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Rev. 3

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River Corridor Closure Contract

Sampling and Analysis Instructions for the Remedial Investigation of Hanford Site Releases to the Columbia River

January 2010

For Public Release

Washington Closure Hanford

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Assistant Manager for River Corridor

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Title: Sampling and Analysis Instructions for the Remedial Investigation of Hanford Site Releases to the Columbia River

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L. C. Hulstrom

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REVISION HISTORY

Revision	Date	Reason for revision	Revision initiator
0	10/2008	Initial issuance	NA
1	5/2009	Section 3.1.3 changed to reflect refinement of scope associated with sturgeon sampling. Section 3.1.4.1 changed to reflect clarification of MIS process. Section 3.1.5.1 updated to provide additional details regarding surface water sample preparation. Section 3.2 updated to add Tables 3-4 and 3-5 regarding laboratory analysis requirements for fish. Other minor clarifications throughout the text were also incorporated.	L. C. Hulstrom
2	7/2009	Section 3.1.3 updated to reflect additional details regarding electrofishing, long line techniques for sturgeon fishing, and field preparation of histology samples for sturgeon.	L. C. Hulstrom
3	1/2010	Section 3.1.3.7 updated to include the sediment determination method. Section 3.1.4.3 updated with Phase III sediment collection instruction. Section 3.1.5.2 updated with Phase III pore water and surface water sampling instruction. Section 3.2 updated with specific analyte lists for Phase III sampling media. Added Appendix A that specifies specific Phase IIb and Phase III sample locations. Section 3.1.4.3 and 3.1.5.2 updated to specify t that underwater photographs and sediment photographs taken as part of Phase IIb and Phase III sampling will be submitted as electronic data as part of the field summary report after sampling is completed. Added Appendix A with locations of Phase IIb and Phase III sample locations.	H. M. Sulloway

ACRONYMS

AVS	acid volatile sulfide
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CRC	Columbia River Component
DI	deionized (water)
DO	dissolved oxygen
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HEIS	Hanford Environmental Identification System
HGET	Hanford General Employee Training
IWCP	Integration Work Control Program
JHA	Job Hazard Analysis
MIS	*MULTI INCREMENT SAMPLING*®
OD	outer diameter
PCB	polychlorinated biphenyl
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RCBRA	River Corridor Baseline Risk Assessment
RCCC	River Corridor Closure Contractor
SAF	sample authorization form
SAI	sampling and analysis instruction
SAP	sampling and analysis plan
SCUBA	self-contained underwater breathing apparatus
SDG	sample delivery group
SEM	simultaneously extracted metals
STR	Subcontract Technical Representative
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbons
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
VOA	volatile organic analysis
VOC	volatile organic compound
WCH	Washington Closure Hanford

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METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

This sampling and analysis instruction (SAI) guide was prepared to define the detailed sampling and analysis activities to be performed in support of the remedial investigation in progress to characterize potential impacts from Hanford Site releases to the Columbia River. Appendix A of the *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* (DOE-RL 2008a) is the sampling and analysis plan (hereafter referred to as the SAP). The SAP defines data collection methods that fill data gaps associated with completing a baseline risk assessment report for the Columbia River Component (CRC) of the River Corridor Baseline Risk Assessment (RCBRA).

This SAI is a successor to WCH-47, which was written to support sampling for the *River Corridor Baseline Risk Assessment* (DOE-RL 2008b). WCH-47 was used as a template for Rev. 0 of WCH-286 and included the following updates to:

- Make improvements based on lessons learned from previous sampling
- Create a document that is specific to the CRC sampling (e.g., no upland sampling is planned and only limited biota sampling is scheduled)
- Add text to include deep river sampling for sediment, sediment cores, and water.

Additional changes made subsequently for Rev. 1 of WCH-286 include the following:

- Refinement of the scope associated with sturgeon sampling
- Clarification of the *MULTI INCREMENT SAMPLING®* (MIS) process
- Provide additional details regarding surface water sample preparation
- Updates to provide additional details regarding laboratory analysis requirements for fish
- Incorporation of other minor clarifications throughout the text.

The CRC geographical investigation area has been divided into five sub-areas based on proximity to the Hanford Site and the relation of production operations. These five sub-areas include the upriver, 100 Area, 300 Area, Lake Wallula (downriver), and Bonneville Dam pool segments (Figure 1-1). The investigation area includes the Columbia River and islands from the Priest Rapids Dam (located just upriver from the Hanford Site towards McNary Dam, the first downriver dam from the Hanford Site). In addition, there will be a limited investigation of the area immediately upstream of Bonneville Dam and north of the Wanapum Dam.

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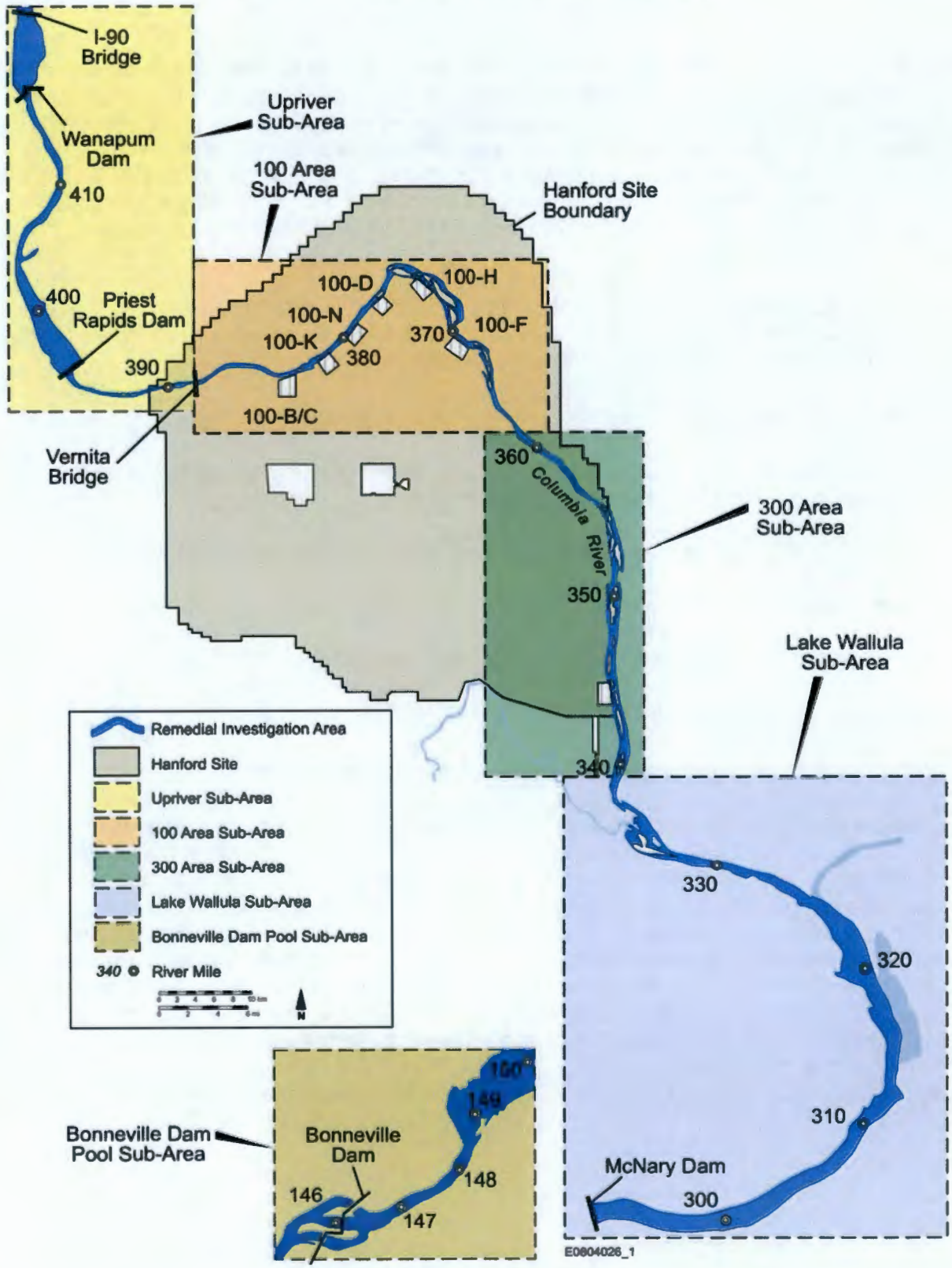
Figure 1-1. Columbia River Component Map.



The lateral investigation area of the Columbia River extends shore to shore (ordinary high water mark to ordinary high water mark[1]), except for areas within the Hanford Reach that have been previously characterized and assessed by DOE-RL (2008b) (generally to a depth of 2 m [6 ft] into the river from the low water mark). In these areas of the Hanford Reach, the investigation area for this SAP begins where the RCBRA (DOE-RL 2008b) stopped. Additional information on the investigation area boundaries is presented in Section 4.0 of the *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* (DOE-RL 2008a).

Contaminant concentrations in abiotic and biotic media will be compared to endpoint criteria specified by Washington State regulations, U.S. Environmental Protection Agency (EPA) technical guidance, U.S. Department of Energy (DOE) technical guidance, or as supported by the scientific literature. The sampling will be used to characterize the nature and extent of Hanford Site-related contaminants that have come to be located within the Columbia River, and assess the current risk to ecological and human health receptors that is posed by those Hanford Site-related contaminants.

1.1 BACKGROUND, PURPOSE, AND SCOPE

The Hanford Site became a federal facility in 1943 when the U.S. Government took possession of the land to produce weapons-grade plutonium during World War II. The Hanford Site's production mission continued until the late 1980s, when the mission changed from producing nuclear materials to cleaning up the radioactive and hazardous wastes that had been generated during the previous decades. In 1989, the 100 Area (encompassing the former plutonium production reactors along the Columbia River) and the 300 Area (which housed fuel fabrication plants as well as many research and development projects) were placed on the National Priorities List under the authority of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Placement on the National Priorities List initiated the CERCLA process, leading to the cleanup of contaminated areas.

The purpose of this sampling is to support performance of a CERCLA-compliant remedial investigation that:

- Characterizes the nature and extent of Hanford Site-related contaminants that have come to be located within the Columbia River
- Assesses the current risk to ecological and human receptors posed by Hanford Site-related contaminants.

The scope of this sampling focuses on the impacts of Hanford Site releases to the Columbia River and its users. In order to evaluate the impacts from Hanford Site releases, it will also be important to understand the contributions of non-Hanford Site influences to the Columbia River upstream, within, and downstream of the Hanford Site. The risk assessment activities

[1] From WAC 173-22-030, "the ordinary high water mark on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland".

performed as part of the associated work plan (DOE-RL 2008a) will become a component of the RCBRA.

1.2 PREVIOUS INVESTIGATIONS

The federal government has extensively monitored the environment within and adjacent to the Hanford Site from the beginning of operations in the 1940s through the present. Radioactivity from the Hanford Site has been measured at detectable levels in various media (e.g., soil, sediment, biota, and groundwater) over a large regional area. Most of this detectable radioactivity has largely decayed away over the years due to the short half-lives associated with many of the isotopes that were released.

To begin the scoping effort for this work plan (DOE-RL 2008a), an extensive data compilation effort was performed between 2004 and 2006 to identify and organize the results from these investigations and programs, as documented in the *Columbia River Component Data Evaluation Summary Report* (WCH-91). The compiled data include results from more than 5,900 surface water samples; 1,400 sediment samples; and 7,000 biota samples (e.g., fish, shellfish, waterfowl). The compiled data was then further evaluated with the purpose of identifying potential data gaps to be addressed in a remedial investigation work plan. Results of this evaluation and the associated data gaps were summarized in the *Columbia River Component Data Gap Analysis* (WCH-201).

Current activities in the River Corridor include performance of a baseline risk assessment of the upland, riparian, and near-shore zones. Collectively, these zones are referred to as the RCBRA (DOE-RL 2008b). The assessment began in 2004 and includes evaluation of potential impacts to ecological and human receptors.

1.3 INDICATOR CONTAMINANTS AND CONTINGENCIES

The *DQO Summary Report for the Remedial Investigation of Hanford Site Releases to the Columbia River* (WCH-265) (DQO Summary Report) and the SAP (DOE-RL 2008a) described the process of identifying indicator contaminants. The target analytes for soil/sediment surface water and pore water are identified in Tables 4-2, 4-3, and 4-4 of the work plan, respectively (DOE-RL 2008a). Analyses and tissues proposed for fish are listed in Table 4-14 of the SAP (DOE-RL 2008a); the analytical suites proposed for each medium are identified in Table 2-7 of the SAP.

It is necessary to prepare for contingency sampling in the event that the planned scheduling or collection activities are not met. For example, limited sediment recovery from a sediment grab sample may result in insufficient sample mass for all proposed analyses. If insufficient mass is obtained for a particular sample, the field team leader may continue sampling until sufficient sample mass is obtained, if possible. If it is exceedingly difficult to obtain sufficient mass/volume of sediment, soil, or fish, the analytes shall be analyzed in the following general priority order:

1. Gamma spectroscopy - because it is a nondestructive analysis
2. Metals
3. Other radionuclides

4. Polychlorinated biphenyls (PCBs)
5. Pesticides
6. Semivolatile organic compounds (SVOCs)
7. Volatile organic compounds (VOCs).

Except in the 300 Area, pore water will be analyzed according to the following priority order:

1. Metals (including uranium)
2. VOCs
3. Gamma spectroscopy
4. PCBs
5. Pesticides
6. SVOCs.

1.4 PROBLEM DEFINITION

Although there have been extensive environmental monitoring showing general trends that reflect decreasing concentrations within the investigation area, gaps in the spatial knowledge of environmental impacts from Hanford Site operations do exist. Several site characterization and data needs were identified based on process and operational knowledge, review of the existing data, an understanding of the contaminant transport mechanisms, and input received from the DQO interviews and workshops. These needs are summarized in Table 1-1 and include collection of supplemental data to characterize Hanford Site releases to the river and to support evaluation of exposure pathways, media-specific exposures, and risk calculations consistent with applicable regulatory guidance.

Table 1-1. Summary of Characterization and Data Needs. (2 Pages)

Area	Characterization and Data Needs
Upriver sub-area	– Upriver surface water and sediments – Upriver fish tissue to support the human health risk assessments.
100 Area sub-area	– Sediment cores from river water inlet structures – Surface water and sediments for irrigation returns along the Hanford Reach – Sediments from the sloughs and backwaters on the far shore of the river – Island soils – Surface water, pore water, and sediment in areas of contaminated groundwater upwelling – Fish tissue to support the human health risk assessments.

Table 1-1. Summary of Characterization and Data Needs. (2 Pages)

Area	Characterization and Data Needs
300 Area sub-areas	– Sediments from the sloughs and backwaters on the far shore of the river – Surface water and sediments for irrigation returns along the Hanford Reach – Island soils – Surface water, pore water, and sediment in areas of contaminated groundwater upwelling – Sediments along the far shore – Fish tissue to support the human health risk assessments.
Lake Wallula sub-area	– Surface water and shallow sediments from near-shore recreational areas in the Richland area and Lake Wallula – Surface water and sediments for other rivers joining the Columbia (i.e., Snake, Yakima, Walla Walla) between Priest Rapids and McNary Dams – Sediment cores from the head water of Lake Wallula – Sediment cores from the Yakima Delta and Snake River depositional areas – Sediment cores from Lake Wallula and directly behind McNary Dam – Fish tissue to support the human health risk assessments.
Bonneville Dam pool sub-area	– Sediment cores from upstream of Bonneville Dam.

2.0 PROJECT MANAGEMENT

This section addresses the roles and responsibilities of the project management team to ensure that project participants understand the sampling goals and approaches to be used and that the planned outputs have been appropriately documented.

2.1 PROJECT/TASK ORGANIZATION

This project will be managed by the River Corridor Closure Contractor (RCCC). The RCCC will assign a project director, project managers ("Project Management and Oversight" in Figure 2-1), and a subcontract technical representative (STR). The risk assessment manager assigned under Project Management and Oversight has overall responsibility for this project, including oversight of the project schedule and budget. The manager makes final project decisions with the authority to commit the necessary resources to perform activities.

The RCCC STR is responsible for coordination and oversight of all environmental data collection activities including sampling, field analytical measurements, and field ecological observations. The STR is responsible for tracking and reporting the progress of field work and laboratory analysis and interfacing with quality assurance (QA), safety and health, and cultural resources representatives to ensure work is performed in accordance with all project objectives and requirements, such as those specified in this SAI, the SAP (DOE-RL 2008a), and the DQO Summary Report (WCH-265).

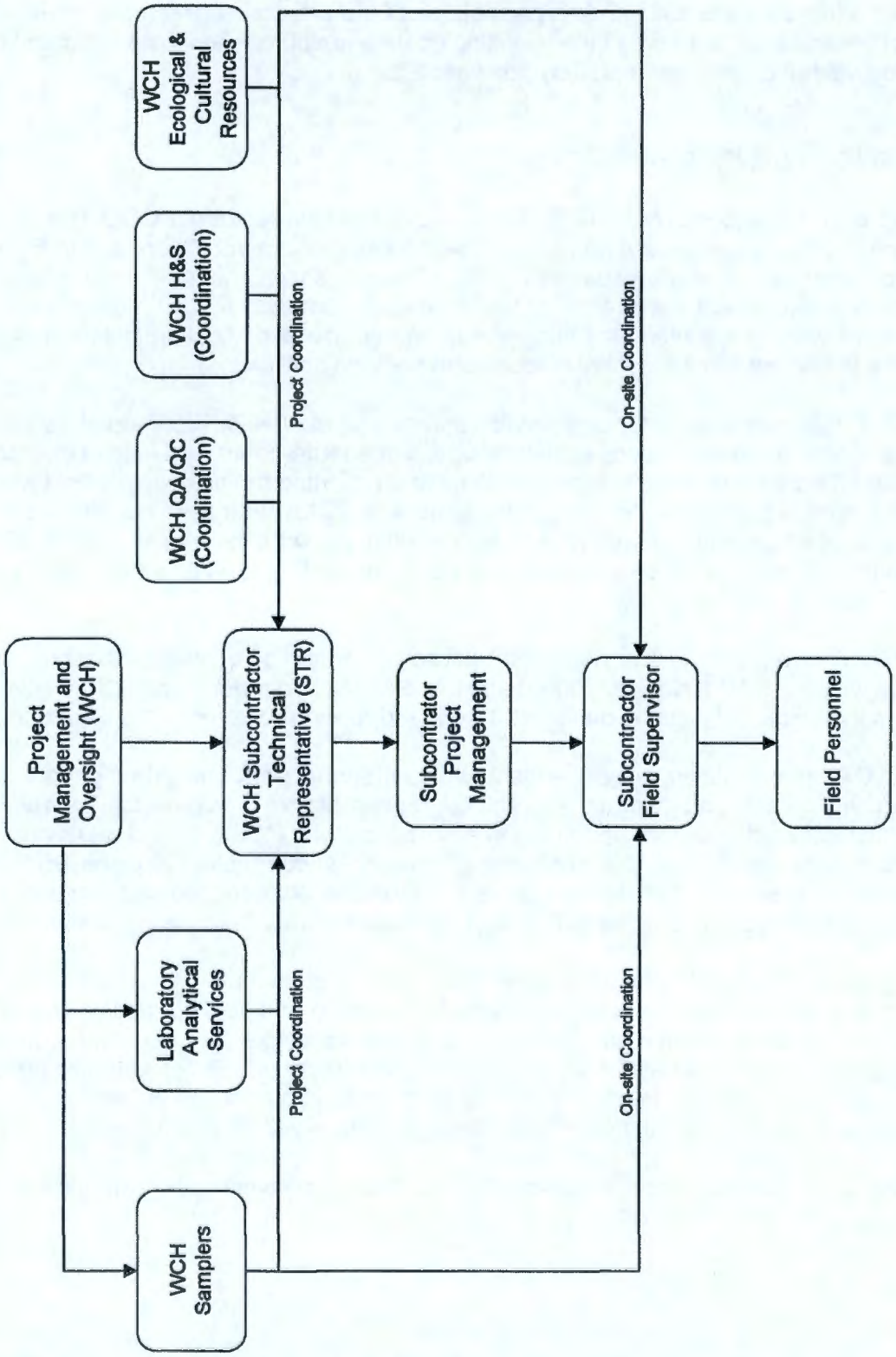
Sample collection (e.g., sediment, water, fish) will be performed by qualified subcontractors in accordance with the SAP (DOE-RL 2008a) and this SAI. Subcontractor and RCCC field personnel will provide daily status during field work and report problems in the field to the STR.

The project QA representative is independent of the personnel performing data generation and oversees quality control and laboratories. The QA representative is responsible for ensuring field and laboratory activities are performed in accordance with RCCC project quality management plans, RCCC-approved field and laboratory subcontractor QA plans, and applicable procedures. The QA representative is also responsible for coordinating and performing audits and assessments of field and laboratory work.

The Ecological and Cultural Resources Specialists work independently of the personnel performing data generation. Each is responsible for ensuring that field activities are conducted in compliance with all applicable natural and cultural resource protection laws and regulations, respectively; establish consultations with appropriate regulatory and Tribal contacts; develop measures to avoid or mitigate impacts to natural or cultural resources due to project activities, respectively; and monitor field activities to ensure compliance with these measures.

An organizational chart showing the relationship and lines of communication among the project participants is provided in Figure 2-1.

Figure 2-1. Project/Task Organizational Structure for the Remedial Investigation for Hanford Site Releases to the Columbia River.



2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The reporting limits and precision and accuracy requirements for each of the analyses performed are summarized in Tables 3-1, 3-2, and 3-3 of the SAP (DOE-RL 2008a). The process for determining these requirements is documented in the DQO Summary Report (WCH-265).

2.3 SPECIAL TRAINING REQUIREMENTS

Training is typically required for subcontractors deployed to the site in support of sampling activities. Required training includes:

- Site-specific waste management instruction
- Hanford general employee training (HGET)
- Integrated work control program (IWCP) training for supervisory personnel, or IWCP training during HGET for non-supervisors
- First aid and cardio-pulmonary resuscitation training
- Cultural resource awareness training (at least one person on each crew).

The qualifications of field personnel must be forwarded to the RCCC STR and must be approved by the STR prior to beginning work (PAS-1-4.5, "Subcontract Technical Representative for Field Activities").

3.0 MEASUREMENT/DATA ACQUISITION

The following subsections present the sampling design and requirements for sampling methods, sample handling and custody, and analytical methods. The requirements for instrument calibration and maintenance and data management are also addressed. The sample design reflects the outcome of the DQO process (WCH-265), with updates pursuant to input from DOE, EPA, and Washington State Department of Ecology (Ecology) (hereafter referred to as the Tri-Parties), as documented in DOE-RL (2008a).

3.1 SAMPLING METHOD REQUIREMENTS

Sampling will be performed in accordance with the SAP (DOE-RL 2008a), this SAI guide, and established procedures (except as noted in this SAI or the SAP).

Established procedures that are applicable to this work include the following:

- ENV-1-2.5, "Field Logbooks"
- ENV-1-2.10, "Sample Event Coordination"
- ENV-1-2.13, "Chain of Custody"
- ENV-1-2.14, "Sample Packaging and Shipping" (for samples shipped from Hanford)
- ENV-1-2.15, "Field Decontamination of Sampling Equipment"
- ENV-1-2.16, "Soil and Sediment Sampling."

3.1.1 Potentially Impacted Areas

The study locations include geographically distinct areas and sampling media that include sediment, water, island soils, and fish. Investigation areas are based on potential contaminant distributions and suitable sediment deposition areas. A description of the number of samples in each area and sample category can be found in the SAP (DOE-RL 2008a) in Tables 2-2 through 2-6.

3.1.2 Establishing Sampling Locations

Maps showing the approximate locations of all the samples to be taken under this SAI are shown in the SAP (DOE-RL 2008a), Figures 2-1 through 2-20. The reconnaissance surveys described in Section 2 of the SAP will be completed prior to finalizing the sampling design. Once these surveys are completed and the information reviewed and evaluated, the final sample design will be produced in "D-Size" drawings. These will be provided to the Tri-Parties for review prior to sample collection, and are used by the Tri-Parties to determine actual sample collection sites. The current sediment and groundwater upwelling locations discussed in Section 2.0 of the SAP (DOE-RL 2008a) are also approximate. Final locations will be based on the outcome of the reconnaissance surveys.

The sample design for shoreline, shallow sediments, and soil has been identified in the SAP as "Random/Stratified" (DOE-RL 2008a, Tables 2-2 through 2-5 of the SAP). Using a random/stratified sampling approach will result in a variance at least as small as would be

obtained if simply random sampling were used (Gilbert 1987). The following describes how specific sampling collection locations will be identified.

- The approach for the proposed sampling plan focuses on historic information, evaluation of existing data, and a good understanding of the conceptual site model (e.g., sources, migration pathways, and potential receptors). This sample design approach has focused on areas that are most likely to contain Hanford Site contaminants. Previous studies have established a direct relationship between particle size and contaminant concentration. In general, fine-grained sediments (these are also high in organic content) have a higher level of Hanford Site contaminants than do coarse-grained sediments. Therefore, the random/stratified sample design is focused on identifying areas of fine-grained sediments, depositional areas directly downriver from source areas, and analysis for known or suspected Hanford Site contaminants.

- The river morphology is typical of a major river sequence where cutbanks, point bars, gravel bars, and braided islands are features of the erosion and deposition of river sediment transport. As shown in Figures 2-2 through 2-20 of the SAP (DOE-RL 2008a), these depositional features are irregularly shaped and vary in size from several feet (small pockets of sediment along the shoreline) to islands over a mile in length. To characterize one of these areas, a random sampling approach has been integrated into the focused or biased approach used to select sampling areas. A random approach will be used to select specific sampling locations within each area of interest (e.g., sediment depositional area, gravel bar, or island).

- As described in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987), a combination of stratified sampling (e.g., sampling grid) combined with random sampling within each grid will be used. To structure the data collection under a probability-based design, the initial unit for the first sample location of size n (n = number of samples specified for a given area of interest) is chosen at random; the remaining (n-1) sample locations are then randomly selected within each established grid cell. The area of interest will be divided into equal size blocks or grid cells with n number of cells. A single sample will be taken at a random location within each cell. This approach allows for a biased approach, focused on the area of likely contamination that allows for a more uniform coverage than a purely random approach.

- A MIS approach will be completed at two downriver recreational sites. These samples will consist of 50 sub-samples collected five times at each location. The techniques used to implement this approach are described in detail in Section 3.1.4.1.

The sampling team will work with the STR, who will in turn consult with the Tri-Parties, to determine the exact field locations and number of samples to be taken at each location using the final "D-Size" drawings and the random/stratified sample design.

3.1.3 Fish Samples

Data on fish contaminant concentrations will be used primarily for addressing human health data gaps. The species of fish that are to be collected are as follows: white sturgeon (*Acipenser transmonatnus*), common carp (*Cyprinus carpio*), largescale sucker (*Catostomus macocheilus*), bridgelip sucker (*Catostomus columbianus*) (either species of sucker is acceptable), mountain whitefish (*Prosopium williamsoni*), smallmouth bass (*Micropterus*

dolomieui), and walleye (*Stizostedion vitreum)*. Fish will be analyzed for Hanford and non-Hanford contaminants and examined for general health metrics (i.e., length, weight, description of fatty tissues). Any abnormalities in the fish collected will be noted. Concentrations of these contaminants in fish will be based on three sample types: organs (liver and kidneys), fillets, and carcass. Only legal-sized fish of each species will be collected.

The most effective methods will be used to capture specimens of each species submitted for tissue analysis. Methods that will be used to collect the fish samples include, but may not be limited to, the following:

- Electrofishing
- Hook and line
- Long-line.

Only the target species will be retained for tissue analyses. Non-target species that are incidentally captured will be immediately released back at the sample location from which they were taken.

3.1.3.1 Electrofishing Collection Techniques. Collecting fish using electrofishing gear is efficient, quick, and relatively safe if properly conducted by trained personnel. The target species for which this collection method is expected to be most effective are bass, whitefish, carp, and suckers. Electrofishing involves the transmission of an electrical current through the water, creating high voltage potential. If a fish is in the vicinity of this potential, it becomes temporarily stunned from an electrical current delivered by the boat or backpack unit. The electrical current causes uncontrolled muscular contractions that immobilize the fish so that it can be captured with a net. A minimum of two sampling crew members are needed to net the stunned fish. Electrofishing may be conducted from the shore using a backpack unit or from a boat equipped with a generator and the electrofishing unit (a.k.a. gas-powered pulsator). The advantage of using this method is that non-target species of fish stunned by the electrical field do not have to be handled by the field crew and can be immediately let free from the electrical field. The efficiency of electrofishing is dependent on water depth and the conductivity of the water. The technique is most effective in shallow waters of high conductivity. In the Columbia River, boat electrofishing is effective to a maximum river depth of near 15 ft.

Techniques used are consistent with state and federal scientific collection permit conditions and the Hanford Site Salmonid Management Plan (DOE-RL 2000). Electrofishing typically takes place during the months of August, September, January, and February to minimize incidental take of state- and federally-listed salmonids.

3.1.3.2 Hook and Line Collection Techniques. Hook and line is a method most often used by recreational fishermen to catch fish and has been adopted by biologists as a means to assess fish populations. This method is expected to be implemented in deeper areas of the river where electrofishing is less effective or in areas that might have been missed using other techniques. Baited hooks or lures will be deployed in areas selected for fish sampling. Baited hooks may be allowed to rest on the river bottom to allow the target species of fish more opportunity to detect the bait. Hook-and-line methods are expected to be an effective means for collecting bass, walleye, and sturgeon.

3.1.3.3 Long-Line (Setline) Collection Techniques. Setlines with baited hooks will be used to collect white sturgeon. This method provides the greatest catch-rate of white sturgeon and rarely captures non-target species. A long-line configuration will be used, similar to that developed by the Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife, to capture white sturgeon in the lower Columbia River (Rien et al. 1997). Setlines will consist of 2 buoys, 2 anchors, and approximately 60 m to 90 (200 ft to 300 ft) rope set with 6 to 12 leaders with circle hooks attached at approximately 4.6 m (15-ft) intervals in between the anchored buoys. Additional weights may be attached at several points along the ground line to help keep all the baited hooks on or near the river bed.

Setline hooks will be baited as appropriate (i.e., shad or commercially available pickled squid). Setlines will be deployed from a boat and set either parallel to the shore in fast flowing water areas or perpendicular to the shore in calm water. Prior to each set, water depth will be determined and used to select a float line of appropriate length. Float lines in fluctuating water zones should be at least 15 to 20 feet longer than the actual water depth. Crews will attach an anchor and float line to one end of the mainline.

Lines will be retrieved within 12 hours of setting to reduce mortality to target and incidental captures. All non-target sturgeon will be released after measurement and observations are recorded. Floats have a tag clearly labeled with scientific permit number and the name and address of the point of contact.

3.1.3.4 Fish Sampling. The following is a list of fish sampling field equipment:

- Spring scales (for sub-samples collected for histology or for other research needs and/or whole organism weights as required)
- Latex, nitrile, or rubber gloves
- Safety glasses
- Boat and all necessary safety equipment
- Sample collection equipment (e.g., electrofishing; long-line; or hook, line, and bait)
- Personal protective equipment (PPE) (see boat and fish collection job hazard analysis [JHAs] and fishing work package) and dip nets
- Fishing gear and dip nets
- Valid scientific collecting permits (federal and state) and applicable certifications/licenses
- "Research" sign readable by unaided eye at 30 m (100 ft)
- Global positioning system (GPS) (± 20 m [66 ft]) and/or range finder (± 2 m [6.6 ft])
- Digital camera
- Lights (if sampling at night)

- Field record book and/or fish collection record forms
- Ice and containers to hold fish (e.g., covered plastic tubs or coolers large enough to hold five individuals [or one sturgeon]).

Electrofishing - The following is a list of equipment for electrofishing:

- Dry rubber boots (one pair per person)
- Non-leaking rubber electrician gloves (one pair for the netter) – certified bi-annually to at least 5 kVa
- Waterproof chest waders (for those entering water to dislodge arrays and/or nets)
- Insulated netting pole
- Conductivity meter.

Fish Sampling and Field Preparation - The following are instructions for fish sampling and field preparation:

1. Collect fish using the methods as described above.
2. Record the start and stop points of the waters fished (using GPS points), all specimens observed, and the method and amount of time fished on the fish sample field record form and/or in the field logbook. If a fish record form is used, reference the corresponding field logbook number on each form. For the electrofishing method, record the conductivity of water and electrofisher settings used for the collection efforts.
3. Collect sufficient individuals of each species at each sampling sub-area per the requirements specified in Table 3-1. If more fish than necessary are acquired, select the larger specimens for sampling. If there is undue difficulty in collecting sufficient fish from the pre-determined fishing holes described in the SAP, contact the STR to discuss options. Samples of all fish except sturgeon consist of composite samples. Only one sturgeon per sample will be used.

Table 3-1. Summary of Target Fish Sample Sizes/Numbers. (2 Pages)

	Carp	Sturgeon	Suckers[a]	Whitefish	Walleye	Bass
Target size	>18 in.	43 – 54 in.[b]	>12 in.	>10 in.	> 18 in.	≤14 in.
Number of composite samples per sub-area	5	--	5	5	5	5
Anticipated number of individuals per composite	5	Composite not collected	5	5	5	5

Table 3-1. Summary of Target Fish Sample Sizes/Numbers. (2 Pages)

	Carp	Sturgeon	Suckers[a]	Whitefish	Walleye	Bass
Number of non-composite, sturgeon samples from 100-Area, 300-Area and Lake Wallula Sub-Areas	--	25	--	--	--	--
Number of noncomposite sturgeon samples from control sub-area		5				
Anticipated number of individuals for entire study	100	30	100	100	100	100
Total number of samples for entire study	20	30	20	20	20	20

[a] Either largescale sucker or bridgelip sucker may be collected.
[b] Sturgeon length is measured as fork length, not total length.

4. Sturgeon setlines may be brought in by hand or using a davit depending on size and number of fish on the setline.

5. Prior to commencing field work, contact Washington State Department of Wildlife for direction in the event of there is an incidental mortality of a non-target sturgeon.

6. Sturgeon may be brought into boat by hand or by gurney. If conditions are such that additional assistance is needed for the task, a gurney may be attached onto the side of the boat. Fish that are less than legal size have sharp scutes and dip gloves should be worn when working with these fish to avoid worker injury. Sturgeon for sample collection should be immediately euthanized by severing the spinal cord to allow collection of gill tissue for histology. If severing of the spinal cord does not cause immediate death, pithing the fish will be necessary. For sturgeon, see additional histological sample instructions in Section 3.1.3.6. Histological samples will be taken after the spinal cord is severed.

7. Measure and record the total length of each fish as well as the Washington State Plane coordinates of the capture location for each fish that is retained for sampling and analysis.

   For sturgeon only, all fish that are caught (even those that are released) will be scanned for a pit tag, measured for total and fork length, and examined for anomalies in scute pattern (as an indication that the animal has been previously captured and tagged). The measurements and examinations for fish outside of the size range will be done while the fish is on line and outside of the boat. This information will be recorded on a field record form and/or in the field logbook. For sturgeon, follow instructions regarding field collection techniques for histopathology sample collection in Section 3.1.3.6.

8. Euthanize non-sturgeon specimens by stunning and pithing. Place euthanized, whole organisms in coolers containing ice until samples can be processed or locked in the freezer at the processing facility. Return any non-target species to the water.

9. Record each fish's unique specimen field id (e.g., Lake Wallula Whitefish #4), total length (method varies by species according to state recreational harvest rules), sample date, and general sample location in the logbook.

10. Label sample containers (bags) with unique specimen field id, collection date, location, collection permit numbers, initials of collector, and sample media.

3.1.3.5 Fish Condition Inspections and Sample Preparations at the Laboratory Facility. The following is a list of fish inspection and sample preparation equipment:

- Appropriate sample containers (DOE-RL 2006, Table 3-4)
- Absorbent towels
- Stainless steel forceps and scissor
- Small spatulas (e.g., scoopulas)
- Fillet knife and scalpels
- Latex, nitrile, or rubber gloves
- High purity deionized water (≥ 10Mohms) in Teflon squeeze bottle
- Liqui-Nox or Alco-Nox detergent solution
- Teflon or aluminum weighing trays
- Aluminum foil
- Laboratory-grade blender(s)
- Food-grade tissue grinder
- Dry ice (if processing small quantities)
- Animal sample processing forms
- Calibrated balances (the most sensitive to be ± 0.1 g) and measuring device (the most sensitive to be 1 mm [0.04-in.] intervals)
- Chain-of-custody seals
- Chain-of-custody forms.

Prior to combining individuals together to form a single sample (a.k.a., homogenized composite sample), determine the specific specimens to be included in each composite sample. Guidelines for specimen composite selection are presented in Section 2.4.4.3 of the SAP. Keep specimens and prepared samples frozen unless they are being processed.

Approximately 900 g of tissues are required for the tissue analyses with minimum quality control (QC) performed by the analytical laboratory. When sufficient mass is available, approximately 1.85 kg, a sample for full QC should be included in the sample delivery group (SDG). The entire tissue mass of a given type (i.e., fillet, carcass) from all specimens comprising a single composite will be combined and the appropriate mass removed for sample shipment.

The following are instructions for fish inspections and sample preparation:

1. Remove fish samples from the container and place on absorbent towels. Remove as much slime/sediment from exterior of fish specimens as practical and necessary (using forceps, scalpel, and/or absorbent towels).

2. Measure and record the following:

   - Total, whole-body length (± 1 cm [0.4 in.])

   - Sex (if possible through verification of morphological characteristics or spawn material present)

   - Weight (± 5 g for smaller fish and up to ±30 g for larger fish depending on scale).

3. Conduct gross external body condition inspection (i.e., note any unusual skin colorations, lesions, or any other abnormalities apparent before opening the specimen) and record on the laboratory processing form or in the laboratory record book.

4. Don surgical gloves and wash with Liqui-Nox solution and deionized water.

5. Make incision longitudinally in abdomen of fish using a pre-cleaned fillet knife or scalpel.

6. Carefully remove the internal organs and separate the liver and kidneys from the rest of the entrail. Examine internal organs and note anomalies. Make a note if not all of the organs were removed. Weigh each of the tissues listed below separately on a pre-cleaned tared weighing tray and record total weight (± 0.1 g up to 300 g).

Weigh and record the following tissues for each <u>non-sturgeon fish</u>:

- Fillet (muscles, skin, and scales)
- Liver
- Kidney
- Entrails (internal organs less liver and kidney)
- Carcass (all remaining portions including head, fins, and bones).

Weigh and record the following tissues for each <u>sturgeon</u>:

- Fillet (muscle), also note the color of fat (white or yellow)
- Liver
- Kidney
- Stomach

- Entrails (internal organs less stomach, liver, and kidney)
- Carcass (all remaining portions including skin, head, fins, and bones).

7. For all species except sturgeon, combine livers and kidneys for each composite sample per Section 2.4.4.4 and Table 3-1. Homogenize the liver and kidneys in a laboratory-grade blender. If necessary, combine tissues with approximately equal fractions of dry ice, let stand for 1 to 2 minutes to allow tissue to harden, then homogenize the entire sample for 30 seconds to 1 minute.

   All of the kidneys and livers from each non-sturgeon fish within a composite group will be used to make up the homogenized composite. Carp and suckers do not have a distinct liver as the liver and pancreas are conjoined (hepatopancreas). For these fish, remove as much of the liver as possible without including pancreas in the tissue sample. For all composites, the mass from the combined livers and kidneys will be insufficient to run the full analytical suite. See Section 3.2 for direction on analytical priority for organ samples.

   For sturgeon, remove the internal organs and separate the liver and kidneys from the rest of the entrails. The liver and kidney from each sturgeon are processed and packaged separately.

8. Remove the remaining entrails from the stomach (offal). A pectoral fin shall be removed from each sturgeon, cataloged, and frozen for later age dating. For sturgeon only, any eggs that are found will also be collected, cataloged, and frozen separately. Catalog and freeze all offal and stomach samples. A subset of offal samples will be later homogenized and sent for analysis as shown in Section 3.2.

9. If remaining fish tissue is not to be processed in the same work cycle, return the tissues to the freezer. Wrap tissues tightly in aluminum foil.

10. Record the final weight of each sample and place in sample containers for analyses of the analytes listed in the tables in Section 3.2. Immediately re-freeze samples until a shipment is ready keeping in mind that hold times must be met. The hold time begins when the sample is prepared/processed.

11. Collect as much muscle tissue (e.g., fillet) from each fish as practical. Fillets for sturgeon should not include the skin, but fillets for other species should have the skin still attached. Be sure to include the dark tissue adjacent to the skin in each sturgeon fillet samples. Weigh the total mass of tissue and collect two fillets, one from each side of the fish, in the approximate mid-section of the fish. Combine target tissue types (fillet/carcass) from five fish and grind tissues together in food grade grinder. Ensure ground tissue is homogenized, if necessary, mix ground tissues using a pre-cleaned instrument (e.g., scoopula). Fill the sample bottles by taking a number of sub-samples systematically across the tray of ground/homogenized material.

12. Record the final weight of each sample and place in sample containers for analyses of the analytes listed in the tables in Section 3.2. Immediately re-freeze samples until the shipment is ready. The hold time begins when the sample is prepared/processed.

13. After the fillets and entrails have been removed, the remaining carcasses will be prepared for compositing.

For large fish such as sturgeon, the entire carcass may be too large to homogenize so only a portion of carcass may need to be sampled. To preserve the proportions of carcass tissue, subsamples should consist of longitudinal sections. The fish may be divided lengthwise by a dorsoventral cut, producing a right and left-side section. One of these sections may be homogenized for sampling. If the volume of the half-fish is still too large, a longitudinal horizontal section may be taken down the length of the fish, so that portions of the head, sides (including scutes), and tail are included. This method may be used, as necessary, to reduce the volume of tissue to a homogenizable size. From the final homogenate, withdraw an appropriate sample (include one full protocol QC sample per SDG when sufficient mass is available). Document carefully the portions of the fish and the location of the section used to produce the sample.

14. Record the final actual weight of each sample and place in sample containers for analyses for the target analyte suites listed in the tables in Section 3.2.

15. For non-sturgeon fish, catalog and freeze the entrails and stomachs from one sample composite (five stomachs plus five entrails) from each of the four sub-areas (four sets per species) for each fish species. For sturgeon, catalog and freeze all remaining sample material and tissue. At the end of the project, dispose of any remaining tissue per the *Waste Control Plan for IDW from the Columbia River Component Assessment* (WCP-2008-0001).

16. Label, store, and/or ship samples to appropriate contract laboratory as stated on the chain of custody.

3.1.3.6 Sturgeon Histological Samples. Immediately after a sturgeon that meets the acceptance criteria for size is captured, euthanized, and measured (total length), histological samples will be collected while on the fishing boat. The sturgeon will be weighed after the fish is brought onto the boat and before any work is done with the fish that would lead to fluid/weight loss.

Rather than stunning and pithing, the spinal cord of the sturgeon will be severed near the base of the head to avoid damaging gill tissue during the stunning. Immediately after severing, the gill histological samples will be taken. If the fish is still alive after the gill tissues are taken, then the fish will be immediately pithed.

Samples of gonad, liver, kidney, and gill will be collected for histology. A commercially purchased sturgeon will be used to develop and practice preparation of histological samples and other tissue preparations in the laboratory.

A general outline for the preservation of histological samples is below. Cleanroom nitrile gloves are the preferred gloves to be worn by staff handling histological sample tissues. If unavailable, decontaminated nitrile gloves may be worn.

1. Collect sample and place in formaldehyde based fixative solution for 24 to 72 hours.

2. After formaldehyde treatment, remove sample and rinse with water.

3. After rinsing, saturate sample with denatured ethanol and place into final sample container for shipment. Multiple tissue types may be combined into one sample container.

The weights of the histology samples and any other samples collected from each organ will be recorded. The weights may be obtained prior to preservation or after removal from the preservative, but should be included in the total fish weight.

3.1.3.7 Sturgeon Stomach Sediment Determination. The amount of sediment in each of the 30 sturgeon stomachs will be determined as a percentage of the entire stomach content. Some sediment samples may be analyzed for radiological contaminants after the percentage of sediment is determined.

The following is a list of equipment for sturgeon stomach sediment determination:

- Latex or nitrile gloves
- Dissecting tray
- Stainless steel scalpel or filet knife
- 2 mm stainless steel sieve
- Büchner filter
- Büchner flask
- Vacuum pump and hose
- Whatman ashless filter, grade 43: 16 µm
- Aluminum weighing tray
- Calibrated balances (the most sensitive to be ± 0.01g)
- Drying oven
- Crucibles
- Ashing furnace
- Desiccator
- Forceps
- Spatulas/scoopula
- Liqui-Nox solution (1%) and deionized water.

The following are instructions of processing sturgeon stomach contents:

1. Pre-clean and air dry two 500 mL beakers for each sturgeon sample. Record the weight of each beaker to the nearest 0.01 g.

2. Remove stomach from freezer and allow it to thaw for approximately 1 hour.

3. Don gloves and wash gloves with Liqui-Nox solution and rinse with deionized water.

4. Make incision in stomach lining and empty all stomach contents into pre-cleaned 2 mm sieve. Flush stomach lining with deionized water to ensure all stomach contents will be removed and place stomach back into a plastic bag and freeze.

5. Thoroughly rinse all gut contents in sieve and collect all gut contents and rinsate that has gone through sieve in pre-cleaned 1000 mL beaker.

6. Transfer gut contents greater than 2 mm in size (i.e., gut content that did not rinse through sieve) into a labeled, pre-cleaned aluminum tray and dry in an oven at 105 °C for at least 24 hours.

7. Filter gut contents less than 2 mm in size and rinsate under vacuum using a Büchner funnel and pre-tared Whatman filter (see equipment list above). Transfer unfiltered material as well as the Whatman filter to a labeled, pre-cleaned aluminum tray and dry in an oven at 105 °C for at least 24 hours.

8. Once both sets of gut contents have been dried, weigh and record weight of each to the nearest 0.01 g. The sum of these two weights will be the total dry weight of sturgeon stomach contents. Weigh all pebbles and identifiable taxa separately in order to calculate the proportion of each food item. Discard pebbles (rocks > 2 mm in size) and set aside all discernable macroinvertebrate shells (shells > 2 mm in size) after weighing separately. Remove all organic content and/or sediment that is within shells using pre-cleaned scoopula and return to dried gut contents. It may be necessary to process shells at step 5 if significant deposits of fine particles remain on the dried shells.

9. Empty dry contents from each aluminum tray into pre-cleaned and pre-weighed, pre-labeled crucibles. Don gloves if using hands to transfer crucibles (oil on your hands can alter the weight of the crucible).

10. Move samples (<2mm, >2mm) to fume hood and place on hot plate at highest temperature (this process can potentially produce highly toxic fumes). Don safety goggles and leather gloves. Apply direct flame from a propane torch until all fumes have ceased to evolve. Stir sample with a pre-cleaned scoopula and torch again to make sure all of sample has come in contact with direct flame from propane torch. Allow samples to cool for 30 minutes.

11. Transfer crucibles containing torched samples to muffle furnace and ash samples at 550 °C for no less than 2 hours. After this time has elapsed turn temperature down to 200 °C and crack the doors open for 15 minutes (opening too quickly can cause a vacuum effect inside muffle furnace and potentially disturb samples). Once this has been done open doors completely for 30 minutes.

12. Transfer each crucible to a dessicator and allow to cool for 1 hour.

13. Record the final actual weight (± 0.01g) of ashed gut content from both samples within 1 hour of removal from dessicator. The sum of these two weights will be the total dry weight of sediment in a sturgeon's stomach. The percentage of sediment in a sturgeon stomach can be calculated from this weight and the total dry weight of sturgeon stomach contents that was recorded after the drying process. Final actual weight is the weight recorded minus the crucible weight and tare weight of filter. Tare weight of filter only applies to the samples that were filtered.

14. Place samples in labeled sample containers and store at room temperature.

3.1.4 Sediment and Soil Samples

The purpose of sediment sampling is to estimate the concentrations of contaminants in sediment for site characterization. As described in previous studies, relative to other substrate classes, fine-grained sediment has the highest surface area. This high surface area allows for more contaminants to adsorb on to the fine particles relative to sands, which have a smaller surface area for a given mass (Reneau et al. 2004). It should be noted that fine sediments (i.e., ≤ 2 mm) represent a relatively small proportion of the riverine habitat.

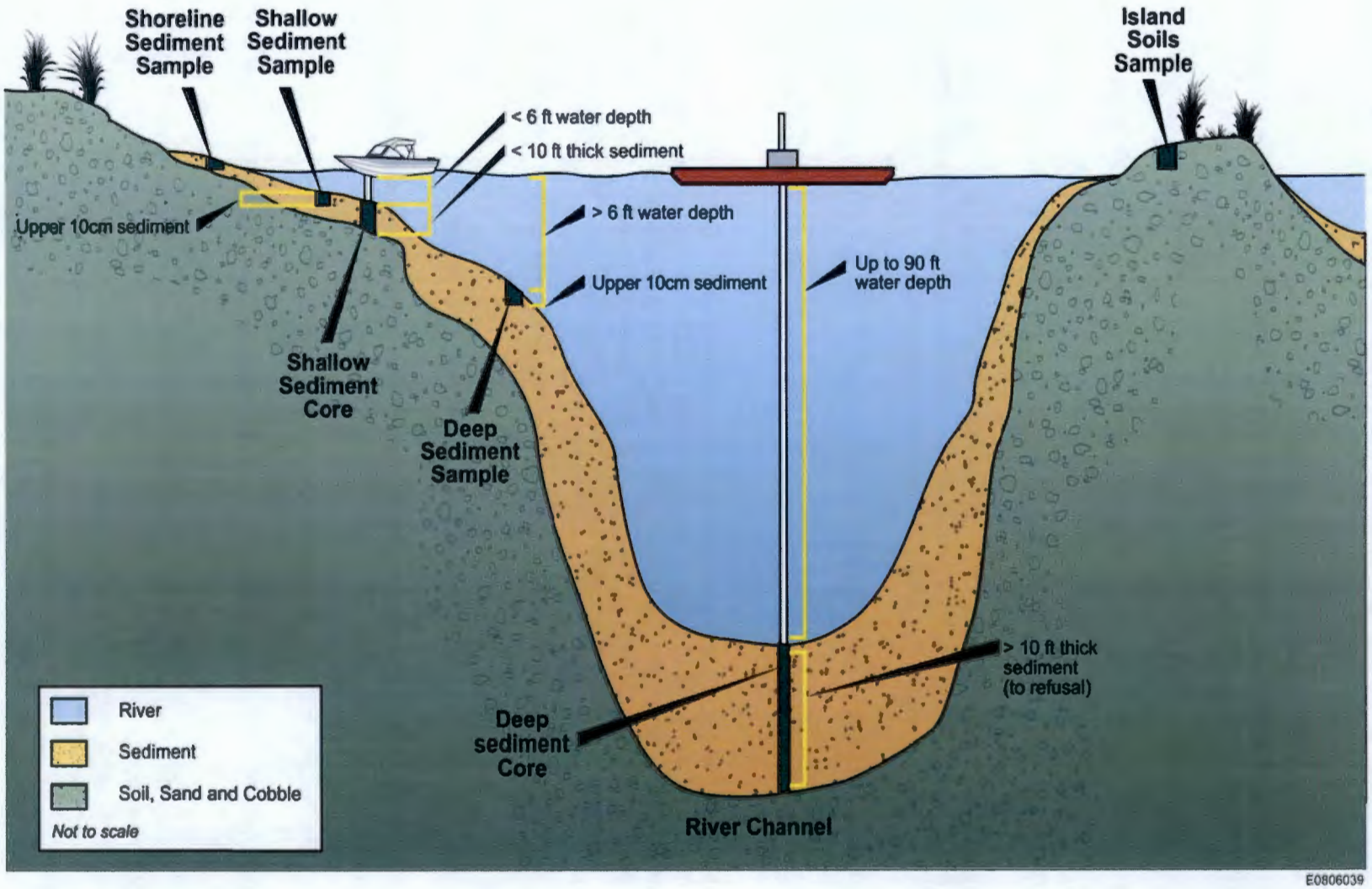
The sediment and soil can be divided first into three categories, with two or four subcategories in each based on the collection techniques that may be used. The subcategories of sediment/soil samples are as follows (Figure 3-1).

- Category 1 is sediment/soil samples from above the water line. This category has two subcategories:
  - Island soils (reworked sediments that currently reside above the high water line)
  - Shoreline sediments (fine-grained material from areas below riparian vegetation prominence) from recreational areas.
- Category 2 is shallow water and above. Shallow water is defined in the SAP (DOE-RL 2008a) as areas that are less than 6 m (20 ft) deep below a surface water elevation at 80 kcfs at Priest Rapids Dam. However, for the purposes of actually taking samples in flowing water, shallow water will be considered as generally less than 0.3 m (1 ft) deep or above the waterline. There are two subcategories:
  - Shoreline sediments from non-recreational areas
  - Shallow sediments (those that will generally be collected at water depths less than 0.3 m [1 ft]).
- Category 3 is deeper water. Deep water is defined in the SAP (DOE-RL 2008a) as areas that are more than 6 m (20 ft) deep below a surface water elevation at 80 kcfs at Priest Rapids Dam. However, for the purposes of actually taking samples, deeper water will be considered as generally deeper than 0.3 m (1 ft) because of the effect of river flow on collecting samples from depths greater than that. Category 3 has four subcategories:
  - Shallow sediments (those that will generally be collected at water depths from 0.3 m [1 ft] to 1.8 m [6 ft])
  - Deep sediments (collected in greater than 1.8 m [6 ft] of water)
  - Shallow cores (collected from specific depositional areas at water depths up to 9 m [30 ft])
  - Deep cores (collected from behind the dams at depths up to about 27 m [90 ft] of water).

Analytical parameters for all sediment samples are presented in Tables 2-2 to 2-6 of the SAP (DOE-RL 2008a).

Shoreline sediments collected from downriver recreational sites will be collected by MIS (described in Section 3.1.4.1). Sediment and soil samples located in culturally sensitive areas will be collected using a discrete sampling approach per ENV-1-2.16, "Soil and Sediment Sampling." Sample volume, sample containers, and sample preservation for soil and sediment are described in Table 3-4 of the SAP (DOE-RL 2008a).

Figure 3-1. Conceptual Locations of Sediment/Soil Samples.



3.1.4.1 Category 1 Sediment/Soil Samples. Island soils – Island soils will be collected from the riparian zone and above. These soils are distinctly different in origin and composition from the upland soils sampled in the 100/300 Area investigation. Island soils are reworked sediments that currently reside above the high water line. These samples will be collected by establishing an unaligned sampling grid using the systematic sampling approach. For the remainder of Section 3.1.4.1, soil and sediment on the shorelines are collectively referred to by the term "soil" for the purposes of simplifying the explanation of the techniques.

D Island, located in the 100 Area sub-area near RM 377, is a posted radiological control area where special access restrictions are in effect. Samples collected from this location will need a radiological scan before shipping to the laboratory.

Shoreline sediments from recreational areas – The recreational areas are identified in the SAP in Tables 2-4 through 2-5 (DOE-RL 2008a). Shoreline sediments will be collected from within the lower riparian zone, typically the area devoid of terrestrial vegetation. These samples will be collected using the MIS approach described below. These samples will be used to assess potential exposure to ecological and human receptors.

3.1.4.1.1 MIS Soil and Sediment Sampling Instructions. Purpose - MIS of soil will be performed to estimate the mean concentrations of contaminants in soil as a measure of potential exposure to ecological and human receptors. Each sampling location will consist of a discrete area (e.g., recreational area). Surface soil (within the top 15 cm [6 in.]) will be characterized by collecting multi-increment samples to obtain an analytical sample that represents the mean contaminant concentration for the entire investigation area. Methods are also described to reduce laboratory subsampling error.

Method Summary - MIS and laboratory subsampling are based on a particulate sampling theory (Gy 1992, Pitard 1993) that incorporates the relationship that exists between the variability of particle sizes in the soil, the spatial variability of the contaminant in the soil, and the size of the sample taken. The Remedial Investigation for Hanford Site Releases to the Columbia River will only evaluate contaminant concentrations in the soil fraction less than 2 mm in size, consistent with the Model Toxics Control Act Cleanup Regulation (Ecology 2001). Selected investigation areas will be evaluated using a MIS approach. The 95% upper confidence limit will be evaluated by collecting five multi-increment sample replicates. To further reduce error caused by soil heterogeneity, subsampling of each multi-increment soil sample will be performed in the laboratory to obtain the final analytical soil sample.

3.1.4.1.2 Equipment, Supplies, Procedures, and Instructions. Field Sampling. The following is a list of equipment and supplies for MIS field sampling:

- Clean shovels or hand augers suitable for soil sample collection
- Wooden stakes for marking grid locations
- 2 mm sieves with covers (2)
- 5-gal plastic buckets (7)
- Plastic bags (10) sized for bucket liners
- Disposable scoops, 4 and 8 ounce (5 each)
- Digital camera
- Scale capable of weighing 5 kg in gram units
- 100 m measuring tapes (4)

- Flagging and pin flags, three colors (100 each)
- Decontamination supplies and water
- Stiff bristle brushes
- Chain-of-custody and sample labels with seals
- Orange and blue spray paint
- Tape for sealing sample bags.

Laboratory Subsampling - The following is a list of equipment and supplies for MIS laboratory subsampling:

- Sample drying pans – large aluminum cooking sheet (16-in. by 24-in. by 1-in. deep). Cleaned using the following sequences of rinses: 1+4 HNO3 acid, deionized water, methanol, and multiple deionized water rinses with air drying prior to use.

- Laboratory scales – certified accuracy, suitable for weighing the soil and pan for moisture.

- Mixing utensils – clean stainless steel implements for hand mixing soil samples.

- Pan utensil cleaning solutions - 1+4 HNO_3 acid, methanol, de-ionized water (type I reagent grade water or equivalent) for use in cleaning drying pans, utensils, or other instruments between use.

- PPE – gloves, particulate masks, and safety glasses.

- Thermometer and hydrometer to measure and record room temperature and humidity.

- Moisture analysis bench sheets formatted to record and track sample moisture content.

Field Sample Collection Procedures - Soil samples will be collected from sample discrete investigation areas (e.g., recreational areas). Each investigation area will be established and delineated by the project lead in the office. GPS locations will be provided to the field crews for all 50 sub-sample locations prior to initiating filed activities. The shape of the investigation area will vary depending on the site-specific requirements of the investigation area. Vegetation of varying amounts may be present at the site and will require consideration during sample collection. Organic matter deposits on the surface of the soil will be removed prior to collecting increment samples. Root and biological masses will be separated during the sieving process after capturing attached soil. To facilitate the sieving process during wet soil conditions, a stiff nylon bristle brush may be used.

Investigation Area Sampling Procedure - The following procedures for MIS investigation area sampling should be completed in the following order:

1. Based on the site dimensions, the investigation area will be divided into square or rectangular grids, establishing approximately 50 cells (boxes).

2. Five random sample locations will be generated for each grid cell. The sampler may identify the position within the grid cell using a GPS x-y coordinate. Since this starting point is randomly generated, statistical inferences can be drawn from the resulting data. This

sampling approach is equivalent to a systematic grid sampling design with a random starting point.

3. The sampler will collect a soil increment from the starting location and then methodically move to the same x-y coordinates within the adjacent grid cell, continuing across the entire investigation area until five soil increments have been collected from each of the 50 cells. All 50 increments will be combined into one sample.

4. At each soil increment location, an auger, shovel, or trowel will be used to collect a discrete soil sample to a depth of approximately 15 cm (6 in.). Each soil increment will be of similar size as possible. Each increment will be placed into a 2-mm screen secured on top of a 5-gal high-density plastic bucket fitted with an inner plastic liner or bag.

5. The sample will be field-sieved by placing a lid (if dust becomes apparent) onto the 2-mm sieve and shaking vigorously for 1 minute. The lid will then be removed and observations concerning root mass and 2-mm fraction will be recorded. If necessary, a brush will be used to aid in removal of remaining soil on roots and to brush the sieve openings until clear of debris. The remaining >2-mm fraction will be emptied from the sieve into the original sample location. No attempt to quantify the >2-mm fraction will be conducted.

NOTE: In order to ensure adequate sample collection volume, a test will be performed after five increments have been collected and sieved by weighing the residual 2-mm fraction and adjusting the volume as necessary. If adjustments are required, the material will be discarded and the sampling will be repeated.

6. The increment size is determined in the field based on evaluation of the soil particle size and will achieve collection of a <2-mm MIS soil sample weighing a minimum of 2 kg.

7. The plastic liner for each soil sample will be closed with a plastic zip-tie or taped securely and placed inside of the plastic bucket for shipment to the laboratory. The inner bag and the outer bucket will each be identified with the investigation area identification number and the applicable Hanford Environmental Identification System (HEIS) sample number. A custody seal will be placed on the bucket between the bucket's body and lid to demonstrate sample integrity during shipping.

Sample Handling, Shipping, and Custody Requirements - Each soil sample will be handled in the field, shipped, and custody maintained in accordance with ENV-1, *Environmental Monitoring & Management*, ENV-1-2.13, "Chain of Custody"; ENV-1-2.14, "Sample Packaging and Shipping"; and ENV-1-2.17, "Sample Storage and Shipping Facility." All samples will be transported to the laboratory using a secured vehicle under chain of custody.

3.1.4.1.3 Laboratory Subsampling. This section describes the process for laboratory subsampling of soil and sediments and will be consistent with receiving the laboratory's sample preparation and subsampling procedure.

Initial Sample Processing - The following is a list of directions for initial sample processing:

1. Open each sample bucket and examine the contents against the chain of custody.

2. Prepare the moisture analysis bench sheet with all necessary information (e.g., project name, sample identification number, date, time) and label drying pans with sample identification numbers. Record room temperature and relative humidity with each weight measurement.

3. Record the tare weight of the empty drying pan.

4. Place the soil sample into the drying pan. Save the sample bucket for sample archiving. Use a clean mixing utensil to spread the sample evenly across the pan.

5. Measure the wet weight of the soil and the pan. Calculate the "as received" weight of the soil.

6. Place the drying pan in a clean area, open to ambient room conditions where temperature and humidity are recorded daily.

7. As the soil begins to dry, use a clean utensil to mix the soil to promote drying. Clean between uses by rinsing with 1+4 HNO3 acid, several deionized water rinses followed by air drying – or dedicate a mixing utensil to each sample. If present, break up any large soil clumps.

8. Reweigh the sample at ~24-hour intervals. Record and track moisture changes.

9. Continue the mixing and reweighing process, increasing the weighing frequency as the sample nears equilibrium until the soil has reached its air-dry condition, as indicated by no further changes in the sample weight. Record the final weight.

Multi-Increment Subsampling Process - After each sample is dried, MIS of the "parent" mass of soil collected in the field will be performed to generate representative subsamples for laboratory analyses by mixing, spreading, and collecting the subsample increments by hand using volume-specific scoops or spatulas from up to 50 grid points on the drying pan.

Subsamples of 30 or 500 g will be created. Each analysis will be performed on individual soil subsamples. Subsamples for analytes specified in the SAP will require a collection of 50 individual scoops of soil from a 5-by-10 sample pan grid pattern.

The following procedure applies to the generation of the subsamples required for all manually collected constituents. The weight of each analysis subsample is provided in Table 3-2 along with the increment weight needed from each grid cell.

Table 3-2. MIS Laboratory Analysis Subsampling.

Analyte	Analytical Method	Laboratory Subsample Size	QA/QC Sample Volumes	Laboratory
SVOAs	SW-846 EPA method 8270	30 g	MS 30g MSD 30g	Lionville
ICP metals	SW-846 EPA method 6010	30 g	MS 30g MSD 30g	Lionville
CrVI	Method 7196A	30 g	MS 30g MSD 30g	Lionville
Pesticides	SW-846 EPA method 8081	30 g	MS 30g MSD 30g	Lionville
PCBs	SW-846 EPA method 8082	30 g	MS 30g MSD 30g	Lionville
TOC	Method 9060	TBD	NA	TBD
Particle size distribution	ASTM method -D4222	1000g	1000g Dup	Lionville or CH2M Hill
TPH	WTPH_Diesel	30 g	MS 30g MSD 30g	Lionville
Gamma-emitting radionuclides	GEA - gamma spectroscopy	500 g	NA	Eberline
Alpha-emitting radionuclides	AEA – alpha energy analysis	30 g	30 g Dup	Eberline

AEA = alpha energy analysis
ASTM = American Society for Testing and Materials
CrVI = hexavalent chromium
Dup = duplicate
EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
ICP = inductively coupled plasma
MIS = *MULTI INCREMENT SAMPLING*
MS = matrix spoke
MSD = matrix spike duplicate
NA = not applicable
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analyte
TBD = to be determined
TOC = total organic carbon
TPH = diesel range WTPH-Diesel

1. Fill out the multi-increment subsampling generation bench sheet with all the necessary information (e.g., project, sample identification, date, time, sampled by) and label the proper sample bottle for the analyte subsample being collected. The sample designation is: *MI – XXXXXX – 01-A– 03/05* where:

Character	Designation
MI	Designates *MULTI INCREMENT SAMPLING*
XXXXXX	Project-defined HEIS sample number
01	Designates the first sample in the series of samples collected at location XXXX
A	Designates the analysis group for which the sample was created (A=metals, B=mercury, C=TPH, D=PCBs, E=pesticides, F= SVOCs
03/05	Date of subsample creation (e.g., March 5th)

2. Place the sample bottle on the analytical balance and use the tare feature to zero the balance.

3. Spread the dried soil sample to create an even depth on the sample pan. Minimize disturbances that would cause the material to stratify (e.g., accumulation of finer particles on the pan bottom).

4. Position the pan over the 50-cell grid guide.

5. Using a volume-specific sample scoop, collect the increment of soil required near the center of each grid cell (be sure the scooping motion collects soil from the entire depth of the sample). Place each increment in the labeled and tared sample bottle. As sample increment collection continues, periodically use the analytical balance to verify that the weight of soil collected is within the tolerance required (±10% of the weight required; between 1.8- and 2.2-g for a 2-g subsample). Each soil increment should be collected by performing only one scoop per grid cell.

6. After all subsample increments are collected for an analyte, verify that the soil mass required for the analysis has been obtained. If this is not the case, return the entire subsample to the sample pan, remix, re-spread, and recollect the sample. Record the total subsample weight on the sample collection form and store the subsample accordingly, prior to analytical analysis.

7. Reposition the grid guide to create a new grid pattern. Repeat steps 2 through 6 for the remaining analytes for that sample.

8. Once all the required subsamples are collected, weigh the remaining sample, record the weight in the logbook, and archive the unused soil in its original bucket.

Quality Control and Quality Assurance - During the field sampling, one equipment blank will be collected by running clean silica sand over the sampling equipment and through the sieve, collecting the sieved sand into a plastic lined bucket. The equipment blank will be shipped to an appropriate laboratory for analysis of metals, excluding hexavalent chromium. No MIS preparation will be performed for equipment blank samples and they will be shipped directly to the analytical laboratory for analysis.

No field duplicate samples will be collected for the MIS sampling activity because large sample volumes would be necessary to perform the laboratory subsampling and there would be difficulty in adequately performing the subsampling.

Laboratory matrix spikes and matrix spike duplicates will be generated during the subsampling and shipped to an appropriate laboratory for analysis.

A clean dry silica sand sample will be used as a subsample control during the drying process and subsampling process once for each seasonal sampling event (spring and fall). With the exception of subsampling, the control sample with be handled in like fashion as the field parent sample. The control sample will be sent to an appropriate laboratory for standard aliquot analysis.

3.1.4.2 Category 2 Sediment Samples. Shoreline sediments from non-recreational areas. The non-recreational areas are identified in the SAP in Tables 2-2 through 2-5 (DOE-RL 2008a). Shoreline sediments will be collected from below the lower riparian zone, typically the area devoid of terrestrial vegetation, using a random/stratified sample design. Geographical Information System coordinates will be provided for each location depending on observations made during the reconnaissance survey. These samples will be used to assess potential exposure to ecological and human receptors.

Shallow sediments - Shallow sediments are those collected in less than 1.8 m (6 ft) of water. However, those in very shallow water (generally less than about 0.3 m [1 ft]) and those collected in water at depths of between 0.3 m to 1.8 m (1 ft to 6 ft) may need to be collected differently, especially depending on river flow (finer-grains would be washed away from collection equipment such as spoons in deeper waters). Category 2 shallow sediments are those collected in water at depths generally less than 0.3 m (1 ft) and include sediments associated with groundwater upwelling areas at those depths.

Shallow sediments describe samples that are collected from the top of the riverbed and will be collected from the upper 10 cm (4 in.) of the sediment below the mean low waterline (e.g., generally submerged). This upper region of the sediment is the most biologically active zone where humans are most likely to come in contact with sediments, thus being the focus of this investigation. Prior to sampling, a reconnaissance survey will be conducted using single-beam sonar to identify fine-grained sediments within the area of interest. Once the extent of fine-grained sediments has been identified, an unaligned sampling grid will be established using the stratified-random sampling design previously described. One sediment sample will be collected randomly from within each grid cell. GPS coordinates for each sample location will be provided prior to field mobilization.

3.1.4.2.1 Sediment Sample. The following is a list of equipment and supplies for sediment sampling:

- Teflon (preferred) or stainless steel scoop
- 38 L (10 gal) Rubbermaid® tub
- Stainless steel or aluminum sample tray (approximately 18 in. by 24 in.)
- Sample containers
- Sample labels
- Latex, nitrile, or rubber gloves
- Cooler with reusable ice packs
- Chain-of-custody seals
- Chain-of-custody form
- Cooler and ice
- Nontoxic permanent marker
- Plastic bags (if necessary, to discard sample wastes and to mix samples in Rubbermaid tub)
- Appropriate PPE
- Digital camera.

® Rubbermaid is a registered trademark of Newell Rubbermaid, Freeport, Illinois.

3.1.4.2.2 Sediment Sample Preparation Instructions. The following is a list of instructions for sediment sample preparation:

1. Collect samples at the locations specified by the Remedial Project Manager.

2. Sediment grab samples will be collected using a pre-cleaned or field decontaminated stainless steel scoop. In areas with a substrate dominated by larger materials, a shovel will be used to access the finer grained materials.

3. Approach the target sampling area, being careful not to disturb the sediment surface or substrate. If surface water covers the intended sample area, approach the area from downstream.

4. Document the sample location using GPS instruments capable of logging the position (± submeter accuracy).

5. Use the pre-cleaned (or field decontaminated) stainless steel scoop to obtain samples.

6. Obtain soil samples from 0 cm to a maximum depth of 10 cm (4 in.).

7. Push the scoop firmly downward into the sediment and then lift upward. If water is present, quickly raise the scoop out of the water in an effort to reduce the amount of sediment lost to the water current. Transfer and collect volatile organic analysis (VOA) and acid volatile sulfides/simultaneously extracted metals (AVS/SEM) into sample jars. Continue to transfer the sediment from the scoop into a plastic-lined Rubbermaid tub until sufficient mass has been obtained for the full suite of analyses.

8. Mix the entire sample thoroughly for approximately 30 seconds to 1 minute.

9. Collect requested analysis directly from the tub with a stainless steel spatula OR place the parent soil sample on a pre-cleaned stainless steel sample tray (18 in. by 24 in.) and spread soil evenly across the tray using a stainless steel spatula to prepare the sub-samples necessary for the analyses requested.

10. Fill and cap the sample jars and attach sample label and custody seal as directed by the SAP (DOE-RL 2008a). Immediately place the sample jar into a chilled cooler.

11. There should be minimum contact with air for VOA or AVS/SEM analyses sampling handling. Bottles should be filled to minimize headspace.

3.1.4.3 Category 3 Sediment Samples. Shallow sediments - Shallow sediments are those collected in less than 1.8 m (6 ft) of water. However, as noted previously, those in very shallow water (generally less than about 0.3 m [1 ft]) and those collected in water at depths of between 0.3 m to 1.8 m (1 ft to 6 ft) may need to be collected differently, especially depending on river flow. Category 3 shallow sediments are those collected in water at depths generally between 0.3 m and 1.9 m (1 ft to 6 ft), and may include sediments associated with groundwater upwelling areas at those depths.

Shallow sediments describe samples that are collected from the top of the riverbed and will be collected from the upper 10 cm (4 in.) of the sediment below the mean low waterline

(e.g., generally submerged). This upper region of the sediment is the most biologically active zone where humans are most likely to come in contact with sediments, thus being the focus of this investigation. Prior to sampling, a reconnaissance survey will be conducted using a single-beam sonar to identify fine-grained sediments within the area of interest. Once the extent of fine-grained sediments has been identified, an unaligned sampling grid will be established using the systematic sampling approach previously described in the work plan (DOE-RL 2008a). One sediment sample will be collected randomly from within each grid cell using a grab sampler tool, such as a petit ponar. GPS coordinates for each sample location will be provided prior to field mobilization. Sediment collection will not be attempted in areas of the river with hard bottoms (e.g., where the river bed is composed of cobbles) because grab sample tools cannot penetrate this material.

Groundwater Plume Upwelling Characterization (Phase III) Sediment Samples. – Sediment samples collected for groundwater plume characterization may be from either shallow or deep sediment areas. For Phase III of the groundwater upwelling work, DOE/RL-2008-11 prescribes a petite ponar to be used to collect sediment samples associated with the groundwater sample. However, the preferred sampling tool for Phase III sediment sampling is a stainless-steel ponar-type equivalent (power-grab) sampler as described in WCH-352 (2009) (pp. 2-9 to 2-10), or equivalent. A power-grab sampling tool was previously used to collect shallow and deep Category 2 and 3 sediments (Sections 3.1.4.2 and 3.1.4.3). Therefore, for consistency, a power-grab sampler shall also be the primary device for Phase III sediment sample collection.

A split-spoon-type sampler will be used in cases where the power-grab sampler is either (1) considered unable to work due to site-specific riverbed conditions (i.e., substrate size and/or depth of unconsolidated substrates) or (2) not able to collect sufficient material after three, consecutive field deployment attempts. Prior to sampling, each Phase III sample location shall be evaluated and categorized as to which sample locations are to be sampled with

1) power-grab only,

2) power-grab sampler as the first choice method with the split-spoon sampler as a backup method, or

3) split-spoon only.

Before deployment for sample collection, field tests of both a power-grab and a split-spoon sampling devices shall be conducted in varying river substrates. The results of the field testing shall be used to determine which type of sampler shall be proposed for use at each sample location.

The split-spoon-type sampler shoe shall be constructed of stainless steel; the sampler body shall be constructed of either stainless steel or carbon steel. If constructed of carbon steel, the split barrel shall include a Lexan© or poly carbonate liner. The sampler shall be equipped with either a stainless steel or Teflon© core catcher

At Phase III pore-water sample locations, an underwater camera shall be used to determine the relative amount of sediment available at the sampling location. If sediment availability is low at the location of the actual pore-water sample collection, the area within 2 boat-lengths of the actual pore-water sample location shall be qualitatively surveyed to find an alternate location for sediment sample collection. Before leaving a location, sediment collection shall be attempted at

each pore-water sample location, either at the actual pore-water sample location or at an alternate location within 2 boat-lengths from the actual pore-water sample location.

The final power-grab sample material (which may consist of a composite of several individual power-grab sub-samples) shall be photographed prior to sample processing and be referenced with the associated sampling activity. Photographs of Phase III sediment shall be identified and submitted as electronic data files as part of the field summary report after the sampling is complete.

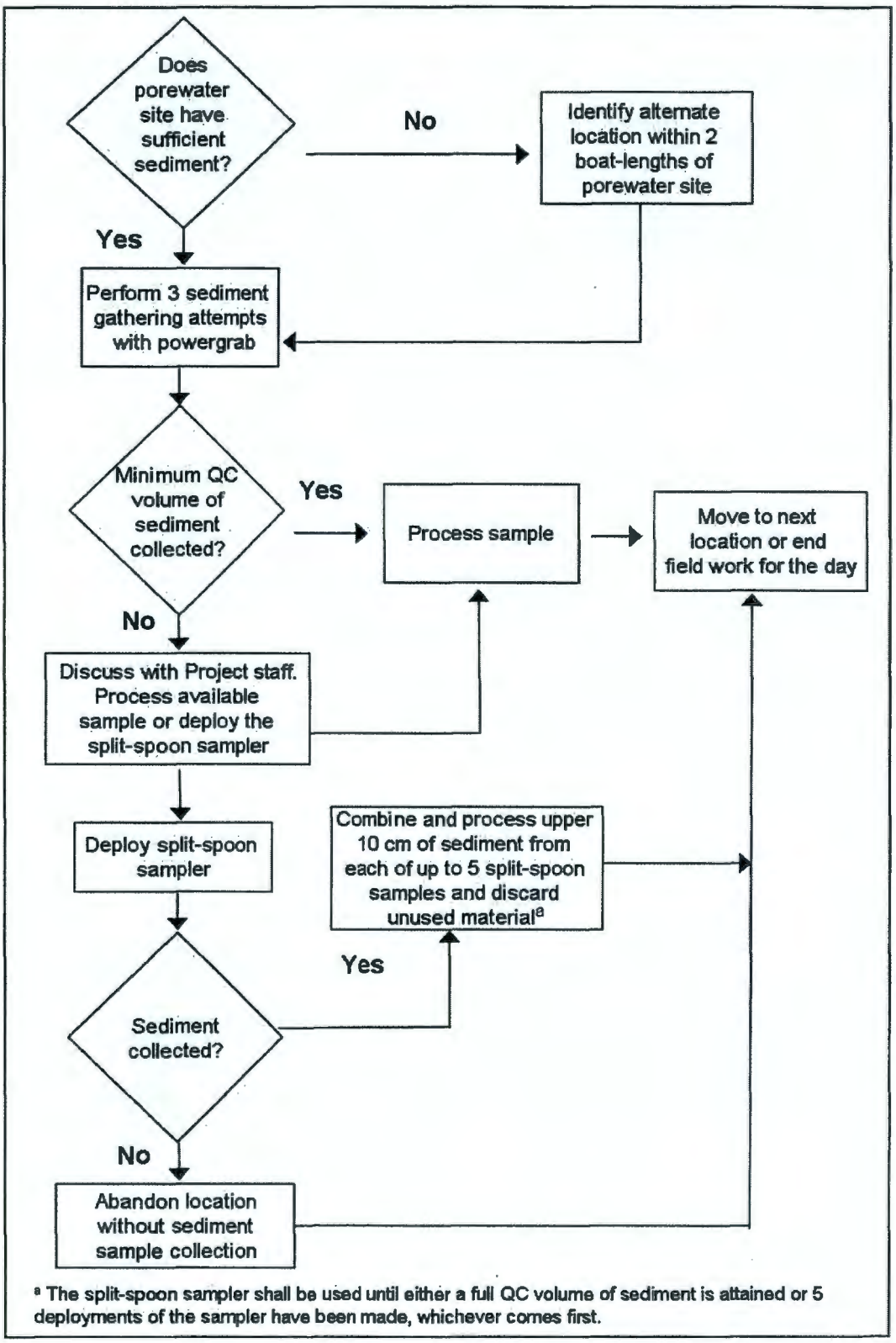
For Phase III sample locations that fall into the category 2 (power-grab as the first choice method with the split-spoon as a backup sampling method), three consecutive attempts to recover sediment using the power-grab sampling tool shall be conducted. If less than minimum QC sample volume of sediment has been recovered, either the available sample material will be processed, or the split-spoon sampler will be deployed to collect sediment at the Project's discretion. See Figure 3-2 for the category 2 sediment sampling method strategy.

The first choice for sediment sample volume is to collect sufficient material for full QC sample volumes as shown in Table 3-3. However, if the full QC sample volumes cannot be attained with a maximum 3 powergrab samples or 5 split-spoon samples, then a lesser volume of material with minimal QC is acceptable for sampling as shown in Table 3-4. From locations that supply less than minimal QC mass for analyses, material shall be distributed as shown in Table 3-5.

Up to five attempts can be made to collect sufficient sediment mass for sampling with the split-spoon sampler. From each sample attempt, the upper 10 cm (4-in.) of sediment material shall be removed from the sampler and collected for sampling. The remaining material shall be discarded. Rocks and gravel (greater than 1 cm diameter) shall be removed from the sample material. It is assumed that sufficient sample will be collected within 5 attempts to allow at least a subset of analyses to be run.

All sediment cores recovered using the split-spoon sampler shall be photographed and documented immediately after the split-spoon barrel is opened. Photographs of Phase III sediment shall be identified and submitted as an electronic data file as part of the field summary report after the sampling is complete.

Figure 3-2. Decision Tree for Category 2 Groundwater Plume Characterization Sediment Sampling.



[a] The split-spoon sampler shall be used until either a full QC volume of sediment is attained or 5 deployments of the sampler have been made, whichever comes first.

Table 3-3. Phase III Sediment Sample Full QC Volume (Preferred).

Analysis	Sample volume by area (g)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals	15	15	15	15	15	15	15	15
TOC	25	25	25	25	25	25	25	25
Particle size	1000	1000	1000	1000	1000	1000	1000	1000
Hexavalent chromium	15	15	15	15	15	15	15	15
AVS	125	125	125	125	125	0	125	125
VOC							100	
GEA	1500	1500	1500	1500	1500	1500	1500	1500
Isotopic radionuclides[a]	10	10	10	10	10	10	10	10
Carbon-14					100			
Technetium-99								10[b]
Tritium								50
TOTAL (g)	**2690**	**2690**	**2690**	**2690**	**2790**	**2565**	**2790**	**2750**

[a] Includes isotopic uranium, plutonium, thorium, and (for reactor areas only) strontium-90.
[b] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford Townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Table 3-4. Phase III Sediment Sample Minimum QC Volume.

Analysis	Sample volume by area (g)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals	5	5	5	5	5	5	5	5
TOC	25	25	25	25	25	25	25	25
Particle size	250	250	250	250	250	250	250	250
Hexavalent chromium	4	4	4	4	4	4	4	4
AVS	60	60	60	60	60	0	60	60
VOC							25	
GEA	750	750	750	750	750	750	750	750
Isotopic rad[a]	5	5	5	5	5	5	5	5
Carbon-14					2			
Technetium-99								5[b]
Tritium								20
TOTAL (g)	**1099**	**1099**	**1099**	**1099**	**1101**	**1039**	**1124**	**1124**

[a] Includes isotopic uranium, plutonium, thorium, and (for reactor areas only) strontium-90.
[b] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford Townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Table 3-5. Phase III Sediment Sample Minimal Volume for Non-QC Data.

Analysis	Sample volume by area (g)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals	2	2	2	2	2	2	2	2
TOC	25	25	25	25	25	25	25	25
Particle size	NA	NA	NA	NA	NA	NA	NA	NA
Hexavalent chromium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
AVS	60	60	60	60	60	0	60	60
VOC							5	
GEA	125	125	125	125	125	125	125	125
Isotopic rad[a]	5[b]	5[b]	5[b]	5[b]	5[b]	5[b]	5[b]	5[b]
Carbon-14					2[b]			
Technetium-99								5[b, c]
Tritium								20[b]
TOTAL (g)	**214.5**	**214.5**	**214.5**	**214.5**	**214.5**	**154.5**	**219.5**	**214.5**

[a] Includes isotopic uranium, plutonium, thorium, and (for reactor areas only) strontium-90.
[b] Mass not included in volume calculation. Sample material to be obtained by the contracted analytical laboratory as a subsample of GEA sample.
[c] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford Townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Deep sediments - Deep sediment samples are those that are collected in greater than 1.8 m (6 ft) of water. Prior to sampling, a reconnaissance survey will be conducted using single-beam sonar to identify fine-grained sediments within the area of interest. These samples will be collected using a grab-sample tool such as a petite ponar. Based on a preliminary study conducted by Environmental Assessment Services in March 2008, the petite ponar generally penetrates to a depth of 10 cm (4 in.) (Appendix B, DOE-RL 2008a). Deep sediment results will be used primarily in the assessment of ecological exposure.

However, several deep sediment GPS coordinates for each sample location will be provided prior to field mobilization. Samples will also be collected from the navigational channel shown in Figure 2-21 in the SAP (DOE-RL 2008a).

Shallow sediment cores - The purpose of shallow sediment core is to evaluate the occurrence and concentrations of Hanford Site-related contaminants in sediment depositional areas (e.g., sediment traps). Shallow sediment cores will be completed using a vibracore drilling tool that will result in continuous 10 cm (4-in.-) diameter cores. This tool can typically penetrate

fine-grained sediments up to 3 m (10 ft) thick with an 80% to 90% recovery success. These cores will be advanced through the unconsolidated sediments to refusal. Shallow sediment cores will be divided into separate sub-samples (approximately 0.2 m [8 in.] each). Each linear foot of sample will result in approximately 1,100 g of sample. If additional mass is needed for a sample, a second shallow core will be completed to obtain the mass.

Shallow cores are planned to investigate depositional areas located within the source areas (e.g., water inlet structures), at the head of Lake Wallula (e.g., directly upriver of the 300 Area), from the Yakima River delta, and directly downriver of the Snake River confluence. GPS coordinates for each core location will be provided prior to field mobilization. It is anticipated that these cores will be completed at a water depth of up to 9 m (30 ft). Core locations have been selected in areas of anticipated, relatively thick sediment sequences that may contain sediments dating back to operational time frames. Because the biologically active zone is limited to the upper 0.1 m, the results from the 0 to 0.3 m (0 to 1-ft) sub-sample will also be used during the ecological and human health risk evaluation.

Deep sediment cores - Deep sediment cores will be completed using a vibracore drilling tool or a drill rig located on a barge. These cores are planned to investigate depositional areas located within Lake Wallula and from within the Bonneville Dam pool as well as an upstream location in the backwaters of Priest Rapid Dam. GPS coordinates for each core location will be provided prior to field mobilization. It is anticipated that these cores may be completed at a water depth of up to 27 m (90 ft). Deep sediment cores will be completed using the vibracore or a drilling rig that will result in continuous 10-cm (4-in.) diameter cores. These tools can typically penetrate fine-grained sediments to refusal with an 80% to 90% recovery success. Deep sediment cores will be divided into separate sub samples (approximately 20 cm [8 in.] each). Each 20 cm (8-in.) sample will result in approximately 2,800 g of sample. Analytical results from the sediment cores will be used to characterize sediments deposited from reactor operations to the present.

3.1.4.3.1 Deep Sediment Sample Equipment. The following is a list of equipment and supplies for deep sediment sampling:

- Suitable sampling tool, such as petit Ponar grab, Vibracorer, or a drill rig with corer
- Suitable boat/barge and winching system to support equipment
- Teflon (preferred) or stainless steel scoop
- 38 L (10-gal) Rubbermaid tub
- Sample containers
- Sample labels
- Latex, nitrile, or rubber gloves
- Cooler with reusable ice packs
- Chain-of-custody seals
- Chain-of-custody form
- Nontoxic permanent marker
- Plastic bags (if necessary to discard sample wastes and to mix samples in Rubbermaid tub)
- Appropriate PPE
- Digital camera.

3.1.4.3.2 Sediment Sample Preparation Instructions for Deep Sediment Grab Sampler. The following general procedure may be used when sampling sediments with a grab sampler (e.g., Ponar sampler). The manufacturer's directions to any tool used should be referenced for more detailed instructions.

1. Use a boat, barge, or other stable, working platform over the area to be sampled.

2. Ensure that the winching system to be used is of sufficient strength for the sampling tool and depth of water. Along with the winching system, the rope, swivel, and shackles should be rated for a load capacity at least three times the weight of the tool.

3. Ensure boat is positioned to an area within about 20 m (66 ft) of the planned locations, specified by the remedial project manager, and is anchored well enough to remain fixed during the sampling work.

4. Spread new plastic sheeting on the boat's deck at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination.

5. Measure the depth to the top of the sediment with a weighted object.

6. Mark the distance to the top of the sediment on the sample line with a mark 1 m above the sediment. Record the depth to top of sediment and depth of sediment penetration.

7. For locations in deep, fast current, additional weights may be added to the sampler, as required, to ensure a vertical or near-vertical drop from the boat to the river bottom.

8. Open sampler jaws until latched. Remove the safety pin, keeping hands and fingers out of opening.

9. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.

10. Tie the free end of the sample line to fixed support to prevent accidental loss of sampler.

11. Lower the sampler at a slow, controlled rate of descent (approximately 1 ft/sec) until contact is felt and the mark is reached.

12. Allow the sample line to slack several centimeters to release the trigger mechanism. In strong currents, more slack may be necessary to release the mechanism.

13. Raise the sampler in a slow, controlled manner (approximately 1 ft/sec) to clear the water surface and bring on to the boat.

14. Evaluate the characteristics of the sample to determine acceptability. Characteristics of an acceptable sample collection include:

    - The grab jaws are completely closed
    - There is no evidence of washout through the mesh lids
    - Sediment is evenly distributed in the sampling device
    - Sufficient sample volume has been recovered (may include multiple grabs).

15. If the sample is deemed not acceptable, empty the contents off the downstream side of the boat and attempt to get another sample.

16. Once the sample is deemed acceptable, drain free liquids, being careful not to lose fine sediments.

17. Place the sampling tool into a stainless steel or polytetrafluoroethylene tray and open. Lift the tool clear of the tray and set aside for decontamination.

18. Record the physical description of the sample, such as color, odor, gross particle sizes, biological material, and debris. Photograph the sediment.

19. Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Samples should be taken from the center of the mass of sediment, avoiding material that has come in contact with the walls of the sampler.

20. For VOA or AVS/SEM analyses sampling handling should minimize contact with air, bottles should be filled to minimize headspace.

21. Repeat these steps until sufficient sample volume has been collected for all of the remaining parameters.

22. Cap the sample jars and attach sample label and custody seal as directed by the SAP (DOE-RL 2008a) and immediately place the sample jar into a chilled cooler.

23. Place filled sample containers on ice immediately.

24. Complete all chain-of-custody documents and field sheets, and record information in the field logbook.

25. Thoroughly decontaminate the equipment after each use.

3.1.4.3.3 Sediment Sample Preparation Instructions for Coring. The following generalized procedure may be used when sampling sediments by a coring device (e.g., Vibracore).

1. Use a boat, barge, or other stable, working platform over the area to be sampled.

2. Ensure that the winching system to be used for the sampling tool and depth of water is of sufficient strength. The system, along with the rope, swivel, and shackles, should be rated for a load capacity at least three times the weight of the tool.

3. Ensure that the boat is positioned to an area within about 20 m (66 ft) of the planned position and is anchored well enough to remain fixed during the sampling work.

4. Assemble a decontaminated vibratory corer and connect an external power source.

5. Attach decontaminated corer to the required length of sample line to reach the top of the sediment.

6. Lower the corer down to the top of sediments and begin vibratory coring until refusal (i.e., the core tube has fully penetrated). Refusal is defined as three minutes of vibration with less than 15 cm (6 in.) of penetration by the core barrel.

7. Carefully retrieve the core tube.

8. Divide core into separate samples of about 20 cm (8 in.) each.

9. Record the physical description of each sample, such as color, odor, gross particle sizes, biological material, and debris. Photograph the sediment.

10. Begin sampling with the top 20 cm (8 in.) of the sediment, which will be analyzed for VOC, along with the other analyses identified in the SAP (DOE-RL 2008a), conducting the sampling with as little disturbance as possible to the media.

11. There should be minimum contact with air for VOA or AVS/SEM analyses sampling handling. Bottles should be filled to minimize headspace.

12. Proceed down the rest of the core tube, making a new sample for each 20 cm (8-in.) segment. If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.

13. Label each sample bottle with the appropriate sample label. Be sure to complete the labels carefully and clearly, addressing all the categories or parameters.

14. Thoroughly mix the remaining sample as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, transfer into appropriate sample bottles, secure caps tightly, and put the containers on ice.

15. Complete all chain-of-custody documents and field sheets, and record information in the field logbook.

16. Thoroughly decontaminate the equipment after each use.

3.1.4.3.4 Sediment Sample Preparation Instructions for Coring Device. The following are instructions for sediment sample preparation for a coring device, such as a drill rig or core tube.

1. Use a barge or other stable, working platform over the area to be sampled.

2. Ensure boat is positioned to an area within about 20 m (66 ft) of the planned position and is anchored well enough to remain fixed during the sampling work.

3. Assemble decontaminated drill equipment.

4. Lower the drill bit down to the top of sediments and begin coring until refusal (e.g., original river bed [cobble]) is reached.

5. Carefully retrieve the core tube.

6. Divide core into separate samples of about 20 cm (8 in.) each for 4-in. cores and 1 ft for 2-in. cores.

7. Record the physical description of each sample, such as color, odor, gross particle sizes, biological material, and debris. Photograph the sediment.

8. Begin sampling with the top 20 cm of the sediment, which will be analyzed for VOC, conducting the sampling with as little disturbance as possible to the media.

9. There should be minimum contact with air for VOA or AVS/SEM analyses sampling handling. Bottles should be filled to minimize headspace.

10. Proceed down the rest of the core tube, making a new sample for each 20 cm (8-in.) segment for 4-in. cores and 1 ft for 2-in. cores. If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.

11. Label each sample bottle with the appropriate sample label. Be sure to complete the labels carefully and clearly, addressing all the categories or parameters.

12. Thoroughly mix remaining sample as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, transfer into appropriate sample bottles, secure caps tightly, and put the containers on ice.

13. Complete all chain-of-custody documents and field sheets and record information in the field logbook.

14. Thoroughly decontaminate the equipment after each use.

3.1.5 Water Samples

3.1.5.1 Surface Water. Surface water samples will be collected to evaluate the potential exposures of aquatic biota and humans. Filtered and unfiltered surface water samples will be collected from all surface water samples. Sample volume, sample containers, sample preservation, and holding time requirements for each analyte group are described in Table 3-4 of the SAP (DOE-RL 2008a) and sample authorization form.

Surface water samples - The majority of surface water samples will be collected at 2/3 the depth of the water column using surface water collection devices. This SAI will describe one of those methods, a peristaltic pump and polyethylene tubing. The water depth will be measured using a tape measure or single-beam depth meter. The tubing will be lowered to the required depth and the required volume will be collected. During collection the following field parameters will be measured: temperature, pH, conductivity, and dissolved oxygen.

For "wasteway" locations where irrigation returns discharge to the river (Tables 2-3 and 2-4 in the SAP, DOE-RL 2008a), an initial sample shall be collected during the fall of 2008 before irrigation flows cease (approximately October 15, 2008) and a second sample shall be collected from the same location in the spring of 2009 once irrigation discharges resume (approximately April 15, 2009).

Deep surface water samples - To assess potential exposures of aquatic biota, a limited number of "deep" surface water samples will be collected from deep river trenches near the bottom of Lake Wallula, and above the pore-water sediment sampling locations. These samples will be collected directly above the riverbed (e.g., less than 0.3 m [1 ft] above sediment) using tubing and pump as described above. During collection, the following field parameters will be measured: temperature, pH, conductivity, and dissolved oxygen.

Surface Water - The following is a list of equipment and supplies for surface water sampling:

- Peristaltic pump
- Tygon® tubing capable of fitting over 5/16-in. outer diameter (OD) polyethylene tubing
- Calibrated field parameter measuring equipment to measure pH, conductivity, dissolved oxygen, and temperature
- Waterproof Teflon® tape
- Weight sufficient to hold tube in place at a desired depth
- Deionized (DI) water
- Sample jars
- Sample labels
- Sample preservatives
- 27 L (~7-gal) plastic carbouys (one for each site)
- Cooler with reusable ice packs
- Chain-of-custody seals
- Chain-of-custody form
- Nontoxic permanent marker
- Plastic waste bags (if necessary to discard sample wastes)
- Water depth measuring device (0.1 m intervals).

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®Teflon is a registered trademark of E.I. du Pont de Nemours and Company or its affiliates.

Surface Water Sample Preparation - The following are instructions for surface water sample preparation:

1. Water samples are collected using a peristaltic pump to pull water from polyethylene tubing located 2/3 the depth of the water column or 10 cm (6 in.) above the river bed of each site prescribed in the SAP (DOE-RL 2008a).

2. Deep surface water samples (including those associated with groundwater upwelling areas [pore water]) will be collected within 1 ft of the mudline.

3. Sample bottles requiring preservatives should be prepared over a polycooler or poly tub, lined with adsorbent material or pad, prior to collection of sample.

4. Record standing water depth (to river bed) over the sample station.

5. Rinse the end of a sufficient length of polyethylene tubing using DI water to remove particulates and other potential contributors to cross-contamination.

6. Mark the distance on the tube to 2/3 depth to the river bed, or the depth to 0.3 m (1 ft) above sediment for the deep water samples. Lower tube into water with weight until the correct distance is reached.

7. Connect the end of Tygon tubing that feeds through the peristaltic pump to the end of the polyethylene tubing. Insert opposite end of Tygon tubing into bucket.

8. Turn on peristaltic pump according to manufacturers instructions. Purge 3-tube volumes (approximately 1.7 L [0.45 gal]). Dispose of purge water in accordance with the Waste Control Plan (WCP-2008-0001).

9. After purging, fill approximately 110 mL of water into the water quality beaker and measure the selected water quality parameters (temperature, pH, conductivity, and dissolved oxygen). Record readings in the field logbook.

10. Fill the sample containers specified in the SAP (DOE RL 2008a) directly from the pump tubing. Be sure to collect one full quality control sample per week and determine which sites should have duplicate samples (two sample sets collected from the same carbouy) based on objectives in DOE-RL 2008a.

11. Decontaminate the sample tubing in accordance with ENV-1-2.15, "Field Decontamination of Sampling Equipment." Collect and dispose of all decon fluids in accordance with the Waste Control Plan (WCP-2008-0001).

3.1.5.2 Riverbed Pore Water. This field instruction is to be implemented during water sample collection from areas identified as groundwater upwelling locations. If proven successful, the Trident probe will be used to collect pore water and related conductivity and temperature data from these locations. Sampling locations will be selected and sampled in accordance with the SAP (DOE-RL 2008a).

A Trident probe is a simple direct-push system of penetrating the bed of a body of water to determine the temperature and conductivity and to retrieve a sample of water, all from

three probes. The Trident probe allows the collection of pore water at the same depth the conductivity and temperature are measured, up to about 2 ft into sediment. The probes are connected to an aluminum mounting base plate and submersible air hammer with a coupling for a 2 m push rod that can be lengthened to a total length of about 10 m. The probes are each about 60 cm long and spaced about 10 cm from each other. A bundled cable holding the temperature and conductivity signals, sampling tube, and pneumatic air hammer hose connects the probe to the surface and equipment on the boat.

This survey will be completed in three phases:

- Phase I (Technology Demonstration) is a test of the applicability of the proposed Trident probe technology to Hanford Reach conditions.
- Phase II (Groundwater Plume Upwelling Delineation) will focus on delineating the eight areas of suspected groundwater plume upwelling.
- Phase III (Groundwater Plume Upwelling Characterization) will be characterization of upwelling conditions through pore-water, sediment, and surface water sampling.

The following provides a detailed discussion of these phases.

Phase I: Technology Demonstration - The first phase of this investigation will be to perform a preliminary test of the Trident probe technology within the Hanford Reach to evaluate its application within the river environment. The Trident probe is a flexible, multi-sensor water-sampling probe for screening and mapping groundwater plumes at the surface water interface. Its capabilities include:

- Conductivity – detects contrast in salinity between groundwater and surface water
- Temperature – detects groundwater by thermal contrast with surface water
- Pore-water sampler – allows for contaminant characterization and detection of other groundwater-specific tracers (e.g., Cr+6).

It is anticipated that the Trident probe will be deployed over several days within the Hanford Reach. During this technology demonstration, the probe will be deployed within a range of river conditions to test its applicability in fine-grained sediments (e.g., silt), coarse-grained sediments (e.g., gravel and cobbles), and at a variety of water depths and speeds. During this test, collection of pore-water, samples will be evaluated along with the collection of temperature and conductivity measurements of both surface water and groundwater. It is anticipated that differences in temperature and conductivity will be good indicators of groundwater plume upwelling areas. River water should have a higher temperature and lower conductance relative to the groundwater. Based on the results of this technology demonstration, a recommendation as to the applicability of the Trident probe within the Hanford Reach will be determined. If it is determined that the Trident probe technology is not suitable to meet project objectives, other technologies will be considered to collect pore water, including steel drive points.

Phase II: Groundwater Plume Upwelling Delineation - To assess groundwater plume upwelling, river stage and flow condition will need to be favorable for groundwater discharge to the river (e.g., depending of the distance below Priest Rapids Dam); this will generally flow in

the 80 to 120 kcfs range at Priest Rapids Dam. Once these favorable flow conditions (i.e., groundwater discharge to the river) are met, pore-water screening activities will be completed at each of the eight upwelling study areas (i.e., 100-B/C Area, 100-K Area, 100-N Area, 100-D Area, 100-D Area, 100-F Area, Hanford townsite, and 300 Area). The screening will consist of collecting pore-water samples along transects as summarized in the following paragraphs.

- Transects – As shown in Figures 2-4 through 2-11 and Figure 2-14 of the SAP (DOE-RL 2008a), five transects are planned for each area. Transects were selected based upon the 2007 aquifer tube sampling results, as summarized in the figures. These transects will start at the near shore (e.g., reactors areas) and continue across the entire river channel to the far shore. Depending on conditions, it is anticipated that four to seven locations will be sampled per transect (two or three locations on the Hanford side of the river, one or two locations at or near mid-channel, and one or two locations on the far shore). At each of these locations, pore water will be sampled as described below. The actual number of sampling locations along each transect will vary based on conditions encountered.

- Phase IIb pore water screening – At each pore water sampling location, the Trident probe (or alternate sampling device) will be deployed 6 to 12 in. below the mudline. Pore water will be extracted using a peristaltic pump. The pump rate will depend on aquifer recharge conditions, but will be kept to a minimum. Field measurements consisting of temperature and conductivity will be collected to demonstrate that surface water has not been drawn down into the sampling port by pumping conditions. If pore water has conductivity less than 160 us/cm, no sample will be collected. At each sampling location, pore water will be collected for indicator compounds (Table 3-6). Underwater photographs of the riverbed will be taken at Phase IIb sampling locations. The photographs shall be identified and submitted as an electronic data file after the sampling is complete as part of the sampling summary report.

Table 3-6. Summary of Pore-Water Indicator Compounds.

Groundwater Upwelling Areas	Indicator Compound	Analytical Method	Volume Requirements (mL)
100-B/C	Cr+6	Method 7196	500
100-K	Cr+6	Method 7196	500
100-N	Sr-90, TPH	α, β proportional counting; WTPH	1000
100-D	Cr+6	Method 7196	500
100-H	Cr+6	Method 7196	500
100-F	Cr+6	Method 7196	500
Hanford townsite	tritium	LSI	150
300 Area	VOC, U	Method 8260 & KPA	540

- Tri-Party review and approval – Once pore-water results for Cr+6 (or other site-specific indicator compounds), temperature, and conductivity are available, maps summarizing the results of the screening will be developed for each of the eight groundwater plume upwelling areas. These figures will also present the proposed locations for additional pore-water, sediment, and surface water sampling that are needed for plume characterization (see

Phase III below). These locations will be selected in areas that have the highest contaminant flux.

The sample locations and coordinates for the Phase II(b) samples are presented in Appendix A, Table A-1.

Phase III: Groundwater Plume Upwelling Characterization – Based on the results of the pore-water screening and Tri-Party comments and approval, pore-water sampling locations will be selected for groundwater plume upwelling characterization. Once areas of groundwater plume upwelling have been identified, sediment and surface water samples will be collected adjacent to the pore-water sampling locations to evaluate the potential impact upwelling groundwater plumes are having on these media. Surface water and sediment samples will be collected as described in Section 2.5 of the SAP (DOE-RL 2008a), and in Sections 3.2.4 and 3.2.5 of this document. Pore water, sediment, and surface water samples will be analyzed for the following analytical parameters, as shown in Tables 2-3 through 2-4 of the SAP (DOE-RL 2008a):

- Pore-water analyses – all pore-water samples collected for groundwater plume upwelling characterization will be analyzed for metals, hexavalent chromium, and tritium. Pore-water samples collected in the 300 Area will also be analyzed for VOCs and uranium (kinetic phosphorescence analysis). Samples in the 100-B/C, 100-K, 100-N, 100-D, 100-H, and 100-F Areas will be analyzed for Sr-90. Samples at 100-N will be analyzed for total petroleum hydrocarbons (TPH). Samples for metals analyses will be prepared both with and without filtering (0.45 micron). Analysis for anions (EPA method 300.0) will be conducted in addition to nitrate analysis (EPA method 353.2). Total inorganic carbon will be collected at all sample locations. Samples obtained from Hanford townsite area locations JHTS33, JHTS18, and JHTS19 will also be analyzed for technetium-99.

  The analytes for any given sample may be limited by volume constraints due to the extended times required to collect pore water. In these cases, analyses for metals and radionuclides are of primary importance. In 300 Area, VOC samples are prioritized after metals and radionuclides.

- Sediment and surface water analyses – sediment samples will be analyzed for metals, hexavalent chromium, total organic carbon (TOC), grain size, AVS/SEM, and radionuclides. Sediment samples in the 300 Area will also be analyzed for VOCs. Surface water samples will be analyzed for metals, hexavalent chromium (except at Hanford townsite), and radionuclides. Surface water samples in the Hanford townsite area will also be analyzed for tritium, while surface water samples in the 300 Area will also be analyzed for VOCs. Samples obtained from Hanford townsite area locations JHTS33, JHTS18, and JHTS19 will also be analyzed for technetium-99.

  Due to difficulty in attaining sediment from riverbed areas dominated by river cobble, the analytes attainable from these samples may be limited. In these cases, analyses for metals and radionuclides are of primary importance for the available sediment mass. In 300 Area, VOC samples are prioritized after metals and radionuclides.

The sample locations and coordinates for the Phase III samples are presented in Appendix A, Table A-2.

Collecting Pore-Water Samples - This field instruction pertains to collection of water samples for the following analyte groups. See Tables 2-3 through 2-4 of the SAP (DOE-RL 2008a) for pore-water analyses.

Sample volumes, sample containers, and sample preservations for each analyte group are described on the applicable sample authorization form (SAF). For Phase III pore-water sampling, the minimum QC volume is preferred for all samples (Table 3-7). However, in those cases where this volume is not attained, the minimum volumes for data may be used (Table 3-8).

Table 3-7. Phase III Pore-Water Sample Minimum QC Volume (Preferred).

Analysis	Sample volume by area (ml)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals (unfiltered)	300	300	300	300	300	300	300	300
Metals (filtered)	300	300	300	300	300	300	300	300
TOC/TIC	50	50	50	50	50	50	50	50
KPA							100	
Hexavalent chromium	300	300	300	300	300	300	300	300
Anions	100	100	100	100	100	100	100	100
Nitrate	100	100	100	100	100	100	100	100
VOC							120	
TPH						1000		
Strontium-90	1000	1000	1000	1000	1000	1000		
Technetium-99								250[a]
Tritium	125	125	125	125	125	125	125	125
TOTAL (ml)	**2275**	**2275**	**2275**	**2275**	**2275**	**3275**	**1495**	**1525**

[a] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Table 3-8. Phase III Pore-Water Sample Minimum Volume for Data. [a]

Analysis	Sample volume by area (ml)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals (unfiltered)	50	50	50	50	50	50	50	50
Metals (filtered)	50	50	50	50	50	50	50	50
TOC/TIC	25	25	25	25	25	25	25	25
KPA							10	
Hexavalent chromium	50	50	50	50	50	50	50	50
Anions	10	10	10	10	10	10	10	10
Nitrate	25	25	25	25	25	25	25	25
VOC							40	
TPH						250		
Strontium-90	100	100	100	100	100	100		
Technetium-99								250 [b]
Tritium	125	125	125	125	125	125	125	125
TOTAL (ml)	**435**	**435**	**435**	**435**	**435**	**685**	**385**	**585**

[a] Due to volume constraints, samples may be submitted with these minimal volumes. However, QC cannot be performed at most of these volumes so the minimum QC volumes in Table 3-4 are preferred.
[b] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Pore-Water Sampling - The following is a list of equipment and supplies for pore-water sampling:

- Trident probe and push rods
- Communications/pneumatic cables
- Field computers for receiving temperature and conductivity signals
- GPS unit with RS-232 interface for connecting to probe
- Appropriate batteries for equipment

- Self-contained underwater breathing apparatus (SCUBA) tank and regulator for air hammer, if air hammer is to be used
- Appropriate personal protective equipment
- Water depth measuring device (0.1-m intervals)
- Peristaltic pump
- 12V battery
- Silicon tubing capable of fitting over 5/16-in. OD polyethylene tubing
- Calibrated field parameter measuring equipment to measure pH, dissolved oxygen, and anions (primarily nitrate)
- Two graduated volumetric (500 mL) measuring devices
- 27 L (7-gal) plastic carbouys (one for each site)
- Decontamination fluid (e.g., DI water)
- Sample jars
- Sample labels
- Sample preservatives
- Two graduated volumetric (500 mL) measuring devices
- Cooler with reusable ice packs
- Chain-of-custody seals
- Chain-of-custody form
- Nontoxic permanent marker
- Plastic waste bags (if necessary to discard sample wastes)
- Digital camera.

Deploying the Trident Probe - The Trident probe can be deployed by using a push-pole, a diver, a deployment frame, or by hand. The method depends on the site characteristics and resources available. The push-pole deployment method can be used from a small boat in water up to 30 ft deep. Diver or frame deployment can be used in deeper water.

Push-Pole Deployment from a Boat - Trident probe deployments in water depths up to 30 ft deep can be performed from a small boat using the push-pole method. Ensure the boat is well

anchored to minimize the lateral loading on the probe during the insertion and sampling. Combine the 6-ft sections of pole to accommodate the water depth. These poles can be assembled as the probe initially descends and decoupled or left intact upon retrieval. Configure the push-pole to remain attached to the probe (see Rigid Coupling below) when set in soft sediments, but configure it to detach from the probe (see Detachable Coupling below) when set in firmer sediments. In this configuration, the probe is retrieved via the cable assembly.

Rigid Coupling - Deploying the Trident probe while leaving the push-pole attached presents certain conditions that require attention. You must remain stationary over the site to prevent lateral forces on the probe if the push-pole is physically held while the Trident probe is operating. A 3-point anchor can hold the probe; anchors can be set past each end of transect, another set perpendicular (astern), and lines made taunt. Positions can be adjusted along transect by slacking one anchor line and pulling in on the other. In many cases, once the Trident probe has been set into the sediment, the push-pole will remain vertical after release, as long as the height of the push-pole above the water surface is kept to a minimum. If this is the case, the boat position should be maintained close to the push-pole without the possibility of drifting into the pole or pulling the Trident probe out of the sediment via the cable assembly.

Detachable Coupling - To decouple the push-pole from the Trident probe, the short section of pipe with two short rods protruding from each side is threaded onto the top of the air hammer housing. The initial push-pole that attaches to the Trident probe for this purpose has slots that engage these rods with a counterclockwise push-and-twist motion. A spring, tethered to the pole connector, is placed between the two connectors before being coupled. This spring keeps the probe attached until probe placement is completed. A clockwise twist on the push-pole disengages the probe. The pole can then be pulled from the water while the Trident probe remains in place. This bridle relieves stress on the probe connections when the cable assembly is used to pull the probe back to the surface. A stress relief bridle on the hammer housing is fastened to the cable assembly, which leaves slack on the probe connections when taut.

Setting the Trident Probe into Sediment - Lower the Trident probe with the push-pole while maintaining minimal slack in the cable assembly until it contacts the sediment; continue to push the probe until it is set. In firmer sediments, you may use the air hammer to assist the insertion. Turn on the SCUBA tank valve while pushing on the pole until the Trident probe can no longer be inserted further. You can bend the probes if objects are buried in the sediment. Hard objects such as rocks can be felt via the push-pole. Reposition the Trident probe if there is any question of striking hard objects. If the Trident probes get bent, they can be easily straightened by hand.

The Trident probe also can be mounted into a frame for deployment from a support vessel's davit. Pass a 4-ft pipe, threaded into the top of the Trident air hammer housing, through a plastic guide at the top of a 3-ft-high deployment frame. A locking pin, placed through a hole in the pipe above the guide, secures the Trident probe within the frame when out of the water. A shackle attached to the top of the pipe connects the davit cable. Once the Trident probe and frame are suspended for deployment, the locking pin is removed. The Trident is lowered to the bottom and the air hammer is actuated for insertion into the sediment (if used).

Phase III Pore-Water Sampling Guidelines - During Phase IIb sample collection, field sampling guidelines were developed to guide decisions on sampling. The following three guidelines represent the best conditions for pore-water collection. However, in the event that river flows are too high or too erratic to support pore-water sampling under these guidelines

during the sampling time frame of January to (potentially) March, this guidance will be altered so that the work may be completed prior to spring floods.

For Phase III sampling, pore-water collection will proceed when at least one of the following conditions is met:

- River levels are less than 0.8 m above low water level and steady river flows of approximately 70,000 cubic feet per second (cfs) have been present for at least 1 hour prior to sampling.
- Pore-water conductivity checks at selected QC stations near sampling site do not show signs of dilution from bank recharge and/or surface water pressure.
- Phase III pore-water conductivity reading is producing values > 90% of the conductivity measurements reported during Phase II(a) or Phase II(b) sampling (under favorable conductivity measuring conditions).

Pore-Water Sampling Preparation. The following are instructions for pore-water sampling preparation:

1. Samples should be collected during periods of lower river flow to maximize the amount of shallow groundwater sampled.
2. Sample bottles requiring preservatives should be prepared over a polycooler or poly tub, lined with adsorbent material or pad, prior to collection of sample.
3. Push probe into the sediment until refusal per manufacturer's instructions. Measure and record the depth of the unit into the sediment.
4. Measure the water depth (0.1 m intervals) and water quality parameters (temperature, conductivity, dissolved oxygen [DO], and pH) of the pore water during each sampling event (see surface water sampling instructions).
5. Rinse the ends of polyethylene tubing using deionized water to remove particulates and other potential contributors to contamination and connect one end to the sampling tubing connected to the Trident probe.
6. Connect the other end of the polyethylene tubing to the Tygon tubing that feeds through the peristaltic pump. Insert the opposite end of the Tygon tubing into the bucket.
7. Turn on the peristaltic pump according to manufacturer's instructions. Purge the polyethylene tube volume (e.g., 20 ft of tubing equals ~ 670 mL of purge water) and discard.
8. After purging, place ~120 mL of water into water quality cap and measure DO and pH; the probe will record conductivity and temperature automatically. If conductivity values are less than 160 us/cm do not collect a pore-water sample.
9. Check conductance readings from probe during the sample draw and stop sampling temporarily or slow down the pumping rate if specific conductance drops substantially from the initial reading, to allow the conductivity to restore near the starting value. Because of the

variability of each location, the time required will vary from site to site and vary with river level.

10. Fill the plastic carbouy container with the desired amount of pore-water sample (volume required per SAP [DOE-RL 2008a]). If possible, use 120 mL of this material to measure the final water quality readings (DO and pH) and discard this material in accordance with WCP-2008-0001.

11. Decontaminate the sample tubing in accordance with ENV-1-2.15, "Field Decontamination of Sampling Equipment." Collect and dispose of all decon fluids in accordance with the Waste Control Plan (WCP-2008-0001).

12. Fill individual sample containers from plastic carbouy, attach sample labels and custody seals, and immediately place sample jars into a chilled cooler. Samples can be brought back to the laboratory and placed into specific sample jars if extreme weather conditions or water conditions limit field sampling time. Samples should be collected during relatively steady water levels. Note starting and ending water depths at the sample location.

Surface Water Sampling

Surface water samples are to be collected per DOE/RL-2008-11, Appendix A, Section 2.4.2. Surface water samples will be collected concurrently with pore-water samples.

Sample volumes, sample containers, and sample preservations for each analyte group are described on the applicable SAF. For Phase III surface water sampling, the full QC volume shall be collected for all samples. These volumes are shown in Table 3-9.

Table 3-9. Phase III Surface Water Sample Volume. (2 Pages)

Analysis	Sample volume by area (ml)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Metals (unfiltered)	500	500	500	500	500	500	500	500
Metals (filtered)	500	500	500	500	500	500	500	500
Hexavalent chromium	500	500	500	500	500	500	500	
Anions	500		500					500
Nitrate	250		250					250
VOC							120	
Hardness	250	250	250	250	250	250	250	250
Alkalinity	250	250	250	250	250	250	250	250
DOC	125	125	125	125	125	125	125	125
GEA	1000	1000	1000	1000	1000	1000	1000	1000

Table 3-9. Phase III Surface Water Sample Volume. (2 Pages)

Analysis	Sample volume by area (ml)							
	100-BC	100-D	100-F	100-H	100-K	100-N	300	HTS
Isotopic uranium	2000	2000	2000	2000	2000	2000	2000	2000
Isotopic plutonium	1000	1000	1000	1000	1000	1000	1000	1000
Isotopic thorium	1000	1000	1000	1000	1000	1000	1000	1000
Strontium-90	2000	2000	2000	2000	2000	2000		
Carbon-14					250			
Technetium-99								250[a]
Tritium								250
TOTAL (ml)	**9875**	**9125**	**9875**	**9125**	**9375**	**9125**	**7245**	**7875**

[a] To be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS = Hanford townsite
KPA = kinetic phosphorescence analyzer
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

3.2 LABORATORY ANALYSIS

Each sample will be submitted to the analytical laboratory for the analysis specified in the SAP. Fish samples will be submitted to the analytical laboratory for the analysis specified in Tables 3-10 and 3-11. Phase III pore water, surface water, and sediment will be submitted to analytical laboratories for the analyses specified in Tables 3-12, 3-13, and 3-14. A SAF prepared in accordance with ENV-1-2.10, "Sample Event Coordination," will provide the specific requirements for sample analysis.

Table 3-10. Analyses for Fish Samples Except Sturgeon.

Tissue	Sample Analyses [a]													
	Gamma Spectroscopy	Carbon-14	Tritium	Strontium 89/90	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Technetium-99	Metals	Mercury	Total Inorganic Arsenic	Pesticides	Percent Lipids	PCB congeners
Fillet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Carcass	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Liver/Kidney [b,c]	X	X	X	X	X	X	X	X	X	X	X	X	X	X

[a] When insufficient mass is available for all fish analyses, the priority for analyses as described in Appendix A, Section 2.4.5 of the Work Plan is metals and radionuclides, then PCB congeners and pesticides.
[b] Given the small organ mass from most fish species, it is unlikely that all analyses listed will be run.
[c] The liver and kidney samples for carp may be processed and analyzed separately.

PCB = polychlorinated biphenyls

Table 3-11. Analyses for Sturgeon Samples. (2 Pages)

Tissue	Sample Analyses [a]																
	Gamma Spectroscopy	Carbon-14	Tritium	Strontium 89/90	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Technetium-99	Metals	Mercury	Total Inorganic Arsenic	Pesticides	Percent Lipids	PCB congeners	Hexavalent Chromium	Methyl Mercury[b]	Percentage Sediment
Fillet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Carcass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Liver	X	X	X	X	X	X	X	X	X	X		X	X	X			
Kidney[c]	X	X	X	X	X	X	X	X	X	X		X	X	X			

Table 3-11. Analyses for Sturgeon Samples. (2 Pages)

Tissue	Sample Analyses [a]																
	Gamma Spectroscopy	Carbon-14	Tritium	Strontium 89/90	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Technetium-99	Metals	Mercury	Total Inorganic Arsenic	Pesticides	Percent Lipids	PCB congeners	Hexavalent Chromium	Methyl Mercury[b]	Percentage Sediment
Stomach[d]																	X
Viscera [e]	X	X	X	X	X	X	X	X	X	X		X	X	X	X		

[a] When insufficient mass is available for all analyses, the priority for analyses as described in Appendix Section 2.4.5 of the Work Plan is metals and radionuclides, then PCBs and pesticides.
[b] Methyl mercury to be performed on a subset of samples (6 sturgeon) only
[c] Kidney mass from sturgeon may be as low as 30 g. Radiological and metal analyses are the priority for the organ samples. Histology samples from small mass organs should be of minimal size. Larger kidney samples may include the PCB congener and pesticide analyses as mass allows.
[d] Stomach sediment samples may be sent for radiological analysis at a later time.
[e] For sturgeon samples, viscera consists of visceral organ material minus kidney, liver, and the contents of the stomach). A total of six viscera samples will be analyzed.

PCB = polychlorinated biphenyls

Table 3-12. Analytes for Phase III Pore-Water Sampling. [a]

Sub-Area	Analytes										
	Metals [b] (filtered)	Metals [b] (unfiltered)	Uranium (KPA)	Hexavalent Chromium	Nitrate and anions	VOC	TPH	Strontium-90	Tritium	Technetium-99 [c]	TOC/TIC
100-BC	X	X		X	X			X	X		X
100-D	X	X		X	X			X	X		X
100-F	X	X		X	X			X	X		X
100-H	X	X		X	X			X	X		X
100-K	X	X		X	X			X	X		X
100-N	X	X		X	X		X	X	X		X
300	X	X	X	X	X	X			X		X
HTS	X	X		X	X				X	X	X

[a] Analyses conducted may be subject to sample volume constraints.
[b] ICP metals including uranium (6010TR) and mercury (7471).
[c] Technetium-99 sample to be collected at locations JHTS33, JHTS18, and JHTS19 only.

HTS j= Hanford townsite
TOC = total organic carbon
TIC = total inorganic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Table 3-13. Analytes for Phase III Surface Water Sampling.

Sub-Area	Analytes														
	Metals (filtered)[a]	Metals (unfiltered)[a]	Hexavalent Chromium	Nitrate and anions	VOC	Hardness/ DOC/alkalinity	Radionuclides, GEA[b]	Isotopic Uranium	Isotopic Thorium	Isotopic Plutonium	Tritium	Strontium-90	Carbon-14	Technetium-99[c]	Field Parameters[d]
100-BC	X	X	X	X		X	X	X	X	X		X			X
100-D	X	X	X			X	X	X	X	X		X			X
100-F	X	X	X	X		X	X	X	X	X		X			X
100-H	X	X	X			X	X	X	X	X		X			X
100-K	X	X	X			X	X	X	X	X		X	X		X
100-N	X	X	X			X	X	X	X	X		X			X
300	X	X	X		X	X	X	X	X	X					X
HTS	X	X		X		X	X	X	X	X	X			X	X

[a] ICP metals including uranium (6010TR) and mercury (7471).
[b] Radionuclides include americium-241, antimony-125, beryllium-7, cesium-134, cobalt-60, europium-152, europium-154, europium-155, potassium-40, radium-226, radium-228, and ruthenium-106.
[c] Technetium-99 sample to be collected at locations JHTS33, JHTS18, and JHTS19 only.
[d] Parameters for surface water include temperature, specific conductivity, dissolved oxygen, and pH.

GEA = gamma energy analysis
HTS = Hanford townsite
VOC = volatile organic compound

Table 3-14. Analytes for Phase III Sediment Sampling.[a]

Sub-Area	Analytes												
	Metals[b]	Hexavalent Chromium	TOC/Grain Size	VOC	AVS/SEM	Radionuclides, GEA[c]	Isotopic Uranium	Isotopic Thorium	Isotopic Plutonium	Tritium	Strontium-90	Carbon-14	Technetium-99[d]
100-BC	X	X	X		X	X	X	X	X		X		
100-D	X	X	X		X	X	X	X	X		X		
100-F	X	X	X		X	X	X	X	X		X		
100-H	X	X	X		X	X	X	X	X		X		
100-K	X	X	X		X	X	X	X	X		X	X	
100-N	X	X	X		X	X	X	X	X		X		
300	X	X	X	X	X	X	X	X	X				
HTS	X		X		X	X	X	X	X	X			X

[a] Analyses conducted may be subject to sample mass constraints.
[b] ICP metals including uranium (6010TR) and mercury (7471).
[c] Radionuclides include americium-241, antimony-125, beryllium-7, cesium-134, cobalt-60, europium-152, europium-154, europium-155, potassium-40, radium-226, radium-228, and ruthenium-106.
[d] Technetium-99 sample to be collected at locations JHTS33, JHTS18, and JHTS19 only.

AVS/SEM = acid volatile sulfides/simultaneously extracted metals
GEA = gamma energy analysis
HTS = Hanford townsite
TOC = total organic carbon
VOC = volatile organic compounds

3.3 SAMPLE HANDLING, SHIPPING, AND CUSTODY REQUIREMENTS

All sample handling, shipping, and custody requirements will be consistent with established Washington Closure Hanford (WCH) procedures. Sample transportation shall be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste that are mandated by the U.S. Department of Transportation (49 CFR 171-177, Chapter 1, "Research and Special Programs Administration, Department of Transportation," Part 171, "General Information, Regulations, and Definitions," through Part 177, "Carriage By Public Highway") in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

3.4 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

The sample preservation, container, and holding time requirements for the analyses to be performed are provided in Table 3-4 of the SAP (DOE-RL 2008a).

3.5 QUALITY CONTROL REQUIREMENTS

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. When performing this field sampling effort, care shall be taken to prevent the cross-contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity. The RCCC or subcontractor QA plan will be reviewed and consistent with *Hanford Analytical Services Quality Assurance Requirements* (HASQARD) (DOE-RL 1996) guidelines.

3.6 INSTRUMENT CALIBRATION AND MAINTENANCE

All field screening and analytical instruments shall be calibrated and maintained in accordance with the applicable portions of HASQARD. The results from all instrument calibration and maintenance activities shall be recorded in a bound logbook in accordance with procedures outlined in ENV-1.-2.5, "Field Logbooks."

3.7 FIELD DOCUMENTATION

Project documentation and records include field logbooks, field measurement records, chain-of-custody records, analytical data packages, and validation reports. At the direction of the STR, all data packages and/or validation reports shall be subject to technical review before submittal to regulatory agencies or inclusion in reports/technical memoranda.

When appropriate, electronic access shall be through computerized databases (e.g., Hanford Environmental Information System). Where electronic data are not available, hard copies will be provided in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

Field documentation shall be kept in accordance with ENV-1, including the following procedures:

- ENV-1-2.5, "Field Logbooks"
- ENV-1-2.8, "Environmental Site Identification and Information Reporting"
- ENV-1-2.13, "Chain of Custody."

4.0 ASSESSMENTS AND RESPONSE ACTIONS

Random surveillance and assessments may be conducted in accordance with QA-1, *Quality Assurance*, QA-1-1.5, "Self-Assessment," to verify compliance with the requirements outlined in this SAI, project work packages, the WCH quality management plan, WCH procedures, and regulatory requirements.

Deficiencies identified by one of these assessments shall be reported in accordance with QA-1-1.5. When appropriate, corrective actions will be taken by the project engineer in accordance with HASQARD Volume 1, Section 5.0, to minimize recurrence.

5.0 DATA VERIFICATION AND VALIDATION REQUIREMENTS

Data verification and validation are performed on analytical data sets primarily to confirm that sampling and chain-of-custody documentation is complete, sample numbers can be tied to the specific sampling location, samples were analyzed within the required holding times, and analyses met the data quality requirements specified in this SAI. All data verification and validation, as identified in the SAP (DOE-RL 2008a), shall be performed in accordance with ENV-1-2.12, "Data Package Validation."

6.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Waste generated by sampling activities will be managed consistent with an established waste management plan (WCP-2008-0001). Unused samples and associated laboratory waste for analysis will be dispositioned in accordance with the laboratory contract and agreements. In accordance with 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan, Procedures for Planning and Implementing Off-Site Response Actions," remedial project manager approval is required before unused samples or waste is returned from offsite laboratories.

7.0 HEALTH AND SAFETY

All field operations will be performed in accordance with WCH's S&H requirements, which are outlined in SH-1, *Safety and Health*, and RC-1, *Radiation Protection Procedures*. In addition, the work will be conducted in accordance with an approved project-specific health and safety plan. The work control package includes, but is not limited to, a Risk Rank Determination, hazard and discipline identification tool, JHA, and task instructions.

The sampling procedures and associated activities will consider exposure reduction and contamination control techniques that will minimize the radiation exposure to the sampling team as required by RC-1 and QA-1, *Quality Assurance*.

8.0 REFERENCES

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, as amended.

49 CFR 171-177, "Transportation," *Code of Federal Regulations*, as amended.

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SH-2, *Safety and Health*, Washington Closure Hanford, Richland, Washington.

WAC 173-22-030, "Definitions," Washington Administrative Code, Olympia, Washington.

WCH-47, 2007, *Sampling and Analysis Instructions for the 100 Area and 300 Area Component of the RCBRA Project*, Rev. 1, Washington Closure Hanford, Richland, Washington.

WCH-91, 2006, *Columbia River Component Data Evaluation Summary Report*, Rev. 0, Washington Closure Hanford, Richland, Washington.

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APPENDIX A

PORE WATER SCREENING (PHASE IIB) AND GROUNDWATER PLUME UPWELLING CHARACTERIZATION (PHASE III) SAMPLE LOCATIONS

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
			100-BC		
2A-A	564668.7	145301.0	0.374	Hexavalent chromium	
J100BC10	564815.6	145381.5	0.230	Hexavalent chromium	
J100BC13	565039.9	145386.1	0.217	Hexavalent chromium	
J100BC18	565194.8	145507.8	0.203	Hexavalent chromium	
J100BC19	565236.3	145423.8	0.244	Hexavalent chromium	
J100BC2	564582.1	145379.0	0.226	Hexavalent chromium	
J100BC21	565286.8	145494.4	0.253	Hexavalent chromium	
J100BC23	565635.1	145573.8	0.171	Hexavalent chromium	
J100BC25	565803.2	145605.6	0.180	Hexavalent chromium	
J100BC33	566414.1	145749.0	0.277	Hexavalent chromium	
J100BC42	567596.3	146290.2	0.358	Hexavalent chromium	
J100BC47	566123.1	145683.6	0.253	Hexavalent chromium	
J100BC5	564652.7	145367.5	0.195	Hexavalent chromium	
J100BC9	564817.2	145452.6	0.176	Hexavalent chromium	
T100BC1J1	564834.2	145289.4	0.363	Hexavalent chromium	
T100BC1J5	564804.7	145325.8	0.369	Hexavalent chromium	
T100BC2A	564896.4	145349.0	0.255	Hexavalent chromium	
T100BC2B	564917.0	145425.9	0.280	Hexavalent chromium	
T100BC2C	564844.2	145569.7	0.146	Hexavalent chromium	
T100BC3C	565053.1	145584.1	0.272	Hexavalent chromium	
T100BC3D	565070.6	145736.6	0.350	Hexavalent chromium	
T100BC3E	565017.4	145838.3	0.247	Hexavalent chromium	
T100BC4A	565441.0	145468.3	0.348	Hexavalent chromium	
T100BC4B	565420.4	145532.5	0.227	Hexavalent chromium	
T100BC5C	565510.3	145711.4	0.234	Hexavalent chromium	
T100BC6A	567230.0	146047.1	0.308	Hexavalent chromium	
T100BC6J10	565583.7	145516.5	0.229	Hexavalent chromium	
T100BC6J2	567386.1	146121.1	0.250	Hexavalent chromium	
T100BC6J4	566987.6	145954.3	0.184	Hexavalent chromium	
T100BC6J5	566728.3	145860.3	0.223	Hexavalent chromium	
			100-D		
D-A	572762.9	151762.7	0.975	Hexavalent chromium, anions, nitrate/nitrite, metals [c,d]	
D-D	572729.8	151782.3	0.284	Hexavalent chromium	
J100D12	573346.8	152301.2	0.189	Hexavalent chromium	
J100D16	573011.5	152074.8	0.177	Hexavalent chromium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
J100D18	572832.4	151835.8	0.206	Hexavalent chromium	
J100D2	572325.8	151344.0	0.220	Hexavalent chromium	
J100D20	572275.5	151262.2	0.291	Hexavalent chromium	
J100D22	572314.9	151362.7	0.208	Hexavalent chromium	
J100D23	572874.0	151875.2	0.242	Hexavalent chromium	
J100D9	573701.6	152561.2	0.197	Hexavalent chromium	
T100D1A	572402.4	151402.7	0.223	Hexavalent chromium	
T100D2A	572601.5	151630.7	0.203	Hexavalent chromium	
T100D2E	572197.2	151928.2	0.402	Hexavalent chromium	
T100D3A	572670.5	151687.1	0.438	Hexavalent chromium	
T100D3C	572471.0	151864.8	0.168	Hexavalent chromium	
T100D3J5	572302.1	152047.3	0.416	Hexavalent chromium, anions, nitrate/nitrite, metals [c,d]	
T100D5B	573794.3	153103.7	0.185	Hexavalent chromium	
T100D5J2	573956.0	154762.0	0.765	Hexavalent chromium	
T100D5J3	573978.1	154771.2	0.755	Hexavalent chromium	
T100D5J5	573932.4	154812.9	0.782	Hexavalent chromium	
J100D8	573761.3	152712.3	[a]	Hexavalent chromium	Samples locations identified for Phase IIa sampling but were not sampled. The locations that show elevated conductivity indicating groundwater upwelling are also to be sampled for indicator contaminants under Phase IIb.
J100D11	573474.9	152470.2	[a]	Hexavalent chromium	
J100D13	573304.4	152356.5	[a]	Hexavalent chromium	
J100D15	573137.7	152250.7	[a]	Hexavalent chromium	
J100D17	572964.7	152131.2	[a]	Hexavalent chromium	
J100D19	573825.1	152818.4	[a]	Hexavalent chromium	
J100D36	573147.4	152178.6	[b]	Hexavalent chromium	
J100D37	573653.9	153260.5	[b]	Hexavalent chromium	
J100D38	573828.0	152720.6	[b]	Hexavalent chromium	
J100D39	573595.0	152478.0	[b]	Hexavalent chromium	
100-F					
J100F1	580166.0	148780.6	0.190	Hexavalent chromium	
J100F10	581049.3	148145.5	0.208	Hexavalent chromium	
J100F11	581093.4	148107.1	0.184	Hexavalent chromium	
J100F14	581153.6	148067.9	0.175	Hexavalent chromium	
J100F2	580280.6	148684.3	0.229	Hexavalent chromium	
J100F23	582411.5	147146.7	0.205	Hexavalent chromium	
J100F25	582547.1	146915.2	0.207	Hexavalent chromium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
J100F4	580738.0	148527.0	0.212	Hexavalent chromium	
T100F2A	580947.0	148183.0	0.185	Hexavalent chromium	
T100F2C	581103.3	148396.3	0.174	Hexavalent chromium	
T100F2D	581196.0	148502.0	0.183	Hexavalent chromium	
T100F2E	581271.5	148582.0	0.362	Hexavalent chromium	
T100F4E	581753.6	148412.9	0.798	Hexavalent chromium	
T100F4J1	581758.5	148504.1	0.858	Hexavalent chromium	
T100F5E	582669.1	147900.6	0.638	Hexavalent chromium	
T100F5J1	582226.2	147316.5	0.138	Hexavalent chromium	
J100F16A	581450.7	148045.3	[a]	Hexavalent chromium	Samples locations identified for Phase IIa sampling but were not sampled. The locations that show elevated conductivity indicating groundwater upwelling are also to be sampled for indicator contaminants under Phase IIb.
J100F17	581536.4	148151.2	[a]	Hexavalent chromium	
J100F18	581627.2	148262.1	[b]	Hexavalent chromium	
J100F19	581773.4	148171.4	[b]	Hexavalent chromium	
J100F28	581975.1	146678.7	[a]	Hexavalent chromium	Samples locations are in 100-F slough. All were identified for Phase IIa sampling but were not sampled. Collect 1 Phase IIb sample at the single location of maximum upwelling from among these 5 locations.
J100F29	582070.9	146466.9	[a]	Hexavalent chromium	
J100F30	582121.4	146315.7	[a]	Hexavalent chromium	
J100F31	582186.9	146179.5	[a]	Hexavalent chromium	
J100F27	581949.9	146865.3	[a]	Hexavalent chromium	
100-H					
J100H17	578079.0	153049.8	0.178	Hexavalent chromium	
J100H38	579428.5	150163.8	0.207	Hexavalent chromium	
J100H39	579487.7	149905.6	0.241	Hexavalent chromium	
J100H43	579651.2	149515.3	0.182	Hexavalent chromium	
J100H5	577070.9	153839.4	0.168	Hexavalent chromium	
J100H7	577452.4	154200.1	0.171	Hexavalent chromium	
T100H1A	577199.4	153713.2	0.207	Hexavalent chromium	
T100H1E	577664.8	154630.8	0.170 b	Hexavalent chromium	
T100H1J3	577406.5	153608.1	0.782	Hexavalent chromium	
T100H1J4	577476.6	153567.8	0.187	Hexavalent chromium	
T100H1J7	577547.7	153512.1	0.183	Hexavalent chromium	
T100H1J8	577545.8	153535.4	1.347	Hexavalent chromium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
T100H1J9	577555.1	153529.9	1.227	Hexavalent chromium	
T100H2A	578112.6	152992.4	0.221	Hexavalent chromium	
T100H3A	578193.7	152814.5	0.170	Hexavalent chromium	
T100H3E	579001.8	153528.7	0.185	Hexavalent chromium	
T100H5D	579626.6	152538.7	0.174	Hexavalent chromium	
T100H6A	580089.8	150543.8	0.244	Hexavalent chromium	
T100H6J2	580576.5	150303.5	0.637	Hexavalent chromium	
T100H6J5	580072.8	149811.0	1.535	Hexavalent chromium	
T100H6J6	580156.2	149811.0	0.669	Hexavalent chromium	
T100H6J8	579611.1	149660.4	0.252	Hexavalent chromium	
J100H2	576559.0	154142.0	[a]	Hexavalent chromium	Samples locations identified for Phase IIa sampling but were not sampled due to presence of salmon redds. The locations that show elevated conductivity indicating groundwater upwelling are also to be sampled for indicator contaminants under Phase IIb.
J100H3	576700.3	154038.7	[a]	Hexavalent chromium	
J100H4	576862.1	153935.4	[a]	Hexavalent chromium	
J100H6	577261.6	153897.5	[a]	Hexavalent chromium	
J100H10	577427.0	153670.2	[a]	Hexavalent chromium	
J100H11	577499.3	153615.1	[a]	Hexavalent chromium	
J100H12	577575.1	153577.2	[a]	Hexavalent chromium	
J100H14	577654.3	153690.8	[a]	Hexavalent chromium	
J100H15	577575.1	153752.8	[a]	Hexavalent chromium	
J100H16	577506.2	153794.2	[a]	Hexavalent chromium	
J100H18	578188.1	153050.2	[a]	Hexavalent chromium	
J100H19	578329.3	153160.5	[a]	Hexavalent chromium	
J100H20	578325.9	152895.3	[a]	Hexavalent chromium	
J100H21	578453.3	153002.0	[a]	Hexavalent chromium	
J100H22	576641.7	154228.1	[a]	Hexavalent chromium	
J100H23	576776.0	154159.2	[a]	Hexavalent chromium	
J100H24	578343.1	152602.5	[a]	Hexavalent chromium	
J100H25	578384.4	152637.0	[a]	Hexavalent chromium	
J100H26	578429.2	152678.3	[a]	Hexavalent chromium	
J100H27	578505.0	152757.5	[a]	Hexavalent chromium	
J100H28	578670.3	152523.3	[a]	Hexavalent chromium	
J100H29	578553.2	152397.4	[a]	Hexavalent chromium	
J100H30	578878.7	152387.1	[a]	Hexavalent chromium	
J100H31	578788.6	152304.0	[a]	Hexavalent chromium	
J100H32	579044.8	152051.2	[a]	Hexavalent chromium	
J100H33	579155.6	152134.3	[a]	Hexavalent chromium	
J100H34	579266.4	151756.9	[a]	Hexavalent chromium	
J100H35	579636.9	151473.1	[a]	Hexavalent chromium	
J100H36	579906.9	151144.2	[a]	Hexavalent chromium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
J100H37	580093.9	150801.4	[a]	Hexavalent chromium	
J100H44	578264.7	152683.7	[a]	Hexavalent chromium, strontium-90 [c]	
100-K					
J100K12	569249.2	147689.5	0.211	Hexavalent chromium	
J100K2	568445.1	146911.1	0.235	Hexavalent chromium	
J100K23	570237.8	148693.6	0.226	Hexavalent chromium	
J100K24	570363.7	148794.0	0.269	Hexavalent chromium	
J100K25	570444.0	149062.9	0.168	Hexavalent chromium	
J100K27	570613.2	149052.6	0.228	Hexavalent chromium	
J100K28	570682.8	149115.7	0.212	Hexavalent chromium	
J100K29	570775.7	149224.6	0.207	Hexavalent chromium	
J100K3	568536.3	146969.9	0.307	Hexavalent chromium	
J100K32	568419.5	146940.8	0.216	Hexavalent chromium	
J100K33	568239.8	146794.3	0.274	Hexavalent chromium	
J100K37	568553.3	147092.4	0.205	Hexavalent chromium	
J100K39	568688.8	147160.6	0.198	Hexavalent chromium	
J100K4	568607.4	147046.3	0.207	Hexavalent chromium	
J100K40	568645.9	147226.9	0.145 b	Hexavalent chromium	
J100K52	570243.3	148881.5	0.175	Hexavalent chromium	
J100K7	568835.7	147229.0	0.206	Hexavalent chromium	
J100K9	568982.5	147378.5	0.238	Hexavalent chromium	
K Intake Test 1	568739.4	147089.0	0.533	Hexavalent chromium	
K Intake Test 3A	568708.5	147110.9	0.178	Hexavalent chromium	
KWIN Test 1	568251.1	146742.2	0.391	Hexavalent chromium	
KWIN Test 3	568249.3	146766.6	0.385	Hexavalent chromium	
T100K1A	568321.3	146830.8	0.217	Hexavalent chromium	
T100K1B	568273.0	146900.3	0.343	Hexavalent chromium	
T100K1C	568239.8	146933.2	0.252	Hexavalent chromium	
T100K2A	568785.8	147181.8	0.298	Hexavalent chromium	
T100K2B	568723.3	147288.9	0.197	Hexavalent chromium	
T100K3A	569179.1	147592.0	0.240	Hexavalent chromium	
T100K3D	568920.6	147778.0	0.415	Hexavalent chromium	
T100K3E	568876.0	147857.5	0.445	Hexavalent chromium	
T100K4A	569882.1	148416.0	0.172	Hexavalent chromium	
T100K6E	570398.4	149422.5	0.346	Hexavalent chromium	
100-N					
JT100N2D	570754.9	149691.2	0.335	Strontium-90	
JT100N2E	570644.7	149762.2	0.244	Strontium-90	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
JT100N3A	571113.9	149681.0	0.311	Strontium-90, TPH	
JT100N5A	571648.2	150429.9	0.220	Strontium-90	
JT100N6A	571764.9	150589.1	0.265	Strontium-90	
JT100N6C	571579.5	150743.7	0.175	Strontium-90	
JT100N6E	571460.1	150872.3	0.395	Strontium-90	
N Intake 1	570978.3	149496.0	0.450	Strontium-90	
N Intake 2	570948.1	149460.1	0.770	Strontium-90	
N Intake D	570952.4	149487.9	0.848	Strontium-90	
N Outfall	571024.1	149574.3	0.504	Strontium-90	
T100N1A	571225.0	149863.5	0.655	Strontium-90, TPH	
T100N1B	571113.4	149912.2	0.180	Strontium-90, TPH	
T100N1C	571084.9	149934.1	0.168	Strontium-90, TPH	
T100N1E	570876.6	150079.5	0.374	Strontium-90, TPH	
T100N2A	571251.5	149880.5	0.795	Strontium-90, TPH	
T100N3A	571305.8	149947.8	0.445	Strontium-90, TPH	
T100N3B	571235.1	149980.3	0.177	Strontium-90, TPH	
T100N4A	571336.8	149981.5	0.219	Strontium-90, TPH	
T100N4J1	571484.9	150205.6	0.191	Strontium-90	
T100N5C	571415.4	150390.4	0.204	Strontium-90	
T100N5D	571269.6	150492.1	0.256	Strontium-90	
T100N5E	571203.2	150541.3	0.310	Strontium-90	
T100N5RING	571565.5	150312.2	0.302	Strontium-90	
T100N6A	572004.5	150895.5	0.174	Strontium-90	
T100N6C	571810.6	150993.2	0.191	Strontium-90	
T100N6E	571662.8	151197.1	0.373	Strontium-90	
T100NJ12	571528.6	150259.5	0.205	Strontium-90	
T100NJ4	570913.4	149550.8	0.196	Strontium-90	
J100N1	571413.5	150094.7	[b]	Strontium-90, TPH	Phase IIb sample to be taken at the location with higher conductivity
J100N2	571391.9	150122.4	[a]	Strontium-90, TPH	
300 Area					
J3001	594350.2	117083.4	0.257	Uranium	
J30010	594580.3	116039.8	0.188	Uranium, TCE	
J30013	594565.3	115917.3	0.188	Uranium, TCE	
J30014	594622.3	115910.4	0.152	Uranium, TCE	
J30015	594588.3	115776.5	0.185	Uranium, TCE	
J30016	594632.2	115670.4	0.348	Uranium	
J30019	594685.1	115489.0	0.223	Uranium	
J3002	594386.0	116807.1	0.348	Uranium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
J30022	594792.5	115017.1	0.195	Uranium	
J30026	594472.7	116869.6	0.174	Uranium	
J30028	594473.4	116480.6	0.197	Uranium	
J3003	594425.3	116506.5	0.325	Uranium	
J30033	594772.7	115887.2	0.170	Uranium	
J30034	594615.4	115862.5	0.167	Uranium, TCE	
J30035	594677.3	115743.4	0.171	Uranium, TCE	
J30036	594946.9	115475.3	0.231	Uranium	
J30037	594859.2	115034.8	0.172	Uranium	
J3005	594467.0	116299.3	0.277	Uranium, TCE	
J3007	594554.9	116287.3	0.172	Uranium, TCE	
J3008	594540.7	116013.6	0.261	Uranium, TCE	
T3001J2	594395.4	116700.6	0.300	Uranium	
T3001J3	594411.3	116661.9	0.583	Uranium	
T3002D	595020.7	116565.8	0.359	Uranium	
T3002J1	595181.3	116727.3	0.615	Uranium	
T3003A	594510.8	116153.2	0.248	Uranium	
T3005C	594904.3	115641.3	0.180	Uranium	
T3005D	595285.5	115726.2	0.663	Uranium	
T3005E	595367.4	115752.0	0.610	Uranium	
T3005J5	595678.7	113964.9	1.090	Uranium	
T3006J1	594966.9	113858.1	0.423	Uranium	
T3006J6	594895.4	114341.7	0.363	Uranium	
T3006J7	594832.7	114762.0	0.217	Uranium	
J30039	594604.7	115791.6	[b]	Uranium, TCE	
J30040	594636.6	115796.1	[b]	Uranium, TCE	
Hanford Townsite					
JHTS11	590072.2	136795.5	0.223	Tritium	
JHTS13	590906.8	135959.8	0.170	Tritium	
JHTS15	591044.8	136064.1	0.202	Tritium	
JHTS17	591069.4	135500.9	0.176	Tritium	
JHTS18	591432.5	134767.1	0.202	Tritium	
JHTS19	591693.3	134568.7	0.198	Tritium	
JHTS2	585484.5	140410.6	0.192	Tritium	
JHTS21	592874.0	133810.8	0.212	Tritium	
JHTS23	593013.1	133894.1	0.259	Tritium	
JHTS24	593428.1	133252.4	0.201	Tritium	
JHTS26	594278.9	132028.3	0.286	Tritium	
JHTS28	594391.2	131029.6	0.212	Tritium	

Table A-1. Phase IIb Sample Locations and Analytes. (8 Pages)

Phase IIb Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Phase IIa pore water conductivity (mS/cm)	Analytes	Notes
JHTS29	594710.0	128067.6	0.196	Tritium	
JHTS30	594918.8	126697.9	0.187	Tritium	
JHTS33	591169.8	135300.1	0.309	Tritium	
JHTS38	594517.7	129662.0	0.200	Tritium	
JHTS4	586914.9	139054.8	0.284	Tritium	
JHTS8	588309.8	138119.0	0.161	Tritium	
JHTS9	588864.0	137815.9	0.172	Tritium	
THTS1J1	585067.5	140797.2	0.213	Tritium	
THTS1J8	587768.4	138445.7	0.684	Tritium	
THTS2J1	589354.7	137554.1	0.171	Tritium	
THTS3B	589481.9	137561.5	0.226	Tritium	
THTS3D	589611.2	137733.5	0.176	Tritium	
THTS3E	589677.3	137823.4	0.222	Tritium	
THTS3J1	590072.2	136895.5	0.221	Tritium	
THTS3J2	590825.5	135906.3	0.589	Tritium	
THTS4D	593608.8	133672.1	0.232	Tritium	
THTS4E	593682.7	133756.6	0.334	Tritium	
THTS5A	594806.8	125416.7	0.200	Tritium	
JHTS46	591826.5	134711.0	[a]	Tritium	

[a] Location had not yet been sampled under Phase IIa when the Phase IIb sample locations were approved by the Tri-Parties.
[b] Location added as a Phase IIa/IIb sample by the Tri-Parties.
[c] Additional analytes added by the Tri-Parties.
[d] Anions, nitrate/nitrite, and metals will be analyzed by methods 300.0, 353.2, and 6010 (trace), respectively.

TCE = trichloroethylene
TPH = total petroleum hydrocarbons
WSP = Washington State Plane, NAD83

Table A-2. Groundwater Plume Upwelling Characterization (Phase III) Sample Locations. (2 Pages)

Phase III Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Rank [a]	Notes
		100-BC		
T100BC4A	565444.8	145470.5	Primary	
T100BC6J10	565587.4	145523.2	Alternate	
J100BC47	566140.7	145687.1	Primary	
T100BC1J1	564838.1	145281.7	Alternate	
T100BC1J5	564833.8	145328.3	Primary	
T100BC3C	565054.8	145573.0	Primary	
T100BC5C	565484.2	145718.9	Primary	
J100BC23	565627.5	145568.1	Primary	
2A-A	564670.9	145309.9	Alternate	
J100BC21	565283.0	145497.7	Alternate	
		100-D		
J100D36	573141.8	152178.6	Primary	
T100D2A	572603.8	151634.1	Primary	
T100D3A	572670.5	151684.9	Primary	
J100D9	573703.1	152564.5	Primary	
J100D39	573593.9	152484.3	Primary	
T100D1A	572407.7	151406.1	Primary	
J100D40	TBD	TBD	Alternate	Phase IIa sample to be located between T100D1A/T100D1J1 and sampled for hexavalent chromium in pore water only
		100-F		
T100F2A	580951.6	148181.9	Primary	
J100F11	581082.8	148098.1	Primary	
		100-H		
J100H43	579647.3	149521.9	Primary	
J100H44	578261.8	152687.5	Primary	
T100H1A	577208.6	153714.5	Primary	
T100H1E	577661.0	154625.2	Primary	
T100H2A	578121.8	152992.5	Primary	
T100H6A	580097.5	150543.9	Primary	
T100H6J6	580156.9	149814.4	Alternate	Resample pore water only for hexavalent chromium. Review results to determine if full Phase III sample is justified.
J100H3	TBD	TBD	Alternate	Phase IIa sample location to be sampled for hexavalent chromium in pore water only

Table A-2. Groundwater Plume Upwelling Characterization (Phase III) Sample Locations. (2 Pages)

Phase III Sample Location Identification	Easting WSP (m)	Northing WSP (m)	Rank [a]	Notes
		100-K		
J100K24	570365.1	148802.9	Primary	
K Intake Test 3A	568700.7	147127.4	Alternate	
KWIN Test 1	568253.4	146744.4	Primary	
T100K1C	568236.0	146922.1	Primary	
T100K2B	568813.0	147339.9	Primary	
T100K3A	569177.3	147610.9	Primary	
		100-N		
N Outfall	571024.1	149572.1	Primary	
JT100N3A	571112.4	149675.4	Primary	
T100N1A	571231.0	149869.1	Primary	
T100N2A	571247.7	149880.4	Primary	
T100N3A	571305.9	149945.6	Primary	Sample location for sediment collection only
T100N5Ring	571564.0	150306.6	Primary	
		300 Area		
J30016	594629.8	115681.5	Primary	
J30019	594688.8	115496.8	Primary	
T3003A	594515.4	116154.4	Primary	
J3002	594386.0	116809.4	Alternate	
J30013	594568.3	115922.9	Alternate	
J3008	594537.9	116042.5	Primary	
T3005J5	595678.7	113964.9	Primary	
T3001J3	594406.7	116665.2	Primary	
J30040	594653.2	115804.2	Alternate	
		Hanford Town Site		
JHTS9	588864.0	137815.9	Primary	
JHTS18	591433.3	134764.9	Primary	
JHTS19	591696.3	134567.7	Primary	
JHTS33	591173.6	135300.1	Primary	
JHTS40	TBD	TBD	Primary	Located near aquifer tubes C6375 (N 123115.7, E 594448.4)

[a] Primary sample locations are the priority for this study and are to be sampled first. Alternate sample locations may be sampled after primary sample locations are completed, provided favorable river conditions exist.

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