
	oRfD (mg/kg-d)	oRfD Source	Sediment RBC (mg/kg)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Sediment RBC (mg/kg)			
Aluminum	1.0E+00	P	5,733	--		--	5,733		
Antimony	4.0E-04	I	2.3	--		--	2.3		0.1 - 1.4
Arsenic	2.4E-04	I	1.38	1.9E+00	I	0.11	0.11	(a)	1 - 10
Barium	2.0E-01	I	1,147	--		--	1,147		
Beryllium	2.0E-03	I	11	--		--	11		
Cadmium	1.0E-03	I	5.7	--		--	5.7	(b)	
Calcium	--		--	--		--	--		
Chromium	1.5E+00	I	8,600	--		--	8,600	(c)	
Cobalt	2.0E-02	P	115	--		--	115		
Copper	4.0E-02	H	229	--		--	229		10 - 25
Iron	7.0E-01	P	4,013	--		--	4,013		5,100 - 34,000
Lead							400	(d)	8 - 47
Lithium	2.0E-02	E	115	--		--	115		
Magnesium	--		--	--		--	--		
Manganese	4.7E-02	I	268	--		--	268	(e)	129 - 1,000
Mercury	3.0E-04	I	1.7	--		--	1.7	(f)	
Molybdenum	5.0E-03	I	29	--		--	29		
Nickel	2.0E-02	I	115	--		--	115		
Potassium	--		--	--		--	--		
Selenium	5.0E-03	I	29	--		--	29		
Silver	5.0E-03	I	29	--		--	29		
Sodium	--		--	--		--	--		
Strontium	6.0E-01	I	3,440	--		--	3,440		
Thallium	7.0E-05	O	0.40	--		--	0.40		
Tin	6.0E-01	H	3,440	--		--	3,440		
Titanium	--		--	--		--	--		
Uranium	3.0E-03	I	17	--		--	17	(g)	0.5
Vanadium	1.0E-03	E	5.7	--		--	5.7		
Zinc	3.0E-01	I	1,720	--		--	1,720		

RBC = risk-based concentration HIF = Human Intake Factor -- = no toxicity data

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Oral toxicity values adjusted based on RBA of 0.80.
(b) Based on toxicity values for food.
(c) Based on toxicity values for Chromium III.
(d) Based on residential exposure scenario.
(e) Based on toxicity values for non-food. oRfd adjusted by a modifying factor of 3, in accord with IRIS recommendations.
(f) Assumes chemical form of mercury is mercuric chloride.
(g) Based on toxicity values from IRIS.

[1] As presented in Table 2-2 of the Beach Screening Level Risk Assessment. Values based on sediment reference samples collected by EPA in 2005, the USGS in 1995 and 1990, and Ecology's Natural Background Soil Metals Concentrations in Washington State.

See Appendix H for details on the derivation of the Human Intake Factor (HIF_{sed}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{[oSF_{soil} * IR_{TWAsed} * EF * ED] + [SF_{ext} * ACF * EF/365 * ED * ET]}$$

IR_{TWAsed} = (IRchild * EDchild + IRadult * EDadult) / EDtotal
= (300 mg/d * 4 yrs + 300 mg/d * 64 yrs) / 68 yrs
= 300 mg/d >> 0.3 g/d

ACF = area correction factor (default = 0.9) [1]

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Slope Factor [2]		**Sediment RBC (pCi/g)**
		Soil Ingestion (risk/pCi)	External Exposure (risk/y per pCi/g)	
Radium (88)	Ra-226+D	7.30E-10	8.49E-06	**4.3E-04**
Uranium (92)	U-238+D	2.10E-10	1.14E-07	**3.1E-02**

[1] http://epa-prgs.ornl.gov/radionuclides/acf.shtml
[2] http://www.epa.gov/radiation/heast/

See Appendix H for details on the exposure parameters.

APPENDIX A
Human Intake Factor for Drinking Water (HIF_{dw})
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of drinking water from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Ingestion rate of drinking water	L/day	4	Harper et al. 2002, Harris & Harper 1997 [1]	2	USEPA 2005 [1]
HIF (non-cancer)	**L/kg-d**	**5.71E-02**		**1.16E-01**	
HIF (cancer)	**L/kg-d**	**5.22E-02**		**6.64E-03**	
HIF_{TWA} (cancer)	**L/kg-d**	**5.89E-02**			

Harris and Harper 1997. Umatilla Tribe Exposure Scenarios.
Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Includes extra 1 L/day associated with sweat lodge use

APPENDIX B
CALCULATION OF FISH TISSUE RESIDUE CRITERION FOR MERCURY

Basic Equation --

$TRC = [BW * (oRfD - RSC)] / FI_{total}$

where:

TRC	Fish tissue residue criterion (mg/kg)
BW	Body weight (kg)
RSC	Relative Source Contribution (ug/kg-d)
oRfD	Oral Reference Dose for MeHg (ug/kg-d)
FI_{total}	Fish intake (g ww/d)

See Section 3.1.2.2 of "Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion" EPA 823/B-04/001

Note: Assumes a Target Hazard Quotient (HQ) of 1.0.

Traditional Subsistence Scenario Exposure Parameters

	Adult	Child
BW (kg):	70	17.2
FI_{total} (g ww/day):	1060	530

Toxicity Values

MeHg oRfD (ug/kg-d):	0.1
RSC [1] (ug/kg-d):	0.027
Adj. MeHg oRfD (ug/kg-d):	0.073

[1] Relative source contribution (subtracted from the oRfD to account for MeHg in marine fish).

Tissue Residue Criterion

	Adult	Child
TRC (mg/kg ww) =	4.8E-03	2.4E-03
adjusted to a Target HQ of 0.1	4.8E-04	2.4E-04

TRANSLATING TISSUE RESIDUE CRITERION TO A WATER CONCENTRATION

Basic Equation --

Cw = TRC / BAF

where:

Cw	Water concentration (mg/L)
BAF	Bioaccumulation Factor (L water/kg fish)
TRC	Fish tissue residue criterion (mg/kg)

Bioaccumulation Factors

	Trophic Level		
	2	3	4
Geomean BAF (L/kg):	117,000	680,000	2,670,000

See Section 3.1.3.1.3, Table 1 for draft national BAFs

Risk Based Concentrations in Surface Water

	Trophic Level		
	2	3	4
Cw, Adult (mg/L):	4.1E-09	7.1E-10	1.8E-10
Cw, Child (mg/L):	2.0E-09	3.5E-10	8.9E-11

APPENDIX C
CALCULATION OF RBCs FOR INGESTION OF DRINKING WATER FOR CHEMICALS WITH A MUTAGENIC MODE OF ACTION

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Estimated Order of Potency (EOP)	Toxicity Values		Child				Adult				Target Risk: 1E-06
					HIF_{dw} (L/kg-d): 0.00664				HIF_{dw} (L/kg-d): 0.05224				
					0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/L)
			oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	
Benzo(a)anthracene	56553	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05
Benzo(a)pyrene	50328	1	7.3	I		73		21.9		21.9		7.3	1.3E-06
Benzo(b)fluoranthene	205992	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05
Benzo(k)fluoranthene	207089	0.01	0.073	O	0.00221	0.73	0.00443	0.219	0.00816	0.219	0.04408	0.073	1.3E-04
Chrysene	218019	0.001	0.0073	O		0.073		0.0219		0.0219		0.0073	1.3E-03
Dibenz(a,h)anthracene	53703	1	7.3	O		73		21.9		21.9		7.3	1.3E-06
Indeno(1,2,3-cd)pyrene	193395	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX D
Human Intake Factor for Sweat Lodge Use
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Time	hrs/event	2	USEPA 2005	0.25	USEPA 2005 [1]
Exposure Frequency	events/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of water from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Breathing rate in sweat lodge	m^3/hr	1.0	USEPA 1997 [2]	1.0	USEPA 1997 [2]
Bulk transport factor for water to air	L/m^3	0.15			USEPA 2005 [3]
HIF (non-cancer)	**L/kg-d**	**4.29E-03**		**2.18E-03**	
HIF (cancer)	**L/kg-d**	**3.92E-03**		**1.25E-04**	
HIF_{TWA} (cancer)	**L/kg-d**	**4.04E-03**			

Harris and Harper 1997. Umatilla Tribe Exposure Scenarios.
Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] child value based on heat stress recommendations from American Academy of Pediatrics (2000)
[2] Table 5-23. Mean breathing rate for light activities.
[3] water vapor saturation at 150 degrees F (sweat lodge temperature)

APPENDIX E
CALCULATION OF RBC FOR INHALATION OF BENZO(A)PYRENE IN WATER DURING SWEAT LODGE USE

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Toxicity Values		Child				Adult				Target Risk: 1E-06
				HIF (L/kg-d): 1.2E-04				HIF (L/kg-d): 3.9E-03				
				0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/L)
		iSF $(mg/kg\text{-}d)^{-1}$	iSF Source	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	
Benzo(a)pyrene	50328	3.1	E	4E-05	31	8E-05	9.3	6.1E-04	9.3	3.3E-03	3.1	5.5E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX F
Human Intake Factor for Ingestion of Fish (HIF_{fish})
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of meals from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Ingestion rate of fish	g ww/day	1060	USEPA 2005 [1]	530	Prof. judgment [1]
Conversion factor	*kg/g*	*1E-03*		*1E-03*	
HIF (non-cancer)	**kg ww/kg-d**	**1.51E-02**		**3.08E-02**	
HIF (cancer)	**kg ww/kg-d**	**1.38E-02**		**1.76E-03**	
HIF_{TWA} (cancer)	**kg ww/kg-d**	**1.56E-02**			

Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Adult: Table I, high fish diet -- 885 g/d fish and 175 g/d shellfish
Child: assumed to be 1/2 the adult

APPENDIX G
CALCULATION OF RBCs FOR INGESTION OF FISH TISSUE FOR CHEMICALS WITH A MUTAGENIC MODE OF ACTION

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Estimated Order of Potency (EOP)	Toxicity Values		Child				Adult				Target Risk: 1E-06
					HIF_{fish} (kg ww/kg-d): 1.8E-03				HIFfish (kg ww/kg-d): 1.4E-02				
					0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/kg ww)
			oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	
Benzo(a)anthracene	56553	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05
Benzo(a)pyrene	50328	1	7.3	I		73		21.9		21.9		7.3	5.0E-06
Benzo(b)fluoranthene	205992	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05
Benzo(k)fluoranthene	207089	0.01	0.073	O	0.00059	0.73	0.00117	0.219	0.00216	0.219	0.01168	0.073	5.0E-04
Chrysene	218019	0.001	0.0073	O		0.073		0.0219		0.0219		0.0073	5.0E-03
Dibenz(a,h)anthracene	53703	1	7.3	O		73		21.9		21.9		7.3	5.0E-06
Indeno(1,2,3-cd)pyrene	193395	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX H

Human Intake Factor for Incidental Ingestion of Surface Sediment (HIF_{sed})

Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Exposure Time	hrs/d	4	Prof. judgment	4	Prof. judgment
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Ingestion rate of sediment	mg/day	300	Harper et al. 2002 [1]	300	Harper et al. 2002 [2]
Conversion factor	*kg/mg*	*1E-06*		*1E-06*	
HIF (non-cancer)	**kg/kg-d**	**4.29E-06**		**1.74E-05**	
HIF (cancer)	**kg/kg-d**	**3.92E-06**		**9.97E-07**	
HIF_{TWA} (cancer)	**kg/kg-d**	**4.92E-06**			

Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Table 1. Soil intake rate is reported as 400 mg/d (100 mg/d from indoor sources + 300 mg/d for outdoor scenarios). For the purposes of the HHRA Workplan, it was assumed that UCR site exposures were restricted to outdoor scenarios only (300 mg/d). Reported soil intake rates were assumed to apply to sediment exposures.

[2] Intake rates for child assumed to be equal to adult. This is supported by Section 3.7 in Harper et al. (2002) which identifies soil intake rates for child and adult as being equal.