

APPENDIX A

DATA USABILITY ASSESSMENT

UPPER COLUMBIA RIVER

FINAL **Aquatic Baseline Ecological Risk Assessment** **Appendix A** **Data Usability Assessment**

Prepared for

Teck American Incorporated

P.O. Box 3087
Spokane, WA 99220-3087

Prepared by



200 First Avenue West, Suite 500
Seattle, WA 98119

In Association and Consultation with

ERM and Parametrix, Inc.

July 2026

CONTENTS

LIST OF ATTACHMENTS	V
LIST OF MAPS.....	VI
LIST OF TABLES	VII
ACRONYMS AND ABBREVIATIONS	VIII
UNITS OF MEASURE	XI
1 INTRODUCTION.....	1-1
2 APPROACH	2-1
3 ENVIRONMENTAL CHEMISTRY DATA USABILITY	3-1
3.1 Sediment, Porewater, Surface Water, Aquatic Tissue, and Soil Chemistry Data	3-1
3.1.1 Step 1—Data Inventory	3-1
3.1.2 Step 2—Data Quality Assessment	3-5
3.1.3 Step 3—Data Suitability Assessment	3-6
3.1.4 Step 4—Data Comparability Assessment.....	3-12
3.2 IVBA Data	3-14
3.2.1 Step 1—Data Inventory	3-14
3.2.2 Step 2—Data Quality Assessment	3-15
3.2.3 Step 3—Data Suitability Assessment	3-15
3.2.4 Step 4—Data Comparability Assessment.....	3-15
3.3 Bioaccumulation Data	3-16
3.3.1 Step 1—Data Inventory	3-16
3.3.2 Step 2—Data Quality Assessment	3-16
3.3.3 Step 3—Data Suitability Assessment	3-17
3.3.4 Step 4—Data Comparability Assessment.....	3-17
4 INVERTEBRATE BIOASSAY DATA USABILITY	4-1
4.1 Step 1—Data Inventory	4-1
4.2 Step 2—Data Quality Assessment.....	4-2
4.3 Step 3—Data Suitability Assessment	4-4
4.4 Step 4—Data Comparability Assessment.....	4-6

5	BENTHIC INVERTEBRATE COMMUNITY DATA USABILITY	5-1
5.1	Step 1—Data Inventory	5-1
5.2	Step 2—Data Quality Assessment	5-1
5.3	Step 3—Data Suitability Assessment	5-1
5.4	Step 4—Data Comparability Assessment.....	5-2
6	BSEM DATA USABILITY	6-1
6.1	Step 1—Data Inventory	6-1
6.2	Step 2—Data Quality Assessment	6-1
6.3	Step 3—Data Suitability Assessment	6-1
6.4	Step 4—Data Comparability Assessment.....	6-2
7	SUMMARY.....	7-1
7.1	Environmental Chemistry DUA Summary	7-1
7.2	Bioassay DUA Summary	7-2
7.3	Benthic invertebrate Community DUA Summary.....	7-4
7.4	BSEM Data DUA Summary.....	7-4
8	REFERENCES	8-1

LIST OF ATTACHMENTS

Attachment A1	Field Porewater Data Comparability
Attachment A2	Grain Size Data and CS50 Designations

LIST OF MAPS

- | | |
|----------|--|
| Map A-1a | Sample Locations for Data Sets Considered for Inclusion as Soil Data in the Aquatic BERA |
| Map A-1b | Sample Locations for Data Sets Considered for Inclusion as Soil Data in the Aquatic BERA |

LIST OF TABLES

Table A-1	Results of Chemistry Inventory Screening
Table A-2	Inventory of Chemistry Studies
Table A-3	Chemistry Data Quality Documentation Items
Table A-4	EPA Data Validation Guidance/Level of Variance
Table A-5	Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies
Table A-6	Inventory of IVBA Studies
Table A-7	Inventory of Bioaccumulation Studies
Table A-8	Inventory of Bioassay Studies
Table A-9	Data Quality Information for Bioassay Studies
Table A-10	Bioassay Details Considered in Suitability Assessment
Table A-11	Bioassay Methods Considered in Comparability Assessment
Table A-12	Chemistry, IVBA, and Bioaccumulation Data Usability Assessment Summary
Table A-13	Invertebrate Bioassay Data Usability Assessment Summary

ACRONYMS AND ABBREVIATIONS

ADA	aerial deposition area
ALS	ALS Environmental - Kelso
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
AVS	acid volatile sulfide
BERA	baseline ecological risk assessment
bgs	below ground surface
BLM	biotic ligand model
BMI	benthic macroinvertebrate
BSEM	backscatter electron microscopy
CAS	Columbia Analytical Services (now ALS)
CEC	cation-exchange capacity
CERC	Columbia Environmental Research Center
CLP	Contract Laboratory Program
COC	chain of custody
COPC	chemical of potential concern
CR	concentration-response
D/F	dioxins/furan
DGT	diffusive gradient thin-film
DL	detection limit
DOC	dissolved organic carbon
DOI	Department of the Interior
DU	decision unit
DUA	data usability assessment
DV	data validation
dw	dry weight
EC&T	Environmental Consulting and Testing
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency

EPC	exposure point concentration
ERA	ecological risk assessment
ERDC	Engineer Research and Development Center
FSCA	fish sampling collection area
HASL	Health and Safety Laboratory
HHRA	human health risk assessment
ICP-MS	inductively coupled plasma – mass spectroscopy
ICS	incremental composite sampling
ID	identification
IVBA	in vitro bioaccessibility
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOI	loss on ignition
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NAS	Northwestern Aquatic Sciences
ND	not detected
NRT	Natural Resource Trustees
OC	organic carbon
OU	operable unit
PARCC	precision, accuracy, representativeness, comparability, and completeness
PAH	polycyclic aromatic compound
PCB	polychlorinated biphenyl
PBDE	polybrominated diphenyl ether
PER	Pacific EcoRisk
PSEP	Puget Sound Estuary Program
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RFA	relict floodplain area

RFDA	relict floodplain deposition area
RI/FS	remedial investigation/feasibility study
RL	reporting limit
RM	river mile
RPD	relative percent difference
SDG	sample delivery group
SDU	sediment decision unit
SEM	simultaneously extracted metal
SGS NC	SGS North Carolina
SIM	selected ion monitoring
SLERA	screening-level ecological risk assessment
SM	Standard Method
SOW	statement of work
SPLP	synthetic precipitation leaching procedure
SRM	standard reference material
SVOC	semi-volatile organic compound
TAC	test acceptability criteria
TAI	Teck American Incorporated
TAL	EPA target analyte list
TDS	total dissolved solids
TOC	total organic carbon
TSP	total suspended particulates
TSS	total suspended solids
UCR	Upper Columbia River
UDU	upland decision unit
UMFS	University of Mississippi Field Station
USGS	U.S. Geological Survey
USGS-ML	U.S. Geological Survey Minerals Laboratory
UW	University of Washington
WSDA	windblown sediment deposition area
XRF	x-ray fluorescence

YCT yeast-cerophyl-trout chow

UNITS OF MEASURE

cm	centimeter(s)
ft	foot/feet
g/L	gram(s) per liter
in.	inch(es)
m	meter(s)
mg/L	milligram(s) per liter
mL/day	milliliter(s) per day
µm	micrometer(s)
mm	millimeter(s)
rpm	revolutions per minute

1 INTRODUCTION

This appendix presents the data usability assessment (DUA) conducted by Teck American Incorporated (TAI) to support the baseline ecological risk assessment (BERA) for Operable Unit (OU) 1, OU 2, the relict floodplain deposition areas (RFDAs), and the windblown sediment deposition areas (WSDAs) of the Upper Columbia River (UCR) site (hereafter, the Site¹). A DUA is a critical predecessor to conducting analyses for ecological risk assessments (ERAs) (USEPA 1998).

This appendix presents the approach and findings of the DUA for OUs 1 and 2 and the RFDAs and WSDAs. It establishes the environmental chemistry data set that is suitable and of acceptable quality for use in conducting the BERA for OUs 1 and 2 and the RFDAs and WSDAs (hereafter, the Aquatic BERA). Attachment A1 provides a comparability assessment of the field-collected porewater data, and Attachment A2 addresses the comparability of the grain size information in the Aquatic BERA data set.

¹ The Site is defined in the June 2, 2006, UCR remedial investigation and feasibility study (RI/FS) Settlement Agreement as “the areal extent of hazardous substances contamination within the United States in or adjacent to the UCR, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and those areas in proximity to the contamination that are suitable and necessary for implementation of response actions described in the Agreement.” Sec. II, ¶ 6 o (USEPA 2006b).

2 APPROACH

The DUA established four types of studies considered for use in the Aquatic BERA, as follows:

1. **Environmental chemistry.** These studies include data for: 1) sediment, porewater, surface water, aquatic tissue, and soil² (total metals and associated conventional parameters) for evaluating receptor exposures at the Site; 2) in vitro bioaccessibility (IVBA) data for determining metals bioavailability in sediment and soil; and 3) co-located soil and biota tissue metal concentration data for evaluating terrestrial bioaccumulation.
2. **Bioassays.** These studies include toxicological data and associated laboratory sediment and porewater chemistry data used to evaluate the biological responses of various invertebrate test species after exposure to sediment samples collected at the Site. For fish, the only toxicological study that used sediment or surface water samples collected from the UCR to evaluate biological responses associated with exposure to chemicals of potential concern (COPCs) in media from the Site is the 2010 White Sturgeon Sediment Toxicity Study (TAI 2018a).³ However, the U.S. Environmental Protection Agency (EPA) has expressed concerns with this study (USEPA 2021a, pers. comm.) and directed TAI not to include it in the Aquatic BERA.
3. **Benthic invertebrate community.** These studies include benthic invertebrate community metrics data (e.g., measures of community structure and function) used to assess potential sediment toxicity effects, such as reduced species diversity and richness or increased pollution tolerance.

² For the purposes of this Aquatic BERA, soil samples are defined as those collected between the full pool elevation (elevation contour 1,290 feet downstream of River Mile 730 and the post-1973 flood elevation upstream of there to the U.S.-Canada border) and below the pre-1973 flood elevation as well as samples from windblown sediment deposition areas, both of which are defined in the 2014 Upland Soil Study Quality Assurance Project Plan (TAI 2014). The water regulation provided by the upriver dams in Canada (construction completed in 1973) has significantly reduced the frequency of flooding between the full pool elevation and the pre-1973 flood elevation, although short-term flooding still occurs in some areas during extreme events. Sediment samples are those that were collected below the full pool elevation.

³ There are white sturgeon toxicity studies with water-only exposure but spiked water was used rather than surface water samples from the Site.

4. **Backscatter electron microscopy (BSEM).** These studies include BSEM data used to estimate the slag content of sediment that is, in turn, used to evaluate the relationship between slag content and toxicity.

A four-step process was implemented to assess data usability for the Aquatic BERA, consistent with EPA's *Guidance for Data Useability in Risk Assessment* (USEPA 1992). The four steps are:

- **Step 1—Data inventory.** Identify all studies with data potentially relevant for use in the BERA.
- **Step 2—Data quality assessment.** Assess whether data identified in Step 1 are of acceptable quality for use in the BERA.
- **Step 3—Data suitability assessment.** Assess relevance of sampling locations and types of measurements and the reliability of sampling and analytical methods relative to the risk questions.
- **Step 4—Data comparability assessment.** Determine whether data collected from different studies or using different methods can be combined for specific evaluations.

These four data usability steps are discussed separately for the four types of studies that may provide data for this BERA. The data inventory and data quality assessment (Steps 1 and 2) identify the studies containing relevant data that are available and of acceptable quality to be used in specific risk assessment applications. Studies with data found to be of acceptable quality are carried forward to the data suitability assessment (Step 3).

Step 3 evaluates whether the data of sufficient quality are suitable for answering the risk questions in the Aquatic BERA. This step results in a decision on the overall suitability of the data set within a given study based on the relevance of sampling and analytical methods. Other considerations for the suitability of specific data within a study (e.g., which sediment sample depths or tissue types should be used in specific analyses) are determined prior to each analysis.⁴

Step 4, the data comparability assessment, evaluates methods for sample collection, handling, and analyses to determine whether data sets from different studies are similar enough in study design and analytical method to be combined for a specific analysis, and

⁴ See Section 4, Volume 1, of the Aquatic BERA for the ecological assessment endpoint-specific exposure assessment, Appendix E for bioaccumulation data, and Attachment H3 to Appendix H for IVBA data.

whether such combinations are appropriate for particular analyses being conducted. If it is not appropriate to combine data sets, decisions about how each data set will be used separately to answer specific risk questions will be based on each data set's relevance and reliability.

3 ENVIRONMENTAL CHEMISTRY DATA USABILITY

This section presents the DUA for three types of environmental chemistry data:

1. Data collected for sediment, porewater, surface water, aquatic tissue, and soil (total metals and associated conventional parameters) for evaluating receptor exposures at the Site
2. IVBA data for determining bioavailability in sediment and soil
3. Co-located soil and biota tissue metal concentration data for evaluating terrestrial bioaccumulation.

The following sections document the four data usability steps conducted for each of these data types.

3.1 SEDIMENT, POREWATER, SURFACE WATER, AQUATIC TISSUE, AND SOIL CHEMISTRY DATA

3.1.1 Step 1—Data Inventory

Environmental chemistry data reported in the *Upper Columbia River Screening-Level Ecological Risk Assessment* (TAI 2010), the *Upper Columbia River Baseline Ecological Risk Assessment Work Plan* (TAI 2011), and COPC Refinement documents (TAI 2019a, 2020)⁵, as well as any UCR environmental chemistry data collected since the COPC Refinement was completed, were reviewed for inclusion in the Aquatic BERA data inventory. For sediment, porewater, surface water, and biological aquatic tissue, studies were included if they contained data collected from the Site during or after the year 2000 (consistent with the screening-level ecological risk assessment [SLERA]). For soil, studies were subjected to preliminary screening; all data that passed the screen were included in the environmental chemistry data inventory for the Aquatic BERA. This data inventory does not include several studies with sediment and soil data used to develop background values; see Appendix C for a description of how sediment and soil background data sets were developed and a list of the associated studies. In addition, this data inventory includes only environmental chemistry data used to evaluate the exposure of UCR receptors; the inventories for IVBA data and soil and plant tissue data used for bioaccumulation

⁵ The COPC Refinement (TAI 2019a) included an addendum that was finalized in January 2020 (TAI 2020). This citation (TAI 2020) is used in the remainder of the appendix to cite the COPC Refinement document.

modeling are discussed in Sections 3.2 and 3.3, respectively. The results of the sediment, porewater, surface water, and aquatic tissue data review and the screening of soil data are described in the following subsections.

3.1.1.1 Sediment, Porewater, Surface Water, and Aquatic Tissue Data

The sediment, porewater, surface water, and aquatic tissue chemistry data used to evaluate Site-specific exposure come from eight studies conducted by TAI to support the RI/FS (Table A-1). These data inventory studies, listed by date(s) of sample collection, are as follows:

- 2009 Fish Tissue Study (TAI 2013b)
- 2009–2010 Surface Water Study (TAI 2013a)
- 2009–2011 Beach Sediment Study (TAI 2014)
- 2010 White Sturgeon Sediment Toxicity Study (TAI 2018a)
- 2013 Phase 2 Sediment Study (TAI 2017c)
- 2015 Bossburg Flat Sediment and Soil Study (TAI 2016)
- 2016 Macroinvertebrate Tissue Study (TAI 2018b)
- 2019 Phase 3 Sediment Study (TAI 2022)

Three studies conducted by EPA for the RI/FS that contain sediment, porewater, surface water, or aquatic tissue chemistry data are included in the data inventory (Table A-1) and are as follows:

- 2001 Expanded Site Investigation (USEPA 2003)
- 2005 Phase 1 Sediment Sampling (USEPA 2006a)
- 2005 Phase 1 Fish Tissue Sampling (USEPA 2007)

The data inventory also includes two fish tissue studies conducted by EPA, with the data reports prepared by TAI under EPA oversight, as follows:

- 2016 Sturgeon Tissue Sample Collection (TAI 2017b)
- 2018 Northern Pike Tissue Study (TAI 2019b)

The remaining studies that provide data included in the data inventory, including sediment, porewater, surface water, and aquatic tissue chemistry data, were conducted separately from the UCR RI/FS by U.S. Geological Survey (USGS) or the Washington State Department of Ecology (Ecology). These studies are as follows:

- 2000 USGS Water Quality Data for Northport (USGS 2006a)
- 2000–2007 Water Quality Monitoring at Northport (Ecology 2007b)
- 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001)
- 2002–2003 USGS Sediment Core Sampling (USGS 2005)
- 2004 USGS Sediment Sampling (USGS 2006b)⁶
- 2007 Ecology Reconnaissance and Sediment Sampling (Ecology 2007a)
- 2004, 2008, and 2013 USGS Toxicity Evaluations (Besser et al. 2008; Fairchild et al. 2012; USGS 2016a)
- 2015 USGS Porewater Study (USGS 2016b)
- 2019 Northport Waterfront RI (Ecology 2019)

3.1.1.2 Soil Data

Ten studies were considered for inclusion in the soil chemistry data inventory (Table A-1). Soil chemistry data were screened for grain size, sample depth, and sample media type and location relative to the pre-1973 maximum flood elevation of the UCR. Details of the screening process are as follows:

- **Grain size.** Only studies with soil samples sieved to < 2 mm prior to chemical analysis were included in the Aquatic BERA soil chemistry data inventory. Studies with data representing only the fine-grained fraction of soil samples (i.e., < 150- μ m samples collected specifically for use in the human health risk assessment [HHRA]) were not included.
- **Soil sample depth horizon.** Only studies with soil samples collected from depths of between 0 and 12 in. were included in the Aquatic BERA soil chemistry data inventory. The sampling depth of 0 to lower depths of 25 to 30 cm (0 to approximately 10 to 12 in.) is defined by USEPA (2015) as the “biotic zone” relevant for estimating exposure for plants and soil-dwelling ecological receptors.
- **Sampling location.** Only studies with soil samples collected from locations between the pre-1973 maximum flood elevation and the current annual high-water

⁶ Surface water data from this USGS study are not included in the data inventory because of uncertainties associated with the unusual method used to collect water from the sediment box corer; this method may have allowed surface water to mix with sediments or porewater.

mark of the UCR were included in the soil chemistry data inventory for the Aquatic BERA (Maps A-1a and A-1b). Soil samples collected above the pre-1973 maximum flood extent are evaluated in the Upland BERA for the Site. Samples collected below the current annual high-water mark are evaluated as sediment samples in the Aquatic BERA (see Section 3.1.1.1).

Seven studies were eliminated because they did not meet the screening criteria, as follows:

- Insufficient information was available for the Teck Cominco ERA Biomonitoring Program (Cominco 1998) and the Trail, British Columbia, vegetation recovery study (Archibold 1974) to determine whether any of the criteria were met.
- The two residential soil studies (TAI 2017a; USEPA 2016) and the 2018 Plant Tissue Study (TAI 2019c) were excluded because only samples sieved to < 150 µm had been analyzed.
- All soil samples in the 2012 Ecology Upland Soil Study (Ecology 2013) and the 2015 Bossburg Flat Sediment and Soil Study (TAI 2016) were excluded because they had been collected above the pre-1973 maximum flood elevation (Maps A-1a and A-1b)⁷.

Three studies are included in the Aquatic BERA soil chemistry data inventory because at least one soil sampling location in each study was below the pre-1973 flood elevation (Table A-1). These studies are as follows:

- Le Roi Removal Action Study (USEPA 2005)
- 2014 Soil Study (TAI 2015)
- 2019 Northport Waterfront RI (Ecology 2019)

Table A-2 documents sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation procedures for data from the three soil studies included in the Aquatic BERA soil chemistry data inventory.

⁷ In the case of the 2015 Bossburg Flat Sediment and Soil Study (TAI 2016), samples were designated *a priori* as being either from sediment decision units (SDUs) or upland decision units (UDUs). The samples from SDUs were included in the sediment data inventory in the previous subsection. The samples from UDUs were screened based on their location relative to the pre-1973 maximum flood elevation (Map A-1b). While a couple of the discrete samples associated with UDUs appear to overlap with the pre-1973 maximum flood elevation, they were incorporated with the larger UDU, which was included in the Upland BERA.

3.1.2 Step 2—Data Quality Assessment

The data quality assessment included a review of the 10 data quality documentation items presented in Table A-3, all of which align with the data usability criteria defined by USEPA (1992).⁸ The data validation stage was determined based on the EPA data validation checks listed in Table A-4. The outcome of this review is a data use recommendation for each study with categories as follows:

- **Acceptable.** All necessary documentation is available; the review confirmed that the study data are of adequate quality for use in the Aquatic BERA.
- **Conditionally acceptable.** There are gaps or deficiencies in the available study documentation, precluding review; however, the review of available documentation did not identify any significant data quality issues that would disqualify its use in the Aquatic BERA.
- **Not acceptable.** Significant deficiencies exist in available documentation (i.e., missing data quality documentation items listed in Table A-3), or available documentation indicates that data are not of sufficient quality to support use in a risk assessment.

The data quality recommendations for chemistry data sources are as follows (Table A-5):

- **Acceptable.** All post-Settlement Agreement (USEPA 2006b) studies conducted by TAI to support of the RI/FS meet all documentation requirements and are acceptable for use in the Aquatic BERA. These 11 studies (TAI 2014, 2018a, 2016, 2022, 2017c, b, 2013a, b, 2018b, 2019b, 2015) include chemistry data for sediment, porewater, surface water, fish tissue, invertebrate tissue, and soil (from RFDAs and WSDAs).
- **Conditionally acceptable.** Data from pre- and post-Settlement Agreement (USEPA 2006b) studies conducted by EPA, USGS, and Ecology (USEPA 2003; USGS 2005; USEPA 2006a, 2007; Ecology 2001, 2007a, 2019; Besser et al. 2008; Fairchild et al. 2012; USGS 2016a) are conditionally acceptable due to one or more missing data quality documentation items that prevents a full review and verification of the data quality. However, available documentation does not identify any data quality concerns that result in disqualification of the study data.

⁸ See Exhibit 61 in EPA's *Guidance for Data Useability in Risk Assessments (Part A)* (USEPA 1992).

- **Not acceptable.** Data from the 2000 USGS Water Quality Data for Northport (USGS 2006a) and 2000–2007 Water Quality Monitoring at Northport (2007) surface water studies are of unacceptable quality due to a significant lack of documentation. These studies lack acceptable documentation of data quality item numbers 1, 3, 4, 6, 7, 9, and 10 (Table A-5). Data from the LeRoi Removal Action Study (USEPA 2005) are of unacceptable quality because of the lack of documentation for data quality item numbers 2, 4, 5, 6, and 7 (Table A-5).

The acceptable and conditionally acceptable studies are evaluated further in the suitability assessment Section 3.1.3.

3.1.3 Step 3—Data Suitability Assessment

The suitability of data for use in the Aquatic BERA is dependent on the analysis objectives. Therefore, the first step in a suitability evaluation is to define the objectives of the analysis that will use the data. Consistent with the objectives described in the RI/FS Work Plan (USEPA 2008) and BERA Work Plan (TAI 2011) for the Site, the objectives of the Aquatic BERA are to assess potential risk from hazardous substances in sediment, soil, surface water, porewater, and aquatic tissues to ecological assessment endpoints within OU 1, OU 2, and the RFDAs and WSDAs, and to provide a basis for informed discussions with risk managers about the causes, natures, and extents of any such risks. The data suitability evaluation based on these objectives, as well as the risk questions presented in Volume 1, Section 2 of the Aquatic BERA, is presented in this section.

Environmental chemistry data of acceptable or conditionally acceptable quality have been evaluated further to determine their suitability by assessing the relevance of sampling and analytical methods relative to the study objectives. For conditionally acceptable data sets, the noted data quality limitations have also been evaluated.

This assessment identifies the suitability of entire studies; however, not all data within each suitable study are relevant for use in the Aquatic BERA. For example, data for surface sediment samples (0- to 15-cm [0- to 6-in.] depth) or surface sections of sediment cores⁹ are considered suitable, whereas deeper sediment samples from the same study are not considered suitable. The suitability of specific subsets of data provided by each study

⁹ Surface sections of cores were defined as those with start depths = 0 cm. This resulted in inclusion of some cores with maximum depths of up to 30 cm, or 1 ft below the sediment surface.

to represent exposure for each ecological assessment endpoint is discussed in the exposure assessment for each endpoint in the Aquatic BERA (see Section 4 of Volume 1).

3.1.3.1 Sediment Data Suitability

Some sediment studies are considered suitable for use in the Aquatic BERA for addressing risk questions related to the chemical exposure of receptors in the field, as opposed to exposure in laboratory bioassays. These studies are as follows:

- **RI/FS sediment studies.** The 2005 Phase 1 Sediment Sampling (USEPA 2006a), 2009–2011 Beach Sediment Study (TAI 2014), 2015 Bossburg Flat Sediment and Soil Study (TAI 2016), 2013 Phase 2 Sediment Study (TAI 2017c), 2010 White Sturgeon Sediment Toxicity Study (TAI 2018a), and 2019 Phase 3 Sediment Study (TAI 2022) were RI/FS studies that had approved quality assurance project plans (QAPPs) and were designed to inform the Aquatic BERA. All studies had acceptable data quality, with the exception of the 2005 Phase 1 Sediment Sampling (USEPA 2006a), which is considered conditionally acceptable because the laboratory report and detection limits (DLs) were not available for this data suitability analysis. Sampling methods (Table A-2) used in each of the studies are considered appropriate for use in the Aquatic BERA. Sediment collected at eight locations during the 2013 Phase 2 Sediment Study (TAI 2017c) was from rejected grab samples (i.e., only partial samples could be collected). However, these samples were retained and analyzed to conduct some evaluation of the area, in accordance with the QAPP and Standard Operating Procedure 3 of the field sampling plan.
- **2013 USGS Toxicity Evaluation (USGS 2016a).** This study was not conducted as part of the RI/FS. Most of the samples from this study were collected as splits for EPA as part of the 2013 Phase 2 Sediment Study (TAI 2017c); those samples are not suitable because only parent samples should be used in statistical analyses and risk assessments, per the data management plan for the UCR RI/FS (TAI 2019d). Only the samples collected by the Natural Resource Trustees (NRT) upstream of Onion Creek are suitable for use in the BERA, as these were not split samples.¹⁰ Although the sampling methodology used by NRT differed from that of the sediment studies conducted to support the UCR RI/FS,¹¹ these data are considered

¹⁰ An exception is that split sediment samples collected downstream of Onion Creek were used to develop a linear regression model to predict slag content based on bulk sediment zinc concentrations (see Section 6.3).

¹¹ The NRT samples were collected by hand from preferentially selected areas with the most depositional material at each location, and the samples were sieved to 2 mm.

suitable for addressing Aquatic BERA risk questions. The data quality is conditionally acceptable because source files provided by USGS indicate that non-detected concentrations were reported using a mix of DLs and reporting limits (RLs); this is not a substantial uncertainty affecting data quality.

- **2019 Northport Waterfront RI (Ecology 2019).** This study was not conducted as part of the RI/FS; however, the sampling and analytical methods are suitable for use in the Aquatic BERA, and the data quality is acceptable.

Sediment data from the remaining studies in the data inventory are not considered suitable for use in the Aquatic BERA, the reasons being as follows:

- **2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001).** This study was conducted prior to the Settlement Agreement (USEPA 2006b) and not as part of the RI/FS. Section 3.1.2 identifies missing documentation (i.e., no laboratory report, DLs, data qualifiers, or data validation), which generated uncertainty in the evaluation of data quality. In addition, the sampling locations were in areas covered by other, more recent studies that had been conducted in association with the RI/FS (Phase 1, Phase 2, Phase 3, and the beach sediment studies). Therefore, data from this study are not considered suitable for use in the Aquatic BERA.
- **2001 Expanded Site Investigation (USEPA 2003).** This study was conducted prior to the Settlement Agreement (USEPA 2006b) to determine, in part, if the Site should be placed on the National Priority List. The study was designed to inform future, more detailed investigations and/or response actions, like the 2005 Phase 1 Sediment Sampling. Samples collected as part of Phases 1, 2, and 3 adequately overlapped with the 2001 Expanded Site Investigation samples. Missing data quality documentation identified in Section 3 (i.e., no laboratory report or laboratory qualifier definitions, no qualifiers in data file, and some missing pages in the data validation reports) generated uncertainty in the data. Therefore, data from this study are not considered suitable for use in the Aquatic BERA.
- **2002–2003 USGS Sediment Core Sampling (USGS 2005).** This study was conducted prior to the Settlement Agreement (USEPA 2006b) and not as part of the RI/FS. The analytical method used to prepare sediment samples for metals analysis (four-acid digestion) was a near-total digestion method and unsuitable for assessing risk posed by bioavailable COPCs to ecological receptors. A subset of samples was pre-treated with hydroxylamine hydrochloride to remove weakly sorbed elements prior to chemical analysis to obtain more biologically relevant

samples. Finally, these samples came from subsurface locations and are therefore not applicable for use in the Aquatic BERA.

- **2004 USGS Sediment Sampling (USGS 2006b).** This study was conducted prior to the Settlement Agreement (USEPA 2006b) and was not associated with the RI/FS. Like the 2002–2003 USGS Sediment Core Sampling (USGS 2005), this study used more aggressive methods to extract COPCs from sediment (four-acid digestion as well as sequential extraction). These aggressive extraction methods likely overestimated bioavailable concentrations compared to those from methods used in studies conducted for the RI/FS, making the data from this study unsuitable for use in the Aquatic BERA.
- **2007 Ecology Reconnaissance and Sediment Sampling (Ecology 2007a).** This study was not conducted as part of the RI/FS. The samples were collected in areas that did not provide sample coverage beyond that provided by Phases 1, 2, and 3 or the beach sediment study. In addition, no data validation report was available, resulting in uncertainty in evaluating data quality. Therefore, data from this study are not suitable for use in the Aquatic BERA.
- **2004 USGS Toxicity Evaluation (Besser et al. 2008).** This study was conducted prior to the Settlement Agreement (USEPA 2006b) and not as part of the RI/FS. For this study, the USGS used sediment split samples from the 2004 USGS Sediment Sampling (USGS 2006b). Per the data management plan (TAI 2019d), only parent samples should be used in statistical analyses and risk assessments. Therefore, data from this study are not suitable for use in the Aquatic BERA. See Section 4.3 for a discussion of the suitability of data from this study for addressing bioassay-specific risk questions.
- **2008 USGS Toxicity Evaluation (Fairchild et al. 2012).** This study was not conducted as part of the RI/FS, and samples were collected in areas that have been covered by RI/FS studies. In addition, as discussed in Section 3, Step 3 of the DUA identified missing documentation (no chain of custody forms, no QAPP, no laboratory report, no DLs or RLs reported, no qualifiers, and no data validation), generating uncertainty in the evaluation of data quality. Therefore, data from this study are not suitable for use in the Aquatic BERA.

3.1.3.2 Porewater Data Suitability

This section addresses the suitability of porewater studies in answering risk questions related to chemical exposure of receptors under field conditions, as opposed to exposure

in laboratory bioassays. Porewater data from some studies are considered suitable for use in the Aquatic BERA, as follows:

- **2013 Phase 2 Sediment Study.** This RI/FS study had an approved QAPP and was designed to inform the Aquatic BERA. Data quality was considered acceptable, although there was some difficulty collecting porewater according to QAPP methodology, resulting in deviations from the methods described therein (e.g., different types of airstones were used).¹² These deviations are discussed in Attachment A1 of this appendix. EPA has indicated that these data should only be used as a supporting line of evidence in the Aquatic BERA, with an appropriate discussion of uncertainties (USEPA 2021a). The suitability of the laboratory-collected porewater data associated with the bioassay component of the Phase 2 Sediment Study is discussed in Section 4.1.3.
- **2019 Phase 3 Sediment Study (TAI 2022).** This RI/FS study had an approved QAPP, and analytical and sample collection methods were designed to inform the BERA. Data quality was considered acceptable. The suitability of the laboratory-collected porewater data associated with the bioassay component of the Phase 3 Sediment Study is discussed in Section 4.1.3.
- **2015 USGS Porewater Study (USGS 2016).** This study was not conducted as part of the RI/FS and no data report was produced. In addition, no QAPP or laboratory report was available, nor was information on chemicals of concern, sample handling documentation, DLs and RLs, or data validation, resulting in uncertainty in the evaluation of data quality. Analysis of the data indicated that the sampling method may have introduced some overlying water to the porewater sample (see Attachment A1). While these data are considered suitable for addressing risk questions, uncertainties associated with sampling methodology are discussed in the Aquatic BERA.

Porewater data from the remaining studies in the data inventory (Besser et al. 2008; TAI 2019b; USGS 2005, 2006b; USEPA 2006a) are not considered suitable for use in the Aquatic BERA, because data were not from samples collected in situ and do not represent field exposure conditions.

¹² In addition, at six sampling locations (1B-C1, 1B-R2, Trib-2, Trib-4, Trib-5, and Trib-6), it is possible that overlying water became mixed with porewater as a result of sample collection methods (TAI 2017c).

3.1.3.3 Surface Water Data Suitability

The 2009–2010 Surface Water Study (TAI 2013a) was conducted under an approved QAPP as part of the RI/FS and data quality was acceptable. Use of data to inform the Aquatic BERA was included as a primary study objective. Therefore, these data are considered suitable for use in the Aquatic BERA.

The 2015 USGS Porewater Study (USGS 2016) included surface water data collected near the sediment-water interface. This study was not conducted as part of the RI/FS and a data report describing its objectives is not available. However, this study was conducted using relevant sampling and analysis methods and data quality is conditionally acceptable; therefore, data from this study are suitable for use in the Aquatic BERA.

3.1.3.4 Aquatic Tissue Data Suitability

The 2005 Phase 1 Fish Tissue Sampling (USEPA 2007), 2009 Fish Tissue Study (TAI 2013), and 2016 Macroinvertebrate Tissue Study (TAI 2018b) were conducted as part of the RI/FS process with approved QAPPs and acceptable data quality; therefore, data from these studies are considered suitable for use in the Aquatic BERA. Whole-body fish, mussel, and crayfish tissue samples from these studies are suitable for evaluating ecological risk. Data for fillet-only fish samples and partial-body crayfish samples also collected for these studies are not used in risk calculations, because they do not represent the media to which ecological receptors are exposed. However, data from fillet or partial-body samples are suitable for use in the Aquatic BERA, when combined with data from remaining sample fractions to provide estimates of whole-body tissue concentrations.

Tissue data from the 2016 Sturgeon Tissue Sample Collection (TAI 2017b) and 2018 Northern Pike Tissue Study (TAI 2019b) are not considered suitable for use in the Aquatic BERA, because these studies collected only fillet samples in support of the Site HHRA.

3.1.3.5 Soil Data Suitability

The 2014 Soil Study (TAI 2015) had an approved QAPP and acceptable data quality, and the study was designed, at least in part, to inform the Aquatic BERA. Therefore, data from this study are considered suitable for evaluating risk to wildlife exposed to soil in areas below the pre-1973 flood elevations in the RFDA and WSDA portion of the Aquatic BERA (Volume 4).

Use of soil data from the 2019 Northport Waterfront RI (Ecology 2019) for ERA purposes was not identified as a data quality objective. Method DLs and RLs were not compared to soil screening levels to evaluate whether analytical methods were adequately sensitive for

ERA. This could impact the data's suitability for certain receptor-metal combinations, but in general, data from the study are considered suitable for use in the Aquatic BERA.

3.1.4 Step 4—Data Comparability Assessment

The data comparability evaluation of environmental chemistry was conducted for data considered suitable in Step 3. This evaluation examined whether sediment, porewater, surface water, fish tissue, and soil data collected from different studies or using different methods should be combined for specific evaluations, such as calculating exposure point concentrations (EPCs). A comparability assessment for benthic macroinvertebrate tissue (mussel and crayfish) data is not applicable because there is only one suitable study. Chemistry data from the bioassay studies (i.e., laboratory-collected sediment and porewater data) are addressed in conjunction with the bioassay comparability evaluation provided in Section 4.4.

Comparability was determined by reviewing data collection and analysis information in the data inventory table (Table A-2), as well as reviewing the purposes and objectives of the studies being combined, as documented in available planning documents and data reports.

Post-Settlement Agreement (USEPA 2006b) studies conducted as part of the RI/FS have followed a prescribed general approach that includes a standardized QAPP, employed comparable sample collection and analytical procedures, and followed standardized data reporting and acceptance procedures. Chemistry data from these studies are, by design, intended to be comparable, and they each included the Aquatic BERA as a primary or secondary objective of the study. As such, data from these studies are considered comparable with one another.

Based on this review, the conclusions regarding the comparability of studies are provided in the following sections.

3.1.4.1 Sediment

All suitable field-collected sediment studies used similar analytical methods and are considered comparable with one another. These include the 2005 Phase 1 Sediment Sampling (USEPA 2006a), the post-Settlement Agreement studies (TAI 2014, 2016, 2017c, 2022, 2018a), 2013 USGS Toxicity Evaluation (USGS 2016a) (samples collected by the NRT), 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2019), and 2019 Northport Waterfront RI (Ecology 2019). The 2005 Phase 1 Sediment Sampling (USEPA 2006a) pre-dated the Settlement Agreement (USEPA 2006b) and therefore may

not have adhered to the same level of study standardization as the post-Settlement Agreement studies. However, the 2013 Phase 2 Sediment Study was designed to supplement and address data gaps identified in Phase 1; therefore, the Phase 1 data are considered comparable. Although the 2013 USGS Toxicity Evaluation (USGS 2016a) NRT samples were collected using a different method than the RI/FS study methods (see Section 4.1), the analytical methods were similar to those of other suitable studies and therefore the data are considered comparable.

The specific grain size fractions reported and the grain size cutoffs for these are not consistent across the studies included in the Aquatic BERA data set. Attachment A-2 to this appendix summarizes grain size reporting conventions among studies and describes how sediment grain size data for the Aquatic BERA data set were adjusted to help improve comparability and to support the analysis of certain lines of evidence.

3.1.4.2 Porewater

There are three suitable post-Settlement Agreement (USEPA 2006b) studies with field porewater data: the 2013 Phase 2 Sediment Study (TAI 2017c), the 2015 USGS Porewater Study (USGS 2016b), and the 2019 Phase 3 Sediment Study (TAI 2022). These studies were conducted using different field sampling methods, although the laboratory analytical methods were comparable. As described in Attachment A1, which provides more detail regarding sampling methodologies and analytical chemistry results, it is uncertain whether data from these three studies are comparable, given the difference in sampling methods. However, the data are not combined to calculate EPCs, so the comparability of these data is not relevant.

3.1.4.3 Surface Water

The 2009–2010 Surface Water Study (TAI 2013a) analyzed surface water for both total and dissolved fractions, whereas the 2015 USGS Porewater Study (USGS 2016b) analyzed for only the dissolved fraction. The dissolved data from the USGS study are not combined with the total data from the 2009–2010 Surface Water Study (e.g., in the case of wildlife exposure, which is based on total fractions). In addition, the two studies collected samples at different depths. In the 2009–2010 Surface Water Study, water samples were collected in nearshore areas ~0.25 m above river bottom and along river transects ~1 m above river bottom and ~1 m below water surface. In the 2015 USGS Porewater Study, surface water samples were collected 7 cm above river bottom.

The 2009–2010 Surface Water Study (TAI 2013a) also collected disturbed surface water samples for use in the HHRA; to do so, individuals walked in the river upstream of the

sampling device to disturb the sediment. The disturbed water samples are not considered comparable to the undisturbed samples, and these two sample types are not combined in the Aquatic BERA.

3.1.4.4 Fish Tissue

The 2009 Fish Tissue Study (TAI 2013b) was designed to supplement the 2005 Phase 1 Fish Tissue Sampling (USEPA 2007) by collecting samples for additional species and size classes. The 2009 Fish Tissue Study sampled areas nearly identical to those sampled in the 2005 Phase 1 Fish Tissue Sampling and employed comparable analytical methods; therefore, the results of the two studies can be combined for use in the Aquatic BERA.

3.1.4.5 Soil

Soil data from the 2014 Soil Study (TAI 2015) and the 2019 Northport Waterfront RI (Ecology 2019) are considered suitable for use in the Aquatic BERA. However, sampling methods were different between the two studies. The 2014 Soil Study used incremental composite sampling (ICS), compositing 30 soil sample increments from either approximately 25- or 1- to 3-acre areas, whereas discrete grab samples were collected for the 2019 Northport Waterfront RI. In addition, sampling areas did not overlap. Therefore, these data are not combined in the Aquatic BERA.

3.2 IVBA DATA

This section describes the results of the four-step DUA for IVBA data.

3.2.1 Step 1—Data Inventory

Three studies with IVBA data passed through the screening process and were therefore included in the IVBA data inventory, as follows:

- **2009–2011 Beach Sediment Study (TAI 2014).** Samples were analyzed for lead IVBA and pH.
- **2014 Soil Study (TAI 2015).** Samples were analyzed for IVBA (all metals), pH, and total organic carbon (TOC).
- **2015 Bossburg Flat Sediment and Soil Study (TAI 2016).** Samples were analyzed for lead IVBA and pH.

Table A-6 documents sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation procedures for the three studies included in the IVBA data inventory.

3.2.2 Step 2—Data Quality Assessment

The process for conducting the data quality assessment for IVBA data is the same as discussed in Section 3.1.2. None of the IVBA data sources are missing any data documentation items, and all are acceptable for use in the Aquatic BERA (Table A-5). The three studies (TAI 2014, 2016, 2015) are evaluated further in the data suitability assessment (Section 3.3.2).

3.2.3 Step 3—Data Suitability Assessment

IVBA data are used to estimate the bioavailability of metals in soil to wildlife receptors, although the IVBA methods are intended for HHRA purposes. Based on a detailed evaluation (Appendix H, Attachment H3), data indicate that IVBA methods are suitable for application to wildlife. In addition, the size fractions of the soil or sediment samples analyzed for IVBA were smaller than those analyzed for the total metals analyses (used to estimate exposure in the Aquatic BERA). For reasons discussed in Appendix H, the IVBA data for the smaller size fractions (e.g., < 150 µm) are suitable for estimating the bioavailability of metals in bulk soil with the larger size fractions (< 2 mm). IVBA data for all soil and sediment samples are suitable for establishing regression relationships for pH/lead and TOC/zinc, with the exception of core samples from the 2015 Bossburg Flat Sediment and Soil Study (TAI 2016); these data are from samples geographically redundant with the ICS samples and are less relevant to wildlife exposures due to their greater depth.

3.2.4 Step 4—Data Comparability Assessment

The three studies with IVBA data used the same analytical methods (USEPA 2017). Among soil samples used in estimating wildlife exposures in the RFDAs and WSDAs, IVBA data are available for only three RFDA samples from the 2014 Soil Study (TAI 2015). Therefore, the question of whether data should be combined across studies (e.g., for calculating 95 upper confidence limits [UCLs]) for soil samples is not relevant.

For sediment samples used in estimating wildlife exposures in OUs 1 and 2, IVBA data are available for ICS samples from the 2015 Bossburg Flat Sediment and Soil Study (TAI 2016) and for composite samples from the 2009–2011 Beach Sediment Study (TAI 2014).

The question of whether sediment data should be combined across studies for these samples is not relevant because approaches for estimating areawide IVBA values (Appendix H, Attachment H3) do not involve calculating 95 UCLs.

For IVBA regression analyses, sampling methods differed slightly among studies, as follows:

- **2014 Soil Study (TAI 2015).** Soil samples were collected using ICS from depths of 0 to 7.5 cm; samples were sieved to < 149 μm .
- **2015 Bossburg Flat Sediment and Soil Study (TAI 2016).** Soil and sediment samples were collected using ICS from depths of 0 cm to 15 cm; soil samples were sieved to < 150 μm , and sediment samples were sieved to < 250 μm .
- **2009–2011 Beach Sediment Study (TAI 2014).** Sediment samples were collected from depths of 0 to 15 cm; samples from 60 randomly distributed locations on each beach were used to create 5 composite samples, and 1 composite sample from each beach was analyzed for IVBA. Four grain size fractions were analyzed for IVBA: < 63 μm , 63 to 125 μm , 125 to 250 μm , and 250 μm to 2 mm.

It is considered acceptable to combine these data to develop regression relationships for reasons described in Appendix H (Attachment H3).

3.3 BIOACCUMULATION DATA

3.3.1 Step 1—Data Inventory

Bioaccumulation modeling requires co-located data for biota tissue and soil or sediment. The only study with relevant data is the 2018 Plant Tissue Study (TAI 2019c). Table A-7 summarizes sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation for the study.

3.3.2 Step 2—Data Quality Assessment

The process for conducting the data quality assessment for bioaccumulation data is the same as that discussed in Section 3.1.2. All relevant data quality documentation items are available for the 2018 Plant Tissue Study (TAI 2019c). Plant tissue data from this study are acceptable for use in the Aquatic BERA and are further evaluated in the data suitability assessment in the Section 3.3.3.

3.3.3 Step 3—Data Suitability Assessment

Plant tissue and co-located soil data from the 2018 Plant Tissue Study (TAI 2019c) were collected from the Site for use in the RI/FS and HHRA. These data were collected from 12 sampling areas geographically separate from and not spatially representative of the areas below the pre-1973 flood elevation; these sampling areas are the focus of the Aquatic BERA. Additionally, these data may lack relevance to ERA due to soil sieve size and sampled plant species and plant parts. Thus, these data are not suitable for direct use as wildlife dietary exposure estimates for the Aquatic BERA. However, as the data represent co-located soil and plant tissue data, they are suitable for use in modeling plant tissue concentrations for evaluation in the Aquatic BERA. Further discussion of the suitability of these data for bioaccumulation modeling is provided in Appendix E.

3.3.4 Step 4—Data Comparability Assessment

The data comparability evaluation is not applicable to the 2018 Plant Tissue Study (TAI 2019c).

4 INVERTEBRATE BIOASSAY DATA USABILITY

This section describes the DUA for invertebrate bioassay studies.

4.1 STEP 1—DATA INVENTORY

The UCR sediment invertebrate bioassay data are from the Phases 1, 2, and 3 sediment studies; the USGS toxicity study conducted on samples collected during the Phase 2 study; and three additional invertebrate bioassays identified in the BERA Work Plan (TAI 2011) that were conducted using Site sediment during or after the year 2000. Specifically, studies providing bioassay data included in the data inventory are as follows:

- 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001)
- 2004 USGS Toxicity Evaluation (Besser et al. 2008)
- 2005 Phase 1 Sediment Sampling (USEPA 2006a)
- 2008 USGS Toxicity Evaluation (Fairchild et al. 2012)
- 2013 Phase 2 Sediment Study (TAI 2017c)
- 2013 USGS Toxicity Evaluation (USGS 2016a), consisting of:
 - Samples collected by TAI during the 2013 Phase 2 Sediment Study (TAI 2017c) from the same Phase 2 sampling locations downstream of River Mile (RM) 730 at Onion Creek but as separate grabs (i.e., co-located but not split or replicate samples). These samples were transferred to the NRT (specifically National Park Service) as a condition of sediment collection permits issued to TAI for the Phase 2 Sediment Study by the National Park Service and Confederated Tribes of the Colville Reservation.
 - Samples collected by the NRT upstream of RM 730 and provided to USGS for use in bioassays
- 2019 Phase 3 Sediment Study (TAI 2022).

Table A-8 presents the types of invertebrate bioassays conducted for each of the above-listed studies and indicates whether sediment and/or porewater data were collected and analyzed during the bioassays. Invertebrate bioassay chemistry data are summarized in more detail in the chemistry data inventory (Table A-2).

4.2 STEP 2—DATA QUALITY ASSESSMENT

Data quality was evaluated for both the toxicity measurement endpoints and the associated laboratory chemistry data for the invertebrate bioassays. The data quality evaluation for the toxicity endpoints was based on the following criteria:

- Results from the quality assurance/quality control (QA/QC) program followed by the testing laboratory
- Test organism sensitivity based on standard reference toxicant tests (i.e., positive controls)
- Comparison of negative control results to test acceptability criteria.

Table A-9 summarizes data quality findings for the toxicity portion of the invertebrate bioassay studies.

Any inconsistencies between the design of the bioassays and that of the actual bioassay tests, as well as issues identified in the results, are noted if they are not otherwise reported. The toxicity data for the seven studies are of acceptable quality, with the following exceptions and/or data quality limitations:

- 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001)
 - Microtox results are not acceptable because a subset of samples were inadvertently homogenized prior to analysis, contrary to test method guidelines.
 - *Chironomus dilutus* survival results did not meet test acceptability criteria; therefore, *C. dilutus* endpoints are not acceptable.
- 2004 USGS Toxicity Evaluation (Besser et al. 2008)
 - Toxicity data are acceptable, although porewater concentrations in the sediment control sample were high for conductivity and hardness.
- 2004 and 2008 USGS Toxicity Evaluations (Besser et al. 2008; Fairchild et al. 2012)
 - Information on whether the test acceptability criteria were met was not provided. However, American Society for Testing and Materials methods were used and it is assumed that the data are acceptable for the peer-reviewed publications.

- 2005 Phase 1 Sediment Sampling (USEPA 2006a)
 - *C. dilutus* weight and biomass results should be interpreted with caution because of the high occurrence of pupation in the test leading to loss of biomass, as discussed in detail in the BERA Work Plan (TAI 2011).
- 2013 Phase 2 Sediment Study (TAI 2017c)
 - Interpretation of results may be confounded by batch variability.
- 2013 USGS Toxicity Evaluation (USGS 2016a)
 - Weight was not directly measured in Cycle 3 for the short-term endpoints in the *C. dilutus* and *Hyalella azteca* tests. Reported values were estimated from 42-day results.
- 2019 Phase 3 Sediment Study (TAI 2022)
 - Quartz sand negative control samples did not meet most of EPA's suggested performance-based guidelines (Mount 2011). While EPA did not require the tests to be rerun, EPA provided recommendations for use of the Phase 3 bioassay data (USEPA 2021b), as follows:
 - Data for survival at Day 28 can be used for all analyses without qualification related to quartz sand control performance.
 - Growth data can be used for control comparisons and concentration-response modeling, but results should be qualified as having potentially reduced performance. The growth endpoint should not be used for reference comparisons.
 - Reproduction appears to be more strongly confounded by the quartz sand control performance issue than does growth. However, the results of the two endpoints generally correlate, indicating that reproduction does not provide substantially different information than does growth. Use of the reproduction endpoint should be avoided.

The data quality evaluation for the laboratory-collected chemistry data followed the same methods presented in Section 3.1.2 for the environmental chemistry data; findings are presented in Table A-5. Bioassay chemistry data are acceptable or conditionally acceptable.

4.3 STEP 3—DATA SUITABILITY ASSESSMENT

Invertebrate bioassay data were evaluated to determine whether the methods and completeness of the biological and chemical measurements are suitable for addressing the risk questions in the Aquatic BERA. For bioassay data, suitability depends upon whether the data are being used to evaluate differences in the survival, growth, or reproduction of benthic invertebrates exposed to Site media compared to control or reference sediments, or to establish concentration-response relationships between measured metal concentrations and observed biological effects.

A detailed inventory of measurements made during bioassays is presented in Table A-10. Results from the 2008 USGS Sediment Toxicity Evaluation (Fairchild et al. 2012) are not suitable for use in the Aquatic BERA because the sediment samples were collected in a semi-wet state from just above the waterline, resulting in uncertainty about the oxidation-reduction status. Data from the 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001) and the 2004 USGS Toxicity Evaluation (Besser et al. 2008) are not included in the Aquatic BERA because these are smaller, older studies (each one sampled seven locations from OUs 1 and 2) that have missing documentation for some of the chemistry data (Table A-5) and are superseded by larger, more robust studies conducted for the purposes of the RI/FS (i.e., the Phases 1, 2, and 3 studies).

Bioassay data from the remaining four studies—the 2005 Phase 1 Sediment Sampling (USEPA 2006a), the 2013 Phase 2 Sediment Study (TAI 2017c), the 2013 USGS Toxicity Evaluation (USGS 2016a), and the 2019 Phase 3 Sediment Study (TAI 2022)—are suitable for use in the Aquatic BERA, with exceptions as follows:

- Results from the *Ceriodaphnia dubia* test conducted during the 2005 Phase 1 Sediment Sampling (USEPA 2006a) are not considered suitable for use in evaluating risk to benthic organisms in the Aquatic BERA. EPA provided a detailed ranking of the three sediment toxicity tests evaluated in Phase 1, along with other candidate tests, to select preferred tests for development of standardized protocols for assessing toxicity of freshwater sediments (USEPA 2000), as described in Appendix E of the BERA Work Plan (TAI 2011). Based on 10 selection criteria, EPA stated that tests based on *H. azteca* and *C. dilutus* were preferred for evaluating freshwater sediment toxicity. In contrast, tests based on cladocerans (i.e., *Daphnia* spp. and *Ceriodaphnia* spp.) ranked poorly because 1) the test organisms do not maintain direct contact with sediment, 2) there is no database for interlaboratory comparisons of test methods for whole-sediment studies, 3) cladocerans do not have a niche similar to the that of the organisms of

concern, and 4) their responses in whole-sediment exposures have not been confirmed with responses of natural populations of benthic organisms. In addition, Ecology (Bennett and Cubbage 1992) evaluated different bioassay organisms and found that *C. dubia* were not adequately sensitive for freshwater sediment bioassays, although the organism may have an application when the contaminant typically becomes dispersed into the water column. As a result of these concerns and the prevalence of bioassay data for the more relevant benthic invertebrate species (i.e., *H. azteca* and *C. dilutus*), *C. dubia* data are not evaluated in the Aquatic BERA.

- Porewater chemistry data from the 2005 Phase 1 Sediment Sampling (USEPA 2006a) are not suitable for concentration-response modeling because porewater was collected from co-located but separate sediment samples at each of the bioassay sampling stations, typically on different dates after bioassay and whole-sediment chemistry samples had been collected.

Due to differences among the bioassay data sets, this determination of suitability for concentration-response modeling does not necessarily indicate that it is appropriate to develop such models with each data set. Whether concentration-response models can be developed for a given data set is evaluated in the Aquatic BERA based on the number of samples and level of response.

In addition to the data suitability determinations above, the data gaps exist, affecting risk questions related to these components and/or endpoints (Table A-10). Data gaps are as follows:

- Synoptic bioassay sediment excess simultaneously extracted metal and porewater chemistry data are missing for the following:
 - 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001) bioassays
 - 2005 Phase 1 Sediment Sampling (USEPA 2006a) bioassays
 - 2013 USGS Toxicity Evaluation (USGS 2016a) *C. dilutus* bioassays and Cycle 3 *H. azteca* bioassays

- 2013 USGS Toxicity Evaluation (USGS 2016a) Cycle 3, Day 28 *H. azteca* weight and biomass are estimated values, because neither weight nor length were measured on Day 28 (Steevens and Besser 2017).
- 2013 USGS Toxicity Evaluation (USGS 2016a) bioassay-associated porewater samples were not analyzed for sulfide.

4.4 STEP 4—DATA COMPARABILITY ASSESSMENT

The bioassay comparability evaluation examined whether bioassay data should be combined across studies. Data from interlaboratory bioassay studies have shown that variability can be high among laboratories, in some cases even when identical methods are used (Burton et al. 1996; Bay et al 2003; Norberg-King et al 2006). Therefore, it is crucial to understand the potential differences among methods used to collect data when considering whether data from multiple studies are similar enough to be combined. This evaluation included a comparison of bioassay techniques, ages and sources of test organisms, sediment holding and equilibration times, and analytical methods (Table A-11).

Some important differences noted among the study methods are as follows:

- The timing for collection of synoptic chemistry differed among the 2013 Phase 2 Sediment Study (TAI 2017c), 2019 Phase 3 Sediment Study (TAI 2022), and 2013 USGS Toxicity Evaluation (USGS 2016a); concentrations of chemicals in porewater and sediment may have varied depending on when samples were collected.
- The 2013 Phase 2 Sediment Study (TAI 2017c) and 2013 USGS Toxicity Evaluation (USGS 2016a) associated with Phase 2 used organisms of different ages to initiate the *C. dilutus* life cycle test.
- Overlying water used in the *H. azteca* tests varied among the bioassays; studies have shown that *H. azteca* growth and reproduction are sensitive to variations in water chemistry (Borgmann et al. 2005; Borgmann et al. 2007; Borgmann 1996).
- The feeding rate in the *H. azteca* tests varied among all bioassays; studies have shown that feeding rate can affect *H. azteca* growth and reproduction (Mount 2011; Ivey et al. 2016).

In addition, sediment samples in the 2013 USGS Toxicity Evaluation (USGS 2016a) were handled differently than sediment samples collected in the 2005 Phase 1 Sediment Sampling (USEPA 2006a), 2013 Phase 2 Sediment Study (TAI 2017c), and 2019 Phase 3

Sediment Study (TAI 2022), in that all USGS samples were sieved in the field through a 2 mm mesh screen.

Although there are differences in methods among the studies (as shown in Table A-11), the advantages of combining at least some of the *H. azteca* and *C. dilutus* data to provide more robust concentration-response models were determined to outweigh the disadvantages associated with variations in methods. The most important differences in the *H. azteca* and *C. dilutus* data sets among the studies are the availability and timing of synoptic chemistry data and the synoptic porewater collection methods (i.e., centrifuge or peepers). The handling of these differences when combining data is discussed in detail in the bioassay analyses appendix to the Aquatic BERA (Appendix J). For comparison to control, combining data sets is not relevant because the result for each sample is compared to the control sample in its batch. For comparison to reference, data sets from different studies are not combined because of differences in the timing of collection and completion of bioassays, sampling design, sampling locations, and field sampling methods. However, for the Aquatic BERA, the 2013 USGS Toxicity Evaluation (USGS 2016a) data were combined with the 2013 Phase 2 Sediment Study (TAI 2017c) for the purposes of comparison to bioassay responses from upstream reference locations. Samples for the data sets for these two studies were collected concurrently and, with the exception of samples collected by NRT upstream of Onion Creek, were collected as splits from homogenized Phase 2 sediment.

5 BENTHIC INVERTEBRATE COMMUNITY DATA USABILITY

This section describes the results of the DUA for benthic invertebrate community data.

5.1 STEP 1—DATA INVENTORY

Similar to the environmental chemistry data inventory, benthic invertebrate community studies with appropriate data were searched for by reviewing the SLERA (TAI 2010), BERA Work Plan (TAI 2011), and COPC Refinement (TAI 2020). Studies were included in this inventory if they comprised in situ benthic invertebrate community data collected from the Site during or after the year 2000 (consistent with the SLERA). The 2019 Phase 3 Sediment Study (TAI 2022) is the only relevant data source for the benthic invertebrate community data inventory. For this study, TAI collected sediment samples under EPA oversight and analyzed them for benthic invertebrate taxonomic enumeration and identification, ash-free dry weight, and biomass. Benthic invertebrate metrics such as the Shannon Weaver diversity index, species richness, abundance, and density were calculated from the sample enumeration results.

5.2 STEP 2—DATA QUALITY ASSESSMENT

The 2019 Phase 3 Sediment Study (TAI 2022) benthic invertebrate community data have been evaluated for quality based on results from the QA/QC program, followed by laboratory testing and data validation assessment conducted by the data validator. The data verification and validation procedure was conducted in accordance with the Phase 3 QAPP (ERM et al. 2019) and included examination of sample custody, condition upon receipt, holding times, sorting efficacy, identification similarity, and results reporting. The quality of the benthic invertebrate data is considered acceptable for the purpose of addressing the risk questions identified in the Aquatic BERA.

5.3 STEP 3—DATA SUITABILITY ASSESSMENT

Benthic invertebrate community data were evaluated to determine whether the sampling and analytical methods and completeness criteria used are suitable for addressing risk questions related to the potential effects of COPCs on UCR benthic invertebrate communities. The risk questions relate to whether the community metrics indicate reduced species diversity and richness or increased pollution tolerance, and whether the

metrics from Site locations differ from those at reference locations. In addition, the community metrics data and chemistry data were evaluated to determine whether concentration-response relationships can be established.

The 2019 Phase 3 Sediment Study (TAI 2022) was conducted as part of the RI/FS under EPA oversight. There were no issues identified with the benthic invertebrate sampling or analyses that would affect data suitability to address the risk questions in the Aquatic BERA. In addition, the completeness goal specified in the QAPP (ERM et al. 2019) was met. The 2019 Phase 3 Sediment Study (TAI 2022) benthic invertebrate community data are considered suitable for use in the Aquatic BERA.

5.4 STEP 4—DATA COMPARABILITY ASSESSMENT

The data comparability assessment is not applicable to the benthic invertebrate community data.

6 BSEM DATA USABILITY

This section describes the results of the DUA for BSEM data.

6.1 STEP 1—DATA INVENTORY

BSEM analyses were conducted on a subset of sediment samples collected during three studies: the 2013 Phase 2 Sediment Study (TAI 2017c) and 2019 Phase 3 Sediment Study (TAI 2022) conducted in support of the RI/FS and the 2013 USGS Toxicity Evaluation (USGS 2016a).¹³ These studies used computer-controlled scanning electron microscopy in the backscattered electron imaging mode, and all three incorporated energy-dispersive spectroscopy. The numbers of locations and discrete samples analyzed by BSEM were 42 (of 136 total) for the 2013 Phase 2 Sediment Study, 6 (of 105 total) for the 2019 Phase 3 Sediment Study, and 32 (of 56 total) for the 2013 USGS Toxicity Evaluation.

6.2 STEP 2—DATA QUALITY ASSESSMENT

To evaluate QA during the 2013 Phase 2 Sediment Study (TAI 2017c) and 2019 Phase 3 Sediment Study (TAI 2022), the BSEM laboratory conducted replicate analyses (i.e., analysis of replicate sample remounts) and duplicate analyses (i.e., reanalysis of the same sample mount). In addition, during the 2013 Phase 2 Sediment Study data analyses, the laboratory used a supplementary image analysis procedure applied at low magnification, the results from which were compared to those of the original analysis. The QA results for the 2013 Phase 2 Sediment Study and 2019 Phase 3 Sediment Study did not indicate any issues with data quality; therefore, these data are considered acceptable. No replicate or duplicate analyses were conducted for the 2013 USGS Toxicity Evaluation (USGS 2016a); however, these data are considered acceptable for use in the regression analyses as discussed in Section 6.3.

6.3 STEP 3—DATA SUITABILITY ASSESSMENT

The slag content for sediment, which is predicted using a zinc regression model, is used in the Aquatic BERA to address the question of whether elevated metals associated with slag in depositional sediments cause toxicity in laboratory bioassays or adversely affect

¹³ Only the samples collected by NRT from above Onion Creek, which are not split samples from Phase 2, are included in the Aquatic BERA.

benthic invertebrate communities. TAI previously used BSEM data from the 2013 Phase 2 Sediment Study (TAI 2017c) and 2013 USGS Toxicity Evaluation (USGS 2016a) to create a three-segment linear regression model to predict slag content based on bulk sediment zinc concentrations (ERM et al. 2019). The BSEM data from the 2019 Phase 3 Sediment Study (TAI 2022) was used to confirm the zinc regression model.

There were no data quality concerns identified from the 2013 Phase 2 Sediment Study (TAI 2017c) or 2019 Phase 3 Sediment Study (TAI 2022). Although QC data were missing for the 2013 USGS Toxicity Evaluation (USGS 2016a) samples, the majority of data used to develop the model (42 of the 74 samples) were from the 2013 Phase 2 Sediment Study, and the regression model was confirmed using data from the 2019 Phase 3 Sediment Study. Based on the results of the model development and confirmation, the BSEM data from all three studies and the associated zinc regression model for estimating slag content are considered suitable for use in the Aquatic BERA.

6.4 STEP 4—DATA COMPARABILITY ASSESSMENT

The data comparability evaluation of environmental chemistry examined whether BSEM data from the 2013 Phase 2 Sediment Study (TAI 2017c), 2019 Phase 3 Sediment Study (TAI 2022), and 2013 USGS Toxicity Evaluation (USGS 2016a) can be combined for use in the Aquatic BERA. During the 2013 Phase 2 Sediment Study and 2019 Phase 3 Sediment Study, data were analyzed by the same laboratory using the same methods. During the 2013 USGS Toxicity Evaluation, data were analyzed using the same general method of controlled scanning electron microscopy in the backscattered electron imaging mode, with the incorporation of energy-dispersive spectroscopy. The results of the model development and validation described in Section 6.3, in combination with the use of similar methods, indicate that data are comparable across studies.

7 SUMMARY

This DUA developed an inventory of environmental chemistry, invertebrate bioassay, benthic invertebrate community, and BSEM data and evaluated these data for quality, suitability, and comparability.

7.1 ENVIRONMENTAL CHEMISTRY DUA SUMMARY

Data usability results for environmental chemistry studies (including IVBA and bioaccumulation data) are summarized in Table A-12, with determinations as follows:

- **Sediment.** Suitable studies for sediment evaluations in the Aquatic BERA are the 2005 Phase 1 Sediment Sampling (USEPA 2006a), 2009–2011 Beach Sediment Study (TAI 2014), 2015 Bossburg Flat Sediment and Soil Study (TAI 2016), 2013 Phase 2 Sediment Study (TAI 2017c), 2013 USGS Toxicity Evaluation associated with Phase 2 (USGS 2016a) (only samples collected by the NRT), 2010 White Sturgeon Sediment Toxicity Study (TAI 2018a), Northport Waterfront RI (Ecology 2019), and 2019 Phase 3 Sediment Study (TAI 2022). The data from these eight studies are comparable and are combined to calculate exposure concentrations in the Aquatic BERA.
- **Porewater.** The 2015 USGS Porewater Study (USGS 2016b), 2013 Phase 2 Sediment Study (TAI 2017c), and 2019 Phase 3 Sediment Study (TAI 2022) provide data suitable for use in the Aquatic BERA, although there were some deviations from the planned sampling methods in the 2013 Phase 2 Sediment Study; these deviations are addressed in the uncertainty section of the Aquatic BERA. In addition, it is uncertain whether data from these studies are comparable, given differences in sampling methods. However, the data are not combined to calculate EPCs in the Aquatic BERA, so the question of comparability is not relevant.
- **Surface water.** The 2009–2010 Surface Water Study (TAI 2013a) and 2015 USGS Porewater Study (USGS 2016b) include data suitable for use in the Aquatic BERA. The data are not comparable and are not combined in the Aquatic BERA because the 2009–2010 Surface Water Study measured total concentrations and the USGS Porewater Study measured dissolved concentrations; in addition, samples were collected at different depths. Disturbed and undisturbed water samples from the 2009–2010 Surface Water Study are not comparable and are not combined in the Aquatic BERA.

- **Fish tissue.** The 2005 Phase 1 Fish Tissue Study (USEPA 2007) and 2009 Phase 2 Fish Tissue Study (TAI 2013) provide data suitable for Aquatic BERA evaluations; these data were found to be comparable. Data from these two studies are combined to calculate exposure concentrations in the Aquatic BERA.
- **Benthic macroinvertebrate tissue.** The 2016 Macroinvertebrate Tissue Study (TAI 2018b) is the only study with invertebrate tissue data, which are suitable for use in the Aquatic BERA.
- **Soil.** The 2014 Soil Study (TAI 2015) and Northport Waterfront RI (Ecology 2019) include soil data that are acceptable and suitable for use in the Aquatic BERA. Data from the two studies are not considered comparable due to sampling methods and locations, so the data are not combined to calculate exposure concentrations.
- **IVBA.** Data from all three sources of IVBA data (TAI 2016, 2015, 2014) are suitable for use in the Aquatic BERA. These data are also considered comparable for use in regressions.
- **Bioaccumulation.** The 2018 Plant Tissue Study (TAI 2019c) is the only study with bioaccumulation data, which are suitable for use in the Aquatic BERA.

7.2 BIOASSAY DUA SUMMARY

Seven invertebrate bioassay studies are included in the Aquatic BERA data inventory (Table A-13). The following bioassay data are not considered acceptable for use in the Aquatic BERA:

- 2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001): *C. dilutus* data are not acceptable because survival data did not meet the test acceptability criteria. The microtox data are not acceptable because sediment was homogenized, contrary to test guidelines.
- 2019 Phase 3 Sediment Study (TAI 2022): *H. azteca* growth data are not acceptable for comparison to reference, and reproduction data are not acceptable for any use, based on poor performance in the quartz sand negative control samples.

With the following exception, acceptable data from all studies are considered suitable for use in addressing the question of whether there are significant differences in the survival, growth, or reproduction of benthic invertebrates exposed to Site and control or reference

sediments (i.e., comparison to control and reference samples). The one exception is as follows:

- 2008 USGS Toxicity Evaluation (Fairchild et al. 2012): These bioassays were conducted with sediment collected in a semi-wet state just above the waterline, resulting in uncertainty about the oxidation-reduction status. These data are not suitable for use in the Aquatic BERA.

With the following exceptions, acceptable data from all studies are considered suitable for use in addressing the question of whether concentration-response relationships can be established between measured metal concentrations and observed biological effects. The exceptions are as follows:

- 2005 Phase 1 Sediment Sampling (USEPA 2006a): Porewater chemistry data from this study are not suitable for concentration-response modeling, because porewater samples were collected from co-located but separate sediment samples at each of the bioassay sampling stations, typically on different dates after bioassay and whole sediment chemistry samples had been collected. *C. dubia* data are not considered suitable for use in the Aquatic BERA primarily because of concerns about whether they represent the sediment exposure pathway for the evaluation of benthic invertebrates.
- 2008 USGS Toxicity Evaluation (Fairchild et al. 2012): Bioassays for this study were conducted on sediment collected in a semi-wet state just above the waterline, resulting in uncertainty about the oxidation-reduction status. These data are not suitable for use in the Aquatic BERA.

Although there are some differences in methods among the studies considered suitable for use in the Aquatic BERA, particularly in the availability and timing of synoptic chemistry data from the *H. azteca* and *C. dilutus* tests and the porewater collection methods, these data are considered comparable for the purpose of concentration-response modeling. For comparison to control, combining data sets is not relevant because the result for each sample is compared to the control sample in its batch. For comparison to reference, the only data considered comparable are the 2013 USGS Toxicity Evaluation samples collected as splits from homogenized Phase 2 sediment and the 2013 Phase 2 Sediment Study (TAI 2017c) samples.

7.3 BENTHIC INVERTEBRATE COMMUNITY DUA SUMMARY

The benthic invertebrate community data collected as part of the 2019 Phase 3 Sediment Study (TAI 2022) are the only in situ benthic invertebrate community data in the data inventory. These data are of acceptable quality and are considered suitable for use in the Aquatic BERA.

7.4 BSEM DATA DUA SUMMARY

The BSEM data collected from the 2013 Phase 2 Sediment Study (TAI 2017c), 2019 Phase 3 Sediment Study (TAI 2022), and 2013 USGS sediment studies are considered suitable and comparable for the purpose of predicting slag content, a variable used in addressing risk questions. This determination is based on consideration of data quality results, comparability of methods, and model validation results.

8 REFERENCES

- Archibold, O.W. 1974. Vegetation Recovery Following Pollution Control at Trail, British Columbia. Ph.D., Philosophy, Simon Fraser University, Burnaby, BC.
- ASTM (American Society for Testing and Materials). 2010. Standard Guide for Determination of the Bioaccumulation of Sediment-Associated Contaminants by Benthic Invertebrates. Designation: E 1688-10. American Society for Testing and Materials, West Conshohocken, PA.
- Bay, S.M., A. Jirik, and S. Asato. 2003. Interlaboratory Variability of Amphipod Sediment Toxicity Tests in a Cooperative Regional Monitoring Program. *Environ Monit Assess* 81:257–268.
- Bennett, J., and J. Cubbage. 1992. Evaluation of Bioassay Organisms for Freshwater Sediment Toxicity Testing. Environmental Investigations and Laboratory Services, Washington State Department of Ecology.
- Besser, J.M., W.G. Brumbaugh, C.D. Ivey, C.G. Ingersoll, and P.W. Moran. 2008. Biological and Chemical Characterization of Metal Bioavailability in Sediments from Lake Roosevelt, Columbia River, Washington, USA. *Arch Environ Contam Toxicol* 54:557–570.
- Besser, J.M., W.G. Brumbaugh, N.E. Kemble, C.D. Ivey, J.L. Kunz, C.G. Ingersoll, and D. Rudel. 2011. Toxicity of Nickel-Spiked Freshwater Sediments to Benthic Invertebrates - Spiking Methodology, Species Sensitivity, and Nickel Bioavailability. U.S. Geological Survey, Reston, VA.
- Borgmann, U. 1996. Systematic Analysis of Aqueous Ion Requirements of *Hyalella azteca*: A Standard Artificial Medium Including the Essential Bromide Ion. *Arch Environ Contam Toxicol* 30:356–363.
- Borgmann, U., Y. Couillard, P. Doyle, and D.G. Dixon. 2005. Toxicity of Sixty-Three Metals and Metalloids to *Hyalella azteca* at Two Levels of Water Hardness. *Environ Toxicol Chem* 24(3):641–652.
- Borgmann, U., Y. Couillard, and L.C. Grapentine. 2007. Relative Contribution of Food and Water to 27 Metals and Metalloids Accumulated by Caged *Hyalella azteca* in Two Rivers Affected by Metal Mining. *Environ Pollut* 145:753–765.

- Brumbaugh, W.G., J.M. Bresser, C.G. Ingersoll, T.W. May, C.D. Ivey, C.E. Schlekat, and E.R. Garman. 2013. Preparation and Characterization of Nickel-Spiked Freshwater Sediments for Toxicity Tests: Toward More Environmentally Realistic Nickel Partitioning. *Environ Toxicol Chem* 32(10):2482–2494.
- Burton Jr., G.A., T.J. Norberg-King, C.G. Ingersoll, D.A. Benoit, G.T. Ankley, P.V. Winger, J. Kubitz, J.M. Lazorchak, M.E. Smith, E. Greer, F.J. Dwyer, D.J. Call, K.E. Day, P. Kennedy, and M. Stinson. 1996. Interlaboratory Study of Precision: *Hyalella azteca* and *Chironomus tentans* Freshwater Sediment Toxicity Assays. *Environ Toxicol Chem* 15(8):1335–1343.
- CH2M HILL. 2018. Phase 2 Sediment Study Inter-Laboratory Split Sample Bioassay Comparison/Evaluation - Draft Final. CH2M HILL.
- CH2M HILL. 2022. Phase 3 Sediment Study Inter-Laboratory Split Sample Bioassay Comparison and Evaluation. CH2M HILL.
- Cominco. 1998. Biosystem Development for Cominco Ltd. Baseline Report. Prepared by Larkspur Biological Consultants Ltd.
- DeFoe, D.L., and G.T. Ankley. 1998. Influence of Storage Time on Toxicity of Freshwater Sediments to Benthic Invertebrates. *Environ Pollut* 99:123–131.
- Ecology (Washington State Department of Ecology). 2001. Reassessment of Toxicity of Lake Roosevelt Sediments. Publication No. 01-03-043. Washington State Department of Ecology, Olympia, WA.
- Ecology. 2007a. Field Reconnaissance and Sediment Sampling Report, Upper Columbia River Site, Washington. Washington State Department of Ecology, Spokane, WA.
- Ecology. 2007b. Water Quality Monitoring at Northport (1960–2007). Washington State Department of Ecology.
- Ecology. 2013. Upper Columbia River Upland Soil Sampling Study. Prepared by Hart Crowser, Inc., Seattle, WA.
- Ecology. 2019. Draft-Final Remedial Investigation, Northport Waterfront. Prepared for the Washington State Department of Ecology by GeoEngineers. Spokane, WA.
- ERM, Woodward, HDR, Exponent, Parametrix. 2019. Upper Columbia River. Final. Quality Assurance Project Plan for the 2019 Phase 3 Sediment Study. ERM, Woodward Environmental LLC, HDR, Exponent, and Parametrix, Inc.

- Fairchild, J.F., N.E. Kemble, A.L. Allert, W.G. Brumbaugh, C.G. Ingersoll, B. Dowling, C. Gruenenfelder, and J.L. Roland. 2012. Laboratory Toxicity and Benthic Invertebrate Field Colonization of Upper Columbia River Sediments: Finding Adverse Effects Using Multiple Lines of Evidence. *Arch Environ Contam Toxicol* 63(1):54–68.
- Ivey, C.D., C.G. Ingersoll, W.G. Brumbaugh, E.J. Hammer, D.R. Mount, J.R. Hockett, T.J. Norberg-King, D.J. Soucek, and L. Taylor. 2016. Using an Inter-Laboratory Study to Revise Methods for Conducting 10-d to 42-d Water or Sediment Toxicity Tests with *Hyaella azteca*. *Environ Toxicol Chem* 35(10):2439–2447.
- Kinsman-Costello, L.E., J.M. O'Brien, and S.K. Hamilton. 2015. Natural Stressors in Uncontaminated Sediments of Shallow Freshwaters: The Prevalence of Sulfide, Ammonia, and Reduced Iron. *Environ Toxicol Chem* 34(3):467–479.
- Lee, J.-S., B.-G. Lee, S.N. Luoma, and H. Yoo. 2004. Importance of Equilibration Time in the Partitioning and Toxicity of Zinc in Spiked Sediment Bioassays. *Environ Toxicol Chem* 23(1):65–71.
- Mount, D. 2011. Personal communication (memorandum from D. Mount, EPA, to Great Lakes National Program Office regarding the demonstration of food/water suitability for *Hyaella azteca*). U.S. Environmental Protection Agency, Duluth, MN. November 2011.
- Norberg-King, T.J., P.K. Sibley, G.A. Burton, C.G. Ingersoll, N.E. Kemble, S. Ireland, D.R. Mount, and C.D. Rowland. 2006. Interlaboratory Evaluation of *Hyaella azteca* and *Chironomus tentans* Short-Term and Long-Term Sediment Toxicity Tests. *Environ Toxicol Chem* 25(10):2662–2674.
- Simpson, S.L., and G.E. Batley. 2003. Disturbances to Metal Partitioning During Toxicity Testing of Iron(II)-Rich Estuarine Pore Waters and Whole Sediments. *Environ Toxicol Chem* 22(2):424–432.
- Simpson, S.L., B.M. Angel, and D.F. Jolley. 2004. Metal Equilibration in Laboratory-Contaminated (Spiked) Sediments Used for the Development of Whole-Sediment Toxicity Tests. *Chemosphere* 54:597–609.
- Steevens, J., and J. Besser. 2017. Description of Methods Used to Estimate Dry Weight of the Amphipod *Hyaella azteca* from Digital Length Measurements. U.S. Geological Survey.

- TAI (Teck American Incorporated). 2010. Upper Columbia River Screening-Level Ecological Risk Assessment (SLERA). Prepared by Parametrix, Integral Consulting, Exponent, and HydroQual.
- TAI. 2011. Upper Columbia River Baseline Ecological Risk Assessment Work Plan. Prepared by Parametrix, Exponent, HydroQual, Integral Consulting Inc., and Cardwell Consulting LLC.
- TAI. 2013a. Upper Columbia River Final Surface Water Data Summary and Data Gap Report. Prepared by Exponent, and Parametrix, Inc.
- TAI. 2013b. Upper Columbia River Final Fish Tissue Data Summary and Data Gaps Report. Prepared by Exponent, Parametrix, and Integral Consulting Inc.
- TAI. 2014. Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report. Prepared by Integral Consulting Inc.
- TAI. 2015. Upper Columbia River Final Soil Study Data Summary and Data Gap Report. Prepared by Windward Environmental LLC. Seattle, WA.
- TAI. 2016. Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report. Prepared by Windward Environmental LLC. Seattle, WA.
- TAI. 2017a. Upper Columbia River Final Residential Soil Study Data Summary Report. Prepared by Ramboll Environ, Exponent, Parametrix, Inc., and Windward LLC. Seattle, WA.
- TAI. 2017b. Upper Columbia River Final White Sturgeon Tissue Study Data Summary Report. Prepared for Teck American Incorporated by Windward Environmental LLC, Ramboll Environ, and Parametrix, Inc., Seattle, WA.
- TAI. 2017c. Upper Columbia River Final Phase 2 Sediment Study Data Summary and Data Gap Report. Prepared by Windward Environmental LLC, Exponent, Parametrix, Inc., and HDR, Inc Seattle, WA.
- TAI. 2018a. Upper Columbia River Final Assessment of Sediment Toxicity to White Sturgeon Data Summary Report. Prepared for Teck American Incorporated. Cardno Entrix, Saskatoon, SK; HDR HydroQual, East Syracuse, NY.
- TAI. 2018b. Upper Columbia River Macroinvertebrate Tissue Study Data Summary Report. Final. Prepared by Windward Environmental LLC. Seattle, WA.

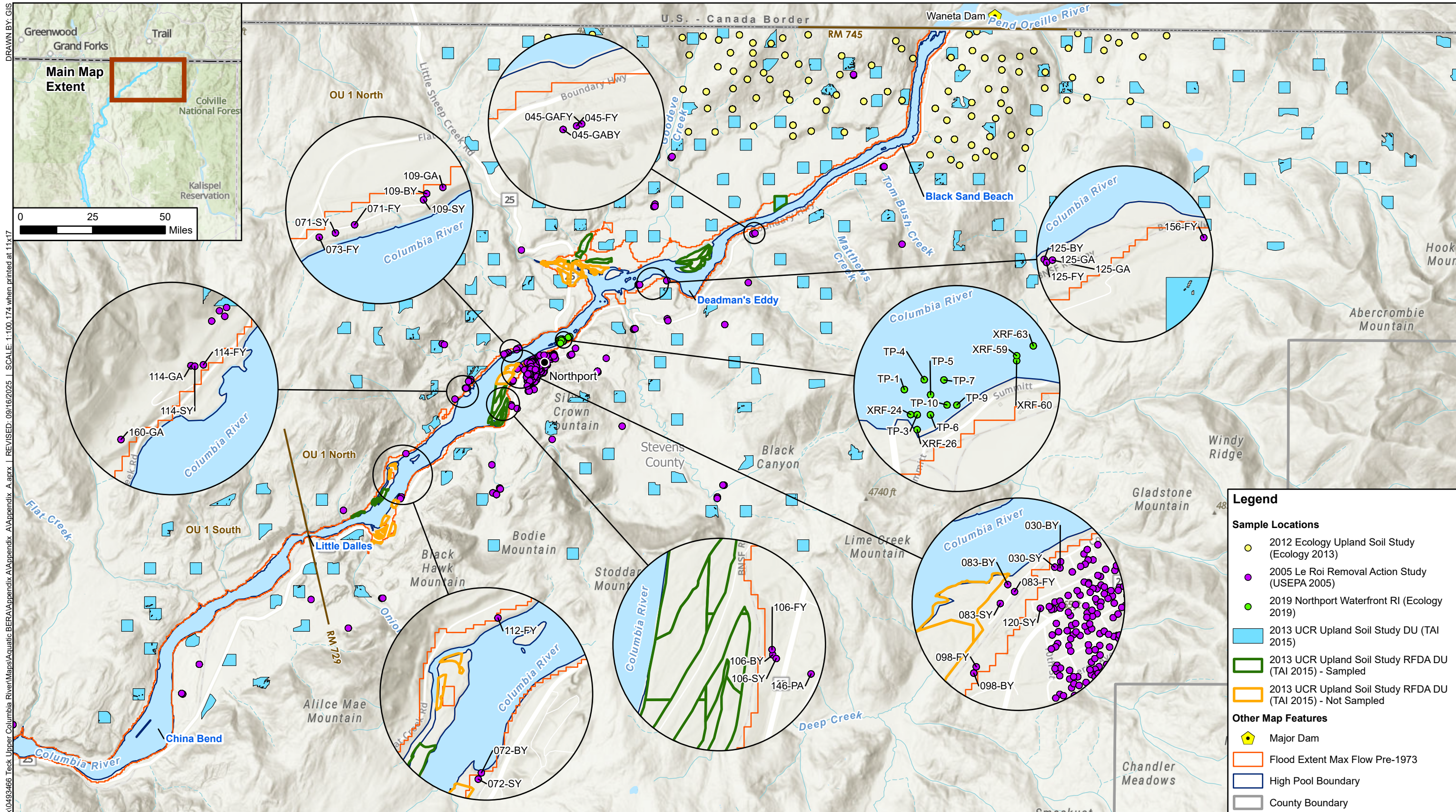
- TAI. 2019a. Upper Columbia River Final Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors. Prepared for Teck American Incorporated by Windward Environmental LLC, Seattle, WA.
- TAI. 2019b. Upper Columbia River Final Northern Pike Tissue Study Data Summary Report. Prepared for Teck American Incorporated by Windward Environmental LLC, Ramboll, and Parametrix, Inc.
- TAI. 2019c. Upper Columbia River Final Plant Tissue Study Data Summary Report. Prepared by Ramboll Environ, AECOM, and Parametrix, Inc.
- TAI. 2019d. Final Upper Columbia River Data Management Plan, Amendment No. 1. Prepared for Teck American Incorporated by Exponent. Bellevue, WA.
- TAI. 2020. Upper Columbia River Final Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors. Addendum No. 1. Prepared for Teck American Incorporated by Windward Environmental LLC, Seattle, WA. January.
<https://www.ucr-rifs.com/assets/Docs/Studies/2020/2020-01-15-FinalCOPCRefinement.pdf>.
- TAI. 2022. Upper Columbia River Final 2019 Phase 3 Sediment Study Data Summary Report. Prepared for Teck American Incorporated by ERM, Windward Environmental LLC, HDR, Exponent, and Parametrix.
- USEPA (U.S. Environmental Protection Agency). 1992. Guidance for Data Useability in Risk Assessments (Part A). PB92 - 963356. [online]. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC.
<https://19january2021snapshot.epa.gov/sites/static/files/2015-11/documents/datause-parta.pdf>.
- USEPA. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002 F. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates. Second Edition. EPA/600/R-99/064. U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA-823-B-01-002. Office of Water, U.S. Environmental Protection Agency, Washington, DC.

- USEPA. 2003. Upper Columbia River Expanded Site Inspection Report, Northeast Washington. TDD:01-02-0028. U.S. Environmental Protection Agency, Region 10 Superfund Technical Assessment and Response Team, Seattle, WA.
- USEPA. 2005. Le Roi Smelter Removal Action Report, Northport, Stevens County, Washington. Prepared for the U.S. Environmental Protection Agency Region 10 by Weston Solutions, Inc., Seattle, WA.
- USEPA. 2006a. Region 10 U.S. Environmental Protection Agency. Draft Final. Phase 1 Sediment Sampling Data Evaluation. Upper Columbia River Site CERCLA RI/FS. Prepared by CH2M HILL and Ecology and Environment, Inc.
- USEPA. 2006b. Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study at the Upper Columbia River Site. U.S. Environmental Protection Agency.
- USEPA. 2007. Region 10 U.S. Environmental Protection Agency. Final Phase I Fish Tissue Sampling Data Evaluation, Upper Columbia River Site CERCLA RI/FS. Prepared by CH2M HILL and Ecology and Environment, Inc.
- USEPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. OSWER No. 9200.1-85. EPA 540-R-08-005 Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2012. Summary and Evaluation of Phase 1 (2005) sediment toxicity tests Upper Columbia River Site. Submitted to U.S. Environmental Protection Agency, Region 10 by CH2M HILL, Inc. CH2M HILL, Inc.
- USEPA. 2015. Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments. EPA/600/R-15/176. ERASC-015F. Ecological Risk Assessment Support Center, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.
- USEPA. 2016. UCR Residential Soil Study Field Sampling and Data Summary Report. Final. Prepared by CH2M HILL. Portland, OR.

- USEPA. 2017. Release of Standard Operating Procedure for an in vitro Bioaccessibility Assay for Lead and Arsenic in Soil and Validation Assessment of the in vitro Arsenic Bioaccessibility Assay for Predicting Relative Bioavailability of Arsenic in Soils and Soil-Like Materials at Superfund Sites. U.S. Environmental Protection Agency.
- USEPA. 2021a. Personal communication (letter from B. Arthur, U.S. Environmental Protection Agency, to D. Mills, Teck American Incorporated, regarding draft data usability for the Aquatic BERA). U.S. Environmental Protection Agency, Seattle, WA. December 23, 2021.
- USEPA. 2021b. Phase 3 Sediment Study 42-day *Hyalella azteca* Bioassay Quartz Sand Negative Control Performance Evaluation. CH2M HILL on behalf of U.S. Environmental Protection Agency.
- USGS (U.S. Geological Survey). 2005. Vertical Distribution of Trace-Element Concentrations and Occurrence of Metallurgical Slag Particles in Accumulated Bed Sediments of Lake Roosevelt, Washington, September 2002. Scientific Investigation Report 2004-5090. U.S. Geological Survey, Reston, VA.
- USGS. 2006a. NASQAN (National Stream Quality Accounting Network) Program. Statistical Summaries of Published Data: Columbia River Basin [online]. U.S. Geological Survey, Portland, OR.
<http://water.usgs.gov/nasqan/data/statsumtxt.html>.
- USGS. 2006b. Concentrations of Elements in Sediments and Selective Fractions of Sediments, and in Natural Waters in Contact with Sediments from Lake Roosevelt, Washington, September 2004. U.S. Geological Survey, Reston, VA.
- USGS. 2016a. Toxicity Evaluation of Metal-Contaminated Sediments from the Upper Columbia River, Washington, to the Amphipod, *Hyalella azteca*, the Midge, *Chironomus dilutus*, and the Mussel, *Lampsilis siliquoidea*. U.S. Geological Survey.
- USGS. 2016b. Trace Elements Concentrations in Pore Water and Surface Water Near the Sediment-Water Interface in the Upper Columbia River, Washington (2015): U.S. Geological Survey Data Release. U.S. Geological Survey.
- Vandeghechuchte, M.B., L.T.H. Nguyen, F. De Laender, B.T.A. Muyssen, and C.R. Janssen. 2013. Whole Sediment Toxicity Tests for Metal Risk Assessments: On the Importance of Equilibration and Test Design to Increase Ecological Relevance. *Environ Toxicol Chem* 32(5):1048–1059.

MAPS

FILE: M:\US\Projects\S-UT\Tech\0493466_Teck_Upper Columbia River\Maps\Aquatic BERA Appendix A\Appendix A.aprx | REVISED: 09/16/2025 | SCALE: 1:100,174 when printed at 11x17



ERM

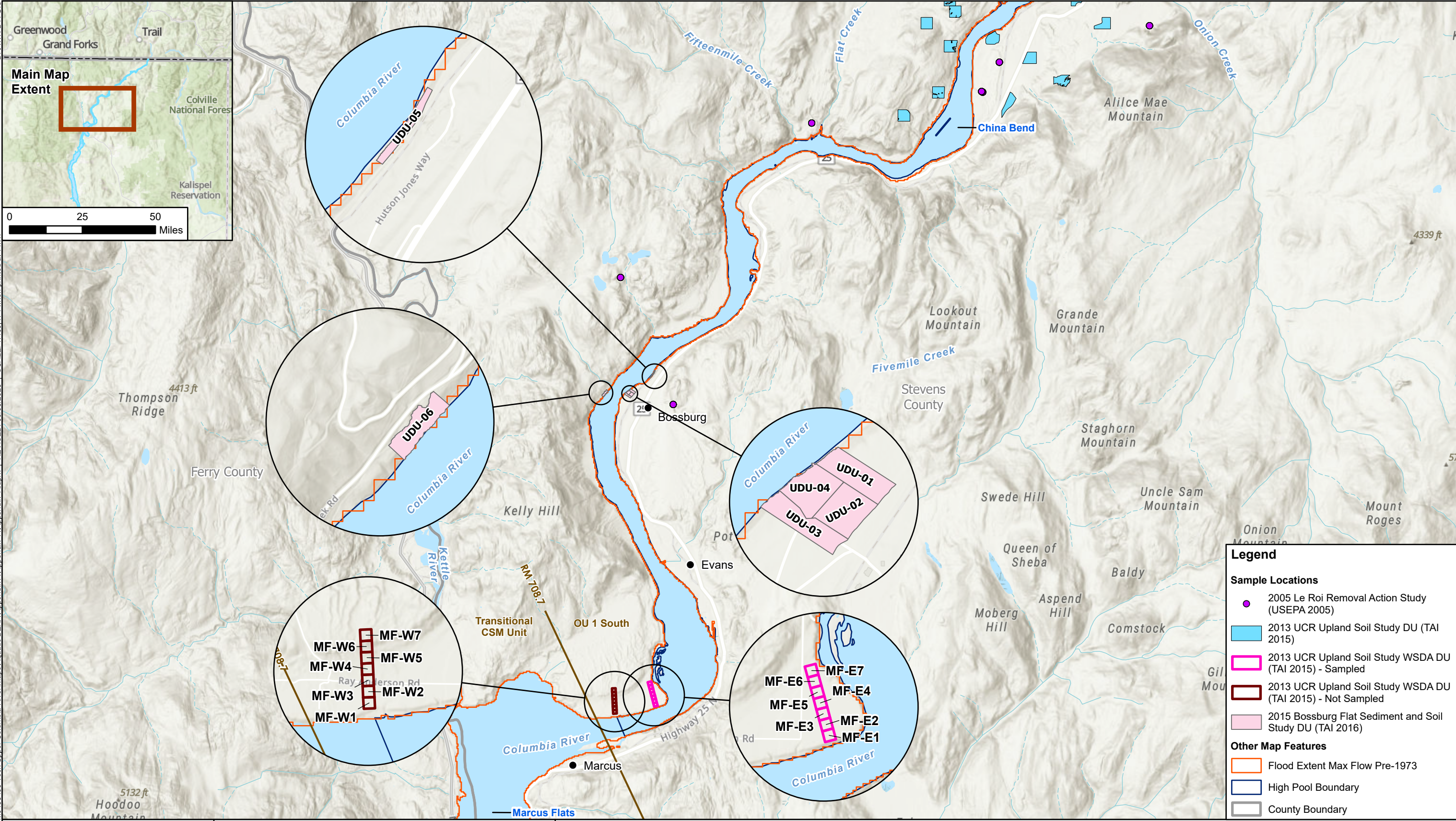
Environmental Resources Management
www.erm.com

0 0.75 1.5 3 Miles



Map A-1a. Sample Locations for Data Sets Considered for Inclusion as Soil Data in the Aquatic BERA
Final Aquatic BERA
Upper Columbia River, Washington

FILE: M:\US\Projects\IS-UT\Tech\0493466_Teck_Upper Columbia River\Maps\Aquatic BERA Appendix A\Appendix A.aprx | REVISED: 09/08/2025 | SCALE: 1:100,174 when printed at 11x17



Map A-1b. Sample Locations for Data Sets Considered for Inclusion as Soil Data in the Aquatic BERA
Final Aquatic BERA
Upper Columbia River, Washington

Source: Esri - World Topographic Map; NAD 1983 UTM Zone 11N

TABLES

Table A-1. Results of Chemistry Inventory Screening

Study	Study ID in UCR Project Database	Included in Chemistry Inventory (Table A-2)?	Relevant Citation
Sediment Studies			
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	WADOE_2001	Yes	Ecology (2001)
2001 Expanded Site Investigation	USEPA_2001_ESI	Yes	USEPA (2003)
2002–2003 USGS Sediment Core Sampling	USGS_Cox2005	Yes	USGS (2005)
2004 USGS Sediment Sampling	USGS_04_LR	Yes	USGS (2006b)
2004 USGS Toxicity Evaluation	Not in database	Yes	Besser et al. (2008)
2005 Phase 1 Sediment Sampling	USEPA 2005 Sediment	Yes	USEPA (2006a)
2007 Ecology Reconnaissance and Sediment Sampling	WADOE_2007	Yes	Ecology (2007a)
2008 USGS Toxicity Evaluation	FAIRCHILD2012	Yes	Fairchild et al. (2012)
2009–2011 Beach Sediment Study	Teck_2009_BeachSD/Teck_2010_BeachSD/Teck_2011_BeachSD	Yes	TAI (2014)
2010 White Sturgeon Sediment Toxicity Study	Teck_2010_Sturgeon_SedTox	Yes	TAI (2018a)
2013 USGS Toxicity Evaluation	CERC_2013_SedTox	Yes	USGS (2016a)
2013 Phase 2 Sediment Study	Teck_2013_SedTox	Yes	TAI (2017b)
2015 Bossburg Flat Sediment and Soil Study	Teck_2015_Bossburg	Yes	TAI (2016)
2019 Northport Waterfront RI	WADOE_2019A	Yes	Ecology (2019)
2019 Phase 3 Sediment Study	Teck_2019_SedTox	Yes	TAI (2022)
Porewater Studies			
2002–2003 USGS Sediment Core Sampling	USGS_Cox2005	Yes	USGS (2005)
2004 USGS Sediment Sampling	USGS_04_LR	Yes	USGS (2006b)
2004 USGS Toxicity Evaluation	Not in database	Yes	Besser et al. (2008)
2005 Phase 1 Sediment Sampling	USEPA 2005 Sediment	Yes	USEPA (2006a)
2010 White Sturgeon Sediment Toxicity Study	Teck_2010_Sturgeon_SedTox	Yes	TAI (2018a)
2013 USGS Toxicity Evaluation	CERC_2013_SedTox	Yes	USGS (2016a)
2013 Phase 2 Sediment Study	Teck_2013_SedTox	Yes	TAI (2017b)
2015 USGS Porewater Study	USGS_2015_SWI_Torpedo	Yes	USGS (2016b)
2019 Phase 3 Sediment Study	Teck_2019_SedTox	Yes	TAI (2022)
Surface Water Studies			
2000 USGS Water Quality Data for Northport	USGS_Northp	Yes	USGS (2006a)
2000–2007 Water Quality Monitoring at Northport	AMS001	Yes	Ecology (2007b)
2009–2010 Surface Water Study	Teck_2009_PhaseII_SW_R1/Teck_2010_PhaseII_SW_R2/Teck_2011_PhaseII_SW_R3	Yes	TAI (2013a)
2015 USGS Porewater Study	USGS_2015_SWI_Torpedo	Yes	USGS (2016b)
Aquatic Tissue Studies			
2005 Phase 1 Fish Tissue Sampling	US EPA 2005 Tissue	Yes	USEPA (2007)
2009 Fish Tissue Study	Teck_2009_fish	Yes	TAI (2013b)
2016 Macroinvertebrate Tissue Study	Teck_2016_Benthic	Yes	TAI (2018b)
2016 Sturgeon Tissue Sample Collection	USEPA_2016_SturgeonTissue	Yes	TAI (2017a)
2018 Northern Pike Tissue Study	USEPA_2018_NPikeTissue	Yes	TAI (2019b)
Soil Studies			
Vegetation recovery following pollution control at Trail, British Columbia	Not in database	No ^a	Archibold (1974)
Biomonitoring System Development for Cominco	Not in database	No ^a	Cominco (1998)
Le Roi Smelter Removal Action Study	LeRoi2005	Yes ^a	USEPA (2005)
2012 Ecology Upland Soil Study	HARTC13A	No ^a	Ecology (2013)
2014 Soil Study	Teck_2014_UplandSoil	Yes	TAI (2015)
2014 UCR Residential Soil Study	USEPA_2014_ResSoil	No ^a	USEPA (2016b)
2015 Bossburg Flat Sediment and Soil Study	Teck_2015_Bossburg	No ^a	TAI (2016)
2016 Residential Soil Study	Teck_2016_ResSoil	No ^a	TAI (2017d)
2018 Plant Tissue Study	Teck_2017_PlantTissue	No ^a	TAI (2019c)
2019 Northport Waterfront RI	WADOE_2019A	Yes	Ecology (2019)

Notes:

^a Soil studies were not included in the chemistry inventory if they did not meet at least one of the following soil data screening criteria: 1) samples were sieved to < 2 mm prior to chemical analyses, 2) samples were collected from depth intervals between 0 and 12 in., or 3) sampling locations were below the pre-1973 maximum flood extent of the river.

Ecology - Washington State Department of Ecology

ID - identification

RI - remedial investigation

Table A-2. Inventory of Chemistry Studies

Study ¹	Citation	Sampling Date(s) ¹	Media Type ^{1,3}	Samples Collected in Field or Lab	Invertebrate or Fish Bioassay-Associated Chemistry ² Included in Data Set?	Number of Locations and Samples with Chemistry Data, Excluding Field Duplicates ^{1,5}			Sample Collection Methods ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage ^{1,10}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}	
						Total	OU 1	OU 2								
Sediment																
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	Ecology (2001)	5/7/2001–5/9/2001	surface sediment	field	yes (see Table A-8)	9 locations (including 1 reference location and 2 tributary locations); 1 sample at each location	3 locations; 3 samples	6 locations; 6 samples	most samples were composites of 3 grab samples collected from 0–10 cm using a 0.1-m ² stainless steel van Veen grab or stainless steel spoon	grain size: PSEP TOC: PSEP total solids: EPA 160.3 select metals: EPA 3050B/6010B mercury: EPA 7471A/245.5	Manchester, Rosa Environmental (grain size only)	formal DV not conducted (no mention in data report and no DV qualifiers applied, however, QAPP cites the functional guidelines and refers to internal lab review)	NA	none reported based on available documentation	no COCs, field documentation, lab report, DLs (RLs are not in Excel file but available elsewhere), lab or DV qualifiers, DV	
2001 Expanded Site Investigation	USEPA (2003)	May–June 2001	mostly surface sediment (2 subsurface samples)	field	no	58 locations (excluding a large number of tributary samples); 58 samples	33 locations; 33 samples	25 locations; 25 samples	discrete samples collected with stainless steel petit ponar dredge, hand auger, and/or bowls and spoons; depths: 0–0.25 in., 0–0.5 in., 0–1 in., 0–2 in., 0–3 in., 0–4 in., 0–5 in., 0–6 in., 0–6.5 in., 0–7 in., 0–8 in., 18–24 in.	TAL metals: CLP SOW ILM04.1 chlorinated pesticides and PCB Aroclors (subset): CLP SOW OLM04.2 TOC (subset): EPA SW-846 Method 9060 modified	Sentinel, Inc., DataChem Laboratories (TAL metals), North Creek (TOC), Compuchem, Inc., Mitkem, Inc. (organics)	EPA	2B	none reported based on available documentation (some pages of the DV reports are missing)	no COCs, DLs/RLs, lab qualifier definitions, DV qualifiers; some pages of DV reports are missing	
2002–2003 USGS Sediment Core Sampling	USGS (2005)	September 2002, July 2003	surface and subsurface sediment	field	no	5 locations; 1 surface core sample at each location (total of 70 core samples)	none	5 locations; 1 surface core sample at each location (total of 70 core samples)	bottom core depths ranging from 38–164 cm, 2–5 cm thick subsections; sediment freeze-dried and ground at lab prior to digestion	select metals: ICP-MS mercury: CV-AFS TOC: PSEP slag characterized via SEM-EDS	USGS-ML	unknown if DV was conducted	unknown	none reported based on available documentation	no COCs, specific analytical methods, QAPP, lab report, DLs/RLs, lab qualifiers, DV report	
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	surface sediment (composite sample types only)	field	no	8 locations (including 1 reference site); 1 sample at each location	3 locations; 3 samples	4 locations; 4 samples	10-L composite sediment samples made up of multiple cores collected with a stainless box corer, split samples used for USGS (Besser et al. 2008)	select total metals: ICP-MS mercury: EPA 7473 carbon calculated from LOI grain size: ASTM D422-63 AVS, TOC, moisture: methods not reported	USGS-CERC (grain size, LOI, moisture, AVS for composite samples), USGS-ML (metals)	assumed DV not conducted; no DV qualifiers applied	NA	none reported based on available documentation	no COCs, QAPP, complete list of analytical methods, lab reports, data report, DLs/RLs, lab qualifiers, DV qualifiers	
2004 USGS Toxicity Evaluation	Besser et al. (2008)	September 2004	surface sediment (split samples from USGS Sediment Sampling 2004)	field	yes (see Table A-8)	8 locations (including 1 reference site); 1 sample at each location	3 locations; 3 samples	4 locations; 4 samples	10-L composite sediment samples made up of multiple cores collected with a stainless box corer	select metals: ICP-MS mercury: EPA 7473 AVS/SEM: Brumbaugh and Arms (1996) particle size: ASTM (2007) TOC: estimated from LOI	USGS CERC	unknown if DV was conducted	unknown	none reported based on available documentation	no COCs, QAPP, lab report, DLs/RLs, qualifiers, DV	
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	surface and subsurface sediment	field	yes (see Table A-8)	76 transect locations; 186 samples	26 transect locations; 49 samples	50 transect locations; 137 samples	collected with van Veen grab sampler (below-water samples) or stainless steel hand tools (above-water samples), cores also collected with Vibracorer; subset of samples sieved to > 75 µm and < 75 µm; depths: upper 10–15 cm was typically sampled, except for cores (0 to 5, 7, or 9 ft); all depths: 0–0.5 ft, 0–1 ft, 1–3 ft, 3–5 ft, 5–7 ft, 7–9 ft	TAL metals and uranium: CLP AVS/SEM: PSEP SVOCs: CLP pesticides and PCB Aroclors: CLP D/F (subset): CLP TOC: PSEP (EPA 415.1) grain size: ASTM D422	Manchester, A4 Scientific, Ceimic Cor, Paradigm A	EPA	Stage 4 on all D/F data and four SDGs for other analyses; if no issues, Stage 4 on 30% of data and Stage 2B on 70% of data (per QAPP)	rejected data: SVOCs for continuing calibration issues, metals for low matrix spike recoveries	no COCs, field documentation, lab reports, DLs (CLP referenced); DV reports not included but available upon request	
						15 beaches; 66 samples	4 beaches; 19 samples	11 beaches: 47 samples								
						9 core locations; 44 samples	1 core location; 1 sample	8 core locations; 43 samples								
						56 bioassay/ transect/ reference samples	26 bioassay/ transect/ reference samples	30 bioassay/ transect/ reference samples								
2007 Ecology Reconnaissance and Sediment Sampling	Ecology (2007a)	5/14/2007	surface sediment	field	no	10 locations; 10 samples	7 locations; 7 samples	3 locations; 3 samples	5-point composite samples within a 10-ft radius; collected with stainless steel spoon; sieved in lab to < 2 mm after 2 days air drying; depths: 0–3 in., 0–4 in., 0–6 in., 2–6 in.	select metals: EPA 200.8	Manchester	assumed DV not conducted; no mention of DV in data report and no DV qualifiers applied	NA	matrix spike recoveries for Cu, Pb, and Zn were not calculated due to insufficient spike used	no COCs, field or sampling handling documentation, DLs/RLs (but no non-detects), PARCC discussion, DV	
2008 USGS Toxicity Evaluation	Fairchild et al. (2012)	5/28/2008, 6/11/2008; bioassays started 6 weeks later	surface sediment	field	yes (see Table A-8)	5 locations; 5 samples	suitable	2 locations; 2 samples	semi-wet sediment collected with stainless steel spoon (0–30-cm depth) immediately adjacent to the waterline; sieved to 2 mm	particle size: Bouyoucos (1962) TOC: Coulometrics carbon analyzer metals screen: XRF total recoverable metals (nitric digestion per Brumbaugh et al. [1994]): Brumbaugh and Arms (1996) AVS/SEM: Brumbaugh and Arms (1996)	USGS CERC	unknown if DV was conducted	unknown	samples were refrigerated for 6 weeks before starting testing; unclear if chemical analyses also took place after 6 weeks. If so, the standard hold time for AVS-SEM was exceeded.	no COCs, QAPP, lab report, DLs/RLs, qualifiers, DV	
2009–2011 Beach Sediment Study	TAI (2014)	9/8/2009–9/11/2009; 4/27/2010–4/30/2010; 5/5/2011	surface and subsurface sediment	field	no	33 beaches; at each beach 5 composite surface sediment samples and at most beaches 5 discrete and 3 composite core samples (multiple intervals)	10 beaches	23 beaches	surface sediment: stainless spoon and bowl cores: Lexan core tubes and electric impact corer	TAL metals and uranium: EPA 6010, EPA 6020 mercury: EPA 7471A alternative method for As (EPA 7062) and Se (EPA 7742) if non-detect: EPA 6020 TOC: PSEP (1986) pH: EPA 9045C grain size and total solids: PSEP (1986) total sulfides: EPA 9030 radionuclides: radium-226: EPA 903.1M, uranium-238: HASL-300M PCB congeners: EPA 1668A PCBs: EPA 8082A D/F: EPA 1613B PBDEs: EPA 1614 PAHs: EPA 8270M SIM pesticides: EPA 8081B or EPA 1856A SVOCs: EPA 8270D or EPA 1625 IVBA: EPA 6020/7742	CAS, SGS NC (PCB congeners, D/F, PBDEs), Pace (radionuclides)	Environmental Standards Inc.	2B (70%), 4 (30%)	2009 data: 8 results rejected for PBDEs because the analyte was not recovered; 2010 data: no rejected results; 2011 data: 47 results rejected for SVOCs due to low LCS/LCSD recoveries, some data qualified due to hold time exceedances	NA	
										2010 White Sturgeon Sediment Toxicity Study	TAI (2018a)	5/12/2010–9/6/2010	surface sediment	field	yes	4 areas (excluding 2 upstream reference areas); 4 composite samples bioassays conducted at 5 areas
2013 USGS Toxicity Evaluation	USGS (2016a)	field: September–October 2013 bioassay (Cycles 1 and 2 start dates): 12/2013, 2/2014	surface sediment	field and lab	yes (see Table A-8)	12 locations upstream of Onion Creek (collected by NRT) and 44 Phase 2 split samples downstream of Onion Creek (collected by TAI), including a <i>priori</i> reference samples and tributaries	25 locations; 25 samples	31 locations; 31 samples	NRT: collected with Besser scoop or stainless steel tools, all sieved to 2 mm TAI Phase 2: collected with modified van Veen grab, petite ponar, or stainless steel shovel, some sieved to 5 mm but most not sieved	select total recoverable metals: EPA 6020A, EPA 7473 AVS/SEM (bioassay sediment only) TOC: LECO CR-412 carbon analyzer moisture: gravimetric grain size: Wentworth scale	USGS CERC, University of Missouri (TOC, grain size)	CH2M Hill	2B (90%), 4 (10%)	none reported based on available documentation	files provided by USGS indicate the non-detects are a mix of RLs and MDLs	

Table A-2. Inventory of Chemistry Studies

Number of Locations and Samples with Chemistry Data, Excluding Field Duplicates ^{1,5}															
Study ¹	Citation	Sampling Date(s) ¹	Media Type ^{1,3}	Samples Collected in Field or Lab	Invertebrate or Fish Bioassay-Associated Chemistry ² Included in Data Set?	Total	OU 1	OU 2	Sample Collection Methods ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage ^{1,10}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}
Sediment (continued)															
2013 Phase 2 Sediment Study	TAI (2017b)	field: 9/5/2013–10/24/2013; bioassays initiated 1/22/2015–2/28/2015 and 2/13/2015–5/8/2015	surface sediment	field and lab	yes (see Table A-8)	126 locations; 126 samples (excluding upstream reference locations)	44 locations; 44 samples short-term bioassays at 20 locations; long-term bioassays at 9 locations	82 locations; 82 samples short-term bioassays at 39 locations; long-term bioassays at 11 locations	grab samples (hand-held, Van Veen, and mechanical); sample intervals ranged from 0–3 in. to 0–6 in.; samples with large proportions of material > 2 mm were sieved through a 5 mm screen in the field	TAL metals: EPA 6010, EPA 6020 mercury; EPA 7471B AVS SEM: EPA (1991) TOC: ASTM D4129-05 pH: EPA 9045D grain size: ASTM D422 bioassay: EPA 100.2, 100.4, ASTM Method E 1706-05	ALS and PER	Environmental Standards Inc.	Chemistry data: 2B (80%), 4 (20%); Bioassay data: assessed for acceptability	none reported	NA
2015 Bossburg Flat Sediment and Soil Study	TAI (2016)	4/14/2015–5/8/2015	surface and subsurface sediment	field	no	10 SDUs; 18 surface sediment samples (triplicates at 4 SDUs); 72 subsurface core samples	10 SDUs; 18 surface sediment samples (triplicates at 4 SDUs); 72 subsurface core samples	none	composite samples (0–15 cm ICS method), core samples collected from surface (0–15 cm), and subsurface (0–45 cm) field analyses of Pb using XRF	TAL metals: EPA 6010, EPA 6020 mercury; EPA 7471B grain size: PSEP pH: EPA 9045D TOC: ASTM D4129-05 percent moisture: EPA 160.3 IVBA: Ruby extraction/EPA 6020A	ALS	Environmental Standards Inc.	2B (82%), 4 (18%)	all data usable except for IVBA As and Pb in 1 sample and total As and Pb in 4 samples	NA
2019 Northport Waterfront RI	Ecology (2019)	3/25/2019–3/28/2019	surface and subsurface sediment	field	no	33 surface sediment locations (excluding locations with only XRF analyses); 33 samples ⁹	33 locations and samples	none	surface samples (0–6 in.) collected from test pits dug using a mini-excavator or collected by hand-excavation	Field XRF screen for select metals: based on EPA 6020 TAL metals: EPA 6010C mercury; EPA 7471B percent moisture (method not reported)	Eurofins TestAmerica Spokane	GeoEngineers	2A	none reported based on available documentation	field forms
2019 Phase 3 Sediment Study	TAI (2022)	field: 9/10/2019–10/19/2019; bioassays initiated 6/2020	surface sediment	field and lab	yes (see Table A-8)	87 locations; 87 samples (excluding upstream reference locations)	87 locations; 87 samples (excluding upstream reference locations)	none	grab samples (van Veen power grab sampler, modified Hamon grab sampler, freeze grab sampler, or hand sampling in shallow water using stainless-steel shovel or scoop); sample intervals ranged from 0–4 in. to 0–8 in.; gravel or cobble > 2 mm was removed by hand during field homogenization; samples with large proportions of material > 2 mm were sieved through a 5 mm screen in the field	select metals: EPA 6010C, EPA 6020A mercury; EPA 7471B SEM metals: EPA 6010C/SEM-AVS AVS: EPA 821-R91-SEM percent solids: EPA 160.3 TOC: ASTM D4129-05 grain size: ASTM D422 reference samples only: PAHs: EPA 8270D SIM PCBs (Aroclors and subset of congeners): EPA 8082A pesticides and SVOCs: EPA 8081	ALS	Environmental Standards Inc.	2B (~90%), 4 (~10%)	one rejected data point for methoxychlor (reference sediment) due to low MS recovery	NA
Porewater															
2002–2003 USGS Sediment Core Sampling	USGS (2005)	July 2003	porewater	lab	no	3 locations; 11 samples (cores)	none	3 locations; 11 core samples	14 cm box core, centrifuge for 30 minutes, 0.45 µm filtration	select metals: ICP-MS	USGS-ML	unknown if DV was conducted	unknown	none reported based on available documentation	no COCs, specific analytical methods, QAPP, lab report, DLs/RLs, lab qualifiers, DV report
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	porewater	lab	no	7 locations (excluding 1 reference site); 32 samples	3 locations; 8 samples	4 locations; 24 samples	interstitial water: centrifuge 2,000 rpm for 20 min, in-line filtration	select metals: ICP-MS	USGS-ML	assumed DV not conducted; no DV qualifiers applied	NA	none reported based on available documentation	no COCs, QAPP, complete list of analytical methods, lab reports, data report, DLs/RLs, lab qualifiers, DV qualifiers
2004 USGS Toxicity Evaluation	Besser et al. (2008)	sediment collected in September 2004; bioassays started 10–18 days later	porewater	lab	yes (see Table A-8)	7 locations (excluding 1 reference site) and samples for which bioassays were conducted	3 locations; 3 samples	4 locations; 4 samples	centrifuge, filtered to 0.45 µm	select total recoverable metals: ICP-MS conductivity, pH, alkalinity, hardness, ammonia, dissolved sulfides: APHA (2005) DOC (subset): wet oxidation and colorimetric analysis	USGS CERC	unknown if DV was conducted	unknown	none reported based on available documentation	no COCs, QAPP, lab report, DLs/RLs, qualifiers, DV
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	porewater	lab	yes (see Table A-8)	50 locations and samples (excluding reference) for which bioassays were conducted	22 locations and samples	28 locations and samples	centrifuge	dissolved TAL metals and uranium: CLP	Ceimic Cor	EPA	Stage 4 on all D/F and four SDGs for other analyses; if no issues, Stage 4 on 30% of data and Stage 2B on 70% of data (per the QAPP)	none reported based on available documentation	no COCs, field documentation, lab reports, DLs (CLP referenced); DV reports not included but available upon request
2010 White Sturgeon Sediment Toxicity	TAI (2018a)	5/12/2010–9/6/2010	porewater	lab	yes	5 areas (excluding 2 reference areas); 5 composite samples; porewater collected by airstone, DGT, and/or peepers for a variety of analyses on multiple dates throughout test	4 areas; multiple samples	1 area; multiple samples	Rena Micro Bubbler 6-in. ceramic airstones, peepers/DGT	TAL metals total and dissolved: EPA 6010, EPA 6020 alkalinity: SM 2320B fluoride and sulfate: EPA 300.0 organic carbon: SM 5310C TDS: SM 2540C hardness: SM 2340B	CAS (chemistry), University of Saskatchewan Aquatic Toxicity Research Facility (bioassays)	Environmental Standards Inc.	2B, 4 (subset)	none reported	NA
2013 USGS Toxicity Evaluation	USGS (2016a)	January, March, August 2014	porewater	lab	yes (see Table A-8)	56 locations for which bioassays were conducted; see Table A-10 for details on analyses	25 locations; some analyses conducted at more than one time period during bioassays and for more than one type of bioassay	31 locations; some analyses conducted at more than one time period during bioassays and for more than one type of bioassay	centrifuge or peeper	select dissolved metals: EPA 6020A DOC and TOC: EPA 415.1 cations: EPA 6020A anions: EPA 300.0	USGS CERC	CH2M Hill	2B (90%), 4 (10%)	none reported based on available documentation	files provided by USGS indicate the non-detects are a mix of RLs and MDLs
2013 Phase 2 Sediment Study	TAI (2017b)	field: 9/5–10/24/2013; bioassays initiated 1/22–2/28 and 2/13–5/8/2015	porewater	field and lab	yes (see Table A-8)	97 locations; 97 samples (excluding 4 upstream reference locations) short-term bioassays at 56 locations; long-term bioassays at 20 locations; see Table A-10 for details on analyses	34 locations; 34 samples short-term bioassays at 20 locations; long-term bioassays at 9 locations; some analyses conducted at more than one time period during bioassays	63 locations; 63 samples short-term bioassays at 39 locations; long-term bioassays at 11 locations; some analyses conducted at more than one time period during bioassays	field: Overlying water siphoned and porewater extracted with an airstone bioassay: Centrifuge and peeper	dissolved TAL metals: EPA 6010, EPA 6020 TOC/DOC: EPA 9060A pH: EPA 4500H+ B alkalinity: SM2320B chloride: EPA 300 sulfide: SM 4500 S2- D	ALS and PER	Environmental Standards Inc.	Chemistry data: 2B (80%), 4 (20%) Bioassay data: assessed for acceptability	37 bioassay sulfide porewater results rejected	NA
2015 USGS Porewater Study	USGS (2016b)	April, July, August 2015	porewater	field	no	28 shallow porewater locations/samples; 14 deep porewater locations/samples; 20 drive-point locations/samples	28 shallow porewater locations/samples; 14 deep porewater locations/samples; 20 drive-point locations/samples	none	weighted profile sampler (4.5 cm and 14.5 cm below sediment water interface) or drive-point sampler (6 cm below sediment water interface)	select metals: ICP-MS/Wolf and Adams (2015) select anions: EPA 300.0 charge balance DOC: SM 5310 B-00 alkalinity: probe conductivity and pH: probe	field (alkalinity, conductivity, and pH), USGS Crustal Geophysics and Geochemistry Science Center (metals), USGS CERC (anions), UW (DOC)	DV not conducted	NA	unknown; no lab report or DV	no COCs, sample handling documentation, formal data report, lab report, DLs/RLs, DV
2019 Phase 3 Sediment Study	TAI (2022)	field: 9/17/2019–10/23/2019; bioassays initiated 6/2020	porewater	field and lab	yes (see Table A-8)	104 locations; 104 field samples (excluding upstream reference locations) 40 long-term bioassay samples; see Table A-10 for details on analyses	104 locations; 104 samples (excluding upstream reference locations) 40 long-term bioassay samples; some analyses conducted at more than one time period during bioassays	none	collected from the top 0–6 in. of sediment using the Trident probe	select dissolved metals: EPA 6010C, EPA 6020A TOC and DOC: EPA 9060A alkalinity as CaCO3: SM 2320B hardness as CaCO3: SM 2340B chloride, sulfate: EPA 300.0	ALS	Environmental Standards Inc.	2B (~90%), 4 (~10%)	some blank contamination (U* flags)	NA

Table A-2. Inventory of Chemistry Studies

Number of Locations and Samples with Chemistry Data, Excluding Field Duplicates ^{1,5}																
Study ¹	Citation	Sampling Date(s) ¹	Media Type ^{1,3}	Samples Collected in Field or Lab	Invertebrate or Fish Bioassay-Associated Chemistry ² Included in Data Set?	Total	OU 1	OU 2	Sample Collection Methods ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage ^{1,10}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}	
Surface Water																
2000 USGS Water Quality Data for Northport	USGS (2006a)	February–September 2000 (data prior to 2000 not summarized in this table)	surface water	field	no	8 samples at Northport location	8 samples at Northport location	none	total/dissolved; collection method unknown	select dissolved metals, pesticides, herbicides, conventionals, and nutrients (specific methods not reported)	unknown	assumed DV not conducted; no DV qualifiers applied	NA	none reported based on available documentation	no COCs, specific methods, QAPP, lab report, data report, DLs/RLs	
2000–2007 Water Quality Monitoring at Northport	Ecology (2007b)	location ID 61A070 (Northport); 1/10/2000–6/4/2007 (data prior to 2000 not summarized in this table)	surface water	field	no	90 samples at Northport location	90 samples at Northport location	none	total/dissolved; collection method unknown	select metals: EPA 245.7, EPA 200.8 hardness as CaCO3: SM2340B turbidity: SM2130 TSP: SM2540D, EPA 160.2 ammonia: SM4500NH3H total persulfate nitrogen: SM4500NB nitrate/nitrite: SM4500NO3I orthophosphate: SM4500PG phosphorus: EPA 200.8M fecal coliform: SM9222D, SM16-909C enterococci: EPA1600, SM17-923C (some samples analyzed for a subset)	Manchester	assumed DV not conducted; no DV qualifiers applied	NA	none reported based on available documentation	no COCs, QAPP, lab report, data report, DLs/RLs, DV	
2009–2010 Surface Water Study	TAI (2013a)	9/1/2009–10/29/2009, 2/23/2010–4/19/2010, 4/27/2010–6/17/2010	surface water	field	no	144 locations; 235 samples (excluding 12 upstream reference locations)	39 locations; 63 samples	105 locations; 172 samples	constant-flow composite sampling, grab samples, Go-Flo, and peristaltic pump; total/dissolved; disturbed water samples were collected in nearshore areas ~0.75 m above river bottom; undisturbed water samples were collected in nearshore areas ~0.25 m above river bottom; near-bottom samples were collected ~1 m above river bottom; near surface samples were collected ~1 m below water surface.	select metals: EPA 6010B, EPA 6020 mercury: EPA 1631E inorganic arsenic: EPA 1632 pesticides: EPA 8081A SVOCs: EPA 8270 PAHs: EPA 8270-SIM PCB congeners: EPA 1668A PBDEs: EPA 1614 radionuclides: EPA 903.1 alkalinity: SM2320B hardness: SM 2340C TDS/TSS: SM2450C/D TOC: EPA 5310C pH: SM 4500H+ B silicon dioxide: SM 4500 SiO2 C select anions: EPA 300.0 ammonia: SM 4500-NH3 G phosphorus: EPA 365.3	Columbia Analytical, Frontier Geosciences, SGS Wilmington, Vista, Pace	Environmental Standards Inc.	2B	some rejected data for PBDE, Sb, Cr, Co, Fe, Mn, Mo, Ni, Ta, Sn, and Zn	NA	
2015 USGS Porewater Study	USGS (2016b)	April and August 2015	surface water	field	no	28 locations (including surface water interface data); 50 samples	28 locations; 50 samples	none	weighted profile sampler at 7 cm above the sediment water interface; dissolved only	select metals: ICP-MS/Wolf and Adams (2015) select anions: EPA 300.0 charge balance DOC: SM 5310 B-00 alkalinity: probe conductivity and pH: probe	USGS Crustal Geophysics and Geochemistry Science Center (metals), USGS CERC (anions), UW (DOC)	DV not conducted	NA	unknown; no lab report or DV	no COCs, sample handling documentation, formal data report, lab report, DLs/RLs, DV	
Tissue																
2005 Phase 1 Fish Tissue Sampling	USEPA (2007)	September–December 2005	tissue	field	no	6 sampling areas: 105 whole body composites, 30 estimated whole body ^d composites	FSCAs 1 and 2: 30 whole body composites, 10 estimated whole body ^d composites	FSCAs 3 through 6: 105 whole body composites, 30 estimated whole body ^d composites	gill nets, boat electrofishing, burbot traps	TAL metals: CLP/ILM05.3SW846-6000/7000 inorganic arsenic CLP/OLM04.3/SW8082 PCB congeners: EPA 1668A D/F: EPA 1613B percent lipids: modified Bligh-Dyer percent moisture: PSEP	Manchester (conventionals, metals, PCBs, pesticides/herbicides), Paradigm (conventionals, D/F, metals, PCB, pesticides/herbicides), unknown (ash free dry weight)	EPA	2B (based on available information)	none reported based on available documentation	no QAPP, lab report, DLs/RLs; QAPP and lab reports may be available upon request	
2009 Fish Tissue Study	TAI (2013b)	9/28/2009–10/17/2009	tissue	field	no	6 FSCAs: 66 whole body composites, 176 estimated whole body ^d composites, 45 estimated whole body ^d individual samples	FSCAs 1 and 2: 22 whole body composites, 39 estimated whole body ^d composites, 21 estimated whole body ^d individual samples	FSCAs 3 through 6: 44 whole body composites, 137 estimated whole body ^d composites, 24 estimated whole body ^d individual samples	gill nets, boat electrofishing, backpack electrofishing, burbot traps, beach seines, minnow traps, hoop nets	select metals: EPA 6020, EPA 6010 mercury: EPA 1631E fluoride: EPA 340.2_3 inorganic arsenic: EPA 1632A PCB congeners: EPA 1668A D/F: EPA 1613B PBDEs: EPA 1614 PAHs and SVOCs: EPA 8270C SIM pentachlorophenol: EPA 8151A chlorinated pesticides: EPA 8081A percent lipids and percent solids: freeze-dry/gravimetric	ALS, Frontier Global Sciences (Inorganic As), Vista (PCB congeners, D/F, PBDEs)	Environmental Standards Inc.	2B (90%), 4 (10%)	rejected data: 1-2 samples for Zr, PBDE-209, PBDE-203/200 and PBDE-206; 34 samples for Ti; and many samples for Ta	NA	
2016 Macroinvertebrate Tissue Study	TAI (2018b)	4/26/2016–5/19/2016 and 9/7/2016–10/6/2016	tissue	field	no	6 BMI sampling areas: 36 whole body mussel composites, 12 whole body crayfish composites, 18 estimated whole body ^d crayfish composites, 1 whole body clam composite (excluding Sanpoil River and Buffalo Lake)	BMI sampling areas A1 and A2: 12 whole body mussel composites, 6 estimated whole body ^d crayfish composites	BMI sampling areas A3 through A6: 24 whole body mussel composites, 12 whole body crayfish composites, 12 estimated whole body ^d crayfish composites, 1 whole body clam composite	grabbers and traps	TAL metals: EPA 6010C, EPA 6020A total and methyl mercury: EPA 1631E, EPA 1630M inorganic arsenic: EPA 1632A PCB congeners: EPA 1668A D/F: EPA 1613B total solids: ALS SOP (freeze-dry) lipids: EPA 1668A	ALS; Vista (PCB congeners, D/F, and lipids)	Environmental Standards Inc.	2B (86%), 4 (14%)	none reported	NA	
2016 Sturgeon Tissue Sample Collection	TAI (2017a)	August–September 2016	tissue	field	no	72 fish collected between RM 684 to 723 assigned to 9 composites of 8 fish each representing 3 sturgeon size classes (fillets only)	not applicable; composites contained individual fish from both the OU 1 South OU 2 Transitional CSM Units		set lines	select metals: EPA 6010C, EPA 6020A, EPA 7742 mercury: EPA 1631E inorganic arsenic: EPA 1632A fluoride: SM4500FC PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B PBDEs: EPA 1614	ALS; Vista (PCB congeners, D/F, PBDEs)	Environmental Standards Inc.	4 (100%)	none reported	NA	
2018 Northern Pike Tissue Study	TAI (2019b)	July 2018	tissue	field	no	60 fish collected between RM 699 and 711 assigned to 12 composites (fillets only)	all but two of the composites contained individual fish from OU 2 (Marcus Flats area); the remaining two composites each had 4 fish from OU 2 (Marcus Flats area) and 1 fish from OU 1 (Evans Campground)		gill nets	select metals: EPA 6010C, EPA 6020B, EPA 7742 mercury: EPA 1631E inorganic arsenic: EPA 1632A total solids: freeze-dry/gravimetric lipids: Bligh-Dyer	ALS	Environmental Standards Inc.	4 (100%)	none reported	NA	

Table A-2. Inventory of Chemistry Studies

Number of Locations and Samples with Chemistry Data, Excluding Field Duplicates ^{1,5}												Invertebrate or Fish Bioassay-Associated Chemistry ³ Included in Data Set?	Samples Collected in Field or Lab	Media Type ^{1,3}	Sampling Date(s) ¹	Citation	Study ¹				
Total		OU 1		OU 2		Sample Collection Methods ^{1,3}		Analyte Group(s) and Analytical Method(s) ^{1,6,9}		Analytical Laboratory(s) ^{1,6}								Data Validator ^{1,10}	Data Validation Stage ^{1,10}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}
Soil ⁶																					
Le Roi Smelter Removal Action Study	USEPA (2005)	5/2004– 9/2004	soil	field	no	not clear; 192 properties sampled in and near Northport	an unknown number of samples near Northport		none	four phases of sampling primarily using 5-point composites for residential and commercial properties and public lands; 0–1 in., 1–6 in., 6–12 in., 12–18 in., 18–24 in. depending on part of property sampled and property use (e.g., play area, garden area); samples not sieved	select metals (arsenic, cadmium, copper, lead) (subset): EPA 6010B SPLP extract metals (subset): EPA 6010B TAL metals (subset): EPA CLP-SOW	Laucks Testing, Severn Trent, Bonner Analytical, Sentinel	EPA and Weston	not specified; 2B inferred	none documented	coordinates for some locations, COCs, sample handling and field QA/QC sample information, DLs and RLs, lab reports and Form 1s					
2014 Soil Study	TAI (2015)	9/8/2014– 10/29/2014	soil	field	no	16 RFDA DUs; 24 samples (triplicates at 4 DUs) 13 WSDA DUs; 17 samples (triplicates at 2 DUs) 1 ADA DU; 1 sample	16 RFDA DUs; 24 samples (triplicates at 4 DUs) 6 WSDA DUs; 8 samples (triplicates at 1 DU) 1 ADA DU; 1 sample	7 WSDA DUs; 9 samples (triplicates at 1 DU)	incremental composite sampling, 30 increment locations collected per DU, top 7.5 cm collected, sieved to < 2 mm and < 149 µm	TAL metals plus molybdenum: EPA 6010, EPA 6020 mercury: EPA 7471B metals bioaccessibility (subset of <149 µm fraction): EPA 9200.2-86, EPA 6010B grain size: PSEP pH: EPA 9045D CEC: EPA 9080 TOC: ASTM D4129-05 percent moisture: EPA 160.3	ALS	Environmental Standards Inc.	2B (85%), 4 (15%)	none reported	NA						
2019 Northport Waterfront RI	Ecology (2019)	3/25/2019– 3/28/2019	soil	field	no	1 surface soil sample, XRF-26 (excluding locations with only XRF analyses) ⁸	1 sample	none	test pit samples collected from sidewalls of excavated pit at 6 in. intervals down to 4 feet bgs, surface grab samples collected from top 0–6 in., assumed not sieved (not documented: specific sample collection methods, information about sieving)	TAL metals: EPA 6010C mercury: EPA 7471B percent moisture (method not reported)	Eurofins Test America Spokane	GeoEngineers	2A	none reported based on available documentation	field forms						

Notes:
^{1–10} Superscript numbers (1–10) identify columns used as “Data Quality Documentation Items” discussed in Table A-3.
^a Bioassay-associated chemistry data refers to sediment and porewater data collected in the bioassay laboratory either at the start of the test (from sediment homogenized with sediment used in the bioassays), during the test (from chemistry chambers treated with the same conditions as the bioassay test chambers), or both.
^b Samples from the Northport Waterfront RI collected below full pool reservoir elevation (1,290 ft above mean sea level) are considered sediment samples.
^c Soil studies were screened as described in Section 3.1.1 and only studies that passed through the screening are included in the data inventory.
^d Whole body estimates were calculated using fillet and offal samples for fish and carapace/stomach and whole body minus carapace/stomach for crayfish.
^e Soil samples from the Northport Waterfront RI are included in the Aquatic BERA if they were collected above full pool reservoir elevation (1,290 ft above mean sea level) and below the pre-1973 maximum flood extent.
The sample counts provided refer to the entire study. All samples may not be relevant for the BERA.
If not specified within a study’s documentation, the data validation stage was determined based on the EPA data validation checks listed in Table A-7.
EPA target analyte list (TAL) metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.
ADA - aerial deposition area
ALS - ALS Environmental - Kelso
APHA - American Public Health Association
ASTM - American Society for Testing and Materials
AVS/SEM - acid volatile sulfide/simultaneously extracted metals
bgs - below ground surface
BMI - benthic macroinvertebrate
CAS - Columbia Analytical Services (now ALS)
CEC - cation-exchange capacity
CERC - Columbia Environmental Research Center
CLP - Contract Laboratory Program
COC - chain of custody form
D/F - dioxins/furans
DGT - diffusive gradient thin-film
DL - detection limit
DOC - dissolved organic carbon
DU - decision unit
DV - data validation
Ecology - Washington State Department of Ecology
FSCA - fish sampling collection area
HASL - Health and Safety Laboratory
ICP-MS - inductively coupled plasma - mass spectroscopy
ICS - incremental composite sampling
IVBA - in-vitro bioaccessibility
LCS - laboratory control sample
LCSD - laboratory control sample duplicate
LOI - loss on ignition
MDL - method detection limit
MS - matrix spike
NA - not applicable
NRT - Natural Resource Trustees
OC - organic carbon
PARCC - precision, accuracy, representativeness, comparability, and completeness
PAHs - polycyclic aromatic compounds
PCB - polychlorinated biphenyl
PBDEs - polybrominated diphenyl ethers
PSEP - Puget Sound Estuary Program
RFDA - relic floodplain deposition area
RI - remedial investigation
RL - reporting limit
RM - river mile
SDG - sample delivery group
SDU - sediment decision unit
SEM - simultaneously extracted metal
SGS NC - SGS North Carolina
SIM - selected ion monitoring
SM - Standard Method
SOW - statement of work
SPLP - synthetic precipitation leaching procedure
SVOC - semi-volatile organic compound
TDS - total dissolved solids
TOC - total organic carbon
TSP - total suspended particulates
TSS - total suspended solids
USGS-ML - U.S. Geological Survey Minerals Laboratory
UW - University of Washington
WSDA - windblown sediment deposition area
XRF - x-ray fluorescence

Table A-3. Chemistry Data Quality Documentation Items

Item #	Type of Documentation	Data Usability Criteria ^a in Exhibit 61 of USEPA (1992)
Sampling Event		
1	hard copy or original electronic copy of data report	5.1, 5.2, 5.3
2	field coordinates (or a description of compositing methodology, if applicable)	5.1, 5.2
3	information on sampling methods (e.g., sediment sample depth, soil sample depth and sieve size, tissue whole body or portion)	5.2
4	supporting documentation (e.g., field data and reports, chain-of-custody forms, and sample handling descriptions)	5.1, 5.2, 5.3
Sample		
5	sample type (i.e., field-collected samples vs. laboratory replicate and other QC sample)	5.6
Result		
6	laboratory-generated analytical form/raw data (e.g., Form 1)	5.1, 5.3, 5.4
7	detection/reporting limits, especially for nondetected results	5.1
8	data for individual components for recalculating analytical sums (e.g., total PCBs or total PAHs)	5.1
9	information on analytical methods (e.g., use of routine/EPA-approved methods), qualifier definitions, and data quality indicators (e.g., precision and accuracy components of PARCC)	5.1, 5.4, 5.6
10	data validation conducted and validation qualifiers applied in a manner consistent with EPA functional guidelines	5.5

Notes:

See also USEPA (1992).

Items are numbered to identify them in Table A-5.

^a Data Usability Criteria (USEPA 1992):

- 5.1 Reports to Risk Assessors: site description; sampling design with sample locations; analytical methods; results on per-sample basis; quantitation and detection limits for nondetected results; field conditions; preliminary reports; meteorological data; field reports
- 5.2 Documentation: sample results related to geographic location (chain-of-custody, standard operating procedures, field and analytical records)
- 5.3 Data Sources: analytical data results for one sample per medium per exposure pathway; broad spectrum analysis for one sample per medium per exposure pathway; field measurements data for media and environment
- 5.4 Analytical Methods and Detection Limit: routine (federally documented) methods used to analyze chemicals of potential concern COPCs) in critical samples
- 5.5 Data Review: defined level of data review for all data
- 5.6 Data Quality Indicators: sampling variability quantified for each analyte; QC samples to identify and quantify precision and accuracy; sampling and analytical precision and accuracy quantified

COPC - chemical of potential concern

PAH - polycyclic aromatic hydrocarbon

PARCC - precision, accuracy, representativeness, comparability, and completeness

PCB - polychlorinated biphenyl

QC - quality control

Table A-4. EPA Data Validation Guidance/Levels of Validation

Validation Check	Validation Stage				
	1	2A	2B	3	4
Sample collection and laboratory receipt documentation reported	X	X	X	X	X
Correct analytical methods performed and dates reported	X	X	X	X	X
Correct analytes and laboratory qualifiers reported	X	X	X	X	X
Reporting limits reported and below requested reporting limits	X	X	X	X	X
Basic evaluation of results reported (e.g., to analytical method or contract requirements)	X	X	X	X	X
Requested sample handling and preparation methods performed and dates reported		X	X	X	X
Analytical and field QC data and acceptance criteria reported		X	X	X	X
Requested spikes added and frequency of QC samples appropriate		X	X	X	X
Holding times evaluated		X	X	X	X
Calibration data (e.g., initial and continuing calibration verifications and blanks) reported and frequency appropriate			X	X	X
Instrument performance checks and instrument QC samples reported and appropriate			X	X	X
Instrument response data for all instrument, laboratory, and field QC samples reported				X	X
Recalculation and compliance check of initial calibration curve, opening and/or closing continuing calibration verification and blank, percent ratios for each tune, instrument performance checks, and retention time windows, as applicable				X	X
Instrument response checked against minimum response requirements				X	X
Recalculation of reported results, laboratory QC, and spike recoveries from instrument response				X	X
Instrument outputs (e.g., chromatograms and background/interference corrections) reported					X
Sample results, including nondetected results and tentatively identified analytes, checked against instrument output for correct identification and quantification					X

Source: USEPA (2009)

Notes:

Each subsequent validation stage builds upon the previous stage (e.g., Stage 3 includes the checks for Stages 1 and 2), with Stage 4 providing the most comprehensive level of data review.

Validation checks are intended for use in conjunction with the EPA national functional guidelines for data review.

QC - quality control

Table A-5. Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies

Study	Citation	Sampling Date(s)	Media Type	Missing Documentation ^a	Data Quality Documentation Finding ^b										Data Use Recommendation ^c	
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10		
Sediment																
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	Ecology (2001)	5/7/2001–5/9/2001	surface sediment	#4: no COCs or field documentation #6: no lab report or Form 1s #7: RLs reported in data report but not Excel file, no DLs #9: data qualifiers not applied; data report addressed precision and accuracy; PARCC discussed in the QAPP #10: formal DV not conducted	A	A	A	C	A	N	C	NA	C	N	conditionally acceptable	
2001 Expanded Site Investigation	USEPA (2003)	May–June 2001	mostly surface sediment (2 subsurface samples also collected)	#4: no COCs #7: DLs/RLs not included in Excel file and are not clearly reported on lab data forms #9: Lab qualifiers not defined #10: DV was conducted but DV qualifiers are not included in the Excel file; some pages of DV report are missing	A	A	A	C	A	A	N	A	C	C	conditionally acceptable	
2002–2003 USGS Sediment Core Sampling	USGS (2005)	September 2002 and July 2003	surface and subsurface sediment	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes #6: no lab report/Form 1s #7: DLs/RLs not reported but samples are flagged as ND #9: instrumentation listed but specific methods are not, field dup RPD and SRM recovery listed in report. #10: ND data U-flagged, no other evidence of data validation	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	surface sediment (table does not include samples for incubation experiments or porewater extraction)	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes (sample handling in one of the two papers) #6: no lab report/Form 1s #7: DLs/RLs not reported but non-detects noted by lab #9: no lab data report; no LCS, replicate, or MS/MSD results provided in spreadsheet #10: no DV conducted	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
2004 USGS Toxicity Evaluation	Besser et al. (2008)	September 2004	surface sediment (split samples from Paulson et al. 2006)	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes (sample handling discussed in journal article) #6: no lab report /Form 1s #7: DLs/RLs not reported but non-detects noted in data tables #9: Methods referenced in journal article; data qualifiers and PARCC not addressed #10: no DV documentation	C	A	A	C	A	N	N	NA	N	N	conditionally acceptable	
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	surface and subsurface sediment	#4: no COCs or field documentation #6: lab reports/Form 1s not available; may be possible to request #7: Contract required quantification limits listed in QAPP; detection limits listed as CLP in QAPP but actual DLs unknown	A	A	A	C	A	N	N	A	A	A	conditionally acceptable	
2007 Ecology Reconnaissance and Sediment Sampling	Ecology (2007a)	5/14/2007	surface sediment	#4: no COCs, field notes, or sample handling documentation #7: DLs/RLs not reported but there are no non-detects #9: PARCC not discussed in data report #10: DV not conducted	A	A	A	N	A	A	C	NA	C	N	conditionally acceptable	

Table A-5. Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies

Study	Citation	Sampling Date(s)	Media Type	Missing Documentation ^a	Data Quality Documentation Finding ^b										Data Use Recommendation ^c
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	
Sediment (continued)															
2008 USGS Toxicity Evaluation	Fairchild et al. (2012)	5/28/2008 and 6/11/2008; bioassays started 6 weeks later	surface sediment	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes (sample handling discussed in journal article) #6: no lab report /Form 1s #7: DLs/RLs not reported but non-detects noted in data tables #9: Methods referenced in journal article; data qualifiers and PARCC not addressed #10: no DV documentation	C	A	Suitable	C	A	N	N	NA	N	N	conditionally acceptable
2009–2011 Beach Sediment Study	TAI (2014)	9/8/2009–9/11/2009; 4/27/2010–4/30/2010; 5/5/2011	surface and subsurface sediment	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable
2010 White Sturgeon Sediment Toxicity Study	TAI (2018a)	5/12/2010–9/6/2010	surface sediment	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable
2013 USGS Toxicity Evaluation	USGS (2016a)	Field: September–October 2013 Bioassay (Cycles 1 and 2 start dates): 12/2013, 2/2014	surface sediment	#6: no Form 1s for this lab; have Excel files of lab data #7: uncertainty in non-detect values: source files provided by USGS indicate the non-detects are a mix of DLs and RLs	A	A	A	A	A	C	C	NA	A	A	conditionally acceptable
2013 Phase 2 Sediment Study	TAI (2017b)	Field: 9/5/2013–10/24/2013 Bioassay: 1/22/2015–2/28/2015 and 2/13/2015–5/8/2015	surface sediment	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
2015 Bossburg Flat Sediment and Soil Study	TAI (2016)	4/14/2015–5/8/2015	surface and subsurface sediment	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
2019 Northport Waterfront RI	Ecology (2019)	3/25/2019–3/28/2019	surface and subsurface sediment	#4: field forms	A	A	A	C	A	A	A	NA	A	A	conditionally acceptable
2019 Phase 3 Sediment Study	TAI (2022)	9/10/2019–10/19/2019	surface sediment	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable

Table A-5. Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies

Study	Citation	Sampling Date(s)	Media Type	Missing Documentation ^a	Data Quality Documentation Finding ^b										Data Use Recommendation ^c	
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10		
Porewater																
2002–2003 USGS Sediment Core Sampling	USGS (2005)	July 2003	porewater	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes #6: no lab report/Form 1s #7: DLs/RLs not reported samples flagged as ND #9: instrumentation listed but specific methods are not, core porewater duplicate data reported, no SRM/LCS. #10: ND data "U" flagged, no other evidence of data validation	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	porewater	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes (sample handling in one of the two papers) #6: no lab report/Form 1s #7: DLs/RLs not reported but non-detects noted by lab #9: no lab data report; no LCS, replicate, or MS/MSD results provided in spreadsheet #10: no DV conducted	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
2004 USGS Toxicity Evaluation	Besser et al. (2008)	sediment collected in September 2004; bioassays started 10–18 days later	porewater	#1: no formal data report; journal article includes basic sampling and analysis information #4: no COCs or field notes (sample handling discussed in journal article) #6: no lab report /Form 1s #7: DLs/RLs not reported but non-detects noted in data tables #9: Methods referenced in journal article; data qualifiers and PARCC not addressed #10: no DV documentation	C	A	A	C	A	N	N	NA	N	N	conditionally acceptable	
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	porewater	#4: no COCs or field documentation #6: lab reports/Form 1s not available; may be possible to request #7: Contract required quantification limits listed in QAPP; detection limits listed as CLP in QAPP but actual DLs unknown	A	A	A	C	A	N	N	A	A	A	conditionally acceptable	
2010 White Sturgeon Sediment Toxicity Study	TAI (2018a)	5/12/2010–9/6/2010	porewater	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable	
2013 USGS Toxicity Evaluation	USGS (2016a)	January, March, August 2014	porewater	#6: no Form 1s for this lab; have Excel files of lab data #7: uncertainty in non-detect values: source files provided by USGS indicate the non-detects are a mix of DLs and RLs	A	A	A	A	A	A	C	NA	A	A	conditionally acceptable	
2013 Phase 2 Sediment Study	TAI (2017b)	Field: 9/5–10/24/2013 Bioassay: 1/22–2/28 and 2/13–5/8/2015	porewater	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable	
2015 USGS Porewater Study	USGS (2016b)	April, July, August 2015	porewater	#1: no formal data report; meta data includes basic sampling and analysis information #4: no COCs or sampling handling info; have field data #6: data file only; no lab report or Form 1s #7: DLs/RLs not included in data file #9: parts of PARCC are mentioned in meta data; not complete #10: DV not conducted	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
2019 Phase 3 Sediment Study	TAI (2022)	9/17/2019–10/23/2019	porewater	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable	

Table A-5. Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies

Study	Citation	Sampling Date(s)	Media Type	Missing Documentation ^a	Data Quality Documentation Finding ^b										Data Use Recommendation ^c	
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10		
Surface Water																
2000 USGS Water Quality Data for Northport	USGS (2006a)	February–September 2000 (data prior to 2000 not summarized in this table)	surface water	#1: no data report #3: no sampling method information #4: no COCs, field notes, or sample handling documentation #6: no lab report/Form 1s #7: DLs/RLs not reported but <flag applied by lab to undetected values #9: no data report: no LCS, MS/MSD, or lab replicate provided in spreadsheet #10: DV appears to have been conducted for biological data (some data are "K" flagged [rejected]) and some 1995–2000 data are marked as estimated but no lab or validator flags so source of data qualifiers is unknown	N	A	N	N	A	N	N	NA	N	N	not acceptable	
2000–2007 Water Quality Monitoring at Northport	Ecology (2007b)	Location ID 61A070 (Northport): 1/10/2000–6/4/2007 (data prior to 2000 not summarized in this table)	surface water	#1: no data report #3: no sampling method information #4: no COCs, field notes, or sample handling documentation #6: no lab report #7: DLs/RLs not reported but "U" flag applied by lab for ND values #9: analytical methods unknown, no LCS, MS/MSD, or lab replicate provided in data file #10: no DV documentation	N	A	N	N	A	N	N	NA	N	N	not acceptable	
2009–2010 Surface Water Study	TAI (2013a)	9/1/2009–10/29/2009, 2/23/2010–4/19/2010, 4/27/2010–6/17/2010	surface water	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable	
2015 USGS Porewater Study	USGS (2016b)	April and August 2015	surface water	#1: no formal data report; meta data includes basic sampling and analysis information #4: no COCs or sampling handling info; have field data #6: data file only; no lab report or Form 1s #7: DLs/RLs not included in data file #9: parts of PARCC are mentioned in meta data; not complete #10: DV not conducted	C	A	A	C	A	N	N	NA	C	N	conditionally acceptable	
Tissue																
2005 Phase 1 Fish Tissue Sampling	USEPA (2007)	September–December 2005	tissue - individual and composites	#6: lab reports/Form 1s not available #7: DLs/RLs not reported in data spreadsheet (samples flagged ND)	A	A	A	A	A	C	C	A	A	A	conditionally acceptable	
2009 Fish Tissue Study	TAI (2013b)	9/28/2009–10/17/2009	tissue	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable	
2016 Macroinvertebrate Tissue Study	TAI (2018b)	4/26/2016–5/19/2016 and 9/7/2016–10/6/2016	tissue	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable	
2016 Sturgeon Tissue Sample Collection	TAI (2017a)	August–September 2016	tissue	no missing documentation	A	A	A	A	A	A	A	A	A	A	acceptable	
2018 Northern Pike Tissue Study	TAI (2019b)	July 2018	tissue	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable	

Table A-5. Data Quality Information for Chemistry, IVBA, and Bioaccumulation Studies

Study	Citation	Sampling Date(s)	Media Type	Missing Documentation ^a	Data Quality Documentation Finding ^b										Data Use Recommendation ^c
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	
Soil															
LeRoi Removal Action Study (USEPA 2005)	USEPA (2005)	5/2004–9/2004	soil	#2: no coordinates for some locations #4: no chain-of-custody or sample handling information #5: no field QA/QC information #6: no lab reports or Form 1s #7: no DLs or RLs	A	C	A	N	N	N	N	NA	A	A	not acceptable
2014 Soil Study	TAI (2015)	9/8/2014–10/29/2014	soil	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
2019 Northport Waterfront RI	Ecology (2019)	3/25/2019–3/28/2019	soil	#4: no field forms	A	A	A	C	A	A	A	NA	A	A	conditionally acceptable
IVBA															
2009–2011 Beach Sediment Study	TAI (2014)	9/2009, 4/2010, 4/2011–5/2011	sediment	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
2014 Soil Study	TAI (2015)	9/8/2014–10/29/2014	soil	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
2015 Bossburg Flat Sediment and Soil Study	TAI (2016)	4/14/2015–5/7/2015	sediment, soil	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable
Bioaccumulation															
2018 Plant Tissue Study	TAI (2019c)	4/25/2018–8/28/2018	co-located soil and plant tissue	no missing documentation	A	A	A	A	A	A	A	NA	A	A	acceptable

Notes:
^a Descriptions of data quality documentation items #1–10 are presented in Table A-3.
^b A - acceptable, C - conditionally acceptable, N - not acceptable
^c "Acceptable" studies are those with no missing documentation, while "conditionally acceptable" studies have some missing documentation and "not acceptable" studies have limited documentation.
CLP - contract laboratory program
COC - chain of custody form
DL - detection limit
DV - data validation
IVBA - in vitro bioaccessibility
LCS - laboratory control sample
MS/MSD - matrix spike/matrix spike duplicate
NA - not applicable
ND - not detected
PARCC - precision, accuracy, representativeness, comparability, and completeness
QA/QC - quality assessment/quality control
RL - reporting limit
RPD - relative percent difference
SRM - standard reference material

Table A-6. Inventory of IVBA Studies

Study	Sampling Date(s) ¹	Media Type ^{1,3}	Number of Samples Excluding Field Replicates ^{1,5}	Number of Field Replicates ^{1,5}	Sample Collection Method(s) and Fractions ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage ^{1,10; a}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}	Relevant Citations
2009–2011 Beach Sediment Study	9/2009, 4/2010, 4/2011–5/2011	sediment	33	6 (includes field and EPA splits)	composites collected from 0–15 cm at 33 beaches, sieved to < 63 µm, 63–125 µm, 125–250 µm, 250 µm-2 mm	arsenic and lead: EPA 6010B, EPA 6020 IVBA (arsenic and lead): Ruby extraction: EPA 6020 pH (< 2 mm fraction only): EPA 9045D TOC (<2 mm fraction only): D412982M	CAS Kelso, Pace Analytical	Environmental Standards Inc.	not specified; 2B (~70%) and 4 (~30%) inferred from QAPP	none	NA	TAI (2014)
2014 Soil Study	9/8/2014–10/29/2014	soil	25	14 (includes field splits, triplicates, and EPA splits)	incremental composite sampling from 0-7.5 cm at 25 DUs, sieved to < 149 µm	TAL metals and molybdenum: EPA 6010C, EPA 6020A mercury: EPA 7471B IVBA (TAL metals and molybdenum): Ruby extraction: EPA 6010C, EPA 6020A, EPA 7470A pH (bulk soil only): EPA 9045D TOC (< 2 mm fraction only): ASTM D4129-05 percent moisture: EPA 160.3	ALS	Environmental Standards Inc.	2B (85%), 4 (15%)	none	NA	TAI (2015)
2015 Bossburg Flat Sediment and Soil Study	4/14/2015–5/7/2015	sediment	10	13 (includes field splits, triplicates, and EPA splits)	incremental composite sampling from 0–15 cm at 10 SDUs, sieved to < 250 µm	arsenic and lead: EPA 6020A IVBA (arsenic and lead): Ruby extraction: EPA 6020A pH (bulk soil only): EPA 9045D TOC (< 2 mm fraction only): ASTM D4129-05	ALS	Environmental Standards Inc.	2B (82%), 4 (18%)	none	NA	TAI (2016)
		soil	6 incremental composite samples and 54 discrete core samples (3 separate depths at 18 locations)	4 (incremental composite samples; includes field splits, triplicates, and EPA splits), and 14 (core samples; includes field splits and EPA splits)	incremental composite sampling from 0–15 cm at 6 SDUs, sieved to < 2 mm discrete core samples up to 18 in. deep: 0–6.9 in., 6.9–12 in., and 12–18 in.; collected using a coring tool							

Notes:
^a See Table A-6 for data validation stages.
¹⁻¹⁰ - Superscript numbers (1–10) correspond to item # in Table A-3.
ALS - ALS Environmental Laboratory, Kelso, Washington
ASTM - American Society for Testing and Materials
CAS - Columbia Analytical Servies, Kelso, Washington
DU - decision unit
IVBA - in vitro bioaccessibility
NA - not applicable
SDU - sediment or soil decision unit
TAL - target analyte list
TOC - total organic carbon

Table A-7. Inventory of Bioaccumulation Studies

Study	Sampling Date(s) ¹	Media Type ^{1,3}	Number of Samples Excluding Field Replicates ^{1,5}	Number of Field Replicates ^{1,5}	Sample Collection Method(s) and Fractions ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage ^{1,10; a}	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}	Relevant Citations
2018 Plant Tissue Study	4/25/2018–8/28/2018	co-located soil and plant tissue	156	34 (includes field and EPA splits)	individual samples and composites of six individual plants with co-located soil; soil collected from top 0-3 in., sieved to < 150 µm	TAL metals (except calcium, potassium, and sodium): EPA 6020A mercury (subset): EPA 1631E total solids: EPA 160.3	ALS	Environmental Standards Inc.	2B (86%), 4 (14%)	none	NA	TAI (2019c)

Notes:
^a See Table A-4 for data validation stages.
¹⁻¹⁰ - Superscript numbers (1-10) correspond to item # in Table A-3.
ALS - ALS Environmental Laboratory, Kelso, Washington
NA - not applicable
TAL - target analyte list

Table A-8. Inventory of Bioassay Studies

Study	Citation	Bioassay							Chemistry ^a
		Test	Number of Field Locations			Upstream Reference	Endpoints	Batches or Cycles	
			Total	OU 1	OU 2				
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	Ecology (2001)	<i>Chironomus dilutus</i> 20-day survival and growth	10	3	4	3	survival, weight, and biomass	NA	sediment analyzed prior to test initiation (within 14 days of toxicity testing)
		<i>Hyalella azteca</i> 10-day survival	10	3	4	3	survival	NA	
		Microtox 100% porewater	10	3	4	3	bioluminescence	NA	
2004 USGS Toxicity Evaluation	Besser et al. (2008)	<i>C. dilutus</i> 10-day survival and growth	8	3	4	1	survival, weight, and biomass	NA	sediment and porewater analyzed prior to test initiation; bioassays conducted 10–18 days after sediment and porewater samples were collected
		<i>H. azteca</i> 28-day survival and growth	8	3	4	1	survival, weight, and biomass	NA	
2005 Phase 1 Sediment Sampling	USEPA (2006a)	<i>C. dilutus</i> 10-day survival and growth	56	26	30	0	survival, weight, and biomass	Batches 1 and 2	sediment analyzed prior to test initiation (within 14 days of toxicity testing) ^b
		<i>H. azteca</i> 28-day survival and growth	56	26	30	0	survival, weight, and biomass	Batches 1 and 2	
		<i>Ceriodaphnia dubia</i> 7-day survival and reproduction	56	26	30	0	survival and total number of neonates	Batches 1 and 2	
2008 USGS Toxicity Evaluation	Fairchild et al. (2012)	<i>C. dilutus</i> 10-day survival and growth	5	3	2	0	survival, length, and biomass	NA	sediment and porewater analyzed prior to test initiation; unclear when bioassays were conducted relative to the time of sediment collection
		<i>H. azteca</i> 28-day survival and growth	5	3	2	0	survival, weight, and biomass		
2013 Phase 2 Sediment Study	TAI (2017c)	<i>C. dilutus</i> 10-day survival and growth	69	20	39	10	survival, weight, and biomass	Short-term Batches 1–6	sediment and porewater analyzed at bioassay initiation and during bioassays
		<i>H. azteca</i> 28-day survival and growth	69	20	39	10	survival, weight, and biomass	Short-term Batches 1–6	
		<i>C. dilutus</i> life cycle	27	10	11	6	larval survival	Long-term Batches 1–3	
							larval weight		
							larval biomass		
							percent emergence, time to emergence, egg masses per mated female, eggs per egg mass, percent hatch, total young produced, survival-normalized reproduction		
		<i>H. azteca</i> 42-day survival, growth, and reproduction	27	10	11	6	survival (28- and 42-day)	Long-term Batches 1–3	
							weight (28- and 42-day)		
							biomass (28- and 42-day)		
							young per female, survival-normalized young per female, total young		

Table A-8. Inventory of Bioassay Studies

Table 1. An Inventory of Bioassay Studies									
Study	Citation	Test	Bioassay				Endpoints	Batches or Cycles	Chemistry ^a
			Total	OU 1	OU 2	Upstream Reference			
2013 USGS Toxicity Evaluation ^c	USGS (2016a)	<i>C. dilutus</i> 10-day survival and growth	36	17	19	0	survival weight biomass	Cycle 1a	sediment and porewater analyzed 7 days before bioassay initiation and during bioassays; with the exception of synoptic data for <i>C. dilutus</i> bioassays, and <i>H. azteca</i> Cycle 3 bioassays (i.e., data were collected at test initiation, but not during the bioassays)
		<i>H. azteca</i> 28-day survival and growth	36	17	19	0	survival weight ^d biomass ^d	Cycle 1a	
		<i>Lampsilis siliquoidea</i> 28-day survival and growth	54	24	30	0	survival weight biomass	Cycle 1b	
		<i>C. dilutus</i> life cycle (Cycle 2)	18	8	10	0	survival weight biomass	Cycle 2	
		<i>C. dilutus</i> life cycle (Cycle 3)	22	11	11	0	percent emergence, time to emergence, egg masses per mated female, eggs per egg mass, percent hatch, total young produced, survival-normalized reproduction	Cycle 3	
		<i>H. azteca</i> 42-day survival and growth	40	19	21	0	percent emergence, time to emergence survival (28- and 42-day) weight (28- and 42-day) ^d biomass (28- and 42-day) ^d	Cycles 2 and 3	
							young per female, survival-normalized young per female, total young		
							survival (28- and 42-day) weight (28- and 42-day) biomass (28- and 42-day)	Batches 1–3	
							young per female, survival-normalized young per female, total young		
		2019 Phase 3 Sediment Study	TAI (2022)	<i>H. azteca</i> 42-day survival, growth, and reproduction	57	40	0	17	

Notes:

^a Bioassay-associated chemistry data refers to sediment and porewater data collected in the bioassay laboratory either at the start of the test (from sediment homogenized with sediment used in the bioassays), during the test (from chemistry chambers treated with the same conditions as the bioassay test chambers), or both.

^b Porewater data were collected, but from co-located samples collected on different dates than the sediment used in toxicity tests.

^c The 2013 USGS Toxicity Evaluation included samples combined from two separate sediment collection efforts: 1) samples collected by TAI downstream from Onion Creek during the Phase 2 sediment study field effort and co-located with Phase 2 sample locations, and 2) samples collected by Department of Interior (DOI) upstream from Onion Creek. The samples were collected using different collection methods and were handled differently. The samples evaluated in this document were those collected by TAI downstream from Onion Creek. All samples were sieved through 2-mm mesh screen.

^d In the 2013 USGS Toxicity Evaluation, *H. azteca* weight and biomass were not measured, but were estimated from length measurements using a regression developed by USGS.

NA - not applicable

Table A-9. Data Quality Information for Bioassay Studies

Study	QA/QC Program Results	Standard Reference Toxicant Tests	Comparison of Negative Control Results to TAC	Other
2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001)	No third-party review procedures were reported.	Results were reported as acceptable but details were not provided.	TAC met for all toxicity tests except <i>Chironomus dilutus</i> survival.	Laboratories were not accredited to conduct the 20-day <i>C. dilutus</i> or Microtox tests. The methods were new at the time, although the labs had experience with similar methods. Microtox test was compromised due to sample handling; a subset of samples were homogenized prior to analysis contrary to test method guidelines.
2004 USGS Toxicity Evaluation (Besser et al. 2008)	No third-party review procedures were reported.	The use of reference toxicant tests was not specified.	Information not provided on whether TAC were met; however, ASTM methods were used and it is assumed that the bioassay data were acceptable for this scientific publication.	Porewater concentrations in sediment control sample were high for conductivity and hardness.
2005 Phase 1 Sediment Sampling (USEPA 2006b)	No significant issues identified based on third-party review of procedures and results conducted by external auditor (Dinnel Marine Resources, Anacortes, WA) (see Appendix B of USEPA 2012).	Results were within acceptable limits for reference toxicant tests for <i>C. dilutus</i> with potassium chloride (7-day test) conducted by CH2M HILL, and for <i>H. azteca</i> with cadmium chloride (96-hour test) conducted by Northwestern Aquatic Services (USEPA 2012).	TAC met for all toxicity tests.	Unusually high pupation in the 10-day <i>C. dilutus</i> bioassay was noted as part of a data quality evaluation in the BERA Work Plan (TAI 2011).
2008 USGS Toxicity Evaluation (Fairchild et al. 2012)	No third-party review procedures were reported.	The use of reference toxicant tests was not specified.	Information not provided on whether TAC were met; however, ASTM methods were used and it is assumed that the bioassay data were acceptable for this scientific publication.	No additional considerations.
2013 Phase 2 Sediment Study (TAI 2017c)	No significant issues identified based on: - oversight of short- and long-term bioassays by CH2M HILL on behalf of EPA. - third-party review comparing procedures and results from the Phase 2 inter-laboratory bioassay split sample program (CH2M HILL 2018).	Results were within acceptable limits for 96-hour reference toxicant tests for <i>C. dilutus</i> and <i>H. azteca</i> with sodium chloride and potassium chloride, respectively, conducted by PER (TAI 2017c).	TAC met for all toxicity tests.	Interpretation of results may be confounded by batch variability.

Table A-9. Data Quality Information for Bioassay Studies

Study	QA/QC Program Results	Standard Reference Toxicant Tests	Comparison of Negative Control Results to TAC	Other
2013 USGS Toxicity Evaluation (USGS 2016a)	No third-party oversight was conducted.	Results were within acceptable limits for reference toxicant tests for <i>C. dilutus</i> and <i>H. azteca</i> (48-hour tests) and <i>L. siligoidea</i> (96-hour test) with sodium chloride conducted by CERC (USGS 2016a).	TAC met for all toxicity tests.	Weight was not directly measured in Cycle 3 for the short-term endpoints in the <i>C. dilutus</i> and <i>H. azteca</i> tests. Reported values in the USGS report were estimated from 42-day results.
2019 Phase 3 Sediment Study (TAI 2022)	• In person oversight was not possible because of pandemic-related travel restrictions. PER made videos documenting specific steps in the testing process and those videos were made available to EPA. • A third-party review comparing procedures and results from the Phase 3 inter-laboratory bioassay split sample program (CH2M Hill 2022) noted differences in bioassay response between CERC and PER for some sediment samples. This uncertainty is addressed in the Aquatic BERA.	Results for all three batches were within acceptable limits for 96-hour reference toxicant tests conducted with potassium chloride by PER (TAI 2022).	TAC met for all toxicity tests.	Quartz sand negative control samples did not meet most of EPA's suggested performance-based guidelines (Mount 2011). As a result, EPA recommended that the growth endpoint should not be used for reference comparisons, and the reproduction endpoint should not be used (USEPA 2021).

Notes:

ASTM - American Society for Testing and Materials

CERC - Columbia Environmental Research Center

PER - Pacific Ecorisk

QA/QC - quality assurance/quality control

TAC – test acceptability criteria

Table A-10. Bioassay Details Considered in Suitability Assessment

Test Details								Pre-Test Initiation Measurements		Post-Test Initiation Measurements					
Laboratory	Test Species	Test Duration	Test Method	Reference Toxicant Test (Positive Control)	Control Sediment	Batching	Number of Sample Types per Batch	Porewater Analytes (From Centrifuged Sediment Samples)	Sediment Analytes (From Bulk Sediment Sample after Homogenization)	Overlying Water Quality Data Collected	Test Measurement Time Points	Bioassay Endpoints	Sediment Analytes	Porewater Analytes	Porewater Collection Method
2001 Reassessment of Toxicity of Lake Roosevelt Sediments (Ecology 2001)															
Short-Term Bioassays															
NAS	H. azteca	10-day	ASTM Method E 1706 (ASTM 2000) EPA Method 100.1 (USEPA 2000)	not specified	not specified	not specified	7 site, 1 reference, 2 tributary, 1 control	ND	As, Cd, Cu, Pb, Hg, Zn, TOC, grain size	not specified	T-10	survival	ND	ND	NA
2004 USGS Toxicity Evaluation (Besser et al. 2008)															
Short-Term Bioassays															
CERC	C. dilutus	12-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.2 (USEPA 2000)	not specified	Florissant, MO	not specified	7 site, 1 tributary, 1 control	metals, pH, DOC, alkalinity, hardness, conductivity, sulfide, ammonia	metals, AVS, SEM, TOC, grain size	not specified	T-12	survival, length	ND	ND	NA
CERC	H. azteca	28-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	not specified	Florissant, MO	not specified	7 site, 1 tributary, 1 control			not specified	T-28	survival, weight	ND	ND	NA
2005 Phase 1 Sediment Sampling (USEPA 2006b)															
Short-Term Bioassays															
CH2M HILL	C. dilutus	10-day	ASTM Method E 1706-00 (ASTM 2000) EPA Method 100.2 (USEPA 2000)	48-hour water exposure with NaCl	Beaver Creek, OR	Batch 1 (initiated 4/29/2005)	25 site ^a , 6 reference, 1 control	ND; porewater data were from co-located samples collected on different dates than the sediment used in toxicity tests	TAL metals plus uranium, PAHs, PCBs, pesticides, SEM, AVS, TOC, grain size	standard analyte list ^b	T-10	survival, biomass, weight	ND	ND	NA
						Batch 2 (initiated 5/6/2005)	25 site ^a , 6 reference, 1 control								
NAS	H. azteca	28-day	ASTM Method E 1706-00 (ASTM 2000) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with CdCl ₂	Beaver Creek, OR	Batch 1 (initiated 4/28/2005)	25 site ^a , 6 reference, 1 control			standard analyte list ^b	T-28	survival, biomass, weight	ND	ND	NA
						Batch 2 (initiated 5/5/2005)	25 site ^a , 6 reference, 1 control								
CH2M HILL	C. dubia	7-day	ASTM Method E 1706-00 (ASTM 2000)	7-day water exposure with NaCl	clean silica sand (also water only control with reconstituted synthetic water)	Batch 1 (initiated 4/28/2005)	25 site ^a , 6 reference, 1 control			standard analyte list ^b	T-7	survival, reproduction	ND	ND	NA
						Batch 2 (initiated 5/4/2005)	25 site ^a , 6 reference, 1 control								
2013 Phase 2 Sediment Study (TAI 2017c)															
Short-Term Bioassays ^b															
PER	C. dilutus	10-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.2 (USEPA 2000)	96-hour water exposure with NaCl ₂	PER negative control; quartz sand; ERDC (UMFS) control	Batch 1 ^c (initiated 1/22/2014)	9 site, 1 upstream reference, 1 tributary, 3 control	pH, DOC, alkalinity, hardness, chloride, sulfate, sulfide (centrifuged at PER and analyzed at ALS)	ND	standard analyte list ^b	T-7	ND	AVS, SEM, TOC, moisture, solids	TAL metals (except Hg)	peeper
						Batch 2 (initiated 1/23/2014)	7 site, 4 upstream reference, 3 control								
						Batch 3 (initiated 1/24/2014)	10 site, 1 upstream reference, 1 tributary, 3 control								
						Batch 4 (initiated 1/29/2014)	9 site, 1 upstream reference, 2 tributary, 3 control				T-10	survival, biomass, weight	ND	ND	NA
						Batch 5 (initiated 1/30/2014)	9 site, 2 upstream reference, 1 tributary, 3 control								
						Batch 6 (initiated 1/31/2014)	9 site, 2 upstream reference, 1 tributary, 3 control								

Table A-10. Bioassay Details Considered in Suitability Assessment

Test Details								Pre-Test Initiation Measurements			Post-Test Initiation Measurements				
Laboratory	Test Species	Test Duration	Test Method	Reference Toxicant Test (Positive Control)	Control Sediment	Batching	Number of Sample Types per Batch	Porewater Analytes (From Centrifuged Sediment Samples)	Sediment Analytes (From Bulk Sediment Sample after Homogenization)	Overlying Water Quality Data Collected	Test Measurement Time Points	Bioassay Endpoints	Sediment Analytes	Porewater Analytes	Porewater Collection Method
2013 Phase 2 Sediment Study (TAI 2017c) (continued)															
PER	H. azteca	28-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with KCl	PER negative control; quartz sand; ERDC (UMFS) control	Batch 1 ^c (initiated 1/22/2014)	9 site, 1 upstream reference, 1 tributary, 3 control	pH, DOC, alkalinity, hardness, chloride, sulfate, sulfide (centrifuged at PER and analyzed at ALS)	ND	standard analyte list ^b	T-7	ND	ND	TAL metals (except Hg)	peeper
						Batch 2 (initiated 1/23/2014)	7 site, 4 upstream reference, 3 control								
						Batch 3 (initiated 1/24/2014)	10 site, 1 upstream reference, 1 tributary, 3 control				T-21	ND	AVS, SEM, TOC, moisture, solids	TAL metals (except Hg)	peeper
						Batch 4 (initiated 1/29/2014)	9 site, 1 upstream reference, 2 tributary, 3 control								
						Batch 5-RE (Initiated 3/27/2014)	9 site, 2 upstream reference, 1 tributary, 3 control				T-28	survival, biomass, weight	ND	ND	NA
						Batch 6 (initiated 1/31/2014)	9 site, 2 upstream reference, 1 tributary, 3 control								
Long-Term Bioassays ^c															
PER	C. dilutus	life cycle (~50-day)	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.2 (USEPA 2000)	96-hour water exposure with NaCl ₂	PER negative control; quartz sand	Batch 1 ^d (initiated 2/13/2015)	8 site, 4 upstream reference, 1 tributary, 2 control	pH, DOC, alkalinity, hardness, chloride, sulfate, sulfide (centrifuged at PER and analyzed at ALS)	TAL metals, AVS, SEM, TOC, grain size, pH	standard analyte list ^b	T-7	ND	ND	TAL metals (except Hg)	peeper
											T-16 ^e	survival, biomass, weight	ND	ND	NA
						Batch 2 (initiated 2/25/2015)	7 site, 5 upstream reference, 1 tributary, 2 control				T-21	ND	AVS, SEM, TOC, moisture, solids	TAL metals (except Hg)	peeper
											T-42	ND	AVS, SEM, TOC, moisture, solids	TAL metals (except Hg)	peeper
						Batch 3 (initiated 3/5/2015)	7 site, 5 upstream reference, 1 tributary, 2 control				T-50	percent emergence, time to death, number of eggs/egg case, number of eggs/female, percent hatchability	ND	ND	NA
PER	H. azteca	42-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with KCl	PER negative control; quartz sand	Batch 1 ^d (initiated 2/13/2015)	8 site, 4 upstream reference, 1 tributary, 2 control	pH, DOC, alkalinity, hardness, chloride, sulfate, sulfide (centrifuged at PER and analyzed at ALS)	TAL metals, AVS, SEM, TOC, grain size, pH	standard analyte list ^b	T-7	ND	-	TAL metals (except Hg)	peeper
						Batch 2 (initiated 2/25/2015)	7 site, 5 upstream reference, 1 tributary, 2 control				T-21	ND	AVS, SEM (except for Hg), TOC, moisture, solids	TAL metals (except Hg)	peeper
											T-28	survival, biomass, weight	ND	ND	NA
						Batch 3 (initiated 3/5/2015)	7 site, 5 upstream reference, 1 tributary, 2 control				T-42	survival, weight, biomass, number of offspring/female	ND	ND	NA

Table A-10. Bioassay Details Considered in Suitability Assessment

Test Details								Pre-Test Initiation Measurements		Post-Test Initiation Measurements					
Laboratory	Test Species	Test Duration	Test Method	Reference Toxicant Test (Positive Control)	Control Sediment	Batching	Number of Sample Types per Batch	Porewater Analytes (From Centrifuged Sediment Samples)	Sediment Analytes (From Bulk Sediment Sample after Homogenization)	Overlying Water Quality Data Collected	Test Measurement Time Points	Bioassay Endpoints	Sediment Analytes	Porewater Analytes	Porewater Collection Method
2013 USGS Toxicity Evaluation (USGS 2016a) ^f															
Short-Term Bioassays															
CERC	C. dilutus	10-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.2 (USEPA 2000)	96-hour water exposure with NaCl ₂	West Bearskin Lake, MN; Spring River, MO; quartz sand	Cycle 1a (initiated 12/20/2013)	23 site ^f , 6 a priori reference, 7 tributary, 3 control	pH, DOC, alkalinity, hardness, pH, chloride, sulfate (no sulfide) ^g , fluoride, phosphate, conductivity, dissolved metals (incl. Ca, Mg, K, Na)	total recoverable metals, TOC, grain size	standard analyte list ^b	T-10	survival, biomass, weight	ND	ND	NA
CERC	H. azteca	28-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with NaCl ₂	West Bearskin Lake, MN; Spring River, MO; quartz sand	Cycle 1a (initiated 12/20/2013)	23 site ^f , 6 a priori reference, 7 tributary, 3 control	pH, DOC, alkalinity, hardness, pH, chloride, sulfate (no sulfide) ^g , fluoride, phosphate, conductivity, dissolved metals (incl. Ca, Mg, K, Na)	total recoverable metals, TOC, grain size	standard analyte list ^b	T-14	ND	AVS, SEM	dissolved metals (As, Cd, Cu, Pb, Ni, Zn)	peeper (deployed at T-7) ⁱ
											T-28	survival, biomass, weight ^h	ND	ND	NA
CERC	L. siligoidea	28-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with NaCl ₂	West Bearskin Lake, MN; Spring River, MO; quartz sand	Cycle 1b (initiated 12/19/2013)	40 site ^f , 7 a priori reference, 7 tributary, 3 control	pH, DOC, alkalinity, hardness, pH, chloride, sulfate (no sulfide) ^g , fluoride, phosphate, conductivity, dissolved metals (incl. Ca, Mg, K, Na)	total recoverable metals, TOC, grain size	standard analyte list ^b	T-28	survival, biomass, weight	AVS, SEM	dissolved metals (As, Cd, Cu, Pb, Ni, Zn)	peeper (deployed at T-7) ⁱ
Long-Term Bioassays															
CERC	C. dilutus	life cycle	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.2 (USEPA 2000)	96-hour water exposure with NaCl ₂	West Bearskin Lake, MN; Spring River, MO; quartz sand	Cycle 2 (initiated 2/11/2014)	14 site ^f , 1 a priori reference, 3 tributary, 3 control	pH, DOC, alkalinity, hardness, pH, chloride, sulfate (no sulfide) ^g , fluoride, phosphate, conductivity, dissolved metals (incl. Ca, Mg, K, Na)	total recoverable metals, TOC, grain size	standard analyte list ^b	T-10 (Cycle 2 only)	survival, biomass	ND	ND	NA
						Cycle 3 (initiated 6/25/2014)	15 site ^{f,j} , 4 a priori reference, 3 tributary, 2 control		(only in Cycle 2, and only analyzed in two samples that were not analyzed for in Cycle 1a or 1b)		T-50	Cycle 2 - percent of females with egg cases, number of eggs/egg case, number of emerged females, percent emergence, percent hatch, number of larvae/female, emergence time, number total larvae	ND	ND	NA
												Cycle 3 - percent emergence, emergence time			
CERC	H. azteca	42-day	ASTM Method E 1706-05 (ASTM 2005) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with NaCl ₂	West Bearskin Lake, MN; Spring River, MO; quartz sand	Cycle 2 (initiated 2/10/2014)	14 site ^f , 2 a priori reference, 3 tributary, 3 control	pH, DOC, alkalinity, hardness, pH, chloride, sulfate (no sulfide) ^g , fluoride, phosphate, conductivity, dissolved metals (incl. Ca, Mg, K, Na)	total recoverable metals, TOC, grain size	standard analyte list ^b	T-14 (Cycle 2 only)	-	AVS/SEM (only two Cycle 2 locations that were not included in Cycle 1)	dissolved metals (As, Cd, Cu, Pb, Ni, Zn) (all Cycle 2 locations)	peeper (deployed at T-7) ⁱ
											T-28	survival for both cycles; biomass and weight ^h for Cycle 2 only	ND	ND	NA
						Cycle 3 (initiated 6/26/2014)	15 site ^{f,j} , 4 a priori reference, 3 tributary, 2 control		(only in Cycle 2, and only analyzed in two samples that were not analyzed for in Cycle 1a or 1b)		T-35	survival, number of young	ND	ND	NA
											T-42	survival, biomass, weight ^h , total young, number of females and males, number of young/female, survival-normalized reproduction	ND	ND	NA

Table A-10. Bioassay Details Considered in Suitability Assessment

Test Details								Pre-Test Initiation Measurements		Post-Test Initiation Measurements					
Laboratory	Test Species	Test Duration	Test Method	Reference Toxicant Test (Positive Control)	Control Sediment	Batching	Number of Sample Types per Batch	Porewater Analytes (From Centrifuged Sediment Samples)	Sediment Analytes (From Bulk Sediment Sample after Homogenization)	Overlying Water Quality Data Collected	Test Measurement Time Points	Bioassay Endpoints	Sediment Analytes	Porewater Analytes	Porewater Collection Method
2019 Phase 3 Sediment Study (TAI 2022)															
PER	H. azteca	42-day	ASTM Method E 1706-19 (ASTM 2019) EPA Method 100.4 (USEPA 2000)	96-hour water exposure with KCl	Spring River, MO; quartz sand	Batch 1 (initiated 6/16/2020)	Batch 1: 14 site, 7 upstream reference, 2 control	none	TAL metals and TOC	standard analyte list ^b	T-7	ND	AVS, SEM, TOC	pH, DOC, TOC, alkalinity, hardness, chloride, sulfate, sulfide, dissolved metals (incl. Ca, Mg, K, Na)	centrifuge
											T-21	ND	AVS, SEM, TOC	pH, DOC, TOC, alkalinity, hardness, chloride, sulfate, sulfide, dissolved metals (incl. Ca, Mg, K, Na)	centrifuge
						Batch 2 (initiated 6/17/2020)	Batch 2: 14 site (DM008 repeated), 7 upstream reference (REF013 repeated), 2 control				T-28	survival, biomass, weight	ND	ND	NA
											T-35	survival	ND	ND	NA
						Batch 3 (initiated 6/16/2020)	Batch 3: 14 site (DM008 repeated), 7 upstream reference (REF013 repeated), 2 control				T-42	survival, biomass, weight, total young, number of females and males, number of young/female, survival-normalized reproduction	ND	ND	NA

Notes:

^a In both batches of the Phase 1 short-term toxicity tests, the 50 site samples were split between the two tests and the same six reference samples were tested in each.

^b The standard analyte list includes temperature, pH, dissolved oxygen, conductivity, alkalinity, hardness, and ammonia.

^c Each batch of the Phase 2 TAI short-term tests contained different site, tributary, and upstream samples; the *C. dilutus* and *H. azteca* bioassay samples were batched the same way, except for LAL-6.

^d Phase 2 TAI long-term tests were conducted with a subset of the samples tested in the short-term tests. Samples Ref-10b, G-1, G-3, LAL-3, LAL-5, and TRIB-3 were included in each of the three batches.

^e Typically, T-20 is the second measurement time point in the long-term *C. dilutus* bioassay; however, the Phase 2 bioassay was initiated with older organisms (< 4 days old) rather than neonates, and so the second measurement time point was after 16 days.

^f U.S. Geological Survey (USGS) bioassays were conducted on site samples collected by both TAI and Department of the Interior (DOI); samples from upstream of Onion Creek (River Mile 709) were collected by DOI and samples downstream from Onion Creek were provided by TAI from grab samples collected during the Phase 2 study.

^g USGS did not measure sulfide in centrifuged porewater samples, claiming that centrifugation likely results in a substantial loss of sulfide from the sediment and porewater (USGS 2016a).

^h USGS estimated amphipod weight based on measured length.

ⁱ USGS deployed peepers on Day 7 of the *H. azteca* and *L. siligoidea* bioassays that were retrieved on Day 14, so the total equilibration time was 7 days.

^j USGS Cycle 3 was conducted using primarily the same samples from sediments that were tested in Cycle 1.

ALS - ALS Environmental Laboratory, Kelso, Washington
ASTM - American Society for Testing and Materials
AVS - acid volatile sulfide
CERC - Columbia Environmental Research Center
DOC - dissolved organic carbon
ERDC - Engineer Research and Development Center
NA - not applicable
NAS - Northwestern Aquatic Sciences
ND - no data collected
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PER - Pacific EcoRisk
SEM - simultaneously extracted metal
TAL - target analyte list
TOC - total organic carbon
UMFS - University of Mississippi Field Station

Table A-11. Bioassay Methods Considered in Comparability Assessment

Parameter	2004 USGS Toxicity Evaluation	2005 Phase 1 Sediment Sampling	2013 Phase 2 Sediment Study	2013 USGS Toxicity Evaluation	2019 Phase 3 Sediment Study	Potential Implications from Differences
Bioassay laboratory	CERC	two different laboratories: CH2M HILL (<i>C. dilutus</i> and <i>C. dubia</i>) and NAS (<i>H. azteca</i>)	PER	CERC	PER	Studies conducted by different laboratories have been shown to be variable (Burton et al. 1996; Bay et al. 2003; Norberg-King et al. 2006). Before combining data, the differences in methods highlighted in this table must be understood in terms of their potential implications for the specific analyses being conducted.
Sediment storage time	10 to 18 days	Batch 1: 1 week Batch 2: 2 weeks	short-term tests Batches 1–4 and 6: 4–5 weeks Batch 5RE: 13 weeks long-term tests 13 months	Cycle 1: 2 weeks Cycle 2: 6 weeks Cycle 3: 6 months	8–9 months	Metals are expected to have stable concentrations when properly stored (DeFoe and Ankley 1998; ASTM 2010) and, therefore, an extended storage time for sediments is not likely to be a concern. However, studies indicate that storage time may influence observed toxicity through changes in the presence of indigenous predators (USEPA 2001; DeFoe and Ankley 1998) and speciation of metals (Simpson and Batley 2003). USEPA (2000) recommends that handling, storage, and preparation of sediments for testing be as consistent as possible, and the differences between laboratories be considered when comparing data.
Sediment equilibration time in bioassay beakers	24 hours	24 hours	24 hours; 2 volume renewal of overlying water prior to initiating test by adding organisms	7 days under static conditions (i.e., overlying water not renewed for 7 days), renewed overlying water Day 1	7 days under static conditions (i.e., overlying water not renewed for 7 days), renewed overlying water Day 0	The time sediment is allowed to equilibrate in test chambers prior to test initiation may affect AVS concentrations and metals partitioning through changes in redox conditions related to iron, manganese, and sulfide (Simpson and Batley 2003; Kinsman-Costello et al. 2015). Spiked sediment studies have documented changes in the partitioning of metals (Lee et al. 2004; Simpson et al. 2004; Vandegehuchte et al. 2013).
Batching	no batches, small number of samples (7)	2 batches; no information about what, if any, criteria were used to distribute sediments among batches	6 batches representing range of metals concentrations and geographic conditions	2 batches (termed cycles by USGS) representing range of metal concentrations and geographic conditions	3 batches, repeated the Spring River control, quartz sand, one site sample (DM008) and one reference sample (REF013) in each batch	Dividing samples among multiple batches is standard practice when conducting bioassays on a large number of sediments (USEPA 2012). However, responses in the different batches may vary and normalizing the response data to negative control results may improve comparisons among multiple batches of toxicity data that otherwise meet acceptability criteria. In its review of Phase 1 bioassay data, EPA suggests batch normalization of the laboratory control sediment as a way to account for large differences in organism sensitivity among batches (USEPA 2012).
Measurement of dissolved oxygen in overlying water	not specified, followed USEPA (2000) method with minimum requirement to measure weekly	measured daily	measured twice daily	measured weekly	measured twice daily	Twice daily measurements of dissolved oxygen provide greater confidence than weekly measurements to ensure that levels of dissolved oxygen remained sufficiently high for test organisms throughout the bioassays.
Randomization of test chambers	not specified	yes	yes	uncertain, but data packages with laboratory bench sheets suggest that beakers were not randomized	yes	For the purposes of statistical analysis of the data, the test chamber is the smallest physical unit to which statistical treatments can be independently assigned. Therefore, all test chambers should be treated as similarly as possible (USEPA 2000). Randomization of test chambers distributes treatments in an unbiased fashion so that no treatment is favored over another (e.g., in terms of temperature or lighting) and observations are independent.
Random selection of organisms in test chambers	not specified	yes	yes	yes	yes	Similar to the randomization of test chambers, the random, unbiased selection and addition of organisms to test chambers is critical in the assumption that each treatment is independent (USEPA 2000).

Table A-11. Bioassay Methods Considered in Comparability Assessment

Parameter	2004 USGS Toxicity Evaluation	2005 Phase 1 Sediment Sampling	2013 Phase 2 Sediment Study	2013 USGS Toxicity Evaluation	2019 Phase 3 Sediment Study	Potential Implications from Differences
Synoptic Porewater and Sediment Collection						
Number of chemistry beaker replicates for sediment and porewater collection	NA	NA	3	1	4 per time period for porewater; 1 for sediment	Use of only one beaker does not allow for assessment of intra-sediment variability.
Batches in which chemistry was collected	NA	NA	all for both <i>H. azteca</i> and <i>C. dilutus</i>	Cycle 1 and 2 only (not Cycle 3), and <i>H. azteca</i> only (not <i>C. dilutus</i>) ^b	all batches	Concentration-response for Phase 1 data and for USGS <i>C. dilutus</i> and Cycle 3 <i>H. azteca</i> data would not include a direct measure of exposure.
Porewater collection method	centrifuge for pre-test measurements	NA	centrifuge for pre-test measurements; peepers for synoptic measurements	centrifuge for pre-test measurements; peepers for synoptic measurements	centrifuge for pre-test and synoptic measurements	Concentrations may vary depending on porewater collection method.
Centrifugation methods	5,200 rpm (7,000 g) for 30 minutes; temperature not specified	NA	4,300 g for 30 minutes	5,200 rpm (7,000 g) for 15 minutes at 4 °C in two 250 mL centrifuge bottles per sediment.	4,300 g for 30 minutes	Concentrations may vary based on speed and length of time sediments are centrifuged.
Type of diffusion samplers (peepers) used for measurement of dissolved metals	NA	NA	2.9 mL chambers according to Brumbaugh et al. (2013)	2.9 mL chambers according to Brumbaugh et al. (2013)	NA	The size and type of diffusion samplers used to obtain pore water will influence the time needed for different analytes to reach equilibrium.
Timing for collection of synoptic chemistry	NA	NA	see Table A-10	see Table A-10	see Table A-10	The times when peepers were deployed and retrieved and sediment was collected from chemistry chambers are important to note, because concentrations of chemicals in the porewater and sediment may vary depending on when they were collected. The age (and therefore sensitivity) of the organism will be different at different times; and concentrations may vary because of equilibration times.
<i>H. Azteca</i> Test						
Age of organisms at start of test	not specified	7 to 8 days	7 days	7 days	7–8 days	Starting age affects starting size, which affects measurable differences in growth rates.
Average size of organisms at start of test	not specified	not specified	0.01–0.026 mg dw/individual	0.02–0.035 mg dw/individual	0.019–0.026 mg dw/individual	Starting size affects measurable differences in growth rates.
Organism source	not specified	commercial supplier, Chesapeake Cultures, Hayes, VA	commercial supplier Aquatic BioSystems, Fort Collins, CO	CERC culture	commercial supplier Aquatic BioSystems, Fort Collins, CO	Different cultures may have different growth rates and/or sensitivities.
Number of replicates	8	both batches: 8	short-term tests all batches: 8 long-term tests all batches: 12	Cycle 1 (short-term test): 4 Cycle 2 (long-term test): 12 Cycle 3 (long-term test): 8	12	USEPA (2000) recommends 8 replicates and allows a minimum of 4 replicates. A test with fewer replicates will have decreased power to distinguish the difference in response between control and test samples. The 42-day test is initiated with 12 replicates; all 12 are assessed for survival at Day 28 and 4 are sacrificed for weight measurements.
Overlying water	well water diluted with deionized water to hardness of 140 mg/L	modified tap water (hardness adjusted to 70 ± 5 mg/L)	reconstituted water formulated following Borgmann (1996), modified to contain 0.4 mg/L of bromide	well water diluted with deionized water to target hardness of 100 mg/L and alkalinity of 90 mg/L (as CaCO3) and a target pH of 8.2. Average concentrations (mg/L): Ca – 28, Mg – 10, K – 1.0, Na – 10, Cl – 12, sulfate – 19, and DOC – 0.4	reconstituted water formulated following Borgmann (1996), modified to contain 0.4 mg/L of bromide.	Studies have shown that <i>H. azteca</i> growth and reproduction are sensitive to variation in water chemistry (Borgmann 1996; Borgmann et al. 2005, 2007).
Overlying water renewal frequency	2 volume additions/day renewed automatically	2 volume additions/day	2 volumes/day using calibrated Zumwalt water delivery system	2 volumes/day using automated diluter (Besser et al. 2011)	2 volumes/day using calibrated Zumwalt water delivery system	Water renewal and frequency were consistent between the three studies. Variations in methods used and frequency of water renewal may affect consistency of water quality parameters (dissolved oxygen, pH, conductivity, hardness, alkalinity) important for maintaining the health of the organisms (USEPA 2000) and diffusion of metals into the water column during the test (Borgmann et al. 2005, 2007).
Feeding rate per beaker	not specified	1.0 mL/day of YCT	1.0 mL of Spirulina-amended YCT daily on test days 1 through 13, increasing to 2 mL/day for the remainder of the test period	ramped rations of Tetramin suspension and diatoms	1.0 mL YCT daily; 0.25 mg Tetramin daily ramped to 2.5 mg by Week 6	Feeding rate and type of food affect growth rate (Mount 2011; Ivey et al. 2016).
Weight and biomass endpoints	based on length of survivors	directly measured weight of survivors	directly measured weight of survivors	Cycle 3: estimated weight at Day 28 from estimate of weight at Day 42 (based on length measurements) and survival at Day 28	directly measured weight of survivors	There is uncertainty in estimating 28-day weight using 42-day measurements.

Table A-11. Bioassay Methods Considered in Comparability Assessment

Parameter	2004 USGS Toxicity Evaluation	2005 Phase 1 Sediment Sampling	2013 Phase 2 Sediment Study	2013 USGS Toxicity Evaluation	2019 Phase 3 Sediment Study	Potential Implications from Differences
C. Dilutus Test						
Age of organisms at start of test	not specified	second to third instar	second and third instar, with at least 50 percent being third instar, added to test beakers in their silk tubes (Mount 2011)	Cycle 1: second to third instar, added to test beakers in their silk tubes Cycle 2: 7 days Cycle 3: 7 days	NA	Starting age affects starting size, which affects measurable differences in growth rates.
Average size of organisms at start of test	not specified	not specified	0.027–0.120 mg dw/individual	< 0.12 mg dw/individual	NA	Starting size affects measurable differences in growth rates.
Organism source	not specified	commercial supplier, Aquatic BioSystems, Inc., Fort Collins, CO	commercial supplier EC&T, Superior, WI	CERC culture	NA	Different cultures may have different growth rates and/or sensitivities.
Number of replicates	8	8	all batches: 8	Cycle 1: 4 Cycle 2: 12 Cycle 3: 8	NA	USEPA (2000) recommends 8 replicates and allows minimum of 4 replicates. A test with fewer replicates will have decreased power to distinguish difference in response between control and test samples. The 42-day test is initiated with 12 replicates; all 12 are assessed for survival at Day 28 and 4 are sacrificed for weight measurements.
Overlying water	well water diluted with deionized water to hardness of 140 mg/L	reconstituted synthetic water with total hardness of 72–75 mg/L as CaCO3, alkalinity of 58–60 mg/L as CaCO3, and pH of 7.5–7.6	reconstituted water formulated following USEPA (2000)	well water diluted with deionized water to hardness of about 100 mg/L and alkalinity of about 90 mg/L (as CaCO3) and a pH of about 8.2. Average concentrations (mg/L): Ca – 28, Mg – 10, K – 1.0, Na – 10, Cl – 12, sulfate – 19, and DOC – 0.4	NA	Variations in water chemistry may affect consistency of water quality parameters (dissolved oxygen, pH, conductivity, hardness, alkalinity) important for maintaining the health of the organisms (USEPA 2000) and diffusion of metals into the water column during the test (Borgmann et al. 2005, 2007).
Overlying water renewal frequency	2 volume additions/day renewed automatically	2 volume additions/day	2 volume additions/day using calibrated Zumwalt water delivery system	2 volume additions/day using automated diluter (Besser et al. 2011)	NA	Variations in methods used and frequency of water renewal may affect consistency of water quality parameters (dissolved oxygen, pH, conductivity, hardness, alkalinity) important for maintaining the health of the organisms (USEPA 2000). The volume and frequency of renewal can affect toxicity because diffusion of metals into the water column during the test (Borgmann et al. 2005, 2007).
Feeding rate per beaker	not specified	1.5 mL/day of 4 g/L TetrafinT suspension	1 mL/day of 6-mg/L suspension of Tetramin fish food	1.5 mL/day of 4 g/L suspension of Tetramin fish food	NA	Feeding rate and type of food affect growth rate (Ivey et al. 2016).

Notes:
AVS - acid volatile sulfide
BLM - biotic ligand model
CERC - Columbia Environmental Research Center
DOC - dissolved organic carbon
dw - dry weight
EC&T - Environmental Consulting and Testing
NA - not applicable
NAS - Northwestern Aquatic Sciences
PER - Pacific EcoRisk
YCT - yeast-cerophyl-trout chow

Table A-12. Chemistry, IVBA, and Bioaccumulation Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory				DUA Step 2—Data Quality	DUA Step 3—Suitability of Data for Estimating Chemical Exposure in the BERA ^a	DUA Step 4—Comparability of Data for Estimating Chemical Exposure in the BERA ^b
Study	Reference	Sampling Date(s)	Media Type			
Sediment						
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	Ecology (2001)	May 2001	sediment	conditionally acceptable	not suitable; study superseded by more recent studies at nearby locations	NA; not suitable
2001 Expanded Site Investigation	USEPA (2003)	May–June 2001	sediment	conditionally acceptable	not suitable; superseded by Phase 1 sampling, which the expanded site investigation was designed to inform	NA; not suitable
2002–2003 USGS Sediment Core Sampling	USGS (2005)	September 2002 and July 2003	sediment	conditionally acceptable	not suitable; digestion method and sampling depth not suitable	NA; not suitable
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	sediment	conditionally acceptable	not suitable; digestion method not relevant	NA; not suitable
2004 USGS Toxicity Evaluation	Besser et al. (2008)	September 2004	sediment	conditionally acceptable	not suitable; study superseded by more recent studies at nearby locations	NA; not suitable
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	sediment	conditionally acceptable	suitable	comparable
2007 Ecology Reconnaissance and Sediment Sampling	Ecology (2007a)	May 2007	sediment	conditionally acceptable	not suitable; study superseded by more recent studies at nearby locations	NA; not suitable
2008 USGS Toxicity Evaluation	Fairchild et al. (2012)	May and June 2008	sediment	conditionally acceptable	not suitable; study superseded by more recent studies at nearby locations, sediment collected under "semi-wet" conditions	NA; not suitable
2009–2011 Beach Sediment Study	TAI (2014)	September 2009, April 2010, and May 2011	sediment	acceptable	suitable	comparable
2010 White Sturgeon Sediment Toxicity	TAI (2018a)	May–September 2010	sediment	acceptable	suitable	comparable
2013 USGS Toxicity Evaluation	USGS (2016a)	September–October 2013	sediment	conditionally acceptable	suitable; the primary samples (not the split QC samples) are included in the BERA	comparable
2013 Phase 2 Sediment Study	TAI (2017b)	September–October 2013	sediment	acceptable	suitable	comparable
2015 Bossburg Flat Beach Sediment and Soil Study	TAI (2016)	April–May 2015	sediment	acceptable	suitable	comparable
2019 Northport Waterfront RI	Ecology (2019)	March 2019	sediment	conditionally acceptable	suitable	comparable
2019 Phase 3 Sediment Study	TAI (2022)	September–October 2019	sediment	acceptable	suitable	comparable

Table A-12. Chemistry, IVBA, and Bioaccumulation Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory				DUA Step 2—Data Quality	DUA Step 3—Suitability of Data for Estimating Chemical Exposure in the BERA ^a	DUA Step 4—Comparability of Data for Estimating Chemical Exposure in the BERA ^b
Study	Reference	Sampling Date(s)	Media Type			
Porewater						
2002–2003 USGS Sediment Core Sampling	USGS (2005)	July 2003	porewater	conditionally acceptable	not suitable; not in-situ porewater data and not associated with bioassays	NA; not suitable
2004 USGS Sediment Sampling	USGS (2006b)	September 2004	porewater	conditionally acceptable	not suitable; not in-situ porewater data and not associated with bioassays	NA; not suitable
2004 USGS Toxicity Evaluation	Besser et al. (2008)	September 2004	porewater	conditionally acceptable	not suitable; not in-situ porewater data; suitable for bioassay evaluation only (see Table A-13)	NA; not suitable
2005 Phase 1 Sediment Sampling	USEPA (2006a)	April–May 2005	porewater	conditionally acceptable	not suitable; not in-situ porewater data; suitable for bioassay evaluation only (see Table A-13)	NA; not suitable
2010 White Sturgeon Sediment Toxicity Study	TAI (2018a)	May–September 2010	porewater	acceptable	not suitable; not in-situ porewater data	NA; not suitable
2013 USGS Toxicity Evaluation	USGS (2016a)	January, March, August 2014	porewater	conditionally acceptable	not suitable; not in-situ porewater data; suitable for bioassay evaluation only (see Table A-13)	NA; not suitable
2013 Phase 2 Sediment Study	TAI (2017b)	September–October 2013	porewater	acceptable	suitable	NA; data evaluated on sample-specific basis in the BERA
2015 USGS Porewater Study	USGS (2016b)	April, July, August 2015	porewater	conditionally acceptable	suitable	NA; data evaluated on sample-specific basis in the BERA
2019 Phase 3 Sediment Study	TAI (2022)	September–October 2019	porewater	acceptable	suitable	NA; data evaluated on sample-specific basis in the BERA

Table A-12. Chemistry, IVBA, and Bioaccumulation Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory				DUA Step 2—Data Quality	DUA Step 3—Suitability of Data for Estimating Chemical Exposure in the BERA ^a	DUA Step 4—Comparability of Data for Estimating Chemical Exposure in the BERA ^b
Study	Reference	Sampling Date(s)	Media Type			
Surface Water						
2000 USGS Water Quality Data for Northport	USGS (2006a)	February–September 2000 (data prior to 2000 not summarized in this table)	surface water	not acceptable	NA; data quality not acceptable	NA; data quality not acceptable
2000–2007 Water Quality Monitoring at Northport	Ecology (2007b)	January 2000–June 2007	surface water	not acceptable	NA; data quality not acceptable	NA; data quality not acceptable
2009–2010 Surface Water Study	TAI (2013a)	September–October 2009, February–April 2010, April–June 2010	surface water	acceptable	suitable	Not comparable for the wildlife dietary evaluation; only dissolved data are available for the 2015 USGS Porewater Study, and samples were collected at different depths
2015 USGS Porewater Study	USGS (2016b)	April and August 2015	surface water	conditionally acceptable	suitable	
Tissue						
2005 Phase 1 Fish Tissue Sampling	USEPA (2007)	September–December 2005	tissue	conditionally acceptable	suitable	comparable
2009 Phase 2 Fish Tissue Study	TAI (2013b)	September–October 2009	tissue	acceptable	suitable	comparable
2016 Macroinvertebrate Tissue Study	TAI (2018b)	April–May 2016 and September–October 2016	tissue	acceptable	suitable	NA; no other tissue studies with macroinvertebrate data
2016 Sturgeon Tissue Sample Collection	TAI (2017a)	August–September 2016	tissue	acceptable	not suitable; fillet-only data not appropriate for BERA	NA; not suitable
2018 Northern Pike Tissue Study	TAI (2019b)	July 2018	tissue	acceptable	not suitable: fillet-only data not appropriate for BERA	NA; not suitable
Soil						
Le Roi Removal Action Study	USEPA (2005)	May–September 2004	soil	not acceptable	NA; data quality not acceptable	NA; not suitable
2014 Soil Study	TAI (2015)	September–October 2014	soil	acceptable	suitable; only soil data collected from WSDAs and RFAs was included in the BERA	not comparable; data collected using different methods and areas do not overlap
2019 Northport Waterfront RI	Ecology (2019)	March 2019	soil	conditionally acceptable	suitable; only soil data collected from elevations below the pre-1973 max flood extent of the river was included in the BERA	not comparable; data collected using different methods and areas do not overlap

Table A-12. Chemistry, IVBA, and Bioaccumulation Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory				DUA Step 2—Data Quality	DUA Step 3—Suitability of Data for Estimating Chemical Exposure in the BERA ^a	DUA Step 4—Comparability of Data for Estimating Chemical Exposure in the BERA ^b			
Study	Reference	Sampling Date(s)	Media Type						
IVBA									
Studies with Data for Soil Samples in the Soil Chemistry Inventory									
2014 Soil Study	TAI (2015)	September–October 2014	soil	acceptable	suitable	NA; no other studies for comparison			
Studies with Data for Regressions									
2009–2011 Beach Sediment Study	TAI (2014)	September 2009, April 2010, April–May 2011	sediment	acceptable	suitable	comparable			
2014 Soil Study	TAI (2015)	September–October 2014	soil	acceptable	suitable	comparable			
2015 Bossburg Flat Sediment and Soil Study	TAI (2016)	April–May 2015	sediment, soil	acceptable	suitable	comparable			
Bioaccumulation									
2018 Plant Tissue Study	TAI (2019c)	April–August 2018	co-located soil and plant tissue	acceptable	suitable	NA; no other bioaccumulation studies			

Notes:

^a The data suitability evaluation was conducted for data of acceptable or conditionally acceptable quality in Step 2.

^b The data comparability evaluation was conducted for data categorized as suitable in Step 3.

DUA - data usability assessment

IVBA - in vitro bioaccessibility

NA - not applicable

QC - quality control

RFA - relict floodplain area

RI - remedial investigation

RL - reporting limit

WSDA - windblown sediment deposition area

Table A-13. Invertebrate Bioassay Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory			DUA Step 2—Data Quality	DUA Step 3—Data Suitability ^a		DUA Step 4—Data Comparability
Study	Reference	Type of Data		Control/Reference	CR Modeling	
2001 Reassessment of Toxicity of Lake Roosevelt Sediments	Ecology (2001)	sediment chemistry	conditionally acceptable: no lab report, DLs, data qualifiers, or DV	NA ^b	not suitable; study superseded by more recent and robust studies	NA
		bioassays (<i>Hyalella azteca</i> , <i>Chironomus dilutus</i> , Microtox)	<i>H. azteca</i> data are acceptable; <i>C. dilutus</i> are not acceptable (survival did not meet TAC); Microtox test is not acceptable (sediment was homogenized contrary to test guidelines)	not suitable; study superseded by more recent and robust studies		
2004 USGS Toxicity Evaluation	Besser et al. (2008)	porewater chemistry	conditionally acceptable: no COCs, QAPP, lab report, DLs/RLs, qualifiers, or DV	NA ^b	not suitable; study superseded by more recent and robust studies	NA
		bioassays (<i>H. azteca</i> , <i>C. dilutus</i>)	acceptable, although notably high porewater concentrations for conductivity and hardness ^c	not suitable; study superseded by more recent and robust studies		
2005 Phase 1 Sediment Sampling	USEPA (2006a)	porewater and sediment chemistry	conditionally acceptable: no lab report or DLs	NA ^b	porewater chemistry not suitable for concentration-response modeling because porewater samples were collected from co-located but separate sediment samples at each of the bioassay sampling stations, typically on different dates after bioassay and whole sediment chemistry samples were collected. <i>C. dubia</i> data not suitable for addressing the sediment exposure pathway	Comparison to Control: Issues of comparability are not relevant for control comparisons because the result for each sample is compared to the control sample in its batch. Data sets, therefore, do not need to be combined for the control comparisons. Comparison to Reference: Not relevant because sediment samples were not collected from upstream reference areas in this study. CR Modeling: Data are combined. ^c
		bioassays (<i>H. azteca</i> , <i>C. dilutus</i> , and <i>Ceriodaphnia dubia</i>)	acceptable	suitable: <i>H. azteca</i> and <i>C. dilutus</i> not suitable: <i>C. dubia</i>		
2008 USGS Toxicity Evaluation	Fairchild et al. (2012)	sediment chemistry	conditionally acceptable: no COCs, QAPP, lab report, DLs/RLs, qualifiers, or DV	NA ^b	not suitable because of sample condition at time of collection	NA
		bioassays (<i>H. azteca</i> , <i>C. dilutus</i>)	acceptable ^c	not suitable because of sample condition at time of collection		
		porewater and sediment chemistry	acceptable	NA ^b		
2013 Phase 2 Sediment Study	TAI (2017b)	bioassays (<i>H. azteca</i> , <i>C. dilutus</i>)	acceptable, although interpretation of results may be confounded by batch variability	suitable	suitable	Comparison to Control: Issues of comparability are not relevant for control comparisons because the result for each sample is compared to the control sample in its batch. Data sets, therefore, do not need to be combined for the control comparisons. Comparison to Reference: Phase 2 reference data used for evaluation of both Phase 2 and USGS data because studies were conducted concurrently. CR Modeling: Data are combined. ^c

Table A-13. Invertebrate Bioassay Data Usability Assessment Summary

DUA Step 1—Study Identified for Inventory			DUA Step 2—Data Quality	DUA Step 3—Data Suitability ^a		DUA Step 4—Data Comparability
Study	Reference	Type of Data		Control/Reference	CR Modeling	
		porewater and sediment chemistry	acceptable	NA ^b		Comparison to Control: Issues of comparability are not relevant for control comparisons because the result for each sample is compared to the control sample in its batch. Data sets, therefore, do not need to be combined for the control comparisons.
2013 USGS Toxicity Evaluation	USGS (2016a)	bioassays (<i>H. azteca</i> , <i>C. dilutus</i> , <i>Lamprolaima</i> spp.)	acceptable, although weight not directly measured in Cycle 3 for <i>C. dilutus</i> and <i>H. azteca</i> short-term endpoints (estimated from Day 42 results)	suitable	suitable	Comparison to Reference: Phase 2 reference data used for evaluation of both Phase 2 and USGS data because bioassay studies were conducted concurrently. CR Modeling: Data are combined. ^c
		porewater and sediment chemistry	acceptable	NA ^b		Comparison to Control: Issues of comparability are not relevant for control comparisons because the result for each sample is compared to the control sample in its batch. Data sets, therefore, do not need to be combined for the control comparisons.
2019 Phase 3 Sediment Study	TAI (2022)	bioassays (<i>H. azteca</i>)	acceptable, with the exception that the use of the reproduction endpoint should be avoided and that results with the growth endpoints should be qualified and discussed in the uncertainty section, based on poor performance in the quartz sand negative control samples	suitable	suitable	Comparison to Reference: Phase 3 reference data are compared with Phase 3 OU 1 data because the bioassays were run concurrently. CR Modeling: Data are combined. ^c

Notes:

^a The data suitability evaluation was conducted for data of acceptable or conditionally acceptable quality.

^b Laboratory sediment and chemistry data are not applicable to evaluations that compare the bioassay response from site samples relative to reference. Laboratory sediment and porewater chemistry data are relevant for concentration-response modeling.

^c Although there are differences in methods among the studies, the advantages of combining at least some of the *H. azteca* and *C. dilutus* data to provide more robust concentration-response models were determined to outweigh the disadvantages associated with variations in methods. However, where the uncertainty associated with specific aspects of some data sets was determined to be too great, subsets of data in the *H. azteca* and *C. dilutus* data sets are not combined across studies (e.g., differences in the synoptic porewater collection methods). These decisions are discussed in detail in Appendix J.

COC - chain of custody form

CR - concentration-response

DL - detection limit

DUA - data usability assessment

DV - data validation

NA - not applicable

RL - reporting limit

TAC - test acceptability criteria

ATTACHMENT A1

FIELD POREWATER DATA COMPARABILITY

CONTENTS

LIST OF FIGURES	II
LIST OF TABLES	III
ACRONYMS AND ABBREVIATIONS.....	IV
UNITS OF MEASURE.....	V
1 INTRODUCTION	1
2 SAMPLING METHODS.....	2
2.1 2013 PHASE 2 SEDIMENT STUDY	2
2.2 2015 USGS POREWATER STUDY.....	3
2.3 2019 PHASE 3 SEDIMENT STUDY	3
3 DATA COMPARISON.....	4
3.1 CONCENTRATIONS.....	4
3.2 PRINCIPAL COMPONENT ANALYSIS.....	4
3.2.1 Dissolved Metals Concentrations PCA	5
3.2.2 Relative Concentrations of Dissolved Metals PCA	6
3.2.3 Summary.....	6
4 REFERENCES.....	8

LIST OF FIGURES

- Figure A1-1 Calcium Concentration in Field Porewater Samples from OU 1
- Figure A1-2 Magnesium Concentration in Field Porewater Samples from OU 1
- Figure A1-3 Sodium Concentration in Field Porewater Samples from OU 1
- Figure A1-4 Potassium Concentration in Field Porewater Samples from OU 1
- Figure A1-5 Chloride Concentration in Field Porewater Samples from OU 1
- Figure A1-6 Sulfate Concentration in Field Porewater Samples from OU 1
- Figure A1-7 Iron Concentration in Field Porewater Samples from OU 1
- Figure A1-8 Manganese Concentration in Field Porewater Samples from OU 1
- Figure A1-9 pH in Field Porewater Samples from OU 1
- Figure A1-10 DOC Concentration in Field Porewater Samples from OU 1
- Figure A1-11 Alkalinity in Field Porewater Samples from OU 1
- Figure A1-12 Arsenic Concentration in Field Porewater Samples from OU 1
- Figure A1-13 Cadmium Concentration in Field Porewater Samples from OU 1
- Figure A1-14 Copper Concentration in Field Porewater Samples from OU 1
- Figure A1-15 Aluminum Concentration in Field Porewater Samples from OU 1
- Figure A1-16 Antimony Concentration in Field Porewater Samples from OU 1
- Figure A1-17 Lead Concentration in Field Porewater Samples from OU 1
- Figure A1-18 Molybdenum Concentration in Field Porewater Samples from OU 1
- Figure A1-19 Zinc Concentration in Field Porewater Samples from OU 1
- Figure A1-20 PCA Loadings Plots for Dissolved Metals Concentrations in the Combined Field Porewater Data Set
- Figure A1-21 PCA Biplots for Dissolved Metals in the Combined Field Porewater Data Set
- Figure A1-22 PCA Loadings Plots for Relative Concentrations of Dissolved Metals in the Combined Field Porewater Data Set
- Figure A1-23 PCA Biplots for Relative Concentrations of Dissolved Metals in the Combined Field Porewater Data Set

LIST OF TABLES

Table A1-1	Summary Statistics for Analytes in Porewater from Field Porewater Studies in the UCR
------------	--

ACRONYMS AND ABBREVIATIONS

BERA	baseline ecological risk assessment
DL	detection limit
DOC	dissolved organic carbon
OU	operable unit
PCA	principal component analysis
UCR	Upper Columbia River
USGS	U.S. Geological Survey

UNITS OF MEASURE

cm	centimeter(s)
in.	inch(es)
kg	kilogram(s)
µg/L	microgram(s) per liter
µm	micrometer
mL	milliliter(s)

1 INTRODUCTION

This attachment compares the methods and results of the three field porewater studies included in the Aquatic Baseline Ecological Risk Assessment (BERA): the 2013 Phase 2 Sediment Study (TAI 2017), the 2015 U.S. Geological Survey (USGS) Porewater Study (USGS 2016), and the 2019 Phase 3 Sediment Study (TAI 2022). Section 2 describes the specific methods used in each sampling event, and Section 3 provides a comparison of chemistry data to evaluate whether sampling methods could account for differences in the results.

2 SAMPLING METHODS

This section describes the sampling methods used in each of the three field porewater sampling events.

2.1 2013 PHASE 2 SEDIMENT STUDY

The sampling methodology used to collect porewater in the 2013 Phase 2 Sediment Study (TAI 2017) was more disruptive than the sampling methodologies used in the other two porewater sampling studies. Porewater was not collected in situ; it was collected from the sediment sample immediately after retrieval from the river. In most cases, the porewater samples were collected from the grab sampler before the sediment was removed but, in some cases, the sediment sample was removed from the grab sampler before the porewater sample was taken.

The sediment grab samples were collected using a modified van Veen power grab sampler. After each sample was collected, overlying water was siphoned from the top of the sample, and porewater was extracted from the van Veen sampler into a syringe using an airstone. Two types of airstones were used: 1) ceramic airstones, as proposed in the quality assurance project plan (TAI 2013), and 2) sandstone airstones with larger pore sizes that were used in addition to, or instead of, the proposed ceramic airstones, which quickly became clogged during sampling.

At locations where the syringe did not produce sufficient suction to collect a sample, a peristaltic pump was employed to apply the additional suction needed to obtain sufficient porewater sample volume. For locations with sandy sediment, porewater quickly drained from the grab sampler before a sample could be collected. At these locations, the top 6 in. of sediment from the sampler was transferred to a Lexan™ tub, after which the porewater was extracted.

At two shallow locations in the Upper Columbia River (UCR) (1B-C1 and 1B-R2) and at four of the six tributaries (Trib-2, Trib-4, Trib-5, and Trib-6), sediment samples were collected using either a Petite Ponar® grab sampler or a stainless steel shovel. Using these methods, the samples were first transferred to the Lexan™ tub; any overlying water was then removed using a plastic scoop before porewater was collected through airstones with a syringe or peristaltic pump. These methods did not allow for separation of the overlying water from the sediment sample prior to the latter's transfer to the Lexan™ tub, resulting in the likelihood that some overlying water was mixed with the porewater samples.

2.2 2015 USGS POREWATER STUDY

A data report including a description of the porewater sampling methods for the 2015 USGS Porewater Study (USGS 2016) is not available. However, sampling methods were briefly described by both USGS (2016) and Balistrieri et al. (2018). As described by Balistrieri et al. (2018), a profile sampler (or profiler) was used to collect samples from 29 locations in Operable Unit (OU) 1. The profiler was a modified 91-kilogram (kg) standard USGS model DH-95 surface water sounding weight with a trigger plate and four spring-loaded 60-mL syringes connected to probes located 7.5 cm (3 in.) above the sediment-water interface (i.e., in surface water), at the sediment-water interface (0 cm), and at depths of 4.5 and 14.5 cm (1.8 and 5.7 in.) below the sediment-water interface. The profiler was lowered on a hydrowire to the sediment-water interface, whereupon the trigger plate activated the springs and syringes to simultaneously collect the four water samples. The samples were returned to the surface, filtered through 0.45- μ m filters, and analyzed for chemicals of potential concern.

In addition to the profiler, porewater samples were collected using a drive-point sampler at 10 locations in OU 1 (USGS 2016). The sampler was constructed of stainless steel tubing with Teflon™ liners equipped with 30-mL polyethylene syringes used to collect samples from shallow boulder sites. The sampling port of the drive-point sampler was set 6 cm below the sediment-water interface for sample collection.

2.3 2019 PHASE 3 SEDIMENT STUDY

During the 2019 Phase 3 Sediment Study (TAI 2022), sediment porewater was sampled from the top 0 to 6 in. of sediment from an anchored boat using the Trident probe developed by Coastal Monitoring Associates; these samples were not collected concurrently with bulk sediment. Porewater samples were collected at 104 locations in OU 1. The Trident probe is a direct-push sampler with integrated temperature and conductivity sensors. The decontaminated probe was inserted into the sediment, and porewater was collected by low-flow peristaltic pump extraction through a small-diameter Teflon™ sampling tube. The sampling tube was routed into a glovebox on the vessel. Porewater was collected in sampling containers inside the glovebox, which had been purged with nitrogen to minimize oxidation.

3 DATA COMPARISON

3.1 CONCENTRATIONS

Chemistry results for porewater samples from the Phase 2 and Phase 3 studies, as well as all water samples from the USGS study (i.e., porewater, sediment-water interface, and surface water) are shown in Figures A1-1 through A1-19 for the following constituents: calcium, magnesium, sodium, potassium, chloride, sulfate, sulfide, iron, manganese, pH, dissolved organic carbon, alkalinity, arsenic, cadmium, copper, aluminum, antimony, lead, molybdenum, and zinc. In general, these boxplots show consistent concentrations and low variability among the different water fractions collected during the USGS study. The lack of variability across samples taken from surface water and sediment porewater is unusual, since concentration gradients are typically seen between sediment porewater and surface water, as well as between shallow and deep porewater (Wetzel 1975; DiToro 2001). Results from both the Phase 2 and Phase 3 porewater sampling events in OU 1 show greater variability, with a broader range of concentrations for constituents typically influenced by sediment chemistry.

Porewater concentrations are expected to be higher than surface water concentrations, and are also expected to be highly variable due to differences in sediment composition and redox conditions. In particular, iron and manganese concentrations are expected to be elevated in sediment porewater relative to surface water, because the solubility of both metals increases with decreasing redox conditions (Stumm and Morgan 1996). Concentrations of major ions (e.g., calcium, magnesium) in porewater are also expected to be elevated relative to surface water, given the close contact between porewater and sediments. The Phase 2 and Phase 3 data for sediment porewater in OU 1 show patterns consistent with chemical influences from sediments, while the USGS profiler data appear remarkably consistent across all sampling depths for major ions and redox-sensitive metals. These data for the USGS samples indicate that the sampling method may have inadvertently incorporated surface water into the samples. The USGS profiler data does show elevated concentrations in sediment porewater for some of the other metals of concern (e.g., cadmium, copper), likely because the differences in concentrations between surface waters and porewaters for these metals are much greater than for major ions.

3.2 PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) was used to further compare the concentrations from the three field porewater sampling studies. PCA methodology is described in detail in Section 3.1 of Appendix L to the Aquatic BERA. Consistent with how some PCAs were conducted for other

applications in the Aquatic BERA, two PCAs were conducted with the pooled field porewater data:

- **Dissolved metals concentrations.** This PCA used the dissolved concentrations of metals and additional analytes such as dissolved organic carbon (DOC), pH, alkalinity, and sulfate in porewater, as reported by the analytical laboratory (Figures A1-20 and A1-21).
- **Relative concentrations of dissolved metals.** For this PCA, concentrations of individual metals relative to the total dissolved metals concentrations in each porewater sample were calculated as percentages (Figures A1-22 and A1-23). The non-metal analytes were retained based on the values reported by the analytical laboratory. They were not included in the calculation of relative concentration for metals.

3.2.1 Dissolved Metals Concentrations PCA

For the results of this PCA, PC1 is primarily a metric related to analyte concentrations; negative values indicate samples with relatively low concentrations and positive values indicate samples with relatively high concentrations (especially manganese, DOC, alkalinity, iron, calcium, barium, arsenic, potassium, and cobalt) (Figure A1-20).¹ PC2, however, is more influenced by the mixture of porewater concentrations; negative values indicate samples relatively high in cadmium and copper.² Most USGS profiler data are in the lower left quadrant of the biplot, indicating lower concentrations of analytes such as manganese, DOC, alkalinity, and calcium, while concentrations of sulfate, and antimony may be relatively higher (Figure A1-21). The Phase 3 data are mostly clustered in the upper left quadrant of the biplot, indicating samples with lesser concentrations of analytes such as manganese, DOC, alkalinity, and calcium; however, this is not true for all Phase 3 porewater samples, as some have higher PC1 scores, indicating higher concentrations of those analytes. The positive PC2 values of the Phase 3 porewater samples indicate that they also have relatively low concentrations of cadmium and copper. There is substantially more spread in the Phase 2 porewater data on the biplot, but the data tend to have positive values for PC1 (i.e., higher concentrations for many of the analytes) with a greater mix of samples along PC2. The Phase 2 samples cover a much larger geographic

¹ PC1 results are also positively correlated with dissolved concentrations of nickel and zinc in porewater, but those analytes were detected in fewer than 50 percent of samples (Table A1-1), so those loadings on PC1 are substantially affected by reported detection limits (DLs). Most zinc samples, however, are U* qualified, so the reported values in those cases are not the DL.

² PC2 is negatively correlated with dissolved concentrations of silver, beryllium, thallium, selenium, and chromium, but those analytes were detected in fewer than 50 percent of samples (Table A1-1), so those loadings on PC2 are substantially affected by reported DL.

area and range of conditions than either the Phase 3 or USGS samples, so this variability is not unexpected.

3.2.2 Relative Concentrations of Dissolved Metals PCA

For the results of this PCA, negative PC1 values indicate samples with higher alkalinity and manganese relative to the other samples (Figure A1-22).³ The association of manganese and iron with negative PC1 values indicates samples with more reducing conditions, since the solubilities of these metals increase in anoxic sediments. Negative PC1 values also indicate higher DOC. PC2, however, is positively correlated with relative concentrations of lead and zinc and is negatively correlated with relative concentrations of sodium, calcium, and magnesium. Negative PC2 values indicate samples with higher concentrations of cations that reduce metal bioavailability. Evaluating metals mixtures in porewater based on the relative concentrations of metals makes the differences between the three field porewater data sets more apparent. In the biplots, the samples from each of the data sets cluster separately from each other (Figure A1-23). The USGS profiler data tend to be clustered on the right side of the biplot, indicating fewer characteristics associated with reducing conditions and lower DOC concentrations; however, these samples may also be strongly influenced by the low detection frequency and elevated DLs for silver, thallium, and beryllium in that data set (Table A1-1). The Phase 3 data tend to cluster in the lower middle portion of the biplot, indicating that many of those samples are relatively enriched in sodium, calcium, and magnesium. While there is greater spread in the Phase 2 data, most of those data tend to plot in the upper left quadrant of the biplot, indicating samples relatively enriched in manganese and with higher alkalinity (negative PC1), as well as relatively enriched in lead and zinc and with higher concentrations of DOC (positive PC2).

3.2.3 Summary

The clustering of samples from the same field porewater data sets and the lack of overlap among the clusters from the different data sets show that the porewater chemistry differed systematically among the three porewater studies. The majority of the Phase 2 data are positive on PC1 from the dissolved metals concentrations PCA (Figure A1-21) indicating they tend to have higher total metals concentrations. The relative concentration PCA indicates that they are relatively enriched in lead, zinc, and manganese. These findings suggest that the Phase 2 porewater collection methodology may have mobilized metals into porewater which is

³ PC1 is positively correlated with relative concentrations of silver, thallium, and beryllium but, as identified in footnote 2, those analytes were detected in fewer than 50 percent of porewater samples (Table A1-1).

consistent with the observation that the Phase 2 porewater collection methodology was more disruptive of in situ porewater conditions than were the other two studies' methodologies. The USGS profiler data tend to have lower metals concentrations and a lack of association with indicators of reducing conditions (e.g., manganese and iron), consistent with the observation that surface water may have been incorporated into the porewater samples (as discussed in Section 3.1). The Phase 3 data tend to have lower total metals concentrations than those from the Phase 2 data set (based on PC1 from the dissolved concentrations PCA in Figure A1-21), consistent with the Phase 3 sampling methodology that minimized the disturbance of in situ porewater conditions (unlike the Phase 2 data set).

4 REFERENCES

- Balistrieri, L.S., C.A. Mebane, S.E. Cox, H.J. Puglis, R.D. Calfee, and N. Wang. 2018. Potential Toxicity of Dissolved Metal Mixtures (Cd, Cu, Pb, Zn) to Early Life Stage White Sturgeon (*Acipenser transmontanus*) in the Upper Columbia River, Washington, United States. *Environ Sci Tech* 52(17):9793–9800.
- DiToro, D.M. 2001. *Sediment Flux Modeling*. John Wiley & Sons, Inc., New York, NY.
- Stumm, W., and J.J. Morgan. 1996. *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters*. 3rd ed. John Wiley & Sons, Inc., New York, NY.
- TAI (Teck American Incorporated). 2017. Upper Columbia River. Final. Phase 2 Sediment Study Data Summary and Data Gap Report. Prepared by Windward Environmental LLC, Exponent, Parametrix, Inc., and HDR, Inc Seattle, WA.
- TAI. 2022. Upper Columbia River Final 2019 Phase 3 Sediment Study Data Summary Report. Prepared for Teck American Incorporated by ERM, Windward Environmental LLC, HDR, Exponent, and Parametrix.
- USGS (U.S. Geological Survey). 2016. Trace Elements Concentrations in Pore Water and Surface Water Near the Sediment-Water Interface in the Upper Columbia River, Washington (2015): U.S. Geological Survey Data Release. U.S. Geological Survey.
- Wetzel, R.G. 1975. *Limnology*. W.B. Sanders Company, Philadelphia.

FIGURES

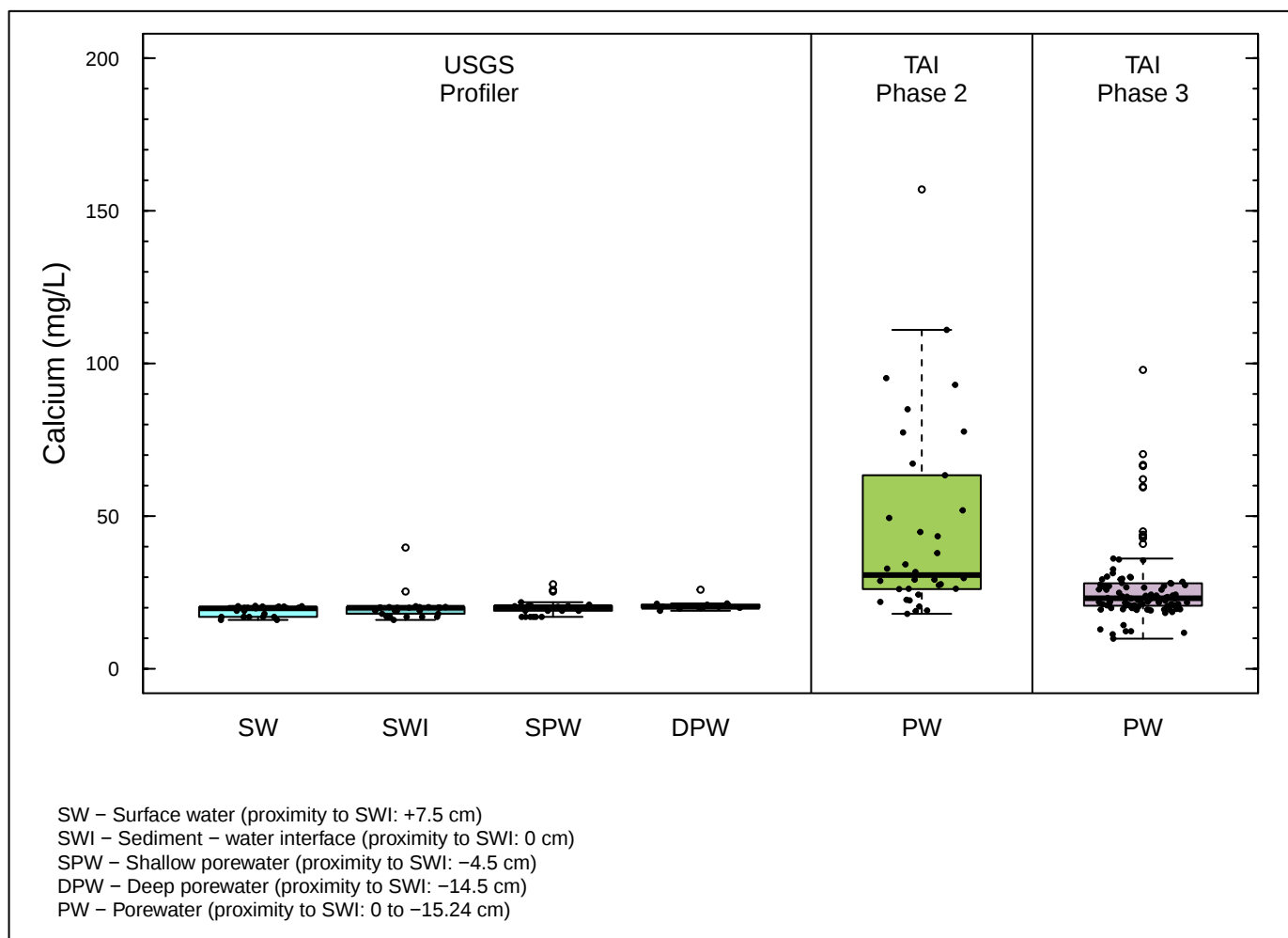


Figure A1-1. Calcium Concentration in Field Porewater Samples from OU1

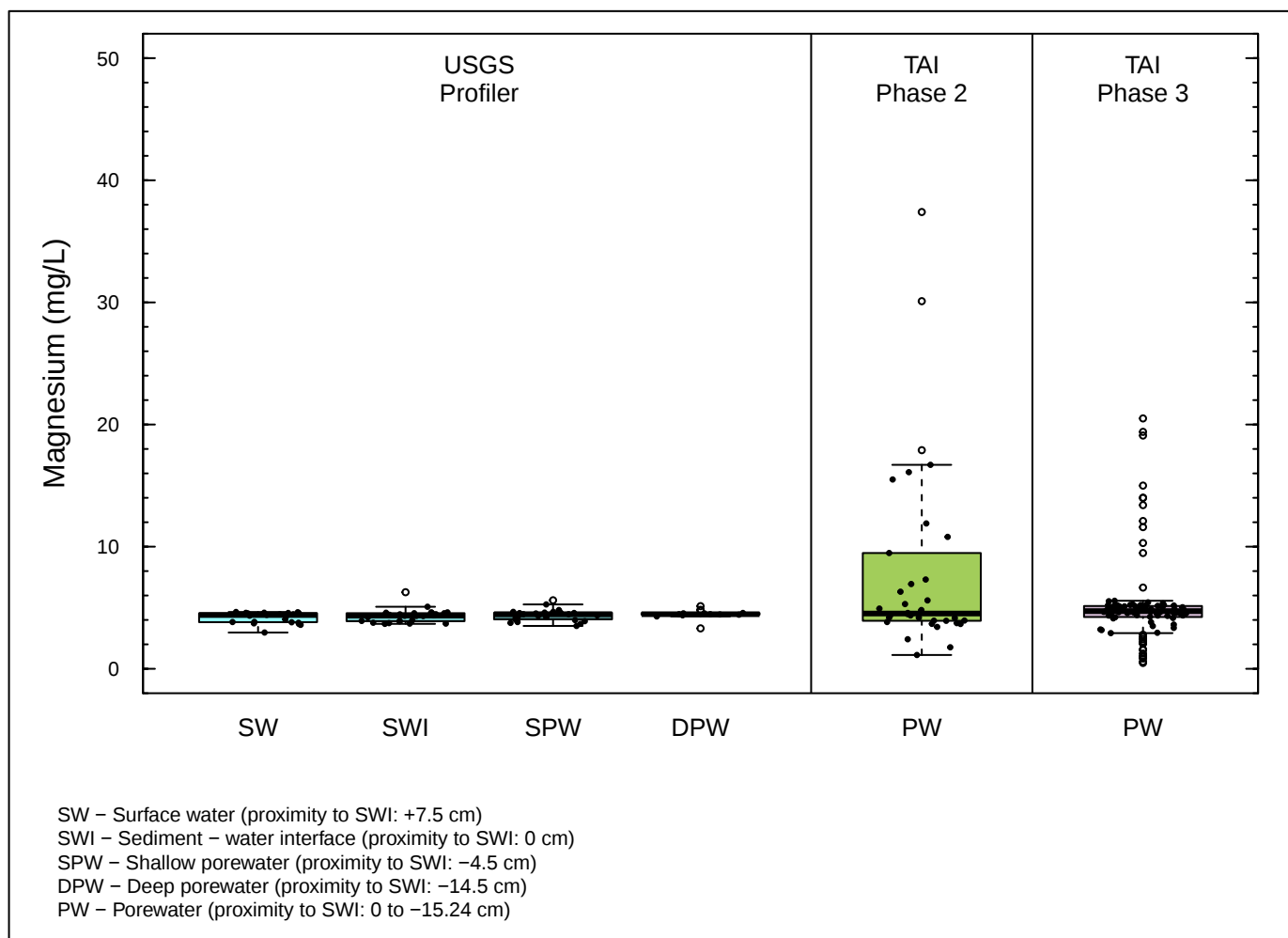


Figure A1-2. Magnesium Concentration in Field Porewater Samples from OU1

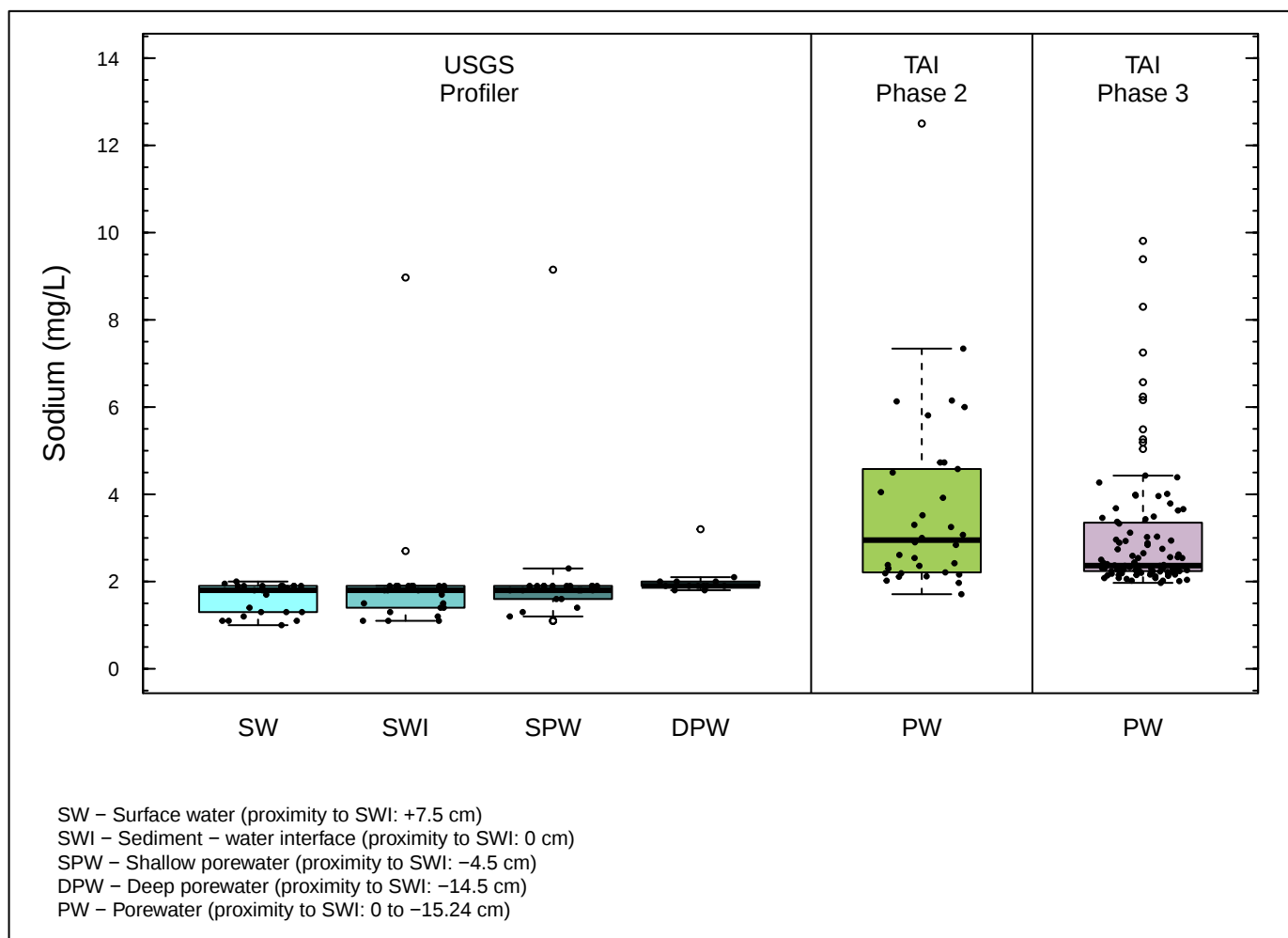


Figure A1–3. Sodium Concentration in Field Porewater Samples from OU1

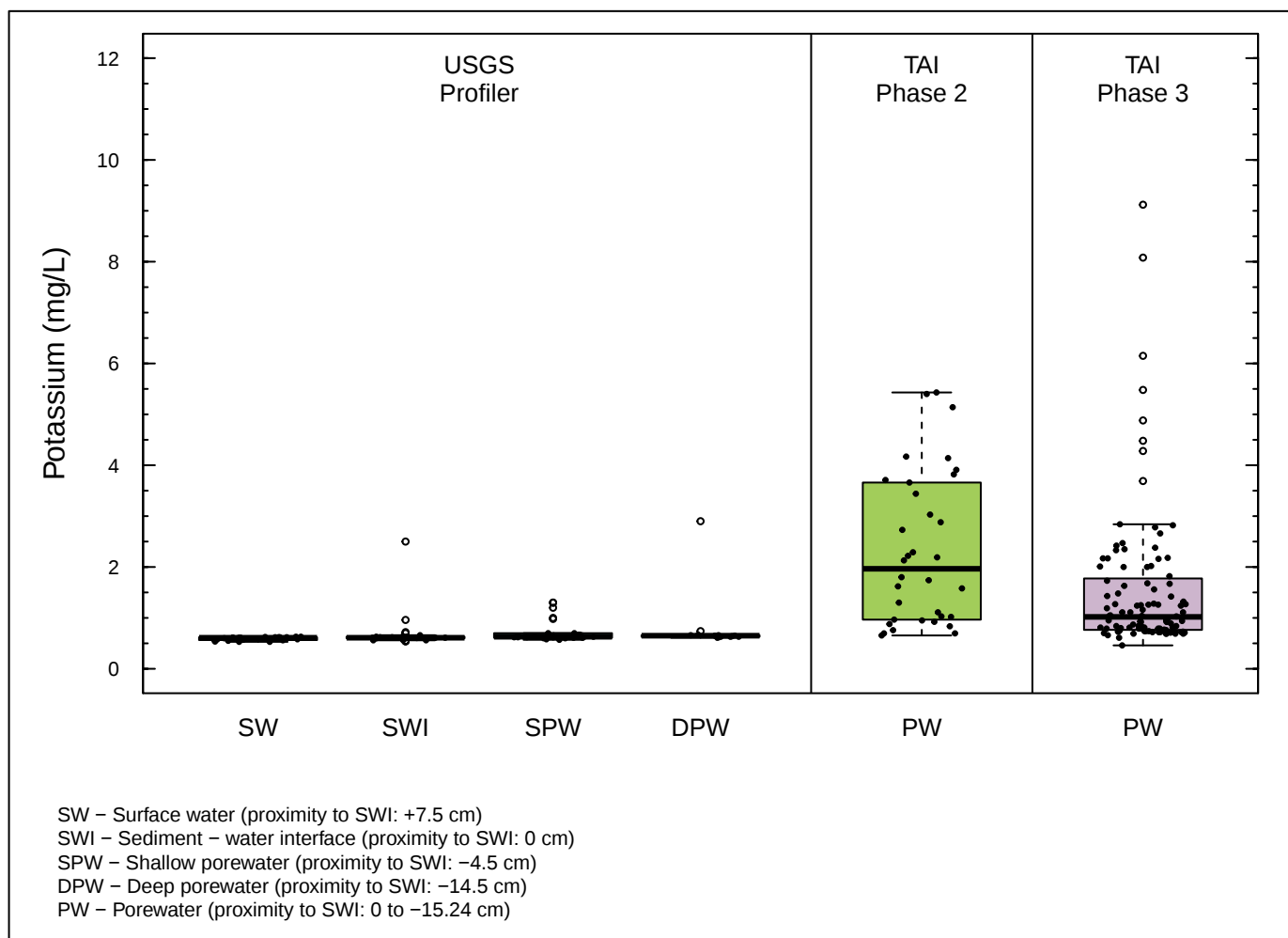


Figure A1–4. Potassium Concentration in Field Porewater Samples from OU1

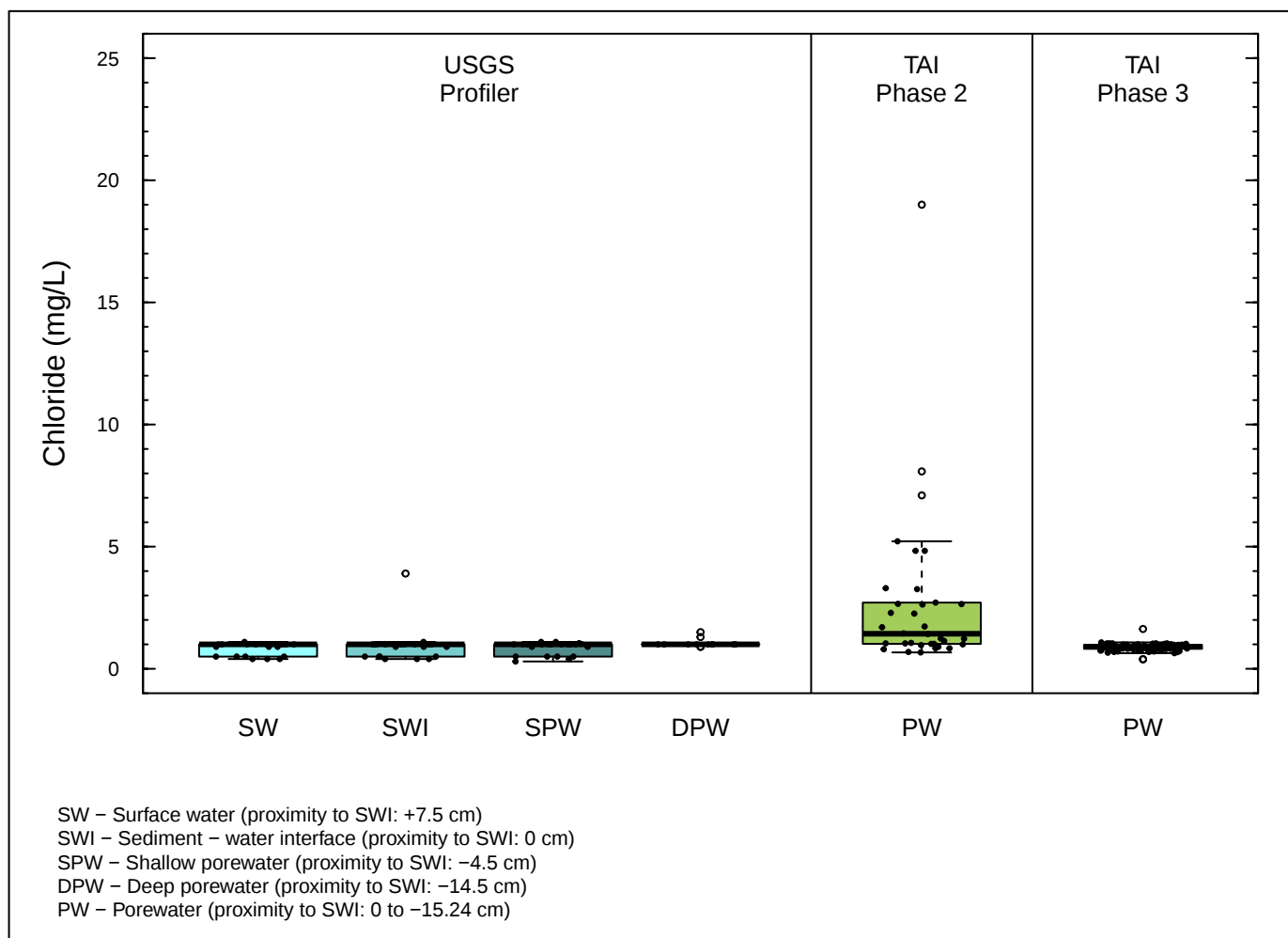


Figure A1–5. Chloride Concentration in Field Porewater Samples from OU1

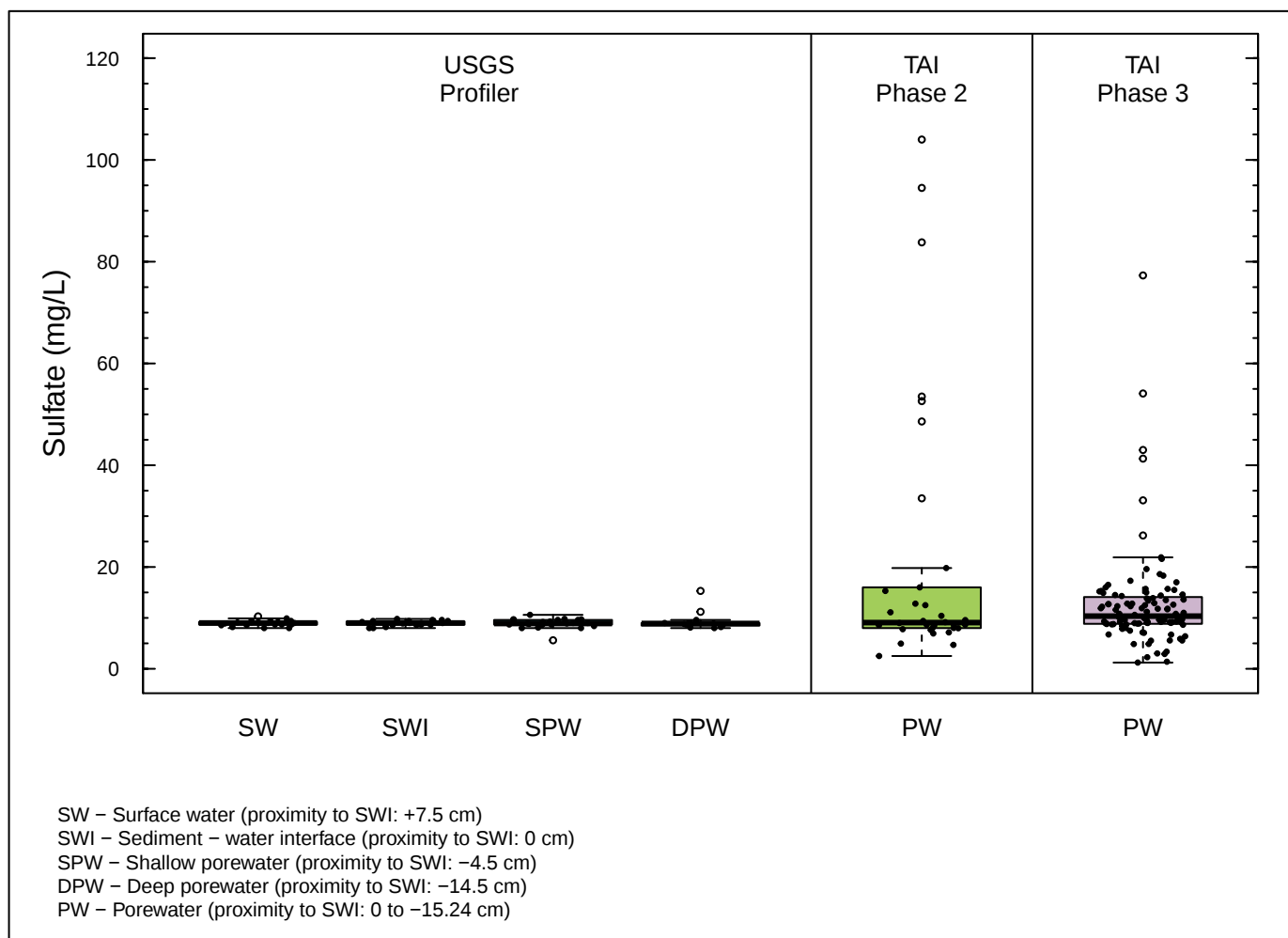


Figure A1-6. Sulfate Concentration in Field Porewater Samples from OU1

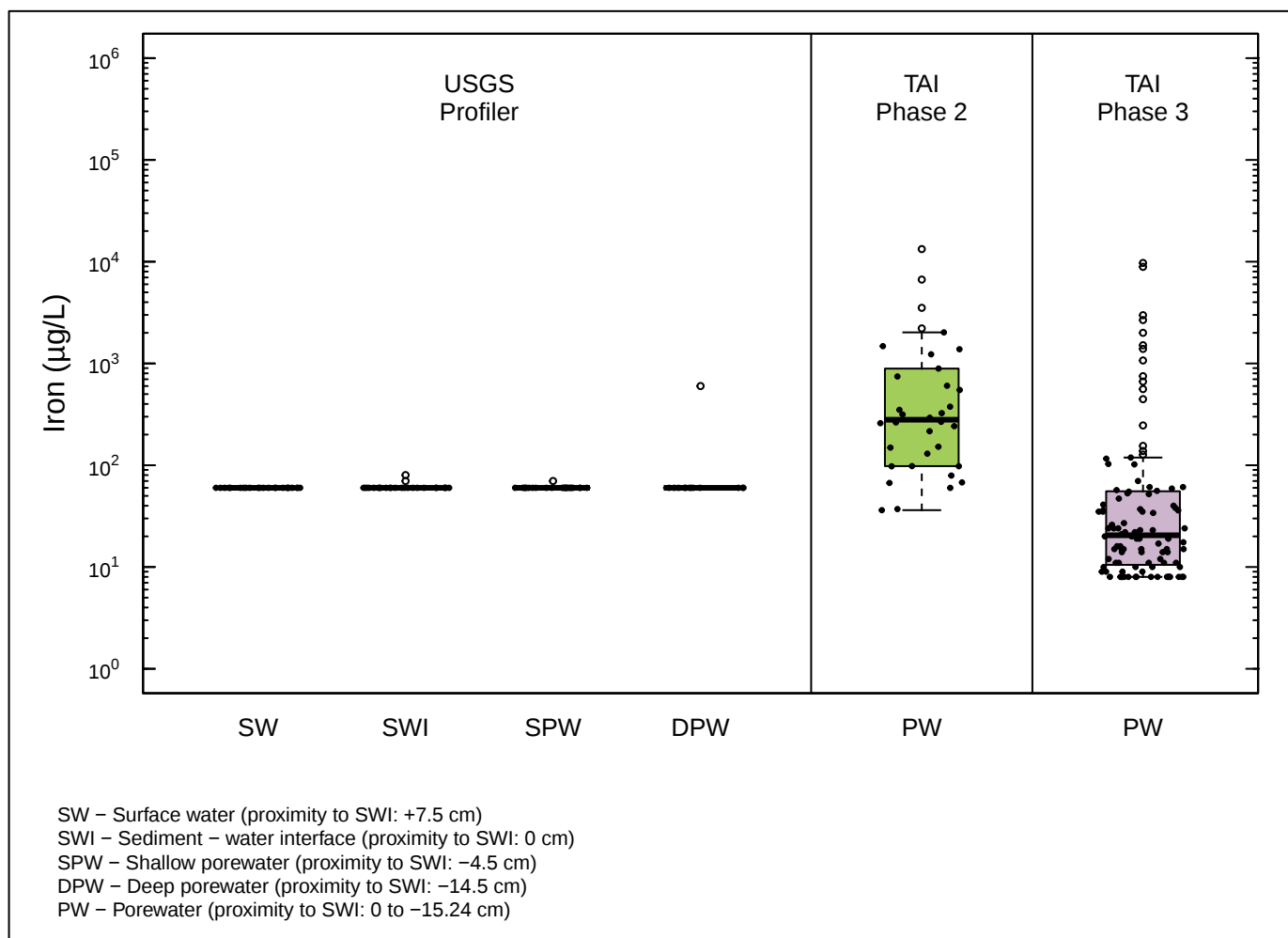


Figure A1–7. Iron Concentration in Field Porewater Samples from OU1

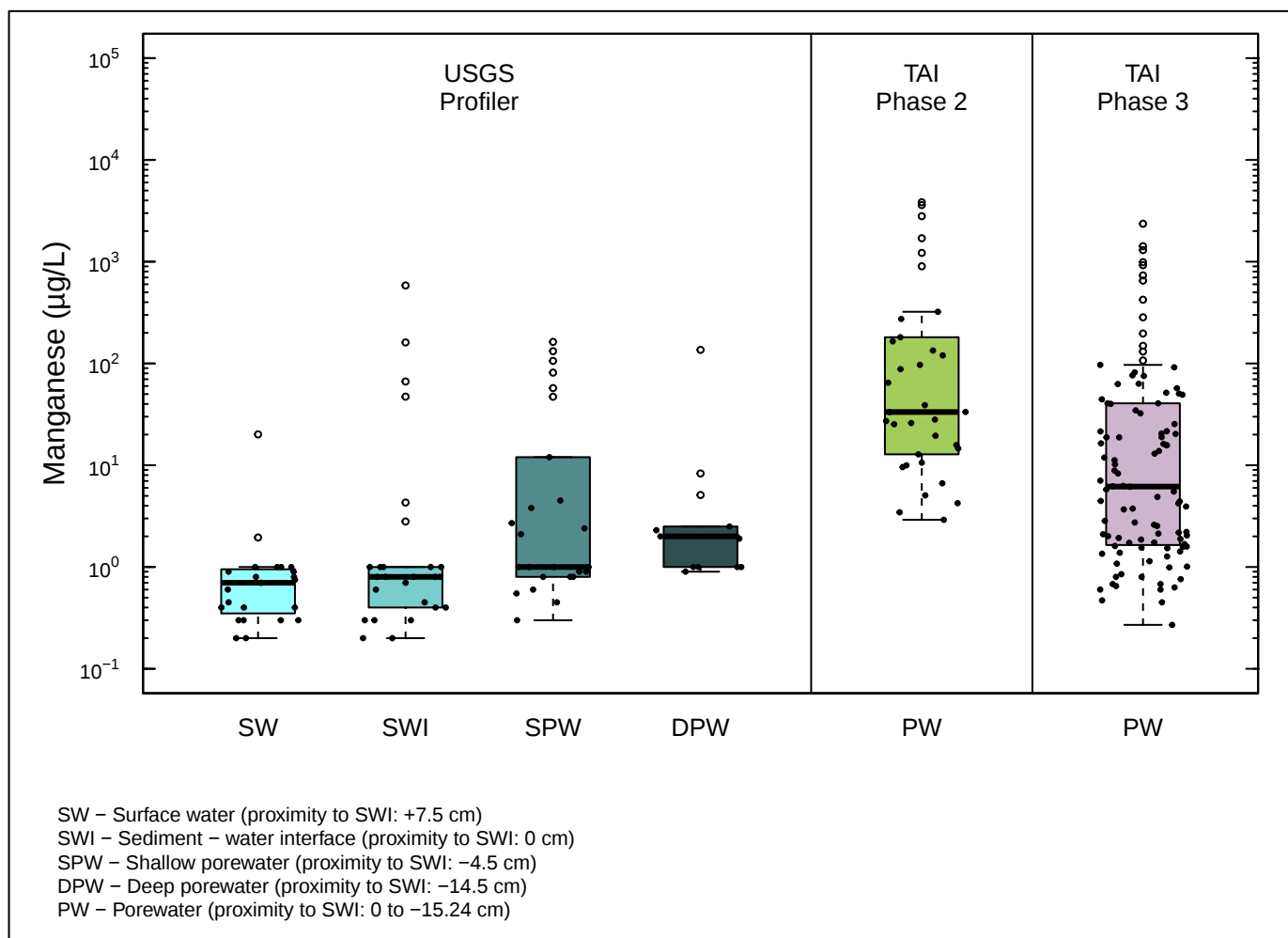


Figure A1-8. Manganese Concentration in Field Porewater Samples from OU1

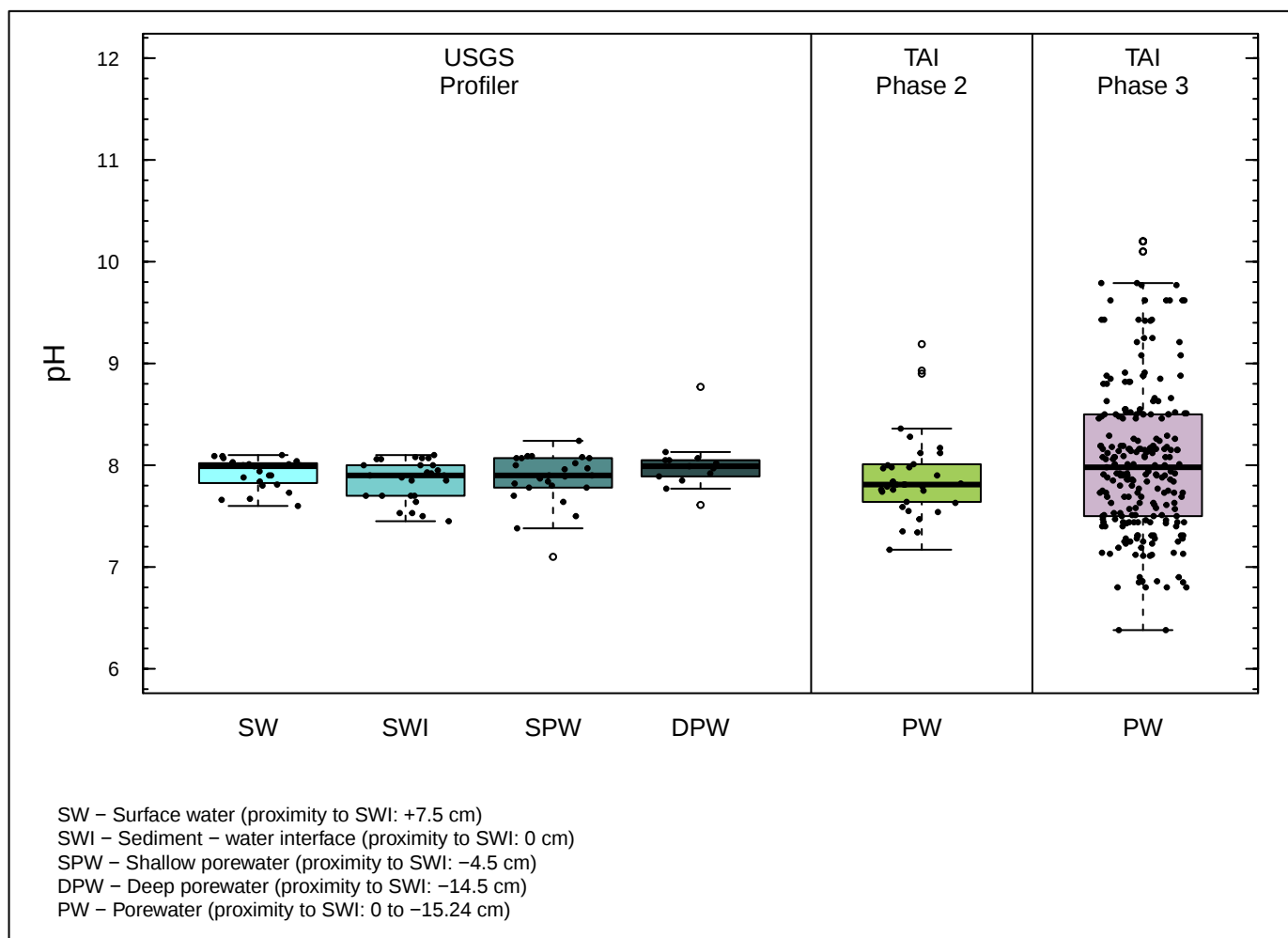


Figure A1–9. pH in Field Porewater Samples from OU1

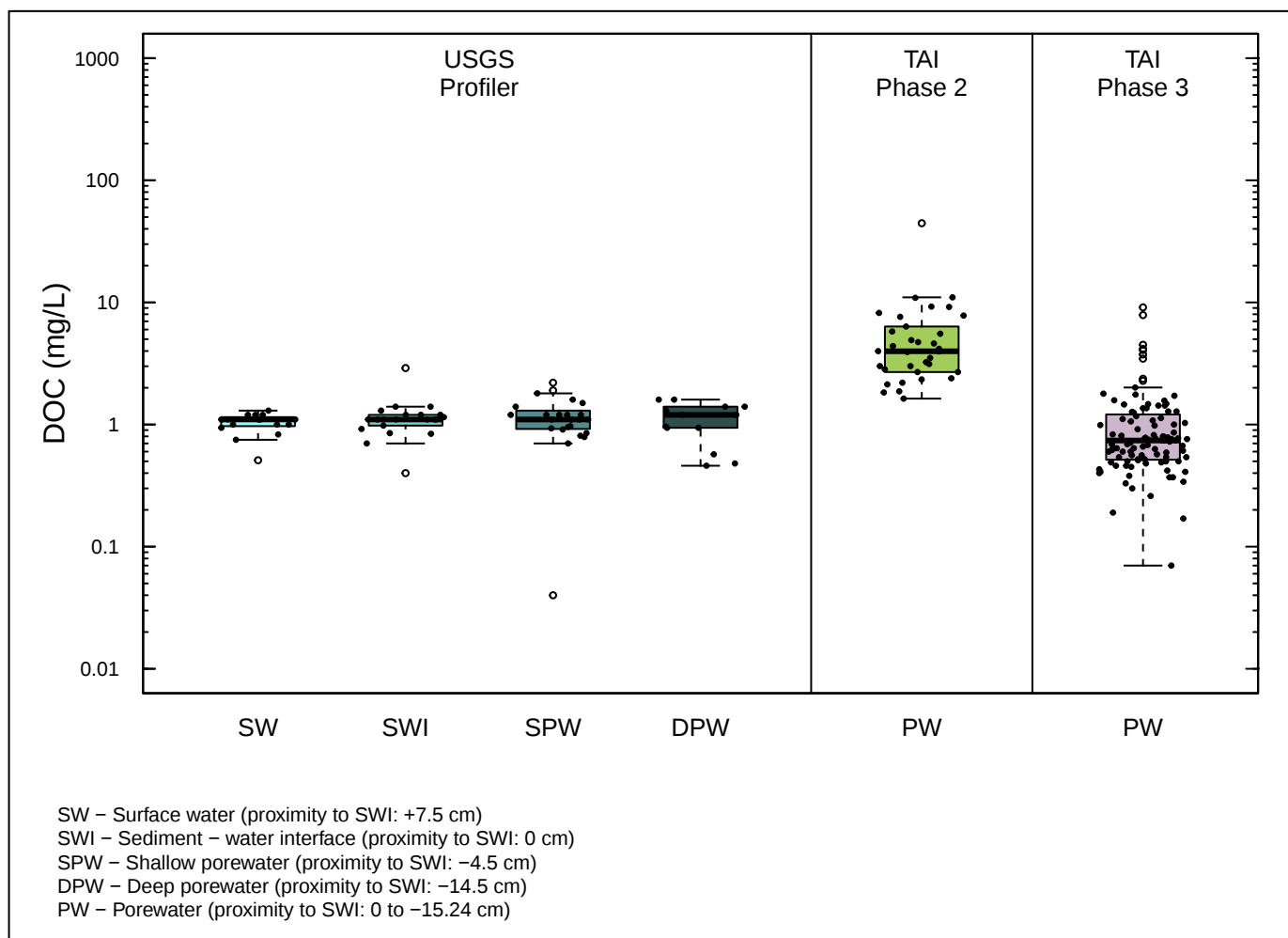


Figure A1–10. DOC Concentration in Field Porewater Samples from OU1

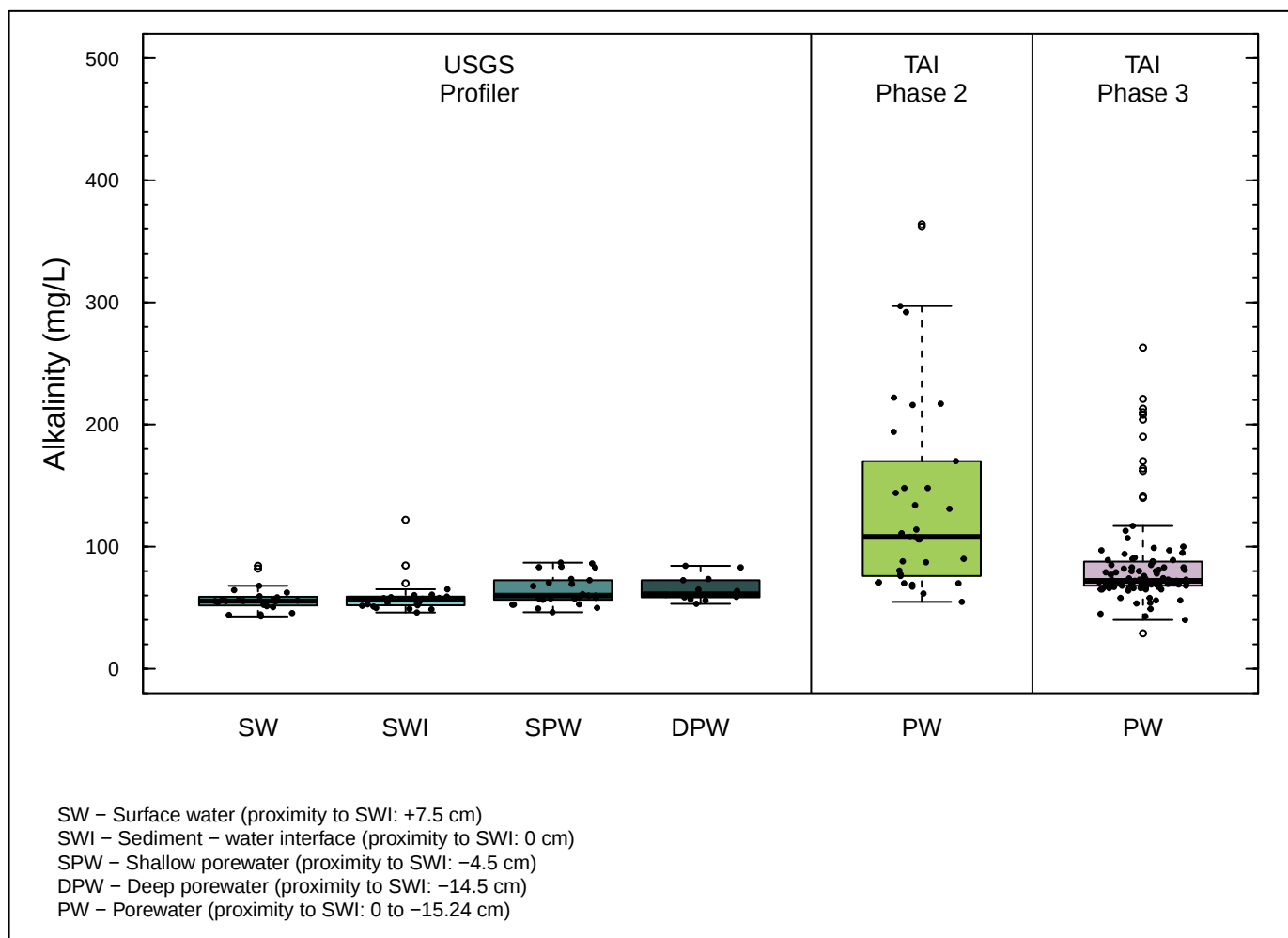


Figure A1-11. Alkalinity in Field Porewater Samples from OU1

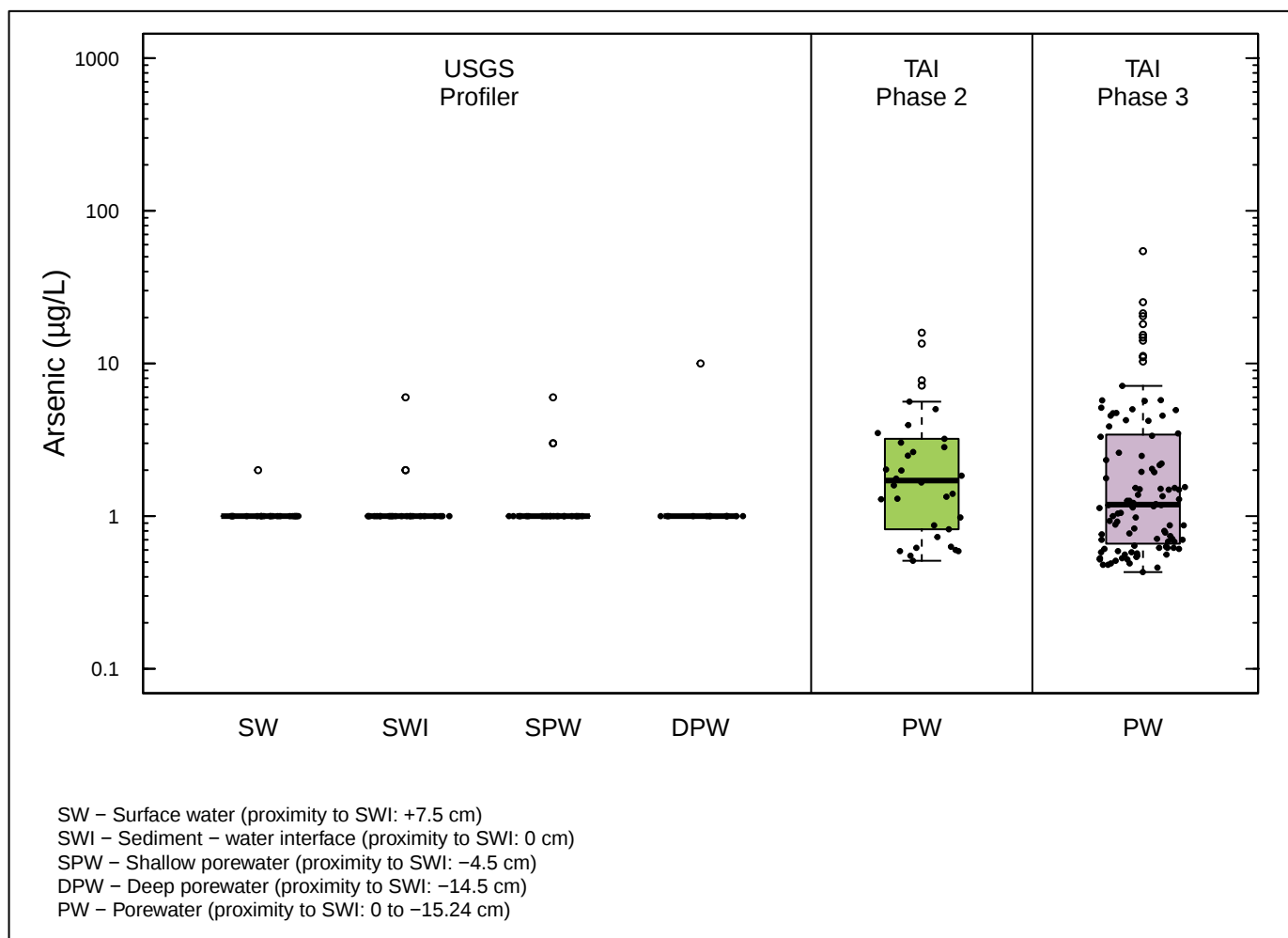


Figure A1–12. Arsenic Concentration in Field Porewater Samples from OU1

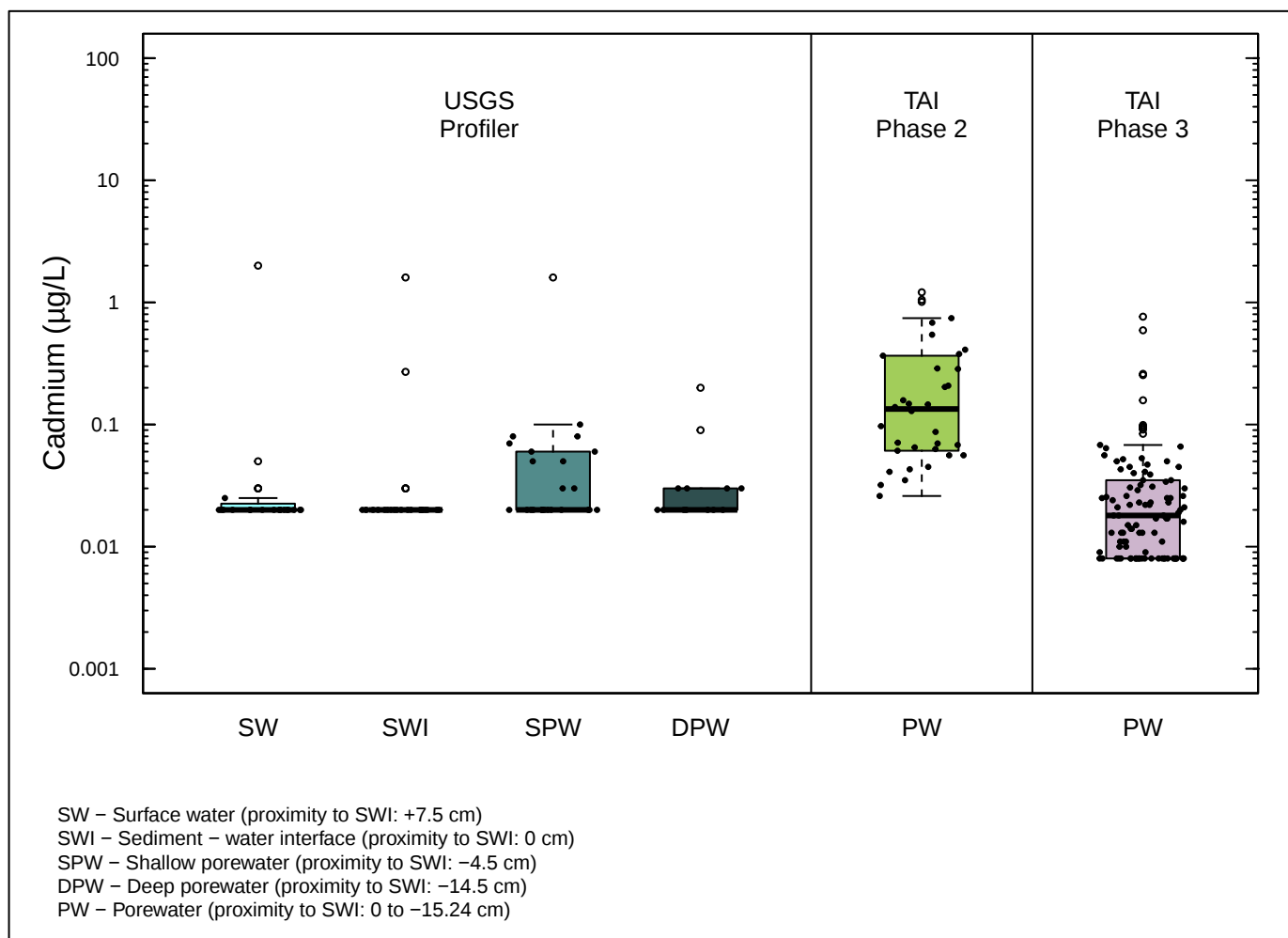


Figure A1–13. Cadmium Concentration in Field Porewater Samples from OU1

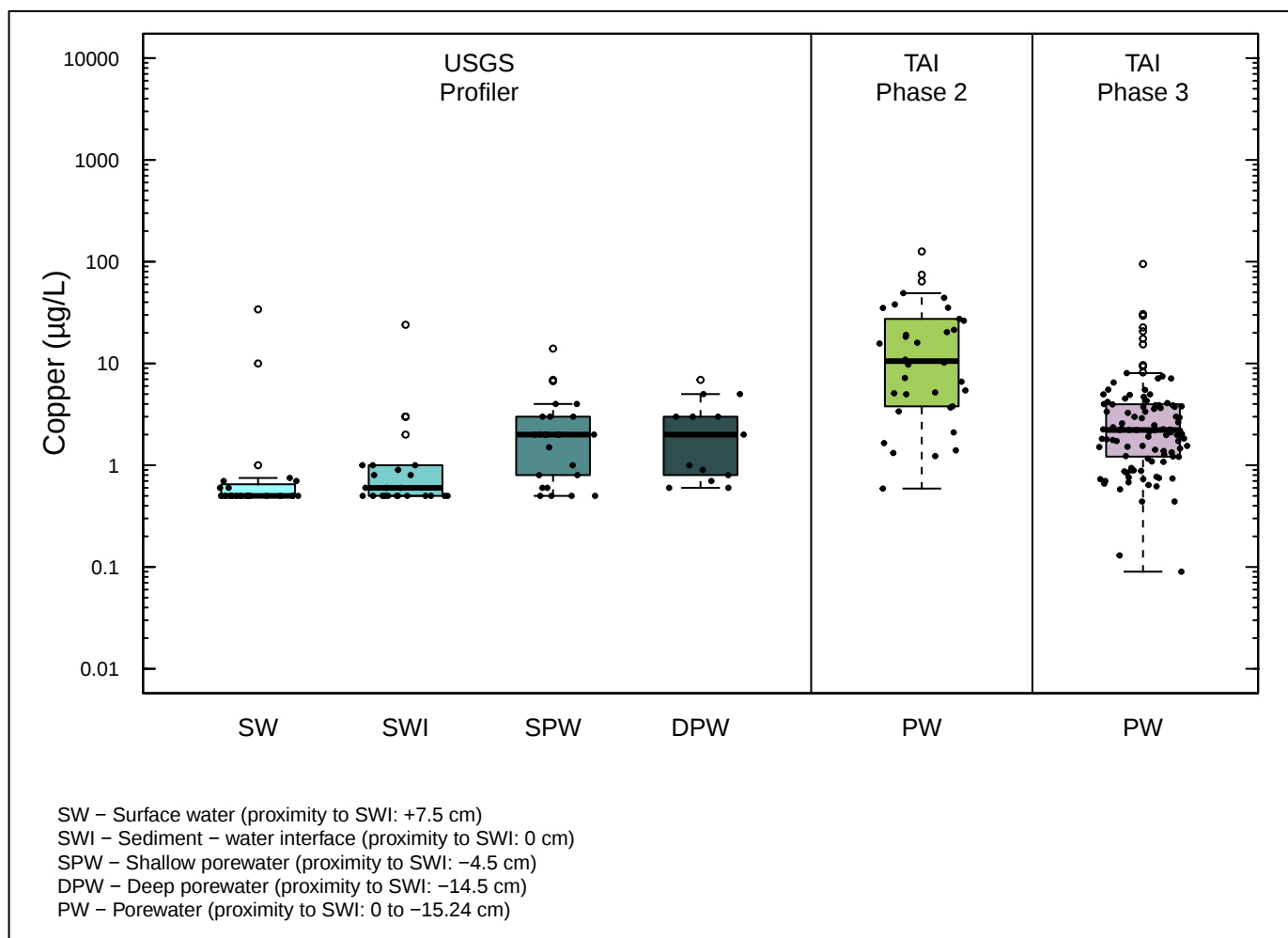


Figure A1-14. Copper Concentration in Field Porewater Samples from OU1

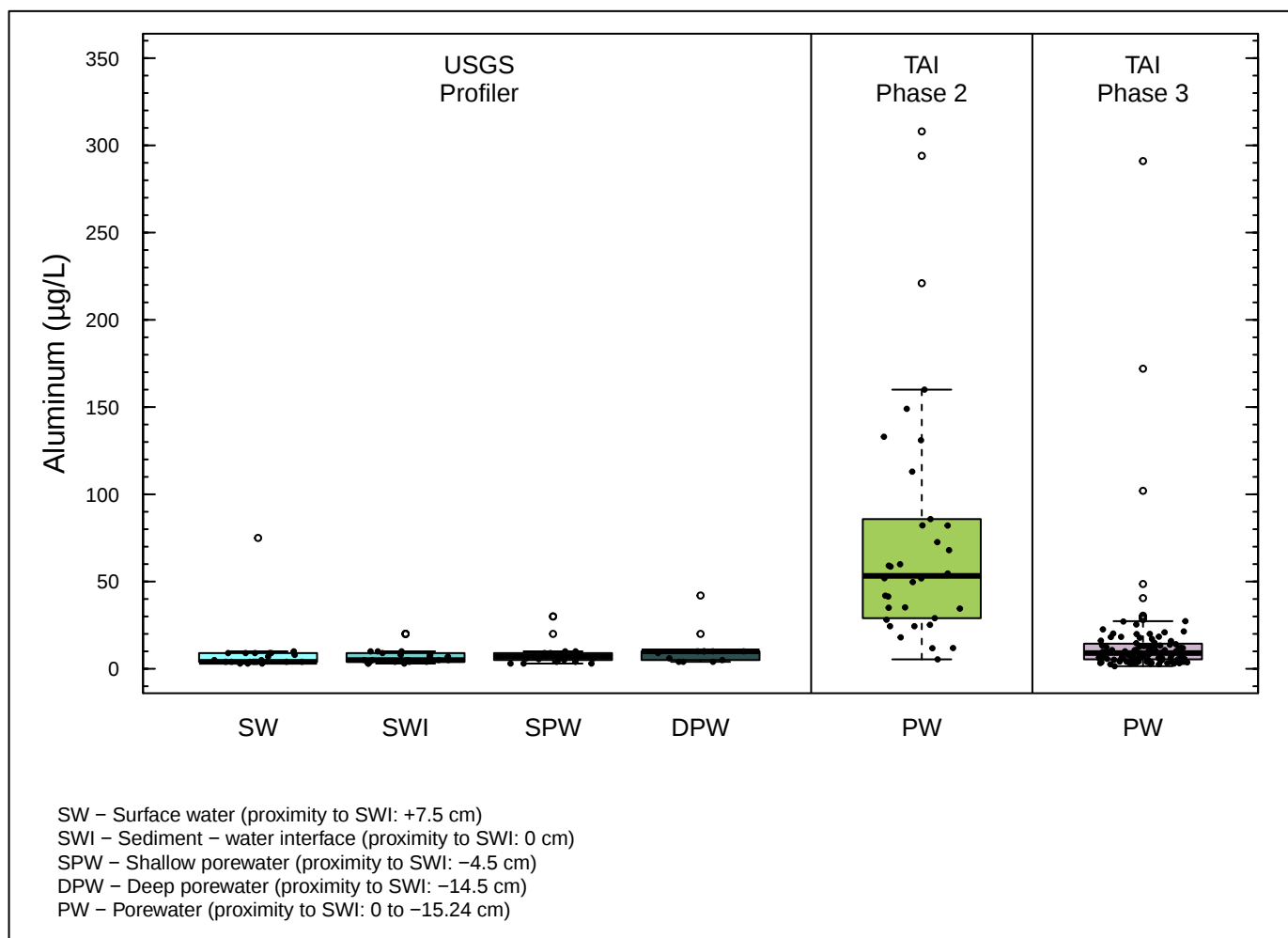


Figure A1–15. Aluminum Concentration in Field Porewater Samples from OU1

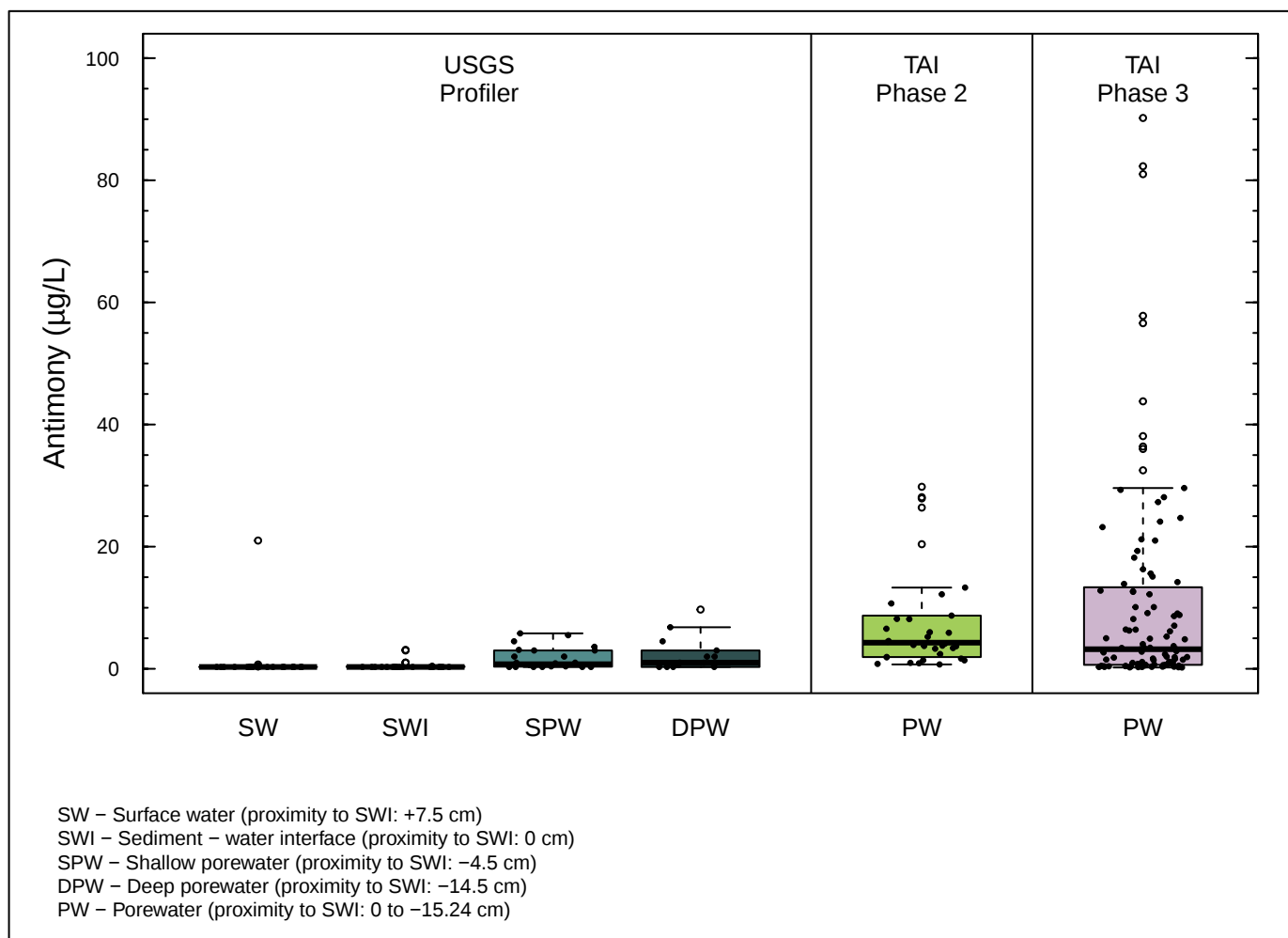


Figure A1-16. Antimony Concentration in Field Porewater Samples from OU1

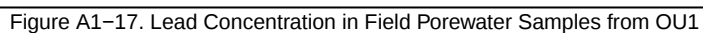


Figure A1-17. Lead Concentration in Field Porewater Samples from OU1

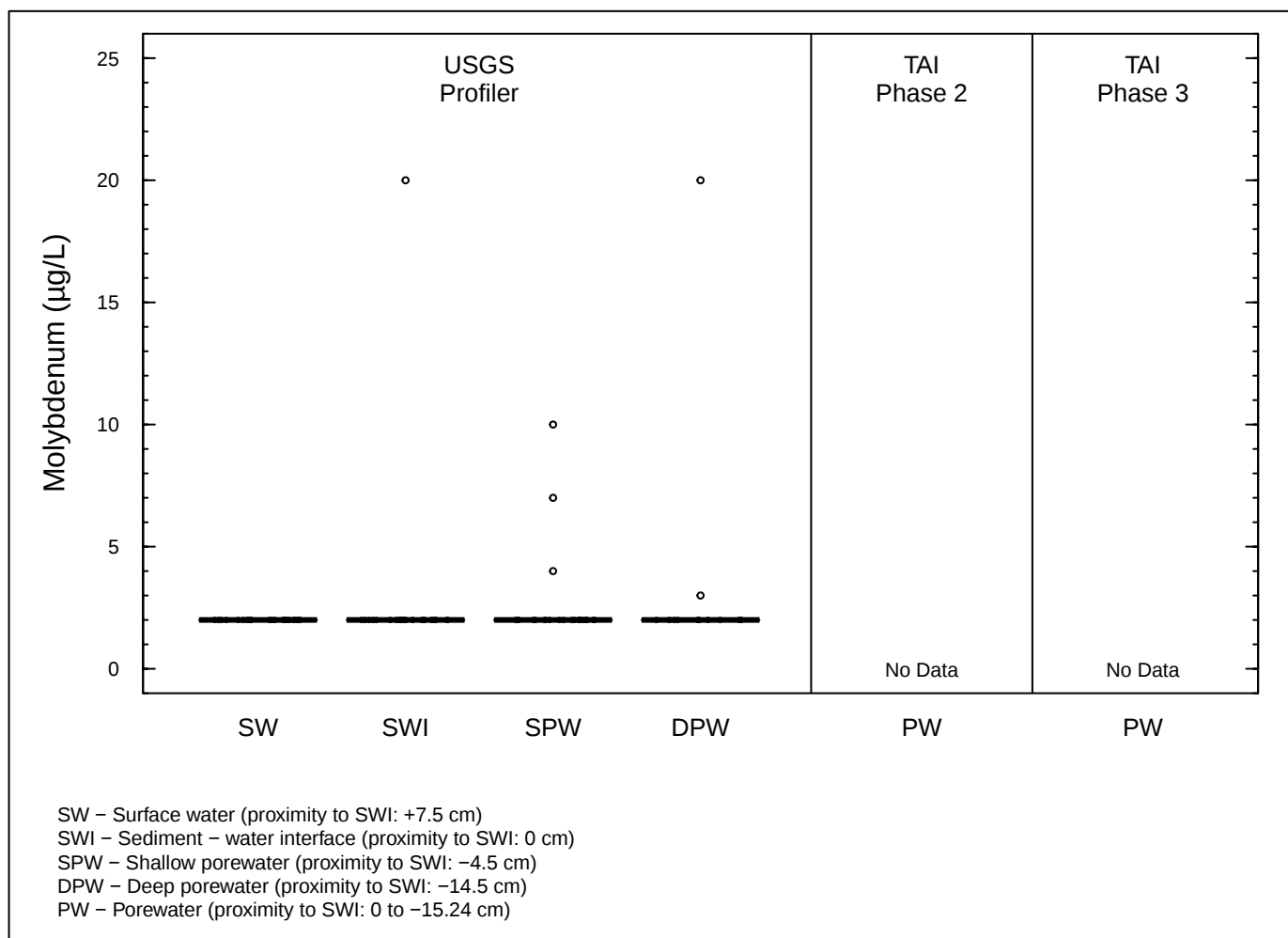


Figure A1–18. Molybdenum Concentration in Field Porewater Samples from OU1

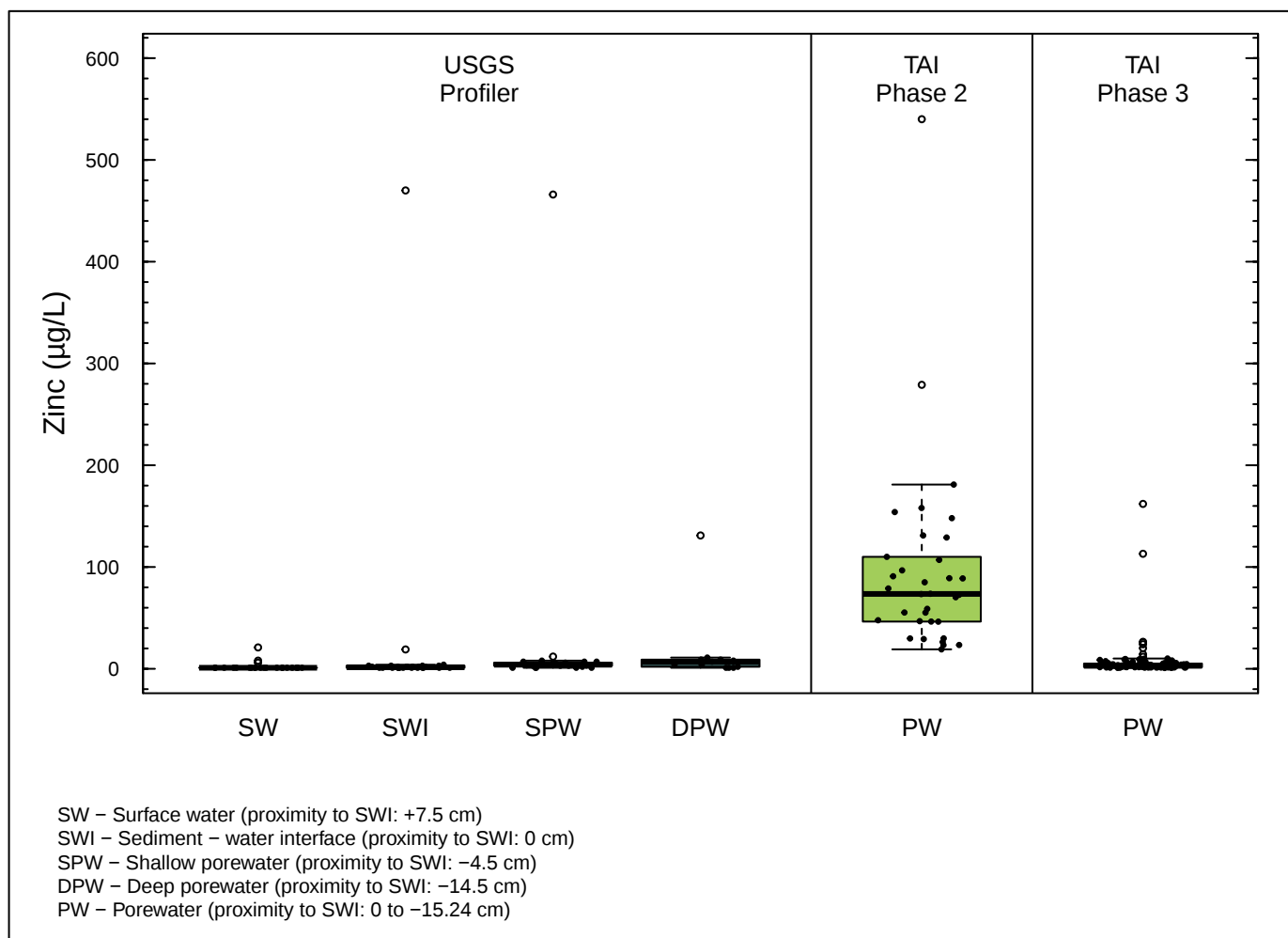


Figure A1-19. Zinc Concentration in Field Porewater Samples from OU1

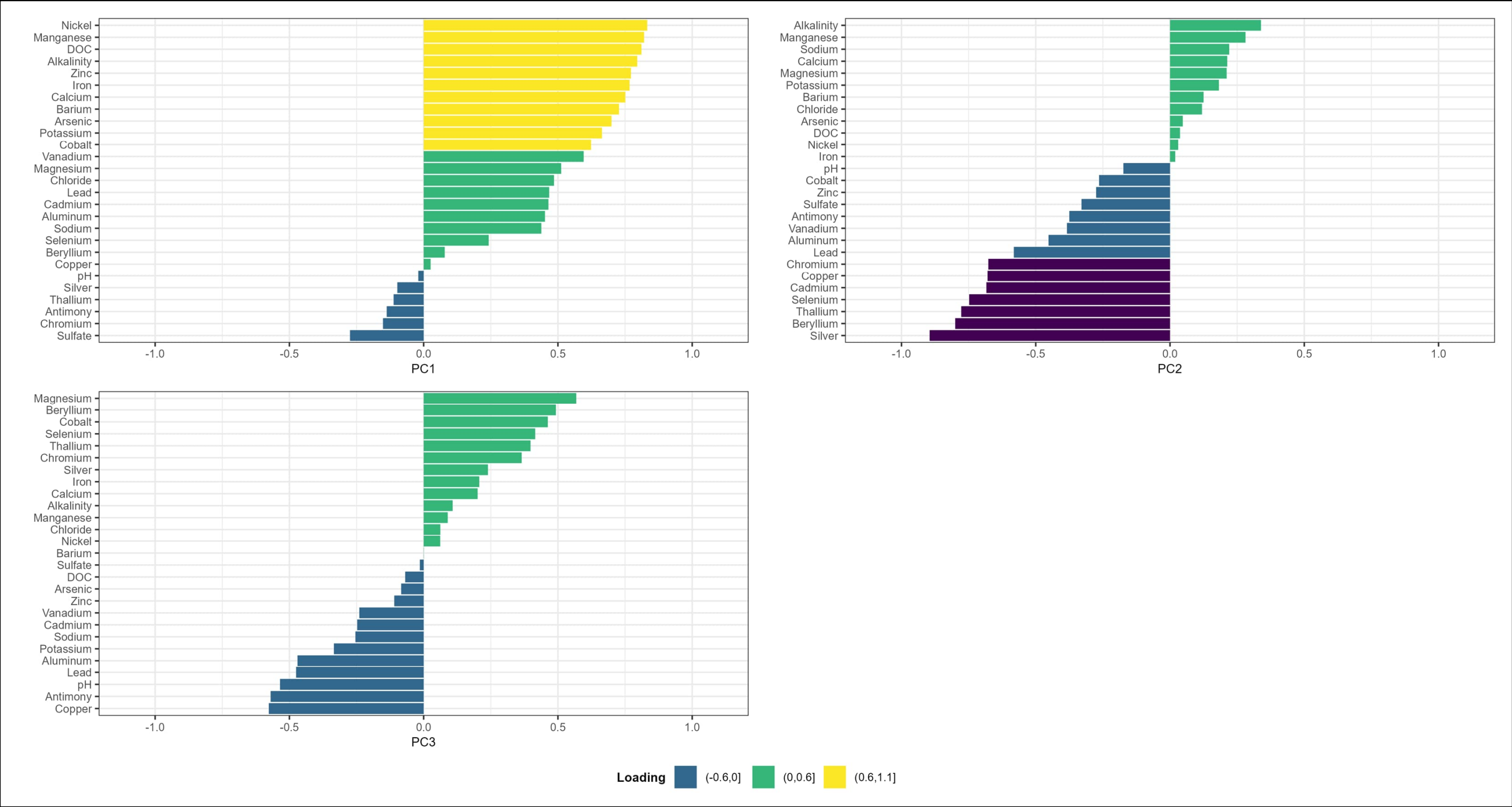


Figure A1-20. PCA Loadings Plots for Dissolved Metals Concentrations in the Combined Field Porewater Data Set

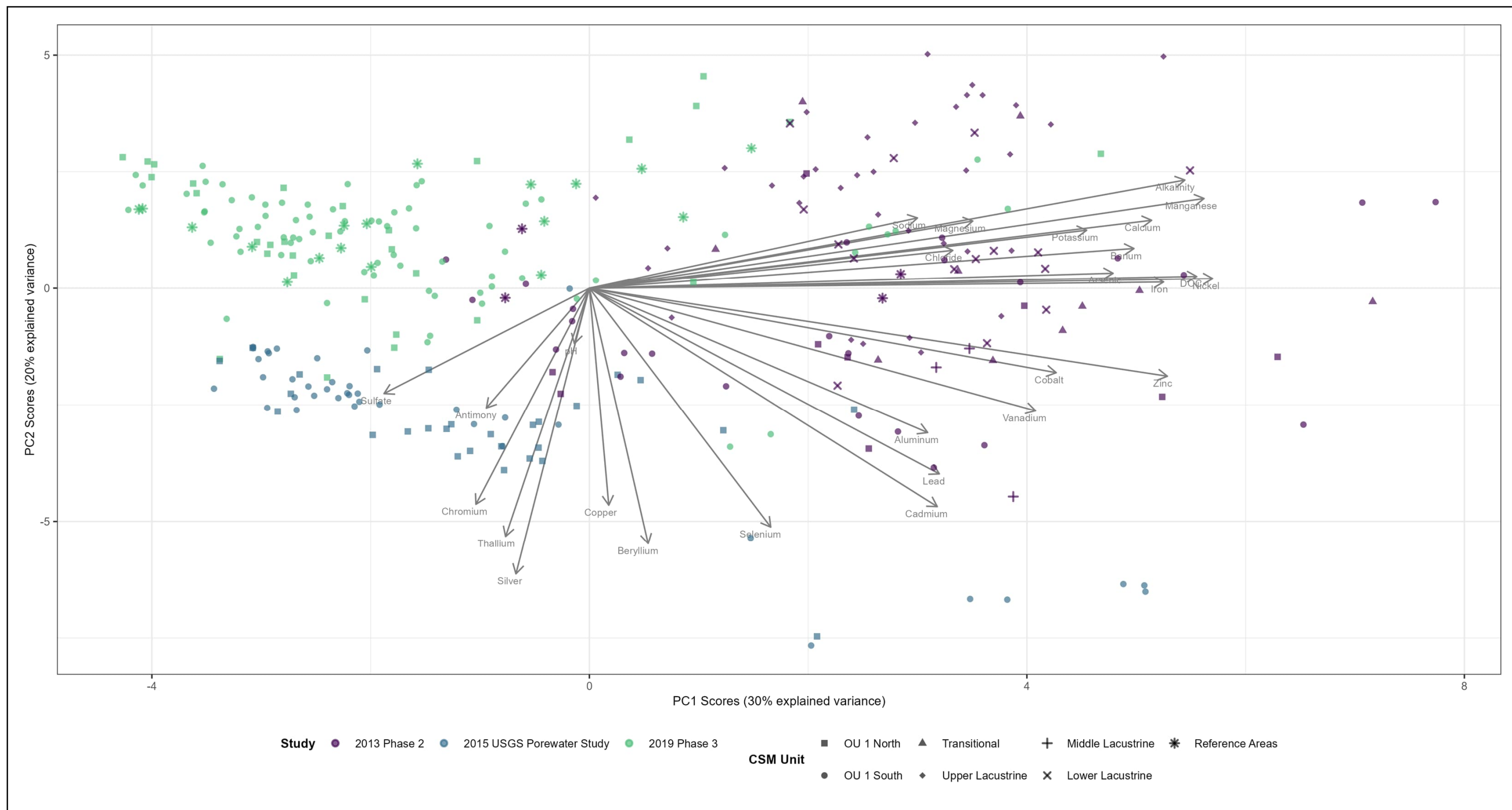


Figure A1-21. PCA Biplots for Dissolved Metals in the Combined Field Porewater Data Set



Figure A1-22. PCA Loadings Plots for Relative Concentrations of Dissolved Metals in the Combined Field Porewater Data Set

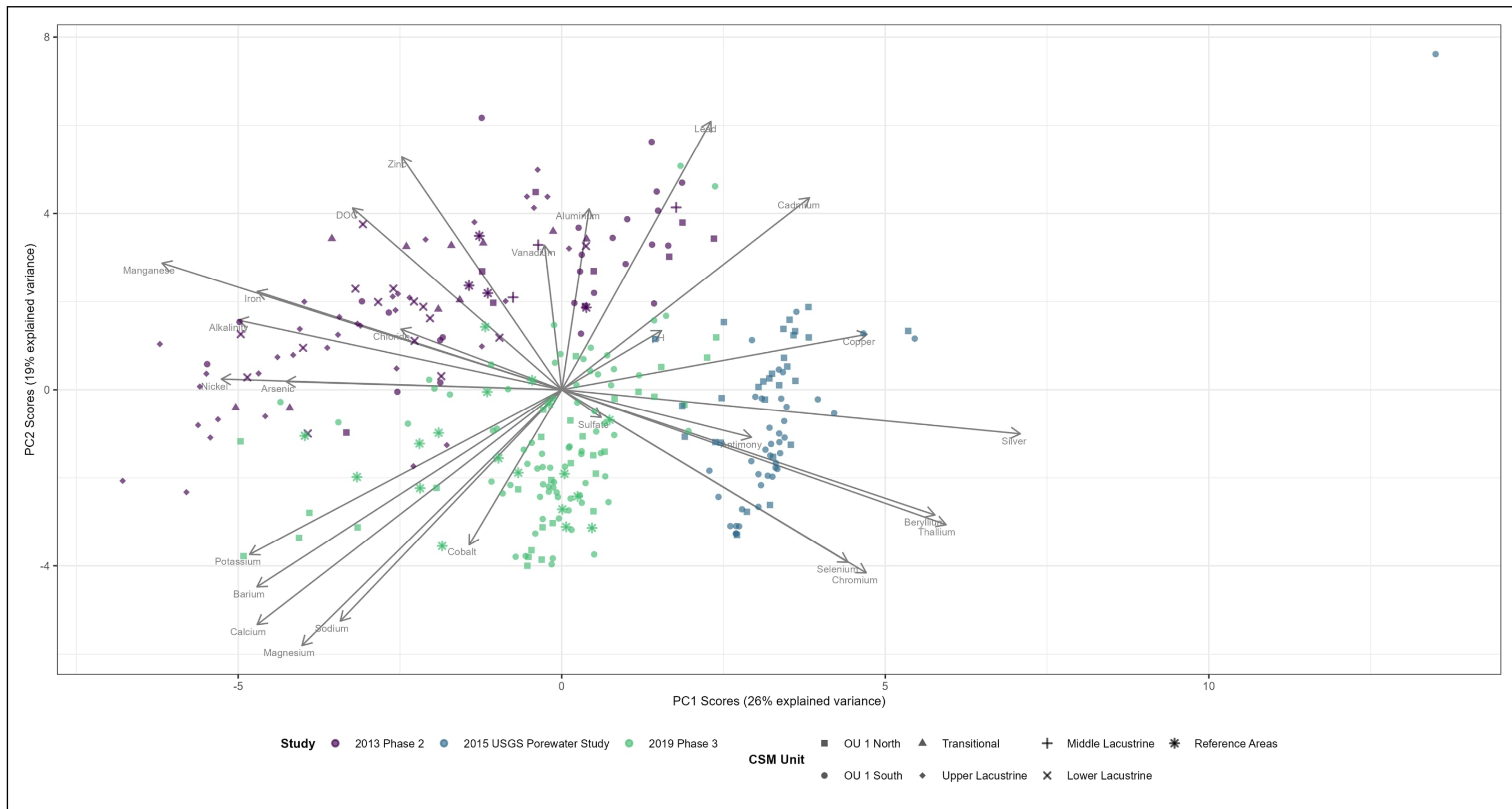


Figure A1-23. PCA Biplots for Relative Concentrations of Dissolved Metals in the Combined Field Porewater Data Set

TABLES

Table A1-1. Summary Statistics for Analytes in Porewater from Field Porewater Studies in the UCR

Analyte	Number of Results	Number of Detected Results (percent)	Minimum Detected Result	Maximum Detected Result	Minimum Nondetected Result	Maximum Nondetected Result
2013 Phase 2 Sediment Study						
<i>Non-metals</i>						
Alkalinity (µg/L)	89	89 (100%)	5.48e+04	3.84e+05	NA	NA
Chloride (µg/L)	92	3 (3%)	1.26e+04	3.01e+04	360	1.03e+04
DOC (µg/L)	94	24 (26%)	1.02e+04	5.74e+04	1.63e+03	9.36e+03
pH (SU)	92	92 (100%)	7.17	9.19	NA	NA
Sulfate (µg/L)	92	92 (100%)	390	1.04e+05	NA	NA
<i>Metals (µg/L)</i>						
Aluminum	101	45 (45%)	54.6	1.04e+03	2.10	51.9
Antimony	101	93 (92%)	0.140	29.8	0.0820	0.186
Arsenic	101	101 (100%)	0.510	80.4	NA	NA
Barium	101	101 (100%)	16.8	417	NA	NA
Beryllium	101	12 (12%)	0.00900	0.0700	0.00600	0.0300
Cadmium	101	71 (70%)	0.00700	1.21	0.00500	0.0490
Calcium	101	101 (100%)	1.70e+04	1.57e+05	NA	NA
Chromium	101	89 (88%)	0.110	1.74	0.0200	0.100
Cobalt	101	86 (85%)	0.136	3.25	0.0510	0.130
Copper	101	73 (72%)	0.750	126	0.100	0.690
Iron	101	100 (99%)	21.7	2.01e+04	26.7	26.7
Lead	101	93 (92%)	0.0660	101	0.00900	0.0570
Magnesium	101	101 (100%)	1.13e+03	3.74e+04	NA	NA
Manganese	101	98 (97%)	4.24	1.28e+04	2.27	3.45
Nickel	101	27 (27%)	2.60	14.3	0.650	3.56
Potassium	101	101 (100%)	655	5.43e+03	NA	NA
Selenium	101	30 (30%)	0.300	3.10	0.300	1.50
Silver	101	43 (43%)	0.00500	0.672	0.00400	0.0540
Sodium	101	101 (100%)	1.07e+03	1.25e+04	NA	NA
Thallium	101	19 (19%)	0.0300	0.172	0.00200	0.0540
Vanadium	101	90 (89%)	0.529	50.9	0.270	0.500
Zinc	101	1 (1%)	540	540	7.80	411

Table A1-1. Summary Statistics for Analytes in Porewater from Field Porewater Studies in the UCR

Analyte	Number of Results	Number of Detected Results (percent)	Minimum Detected Result	Maximum Detected Result	Minimum Nondetected Result	Maximum Nondetected Result
2015 USGS Porewater Study						
<i>Non-metals</i>						
Alkalinity (µg/L)	38	38 (100%)	4.63e+04	8.69e+04	NA	NA
Chloride (µg/L)	47	43 (91%)	300	4.10e+03	600	600
DOC (µg/L)	37	37 (100%)	40.0	2.20e+03	NA	NA
pH (SU)	38	38 (100%)	7.10	8.77	NA	NA
Sulfate (µg/L)	48	48 (100%)	5.60e+03	8.60e+04	NA	NA
<i>Metals (µg/L)</i>						
Aluminum	66	61 (92%)	3.00	61.0	30.0	30.0
Antimony	65	49 (75%)	0.400	21.0	0.300	3.00
Arsenic	66	12 (18%)	1.00	12.0	1.00	10.0
Barium	66	66 (100%)	22.8	185	NA	NA
Beryllium	66	2 (3%)	0.0800	0.400	0.0500	0.500
Cadmium	66	51 (77%)	0.0200	1.60	0.0200	0.200
Calcium	66	66 (100%)	1.60e+04	7.65e+04	NA	NA
Chromium	66	1 (2%)	3.00	3.00	1.00	10.0
Cobalt	66	1 (2%)	1.00	1.00	0.400	4.00
Copper	66	58 (88%)	0.500	16.0	0.500	5.00
Iron	66	11 (17%)	60.0	770	60.0	600
Lead	66	64 (97%)	0.0600	30.1	0.0500	0.0500
Magnesium	66	66 (100%)	3.31e+03	2.69e+04	NA	NA
Manganese	66	66 (100%)	0.300	495	NA	NA
Nickel	66	38 (58%)	0.400	2.00	0.400	4.00
Potassium	66	66 (100%)	570	4.46e+03	NA	NA
Selenium	66	0 (0%)	NA	NA	1.00	10.0
Silver	66	1 (2%)	5.00	5.00	1.00	10.0
Sodium	66	66 (100%)	1.10e+03	9.15e+03	NA	NA
Thallium	66	1 (2%)	2.30	2.30	0.100	1.00
Vanadium	66	11 (17%)	0.500	2.00	0.500	5.00
Zinc	66	62 (94%)	1.00	466	1.00	1.00

Table A1-1. Summary Statistics for Analytes in Porewater from Field Porewater Studies in the UCR

Analyte	Number of Results	Number of Detected Results (percent)	Minimum Detected Result	Maximum Detected Result	Minimum Nondetected Result	Maximum Nondetected Result
2019 Phase 3 Sediment Study						
<i>Non-metals</i>						
Alkalinity (µg/L)	122	122 (100%)	2.90e+04	2.63e+05	NA	NA
Chloride (µg/L)	122	122 (100%)	160	5.40e+03	NA	NA
DOC (µg/L)	122	120 (98%)	170	9.11e+03	70.0	70.0
pH (SU)	122	122 (100%)	6.38	10.2	NA	NA
Sulfate (µg/L)	122	122 (100%)	1.22e+03	7.73e+04	NA	NA
<i>Metals (µg/L)</i>						
Aluminum	122	46 (38%)	10.1	291	1.50	27.9
Antimony	122	93 (76%)	0.311	90.2	0.0760	1.16
Arsenic	122	122 (100%)	0.170	54.4	NA	NA
Barium	122	122 (100%)	15.3	359	NA	NA
Beryllium	122	1 (1%)	0.00800	0.00800	0.00500	0.0190
Cadmium	122	80 (66%)	0.00800	0.764	0.00800	0.0390
Calcium	122	122 (100%)	9.87e+03	9.79e+04	NA	NA
Chromium	122	1 (1%)	0.740	0.740	0.0800	2.43
Cobalt	122	122 (100%)	0.0590	2.45	NA	NA
Copper	122	78 (64%)	0.880	95.0	0.0800	1.56
Iron	122	84 (69%)	9.00	9.72e+03	8.00	100
Lead	122	57 (47%)	0.165	100	0.0110	0.433
Magnesium	122	122 (100%)	478	2.05e+04	NA	NA
Manganese	122	107 (88%)	0.600	2.36e+03	0.270	2.74
Nickel	122	56 (46%)	0.420	4.49	0.200	1.50
Potassium	122	122 (100%)	460	9.12e+03	NA	NA
Selenium	122	23 (19%)	0.200	1.30	0.200	0.200
Silver	122	35 (29%)	0.00900	1.01	0.00900	0.0360
Sodium	122	120 (98%)	1.60e+03	9.81e+03	940	1.13e+03
Thallium	122	46 (38%)	0.00900	0.171	0.00900	0.0360
Vanadium	122	108 (89%)	0.0600	3.42	0.0400	0.250
Zinc	122	38 (31%)	2.90	162	0.800	7.50

Notes:

DOC - dissolved organic carbon

NA - not applicable

SU - standard units

USGS - United States Geological Survey

ATTACHMENT A2

GRAIN SIZE DATA AND CS50 DESIGNATIONS

CONTENTS

LIST OF FIGURES	III
ACRONYMS AND ABBREVIATIONS.....	IV
UNITS OF MEASURE.....	V
1 INTRODUCTION	1
2 GRAIN SIZE DATA.....	2
3 CS50 DESIGNATIONS.....	3
4 REFERENCES.....	4

LIST OF FIGURES

Figure A2-1 Grain Size Categories and the Associated Size Cutoffs for Each of These Studies

ACRONYMS AND ABBREVIATIONS

BERA	baseline ecological risk assessment
EPA	U.S. Environmental Protection Agency
CS	coarse sand
CS50	medium, coarse, and very coarse sand > 50 percent of substrate
LOE	line of evidence
NR	not reported
RI/FS	Remedial Investigation and Feasibility Study
UCR	Upper Columbia River
USGS	U.S. Geological Survey

UNITS OF MEASURE

μm micrometer

mm millimeter

1 INTRODUCTION

This attachment describes how sediment grain size data for the Aquatic Baseline Ecological Risk Assessment (BERA) (hereafter, Aquatic BERA) data set were adjusted to help improve comparability and to support the analysis of certain lines of evidence (LOEs) in the Aquatic BERA.

2 GRAIN SIZE DATA

The specific grain size fractions reported and the grain size cutoffs for fractions are not consistent across every study included in the Aquatic BERA data set. These studies were conducted over many years and by different investigators, and various analytical methods and laboratories were used for grain size analyses. The studies that analyzed for grain size are as follows:

- 2013 Phase 2 Sediment Study (TAI 2017)
- 2019 Phase 3 Sediment Study (TAI 2022)
- 2009–2011 Beach Sediment Study (TAI 2014)
- 2010 White Sturgeon Sediment Toxicity Study (TAI 2018)
- 2015 Bossburg Flat Beach Sediment and Soil Study (TAI 2016)
- 2013 U.S. Geological Survey Toxicity Evaluation (USGS 2016)
- 2005 Phase 1 Sediment Sampling (USEPA 2006)

The grain size categories and associated size cutoffs for each of these studies are illustrated in Figure A2-1.

Because individual grain size fractions for each size category for a given sample did not always add up to 100 percent, a normalization was conducted for each sample. To normalize, grain size percentage for each individual size category was divided by the sum of percentages for that sample in the data set and then multiplied by 100. For samples with field duplicates, normalization to 100 percent was conducted for each duplicate separately, and then values were averaged between the two duplicates. Split samples were removed prior to normalization.

In the Upper Columbia River (UCR) remedial investigation and feasibility study project database, grain size fractions were expressed as both individual size categories, as detailed by study in Figure A2-1, and aggregated categories that included two or more individual size categories (e.g., “< 200 total,” which is the sum of particles that would pass through a #200 sieve [silt, clay, and colloids], or “sand,” which is the sum of fine, medium, and coarse sand fractions). Additionally, some studies reported sub-categories of individual grain size fractions (e.g., fine silt and coarse silt that together make up the silt category). The aggregated category data and sub-category data as reported in the UCR database were not used in the Aquatic BERA. Rather, individual size categories listed in Figure A2-1 were used, specifically to calculate CS50 (as discussed in Section 3) and total fines (i.e., sum of silt and clay) (used in Attachment H3 of Appendix H to the Aquatic BERA).

3 CS50 DESIGNATIONS

The analyses for several LOEs in the Aquatic BERA include the identification of those samples most likely to contain slag. As described in Volume 1, Section 2.5.1.1 of the Aquatic BERA, granular slag released from the Trail Facility is similar in size to sand; therefore, this slag is expected to move and be deposited in the river in a fashion similar to that of sand. The results of analyses conducted by the U.S. Environmental Protection Agency using data from the 2019 Phase 3 Sediment Study¹ suggest that samples containing more than 50 percent medium sand, coarse sand, and very coarse sand are likely to contain more than 10 percent slag (USEPA 2022). Samples containing more than 50 percent medium sand, coarse sand, and very coarse sand are included in what is referred to as the CS50 (medium, coarse, and very coarse sand > 50 percent of substrate) data set for purposes of LOE analyses in the Aquatic BERA.

To assign CS50 status, first the sum of very coarse sand, coarse sand, and medium sand was calculated, as highlighted in green in Figure A2-1 for six of the studies that analyzed for grain size. For the 2005 Phase 1 Sediment Sampling (USEPA 2006), a different grain size classification system was used, so the sum of medium sand and fine sand was used to best align with the system used for the other studies. The CS50 designation was noted as true if the sum of coarse sand was greater than 50 percent and false if the sum of coarse sand was less than 50 percent.

¹ The data summary report for the 2019 Phase 3 Sediment Study (TAI 2022) provides normalized grain size values based on laboratory-reported results and grain size values adjusted for the removal of coarse sediment during field sampling. Coarse sand calculations as described in this attachment use values based on laboratory-reported values and do not consider adjustment for coarse material removed in the field.

4 REFERENCES

- TAI (Teck American Incorporated). 2014. Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report. Prepared by Integral Consulting Inc.
- TAI. 2016. Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report. Prepared for TAI by Windward Environmental LLC, Seattle, WA.
- TAI. 2017. Upper Columbia River Final Phase 2 Sediment Study Data Summary and Data Gap Report. Prepared by Windward Environmental LLC, Exponent, Parametrix, Inc., and HDR, Inc Seattle, WA.
- TAI. 2018. Upper Columbia River Final Assessment of Sediment Toxicity to White Sturgeon Data Summary Report. Saskatoon, SK: Prepared by Cardno Entrix and HDR|HydroQual.
- TAI. 2022. Upper Columbia River Final 2019 Phase 3 Sediment Study Data Summary Report. Prepared for Teck American Incorporated by ERM, Windward Environmental LLC, HDR, Exponent, and Parametrix.
- USEPA (U.S. Environmental Protection Agency). 2006. Phase 1 Sediment Sampling Data Evaluation, Upper Columbia River Site, CERCLA RI/FS. Prepared for the U.S. Environmental Protection Agency by Ecology and Environment Inc. and CH2M HILL, Seattle, WA.
- USEPA. 2022. Personal communication (email to D. Mills, Teck American Incorporated, from B. Arthur, U.S. Environmental Protection Agency, dated March 4, 2022, regarding EPA Draft Comments on the Phase 3 Tech Memo). U.S. Environmental Protection Agency, Seattle, WA.
- USGS (U.S. Geological Survey). 2016. Toxicity Evaluation of Metal-Contaminated Sediments from the Upper Columbia River, Washington, to the Amphipod, *Hyaletella azteca*, the Midge, *Chironomus dilutus*, and the Mussel, *Lampsilis siliquoidea*. Ingersoll, J.M. Besser, W.G. Brumbaugh, J.L. Kunz, S.E. Cox, L.S. Balistreri, C.A. Mebane, D.D. MacDonald, J.A. Sinclair, and A. Schein. U.S. Geological Survey.

FIGURES

Grain Size Fraction per Laboratory Report and UCR RI/FS Database	Study						
	2013 Phase 2 Sediment Study	2019 Phase 3 Sediment Study	2009–2011 Beach Sediment Study	2010 White Sturgeon Sediment Toxicity Study	2015 Bossburg Flat Beach Sediment and Soil Study	2013 USGS Toxicity Evaluation	2005 Phase 1 Sediment Sampling
Cobbles	NR	NR	> 64 mm		NR	NR	NR
Very Coarse Gravel	NR	NR	32–64 mm		NR	NR	NR
Coarse Gravel	NR	NR	19–32 mm		NR	NR	NR
Gravel	NR	NR	NR	NR	> 2 mm	NR	≥ 4.76 mm
Medium Gravel	≥ 4.75 mm		9.5–19 mm		NR	NR	NR
Fine Gravel	2–4.75 mm		4–9.5 mm		NR	NR	NR
Very Fine Gravel	NR	NR	2–4 mm		NR	NR	NR
Very Coarse Sand	0.85–2 mm		1–2 mm				NR
Coarse Sand	425–850 µm		0.5–1 mm				2–4.76 mm
Medium Sand	250–425 µm		250–500 µm				0.42–2 mm
Fine Sand	106–250 µm		125–250 µm				74–420 µm
Very Fine Sand	75–106 µm		62.5–125 µm				NR
Silt	3.9–74 µm		3.9–62.5 µm				5–74 µm
Clay	< 3.9 µm		< 3.9 µm				1–5 µm
Colloids	NR	NR	NR	NR	NR	NR	< 1 µm

Key:

NR The grain size fraction was not reported for sediment samples analyzed in the study.

Green Green highlighting indicates grain size categories that are combined for the study to derive the coarse sand (CS) composition. The CS substrate was identified by EPA based on an analysis of the 2019 Phase 3 Sediment Study data, where CS is calculated as the sum of Medium Sand, Coarse Sand, and Very Coarse Sand as reported by the analytical laboratory.

Figure A2-1. Grain Size Categories and the Associated Size Cutoffs for Each of These Studies