UPPER COLUMBIA RIVER

FINAL
Phase 2 Sediment Study Data Summary and Data Gap Report

Prepared for

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ACRONYMS AND ABBREVIATIONS

%D	percent difference
ACG	analytical concentration goal
AFDW	ash-free dry weight
ALS	ALS Environmental
ASTM	American Society for Testing and Materials
AVS	acid volatile sulfide
BERA	baseline ecological risk assessment
BLM	Biotic Ligand Model
BSEM	backscattered scanning electron microscopy
CCT	Confederated Tribes of the Colville Reservation
COC	chain-of-custody
CSM	conceptual site model
CTL-ERDC	ERDC auxiliary control sediment
CTL-QS	quartz sand auxiliary control
CTL-SS	PER negative control sediment
DGPS	differential global positioning system
DL	detection limit
DO	dissolved oxygen
DOC	dissolved organic carbon
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDS	energy-dispersive X-ray spectroscopy
ESI	Environmental Standards, Inc.
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
FSP	field sampling plan
GAS	general activity schedule(s)
GPS	global positioning system
HHRA	human health risk assessment
ICP	inductively coupled plasma
ID	identification

LC50	concentration that is lethal to 50 percent of an exposed population
LCS	laboratory control sample(s)
LCSD	laboratory control sample duplicate
MDL	method detection limit
mPECq	mean probable effects concentration quotient
MQO	measurement quality objective
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
NPS	National Park Service
OC	organic carbon
PARCC	precision, accuracy or bias, representativeness, completeness and comparability
PER	Pacific EcoRisk
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RL	reporting limit
RM	river mile
R/O	reproduction/oviposition
RPD	relative percent difference
SEM	simultaneously extracted metals
SOP	standard operating procedure
TAI	Teck American Incorporated
TAL	target analyte list
TIE	toxicity identification evaluation
TOC	total organic carbon
UCR	Upper Columbia River
URS	URS Corporation
USACE	U.S. Army Corps of Engineers
YCT	yeast-Cerophyl®-trout chow
Zn/V	zinc to vanadium

UNITS OF MEASURE

AFDW	ash free dry weight
°C	degrees Celsius
cm	centimeter(s)
ft	foot/feet
g	gram(s)
gal	gallon(s)
in.	inch(es)
mg	milligram(s)
mg/individual	milligram(s) per individual organisms
mg AFDW/individual	milligram(s) of ash free dry weight per individual organism
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mL	milliliter(s)
mm	millimeter(s)
µg/L	microgram(s) per liter
µm	micrometer(s)
µmol/g	micromole(s) per gram

1 INTRODUCTION

This report presents the results of the Phase 2 sediment study (herein the 'study') for the Upper Columbia River (UCR) Site, (herein the 'Site'). The Site extends from the U.S.-Canada border (River Mile [RM] 745) to Grand Coulee Dam (RM 596). Analyses were conducted under the U.S. Environmental Protection Agency (EPA)-approved quality assurance project plan (QAPP) for the study (Exponent et al. 2013). The study was conducted as part of the remedial investigation and feasibility study (RI/FS) for the Site in support of the baseline ecological risk assessment (BERA) (to be completed by Teck American Incorporated [TAI]) and the baseline human health risk assessment (HHRA) (to be completed by EPA).

1.1 PURPOSE AND DATA QUALITY OBJECTIVES

TAI collected information on concentrations of metals in sediment and porewater and conducted sediment bioassays to evaluate toxicity to benthic invertebrates. At EPA's direction, the list of sediment and porewater chemicals was limited to target analyte list (TAL) metals[1] (Exponent et al. 2013). Sediment and porewater samples were collected at the Site between September 5 and October 24, 2013. Bioassays using field sediment were performed between January 22 and February 28, 2014 and February 13 and May 8, 2015. All bioassays were performed by Pacific EcoRisk (PER) at its Fairfield, California, laboratory. Chemical analyses were conducted by TAI's contract analytical laboratory, ALS Environmental (ALS), in Kelso, Washington. Backscattered scanning electron microscopy (BSEM) was performed by the RJ Lee Group in Monroeville, Pennsylvania.

The preliminary ecological conceptual site model (CSM) for the UCR RI/FS presented in the expanded problem formulation plan (Exponent and HDR|HydroQual 2012) identified sediment and porewater as potential exposure media for benthic invertebrates. The datasets from historical studies that evaluated sediment chemistry, porewater chemistry, and sediment toxicity (including the Phase 1 sediment study conducted by EPA) have been deemed insufficient to evaluate ecological risk because they did not adequately account for bioavailability (Exponent et al. 2013). Therefore, the Phase 2 sediment study was conducted to collect the data needed to evaluate metal bioavailability and whole sediment toxicity to benthic invertebrates.

[1] TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

The following primary questions developed to meet the goals of this study were presented in the QAPP (Exponent et al. 2013):

- Are TAL metals in sediment bioavailable at concentrations that result in potentially unacceptable risks to benthic invertebrates?
- Are there significant differences in survival, growth, or reproduction of benthic invertebrates (i.e., amphipods and midges) exposed to Site and reference sediments? If significant differences do occur.
    - What are the magnitudes of these differences?
    - Are these differences in survival, growth, or reproduction of benthic invertebrates due to TAL metals measured in sediments and/or porewater?
    - What concentration-response relationships (with concentrations adjusted based on bioavailability measurements) can be established between measured TAL metals concentrations and observed effects?

Data from this study will also be used to inform other components of the ecological risk assessment (e.g., evaluation of risk to aquatic plants, sediment-probing birds, and other receptors).

1.2 REPORT ORGANIZATION

This report is organized into the following sections:

- **Section 1 – Introduction.** This section discusses the purpose and data quality objectives and details the report organization.
- **Section 2 – Study Design and Methods.** This section provides an overview of the study, including sampling locations, chemical analyses, and bioassays.
- **Section 3 – Quality Assurance Project Plan Deviations and Modifications.** This section discusses deviations from and modifications to the QAPP.
- **Section 4 – Chemistry Data Validation and Bioassay Acceptability.** This section provides a summary of the validation assessment results for the sediment and porewater chemical analyses and a summary of the test acceptability results for the bioassays.
- **Section 5 – Summary of Data.** This section presents a summary of the analytical and bioassay results.
- **Section 6 – Assessment of Data Gaps.** This section summarizes any remaining data gaps following the completion of the Phase 2 sediment study.
- **Section 7 – Summary.** This section summarizes the results of the study.
- **Section 8 – References.** This section presents bibliographic information for the documents cited within this report.

Data tables and figures are provided after Section 8. Appendices, including the raw data, are provided in electronic format (see enclosed disk). Data may also be obtained directly from the project database, accessible at http://teck-ucr.exponent.com.

2 STUDY DESIGN AND METHODS

This section presents a summary of the study design and methods (including field collection methods and laboratory methods). Additional details on study design and methods are presented in the QAPP (Exponent et al. 2013).

2.1 STUDY DESIGN

The Phase 2 sediment study was designed using EPA's seven-step data quality objective (DQO) process (USEPA 2006). The overall goal was to characterize the risks to benthic invertebrates (if any) posed by exposure to TAL metals; the data gathered from this study will also be used in the BERA to characterize risks to other receptors exposed to sediment and porewater through the consumption of sediment and/or prey. The study characterized sediment and porewater chemistry, evaluated factors influencing the bioavailability of TAL metals in UCR sediment and porewater, and provided chemistry and bioassay data for establishing concentration-response relationships. The following types and sources of information were identified in the QAPP (Exponent et al. 2013) as necessary to meet the goals of the study:

- Analytical data for TAL metals, acid volatile sulfide (AVS), simultaneously extracted metals (SEM), pH, grain size, and total organic carbon (TOC) in samples collected from the top 4 to 6 in. (15 cm) of sediment from locations throughout the UCR, representing a range of exposure gradients.
- Analytical data for TAL metals in porewater collected in the field from the sediment grab samples and water quality parameters needed to assess metal bioavailability using Biotic Ligand Models (BLMs) (i.e., dissolved organic carbon [DOC], TOC, pH, alkalinity, chloride, and sulfate).
- Bulk sediment bioassays conducted on a subset of the sediment samples using the short-term chronic 10-day midge (*Chironomus dilutus*) and 28-day amphipod (*Hyalella azteca*) tests with survival and growth endpoints[2] (hereinafter "short-term bioassays").
- Bulk sediment bioassays conducted on a subset of the samples collected for bioassays using the chronic 50-to-65-day midge (*C. dilutus)* life-cycle test (endpoints of survival, weight, biomass, emergence, reproduction) and the chronic 42-day amphipod (*H. azteca*) test (endpoints of survival, weight, biomass, and reproduction) (hereinafter "long-term bioassays").

[2] The growth endpoints are weight and biomass. These endpoints differ only in whether total weight of surviving organisms is divided by number of surviving organisms (weight) or by the total number of organisms introduced at the start of the test (biomass).

- Analytical data for SEM metals and organic carbon (OC) on sediment collected during the bioassays (i.e., bioassay sediment) to evaluate the bioavailability of metals to test organisms.
- Analytical data on porewater collected during the bioassays (i.e., bioassay porewater) for dissolved metals and BLM water quality parameters to evaluate the bioavailability of metals to test organisms.

  BSEM analysis on a subset of field sediment samples as a measure of slag content in sediment.

To meet the data needs described above, the following sampling and analysis process was used (Figure 2-1):

- Porewater was extracted from bulk sediment in the field; both bulk sediment and extracted porewater samples were sent directly to the analytical laboratory for chemical analysis.
- Sample aliquots for bioassays were taken from a subset of the bulk sediment samples. Both the short-term 10-day *C. dilutus* and 28-day *H. azteca* tests were conducted on subsamples from all of these aliquots. The long-term 50-to-65-day *C. dilutus* life-cycle and 42-day *H. azteca* tests were conducted on subsamples from a subset of these aliquots.
- Sediment samples were archived and a subset of these samples was analyzed for slag content using BSEM.

The following subsections present additional information on sampling locations, sediment and porewater chemistry analyses, bioassays (including the selection of long-term bioassay locations), and BSEM sample selection.

2.1.1 Sampling Locations

Sampling locations were selected to cover a gradient of exposure concentrations, as described in detail in the QAPP (Appendix F in Exponent et al. 2013). One hundred and forty sediment sampling locations were targeted, including 124 Site locations (10 of which were identified prior to sampling as potential internal reference locations) and 16 external locations for use as potential reference locations (6 in tributaries and 10 in the Columbia River upstream of the Site). The sampling design included the identification of reserve locations to be used when samples could not be collected from targeted locations, and which would be selected in consultation with EPA oversight in the field (see Table 2-1 of the field activity report, which is Appendix A of this report, for a list of targeted and reserve locations). In some cases, neither the targeted nor the reserve locations could be sampled for reasons discussed in detail in Section 3.1. As a result, the final number of sampling locations was 136 (120 Site locations, 6 tributary locations, and 10 upstream locations), 4 locations fewer than the initial 140 targeted locations. The sampling locations are listed in Table 2-1 of this report and are shown on Maps 2-1a to 2-1f and Map 2-2 of this report. All grab sampling attempts, both accepted and rejected, are presented in Table 2-2 and shown on Maps 2-3a to 2-3f and Map 2-4.

The sampling design called for sediment and porewater chemical analyses for all sampling locations. However, porewater could not be collected at 35 of the 136 locations because the sediment was either too sandy (allowing porewater to drain from the sediment before it could be sampled) or too fine-grained (resulting in unsuccessful attempts to draw the porewater through airstones). Table 2-3 identifies the locations where porewater samples were collected.

Short-term bioassays were conducted using sediment samples collected at 69 of the targeted 74 locations (Exponent et al. 2013). Of these locations, 53 were from the Site (including 9 potential reference locations), 6 were from tributaries, and 10 were from the Columbia River upstream of the Site (Table 2-3; Maps 2-1a to 2-1f and Map 2-2).

Long-term bioassays were conducted using sediment samples collected at 27 of the 69 short-term bioassay locations. Although the QAPP outlined that long-term bioassays would be conducted using sediment samples collected at 18 of the short-term bioassay locations, based on an agreement between EPA and TAI, 27 samples were selected for long-term tests (Table 2-3). The discussion between EPA and TAI and final agreement on the samples selected for long-term testing is provided in Appendix B. Sediment samples that underwent long-term toxicity bioassays were originally collected at 20 Site locations (1 of which was identified as a potential reference location), 1 tributary location, and 6 locations in the Columbia River upstream of the Site.

2.1.2 Sediment and Porewater Chemistry

Chemical analyses were conducted on both field and bioassay sediment and porewater samples. Sediment samples were analyzed as follows (Table 2-4; Figure 2-1):

- Field sediment—TAL metals, AVS, SEM, TOC, pH, and grain size
- Bioassay sediment (start of test; for the long-term tests only)—TAL metals, AVS, SEM, TOC, pH, and grain size
- Bioassay sediment (during both tests; Figures 2-2 and 2-3)—AVS, SEM, and TOC.

Porewater samples were analyzed as follows (Table 2-4; Figure 2-1)[3]:

- Field porewater (airstone/suction method)—dissolved TAL metals (except mercury), TOC, DOC, pH, alkalinity, hardness, chloride, and sulfate
- Bioassay porewater (centrifuge method at the start of the test)—DOC, pH, alkalinity, hardness, chloride, sulfate, calcium, magnesium, and sulfide
- Bioassay porewater sampling devices (semi-permeable dialysis membranes [peepers]) deployed at the start of the test and retrieved at various times during the test; Figures 2-2 and 2-3)—dissolved TAL metals (except mercury).

2.1.3 Bioassays

The following short-term bioassays were conducted on 69 samples:

- 10-day *C. dilutus* bioassay (endpoints of survival, weight, and biomass)
- 28-day *H. azteca* bioassay (endpoints of survival, weight, and biomass).

Prior to the initiation of the tests, porewater was extracted from sediment via centrifuge and submitted to the analytical laboratory for analysis (Figure 2-2). During the bioassays, two sets of chambers containing test organisms were used, one for measurement of biological endpoints and the other for measurement of chemical parameters in porewater and sediment (Figures 2-1 and 2-2). Porewater was collected from the chemistry test chambers using peepers at the same time the sediment was removed.

Sediment samples from a subset of the bioassay locations were selected in consultation with EPA to undergo long-term toxicity bioassays. The selection of samples for long-term testing was based on short-term bioassay and sediment and porewater chemistry results. The decision process for selecting long-term bioassay samples is provided in Appendix B.

Long-term bioassays were conducted using the following tests:

- 50-to-65-day *C. dilutus* life-cycle bioassay (endpoints of survival, weight, biomass, emergence, and reproduction)
- 42-day *H. azteca* bioassay (endpoints of survival, weight, biomass, and reproduction).

Sediment and porewater samples were collected on the test day shown on Figure 2-3 using the same methods as those used for the short-term bioassays. In addition, bulk sediment was sub-sampled at test initiation and analyzed for TAL metals, AVS, SEM, TOC, pH, and

[3] Porewater could not be obtained for the following samples at the start of the bioassays because the bioassay laboratory noted that the samples were too sandy to obtain porewater: SE-4-B1, SE-B5, and SE-G-1 at the start of the short-term bioassay, and SE-4-B1, SE-4-B5, and SE-Trib-3 at the start of the long-term bioassay.

grain size; this step was not conducted as part of the short-term bioassays.

The QAPP (Exponent et al. 2013) stated that if equivocal or unexplained biological responses were identified in the sediment toxicity tests, toxicity identification evaluations (TIEs) might be conducted to discern the class of chemicals responsible for the observed effects or to determine whether the responses could be attributed to nonchemical stressors. An additional option was to measure, at EPA's discretion, metal residues in *H. azteca* used in the TIEs. This option was to be considered a secondary line of evidence.[4] TAI met with EPA on August 11, 2015, to discuss preliminary evaluations of the sediment toxicity test data, and EPA determined that TIE testing was not necessary to complete the Phase 2 sediment study, although EPA and TAI reserved the right to reconsider TIEs at a later date, if warranted, in order to complete the RI/FS process for the Site.

2.1.4 Backscattered Scanning Electron Microscopy

To determine the amount of slag present in sediment, a subset of 42 sediment samples (41 Site locations and 1 upstream location) were selected for BSEM analysis (Table 2-3; Maps 2-1a to 2-1f and Map 2-2). These samples were selected based on an initial evaluation by TAI in which 38 samples were proposed for analysis (letter from TAI to EPA dated February 25, 2014 [Teck 2014b], and a follow-up e-mail dated March 11, 2014 [Teck 2014a], both of which are included in Appendix C). The initial selection of samples for BSEM analysis involved a review of the zinc to vanadium (Zn/V) ratio[5] and mean probable effects concentration quotient (mPECq), as well as field observations of silica glass in sediment. EPA reviewed TAI's recommendations and requested the addition of four samples for analysis, for a total of 42 samples (memorandum from EPA to TAI dated June 4, 2014 [USEPA 2014], which is included in Appendix C). The final selection of samples for BSEM analysis was presented in a letter from TAI to EPA dated August 15, 2014 (Teck 2014c) (see Appendix C).

2.2 FIELD SAMPLING METHODS

This section summarizes the collection and field processing methods for sediment samples, which were carried out in accordance with the QAPP (Exponent et al. 2013) and the field sampling plan (FSP) (Appendix A of the QAPP). Field sampling was conducted by URS Corporation (URS) between September 5 and October 24, 2013. Samples were collected from 136 sampling locations in three areas 1) the Site, 2) tributaries to the Site,

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[4] At a meeting on August 11, 2015, EPA and TAI agreed that this data summary report would not include a discussion of TIEs.

[5] Granulated slag from the Trail facility is rich in zinc, lead, iron, and copper, but not in vanadium, aluminum, or nickel (Appendix D in Parametrix et al. 2011). The Zn/V ratio was identified as the most representative metric for the presence of slag in sediment based on an evaluation of Phase 1 data (Appendix D in Parametrix et al. 2011).

and 3) upstream of the Site. Sampling activities were conducted under the direct oversight of EPA or its authorized representatives. As specified in the cultural resources coordination plan (Appendix C of the QAPP), a cultural monitor verified that cultural resources were not present in each sediment grab sample before sample processing. Field sampling deviations to the QAPP occurred in some cases due to safety or sampling concerns; these deviations are detailed in the field activity report (URS 2014), which is included as Appendix A to this report, and summarized in Section 3.1. The sampling locations, sample collection methods, and field documentation are also discussed in detail in the field activity report.

2.2.1 On-water Sample Collection

On-water sampling locations (i.e., all locations except tributaries) were accessed by boat and located using a differential global positioning system (DGPS) and associated navigation software according to methods presented in detail in standard operating procedure (SOP) 1 of the FSP (Exponent et al. 2013). Typically, a modified Van Veen power grab sampler was used to collect samples using the methods described in detail in Section 2.2.4 of the FSP (Exponent et al. 2013). However, mechanically activated grab samplers were used for sampling at extreme water depths (i.e., greater than a depth of approximately 260 feet) where pressures could damage the pneumatic grab samplers.

After each grab sample was collected, the pH was measured, and the sample was evaluated for the sampling acceptability criteria detailed in SOP 3 of the FSP (Exponent et al. 2013). If the collected sediment sample met acceptability criteria, overlying water was siphoned from the top of the sample, and porewater was extracted from the grab sampler into a syringe using an airstone.[6] 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. After the extraction of porewater, the top 6 in. of sediment was transferred from the sampler to a Lexan™ tub. Sediment in the Lexan™ tub was then inspected for cultural resources. For locations with sandy sediment, porewater quickly drained from the grab sampler before a sample could be collected. At these locations (identified in Table 2-2 of Appendix A, the Field Activity Report), the top 6 in. of sediment from the sampler was first transferred to a Lexan™ tub and then the porewater was extracted. This modified porewater sampling method was a deviation from the QAPP, as discussed in Section 3.1 of this report. Potential impacts of

[6] Two types of airstones were used: 1) ceramic airstones, as proposed in SOP-3 of the QAPP, 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. Table 2-2 in the field activity report (Appendix A) shows which types of airstones were used for each sample. Table 2-2 also notes which types of airstones were used for the collection of data for the dissolved metals analysis, if this information was available.

this QAPP deviation on use of the data in evaluating risk to benthic invertebrates will be discussed as part of the risk assessment.

At two locations (1B-C1 and 1B-R2), very shallow water necessitated the use of a Petite Ponar® grab sampler to collect samples. Using this method, the sample was first transferred to the Lexan™ tub, and any overlying water was then removed using a plastic scoop. Therefore, it is possible that overlying surface water may have been mixed with porewater during transfer of the sample to the Lexan™ tub.

If samples did not meet the acceptability criteria, they were labeled "rejected" and temporarily placed in a decontaminated Lexan™ tub for potential chemical analysis in case no acceptable sample could be collected. Sampling steps were repeated until an acceptable sample could be collected, in which case the rejected sample was no longer retained for chemical analysis. At eight locations (2B-4, 2B-R2, 3B-1, 3B-2, 3-B4, 3-R6, 3-R8, and 3-R10), all grabs were rejected, but the sample was retained and analyzed to obtain some evaluation of the area, in accordance with the QAPP and SOP 3 of the FSP (Exponent et al. 2013).

If the sediment acceptability criteria were met (or it was determined that the rejected sample would be analyzed, as discussed above), the sediment was homogenized, and if a large proportion of the material had a grain size >2 mm, the sample was sieved through 5-mm mesh before being transferred to containers for laboratory analysis. If sediment volume was not sufficient for sampling, additional grabs were collected.

Up to nine attempts were made to collect acceptable sediment grabs from a circular area with a 150-ft radius centered on the sampling location. If a representative sample could not be collected after nine attempts, the field team leader consulted with EPA oversight personnel to determine whether additional grabs should be abandoned and the sampling crew move to a designated reserve location as identified in Table A1 of the FSP (Exponent et al. 2013). In most cases, the reason for the inability to collect an acceptable sample was grab sampler refusal, in which case the presence of rocks, cobble, and/or gravel resulted in a very low sediment penetration depth or no sample recovery. Other reasons for sample rejection included winnowing of sample, no overlying water, lack of desired penetration, and/or interference from vegetation or woody debris. Maps 2-3a to 2-3f and Map 2-4 show results from the grab attempts in the following categories:

1) Accepted locations where sample acceptability criteria were met

2) Locations rejected due to refusal (including the eight grab locations where samples were analyzed

3) Locations rejected for reasons other than refusal.

Table 2-2 lists the number of grab samples collected at each location and indicates whether the grabs were accepted, rejected, refused, and/or analyzed.

2.2.2 Tributary Sample Collection

Tributary sampling locations were located with maps and a handheld global positioning system (GPS) unit. A visual assessment was made to determine if the site was suitable for the collection of fine-grained sediment (i.e., ≤ 2 mm). If conditions were not suitable, the sampling location was moved to a designated reserve location in consultation with the onsite EPA representative. Tributary sediment was collected using a manual Petite Ponar grab sampler and/or stainless steel shovel and sieved through 5-mm mesh into a Lexan™ tub for cultural resources inspection. Following cultural resources inspection, the overlying water present in the tub was removed by scooping it out using handheld plastic scoops, after which sediment pH was measured. At four of the tributary locations (Trib-2, Trib-4, Trib-5, and Trib-6), porewater was collected via suction through airstones with a syringe or peristaltic pump; at the remaining two tributary locations (Trib-1 and Trib-3), porewater was collected *in situ* from the stream sediments. Because there was no feasible way to separate any potential overlying water from interstitial water at the four locations where porewater was collected from sediment in the Lexan™ tub, it is possible that overlying surface water may have been mixed with porewater during transfer of the sample to the tub. After porewater collection, the sediment was homogenized and transferred into containers for laboratory analysis.

2.2.3 Field Quality Control Samples

Field quality control (QC) samples included sediment field duplicates, sediment splits,[7] sediment equipment rinsate blanks, and a porewater equipment rinsate blank.[8] In accordance with the QAPP (Exponent et al. 2013), field duplicates were collected at 14 locations (a minimum of 10 percent of the planned sampling locations) to assess the variability associated with sample processing.

EPA chemistry splits were prepared by URS in TAI's contract analytical laboratory according to SOP 10 of the FSP (Exponent et al. 2013), which was developed by TAI and approved by EPA as Change Request 4 (Appendix D). EPA splits were provided to EPA for chemical analysis as part of its quality assurance (QA)/QC program. EPA bioassay splits were collected in the field and shipped to TAI's contract analytical laboratory, where custody was transferred to EPA, and the samples were sent to EPA's contract bioassay laboratory. Split samples for all bioassay sampling locations within the jurisdiction of the Lake Roosevelt National Recreation Area and on lands managed by the Confederated

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7 Sediment splits were collected at a subset of sampling locations for EPA, NPS, and CCT (Table 2-1).

8 According to the QAPP, field QC would also include the use of trip blanks. Trip blanks are used to assess the contamination of volatile compounds during sample transport; however, because volatile compounds were not being assessed in this study, trip blanks were deemed unnecessary and therefore not included.

Tribes of the Colville Reservation (CCT) were collected and provided to the National Park Service (NPS) and CCT in the field.

Equipment blanks were collected to assess possible contamination from the sampling process. Sediment rinsate blanks were generated at a rate of one per piece of sampling equipment, per field crew, per sampling day for a total of 240 rinsate blanks. One field blank was collected for the porewater sampling equipment (i.e., the ceramic airstone/tubing/filter/syringe combination) as required in the QAPP; only one porewater field blank was collected because these components were decontaminated in the laboratory and were for single-use in the field (i.e., each sample had a precleaned set of sampling equipment).

2.2.4 Decontamination

Decontamination procedures for field equipment were followed in accordance with SOP 4 of the FSP (Exponent et al. 2013). Grab samplers, Lexan™ collection tubs, sieves, scoops, and mixer paddles for sediment collection were decontaminated at the beginning of each sampling day and after sampling at each sampling location. Equipment was rinsed with site water, scrubbed with detergent, rinsed with site water again, and rinsed with 5 percent nitric acid followed by a final rinse with deionized water. Porewater sampling equipment and sample containers were decontaminated by the analytical laboratory prior to field sampling.

2.2.5 Sample Identification, Labeling, and Shipping

All sediment and porewater samples were identified and labeled according to SOP 2 of the FSP (Exponent et al. 2013). Sample identifiers included a prefix to indicate the sample matrix (i.e., ″SE″ for sediment, "PW" for porewater, and "ER" for equipment rinsate blank), followed by the unique sampling location identifier based on the list of location identification (ID) numbers for proposed sampling locations presented in the QAPP (Exponent et al. 2013; Tables B3-1 and B3-2). Location ID numbers for site sampling locations included "B" or "C" to indicate which analyses were to be conducted (i.e., bioassay plus chemistry or chemistry only, respectively). Location ID numbers for reserve sampling locations included an "R." Equipment rinsate sample identifiers included additional information to indicate the sampling crew and number of sampling equipment pieces. Field duplicate samples were identified as "MUD," followed by a sequential number. Similar sample ID and labeling were applied to laboratory sediment and porewater samples collected during the bioassays. In addition to sample matrix prefix and unique location IDs, the subset of sediment samples, created from the parent samples collected in the field and used in the bioassay tests, included identifiers for the specific bioassay (i.e., "CD10" and "CD50" for the short- and long-term *C. dilutus* bioassays, respectively, and "HA28" and "HA42" for the short- and long-term *H. azteca* bioassays, respectively) and the time of sampling (e.g., "T1" for the start of the test, "T7" for

Test Day 7). Bioassay control sediment sample IDs also included the test batch number (e.g., "B1" for Batch No. 1).

Sample containers were labeled with the project name, sample identifier, collection date and time, initials of the sampler, laboratory analyses, and any preservatives present in the sample. Samples were stored in coolers on ice or in a refrigerated truck before delivery to ALS. Samples were shipped to ALS using methods and chain-of-custody procedures described in SOP 6 of the FSP (Exponent et al. 2013).

2.3 CHEMICAL ANALYSIS METHODS

Chemical analyses were conducted on sediment and porewater samples shipped from the field to ALS between September 5 and October 24, 2013. Chemical analyses were also conducted on sediment and porewater samples collected by PER as part of the bioassay evaluation (Figure 2-1). Sediment and porewater chemistry samples from the short-term bioassay tests were shipped from PER to ALS in January and February 2014. Sediment and porewater samples from the long-term bioassay tests were shipped from PER to ALS in February, March, and April 2015. Samples were stored at ALS in accordance with the specifications in the QAPP (Exponent et al. 2013; Tables B3-1 and B3-2). Sediment and porewater samples (including rinsate blanks) were analyzed for the chemicals listed in Table 2-4 using the preparation and analysis methods presented in Table 2-5. The SOPs for the laboratory analyses are listed in Appendix A of the laboratory's quality assurance manual, which is Appendix D of the QAPP (Exponent et al. 2013).

EPA chemistry-only split samples were prepared by URS at ALS according to SOP 10, which was created under a QAPP change request (Change Request 4; Appendix D of this document). Sediment chemistry samples designated for EPA splits (Table 2-1) were homogenized using decontaminated Lexan™ tubs, scoops, and paddles. After homogenization, a split of the sample (approximately 200 g) was placed into a labeled sample container for EPA, and the remaining homogenized sample was returned to the original sample bucket. Custody of the sample splits was signed over to EPA's authorized representatives.

2.4 BIOASSAY METHODS

Sediment samples selected for bioassays were shipped from ALS to PER in December 2013.[9] Sediment toxicity testing was conducted on 69 bulk sediment samples using the midge *C. dilutus* and the amphipod *H. azteca* according to EPA (2000) Methods 100.2 and

[9] Additional sediment volume was shipped from ALS to PER prior to initiation of the long-term bioassays if sufficient volume was not available after the short-term bioassays had been conducted (see Table 2-13 for a list of locations affected). This additional sediment was homogenized with sediment already present at PER for the locations affected.

100.4 and American Society for Testing and Materials (ASTM) Method E 1706-05 (ASTM 2010), following PER's SOPs, which were included in Appendix F of the EPA-approved QAPP (Exponent et al. 2013). Table 2-3 provides a list of bioassay sampling locations, which included the following:

- 53 Site locations (including 9 potential internal reference locations)
- 16 external locations (including 6 tributaries and 10 locations upstream of the Site, all of which were considered to be potential reference locations).

The two short-term bioassays (i.e., 10-day *C. dilutus* and 28-day *H. azteca* tests) measured effects on survival, weight, and biomass. The short-term bioassays were conducted using sediment collected from all 69 bioassay locations. The two long-term bioassays (i.e., the 50-to-65-day *C. dilutus* life-cycle test and the 42-day *H. azteca* reproduction test) measured survival, growth, and reproduction. The long-term bioassays were conducted using sediment from 27 of the 69 bioassay locations (20 locations from the Site, including 1 potential internal reference location; 6 locations upstream of the Site; and 1 location in a tributary).

In addition to obtaining data on biological endpoints (e.g., survival, weight, biomass, and reproduction of the test organisms), porewater and sediment samples associated with the bioassays were collected and analyzed for concentrations of metals and associated bioavailability parameters (Figure 2-1).

The general bioassay methods, including the methods used to collect the porewater and sediment samples, are discussed in Section 2.4.1. The test methods specific to the *C. dilutus* and *H. azteca* tests are summarized in Sections 2.4.2 and 2.4.3 for the short- and long-term tests, respectively.

2.4.1 General Bioassay Methods

The methods for the short- and long-term bioassays are summarized in this section and are also described in the bioassay laboratory report prepared by PER titled *An Evaluation of the Toxicity of Upper Columbia River Site Sediment to the Larval Insect Chironomus dilutus and the Amphipod Hyalella azteca* (provided in Appendix E of this report). Sediment samples were received by PER on December 18 and 19, 2013, and January 7, 2014. They were checked into the laboratory and stored at 4°C ±2 °C. Immediately prior to testing, each sample was homogenized, and porewater was collected by centrifugation and sent to ALS for analysis (except for three samples in the short-term and four samples in the long-term bioassays, which were primarily sand from which no porewater could be retrieved). A subsample of sediment also was sent to ALS for analysis at initiation of the long-term bioassays. A total of 100 mL of the sediment was distributed into each replicate beaker and covered with 175 mL of laboratory water formulated for each test (Test Day 1). The quality of this water is documented in the bioassay laboratory report provided in Appendix E. Peepers were inserted into the chemistry test chambers at this time. Test chambers (both chemistry and bioassay test chambers, as discussed in Section 2.1.3) were allowed to equilibrate for 1 day prior to the introduction of the test organisms.

The tests were conducted at 23°C ±1°C with a photoperiod of 16 hours of light and 8 hours of dark (16L:8D). The quality of the overlying water was measured according to EPA guidance (USEPA 2000) (see Tables 2-6 through 2-9). Lighting, room temperature, and other environmental operations of the exposure system were monitored daily. The recorded readings are provided in the bioassay laboratory report (Appendix E). Biological endpoints were assessed and recorded at specified points during the test and upon termination of the bioassays. Test acceptability requirements (i.e., test acceptability criteria and performance goals) for the short- and long-term bioassays, including modifications from EPA (2000), are summarized in Tables 2-10 and 2-11, respectively, and are based on Tables B1-7 through B1-10 in the QAPP (Exponent et al. 2013).[10]

During the bioassays, approximately 200 mL of overlying water was renewed twice each day (i.e., every 12 hours) using a calibrated Zumwalt water delivery system. Food was added to the test chambers after water renewal as discussed in Sections 2.4.2 and 2.4.3.

The endpoints measured in the bioassays include the following:

- Survival—the number of surviving organisms divided by the initial number of organisms[11]
- Weight
    - *C. dilutus*—ash-free dry weight (AFDW) of surviving organisms divided by the number of surviving organisms[12]
    - *H. azteca*—dry weight of surviving organisms divided by the number of surviving organisms

[10] Test acceptability criteria must be met in order for a test to be considered acceptable; all other test acceptability requirements are considered performance goals.

[11] For those replicates to which an incorrect number of organisms was added at test initiation, mean survival was calculated as the number of organisms retrieved from the sediment at the end of the test divided by the intended initial start count. The number of surviving organisms in the *C. dilutus* bioassays includes those organisms that pupated and emerged during the test.

[12] AFDW was obtained for *C. dilutus* to remove the bias introduced by including the weight of inorganic material in the guts of the organisms, which may lead to significant overestimation of weight for *C. dilutus* in sediment toxicity tests (Sibley et al. 1997). AFDW was not obtained for *H. azteca* because sediment in the gut does not comprise a large portion of the overall weight of the organisms (USEPA 2000).

- Biomass
  - *C. dilutus*—AFDW of surviving organisms divided by the initial number of organisms minus the number of organisms that pupated or emerged during the testing period
  - *H. azteca*—dry weight of surviving organisms divided by the initial number of organisms
- Reproduction (applicable only to the long-term bioassays)
  - *C. dilutus*—three endpoints—1) number of eggs divided by the number of egg cases oviposited; 2) number of eggs produced divided by the number of surviving females; and 3) number of fertilized eggs that hatched
  - *H. azteca*—the number of young divided by the number of surviving females
- Emergence (applicable only to the long-term *C. dilutus* test)—the number of organisms that reach adulthood (emerge from the pupae) divided by the initial number of organisms.

Porewater was sampled during the bioassays using centrifugation and peepers (Figures 2-2 and 2-3). Centrifugation was used to collect porewater samples from bulk sediment prior to the initiation of the bioassays. Peepers are *in situ* sampling devices constructed from a plastic 2.9-mL snap-cap vial filled with deionized water and fitted with a microporous membrane (described in the PER laboratory report [Appendix E]). Peepers were placed into each of the chemistry test chambers at the time that the sediment was distributed among the test chambers. The peepers were placed midway in the sediment so that they did not touch the bottom of the test chamber and were fully covered with sediment. Peepers were retrieved from three of the chemistry test chambers at defined periods (e.g., Test Day 7), and the porewater from the three replicates was composited for analysis.[13]

After peepers had been retrieved from the chemistry test chambers, the sediment was composited and distributed to the appropriate sample jars, labeled, and stored in the freezer. All porewater and sediment samples were submitted to ALS for analysis. A total of five sample jars from the short-term bioassays and 20 sample jars from the long-term bioassays cracked during freezing; according to guidance from ALS, these were double-bagged under nitrogen and then placed inside another slightly larger jar with nitrogen headspace prior to shipping (see Appendix E for a list of the samples affected). The data validator noted that the integrity of the samples was not compromised, and the samples were processed normally upon receipt at ALS. Data for these samples were deemed usable without qualification by the data validator.

The following sections provide information specific to each of the tests.

[13] If porewater in any of the three replicates contained sediment, they were not included in the composite (see Appendix E for more detail).

2.4.2 Short-Term Bioassays

Short-term *C. dilutus* and *H. azteca* survival and growth bioassays were conducted on the 69 sediment samples collected for bioassays. The laboratory methods for the short-term bioassays are summarized below; additional details and photographs are presented in Appendix E. Test conditions are summarized in Tables 2-6 and 2-7. A timeline for collection of the porewater and sediment chemistry samples concurrent with the bioassays is presented in Figure 2-2.

The short-term bioassays were initiated following the completion of field sampling and after agreement had been reached with EPA on the batching of the samples (Appendix B). Testing was conducted in multiple batches, with each batch consisting of 11 or 12 samples (i.e., Site samples, external reference samples, and potential internal reference samples) plus three additional controls. Table 2-12 provides a list of the samples included in each batch. The PER negative control sediment[14] was included in each batch. Auxiliary controls included in each batch were quartz sand[15] and sediment used by the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) as a negative control sediment (but identified as auxiliary control sediment in this study).[16]

2.4.2.1 10-day *C. dilutus* Test

C. dilutus were exposed to Site, upstream, tributary, negative, and auxiliary control sediments for 10 days. The test was conducted with 11 replicates for each tested sediment, with each replicate glass beaker containing 100 mL of sediment and 175 mL of reformulated, moderately hard reconstituted water (USEPA 2000). Replicates were designated as follows:

- Biological test chambers—Eight replicates for biological endpoints (survival, weight, and biomass) measured on Test Day 10
- Chemistry test chambers—Three replicates for porewater and sediment chemistry measured on Test Day 7.

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[14] The PER negative control sediment (CRL-SS) consisted of a blend of ambient sediment collected from reference sites in San Francisco Bay and then maintained under freshwater conditions in the laboratory for 1 month prior to use. Results of the chemical analysis of the sediment are in Appendix E.

[15] Quartz sand was included at the direction of EPA as noted in the QAPP (Exponent et al. 2013) and as recommended by Mount (2011b) to assess the physical effects of coarse sediment and nutritional quality of the test conditions. The quartz sand was not intended for use in assessing the acceptability of the tests.

[16] Control sediment from USACE ERDC was included to provide a potential comparison with bioassays performed at the USACE ERDC laboratory and was not intended for use in assessing acceptability of the tests.

Batch Nos. 1 through 6 of the short-term *C. dilutus* bioassays were initiated in January 2014, with Batch No. 1 beginning on January 22 and Batch No. 6 beginning on January 31. *C. dilutus* egg cases were obtained from a commercial supplier (Environmental Consulting & Testing, Superior, Wisconsin), and the eggs and subsequent *C. dilutus* larvae were cultured in the PER laboratory.

Following the 24-hour equilibration of test chambers, approximately 200 mL of overlying water was renewed using the calibrated Zumwalt water delivery system. Approximately 25 mL of the renewed overlying water was then collected from each of the test chambers and composited for measurement of water quality characteristics (pH, dissolved oxygen [DO], conductivity, alkalinity, hardness, and total ammonia); 25 mL of overlying water was then added back to each replicate prior to test initiation. The test was initiated (Test Day 0) by distributing 10 randomly selected larvae, still in their individual cases, to each replicate, including the chemistry test chambers. The larvae were limited to second and third instar, with at least 50 percent being third instar. The mean target starting weight (as AFDW) for each organism was < 0.12 mg as recommended in Mount (2011a). The time zero (T_0) weight measurements were the average of the AFDW of eight replicates of 10 randomly selected organisms.

During the test, approximately 200 mL of overlying water was renewed twice each day using the Zumwalt water delivery system. Five mL of the overlying water was collected and composited for measurement of DO immediately prior to and following renewal; after DO measurement, 5 mL was then added to each replicate. After daily water renewal, 1.0 mL of 6-mg/L suspension of TetraMin® fish food was added to each test chamber. Aeration was implemented in *C. dilutus* test beakers when DO measurements were below 2.5 mg/L (all replicates for that test sample were aerated for the remaining duration of the testing according to EPA guidance [USEPA 2000]).

During the bioassay, biological test chambers were checked daily for pupation and emergence, and the number of mortalities was recorded. Sediment and porewater were obtained from the chemistry test chambers on Test Day 7. Porewater was collected by retrieving peepers (as discussed in Section 2.4.1).

Test batches were terminated on Test Day 10. A 25-mL aliquot of overlying water was collected from each test replicates and composited for analysis of the test treatment "final" water quality characteristics for each sediment sample. The number of surviving organisms (i.e., larvae, pupae, and adults [emerged]) in each replicate was recorded. The surviving larvae from each replicate were dried at 60°C for 24 hours and weighed to the nearest 0.01 mg. The dried larvae were then ashed at 550°C for 2 hours. The ashed larvae were reweighed, and the tissue mass of the larvae in each replicate was calculated as the difference between the weight of the dried larvae and the weight of the ashed larvae. The weight and biomass endpoints were based on these AFDW measurements. The total weight of the *C. dilutus* from each replicate was divided by the number of surviving larvae to obtain an average AFDW per organism for each replicate. Average larval biomass was calculated by dividing the AFDW for each replicate by the corresponding number of initial organisms minus the number of organisms that pupated or emerged during the testing period.

2.4.2.2 28-day *H. azteca* Test

H. azteca were exposed to Site, upstream, tributary, negative, and auxiliary control sediments for 28 days. The test was conducted with 14 replicates for tested sediment, each containing 100 mL of sediment and 175 mL of overlying water. The overlying water was reconstituted water formulated following Borgmann (1996), modified to contain 0.4 mg/L of bromide. [17] Replicates were designated as follows:

- Biological test chambers—Eight replicates for biological endpoints (survival, weight, and biomass) measured on Test Day 28
- Chemistry test chambers—Three replicates each for porewater chemistry on Test Day 7 and porewater and sediment chemistry on Test Day 21.

Batch Nos. 1 through 6 of the short-term *H. azteca* bioassays were initiated in January 2014, with Batch No. 1 beginning on January 22 and Batch No. 6 beginning on January 31. The *H. azteca* used in these tests were obtained from Aquatic BioSystems, Inc. (ABS), Fort Collins, Colorado. ABS isolated <24-hour-old amphipods approximately 7 days prior to test initiation and supplied them to the laboratory at 6 days old. Short-term test organism receipt records are included in Appendix C of Appendix E.[18]

Upon receipt at the laboratory, the amphipods were held in tanks of standard artificial medium. The medium was SAM-5S, a synthetic freshwater prepared according to Borgmann (1996), modified to contain 0.4 mg/L of bromide, at 23°C, and the amphipods were fed yeast-Cerophyl®-trout chow (YCT) food amended with powdered *Spirulina* (90 mg of 250-μm sieved powdered *Spirulina* per 100 mL YCT).

Following the 24-hour equilibration of test chambers, the overlying water was renewed and the test was initiated (Test Day 0) by distributing 10 randomly selected 8-day-old amphipods into each replicate, including the chemistry test chambers. The average

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[17] Borgmann (1996) recommends adding 0.8 mg/L bromide to overlying water for *H. azteca* tests. Ongoing refinements to test conditions for *H. azteca* suggest that bromide concentrations closer to environmentally relevant concentrations, which typically range from 0.014 to 0.2 mg Br/L, are sufficient to support *H. azteca* survival, growth, and reproduction (Ivey and Ingersoll 2016, Ivey et al. 2016). However, at the time testing was conducted for the Phase 2 Sediment Study, these recommendations were not published, and EPA and TAI agreed to add 0.4 mg/L bromide to the overlying water (USEPA 2013).

[18] As agreed to in a meeting between TAI and EPA held July 3, 2012 (Exponent 2012), PER requested that ABS, their supplier for *H. azteca*, provide amphipods of a known age rather than use a sieve to obtain a specific size class.

starting weight (T_0 weight) measurements were obtained from the average of the dry weight of eight replicates of 10 randomly selected organisms.

During the test, approximately 200 mL of overlying water was renewed twice each day using the calibrated Zumwalt water delivery system. Five mL of the overlying water was collected and composited for measurement of DO immediately prior to and following renewal; after DO measurement, 5 mL of water was then added to each replicate. After daily water renewal, 1.0 mL of YCT mixture amended with powdered *Spirulina* was added to each test chamber up to Test Day 13. On Test Days 14 through 27, 2 mL/day of YCT was added to each chamber.

At the initiation and termination of the test (i.e., Test Days 0 and 28), water quality (i.e., hardness, alkalinity, conductivity, pH, and ammonia) was measured in a composite sample of 25-mL aliquots of overlying water collected from all test replicates. Prior to test initiation, 25 mL of overlying water was then added back to each replicate. Sediment and porewater were collected from chemistry test chambers established for this purpose on Test Days 7 and 21.

Test batches were terminated on Test Day 28. Test organisms were collected with a No. 40 mesh sieve (425-µm mesh; U.S. standard size sieve). The number of surviving amphipods in each replicate was recorded. The surviving amphipods from each replicate were dried at 60 °C for 24 hours and weighed to the nearest 0.01 mg. The total weight of the dried amphipods in each replicate was divided by the number of surviving amphipods to obtain an average dry weight per amphipod in each replicate. Biomass was calculated by dividing the pooled amphipod dry weight in a replicate by the corresponding number of initial organisms.

2.4.3 Long-Term Bioassays

Long-term *C. dilutus* and *H. azteca* bioassays were performed on 27 of the 69 samples tested using short-term bioassays. The sample selection process for the long-term bioassays is described in Appendix B. The laboratory methods for the long-term bioassays are summarized below (additional details and photographs are presented in Appendix E). Test conditions are summarized in Tables 2-8 and 2-9. A timeline for collection of the porewater and sediment chemistry samples concurrent with the bioassays is presented in Figure 2-3.

The long-term bioassays were conducted in three batches, with each batch consisting of 13 samples, as discussed in the agreement between EPA and TAI (Appendix B). This included seven Site samples, and six reference samples replicated in each batch; Table 2-13 provides a list of the samples included in each batch. In addition, each batch included the PER negative control sediment used to evaluate test acceptability and quartz sand as an auxiliary control.[19] Immediately prior to initiating the long-term bioassays, sediment samples were homogenized and a subsample was distributed to the appropriate sample jars, labeled, and stored in the freezer for submittal to ALS for chemical analyses as discussed in Section 2.1.2. A total of five sample jars cracked during freezing. As discussed in Section 2.4.1, these samples were double-bagged under nitrogen and then placed inside another slightly larger jar with nitrogen headspace prior to shipment to ALS (see Appendix E for a list of the samples affected).

2.4.3.1 50-to-65-day *C.dilutus* Test

C. dilutus were exposed to Site, upstream, tributary, negative, and auxiliary control sediments for approximately 50 to 65 days.[20] The test was conducted in glass beakers, each containing 100 mL of sediment and 175 mL of reformulated, moderately hard reconstituted water (USEPA 2000). Replicates were designated as follows:

- Biological test chambers
    - Four replicates for biological endpoints measured on Test Day 16 (survival, weight, and biomass)
    - Eight replicates for biological endpoints measured between Test Day 50 and approximately Test Day 65 (survival, weight, biomass, emergence, and reproduction)
    - Four replicates for production of auxiliary males, if needed
- Chemistry test chambers—Three replicates each for porewater chemistry on Test Day 7 and porewater and sediment chemistry on Test Days 21 and 42.

Batch Nos. 1 through 3 of the long-term *C. dilutus* bioassays were initiated during February and March 2015, with Batch No. 1 beginning on February 13 and Batch No. 3 beginning on March 5. Following the 24-hour equilibration of test chambers, the test was initiated (Test Day 0) by distributing 12 randomly selected 4-day-old larvae to each replicate, including the chemistry test chambers. Following EPA methods (USEPA 2000), T_0 weights were not obtained in the *C. dilutus* long-term bioassays[21].

During the test, approximately 200 mL of overlying water was renewed twice each day using the Zumwalt water delivery system. Each day, a 25-mL subsample of test solution

[19] The ERDC control sediment was not used in the long-term bioassays.

[20] Following standard protocol (USEPA 2000), each test sediment in the long-term *C. dilutus* bioassay was ended separately when no additional emergence was recorded for 7 consecutive days.

[21] USEPA (2000) does not require measurement of starting weights for the long-term *C. dilutus* bioassay. The use of 4-day-old midge larvae to start the long-term *C. dilutus* bioassay is documented in Change Order No. 3. Due to the small size of 4-day-old midge larvae, it is impractical to measure weight of the organisms at this life-stage.

was collected from randomly selected "test" replicates at each treatment, and the temperature, pH, DO, and conductivity were determined. After daily water renewal, 1 mL of 6-mg/L suspension of TetraMin® fish food was added to each test chamber. Each evening, each replicate was again flushed with approximately 200 mL of fresh overlying water. Immediately prior to evening water renewal, a DO check was performed for each treatment. Aeration was implemented in *C. dilutus* test beakers when DO measurements were below 2.5 mg/L (all replicates for that test sample were aerated for the duration of the testing according to EPA guidance [USEPA 2000]). During the bioassay, test chambers were checked daily for pupation and emergence, and the number of mortalities was recorded.

Peepers for the collection of porewater were retrieved from the chemistry test chambers on Test Days 7, 21, and 42 (see Section 2.4.1). Sediment was collected from the chemistry test chambers to be analyzed for AVS and SEM on Test Days 21 and 42.

On Test Day 16, 4 of the 12 replicates for each sample designated for the evaluation of biological endpoints were terminated, and larvae were collected to measure survival, growth, and biomass. The number of surviving organisms in each replicate was recorded. A 25-mL aliquot of overlying water from each replicate was collected and composited for each sediment sample and analyzed for alkalinity, hardness, and ammonia. The surviving larvae from each replicate were composited and dried at 60°C for 24 hours and weighed to the nearest 0.01 mg. The dried larvae were then ashed at 550°C for 2 hours. The ashed larvae were reweighed, and the tissue mass of the larvae in each replicate was calculated as the difference between the weight of the dried larvae and the weight of the ashed larvae. The weight and biomass endpoints were based on these AFDW measurements. The total weight of the *C. dilutus* from each replicate was divided by the number of surviving larvae to obtain an average AFDW per organism for each replicate. Average larval biomass was calculated by dividing the AFDW for each replicate by the corresponding number of initial organisms minus the number that pupated or emerged during the testing period. The test was deemed acceptable if mean survival in the negative control sediment was ≥ 80 percent.

Beginning on Test Day 17, the emergence of males and females, pupal and adult mortality, and time to death for previously collected adults were recorded. Each day, surviving adults present in the test chambers were transferred to their respective reproduction/oviposition (R/O) chamber. The R/O chambers were monitored for the production of egg cases, which were transferred on a daily basis from the R/O chamber to their respective Petri dish to monitor incubation and hatch. The numbers of oviposited egg cases, eggs produced (using the ring method[22] or the direct count method[23]), and hatched eggs, were recorded. If no adult males were available from a given replicate at the same time that adult females were present (e.g., the replicate had no emergent males or most of the males had already emerged), emergent auxiliary males from the same sample were transferred to R/O chambers for mating with the females. Eggs that were laid when no males were present in the R/O chamber were noted as potentially not fertilized. If none of the eggs in this egg mass hatched, the unfertilized eggs were excluded from the percent hatch calculation.

After 7 consecutive days with no recorded emergence in any of the replicates, a given test sediment was terminated (typically between Test Days 50 and 65). Prior to test termination, a 25-mL aliquot of water from each remaining replicate was composited for each sediment sample; a subsample of each composite was used for analysis of "final" water quality characteristics.

2.4.3.2 42-day *H. azteca* Test

H. azteca were exposed to Site, upstream, tributary, negative, and auxiliary control sediments for 42 days. The test was conducted in glass beakers, with 18 replicates per treatment. During the first 28 days of the test, each replicate contained 100 mL of sediment and 175 mL of reconstituted water formulated following Borgmann (1996), modified to contain 0.4 mg/L of bromide. On Test Day 28, surviving organisms from 8 replicates were transferred to test chambers containing 275 mL of water (i.e., no sediment) for the water-only exposure. Replicates were designated as follows:

- Biological test chambers
  - Four replicates for biological endpoints measured on Test Day 28 (survival, weight, and biomass)
  - Eight replicates for biological endpoints measured on Test Day 28 (survival), Test Day 35 (survival and reproduction), and Test Day 42 (survival, weight, biomass, reproduction, and number of adult males and females)
- Chemistry test chambers—Three replicates each for porewater chemistry on Test Day 7 and for porewater and sediment chemistry on Test Day 21.

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[22] Eggs in egg cases that appeared normal (i.e., as large, banana shapes) were estimated using the ring method by counting the number of eggs in five rings from the middle of the egg case, determining the mean count of eggs in the five rings, and multiplying this mean by the number of rings in the egg case.

[23] Eggs in egg cases that could not be counted using the ring method (e.g., the egg cases were convoluted or distorted) were counted by placing the egg case in an acid solution overnight and then counting the eggs using a dissecting microscope. Percent hatch could not be obtained for eggs counted using the direct count method.

The long-term *H. azteca* bioassays were initiated in February 2015, with Batch No. 1 beginning on February 13 and Batch No. 3 beginning on March 5. The *H. azteca* used in these tests were obtained from Aquatic BioSystems, Inc., Fort Collins, Colorado. Aquatic Biosystems, Inc. isolated <24-hour-old amphipods approximately 7 days prior to test initiation and supplied them to the laboratory at 6 days old. Long-term test organism receipt records are included in Appendix D of Appendix E.

Upon receipt at the laboratory, the amphipods were held in tanks of standard artificial medium. The medium was SAM-5S, a synthetic freshwater prepared according to Borgmann (1996), modified to contain 0.4 mg/L of bromide, at 23˚C, and the amphipods were fed yeast-Cerophyl®-trout chow (YCT) food amended with powdered *Spirulina* (90 mg of 250-µm sieved powdered *Spirulina* per 100 mL YCT).

Following the 24-hour equilibration of test chambers, 200 mL of overlying water was renewed. Approximately 25 mL of the renewed overlying water was then collected from each of the test chambers and composited for measurement of water quality characteristics (pH, DO, conductivity, alkalinity, hardness, and total ammonia); 25 mL of overlying water was then added back to each replicate prior to test initiation. The test was initiated (Test Day 0) by distributing 10 randomly selected 8-day-old amphipods to each replicate beaker, including the chemistry test chambers. The target starting weight (T_0 weight) for each organism was 0.02 to 0.035 mg. The T_0 weight measurements were obtained from the average of the dry weight of eight replicates of 10 randomly selected organisms.

During the test, approximately 200 mL of overlying water was renewed twice each day (i.e., every 12 hours) using the Zumwalt water delivery system. Each day, prior to and following renewal, a 25 mL aliquot of overlying water was collected from randomly selected test chambers, and the temperature, pH, DO, and conductivity were determined; 25 mL of overlying water was added back to each of the test chambers following the second DO measurement. After water renewal, 1.0 mL of *Spirulina*-amended YCT was added to each test chamber daily after water renewal during Test Days 0 to 13. During the remaining exposure days (Test Days 14 to 42), 2 mL/day of YCT were added to each chamber. Each evening, each replicate was again flushed with approximately 200 mL of fresh overlying water. Immediately prior to evening water renewal, a DO check was performed for all test chambers. For any sediment sample for which a test replicate overlying water DO level had decreased below 2.5 mg/L, all replicates for that sample were aerated for the remaining duration of the test, per EPA guidance; the date of aeration implementation was recorded.

Peepers for the collection of porewater were retrieved on Test Days 7 and 21 from the chemistry test chambers. Sediment was also sampled on Test Days 7 and 21 for AVS and SEM analyses.

On Test Day 28, survival was assessed in all of the 12 replicates of the biological test chambers for each sediment sample, four of which were then terminated to obtain data for Test Day 28 weight and biomass. A 25-mL aliquot of overlying water was also collected from each of the 12 replicates and composited for analysis of water quality characteristics for the sediment sample. Organisms from the remaining eight biological test chambers were transferred to "water-only" test chambers for the remainder of the toxicity test (i.e., Test Days 28 to 42). On Test Day 35, the number of offspring in the eight biological test chambers was recorded and a 25-mL aliquot of water from each replicate was collected and composited for each test treatment for analysis of water quality characteristics for the sediment sample.

Test batches were terminated on Test Day 42 beginning in March 2015. A 25-mL aliquot of water from each replicate was collected and composited for each test treatment for analysis of "final" water quality characteristics for the sediment sample. Test organisms were collected, and the numbers of surviving adult male and female amphipods in each replicate were recorded. This information was used to calculate the number of young (i.e., neonates) produced per surviving female per replicate from Test Days 28 to 42. The surviving adult male and female amphipods from each replicate were dried at 60°C for 24 hours and weighed to the nearest 0.01 mg. The total weight of the dried amphipods from each replicate was divided by the number of surviving amphipods to obtain an average dry weight per amphipod for each replicate. Biomass was calculated by dividing the pooled amphipod dry weight for each replicate by the corresponding number of initial organisms.

2.5 BACKSCATTERED SCANNING ELECTRON MICROSCOPY

This section summarizes the methods for BSEM conducted on sediment samples from 42 of the locations sampled during the Phase 2 Sediment Study (Map 2-5). Additional details on the methods are presented in the final report titled *Characterization of Upper Columbia River Sediment by CCSEM* (Appendix F).

2.5.1 Method Overview

The elemental composition and morphology of sediment samples were evaluated using scanning electron microscopy with energy-dispersive X-ray spectroscopy (EDS). The scanning electron microscope directs a beam of electrons at a prepared sample, and the interaction between the electron beam and the sample results in the scattering of some beam electrons off the sample. These re-emergent beam electrons are known as backscattered electrons. The probability of a beam electron encountering sample material and backscattering is a function of sample electron density—phase brightness is proportional to its average atomic number. The polished epoxy mount of each sample allows particles to be identified using image analysis techniques by setting a particle threshold brightness value between the dark epoxy and the bright mineral. This selection can be further refined by setting the particle selection threshold above common silicate minerals, such as quartz and feldspar, to detect and characterize only particles with relatively high average atomic numbers, including slag and other minerals. In addition, the X-rays generated by the interaction of the electron beam and the sample particle result in an X-ray energy spectrum. Because each element has a characteristic spectrum, the relative elemental composition of the particles can be determined using EDS peak areas[24]. These data are then used, along with particle morphology and internal texture, to develop "rules" to classify the particles as slag or not. Greater detail on the development of these rules, along with a list of the specific rules, is presented in Appendix F. In general, the BSEM method appears to be useful for identifying glassy-like materials, including those that are predominantly slags, within the limitations of the approach indicated therein. However, the method is not sufficient for determining the origin of the slag, which may have come from various sources within the system.

2.5.2 Sample Preparation and Analysis

Sediment samples were received by RJ Lee Group on December 11, 2014, and stored at 3 to 5°C until preparation. The samples were prepared by drying overnight at 110˚C. The dried samples were sieved through 4-mm mesh. The > 4-mm fraction was weighed and the < 4-mm fraction was reduced in volume using a riffle splitter and sieved through 2-mm mesh. The resulting 2-to-4-mm and < 2-mm fractions were weighed, and the two coarsest fractions (i.e., > 4-mm and 2-to-4-mm) were retained for optical microscopic examination and archived. A binocular microscope was used to examine the coarse fractions for slag particles. Particles of uncertain composition were mounted and analyzed in the scanning electron microscope. A split of the < 2-mm fraction was prepared as an epoxy grain mount and polished for BSEM analysis.

The laboratory conducted an initial set of analyses to optimize the instrument calibrations and thresholds. Carbon and aluminum tape fixed to the polished epoxy mounts was used to calibrate the brightness and contrast settings. The < 2-mm sample fraction mounts were analyzed using computer-controlled scanning electron microscopy in the backscattered electron imaging mode. Samples were scanned at a magnification of 25x to characterize particles > 125 µm. A magnification of 200x was also used to scan a random subset of fields for the characterization of particles larger than 15 µm. During scanning, sample particles appear brighter than the epoxy and the brightness is proportional to the average atomic number of the elements within a particle. A brightness threshold was used to categorize particles into relatively low and relatively high average atomic number. The linear dimensions and area of the high atomic number particles (including slag and other materials) were measured. EDS was then used to determine the relative elemental composition of each high atomic number particle—specifically if it contained certain

[24] Elemental compositions determined using EDS peak areas are not directly comparable to chemical compositions determined by digestion and chemical analysis.

elements (i.e., silicon, calcium, and iron) in proportions considered characteristic of slag—so the morphology and internal texture could be assessed for consistency with glassy slag. The EDS spectrum is used to determine relative elemental peak areas for estimating chemical compositions, and to differentiate among different classes of particles in the sample, including slag particles. These compositions have not been converted to weight percent and are not directly comparable to those determined by direct chemical analysis, either by individual element or in the aggregate.

2.5.3 Characterization of Slag

The general characteristics of metallurgical slag in the UCR are described in the literature (e.g., Cox et al. 2005)[25]. The slag is described as black glass, displaying morphology distinct from natural sediment. The composition of the glassy matrix is described as a calcium-iron silicate with lesser amounts of aluminum, zinc, sodium and others. In this study, the objective of which was to identify and measure particles of glassy slag in order to assess its abundance, the composition is presented as the EDS spectrum peak area percentages. For the stated objective, it is not necessary to convert the compositions to weight percent. The major elements found in slag (i.e., silicon, calcium, and iron) are also common in other minerals. To distinguish slag particles from other particles containing silicon, calcium, and iron, the data were processed for more detailed identification following the computer-controlled BSEM analysis. A review of the tabulated data (composition) and images (size, morphology and internal texture) acquired in this study indicated that slag is composed of at least 70 EDS peak area percent iron, silicon, and calcium in combination (Appendix F). Relative proportions of iron, silicon, and calcium were displayed in ternary diagrams for the subset of samples containing particles with this characteristic slag composition (Appendix F). Particles in compositional clusters displayed in the ternary diagrams were then inspected for the morphology and internal texture characteristic of slag. The dominant slag (called "Slag 1" in Appendix F) plotted in a compositional cluster distinct and separate from other sediment. A minor slag (called "Slag 2" in Appendix F) plotted within a compositional cluster of other sediment and was recognized by morphology and internal texture. A few particles of a chromium-rich slag (Slag 3 in Appendix F) were also observed. The composition of altered slag[26] was assessed using manual scanning electron microscopy techniques on a subset of particles with one or more alteration rims. Based on the ternary diagrams and information from the literature suggesting that altered slag should plot outside of the main slag cluster (Cox et al. 2005), preliminary rules were created to classify particles as a slag variety or altered slag. Upon

[25] Note that Cox et al. (2005) assumed that all slag found in the UCR had been discharged by the Trail smelter in Trail, British Columbia; the report does not reference the LeRoi/Northport smelter in Northport, Washington, which also discharged slag to the UCR, nor does it mention copper smelting in the area or other potential sources of slag.

[26] Smelter slag may become altered in physical appearance, morphology, and surficial characteristics as a result of weathering and/or physical transport.

application of the preliminary rules, particles that were classified as being near the edges of the clusters in the ternary diagrams were inspected in detail, and the rules were modified as necessary. A continuum of cross-boundary composition or the presence of morphology or internal texture consistent with glassy slag would result in a rule adjustment. This process was repeated until a stable solution for particle classification was achieved. The final list of rules was used to determine the amount of slag and altered slag in all samples (Appendix F).

Image analysis techniques were used to determine the proportion of epoxy and particles in each sample mount. The total area of slag and altered slag within the analyzed area of the prepared sample was determined using software associated with the computer-controlled BSEM analysis. Each field of analysis was electronically recorded, and the portion of the sample that was epoxy was determined so that the area of slag and altered slag could be compared with the total area of particles. The amount of slag or altered slag present on an areal basis is a consistent estimate of the amount present on a volumetric basis (Chayes 1956). In addition to estimating the volume of slag or altered slag on each slide, the sizes of the individual slag or altered slag particles were estimated. The apparent size of each particle was estimated by detecting the particle periphery in the electron microscopy analysis. The diameter of a circle with the same area as the particle was used to represent the particle size. As in any geological analysis of thin or polished sections, information on grain size, shape and distribution is limited because actual particle size can only be measured where the analyzed polished section of a sample bisects a particle's exact maximum circumference. However, the maximum circumference of any given particle is unknown to the investigator. For example, a particle's size might appear significantly smaller in instances where the polished section bisects only a corner of a particle.

2.5.4 Slag Characterization Quality Assurance

For QA purposes, the BSEM laboratory used an image analysis procedure applied to low magnification for comparison with the original analysis. In addition, the laboratory conducted a manual review of images for two samples, a duplicate (second) analysis on one prepared sample mount, and replicate analyses on four samples for which second (and/or third) mounts were prepared. Additional details are provided in Appendix F.

3 QUALITY ASSURANCE PROJECT PLAN DEVIATIONS AND MODIFICATIONS

This section discusses deviations and modifications to the QAPP that were encountered in the field and during the bioassays. There were no QAPP deviations or modifications associated with chemical analyses.

3.1 FIELD CHANGES AND DEVIATIONS

Procedures presented in the QAPP (Exponent et al. 2013) were followed to the extent possible during field sampling activities. Modifications to the QAPP were categorized as either "changes" or "deviations." Changes and deviations are summarized in Section 4 of the field activity report (Appendix A).

Change request forms were used to document changes that were identified prior to sample collection. These change request forms were prepared, submitted, and approved by EPA and are included in the field activity report (Appendix A). Of the seven change requests approved for the Phase 2 sediment study, three (Changes No. 1, 2, and 4) were related to field sampling activities, as follows:

- Three sampling locations (i.e., LAL-4, LAL-5, and LAL-6) were relocated at the recommendation of a professional archaeologist (Change No. 1).
- SOPs not originally included in the QAPP were created for tributary sampling (Change No. 2) and the collection of EPA chemistry-only splits (Change No. 4).

Deviations from the QAPP that were identified during sampling activities and subsequent corrective actions, if required, were documented in Table 4-1 of the field activity report (Appendix A). None of the deviations were expected to adversely affect the DQOs as outlined in the QAPP. The following deviations were noted:

- Three observers requested to be on the sampling boat on one of the sampling days. Two observers were allowed on the safety boat (instead of one) as agreed to prior to the commencement of work, and an observer rotation was established between the sampling boat and the safety boat.
- The volume collected for the EPA split samples was increased from 3 to 5 gal per EPA request.
- At one location, sampled sediment touched, but did not lift, the lids of the grab sampler. Although this sample deviated from the acceptance criteria in the QAPP, the field crew and the EPA representative agreed that the sample was acceptable.
- Porewater sampling deviations
    - Airstones with larger pore spaces were used when porewater collection was hindered by fine substrate.

   - At locations with sandy sediment, porewater drained too quickly from the grab sampler to obtain a porewater sample. After consultation with EPA, it was decided that in these cases, the sample would be removed from the grab sampler and placed in Lexan™ tubs prior to porewater collection.
   - According to EPA request, the sediment processing procedure was modified for efficiency—while sediment was contained in Lexan™ tubs, the overlying water was removed, the tubs were shaken to separate the porewater, and porewater was sampled from the top of the sediment.
   - At one location, there was a large amount of surface water in the grab sampler that was indistinguishable from porewater. The decision was made to collect porewater *in situ* by inserting the ceramic airstone into the sediment at the margin of the stream. pH measurements were used to confirm that surface water was not collected in place of porewater.
- Sampling location deviations
   - The target sampling locations LAL-1, LAL-2, and LAL-3 were moved to an area near the eastern shore of Lower Arrow Lake because the water depth of the targeted locations was over 500 ft and exceeded the depth capacity of the sampling equipment.
   - The grab sampler snagged after one sampling attempt at one reserve sampling location (2-R10). The retrieval of the sampler required careful maneuvering in a swift current. Further sampling at this location was not attempted because of safety issues and the potential for the loss of the sampler. Sampling was also discontinued after one sampling attempt at location 1-R10 because of a strong current that caused the sampler to be dragged along the bottom, preventing sample collection.
   - Sampling was not attempted at two locations (2-B5 and 2-B6) because a review of the bathymetry data and river conditions indicated the potential for the loss of the grab sampler. In addition, sampling was not attempted at two other locations (1B-6 and 1-C2) because of the strong current and visual observations of cobbles on the river bottom.

In addition to the deviations noted above, in some cases, neither the targeted nor the reserve locations could be sampled regardless of all attempts made to collect samples according to the QAPP (Exponent et al. 2013). It had been expected that difficulties would be encountered in collecting samples in upstream portions of the UCR because of coarse sample substrate, which is why a large number of potential reserve stations were identified for these locations (see Table 2-1 in the field activity report [Appendix A]). The reasons for not collecting a sediment sample at a particular location included the following: 1) sample refusal was encountered because of bedrock and/or large cobbles; 2) sample did not meet acceptability criteria (see SOP 3 of the FSP [Appendix A of the QAPP (Exponent et al. 2013)]); 3) sufficient sediment was not available in any of the grab attempts made at a particular location; or 4) the sample had a relatively large volume of sediment with an unacceptably large grain size (> 2 mm), or 5) high river flow rates were deemed unsafe at a particular location. The originally planned locations and the actual locations are presented in Table 2-1 of the field activity report (Appendix A).

3.2 BIOASSAY CHANGES AND DEVIATIONS

Four change request forms for modifications to bioassay procedures presented in the QAPP (Exponent et al. 2013) were prepared, submitted, and approved by EPA. The change request forms are provided in Appendix D and are for the following modifications:

- Revisions were made to tables, bioassay SOPs, and general activity schedules (GAS) in the QAPP to make them consistent with one another (Change No. 3)
    - Tables B1-3 and B1-5 were revised to correct the feeding rate for *H. azteca* from 1 mL/day throughout the test period to a rate of 1 mL/day during Test Days 1 to 13, increasing to 2 mL/day for the remainder of the test period.
    - Tables B1-6 and B1-10 and the SOP for the long-term *C. dilutus* bioassay were updated to indicate that the test would be initiated with 4-day-old larvae rather than < 24-hour-old larvae as originally specified because better growth and biomass are obtained using the older organisms.
    - The GAS for the long-term *C. dilutus* bioassay was updated to indicate that egg masses would be checked and isolated earlier than originally planned (on Test Days 7 and 6 rather than on Test Days 3 and 2) to provide 4-day-old larvae for test initiation.
    - The GAS for the four bioassays were updated to indicate that the overlying water would be renewed immediately prior to the introduction of test organism into the test replicates.
    - The SOPs for the short- and long-term *H. azteca* bioassays were revised to specify that overlying water would be prepared according to Borgmann (1996), modified to include 0.4 mg/L of bromide.
    - The SOP for the long-term *H. azteca* bioassay was updated to specify that Nitex® mesh would be added to the water-only test chambers.
    - The SOPs for the short- and long-term *C. dilutus* bioassays were updated to specify that overlying water (i.e., reformulated moderately hard synthetic water) would be prepared according to EPA guidance (2000).
    - The SOPs for the four bioassays were revised to include biomass as an endpoint.
- The time when peepers were to be deployed into test chambers was revised to improve efficiency and provide more accurate porewater metals results (Change No. 5).
    - Peepers were inserted into the test chambers at the time that sediment was distributed (i.e., Test Day 1) rather than on Test Day 0 as originally planned.

  - Peepers intended for retrieval at various points during the testing period (e.g., Test Days 7, 21, 42) were all deployed on Test Day 1 rather than 7 days prior to each peeper retrieval as originally specified.
- The SOPs for the short- and long-term *C. dilutus* and *H. azteca* bioassays were revised to stipulate that organisms would be placed in a drying oven at 60°C for 24 hours rather than at the temperatures and for the drying times originally specified (Change No. 6). This change was made to provide standardization in methods used for the two organisms and consistency with methods used by the USACE ERDC laboratory (the laboratory conducting split-sample bioassays for EPA).
- Batch No. 2 testing was delayed by 1 week because an insufficient number of 4-day-old *C. dilutus* larvae were available to initiate the testing as scheduled (Change No. 7). Batch No. 3 testing was also delayed by 1 week because of the shift in schedule.

Deviations associated with the bioassays were noted as follows:

- The temperature in the trip blank associated with 13 bulk sediment samples collected for bioassays delivered at ALS on September 29, 2013, was recorded as 8.3ºC, which is above the prescribed range of 4 ºC (±2 ºC). The bioassay samples included in this shipment were SE-5-B1, SE-5-B2, SE-5-B4, SE-5-B5, SE-5-B6, SE-6-B1, SE-6-B2, SE-6-B4, SE-6-B5, SE-6-B6, SE-6-R3, SE-REF-5, and SE-TRIB-1. Samples were immediately placed into refrigerated storage and remained within the prescribed temperature for the duration of the storage period.

  It is unlikely that the small temperature excursion measured in the trip blank affected the validity of results from the bioassays conducted on these samples. For sediments, preservation requirements (including storage temperatures) are most relevant for chemicals that can be volatilized (e.g., mercury, volatile and semivolatile organic compounds) or degraded (e.g., organic compounds), and for compounds when chemical speciation (e.g., trivalent arsenic) is conducted. In these cases, chemical and biological changes over time can affect the concentration measured, and sample preservation techniques help to ensure that the analysis is conducted before chemical and biological changes are likely to occur. Total metals concentrations, however, are expected to be stable in sediment over time, regardless of the storage temperature, and the metals concentrations likely were unaffected by the short temperature excursion.

- DO levels were measured below the 2.5-mg/L lower limit in 46 percent of the samples in the short-term *C. dilutus* bioassay, 100 percent of the samples in the long-term *C. dilutus* bioassay, and 47 percent of the samples in the long-term *H. azteca* bioassay. All of the samples in the short-term *H. azteca* bioassay had DO levels ≥2.5 mg/L. In the *C. dilutus* bioassays, low DO (e.g., ≤1.0 mg/L) was measured in some replicates; less than 0.5 percent of DO readings taken during the short- and long-term bioassays were ≤1.0 mg/L. If a DO excursion was noted in a replicate during an evening check of DO (the second of two DO measurements made each day), then aeration of all replicates for that sediment sample was immediately initiated. Following implantation of the airstone, no further DO excursions were noted. Any instance of a DO excursion was brief in duration (i.e., between 0 and approximately 6 hours), and any stress to organisms as a result of low DO likely was minimal.[27]

- Four of the replicates in the short-term *C. dilutus* bioassay (i.e., SE-TRIB-3-A, SE TRIB-3-E, SE-8-B2-G, and SE-8-B2-H) and six of the replicates in the short-term *H. azteca* bioassay (i.e., SE-5-B1-H, SE-4-B4-F, SE-TRIB-2-D, SE-2-B2-B, SE 7 B4-D, and SE-LAL-5-C) had more than 10 organisms retrieved at the end of the test, indicating that an incorrect number of organisms had been added to those test chambers at test initiation. In the long-term *C. dilutus* bioassay, there were 11 replicates with more than 12 organisms added at test initiation (SE-G-1-B, SE-G-1-K, SE-G-1-L, SE-G-2-L, SE-G-3-D, SE-6-B5-A, SE-5-B2-A, SE-3-R7-G, SE-LAL-3-J, SE-TRIB-3-J, and CTL-SS-B3-B). Two replicates in the long-term *H. azteca* bioassay (SE-1-B5-A and SE-REF-10b-B) had more than 10 organisms added at test initiation. The number of replicates for which over addition of organisms occurred was low (i.e., ranging from 0.2 percent of replicates in the short-term *H. azteca* bioassay to 2 percent of replicates in the *C. dilutus* bioassay) and therefore, it is unlikely to have an effect on the interpretation of results. For those replicates to which an incorrect number of organisms was added at test initiation, mean survival was calculated as the number of organisms retrieved from the sediment at the end of the test divided by the intended initial start count. Mean weight was calculated by dividing the dry weight of surviving organisms by the number of surviving organisms. Biomass was calculated by dividing the dry weight of survivors by the actual initial start count.
- Two organisms were observed in wastewater cups on February 9, 2014, during a renewal of Batch No. 3 of the *H. azteca* bioassays. The organisms were discarded because it could not be determined from which replicates they had come.

[27] Guidance documents from EPA (USEPA 2000) document the short-term tolerance of *H. azteca* to low DO environments by citing laboratory studies reporting concentrations lethal to 50 percent of the organisms (LC50) of between 0.3 and 0.7 mg/L. *C. dilutus* have been found in British Columbia lakes with DO concentrations as low as 0.22 mg/L.

4 CHEMISTRY DATA VALIDATION AND BIOASSAY ACCEPTABILITY

Validation of the analytical chemistry data was performed by Environmental Standards, Inc. (ESI), of Valley Forge, Pennsylvania, in accordance with the QAPP based on EPA guidance from the following documents:

- Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 540-R-08-005) (USEPA 2009)
- EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 540-R-04-004) (USEPA 2004).

Stage 2B validation was conducted for the majority of the chemistry data. In accordance with the QAPP (Exponent et al. 2013), approximately 20 percent of the data underwent Stage 4 data validation. Data were qualified, as needed, based on an evaluation of the following laboratory and field QC criteria:

- Holding times
- Initial and continuing calibration results
- Laboratory and equipment rinsate blank concentrations
- Matrix spike/matrix spike duplicates (MS/MSDs)
- Recoveries of laboratory control samples (LCS)
- Laboratory and field duplicate relative percent differences (RPDs)
- Interference check samples
- Serial dilutions
- Internal standards.

ESI data validation reports are available on the "Downloads" page in the project database (http://teck-ucr.exponent.com). The results of the data validation are summarized in Sections 4.1, 4.2, and 4.3 for overall data quality of chemistry results, sample transport and holding times, and chemistry validation results, respectively. ESI reviewed laboratory QC samples as part of the data validation process. In the following subsections, the numbers of qualified sample results (excluding laboratory QC results) are listed, followed by the numbers of qualified laboratory QC samples in parentheses. In addition to chemistry data validation, bioassay data were evaluated by TAI to determine if EPA test acceptability criteria were met (USEPA 2000) and the data were determined to be usable. This information is summarized in Section 4.4.

4.1 OVERALL DATA QUALITY

A summary of the data validation qualifiers assigned to inorganic analytes (e.g., metals, metalloids, cations, and anions) and conventional parameters (i.e., alkalinity, DOC, TOC, hardness, pH, and grain size) by ESI are presented in Tables 4-1 to 4-7, along with the original laboratory data qualifiers. The data are deemed acceptable (i.e., usable) by the validator with the qualifiers presented, except for 37 (6) rejected sulfide concentrations in porewater, as detailed in Sections 4.3.4.3 and 4.3.6.3. The qualifiers applied by ESI were as follows:

- "J"—The concentration was considered estimated due to one or more of the following
  - Exceedance of project-specific holding time
  - Analytical interference
  - LCS, MS/MSD, or reporting limit (RL)[28] standard recovery not within acceptable range
  - High percent difference (%D) or RPD for field or laboratory QC, or
  - Concentration is between the method detection limit (MDL) and the method reporting limit (MRL)
- "R"—The data point was unusable (i.e., rejected)
- "U"—The analyte was not detected at or above the MDL
- "UJ"—The analyte was not detected, but the detection limit (DL) was considered approximate due to bias determined during data validation. In some cases, the direction of bias was indeterminate, and both detected and nondetected results were qualified in accordance with EPA guidance (e.g., results flagged "UJ" due to laboratory duplicate RPD or serial dilution exceedances)[29] (USEPA 2004).
- "U*"—The analyte was considered nondetected because a similar concentration was detected in an associated blank sample.

Data quality indicators for precision, accuracy or bias, representativeness, completeness, and comparability (PARCC) were specified in the QAPP (Exponent et al. 2013). The data validator used the measurement quality objectives (MQOs) presented in QAPP Tables B5-1 and B5-2 to evaluate sediment and porewater data for the quantitative components of PARCC (i.e., precision and accuracy or bias). In addition, a control limit of 35 percent was used to evaluate field duplicate RPDs. The data validator also assessed

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[28] RLs were determined by the laboratory based on analytical sensitivity and are included in the UCR project database.

[29] The data validation reports state that a low bias is associated with the "UJ" qualifier; however, additional information provided by ESI clarifies that the bias may be indeterminate (Weinmann 2017).

sample handling, laboratory methods, and holding times to evaluate the representativeness and comparability of analytical data. Data were qualified as necessary by ESI when MQOs were not met. A data completeness goal of 90 percent was specified in the QAPP for all sediment and porewater analytical parameter groups (Exponent et al. 2013). Data completeness was 100 percent for all analyte groups except sulfide in porewater, which was 70 percent.

4.2 SAMPLE TRANSPORT AND HOLDING TIMES

There were no sample transport issues or exceedances of holding times during transport. However, due to laboratory error, the QAPP-specified (Exponent et al. 2013) laboratory holding time of 7 days from sampling to analysis for pH in sediment was exceeded for 108 out of 150 field sediment samples (13 out of 17 laboratory QC samples) and 22 out of 29 long-term bioassay sediment samples (3 out of 4 laboratory QC samples). Based on data validation guidance, holding time exceedances generally result in the rejection of nondetected results but do not typically result in the rejection of positive results, regardless of the length of the exceedance. Depending on the sample, the holding time for pH was exceeded by 1 to 13 days. Since pH is always detected, affected results were flagged by the validator as estimated (“J” flagged).

The QAPP-specified (Exponent et al. 2013) laboratory holding time of 14 days from sampling to analysis for AVS[30] was exceeded for 2 out of 149 field sediment samples (0 out of 8 laboratory QC samples) and 1 out of 164 long-term bioassay sediment samples (0 out of 11 laboratory QC samples). Affected samples were qualified as estimated ("J" flagged).

The QAPP does not specify holding times for the bioassays beyond “as soon as possible” (ASAP). Bioassay testing was not initiated until field sampling activities were completed and the batching scheme for the short-term tests was approved by EPA (Appendix B). The final holding time for the bioassay sediments was based on the time that it took EPA to approve the batching scheme for the short-term tests and the final selection of samples to be included in the long-term tests. The extended storage time for the sediments is not likely to be a concern, because metals are expected to have stable concentrations when properly stored (i.e., refrigerated in a closed container with minimal headspace) (ASTM 2010).

4.3 SEDIMENT AND POREWATER CHEMISTRY VALIDATION RESULTS

The data for inorganic analytes and conventional parameters are usable as qualified, except for sulfide in 35 out of 99 short-term bioassay porewater samples (6 out of

[30] AVS measurements in sediment are identified as “sulfide” in the UCR sediment chemistry database.

13 laboratory QC samples) and 2 out of 26 long-term bioassay porewater samples (0 out of 3 laboratory QC samples) qualified as rejected ("R" flagged; see Sections 4.3.4.3 and 4.3.6.3). Samples with reported concentrations between the DL and the RL were qualified as estimated ("J" flagged) unless previously qualified as "U*." The following subsections summarize the data validation results separately for field-collected sediment, field porewater, short-term bioassay sediment and porewater, and long-term bioassay sediment and porewater samples.

4.3.1 Field Sediment

This section summarizes the number of concentrations qualified by ESI for field sediment (Table 4-1) and associated field equipment rinsate blank samples (Table 4-2). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory blank concentrations, field rinsate blank concentrations, and duplicate RPDs), as detailed in the subsections below.

The laboratory noted on the chain-of-custody (COC) form that one field sediment sample for AVS and SEM contained headspace. The QAPP (Exponent et al. 2013) specified that sediment samples for AVS and SEM analysis should not contain headspace. The affected sample was qualified as follows: SEM arsenic was not detected and qualified "UJ" and the remaining analytes for AVS and SEM were detected and qualified as estimated ("J" flagged).

4.3.1.1 Calibration

All calibration standard concentrations for the analysis of field sediment and equipment rinsate samples were within control limits.

4.3.1.2 Blanks

Sediment concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentrations in the associated calibration and/or preparation blanks for the following analytes and numbers of samples (laboratory QC samples shown in parentheses):

- SEM antimony – 56 (2) out of 149 (8)
- SEM copper – 2 (0) out of 149 (8)
- Total antimony – 9 (1) out of 150 (14)
- Total cadmium – 2 (0) out of 150 (14)
- Total lead – 1 (0) out of 150 (14)
- Total sodium – 2 (0) out of 150 (14)
- Total thallium – 18 (2) out of 150 (14).

The sediment concentration for SEM chromium in 1 (0) out of 149 (8) samples was qualified as estimated ("J" flagged) due to negative instrument bias for the analyte in the associated calibration blanks.

4.3.1.3 Matrix Spikes

Sediment concentrations were qualified as estimated ("J" flagged) due to MS/MSD recoveries that were not within control limits for the following analytes and numbers of samples:

- SEM copper – 10 (1) out of 149 (8)
- SEM lead – 10 (1) out of 149 (8)
- SEM zinc – 10 (1) out of 149 (8)
- Total antimony – 132 (12) out of 150 (14)
- Total barium – 11 (1) out of 150 (14)
- Total beryllium – 40 (2) out of 150 (14)
- Total chromium – 38 (2) out of 150 (14)
- Total copper – 24 (2) out of 150 (14)
- Total lead – 32 (3) out of 150 (14)
- Total manganese – 14 (2) out of 150 (14)
- Total zinc – 23 (2) out of 150 (14).

The nondetected sediment concentration for total antimony in 1 (0) out of 150 (14) samples was qualified "UJ" due to low MS recovery.

4.3.1.4 Laboratory Control Samples

All LCS concentrations for the analysis of field sediment and equipment rinsate samples were within control limits.

4.3.1.5 Laboratory Duplicates and Field Duplicates

Sediment concentrations were qualified as estimated ("J" flagged) due to laboratory duplicate RPDs that were not within control limits for the following analytes and numbers of samples:

- SEM cadmium – 15 (1) out of 149 (8)
- SEM copper – 15 (1) out of 149 (8)
- AVS – 43 (3) out of 149 (8)
- Total aluminum – 14 (2) out of 150 (14)
- Total antimony – 11 (1) out of 150 (14)
- Total beryllium – 11 (1) out of 150 (14)
- Total cadmium – 11 (1) out of 150 (14)
- Total cobalt – 11 (1) out of 150 (14)
- Total iron – 14 (2) out of 150 (14)
- Total lead – 22 (2) out of 150 (14)
- Total magnesium – 3 (1) out of 150 (14)
- Total potassium – 3 (1) out of 150 (14).

Sediment concentrations were qualified as estimated ("J" flagged) due to field duplicate RPDs that were not within control limits for the following analytes and numbers of samples:

- SEM antimony – 2 (0) out of 149 (8)
- SEM arsenic – 2 (0) out of 149 (8)
- SEM cadmium – 10 (0) out of 149 (8)
- SEM chromium – 8 (0) out of 149 (8)
- SEM copper – 10 (0) out of 149 (8)
- SEM lead – 10 (0) out of 149 (8)
- SEM nickel – 6 (0) out of 149 (8)
- SEM zinc – 10 (0) out of 149 (8)
- AVS – 8 (0) out of 149 (8)
- TOC – 2 (0) out of 149 (8)
- Total beryllium – 2 (1) out of 150 (14)
- Total calcium – 2 (0) out of 150 (14)
- Total cadmium – 2 (0) out of 150 (14)
- Total barium – 2 (0) out of 150 (14)
- Total manganese – 2 (0) out of 150 (14)
- Total mercury – 4 (0) out of 150 (13).

Sediment concentrations were qualified "UJ" due to laboratory duplicate RPDs that were not within control limits for SEM copper in 1 (0) out of 149 (8) samples and AVS in 3 (0) out of 149 (8) samples.

4.3.1.6 Interference Check Samples

Sediment concentrations were qualified as estimated ("J" flagged) due to inductively coupled plasma (ICP) interference for SEM chromium in 1 (0) out of 149 (8) samples, total chromium in 1 (1) out of 150 (14) samples, total copper in 1 (1) out of 150 (14) samples, and total lead in 1 (1) out of 150 (14) samples.

4.3.1.7 Serial Dilutions

Sediment concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for the following analytes and numbers of samples:

- Total antimony – 37 (2) out of 150 (14)
- Total arsenic – 16 (1) out of 150 (14)
- Total beryllium – 103 (8) out of 150 (14)
- Total cadmium – 26 (4) out of 150 (14)
- Total cobalt – 3 (1) out of 150 (14)
- Total nickel – 3 (1) out of 150 (14)
- Total thallium – 11 (1) out of 150 (14)
- Total zinc – 3 (1) out of 150 (14).

Equipment rinsate blank concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for total aluminum in 20 (0) out of 240 (0) samples, total calcium in 39 (0) out of 240 (0) samples, total magnesium in 18 (0) out of 240 (0) samples, and total manganese in 11 (0) out of 240 (0) samples.

4.3.1.8 Internal Standards

All internal standard concentrations for the analysis of field sediment and equipment rinsate samples were within control limits.

4.3.2 Field Porewater

This section summarizes numbers of concentrations qualified by ESI for field porewater samples (Table 4-3). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory and equipment blank concentrations, and duplicate RPDs) as listed in the subsections below.

4.3.2.1 Calibration

All calibration standard concentrations for the analysis of field porewater samples were within control limits.

4.3.2.2 Blanks

Porewater concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentration in the associated calibration, preparation, and/or equipment rinsate blanks for the following analytes and numbers of samples:

Note: the total count of samples for metals analyses was updated 5/01/19 from 102 to 101 in sections 4.3.2.2 and 4.3.2.3. The original count erroneously included one porewater field blank. Table 4-3 was not revised as it contains the correct information.

- Dissolved aluminum – 56 (5) out of 101 (6)
- Dissolved antimony – 8 (0) out of 101 (6)
- Dissolved beryllium – 17 (0) out of 101 (6)
- Dissolved cadmium – 23 (1) out of 101 (6)
- Dissolved chromium – 11 (0) out of 101 (6)
- Dissolved cobalt – 15 (1) out of 101 (6)
- Dissolved copper – 28 (3) out of 101 (6)
- Dissolved iron – 1 (0) out of 101 (6)
- Dissolved lead – 8 (1) out of 101 (6)
- Dissolved manganese – 3 (0) out of 101 (6)
- Dissolved nickel – 74 (5) out of 101 (6)
- Dissolved organic carbon – 70 (1) out of 95 (1)
- Dissolved silver – 34 (0) out of 101 (6)
- Dissolved thallium – 57 (2) out of 101 (6)
- Dissolved vanadium – 11 (0) out of 101 (6)
- Dissolved zinc – 100 (6) out of 101 (6)
- Total chloride – 89 (6) out of 93 (6)
- Total organic carbon – 56 (1) out of 95 (1).

4.3.2.3 Matrix Spikes

Porewater concentrations were qualified as estimated ("J" flagged) due to MS/MSD recoveries that were not within control limits for dissolved calcium in 20 (1) out of 101 (6) samples, chloride in 27 (2) out of 93 (6) samples, and sulfate in 17 (1) out of 93 (6) samples.

4.3.2.4 Laboratory Control Samples

All LCS concentrations for the analysis of field porewater samples were within control limits.

4.3.2.5 Laboratory Duplicates

All laboratory duplicate concentrations for the analysis of field porewater samples were within control limits.

4.3.2.6 Interference Check Samples

All interference check concentrations for the analysis of field porewater samples were within control limits.

4.3.2.7 Serial Dilutions

Porewater concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for dissolved antimony in 27 (2) out of 101 (6) samples, dissolved cadmium in 17 (1) out of 101 (6) samples, dissolved nickel in 6 (0) out of 101 (6) samples, and dissolved vanadium in 4 (0) out of 101 (6) samples.

Note: the total count of samples for metals analyses was updated 5/01/19 from 102 to 101 in section 4.3.2.7. The original count erroneously included one porewater field blank. Table 4-3 was not revised as it contains the correct information.

4.3.2.8 Internal Standards

All internal standard concentrations for the analysis of field porewater samples were within control limits.

4.3.3 Short-Term Bioassay Sediment

This section summarizes numbers of concentrations qualified by ESI for short-term bioassay sediment samples (Table 4-4). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory blank concentrations, and duplicate RPDs) as listed in the subsections below.

4.3.3.1 Calibration

All calibration standard concentrations for the analysis of short-term bioassay sediment samples were within control limits.

4.3.3.2 Blanks

Sediment concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentrations in the associated calibration and/or preparation blanks for SEM antimony in 38 (0) out of 189 (13) samples, SEM cadmium in 10 (1) out of 189 (13) samples, SEM chromium in 2 (0) out of 189 (13) samples, SEM copper in 2 (0) out of 189 (13) samples, and SEM zinc in 12 (0) out of 189 (13) samples.

4.3.3.3 Matrix Spikes

All MS concentrations for the analysis of short-term bioassay sediment samples were within control limits.

4.3.3.4 Laboratory Control Samples

All LCS concentrations for the analysis of short-term bioassay sediment samples were within control limits.

4.3.3.5 Laboratory Duplicates

Sediment concentrations were qualified as estimated ("J" flagged) due to laboratory duplicate RPDs that were not within control limits for the following analytes and numbers of samples:

- SEM arsenic – 13 (1) out of 189 (13)
- SEM cadmium – 26 (3) out of 189 (13)
- SEM chromium – 71 (5) out of 189 (13)
- SEM copper – 43 (3) out of 189 (13)
- SEM lead – 21 (2) out of 189 (13)
- SEM nickel – 21 (2) out of 189 (13)
- SEM zinc – 49 (4) out of 189 (13)
- AVS – 53 (5) out of 189 (13).

Sediment concentrations were qualified "UJ" due to laboratory duplicate RPDs that were not within control limits for SEM arsenic in 2 (0) out of 189 (13), SEM cadmium in 3 (0) out of 189 (13) samples, SEM chromium in 1 (0) out of 189 (13) samples, SEM lead in 2 (0) out of 189 (13) samples, SEM nickel in 1 (0) out of 189 (13), and AVS in 15 (0) out of 189 (13) samples.

4.3.3.6 Interference Check Samples

Sediment concentrations were qualified as estimated ("J" flagged) due to ICP interference for SEM antimony in 3 (0) out of 189 (13) samples, SEM cadmium in 4 (0) out of 189 (13) samples, and SEM lead in 1 (0) out of 189 (13) samples.

4.3.3.7 Serial Dilutions

Sediment concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for SEM nickel in 19 (1) out of 189 (13) samples.

4.3.3.8 Internal Standards

All internal standard concentrations for the analysis of short-term bioassay sediment samples were within control limits.

4.3.4 Short-Term Bioassay Porewater

This section summarizes numbers of concentrations qualified by ESI for short-term bioassay porewater samples and associated peeper blanks (Table 4-5). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory and peeper blank concentrations, and duplicate RPDs) as listed in the subsections below.

4.3.4.1 Calibration

All calibration standard concentrations for the analysis of short-term bioassay porewater and peeper blank samples were within control limits.

4.3.4.2 Blanks

Porewater concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentrations in the associated laboratory and/or equipment blanks for the following analytes and numbers of samples:

- Dissolved aluminum – 115 (7) out of 276 (19)
- Dissolved antimony – 146 (5) out of 276 (19)
- Dissolved barium – 2 (0) out of 276 (19)
- Dissolved cadmium – 73 (6) out of 276 (19)
- Dissolved chromium – 40 (1) out of 276 (19)
- Dissolved cobalt – 3 (1) out of 276 (19)
- Dissolved copper – 104 (4) out of 276 (19)
- Dissolved iron – 7 (1) out of 276 (19)
- Dissolved lead – 70 (4) out of 276 (19)
- Dissolved nickel – 15 (1) out of 276 (19)
- Dissolved silver – 6 (0) out of 276 (19)
- Dissolved thallium – 87 (9) out of 276 (19)
- Dissolved zinc – 194 (10) out of 276 (19).

4.3.4.3 Matrix Spikes

Nondetected porewater concentrations were qualified as rejected ("R" flagged) for sulfide in 35 (6) out of 99 (13) samples and detected concentrations were qualified as estimated ("J" flagged) for sulfide in 10 (1) out of 99 (13) samples. Turbidity in these samples interfered with the colorimetric sulfide analysis and the associated MS/MSD recoveries were very low (< 30 percent). Sulfide concentrations were rejected for the following:

- 26 UCR study area samples—PW-4-B3-T1, PW-5-B1-T1, PW-5-B2-T1, PW-5-B3-T1, PW-5-B4-T1, PW-5-B5-T1, PW-5-B6-T1, PW-6-B1-T1, PW-6-B2-T1, PW-6-B5-T1, PW-6-B6-T1, PW-6-R3-T1, PW-7-B1-T1, PW-7-B2-T1, PW-7-B3-T1, PW-7-B4-T1, PW-7-B5-T1, PW-7-B6-T1, PW-8-B1-T1, PW-8-B2-T1, PW-8-B3-T1, PW-8-B4-T1, PW-8-B5-T1, PW-REF-3-T1, PW-REF-5-T1, and PW-REF-7-T1

- Six laboratory duplicate samples—PW-5-B2-T1DUP, PW-5-B3-T1DUP, PW-5-B4-T1DUP, PW-5-B5-T1DUP, PW-6-B2-T1DUP and PW-8-B3-T1DUP
- Six control samples—PW-CTL-ERDC-B1-T1, PW-CTL-ERDC-B2-T1, PW-CTL-ERDC-B3-T1, PW-CTL-ERDC-B4-T1, PW-CTL-ERDC-B5-T1, and PW-CTL-ERDC-B6-T1
- Three external reference and tributary samples—PW-LAL-1-T1, PW-LAL-5-T1, and PW-TRIB-1-T1.

4.3.4.4 Laboratory Control Samples

Porewater concentrations were qualified as estimated ("J" flagged) due to laboratory control sample duplicate (LCSD) recoveries and/or RPDs that were not within control limits for sulfide in 2 (0) out of 99 (13) samples.

4.3.4.5 Laboratory Duplicates

Porewater concentrations were qualified as estimated ("J" flagged) due to laboratory duplicate RPDs that were not within control limits for dissolved thallium in 3 (1) out of 276 (19) samples and sulfide in 7 (0) out of 99 (13) samples.

Nondetected porewater concentrations were qualified "UJ" due to laboratory duplicate RPDs that were not within control limits for dissolved thallium in 7 (0) out of 276 (19) samples.

4.3.4.6 Interference Check Samples

All interference check concentrations for the analysis of short-term bioassay porewater and peeper blank samples were within control limits.

4.3.4.7 Serial Dilutions

Porewater concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for the following analytes and numbers of samples:

- Dissolved arsenic – 15 (1) out of 276 (19)
- Dissolved barium – 15 (1) out of 276 (19)
- Dissolved cadmium – 1 (1) out of 276 (19)
- Dissolved cobalt – 10 (1) out of 276 (19)
- Dissolved iron – 15 (1) out of 276 (19)
- Dissolved lead – 13 (1) out of 276 (19)
- Dissolved manganese – 33 (2) out of 276 (19)
- Dissolved zinc – 4 (0) out of 276 (19).

Peeper blank concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for dissolved barium in 1 (0) out of 276 (19) samples, dissolved iron in 1 out of 276 (19) samples, dissolved lead in 1 (0) out of 276 (19) samples, dissolved manganese in 2 (0) out of 276 (19) samples, and dissolved zinc in 1 (0) out of 276 (19) samples.

4.3.4.8 Internal Standards

All internal standard concentrations for the analysis of short-term bioassay porewater and peeper blank samples were within control limits.

4.3.5 Long-Term Bioassay Sediment

This section summarizes numbers of concentrations qualified by ESI for long-term bioassay sediment samples (Table 4-6). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory blank concentrations, and duplicate RPDs) as listed in the subsections below.

The collection date for sample SE-5-B4-CD50-T42-B3 reported on the analytical laboratory results summary form (April 16, 2015) did not match the collection date listed on the COC (April 12, 2015). The correct sampling date is April 12, 2015, as shown on the COC. The laboratory report was not revised, but the discrepancy was noted in the validation report, and the correct collection date is listed in the project database.

4.3.5.1 Calibration

All calibration standard concentrations for the analysis of long-term bioassay sediment were within control limits.

4.3.5.2 Blanks

Sediment concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentrations in the associated laboratory blanks for the following analytes and numbers of samples:

- Antimony – 4 (0) out of 29 (3)
- Calcium – 1 (0) out of 29 (3)
- Lead – 1 (0) out of 29 (3)
- SEM antimony – 13 (1) out of 164 (11)
- SEM chromium – 3 (0) out of 164 (11)
- SEM zinc – 6 (0) out of 164 (11)
- Sodium – 1 (0) out of 29 (3)
- Thallium – 9 (0) out of 29 (3)
- Zinc – 1 (0) out of 29 (3).
-

4.3.5.3 Matrix Spikes

Sediment concentrations were qualified as estimated ("J" flagged) due to MS/MSD recoveries that were not within control limits for antimony in 24 (3) out of 29 (3) samples, manganese in 7 (1) out of 29 (3) samples, potassium in 14 (1) out of 29 (3) samples, and zinc in 7 (1) out of 29 (3) samples.

Nondetected sediment concentrations were qualified "UJ" due to low MS recoveries for antimony in 1 (0) out of 29 (3) samples and potassium in 1 (0) out of 29 (3) samples.

4.3.5.4 Laboratory Control Samples

All LCS concentrations for the analysis of long-term bioassay sediment were within control limits.

4.3.5.5 Laboratory Duplicates

Sediment concentrations were qualified as estimated ("J" flagged) due to laboratory duplicate RPDs that were not within control limits for the following analytes and numbers of samples:

- Antimony – 7 (1) out of 29 (3)
- AVS – 29 (2) out of 164 (11)
- Copper – 7 (1) out of 29 (3)
- Manganese – 7 (1) out of 29 (3)
- SEM cadmium – 13 (1) out of 164 (11)
- Silver – 7 (1) out of 29 (3).

The nondetected sediment concentrations were qualified "UJ" due to laboratory duplicate RPDs that were not within control limits for AVS in 6 (0) out of 164 (11) samples and SEM cadmium in 2 (0) out of 164 (11) samples.

4.3.5.6 Interference Check Samples

Sediment concentrations were qualified as estimated ("J" flagged) due to ICP interference for the following analytes and numbers of samples:

- Magnesium – 13 (2) out of 29 (3)
- SEM antimony – 30 (4) out of 164 (11)
- SEM arsenic – 8 (1) out of 164 (11)
- SEM cadmium – 91 (9) out of 164 (11)
- SEM chromium – 67 (6) out of 164 (11)
- SEM copper – 59 (5) out of 164 (11)
- SEM lead – 3 (0) out of 164 (11)
- SEM nickel – 37 (4) out of 164 (11)
- Sodium – 14 (1) out of 29 (3).

4.3.5.7 Serial Dilutions

Sediment concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for barium in 14 (1) out of 29 (3) samples, SEM cadmium in 58 (5) out of 164 (11) samples, SEM copper in 13 (0) out of 164 (11) samples, and zinc in 7 (1) out of 29 (3) samples.

Nondetected sediment concentrations were qualified "UJ" due to high serial dilution %D for barium in 1 (0) out of 29 (3) samples and SEM cadmium in 5 (0) out of 164 (11) samples.

4.3.5.8 Internal Standards

All internal standard concentrations for the analysis of long-term bioassay sediment were within control limits.

4.3.6 Long-Term Bioassay Porewater

This section summarizes numbers of concentrations qualified by ESI for long-term bioassay porewater samples and associated peeper blanks (Table 4-7). Numbers of qualified sample results (excluding laboratory QC samples) are shown, followed by the number of qualified laboratory QC samples in parentheses. Qualifiers were applied as needed based on an evaluation of various QC factors (e.g., LCS and MS recoveries, laboratory and peeper blank concentrations, and duplicate RPDs) as listed in the subsections below.

Because of turbidity that persisted after centrifuging, many porewater samples were diluted prior to sulfide analysis. The RLs and MDLs for sulfide in the affected samples were raised accordingly.

Two sample containers, labeled "clean" and "fouled," were received by the analytical laboratory for sample PW-1B-R2-CD50-T21-B1. The COC indicated that the container labeled "clean" should be analyzed. Because the analytical laboratory reported results for both aliquots, the data validator marked the results for the "fouled" aliquot as not reportable by the data validator.[31]

The collection date for sample PW-5-B4-CD50-T42-B3 reported on the analytical laboratory results summary form (April 16, 2015) did not match the collection date listed on the COC (April 12, 2016). The correct sampling date is April 12, 2015, as shown on the COC. The laboratory report was not revised, but the discrepancy was noted in the validation report, and the correct collection date is listed in the project database.

4.3.6.1 Calibration

All calibration standard concentrations for the analysis of long-term bioassay porewater and peeper blank samples were within control limits.

[31] "Fouled" indicates that the sample was collected from a peeper with a discolored membrane. Peepers for the collection of porewater were placed in sediments in triplicate. As stated in Appendix E, if peeper membrane fouling was identified in any of the triplicates during peeper retrieval and processing, porewater samples from the peeper with the fouled membrane were collected separately from porewater samples from the peepers with the non-fouled membrane.

4.3.6.2 Blanks

Porewater concentrations were qualified as nondetected ("U*" flagged) due to the presence of the analyte at similar concentrations in the associated laboratory and/or peeper blanks for the following analytes and numbers of samples:

- Dissolved aluminum – 138 (5) out of 226 (15)
- Dissolved antimony –150 (1) out of 226 (15)
- Dissolved beryllium – 1 (0) out of 226 (15)
- Dissolved cadmium –14 (1) out of 226 (15)
- Dissolved chromium – 8 (0) out of 226 (15)
- Dissolved cobalt – 2 (0) out of 226 (15)
- Dissolved copper – 106 (0) out of 226 (15)
- Dissolved iron –14 (2) out of 226 (15)
- Dissolved lead –74 (2) out of 226 (15)
- Dissolved silver – 2 (0) out of 226 (15)
- Dissolved thallium – 63 (8) out of 226 (15)
- Dissolved zinc –180 (4) out of 226 (15).

Porewater concentrations were qualified as estimated ("J" flagged) due to negative instrument bias in the associated calibration blanks for dissolved cadmium in 3 (1) out of 226 (15) samples and dissolved thallium in 8 (0) out of 226 (15) samples.

Nondetected concentrations were qualified "UJ" due to negative instrument bias in the associated calibration blanks for dissolved cadmium in 11 (0) out of 226 (15) porewater samples, dissolved thallium in 6 (0) out of 226 (15) porewater samples, and dissolved cadmium and dissolved thallium in 1 (0) out of 15 (0) peeper blanks.

4.3.6.3 Matrix Spikes

Nondetected porewater concentrations were qualified as rejected ("R" flagged) for sulfide in 2 (0) out of 26 (3) samples and detected concentrations were qualified as estimated ("J" flagged) for sulfide in 10 (2) out of 26 (3) samples. The associated MS/MSD recoveries were very low (< 30 percent). The laboratory suspected that the oxidizing nature of the samples caused the low bias. Sulfide concentrations were rejected for samples PW-3-R8-T0-B3 and PW-G-2-T0-B3.

Porewater concentrations were qualified as estimated ("J" flagged) due to MS/MSD recoveries that were not within control limits for chloride in 14 (2) out of 26 (4) samples.

4.3.6.4 Laboratory Control Samples

All LCS concentrations for the analysis of long-term bioassay porewater and peeper blank samples were within control limits.

4.3.6.5 Laboratory Duplicates

Porewater concentrations were qualified as estimated ("J" flagged) due to laboratory duplicate RPDs that were not within control limits for dissolved cadmium in 4 (1) out of 226 (15) samples.

Nondetected concentrations were qualified "UJ" due to laboratory duplicate RPDs that were not within control limits for dissolved cadmium in 12 (0) out of 226 (15) porewater samples and 1 (0) out of 15 (0) peeper blanks.

4.3.6.6 Interference Check Samples

All interference check concentrations for the analysis of long-term bioassay porewater and peeper blank samples were within control limits.

4.3.6.7 Serial Dilutions

Porewater concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for dissolved antimony in 9 (2) out of 226 (15) samples, dissolved calcium in 14 (1) out of 26 (3) samples, dissolved hardness in 14 (1) out of 26 (3) samples, dissolved lead in 13 (1) out of 226 (15) samples, and dissolved manganese in 15 (1) out of 226 (15) samples.

Peeper blank concentrations were qualified as estimated ("J" flagged) due to high serial dilution %D for dissolved antimony in 1 (0) out of 15 (0) samples, dissolved lead in 1 (0) out of 15 (0) samples, and dissolved manganese in 1 (0) out of 15 (0) samples.

Nondetected concentrations were qualified "UJ" due to high serial dilution %D for dissolved antimony in 1 (0) out of 226 (15) porewater samples and 1 (0) out of 15 (0) peeper blanks.

4.3.6.8 Internal Standards

All internal standard concentrations for the analysis of long-term bioassay porewater and peeper blank samples were within control limits.

4.4 BIOASSAY ACCEPTABILITY ASSESSMENT

The short- and long-term bioassays incorporated standard QA/QC procedures for evaluating the validity of the test results according to EPA (USEPA 2000) and ASTM (2010) guidelines and as described in the QAPP (Exponent et al. 2013). Standard QA/QC procedures included the use of negative controls, positive controls (to assess the sensitivity of test organisms to toxic stress), and the periodic measurement of water quality during testing. A full discussion of the QA/QC procedures is included in the PER bioassay laboratory report (Appendix E).

Sections 4.4.1 and 4.4.2 discuss the test acceptability criteria and performance goals that were met for the short- and long-term bioassays, respectively. As previously stated in Section 2, the test acceptability criteria must be met in order for a test to be considered acceptable; all other test acceptability requirements are considered performance goals.

4.4.1 Short-Term Tests

Negative control performance was evaluated for each of the six batches conducted in the short-term chronic *C. dilutus* and *H. azteca* bioassays. Table 4-8a summarizes results for the PER negative laboratory control (i.e., CTL-SS) included in each batch for both short-term bioassays and provides the applicable test acceptability requirements from Table 2-10. Table 4-8b summarizes the results for the quartz sand (CTL-QS) and the negative control sediment provided by USACE ERDC (CTL-ERDC), which are considered auxiliary controls. However, as discussed in Section 2.4.2, the auxiliary controls were not intended for use in assessing test acceptability.

Organisms used in the short-term *C. dilutus* test met the test acceptability criterion for starting age (i.e., 2nd to 3rd instar larvae, or about 10-day old larvae). Organisms used in the short-term *H. azteca* test met the performance goal for starting age (i.e., 7- to 8-day old). As discussed in Section 2 and documented in Appendix E, all test organisms used in each batch of the short-term bioassays were obtained from the same commercial supplier; test organisms were cultured at the appropriate temperature (23 °C ± 1 °C).[32] Mean starting weights of the organisms met the test-specific performance goal in Batch 1 of the *C. dilutus* test and in Batches 5-RE and 6 of the *H. azteca* test, as summarized in Table 4-9. The sources of control sediments and overlying water used in the short-term bioassays are documented in Section 2 and Appendix E.[33,34]

Negative control results for *C. dilutus* were acceptable (i.e., mean control survival of at least 70 percent and minimum AFDW of at least 0.48 mg per surviving organism) in the six batches for the PER control negative sediment (CTL-SS).

Negative control results for *H. azteca* were acceptable (i.e., mean survival of at least 80 percent and recommended weight of at least 0.4 mg per surviving organism) for the PER control negative sediment (CTL-SS), with the exception of survival for Batch No. 5, which was re-run with sediment from the same sampling locations (Batch No. 5-RE). Negative control results were acceptable in Batch No. 5-RE and are presented in this

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[32] *C. dilutus* egg cases were supplied by Environmental Consulting & Testing (Superior, Wisconsin); *H. azteca* were supplied by Aquatic BioSystems, Inc. (Fort Collins, Colorado). Organism history documents are provided in Appendix E.

[33] The PER negative control sediment (CTL-SS) consisted of a blend of ambient sediment collected from reference sites in San Francisco Bay and then maintained under freshwater conditions in the laboratory for 1 month prior to use. The ERDC auxiliary control sediment (CTL-ERDC) is negative control sediment used by the USACE.

[34] Overlying water used in the long-term bioassays was reformulated, moderately hard reconstituted water (USEPA 2000) for the *C. dilutus* test and reconstituted water formulated following Borgmann (1996) and modified to contain 0.4 mg/L of bromide for the *H. azteca* test.

report.[35] A comparison of growth in the PER laboratory control with that in the quartz sand following recommendations by Mount (2011b) indicated that weight in the PER laboratory control (CTL-SS) was greater than 20 percent of weight in the quartz sand (CTL-QS) in two of the six batches for both *C. dilutus* and *H. azteca* (Batch Nos. 5 and 6 for *C. dilutus* and Nos. 1 and 6 for *H. azteca)*.

During the tests, the test acceptability criteria for temperature were met (e.g., daily temperature of 23 °C ± 1°, instantaneous temperature of 23 °C ± 3 °C). Testing conducted with *C. dilutus* and *H. azteca* also met the performance goals for water quality of the overlying water (i.e., hardness, alkalinity, and ammonia levels). As discussed in Section 3.2, DO concentrations below the lower limit of 2.5 mg/L were observed in replicates for some Site, tributary, upstream, and negative control samples (85 percent of the samples) in the *C. dilutus* bioassays during the evening check on DO levels. The lowest DO concentration observed was 1.0 mg/L. Aeration was immediately initiated in all replicates for those samples, and DO concentrations remained at acceptable levels for the duration of the tests. Table 4-10 summarizes the range of DO concentrations and instances of aeration triggers during the short-term bioassays. Given the brief duration of DO excursions, and the fact that studies have shown that midge survival and growth were not impaired by DO concentrations of 1.2 mg/L during 10-day *C. dilutus* exposures (Irving et al. 2004), it is expected that the data quality of the *C. dilutus* bioassay was not impacted by the drops in DO concentrations. Water quality data including temperature for each batch of the short-term bioassays are provided in Appendix E.

In addition to the negative and auxiliary controls, positive controls were evaluated for each test. The positive controls consisted of 96-hour reference toxicant tests conducted with the same batch of test organisms as those used in the sediment bioassays, and using sodium chloride and potassium chloride as the reference toxicant for *C. dilutus* and *H. azteca*, respectively. Positive control results for both *C. dilutus* and *H. azteca* were acceptable. LC50 (concentration that is lethal to 50 percent of an exposed population) values for the positive control tests conducted for the test organisms fell within ± 2 standard deviations of the laboratory's historical mean value, indicating that the test organisms responded as anticipated to the known toxicant. The positive control results are provided in the bioassay laboratory report in Appendix E. For reference toxicity tests associated with *C. dilutus* Batch Nos. 1, 3, and 5, laboratory control survival was below acceptable limits (mean survival of at least 90 percent). A reference toxicant test was re-run using the same batch of test organisms that had been used to initiate the original reference toxicant test and the corresponding sediment. The survival responses in the repeated tests were within acceptable control survival limits, with the exception of the re-test of Batch No. 1 that was initiated with older organisms that may have been less

[35] Results for the initial Batch No. 5 for *H. azteca* that did not meet test acceptability criteria for negative control performance are not presented in this report but are included in the bioassay laboratory report (Appendix E).

sensitive (see the PER bioassay report in Appendix E). In the *H. azteca* reference toxicant tests, the laboratory control survival response was acceptable for all batches.

4.4.2 Long-Term Tests

Negative control performance was evaluated for each of the three batches for the long-term *C. dilutus* and *H. azteca* bioassays. Table 4-11a and Table 4-12a summarize results for the negative control (i.e., CTL-SS) included in each batch for *C. dilutus* and *H. azteca*, respectively, and provides the applicable test acceptability requirements from Table 2-11. Tables 4-11b and 4-12b summarize the results for the quartz sand (CTL-QS) for *C. dilutus* and *H. azteca*, respectively.

The test acceptability criterion for organism start age (i.e., < 4-day old) was met for the long-term *C. dilutus* bioassay. As documented in Appendix E, all test organisms used in each batch of the *H. azteca* long-term bioassay were obtained from same commercial supplier,[36] while larvae used in *C. dilutus* long-term bioassay were cultured by PER;[37] test organisms were cultured at the appropriate temperature (23 °C ± 1 °C). As summarized in Table 4-9, mean starting weights of the organisms for the long-term *H. azteca* test were slightly below the performance goal for starting weight; however, the starting age of the organisms used in the test met the performance goal for starting age. The sources of control sediments and overlying water used in the short-term bioassays are documented in Section 2 and Appendix E.[38,39]

Negative control results for *C. dilutus* were acceptable (i.e., mean survival of at least 70 percent and minimum AFDW of at least 0.48 mg per surviving organism on Test Day 16, mean emergence of at least 50 percent, and mean number of eggs per egg case of at least 800) in the three batches for the PER negative control sediment (CTL-SS) (Table 4-11). Results in the PER negative control sediment were also acceptable for mean percent hatch for all three batches with results of at least 80 percent.

[36] *H. azteca* were supplied by Aquatic BioSystems, Inc. Organism history documents are provided in Appendix E.

[37] PER cultured *C. dilutus* larvae from egg cases supplied by Environmental Consulting & Testing for the short-term bioassay.

[38] The PER negative control sediment (CTL-SS) was a blend of ambient sediment collected from reference sites in San Francisco Bay and then maintained under freshwater conditions in the laboratory for 1 month prior to use. The ERDC auxiliary control sediment (CTL-ERDC) is negative control sediment used by the USACE.

[39] Overlying water used in the long-term bioassays was reformulated, moderately hard reconstituted water (USEPA 2000) for the *C. dilutus* test and reconstituted water formulated following Borgmann (1996) and modified to contain 0.4 mg/L of bromide for the *H. azteca* test.

Results for *H. azteca* were acceptable (i.e., mean control survival of at least 80 percent) for the PER negative control sediment; survival at the end of the test (Test Day 42) was also > 80 percent (Table 4-12). The PER negative control sediment met the minimum weight requirement of at least 0.4 mg per surviving organism on Test Day 28 and 0.5 mg per surviving organism on Test Day 42. The number of offspring per surviving female at the end of the test was greater than two, which was above the number reported in round-robin testing by 71 percent of participating laboratories (USEPA 2000).

A comparison of growth in the PER negative laboratory control with that in the quartz sand following recommendations by Mount (2011b) indicated that weight in the PER negative laboratory control (CTL-SS) was greater than 20 percent of weight in the quartz sand (CTL-QS) in one batch (Batch No. 3) on Test Day 16 in the *C. dilutus* bioassay. In the *H. azteca* bioassay, weight in the PER negative laboratory control (CTL-SS) was greater than 20 percent of weight in the quartz sand (CTL-QS) in all three batches on Test Day 28 and in one batch (Batch No. 1) on Test Day 42.

During the long-term tests, the test acceptability criteria for temperature were met (e.g., daily temperature of 23 °C ± 1°, instantaneous temperature of 23 °C ± 3 °C). Testing conducted with *C. dilutus* and *H. azteca* also met the performance goals for water quality of the overlying water (i.e., hardness, alkalinity, and ammonia levels). DO concentrations below the lower limit of 2.5 mg/L were observed for replicates in some samples (Site, tributary, upstream, and negative control samples) during the evening check on DO concentrations (all samples in the *C. dilutus* bioassays and 47 percent of the samples in the *H. azteca* bioassays). Aeration was immediately initiated in all replicates for those samples, and DO levels remained at acceptable levels for the duration of the tests.[40] Table 4-13 summarizes the range of DO concentrations and instances of aeration triggers during the long-term bioassays. Water quality data including temperature for each batch of the long-term bioassays are provided in Appendix E.

In addition to the negative and auxiliary controls, positive controls were evaluated for each long-term test. The positive controls consisted of 96-hour reference toxicant tests conducted with the same batch of test organisms as those used in the sediment bioassays, and using sodium chloride and potassium chloride as the reference toxicant for *C. dilutus* and *H. azteca*, respectively. Positive control results for both *C. dilutus* and *H. azteca* were acceptable. LC50 values for the positive controls conducted for the test organisms fell within ± 2 standard deviations of the laboratory's historical mean value, indicating that the test organisms responded as anticipated to the known toxicant. The positive control results are provided in the laboratory report in Appendix E.

[40] Aeration in the *H. azteca* bioassays was terminated on Test Day 28 when organisms were transferred to the water-only exposure.

5 SUMMARY OF DATA

This section includes summary statistics for all usable data, an evaluation of field QC samples, and a summary of MDLs for nondetected samples. Summary statistics for field and bioassay sediment and porewater are presented by sampling location type (i.e., Site, tributary, upstream, and control samples) and include the number of detected values and the minimum, maximum, and mean values for each analyte. Rejected data (see Section 4) were not used in the data summaries; however, all data are included in the project database. Summary statistics are presented in tables, and sample-specific results are presented in tables and figures, as follows:

- Sediment data
  - Field—Table 5-1 and Figures 5-1a to 5-1al
  - Short-term bioassay—Tables 5-2a and 5-2b and Figures 5-2a to 5-2m
  - Long-term bioassay—Tables 5-3a to 5-3d and Figures 5-3a to 5-3al
- Porewater data
  - Field—Table 5-4 and Figures 5-4a to 5-4ab
  - Short-term bioassay—Tables 5-5a to 5-5d and Figures 5-5a to 5-5ac
  - Long-term bioassay—Tables 5-6a to 5-6f and Figures 5-6a to 5-6ac.

In accordance with the draft data management plan (Exponent 2010), field duplicate samples were averaged prior to the calculation of summary statistics (detected values were averaged; if there were no detected values, the minimum DL was used). In the summary statistics, nondetected results are represented in calculations as one-half of the MDL. Data for EPA split samples, equipment rinsate blanks, and laboratory QA/QC samples, such as MS/MSDs, are not included in the data summaries.

The QAPP (Exponent et al. 2013) identified ecological screening criteria for porewater and toxicity benchmark values for sediment that were used to derive analytical concentration goals (ACGs). For some porewater analytes, more than one screening value was included in the QAPP. In such cases, the lowest value was used as the ACG. The actual MDLs for nondetected samples were compared with ACGs, as summarized in Tables 5-7a to 5-7e.

5.1 SEDIMENT CHEMISTRY

5.1.1 Field Sediment

For field sediment, summary statistics for conventional parameters, metals, AVS, and SEM are presented by sampling location type (i.e., Site and tributary and upstream locations) in Table 5-1. Results are presented by individual sample according to the river mile designation along the x-axis[41] (Figures 5-1a to 5-1d for conventionals, Figures 5-1e to 5-1aa for metals/metalloids, and Figures 5-1ab to 5-1aj for individual SEM and AVS). Calculated values for total SEM (i.e., sum of SEM for cadmium, copper, nickel, lead, and zinc) and excess SEM (i.e., total SEM minus AVS) are presented in Figures 5-1ak and 5-1al.

5.1.2 Bioassay Sediment

For sediment from the short-term bioassays that were conducted using subsamples of the field sediment, summary statistics for conventional parameters and SEM are presented, by sampling location type, in Table 5-2a for *C. dilutus* on Test Day 7 and Table 5-2b for *H. azteca* on Test Day 21. Results are presented by individual sample in Figures 5-2a and 5-2b for conventionals and Figures 5-2c to 5-2k for individual SEM and AVS. Calculated values for total SEM and excess SEM are presented in Figures 5-2l and 5-2m.

For sediment from the long-term bioassays, summary statistics for conventional parameters and SEM are presented by sampling location type in Tables 5-3a to 5-3d for *C. dilutus* and *H. azteca* at the start of the test, *C. dilutus* on Test Day 21, *H. azteca* on Test Day 21, and *C. dilutus* on Test Day 42, respectively. Table 5-3a also presents TAL metals/metalloids for *C. dilutus* and *H. azteca* at the start of the long-term tests. Results are presented by individual sample in Figures 5-3a to 5-3d for conventionals, Figures 5-3e to 5-3aa for metals/metalloids, and Figures 5-1ab to 5-1aj for individual SEM and AVS. Calculated values for total SEM and excess SEM are presented in Figures 5-3ak and 5-3al.

5.2 POREWATER CHEMISTRY

5.2.1 Field Porewater

For field porewater, summary statistics for conventional parameters and dissolved metals are presented by sampling location type (i.e., Site and tributary and upstream locations) in Table 5-4. Results are presented by individual sample in Figures 5-4a to 5-4f for conventional parameters and Figures 5-4g to 5-4ab for dissolved metals/metalloids.

5.2.2 Bioassay Porewater

For porewater from the short-term bioassays, summary statistics for conventional parameters and dissolved metals are presented by sampling location type in Table 5-5a for *C. dilutus* and *H. azteca* at the start of the test (for conventional parameters, calcium, magnesium, potassium, and sodium only) and in Tables 5-5b to 5-5d for *C. dilutus* on Test Day 7, *H. azteca* on Test Day 7, and *H. azteca* on Test Day 21, respectively. Table 5-5a

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[41] Appendix G presents the system used for assigning river mile delineations on the Columbia River as well as river mile designations for each sample.

includes summary data for porewater samples that were collected at the beginning of the retests for the one batch of samples that had low survival of control test organisms and were subsequently restarted (see Section 4.4.1). Results are presented by individual sample in Figures 5-5a to 5-5g for conventional parameters and Figures 5-5h to 5-5ac for dissolved metals/metalloids.

For porewater from the long-term bioassays, summary statistics for conventional parameters and dissolved metals are presented by sampling location type in Table 5-6a for *C. dilutus* and *H. azteca* at the start of the test (for conventional parameters, calcium, magnesium, potassium, and sodium only) and in Tables 5-6b to 5-6f for *C. dilutus* on Test Day 7, *H. azteca* on Test Day 7, *C. dilutus* on Test Day 21, *H. azteca* on Test Day 21, and *C. dilutus* on Test Day 42, respectively. Results are presented by individual sample in Figures 5-6a to 5-6g for conventional parameters and Figures 5-6h to 5-6ac for dissolved metals/metalloids.

5.3 FIELD QC SUMMARY

Field duplicates were collected for 14 field sediment samples. There were no field duplicates for porewater samples. Duplicate RPDs are summarized in Table 5-8. A control limit of 35 percent was used to evaluate field duplicates (Exponent et al. 2013). Results for field duplicate pairs with RPDs greater than 35 percent were qualified as estimated ("J" flagged) by the data validator. Duplicate RPDs greater than 35 percent were as follows (summarized by type of sampling location):

- Site samples
  - Grain size – 20 (total of all grain size categories) out of 108 data points (18.5 percent)
  - Other conventional parameters – 8 (for organic carbon and sulfide) out of 48 data points (16.7 percent)
  - Metals/metalloids – 7 (for beryllium, cadmium, mercury, and thallium) out of 276 data points (2.5 percent)
  - SEM metals – 32 (for all eight metals) out of 96 data points (33.3 percent)
- Tributary and upstream samples
  - Grain size – 2 (for very fine sand category) out of 18 data points (11.1 percent)
  - Other conventional parameters – 0 out of 8 data points
  - Metals/metalloids – 5 (for antimony, barium, calcium, and manganese) out of 46 data points (10.9 percent)
  - SEM metals – 3 (for arsenic, cadmium, and chromium) out of 16 data points (18.7 percent).

5.4 EVALUATION OF METHOD DETECTION LIMITS FOR NONDETECTED SAMPLES

Tables 5-7a to 5-7e present the minimum and maximum MDLs for nondetected metals results compared with the ACGs for field sediment, sediment from long-term bioassays, field porewater, porewater from short-term bioassays, and porewater from long-term bioassays, respectively. The MDL comparison did not apply to short-term bioassay sediment samples because those samples were analyzed only for AVS/SEM, and ACGs for AVS/SEM were not included in the QAPP (Exponent et al. 2013).

The QAPP (Exponent et al. 2013) did not include ACGs for conventional parameters except for chloride in porewater. There were no nondetected results for chloride.

5.4.1 Sediment

The MDLs for all nondetected metals in field and long-term bioassay sediment samples were less than the ACGs (Tables 5-7a and 5-7b).

5.4.2 Porewater

For field porewater, the nondetected metals in sample MDLs were less than the ACGs for all metals except zinc (Table 5-7c). Of 101 field-collected porewater results for zinc, 100 were not detected, and 38 of the nondetects had MDLs greater than the ACG.

The MDLs for all nondetected metals in short- and long-term bioassay porewater samples were less than the ACGs (Tables 5-7d and 5-7e).

5.5 BIOASSAYS

This section presents the results of the short- and long-term bioassays conducted using bulk surface sediment samples collected from 53 Site locations (including 9 potential reference locations), 6 tributary locations, and 10 locations upstream of the Site. The bioassay laboratory report is provided in Appendix E.

5.5.1 Short-Term Bioassays

Data summaries for the short-term chronic *C. dilutus* and *H. azteca* bioassays are presented in Tables 5-9a and 5-9b, respectively. Results for each endpoint are presented on Figures 5-7a to 5-7c for *C. dilutus* and Figures 5-8a to 5-8c for *H. azteca*. Data are presented by batch and include results for Site, tributary, and upstream locations, negative control samples and auxillary controls (quartz sand and ERDC control sediment).

5.5.1.1 10-day *C. dilutus* Bioassay

Mean *C. dilutus* survival in Site samples ranged from 35 percent (SE-6-B4) to 100 percent (SE-3-R1) (Table 5-9a). Mean weight ranged from 0.703 mg AFDW/individual (SE-6-B2) to 2.50 mg AFDW/individual (SE-5-B3). Mean biomass ranged from 0.575 mg AFDW/individual (SE-6-B2) to 1.74 mg AFDW/individual (SE-3-R2). Table 5-10 summarizes the occurrence of *C. dilutus* pupation during the 10-day exposure. Pupation of the larvae occurred prior to the end of the test at Day 10 in 2 of the 6 batches (Batch Nos. 1 and 4). Percent pupation in those two batches ranged from 0.0 to 5.0 percent. None of the organisms emerged as adults during the test.

5.5.1.2 28-day *H. azteca* Bioassay

Mean *H. azteca* survival in Site samples ranged from 66 percent (SE-3-B3) to 100 percent (SE-1-R1, SE-2-B2, SE-5-B4, SE-REF-1, and SE-REF-10b) (Table 5-9b). Mean weight ranged from 0.258 mg/individual (SE-7-B5) to 0.881 mg/individual (SE-5-B6). Mean biomass ranged from 0.202 mg/individual at SE-7-B5 to 0.835 mg/individual (SE-5-B6).

5.5.2 Long-Term Bioassays

Data summaries for the long-term *C. dilutus* and *H. azteca* bioassays are presented in Tables 5-11a and 5-11b, respectively. Results for each endpoint are presented on Figures 5-9a to 5-9f for *C. dilutus* and on Figures 5-10a to 5-10g for *H. azteca*. Results are presented by batch for Site, tributary, and upstream locations, negative control samples and auxillary controls (quartz sand and ERDC control sediment).

5.5.2.1 Life-cycle *C. dilutus* Bioassay

The *C. dilutus* test was terminated when 7 days had passed without observation of emergence. Endpoints of survival, weight, and biomass were evaluated on Test Day 16. Mean survival in Site samples on Test Day 16 ranged from 63 percent (SE-3-R8) to 100 percent (SE-REF-10b) (Table 5-11a). Mean weight on Test Day 16 ranged from 0.88 mg AFDW/individual (SE-3-R8) to 1.99 mg AFDW/individual (SE-7-B5). Mean biomass on Test Day 16 ranged from 0.539 mg AFDW/individual (SE-3-R8) to 1.74 mg AFDW/individual (SE-4-B6). Table 5-12 summarizes the occurrence of *C. dilutus* pupation and emergence during the first 16 days of exposure for replicates that were evaluated for survival, weight, and biomass on Day 16 (i.e., for replicates that were ended to obtain data for the Day 16 endpoints). Pupation of the larvae occurred by Day 16 for those four replicates in all 3 batches. Total percent pupation ranged from 2.1 to 12.5 percent. Adult emergence occurred in Batch Nos. 1 and 2 by Day 16 in a small number of samples (two samples in Batch No. 1 and two samples in Batch No. 2); total percent emergence ranged from 2.1 to 10.4 percent. Reproduction endpoints, including emergence, was tracked for the remaining 8 replicates through the end of the test.

By the end of the test, mean adult emergence in Site samples ranged from 27 percent (SE-7-B5) to 82 percent (SE-4-B6) (Table 5-11a). Reproductive endpoints included total number of eggs per egg mass, total number of eggs laid per female, and percent hatchability. The number of eggs per egg mass ranged from 1,060 (SE-1-B5) to 1,550 (SE-5-B2, SE-7-B2, and SE-REF-10b). The number of eggs laid per surviving female ranged from 553 (SE-1-R2) to 1,240 (SE-6-B5). Mean hatchability ranged from 65 percent (SE-7-B2) to 95 percent (SE-4-B5).

5.5.2.2 42-day *H. azteca* Bioassay

Endpoints of survival, weight, and biomass were evaluated on Test Day 28 of the long-term *H. azteca* test. Mean survival in Site samples ranged from 53 percent (SE-3-R8) to 100 percent (SE-2-R1 and SE-REF-10b) (Table 5-11b). Mean weight ranged from 0.172 mg/individual (SE-3-R8) to 0.663 mg/individual (SE-3-B3). Mean biomass ranged from 0.0783 mg/individual (SE-3-R8) to 0.645 mg/individual (SE-3-B3).

On Test Day 42 at the end of the test, reproductive endpoints (i.e., the number of offspring per female) were evaluated along with survival, weight, and biomass. Mean survival in Site samples ranged from 53 percent (SE-3-R8) to 100 percent (SE-2-B1 and SE-4-B6) (Table 5-11b). Mean weight ranged from 0.498 mg/individual (SE-1-R2) to 0.989 mg/individual (SE-3-B3). Mean biomass ranged from 0.293 mg/individual (SE-3-R8) to 0.951 mg/individual (SE-3-B3). The mean number of offspring per female ranged from 1 (SE-1-R2) to 15 (SE-1-B5).

5.6 BACKSCATTERED SCANNING ELECTRON MICROSCOPY

Results for the percentages of the various slags and altered slag in the subset of samples analyzed using BSEM are presented in Table 5-13 and Figure 5-11. Analyses were conducted on 48 samples, including the 1 mount for each of the 42 primary samples, 5 sample remounts (“replicate analysis”) on four samples (i.e., 1 was replicated twice) and 1 sample mount analyzed a second time (“duplicate analysis”). The ranges in slag content were 0 to 75.3 percent for Slag 1, 0 to 6.3 percent for Slag 2, 0 to 0.45 percent for Slag 3, and 0 to 1.23 percent for altered slag. The count of samples with slag content <0.1 percent were 10 samples for Slag 1, 22 samples for Slag 2, 47 samples for Slag 3, and 26 samples for altered slag.

The particle size distributions among the three size classes analyzed (larger than 4 mm, 4 to 2 mm, and less than 2 mm) for each sample are presented in Table 5-14. The majority of the particles in the samples were less than 2 mm in size.

Slag 1 particles ranged from 15 to 2,000 μm in apparent size, although there were some slag particles in the larger size fractions. Table 5-15 and Figure 5-12 present the percentages of Slag 1 particles in the various size classes for each sample. On average, Slag 1 particles were most frequently in the 250- to 350-, 350- to 500-, and 500- to 710-µm size classes.

For the assessment of coarse fractions (greater than 2 mm) using optical and scanning electron microscopy, only one sample (SE-1B-R3) contained glassy slag. Two particles were observed, which did significantly affect the slag abundance in this sample.

QA results were as follows:

- **Image analysis.** There was a high correlation ($R^2 = 0.9943$) between the original analysis and the low-magnification image analysis, as shown in Figure 13 of Appendix F.
- **Manual review of two samples.** The difference in percent slag between the manual review and the computer-controlled BSEM analysis was estimated to be 4.5 percent for SE-3-B4 and 2.7 percent for SE-3-R7.
- **Duplicate analysis (reanalysis of the same sample mount).** For sample SE-4-B6, duplicate results were 60.0 and 59.6 percent for slag content and 0.145 and 0.193 percent for altered slag content based on computer-controlled BSEM analyses.
- **Replicate sample mounts (analysis of sample remounts**). A second mount was prepared and analyzed for three samples, and a second and third mount were prepared and analyzed for an additional sample.
    - **Slag 1.** The relative percent differences (RPDs) for the three samples with duplicate mounts (i.e., SE-1-R5, SE-3-B4 and SE-4-B6) ranged from 1.8 to 19.9 percent. The RPD for the sample with triplicate mounts (SE-3-R7) was 34.7 percent. The variation in the results for this sample was attributed to the influence of rare larger particles and the difficulty in capturing a representative subsample, even when using the riffle splitter and combining quarters.
    - **Slag 2 and Altered Slag.** RPDs in the sample mounts for Slag 2 and altered slag ranged from 15 to 133 percent. The relatively high RPDs for Slag 2 and altered slag compared to the RPDs for Slag 1 are a result of the very low slag percentages that are being compared and the absolute differences of less than 0.6 percent.

6 ASSESSMENT OF DATA GAPS

This section discusses the sufficiency of the data for meeting the study objectives regarding sample size and representativeness, as presented in the QAPP (Exponent et al. 2013). In addition, this section discusses whether the DQOs associated with analytical and bioassay data were met (i.e., whether the data validation or test acceptability evaluations resulted in rejection of results, and whether MDLs exceeded ACGs).

6.1 SAMPLE SIZE AND REPRESENTATIVENESS

Field sampling was carried out in conformance with the QAPP (Exponent et al. 2013) and communications with EPA before and during sampling (Appendix A). As expected, not all targeted locations could be sampled for various reasons primarily associated with coarse substrate (Maps 2-3a to 2-3f and Map 2-4); therefore, the sampling scheme for selecting reserve locations was followed, as presented in the QAPP. In some cases, neither the targeted location nor its reserve location could be sampled despite an extensive effort made to collect grab samples. As a result, the final number of Site locations was 120 rather than 124. Sufficient sediment volume was collected at 93 percent of the bioassay locations. Sufficient volume could not be collected at 5 of the 74 targeted or reserve Site locations for bioassays. Although the chemistry and bioassay datasets were slightly smaller than planned (the sediment chemistry dataset was 3 percent smaller, and the bioassay dataset was 7 percent smaller), sediment with a wide range of metal concentrations was still obtained throughout the Site.

Field porewater was collected at most locations but could not be collected at 35 of the 136 locations (26 percent). For 14 of the 35 locations, bioassay porewater chemistry data are available. For the remaining 21 samples (15 percent of the dataset), it proved infeasible to directly evaluate the exposure of benthic invertebrates to metals based on porewater. The difficulty in collecting porewater data reflects physical sediment characteristics (i.e., either coarse sediment allowing porewater to drain through before it could be collected or very fine grain size preventing the withdrawal of porewater through the airstones). In addition, for two Site locations and four tributary locations where porewater samples were collected using a Petite Ponar® or stainless steel shovel, overlying surface water may have been incorporated into the porewater sample. In such cases, the collected sample may not be representative of interstitial water at the location sampled.

6.2 CHEMICAL ANALYSIS AND DETECTION LIMITS

All chemical analyses were performed as specified in the QAPP (Exponent et al. 2013). All chemistry results were deemed usable by the data validator, with the exception of a subset of results for sulfide in bioassay porewater. These data were rejected for samples from

29 locations for the short-term bioassays and from 2 locations for the long-term bioassays based on a review of the MS/MSD results (see Sections 4.3.4.3 and 4.3.6.3).

As discussed in Section 5.4, MDLs for all nondetected data points were less than the ACG, with the exception of MDLs for dissolved zinc in 38 field porewater samples (Table 5-7c). The MDLs for the latter ranged from > 74 to 411 µg/L, compared with the ACG of 74 µg/L. The dissolved zinc ACG is based on Washington State Department of Ecology's (Ecology) aquatic life water quality criteria for zinc. It is unknown whether concentrations of zinc in these 38 samples exceeded the ACG.

6.3 BIOASSAYS

The sediments collected from the bioassay locations represent a range of metals and excess SEM concentrations (Figures 5-1e to 5-1aa and Figure 5-1al). Maps 2-1a through 2-1f present both the locations at the Site where bioassays were performed and where they were not performed.

All bioassay results are considered usable based on acceptable PER negative laboratory control sediment performance for both the short- and long-term bioassays. Positive control results used to assess the sensitivity of organisms to known toxicants were also acceptable in all of the bioassays. Water quality results were within acceptable ranges, with the exception of brief low DO concentrations in the *C. dilutus* short-term test and the *H. azteca* short- and long-term tests. Aeration was immediately started in all replicates for affected samples, and DO concentrations remained within the acceptable range for the duration of the tests.

7 SUMMARY

The purpose of this study was to collect additional sediment and porewater samples from throughout the UCR to evaluate the concentrations of metals in sediment and porewater, conduct synoptic bioassays on a subset of samples, and evaluate chemical bioavailability. These data will be used to evaluate risk to benthic macroinvertebrates and other ecological receptors exposed to UCR sediment. Previous data collected from historical studies, including Phase 1, were not considered sufficient for a thorough evaluation of sediment toxicity and chemical bioavailability.

Samples were collected according to the QAPP (Exponent et al. 2013) from 120 locations within the Site, 6 locations in tributaries to the UCR, and 10 upstream locations in Canada. Sediment samples were analyzed for total metals, AVS, SEM, grain size, and TOC; porewater samples were analyzed for dissolved metals and conventional parameters necessary for evaluating bioavailability and toxicity of metals in water. Short-term bioassays were conducted with *C. dilutus* and *H. azteca* using sediment collected from 69 locations. Long-term bioassays were also conducted with *C. dilutus* and *H. azteca* using sediment collected from 27 of the 69 short-term bioassay locations. Sediment and porewater chemistry was evaluated at the start of the bioassays, as well as during and/or at the end of the tests, depending upon the organism and length of the test. In addition, at 41 of the Site locations and one of the upstream locations, a BSEM analysis was conducted to determine the percentage of slag or altered slag in the samples.

Sediment samples were collected at 97 percent of the targeted or reserve locations identified in the QAPP (Exponent et al. 2013), and porewater samples were collected at 74 percent of the locations where sediment was collected. Sediment and/or porewater samples could not be collected at the remaining locations because of sample substrate.

QA and validation of all sediment and porewater chemistry data were performed in accordance with the QAPP (Exponent et al. 2013), and qualifiers were assigned to the data as appropriate. All data were acceptable with the exception of a subset of sulfide results in porewater. Bioassay test data were evaluated according to the acceptability criteria from the QAPP, and were determined to be acceptable for use in the risk assessment.

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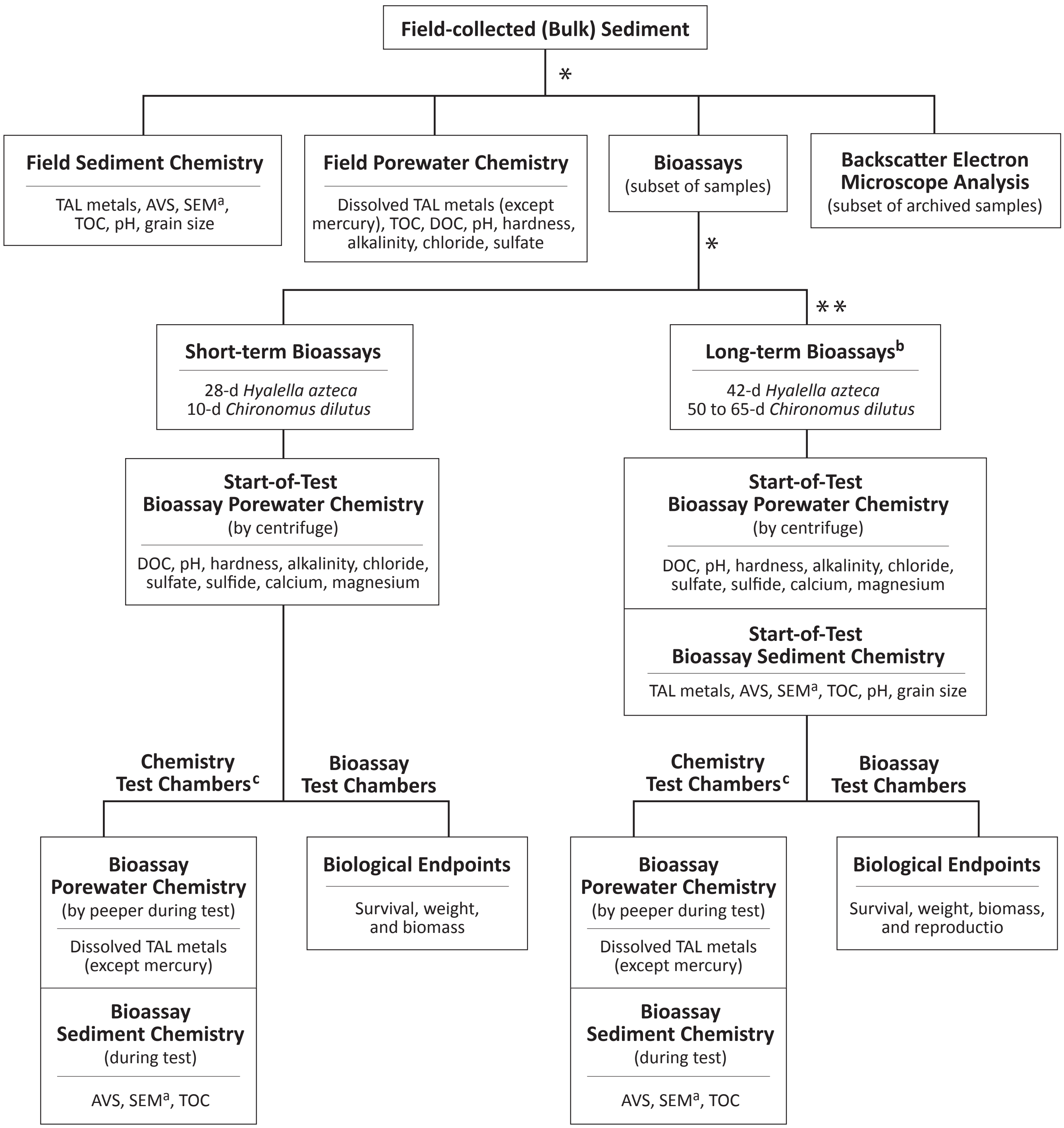
FIGURES



[a] SEM included antimo y, arsenic, cadmium, chromium, copper, lead, nickel, and zinc.

[b] Long-term bioassays were conducted on a subset of samples used for the short-term bioassays.

[c] Chemistry test chambers were treated the same as bioassay test chambers, including addition of o ganisms, and were used only to obtain samples for porewater and sediment chemistry analyses.

* Bulk sediment was homogenized in the field prior to placing in sample containers for various analyses; in addition, sedime t was homogenized before both short-term and long-term bioassays.

** Bioassay sediment samples were homogenized prior to initi ting the long- erm tests. For locations th t did not have sufficient volume of sediment remaining at PER a er the short-term tests, supplemental sediment was shipped from ALS to PER and homogenized with the remaining sediment (see Table 2-13 for the list of locations ffected).

Figure 2-1. Process for Chemical and Biological Analysis of Sediment and Porewater

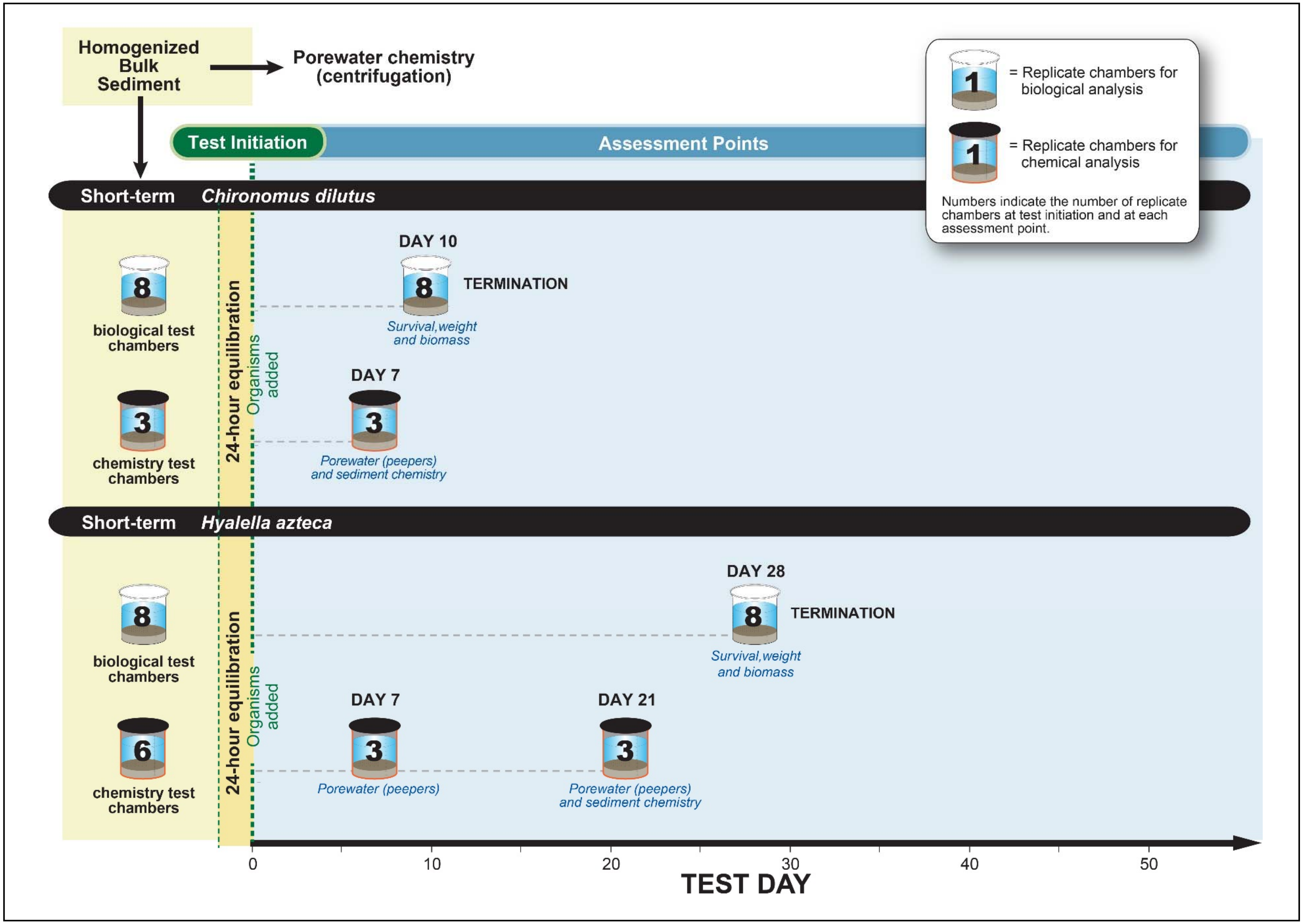


Figure 2-2. Timeline for Short-Term Bioassays

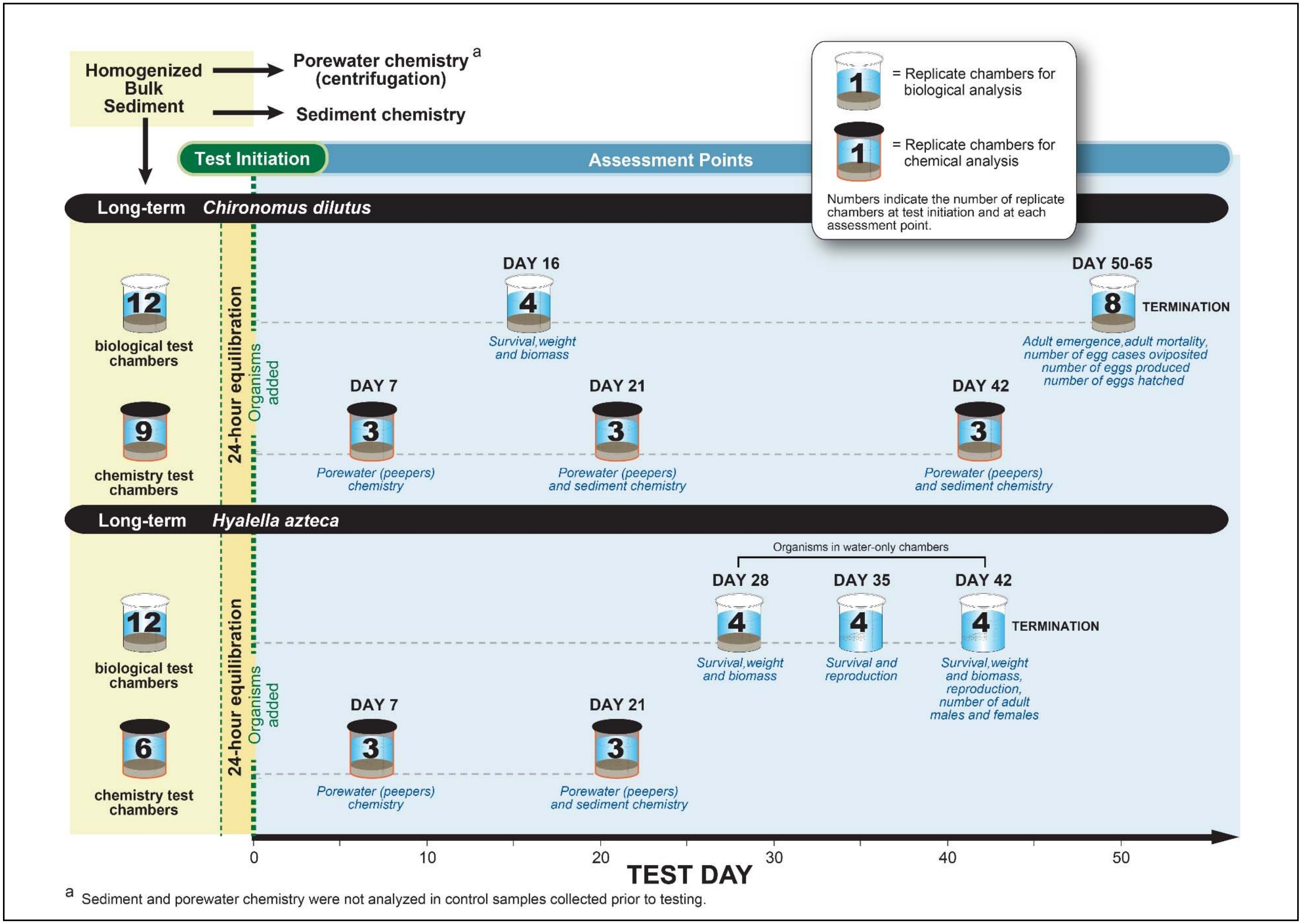


Figure 2-3. Timeline for Long-Term Bioassays

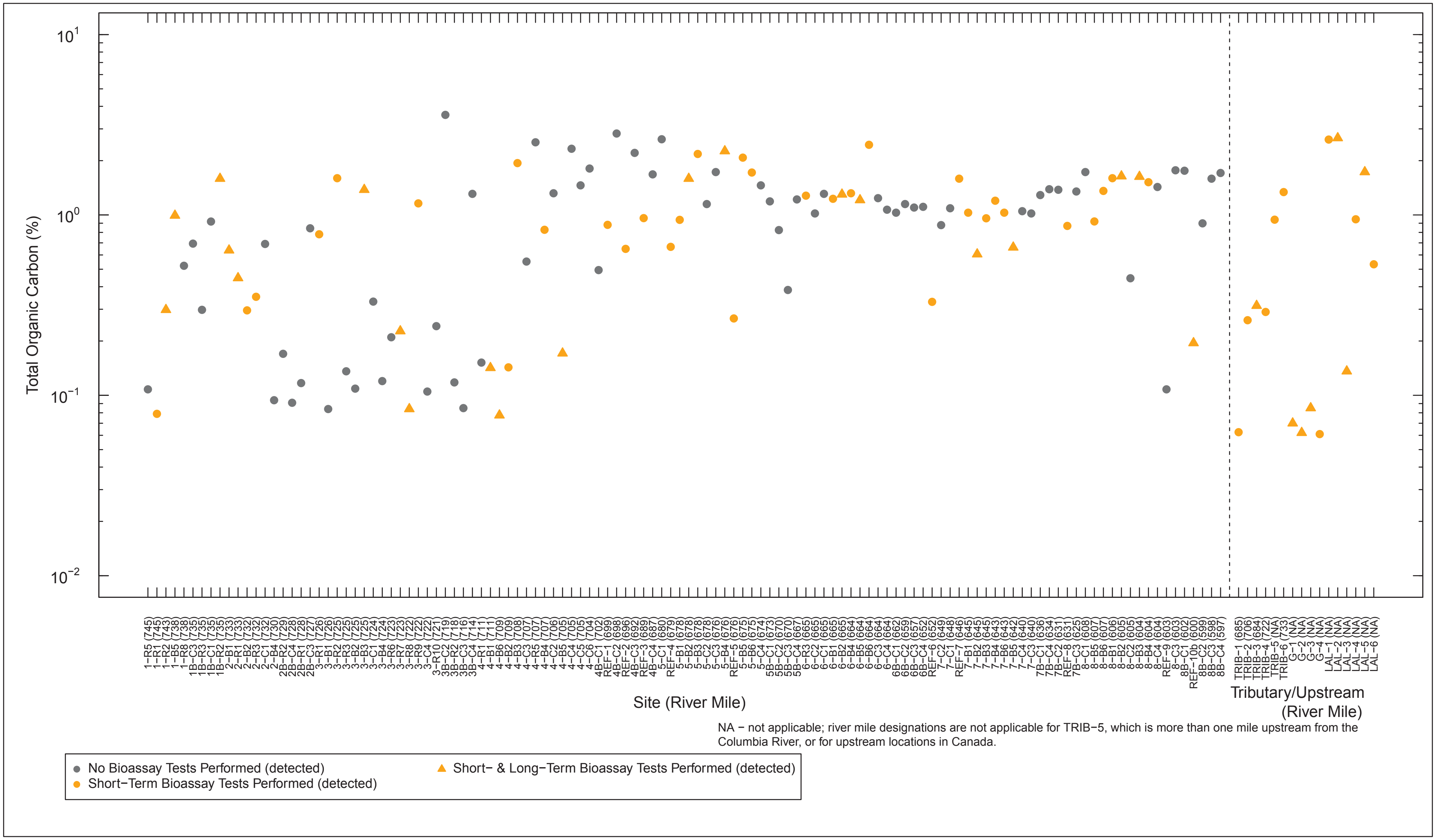
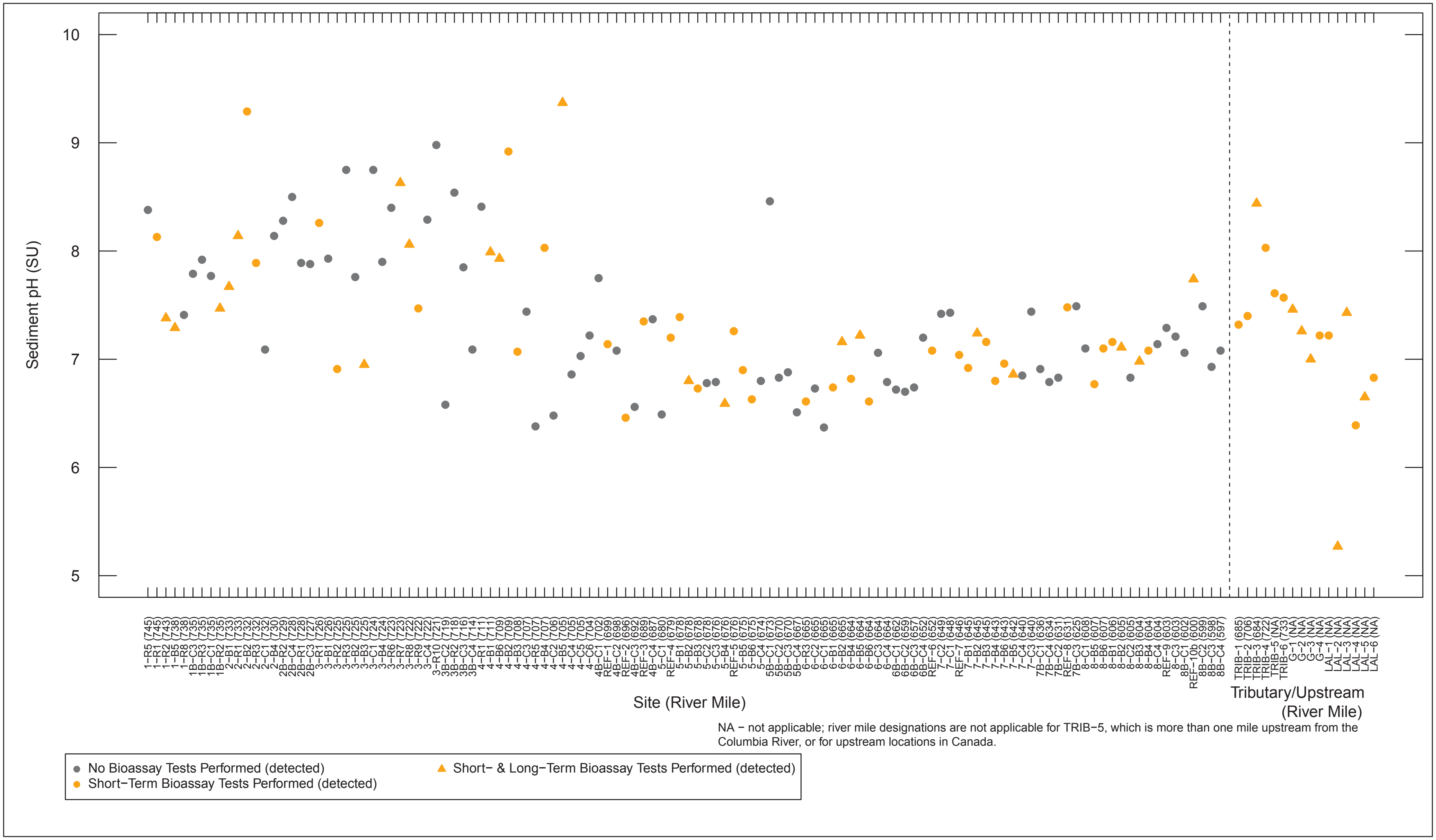


Figure 5−1a. Total Organic Carbon in Field Sediment



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−1b. pH in Field Sediment

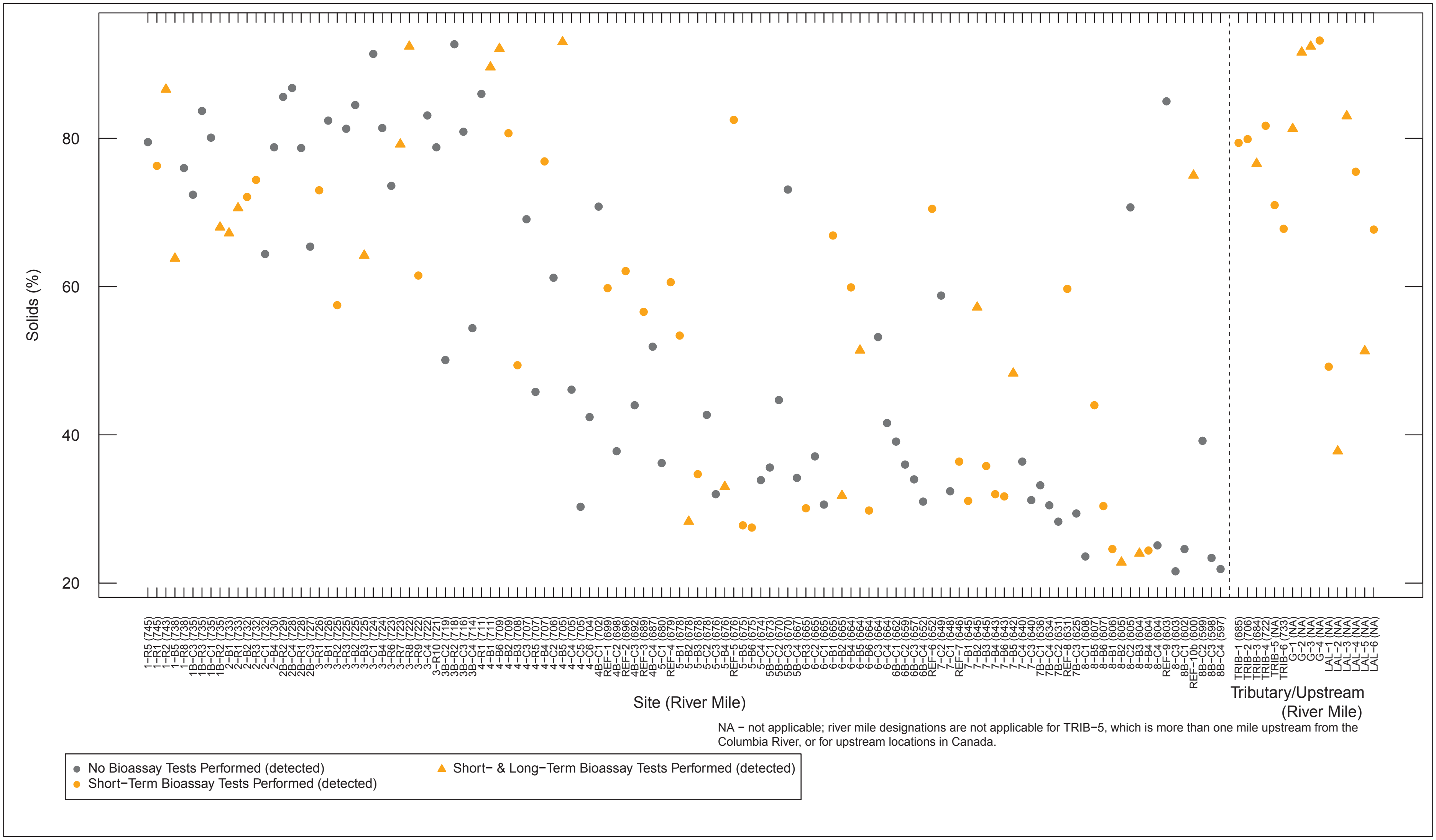


Figure 5−1c. Solids in Field Sediment

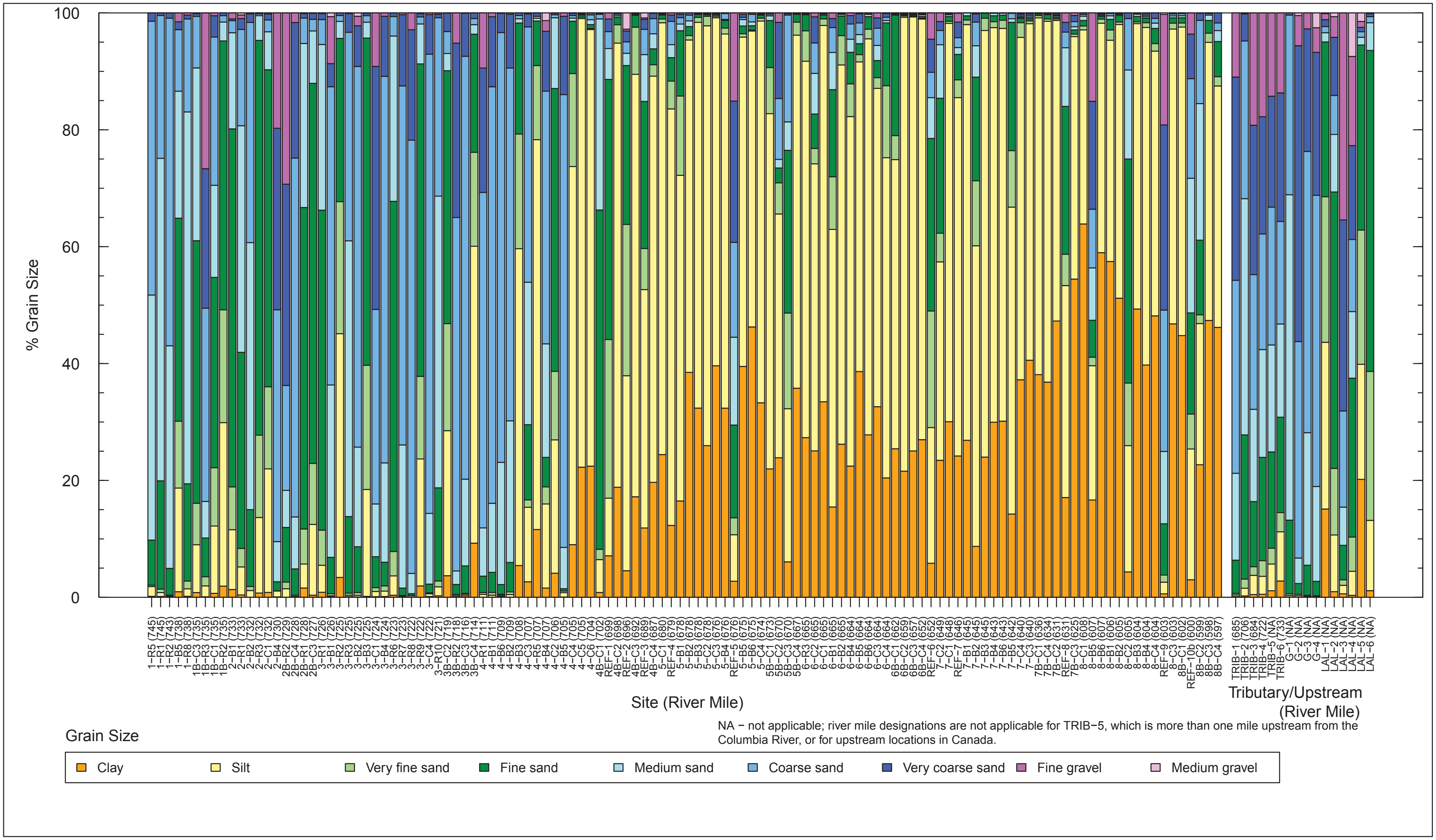


Figure 5−1d. Grain Size Distribution in Field Sediment

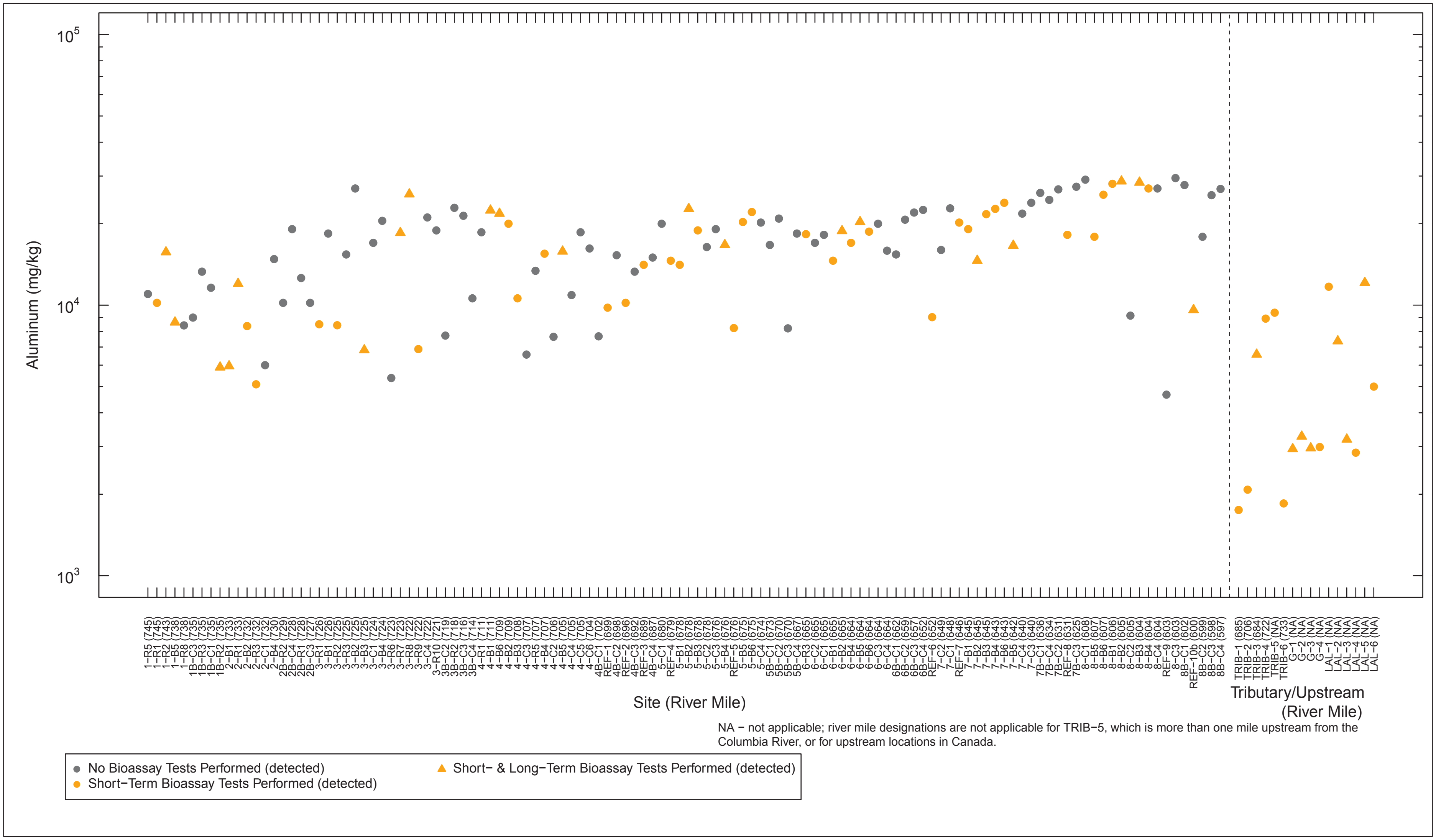


Figure 5−1e. Aluminum in Field Sediment

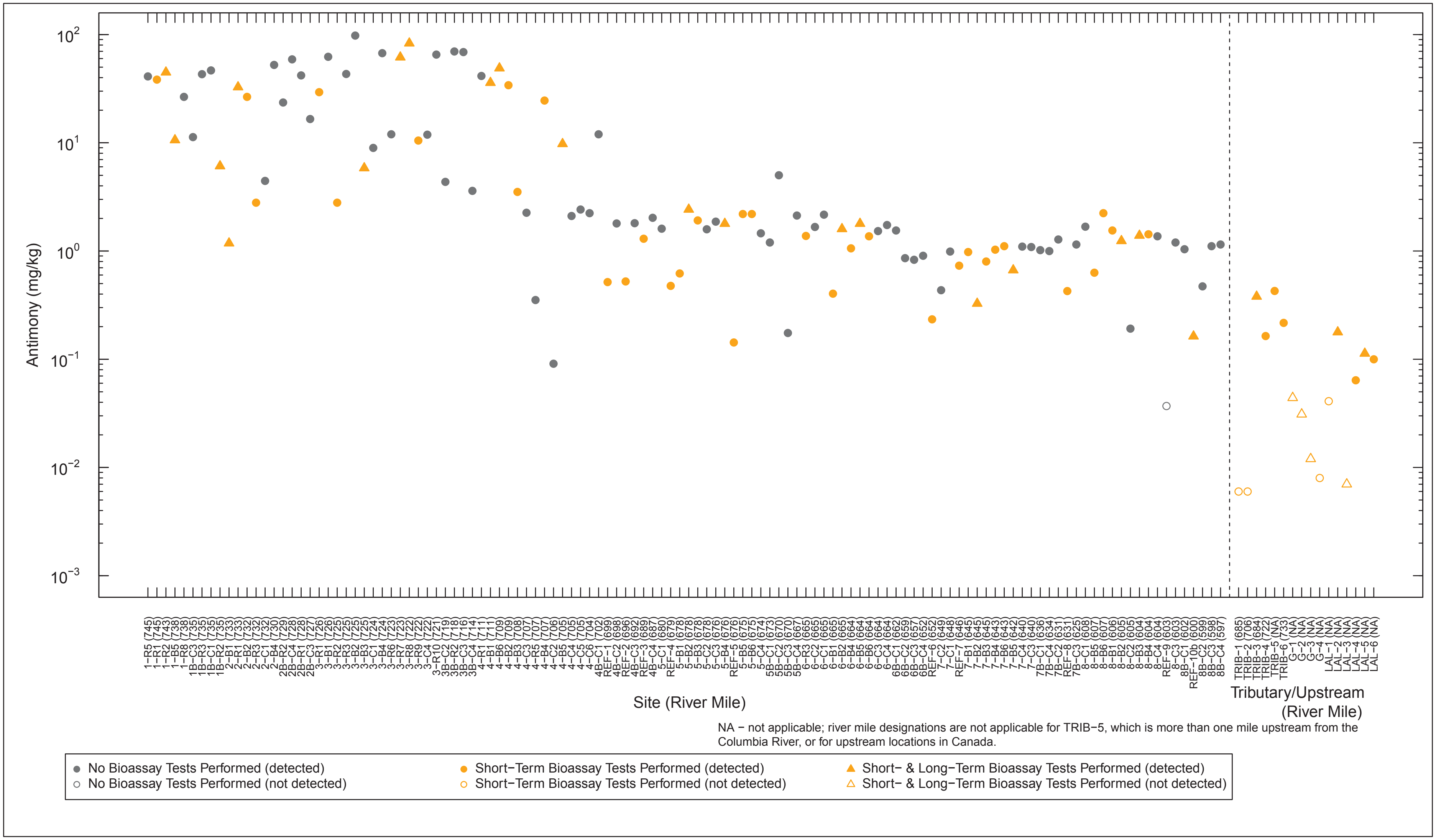


Figure 5−1f. Antimony in Field Sediment

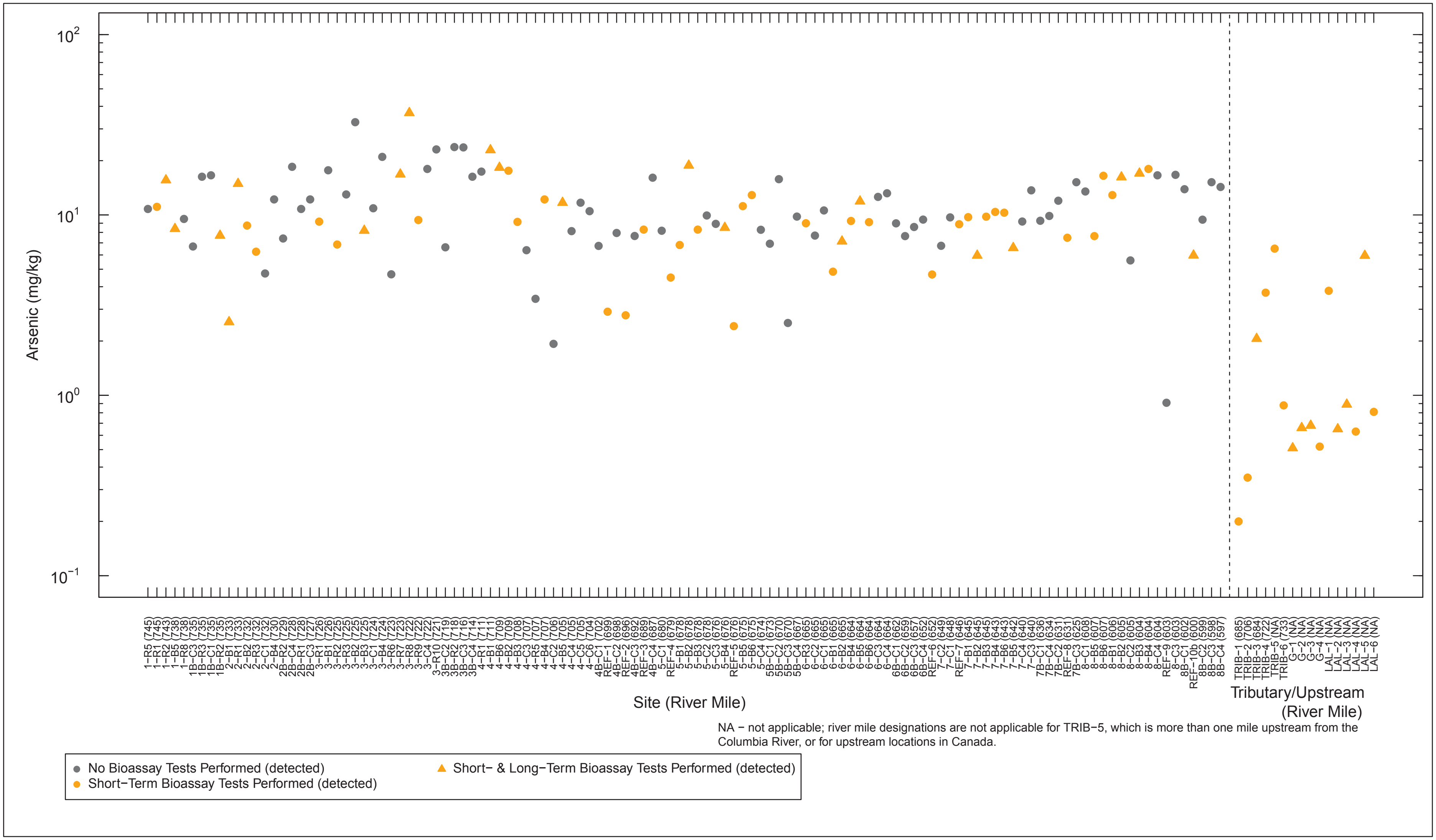


Figure 5−1g. Arsenic in Field Sediment

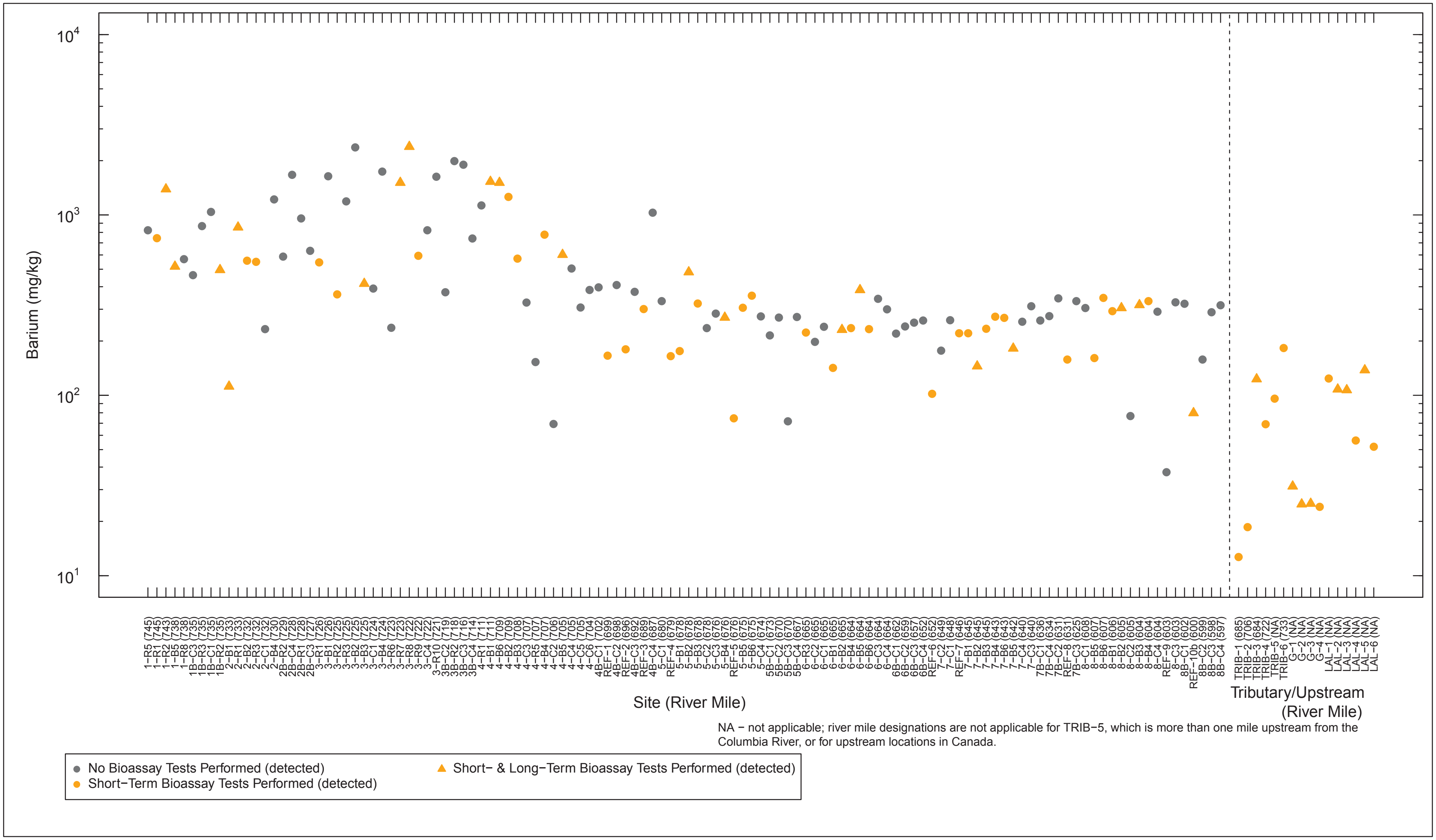


Figure 5−1h. Barium in Field Sediment

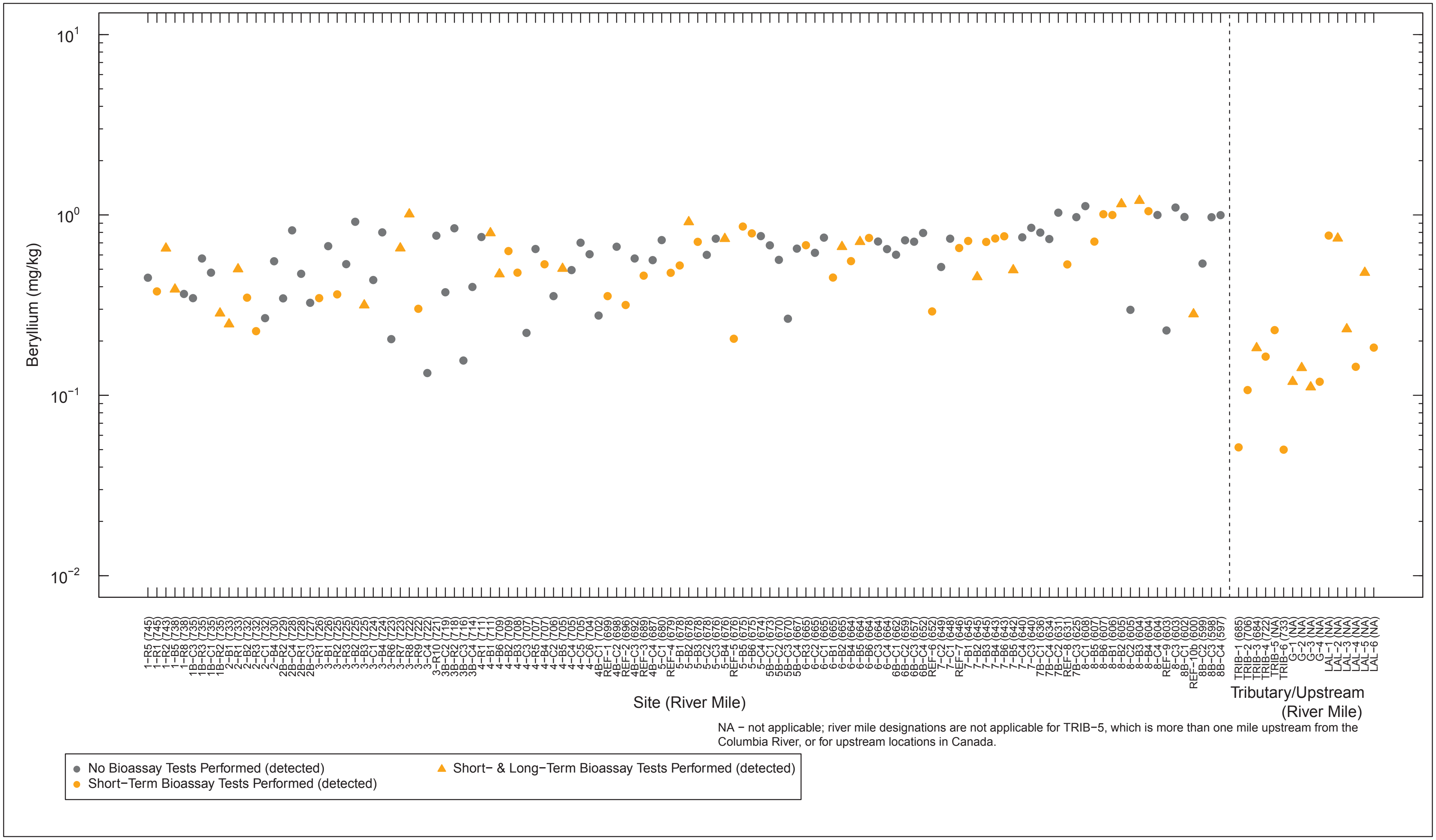


Figure 5–1i. Beryllium in Field Sediment

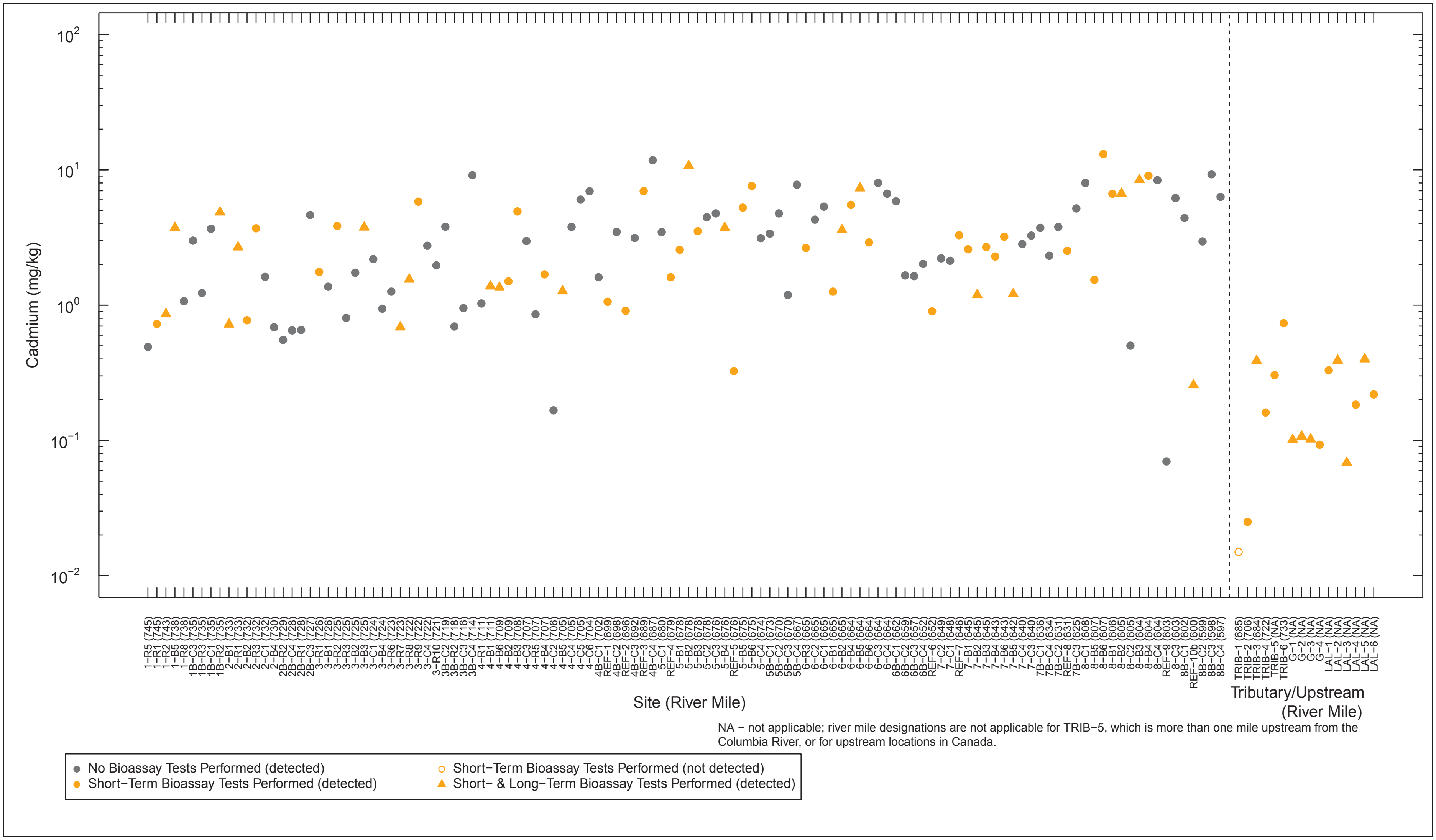


Figure 5−1j. Cadmium in Field Sediment

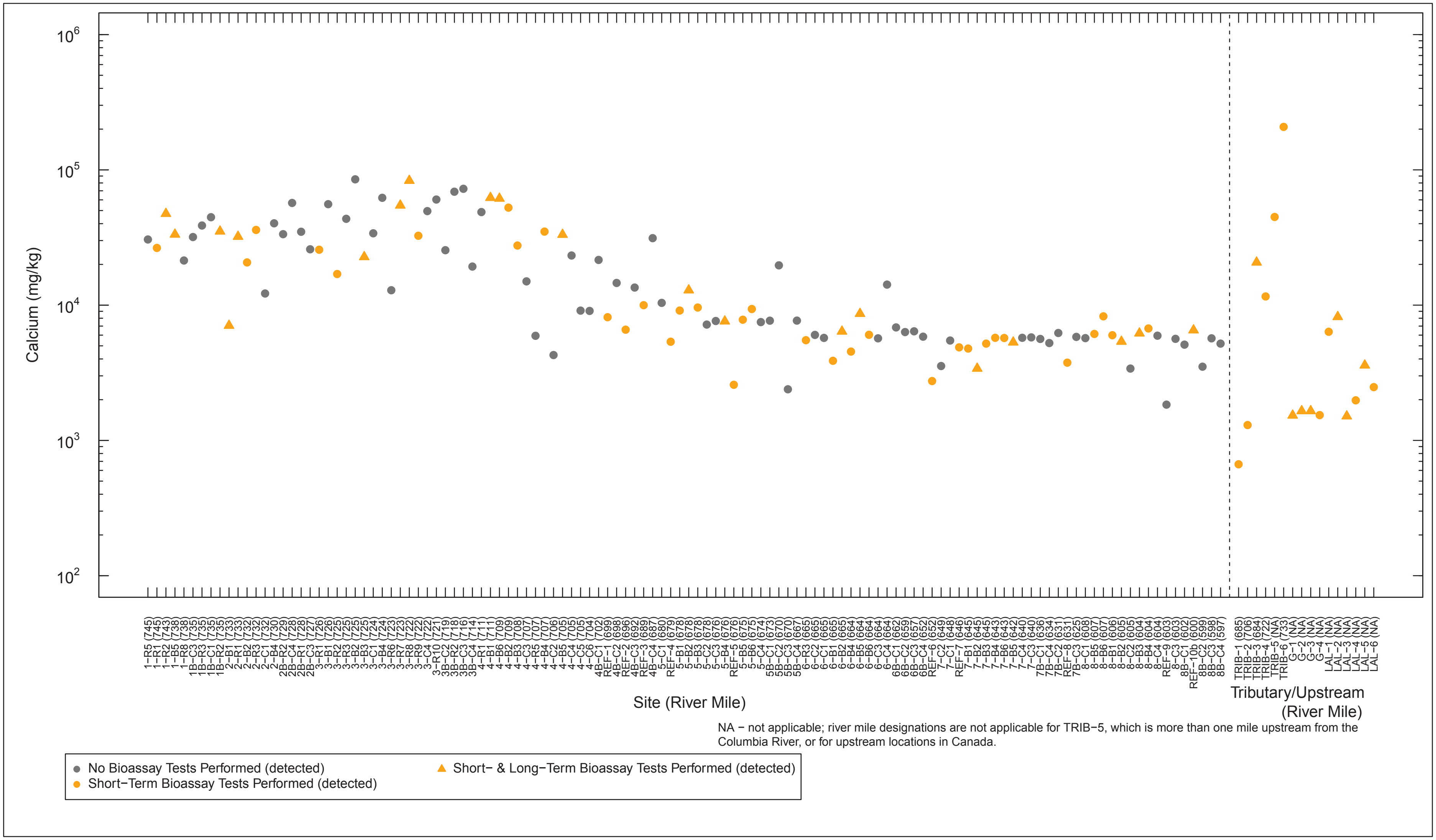


Figure 5−1k. Calcium in Field Sediment

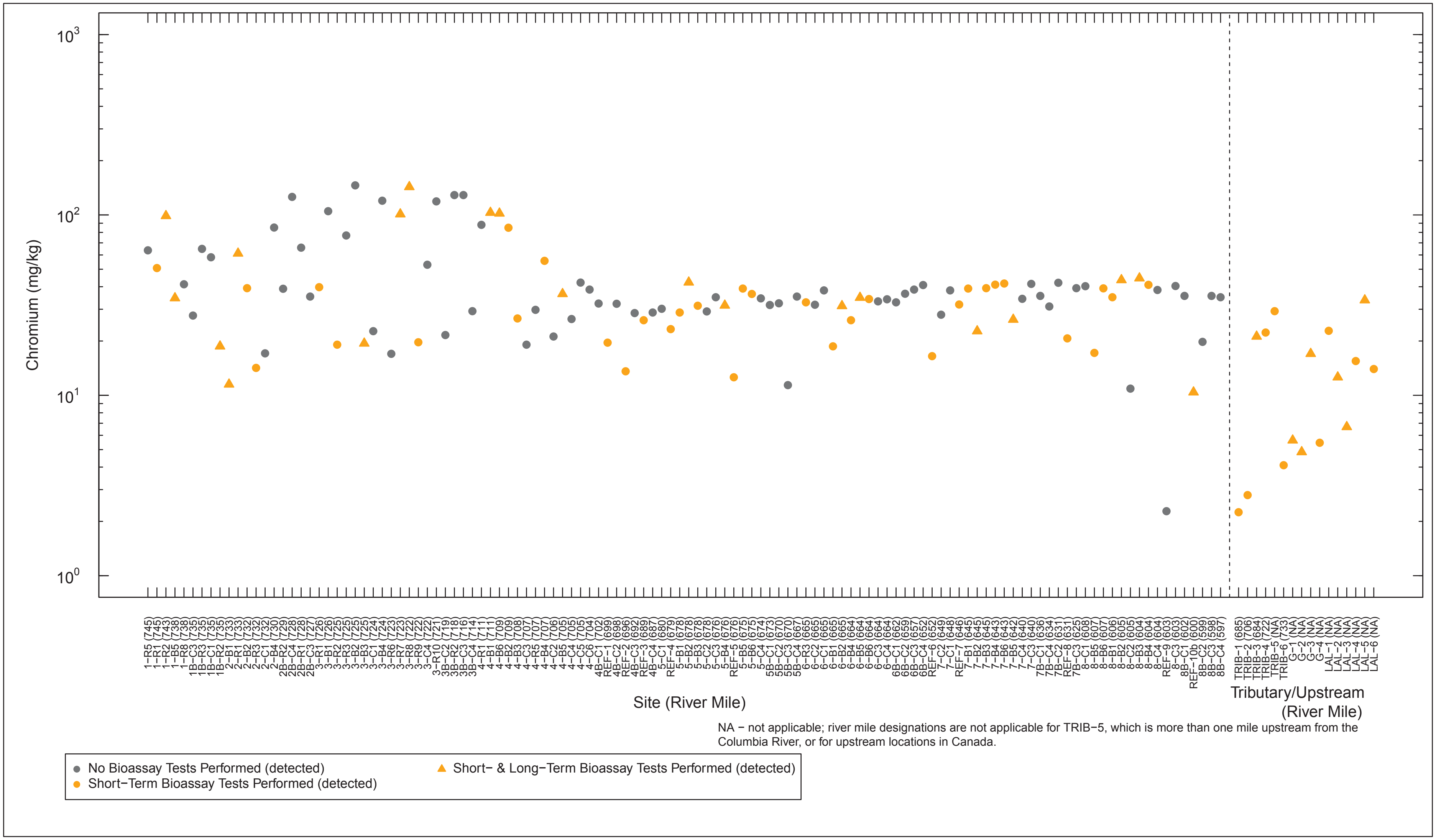


Figure 5−1l. Chromium in Field Sediment

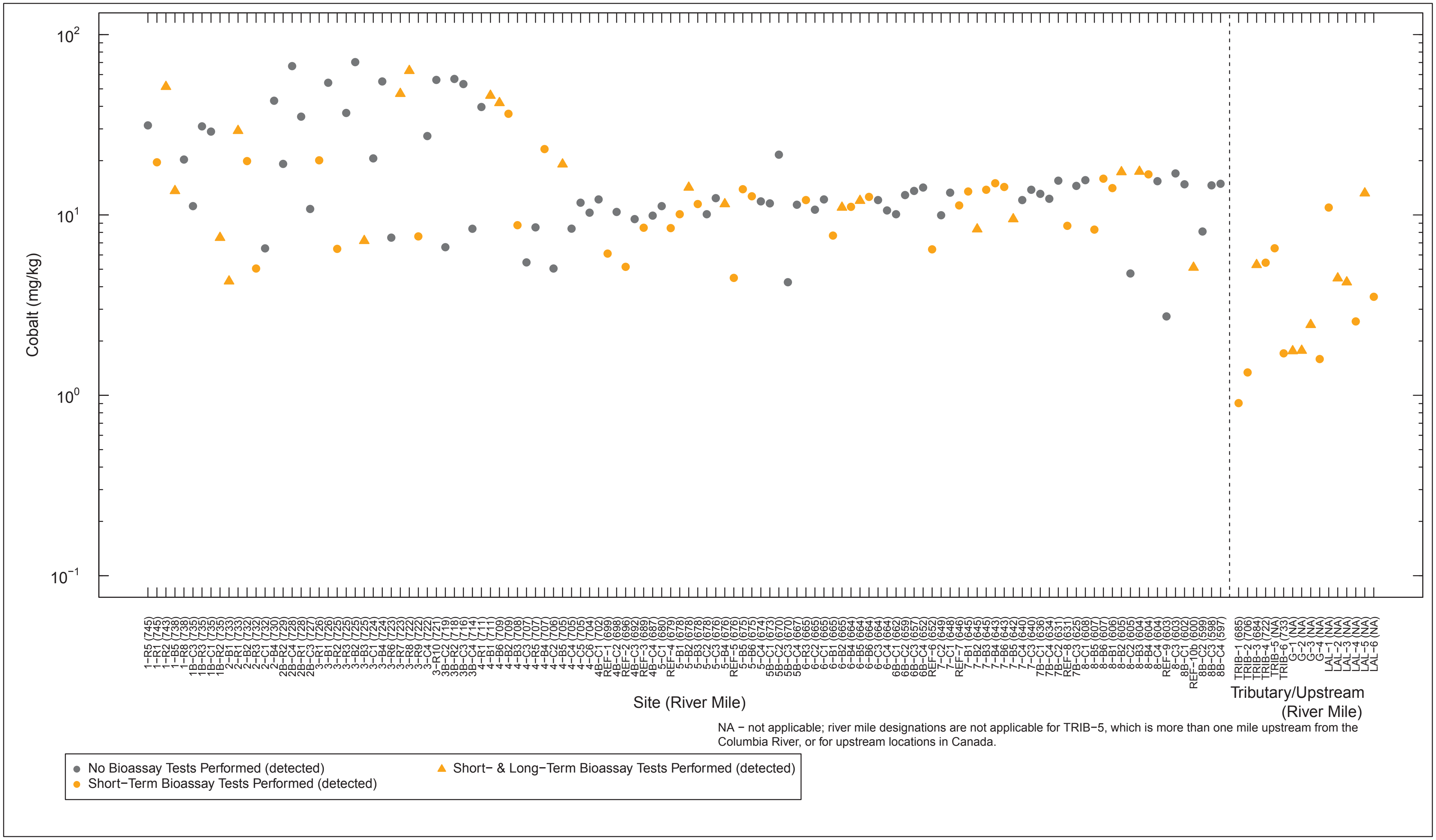


Figure 5−1m. Cobalt in Field Sediment

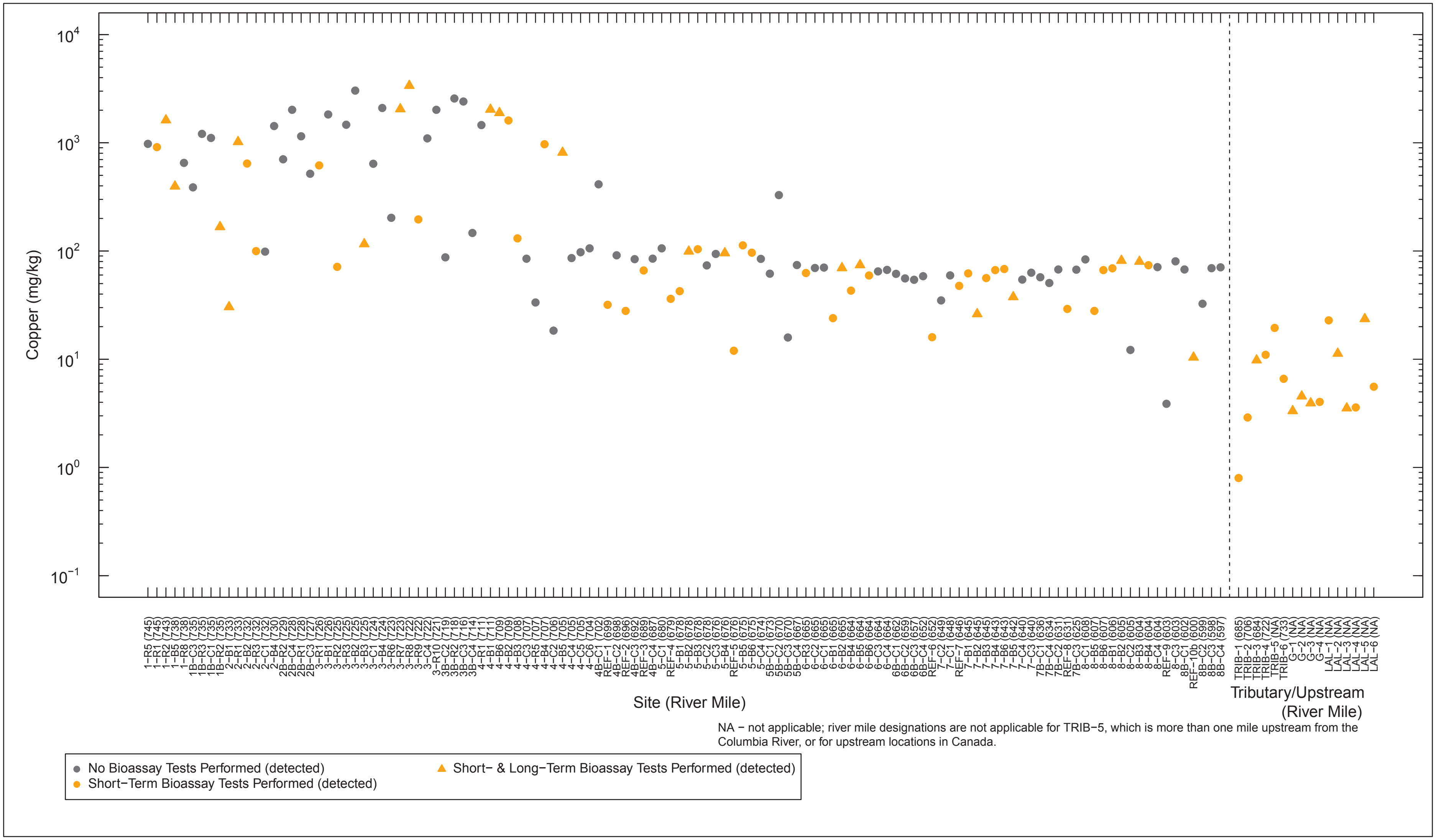


Figure 5−1n. Copper in Field Sediment

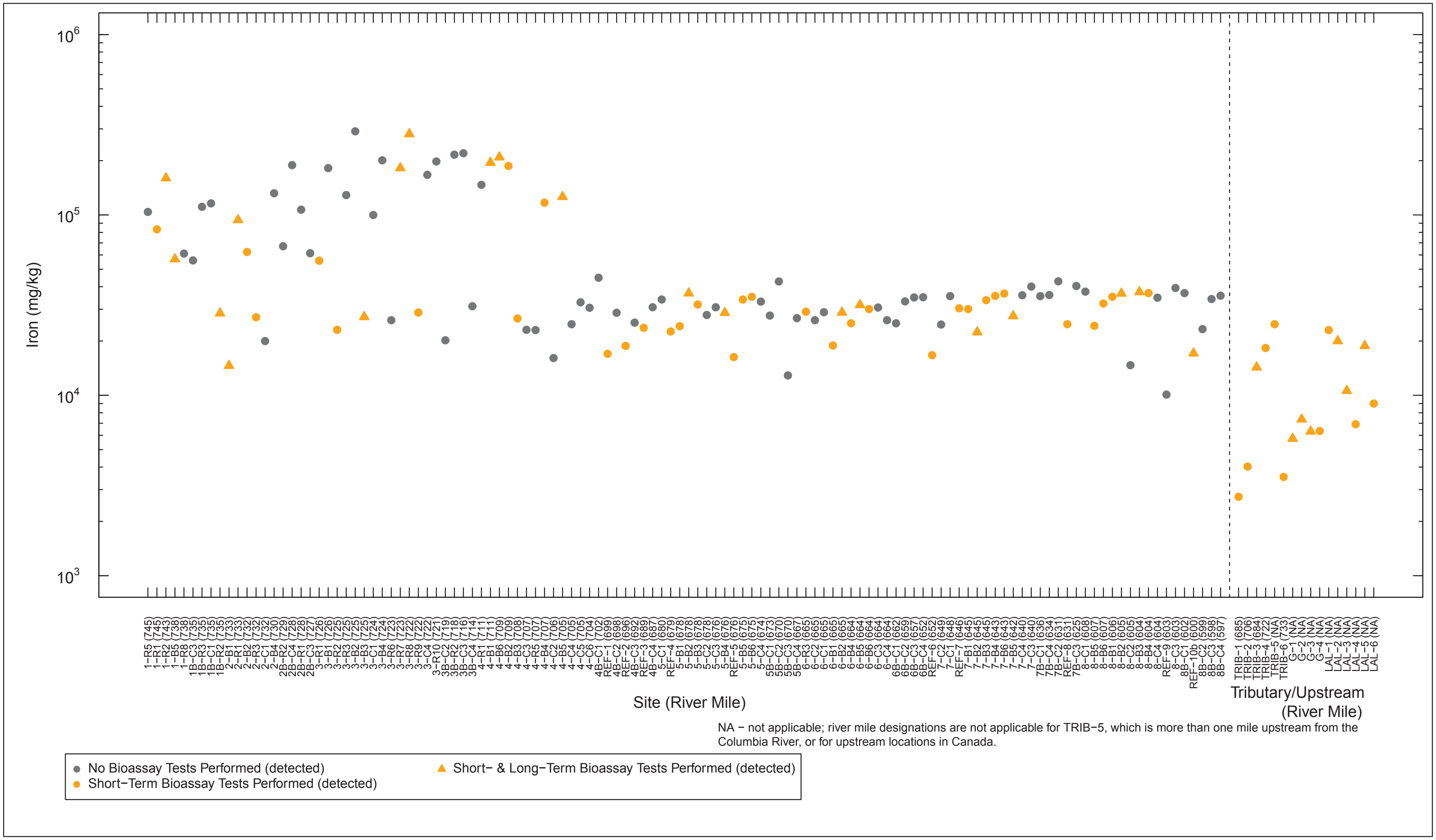


Figure 5−1o. Iron in Field Sediment

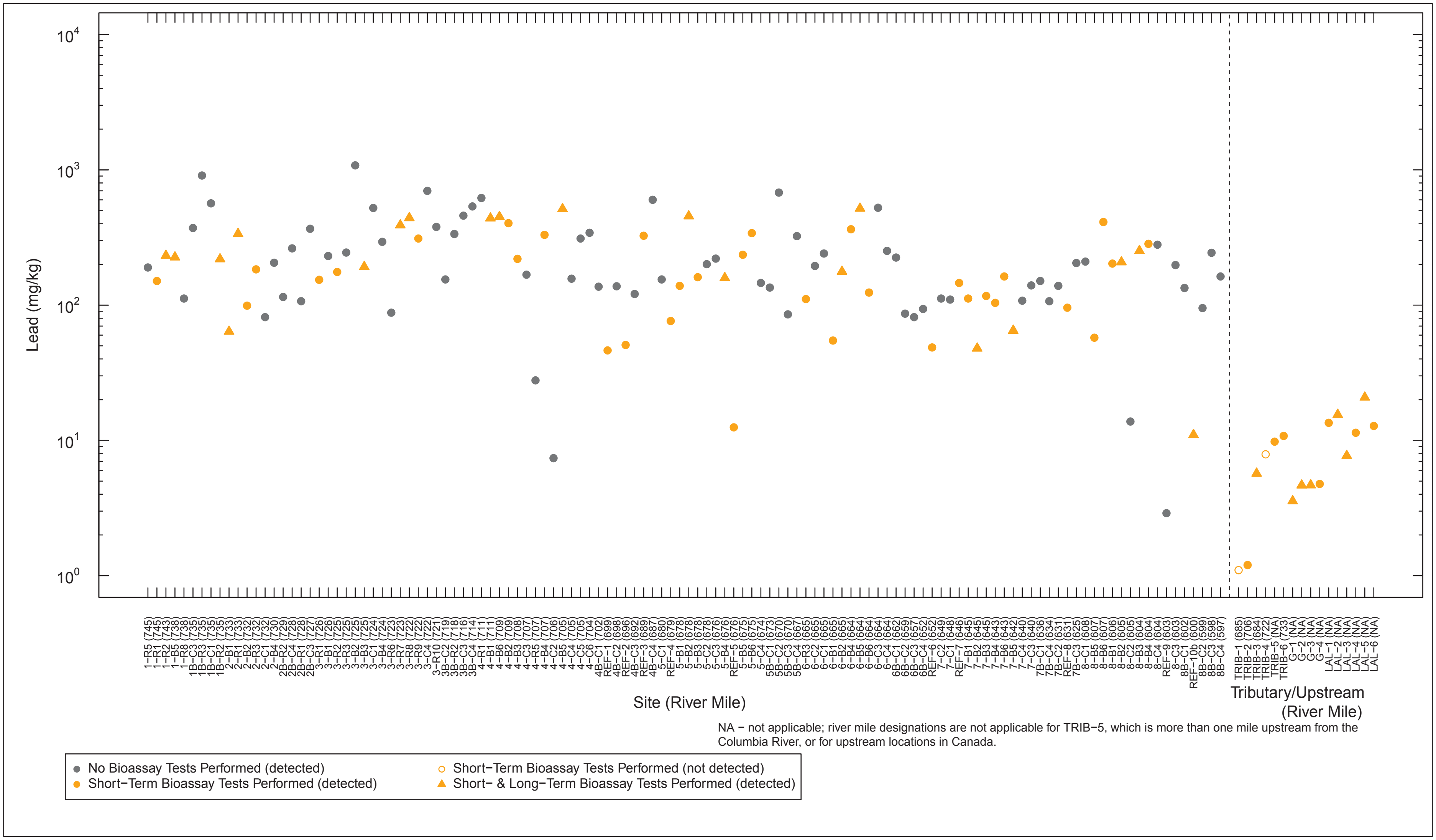
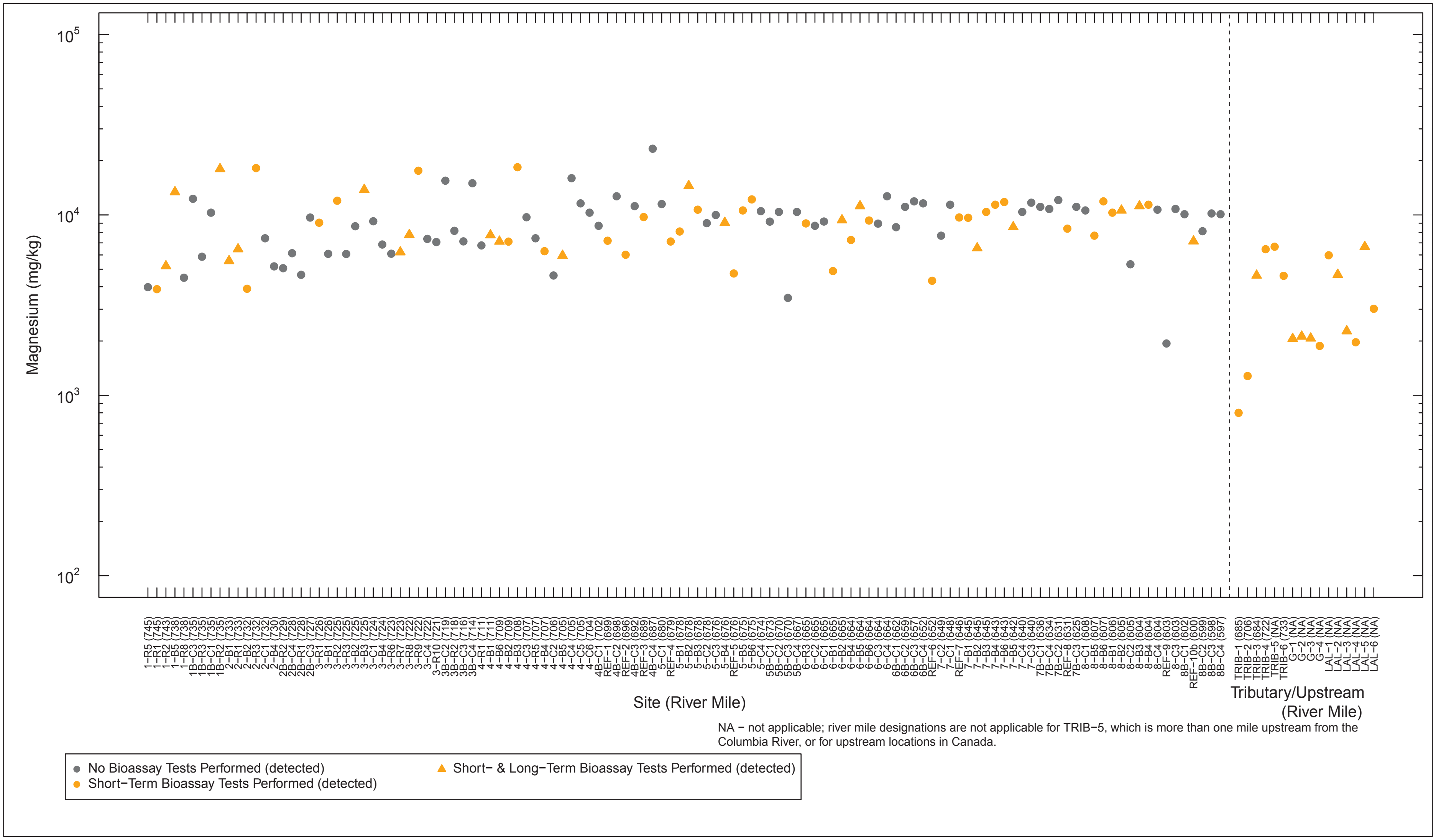


Figure 5−1p. Lead in Field Sediment



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−1q. Magnesium in Field Sediment

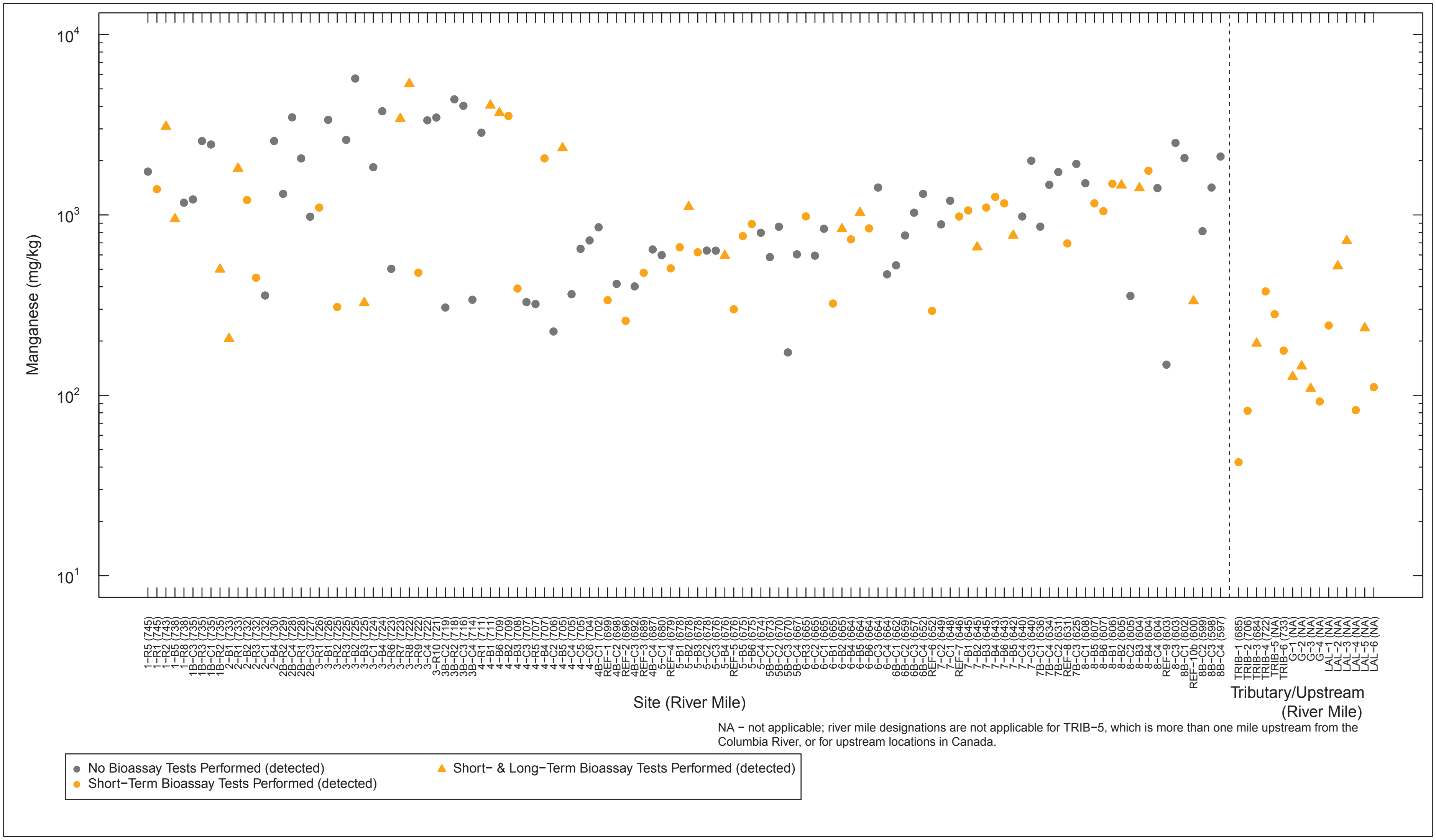


Figure 5−1r. Manganese in Field Sediment

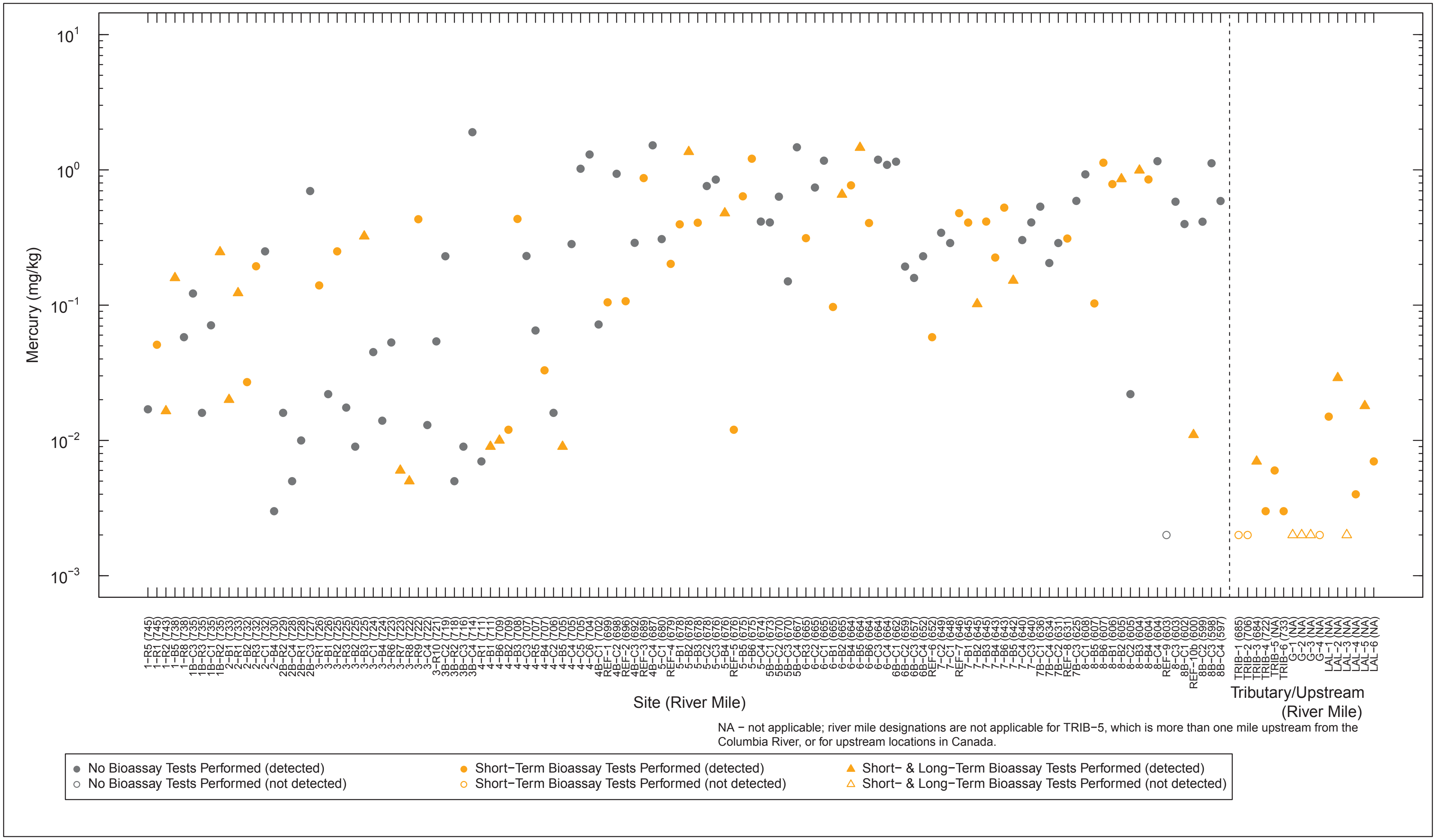


Figure 5−1s. Mercury in Field Sediment

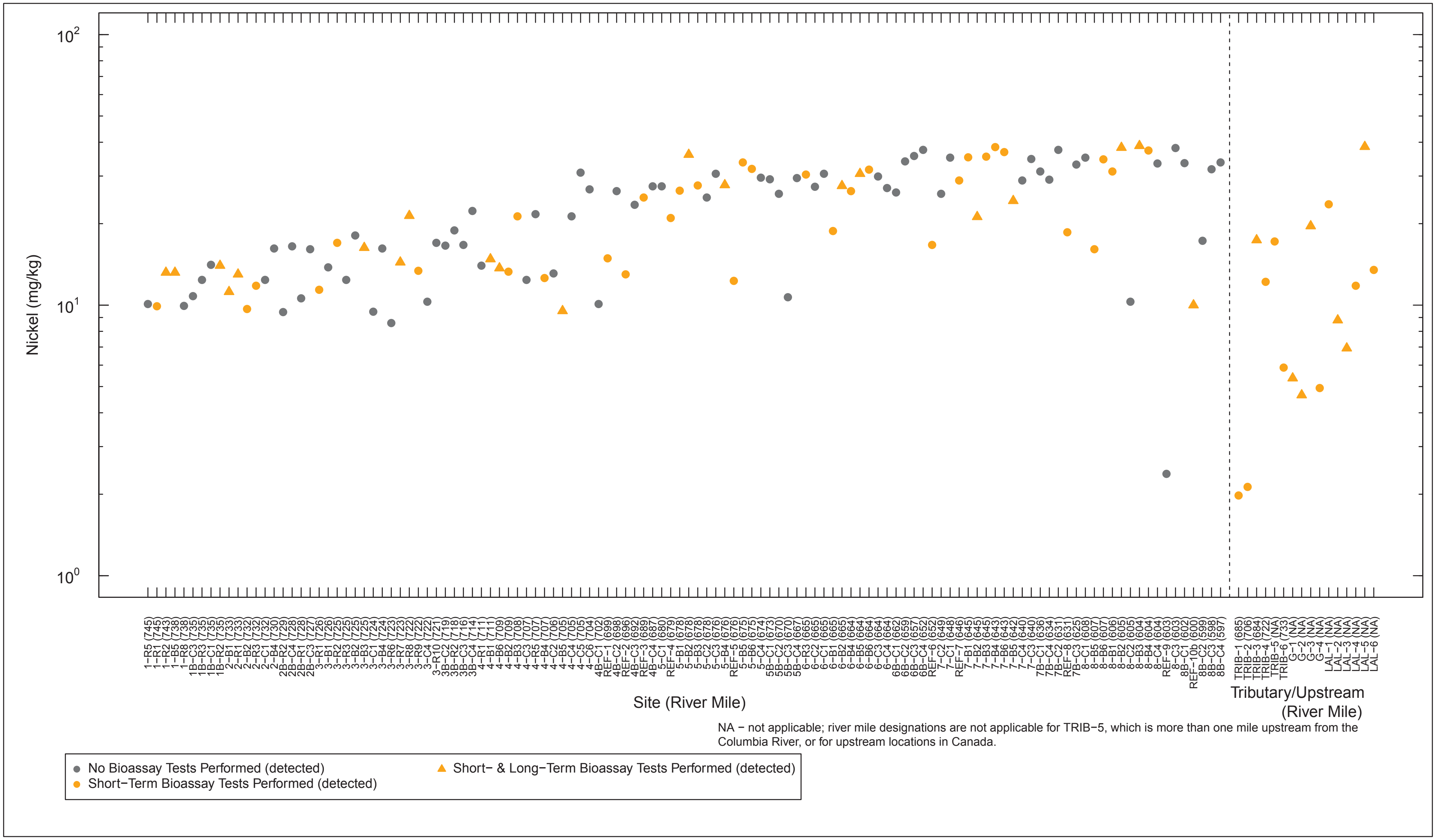


Figure 5−1t. Nickel in Field Sediment

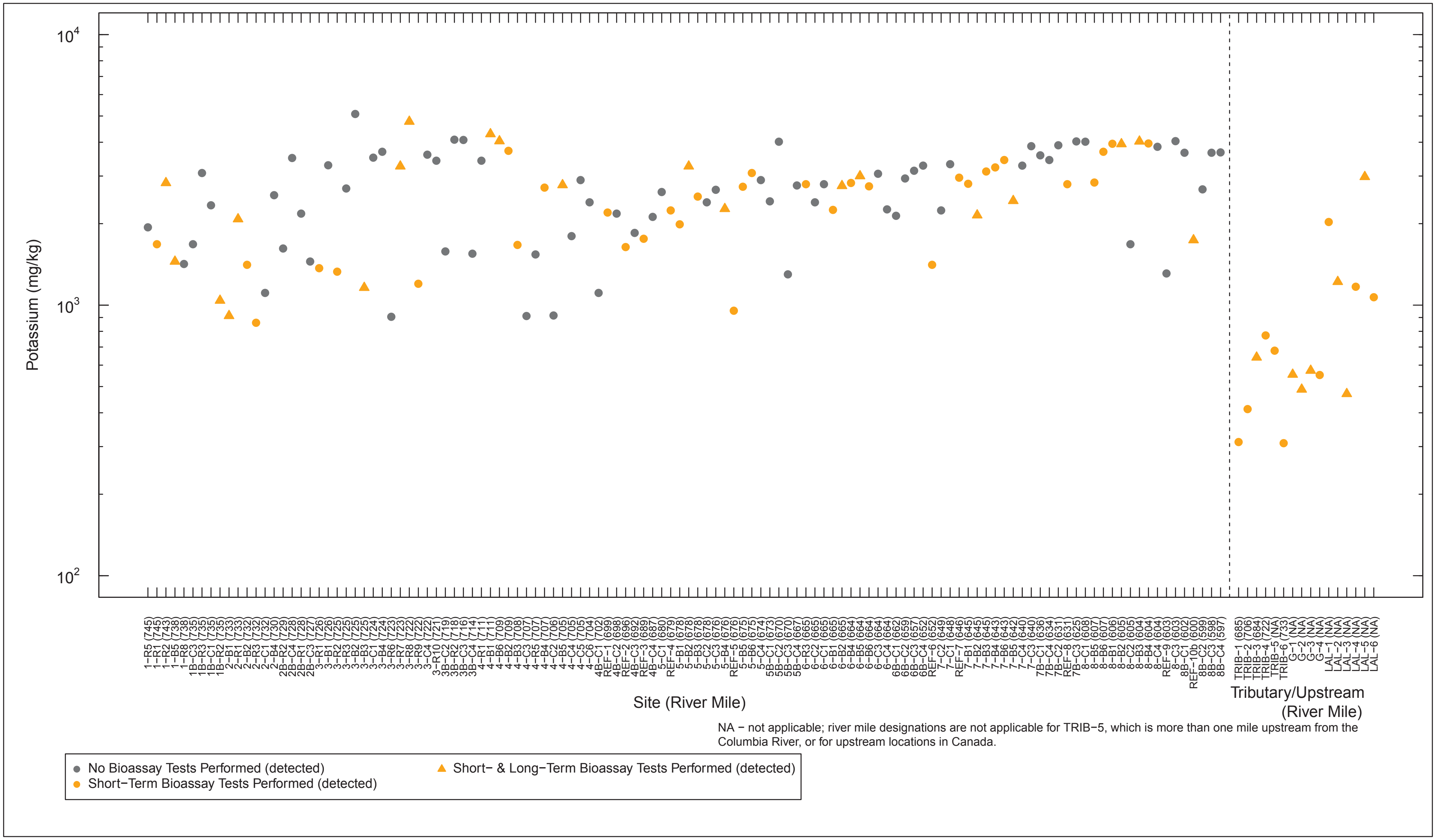


Figure 5−1u. Potassium in Field Sediment

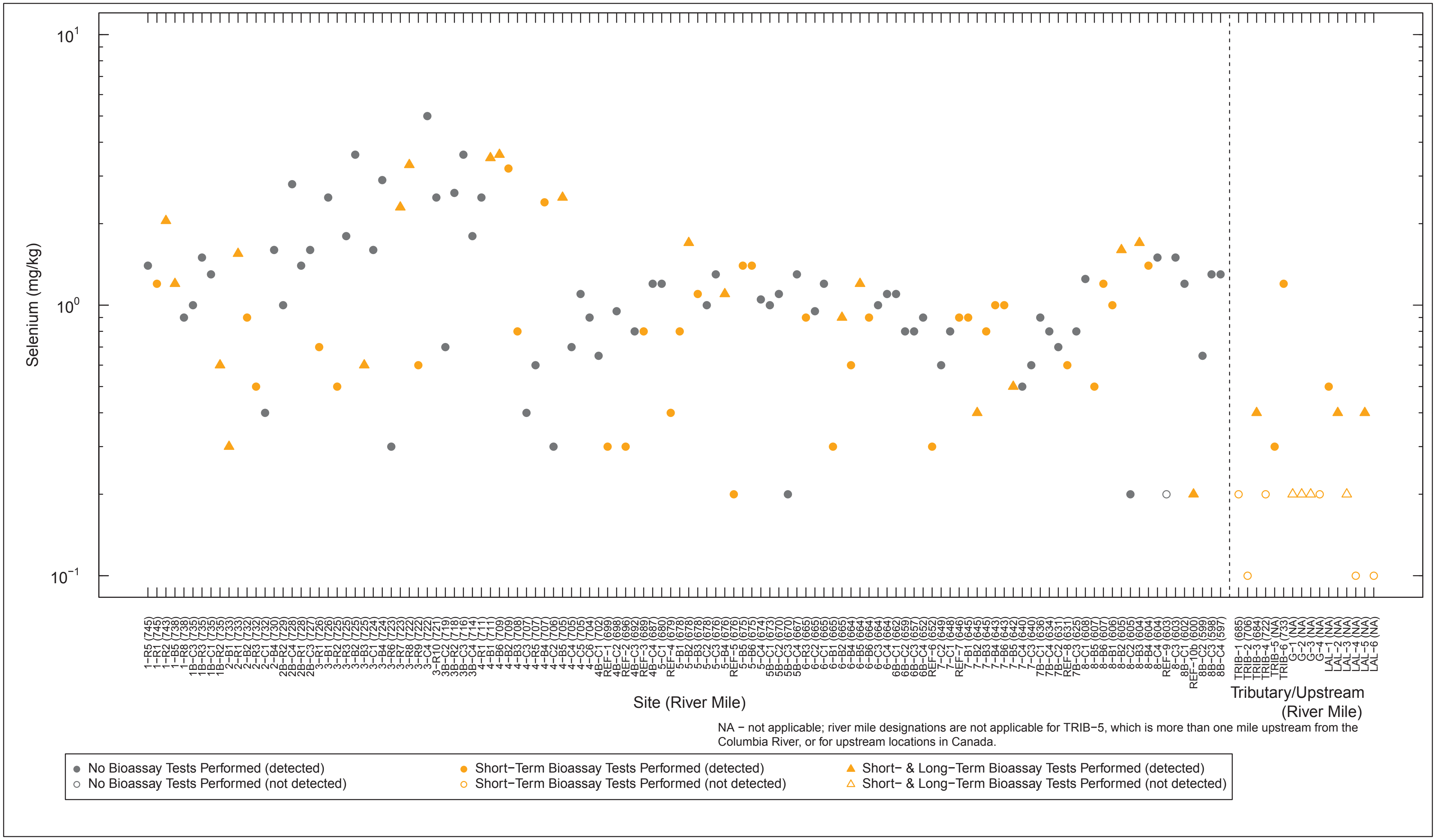


Figure 5−1v. Selenium in Field Sediment

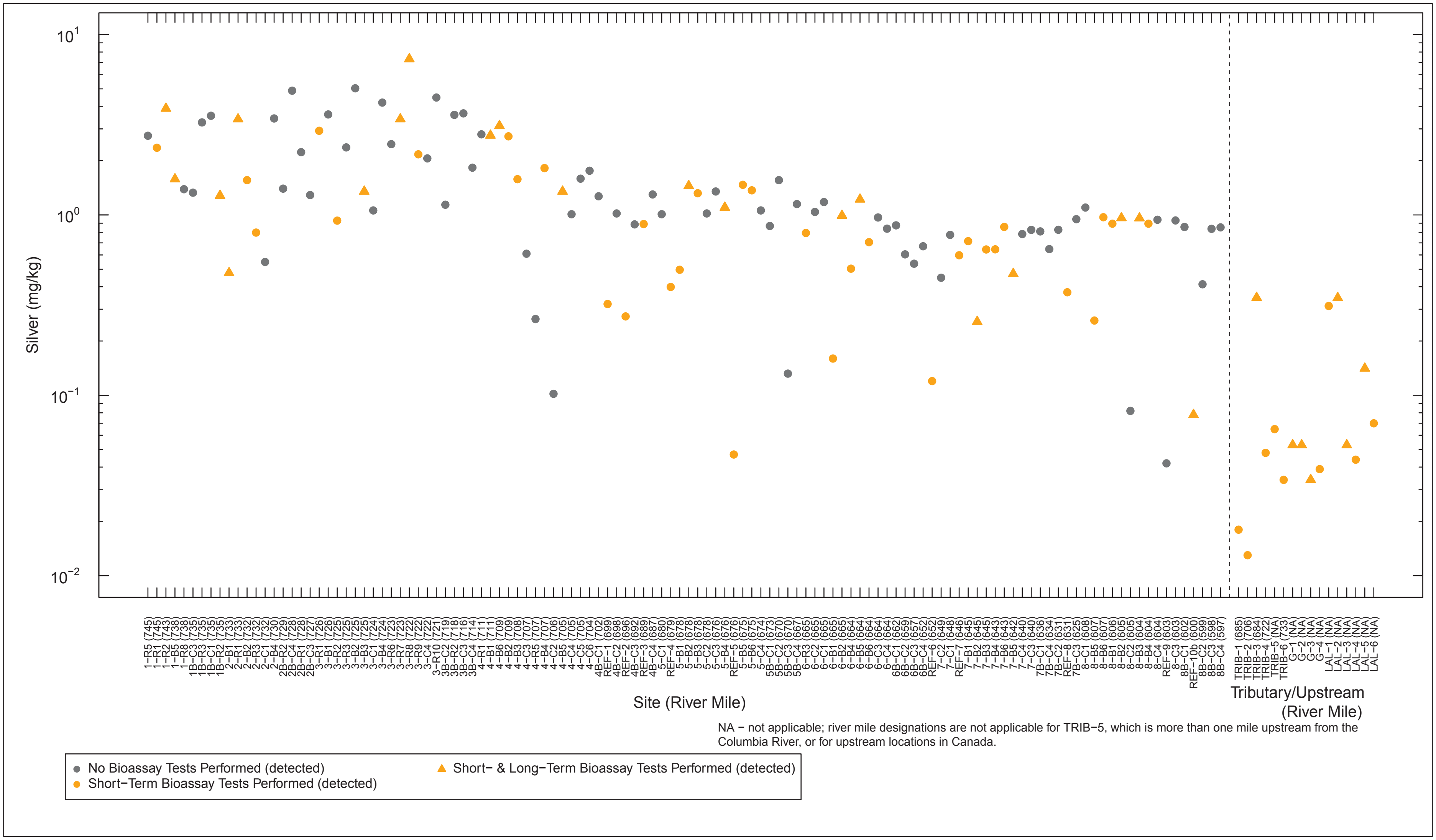


Figure 5−1w. Silver in Field Sediment

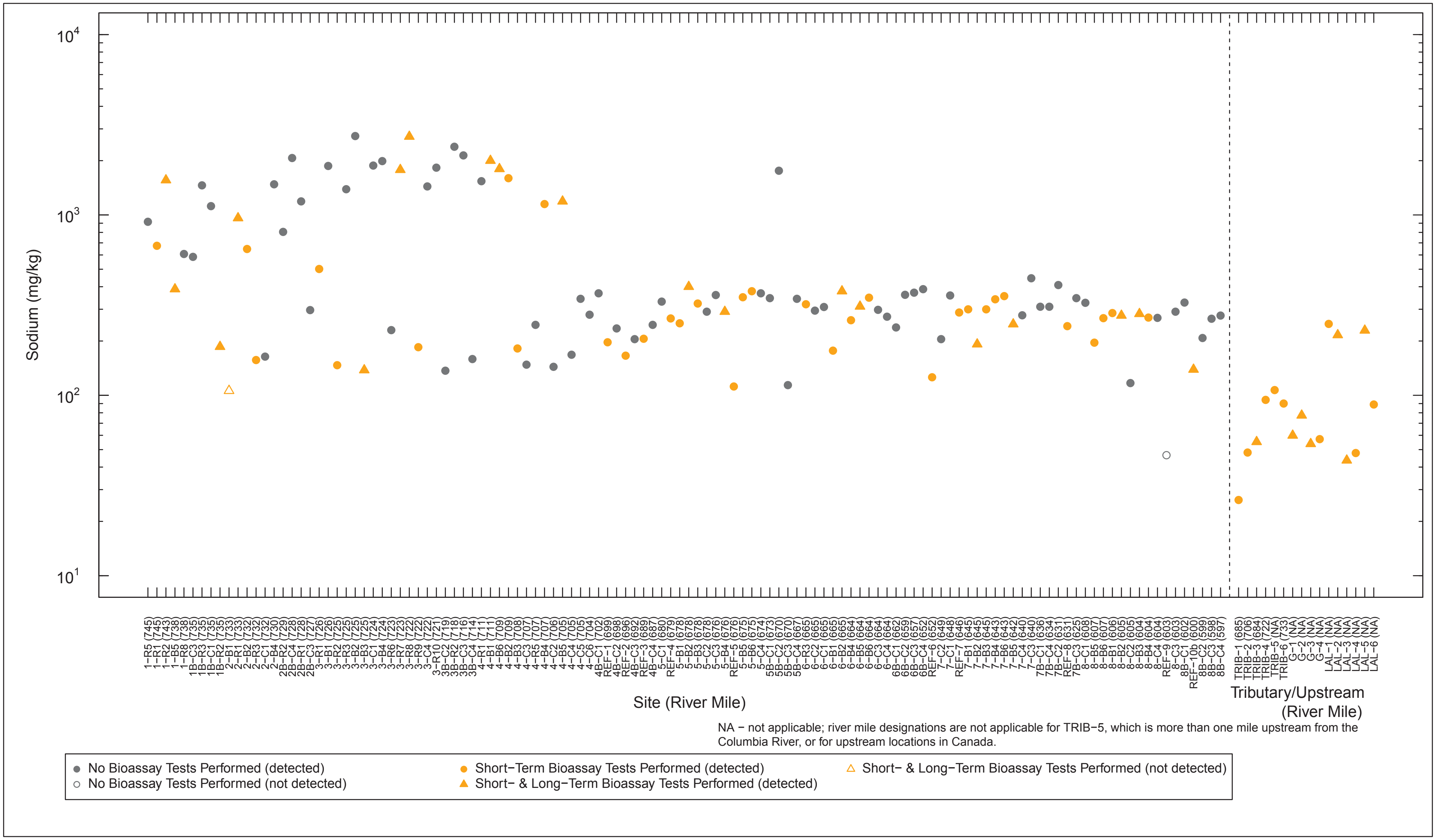


Figure 5−1x. Sodium in Field Sediment

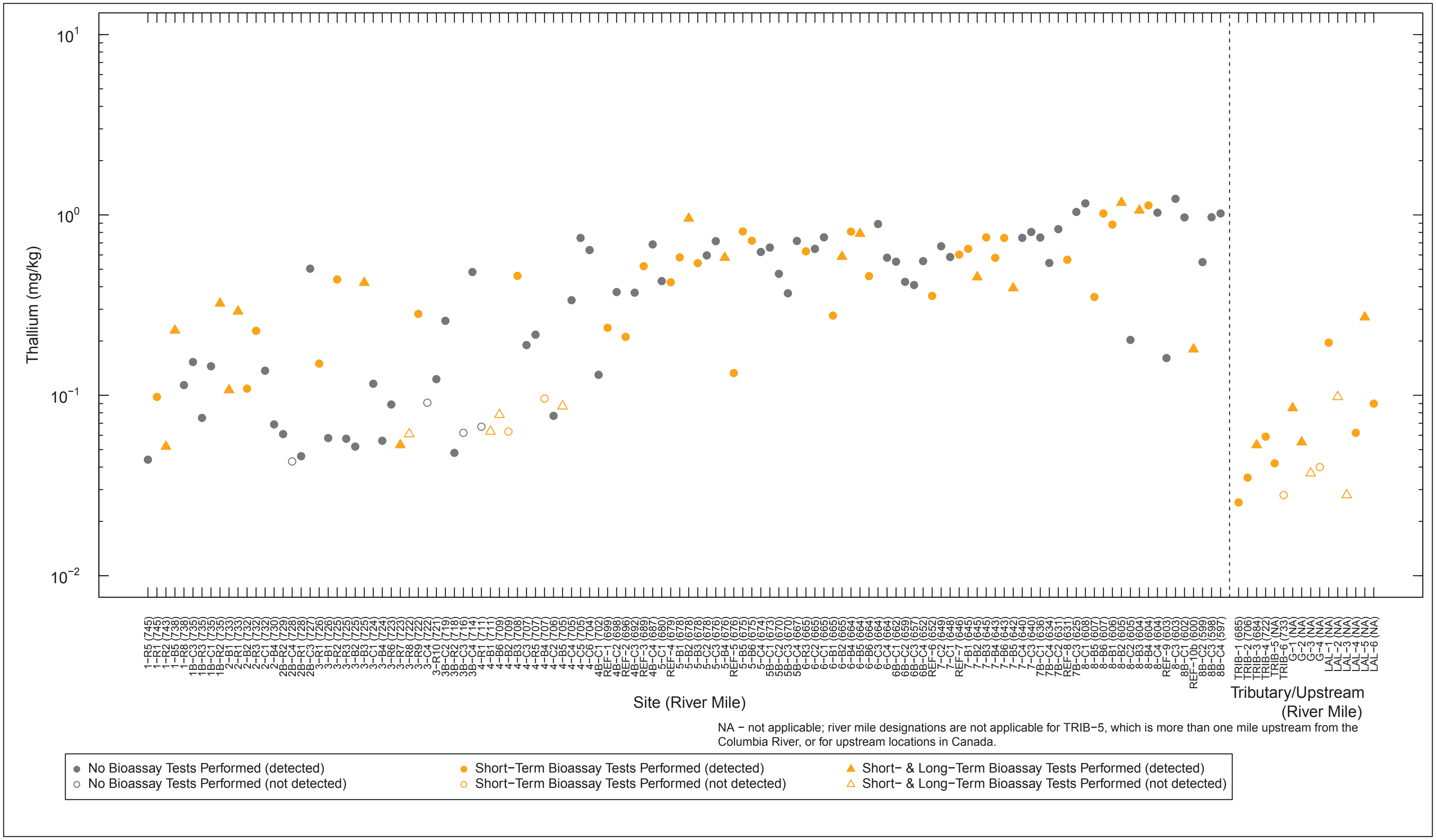


Figure 5−1y. Thallium in Field Sediment

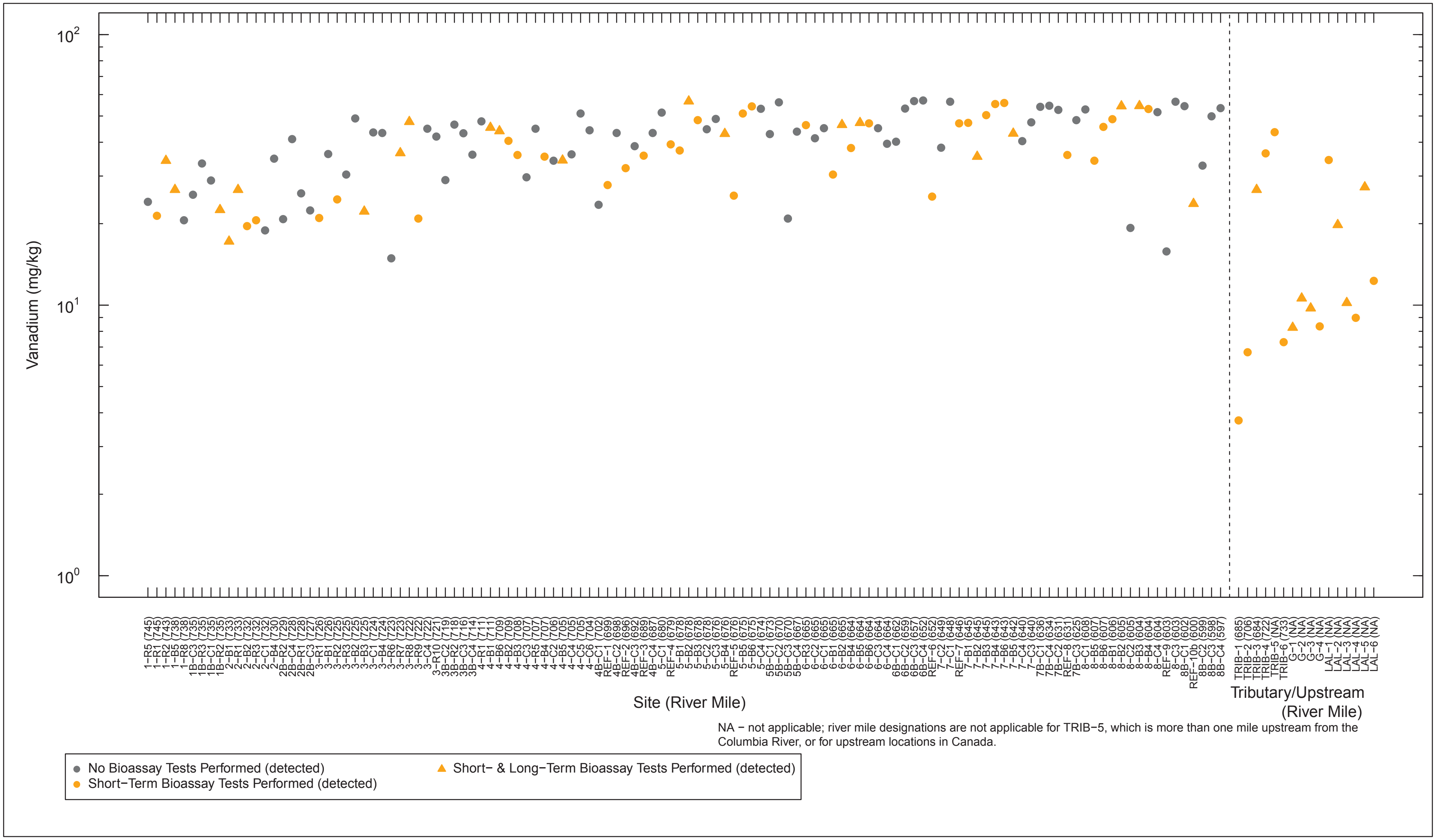


Figure 5−1z. Vanadium in Field Sediment

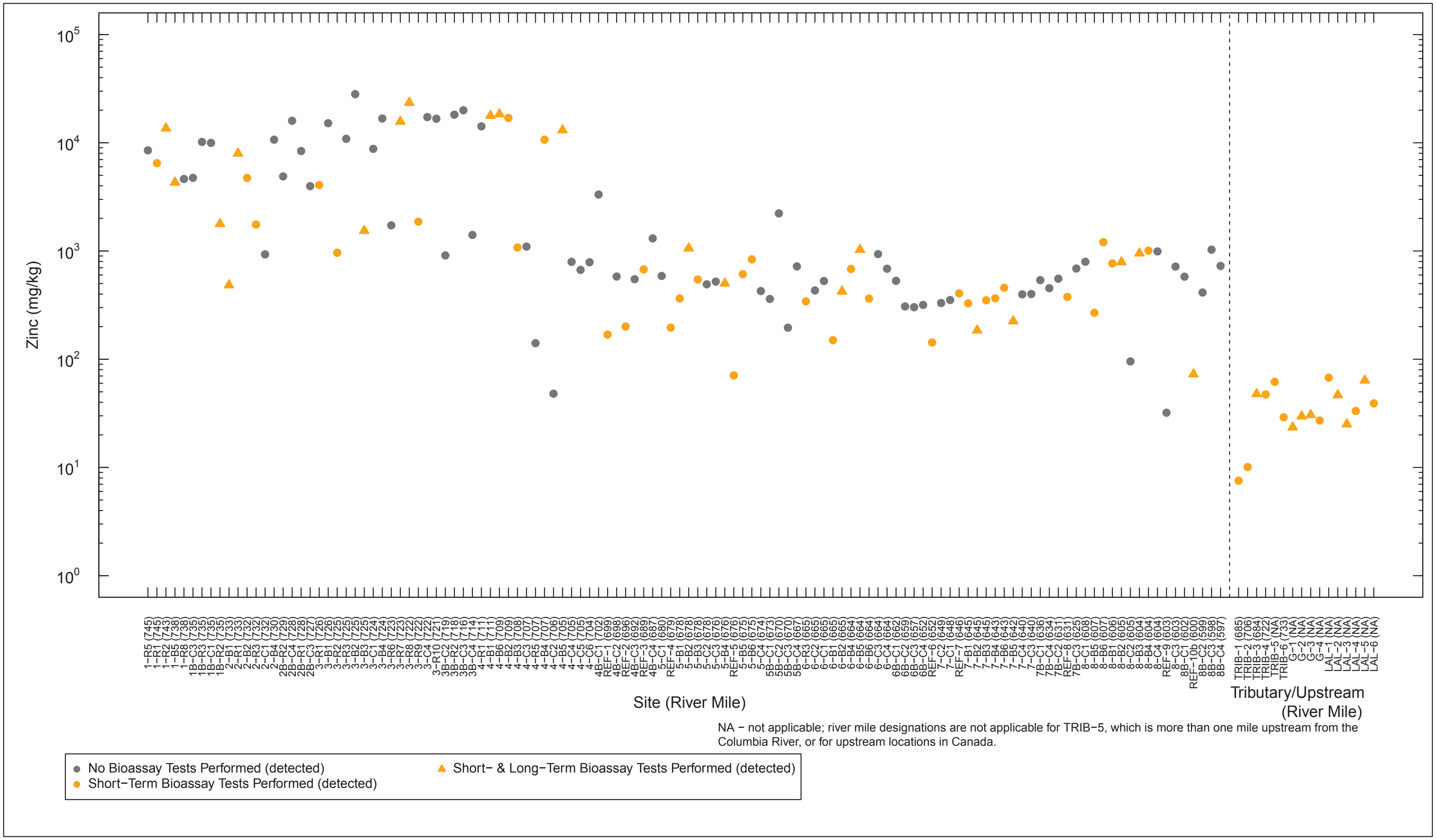


Figure 5−1aa. Zinc in Field Sediment

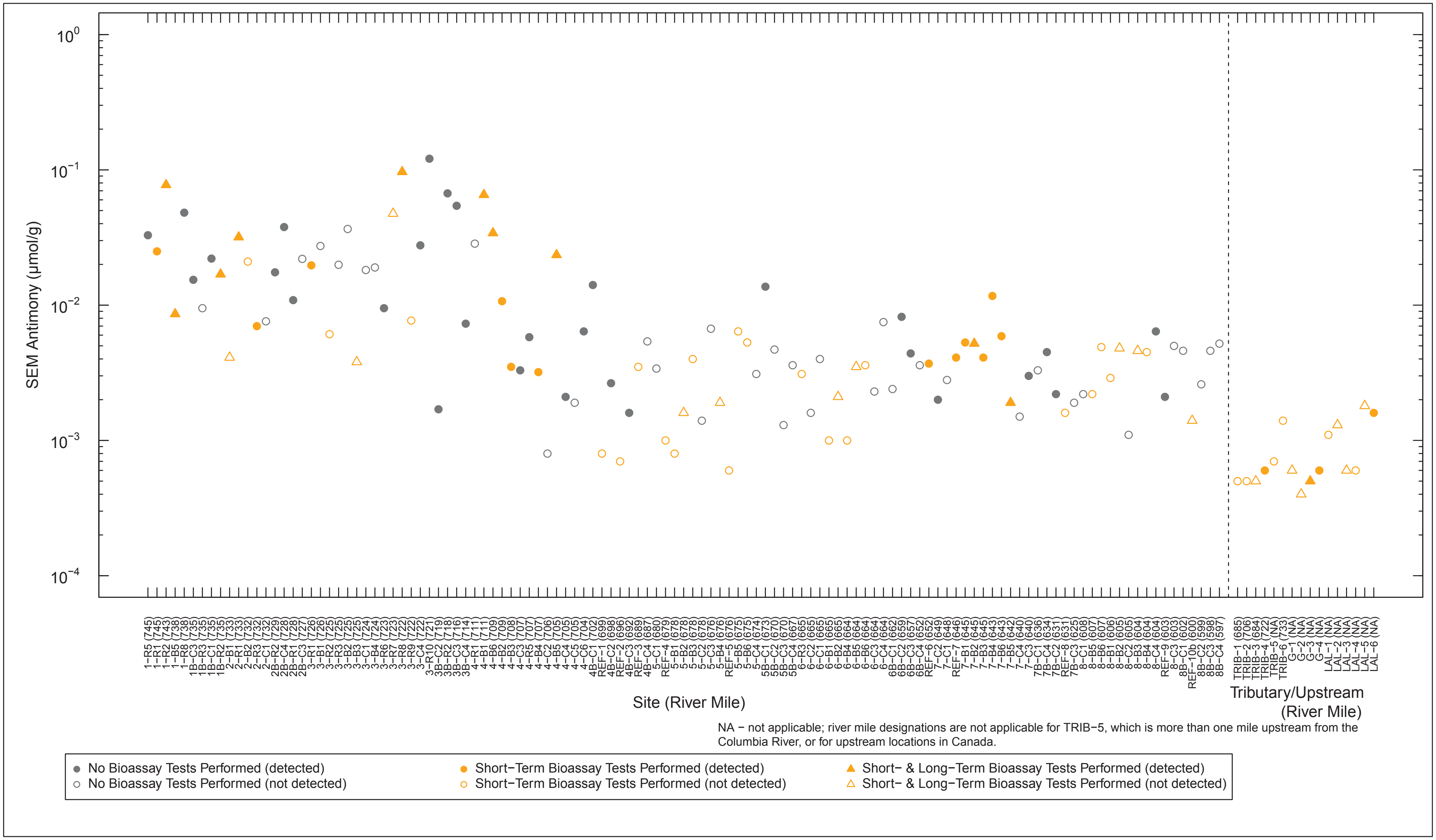


Figure 5−1ab. SEM Antimony in Field Sediment

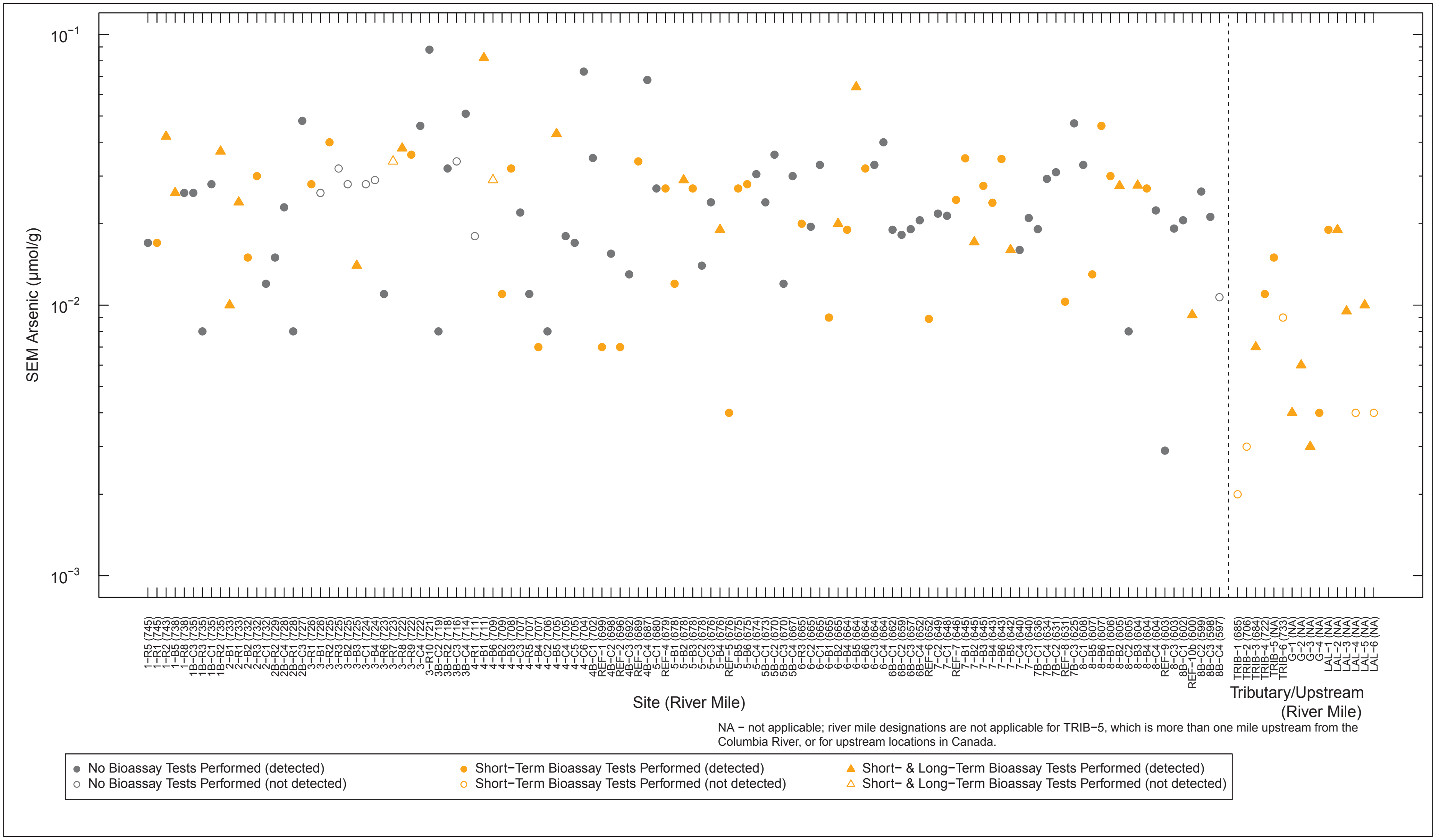


Figure 5−1ac. SEM Arsenic in Field Sediment

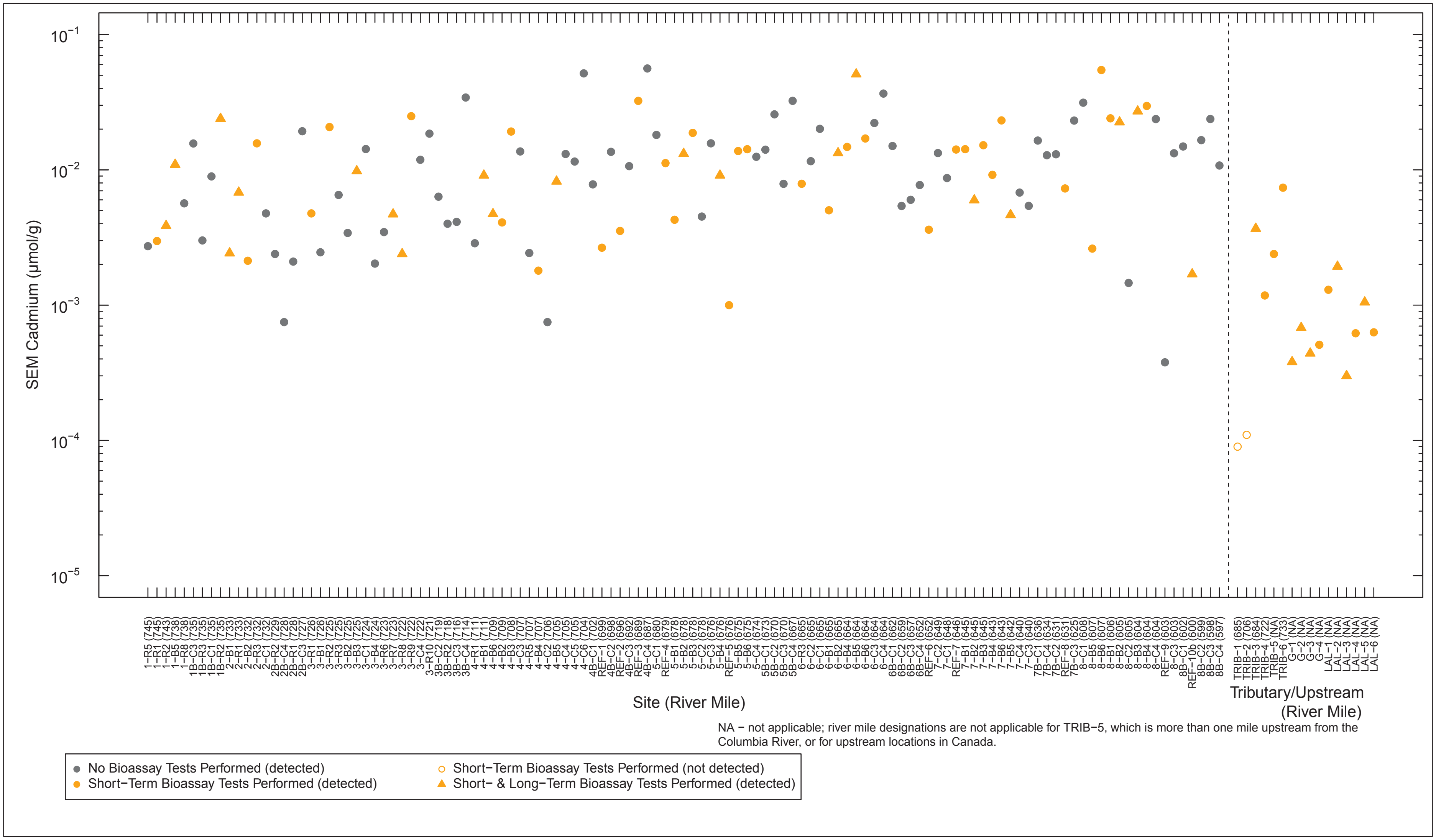


Figure 5−1ad. SEM Cadmium in Field Sediment

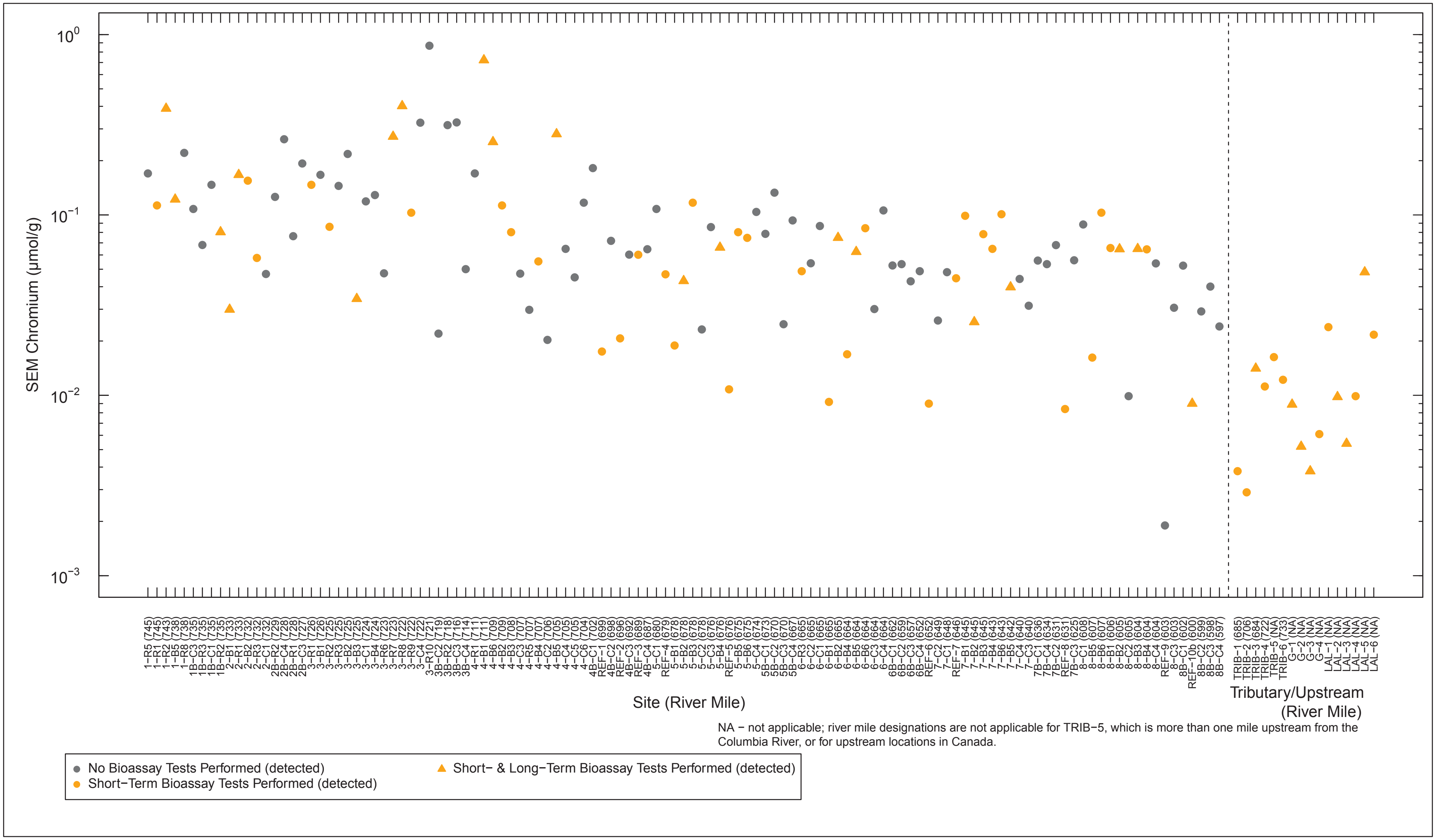


Figure 5−1ae. SEM Chromium in Field Sediment

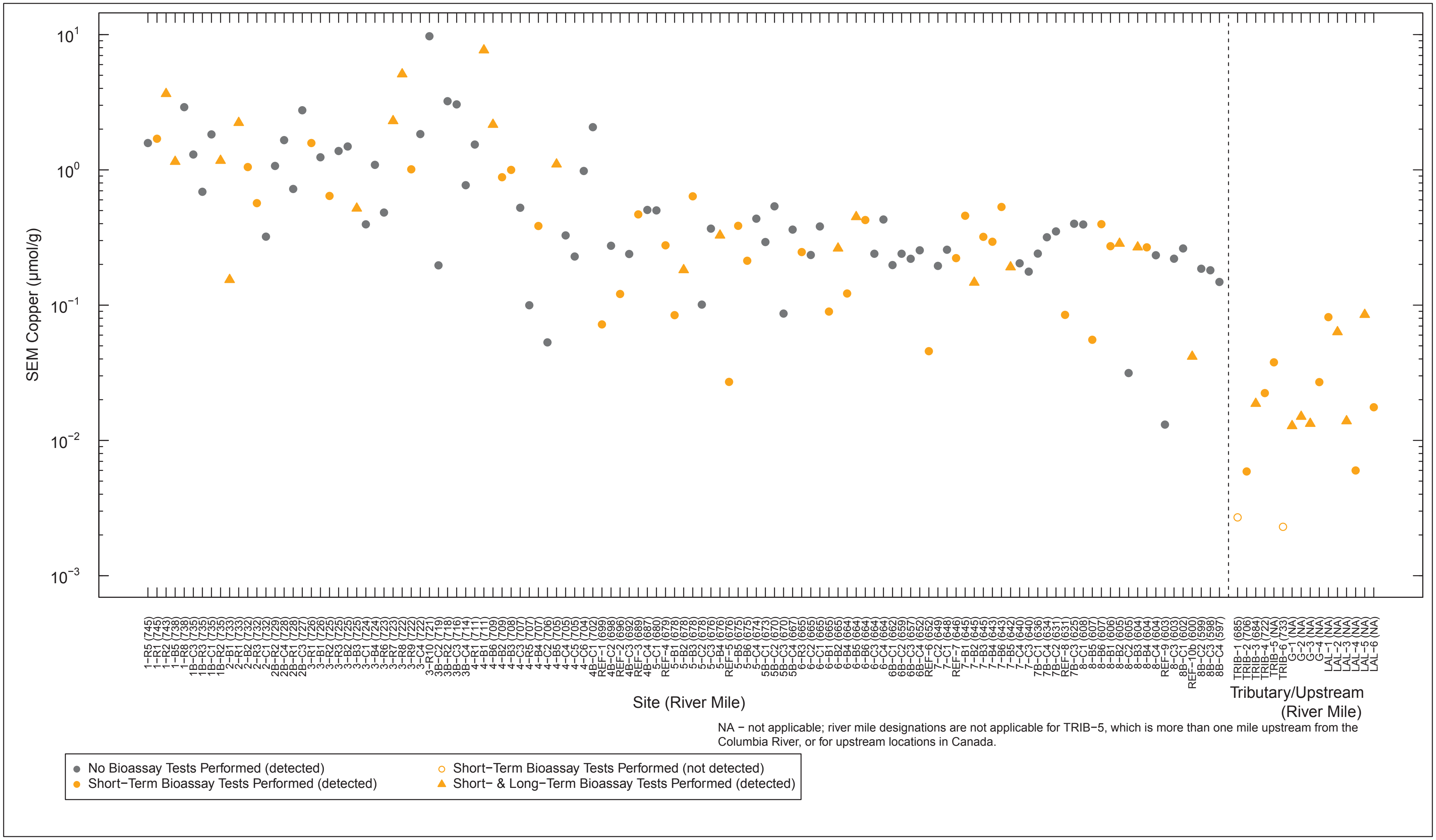


Figure 5−1af. SEM Copper in Field Sediment

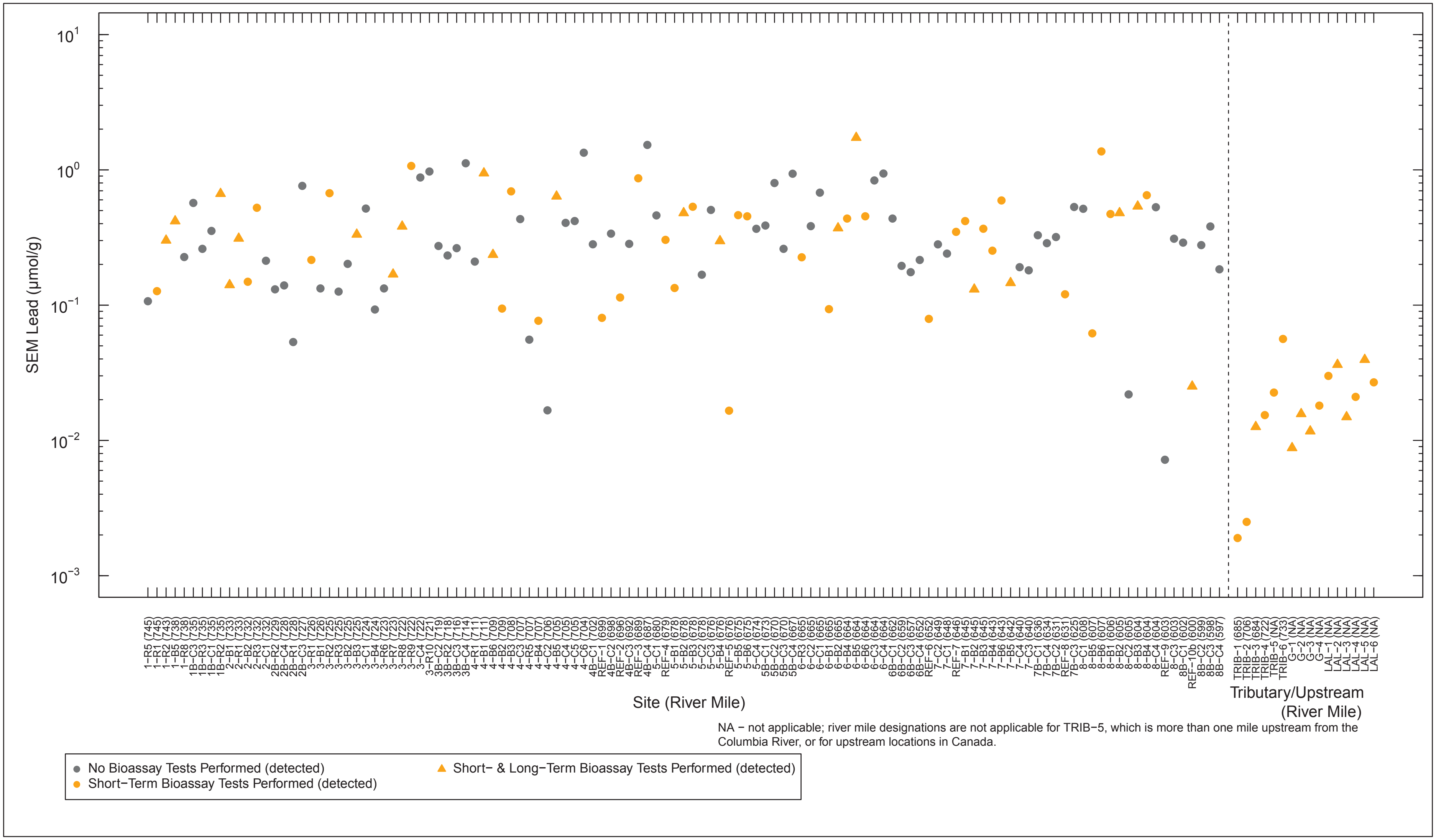


Figure 5−1ag. SEM Lead in Field Sediment

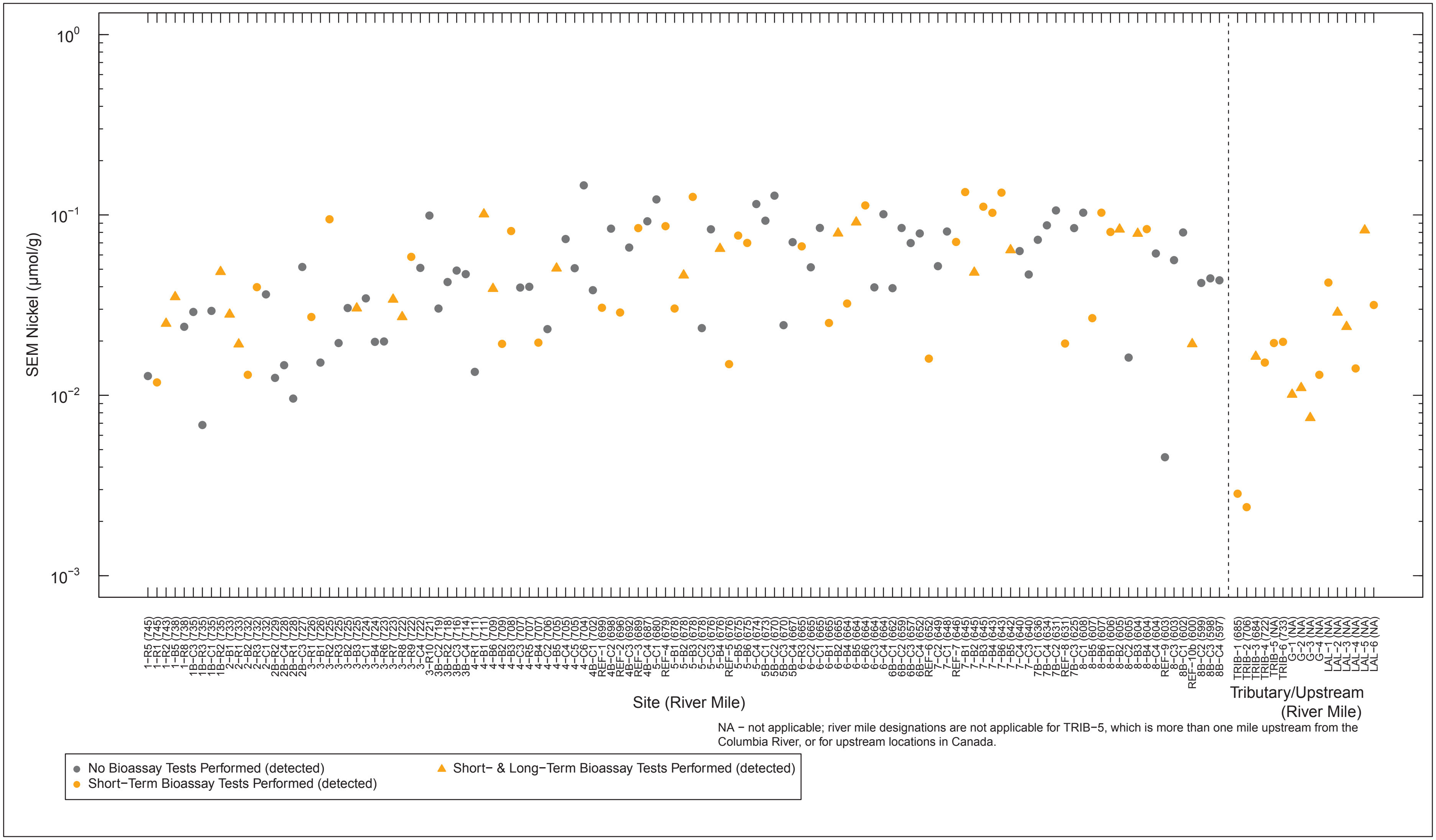


Figure 5−1ah. SEM Nickel in Field Sediment

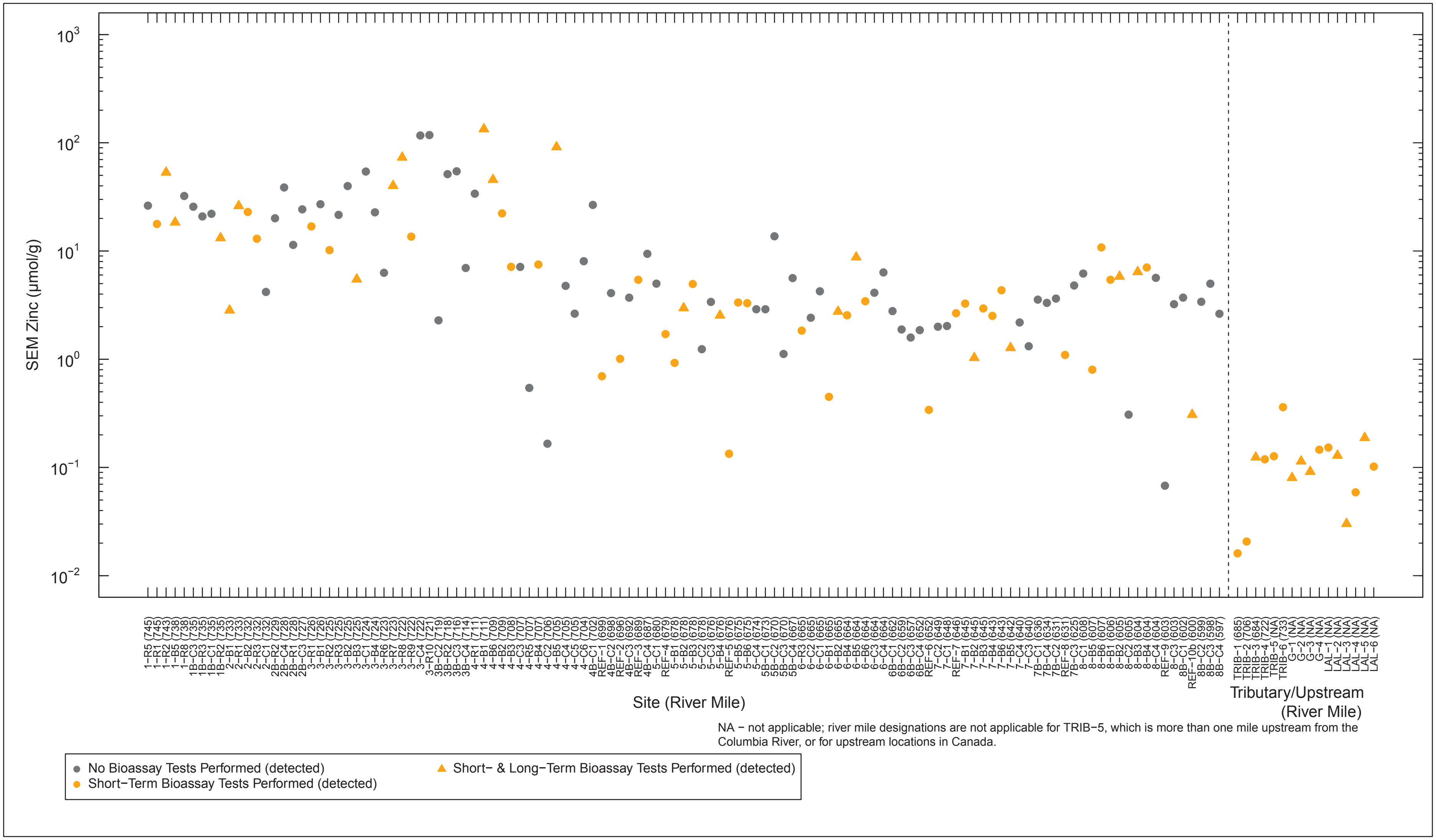


Figure 5−1ai. SEM Zinc in Field Sediment

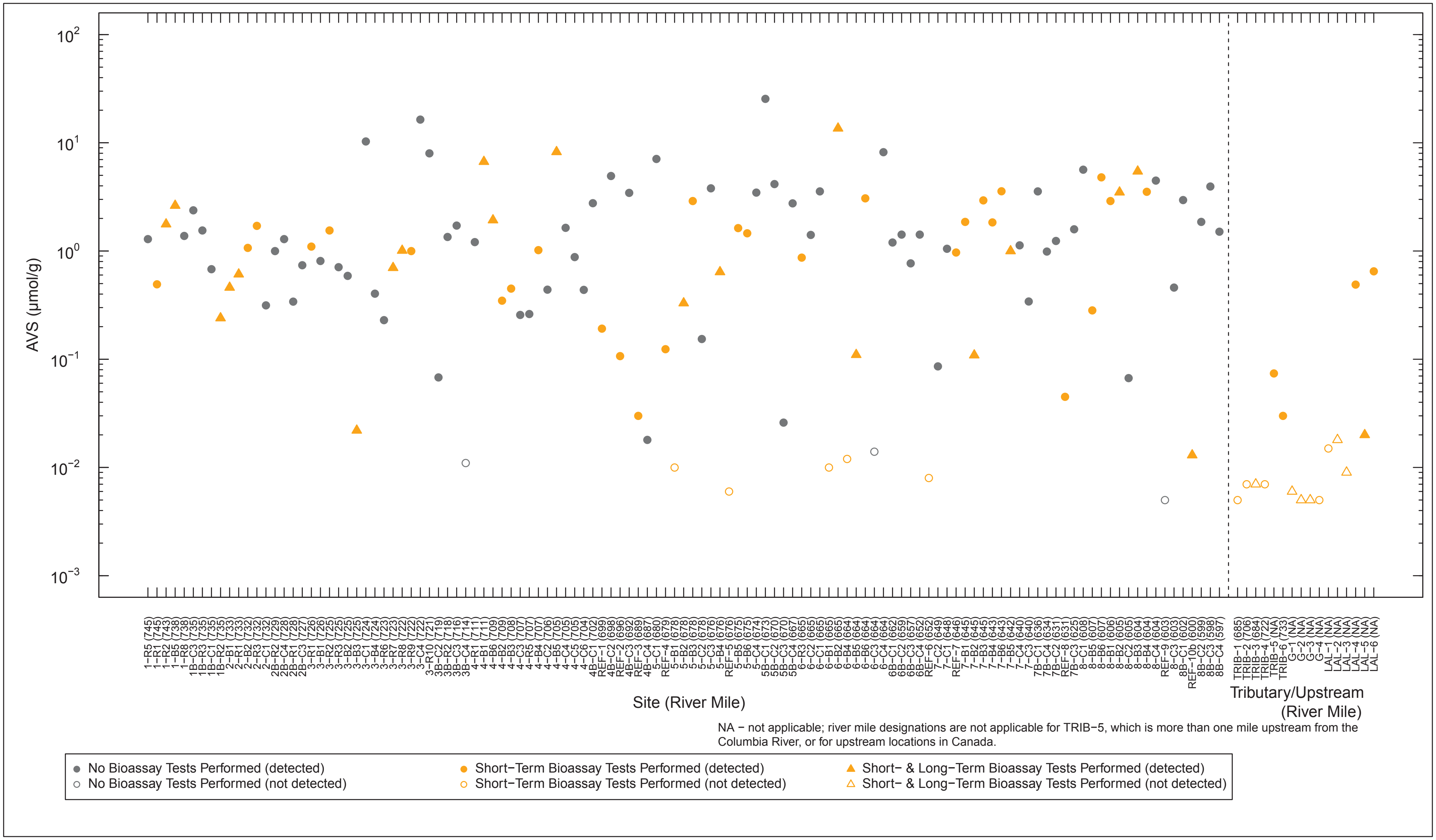


Figure 5−1aj. AVS in Field Sediment

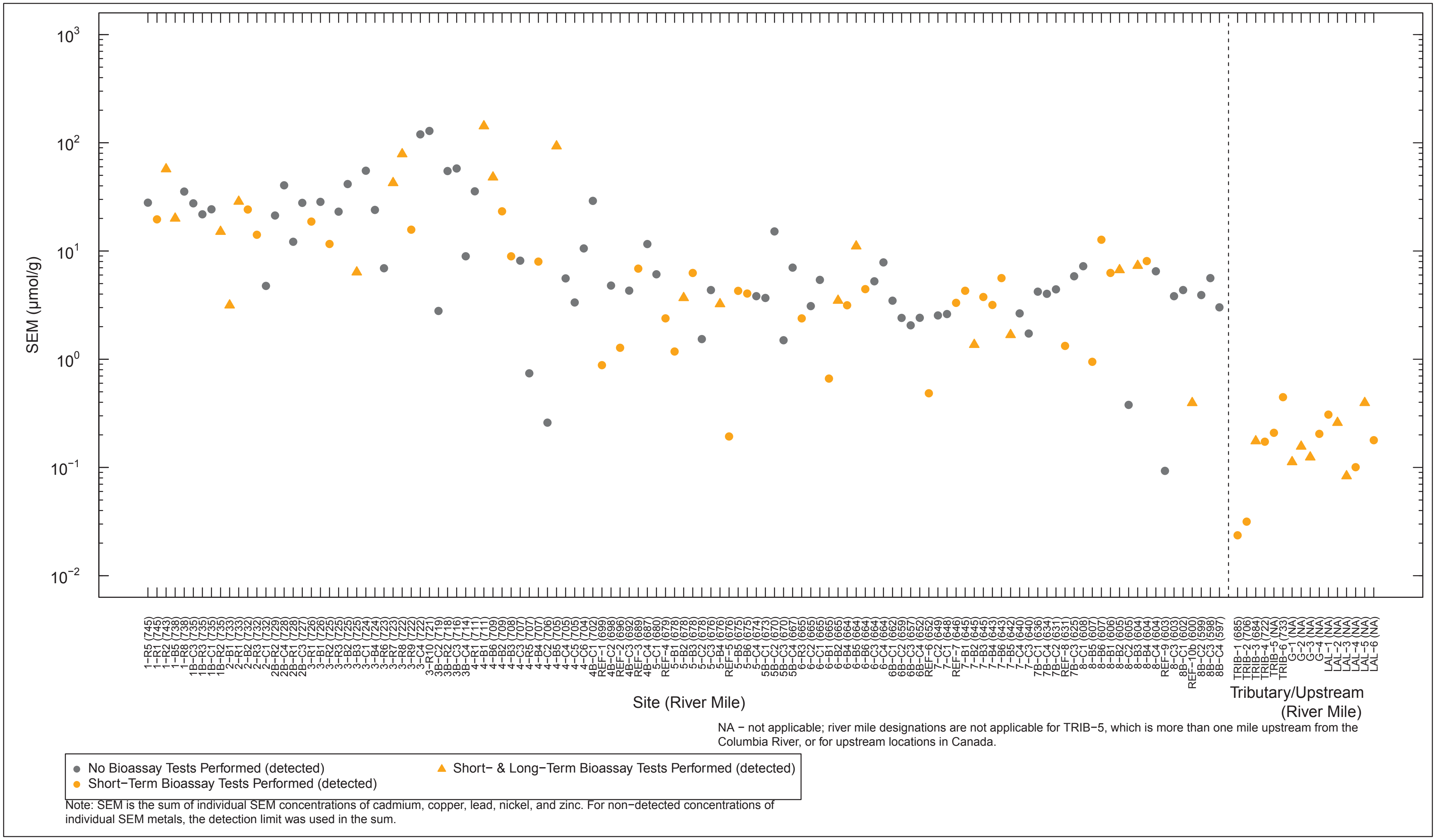


Figure 5−1ak. SEM in Field Sediment

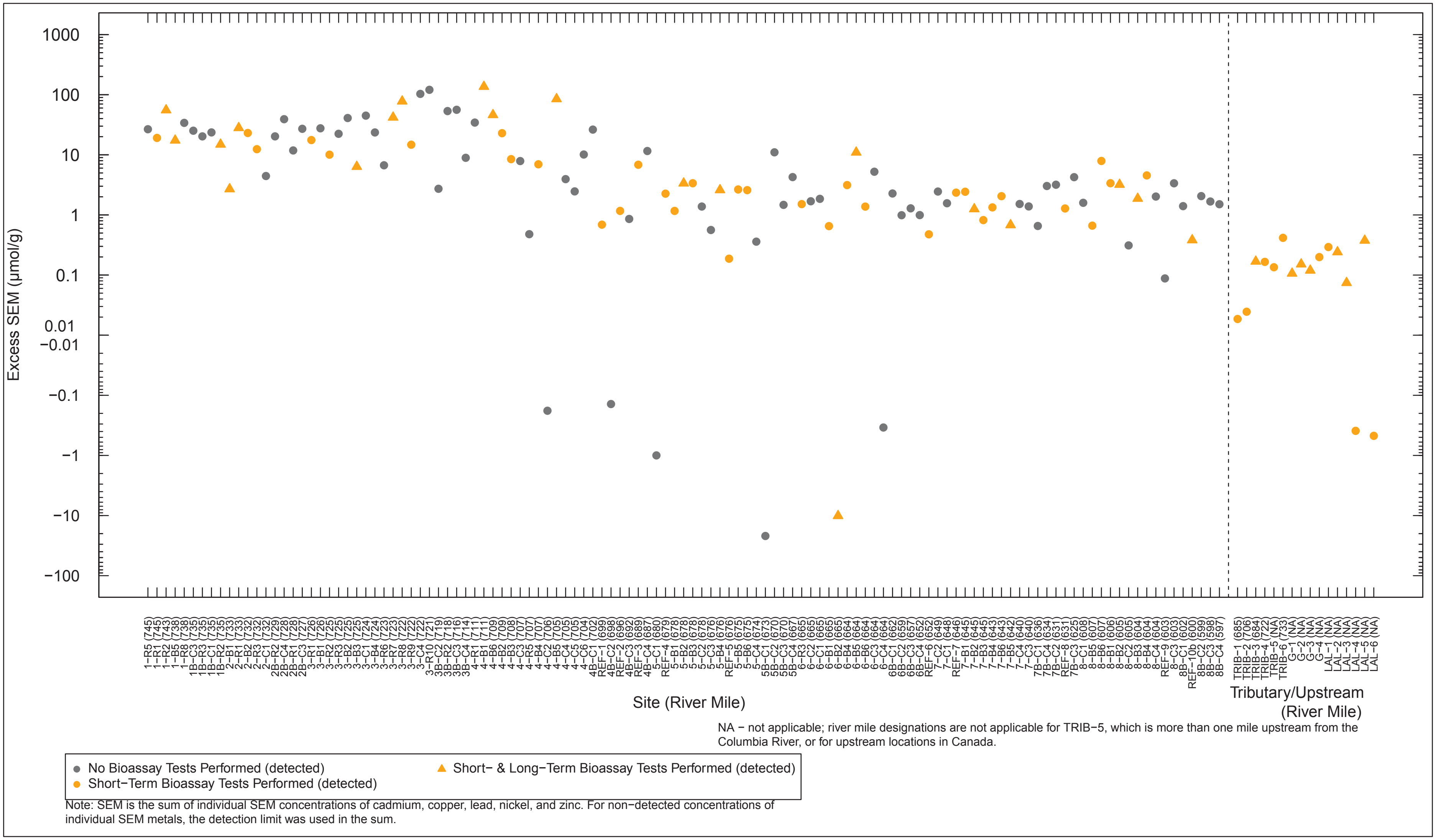


Figure 5−1al. Excess SEM in Field Sediment

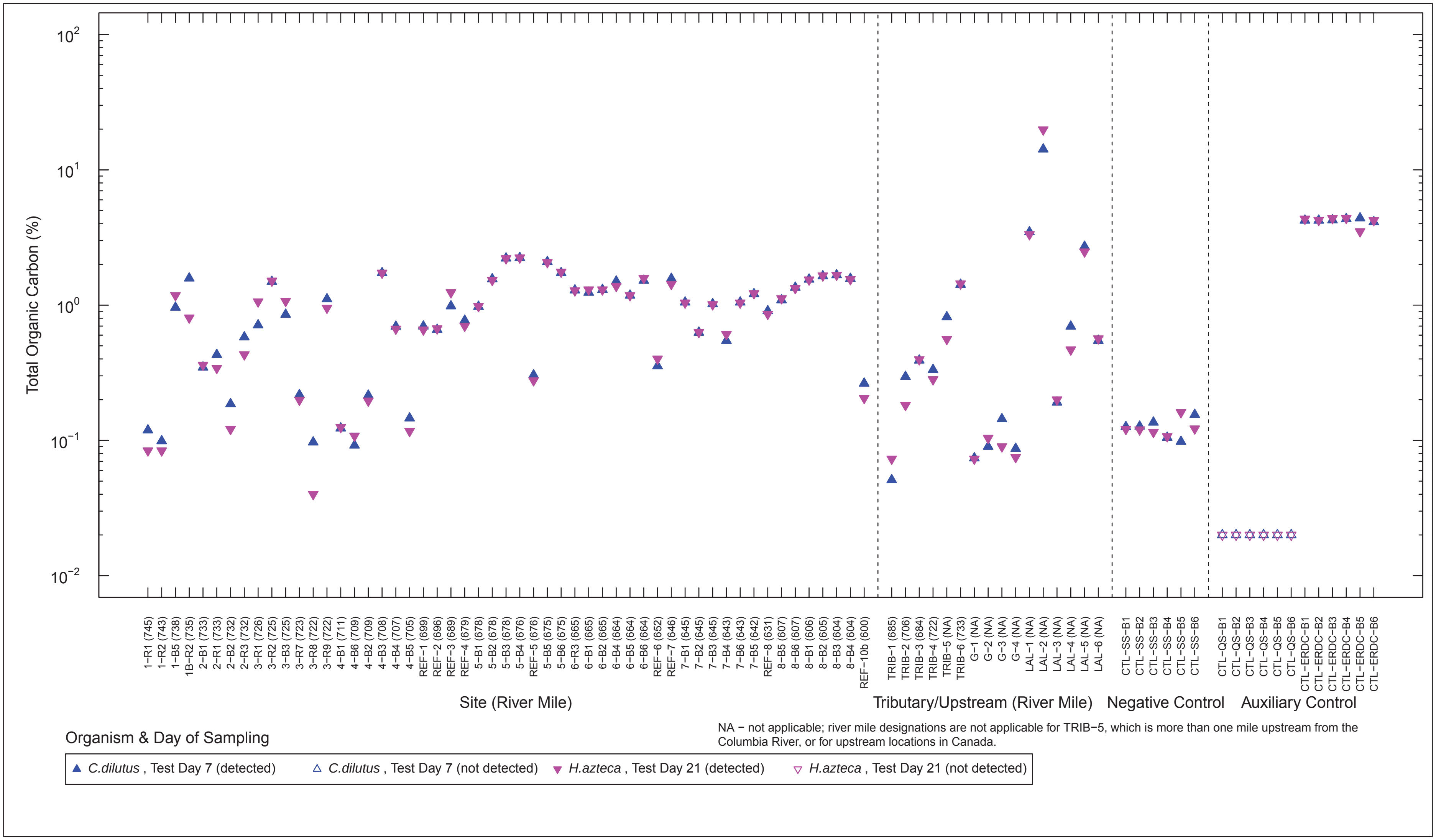


Figure 5−2a. Total Organic Carbon in Sediment from Short−Term Bioassays

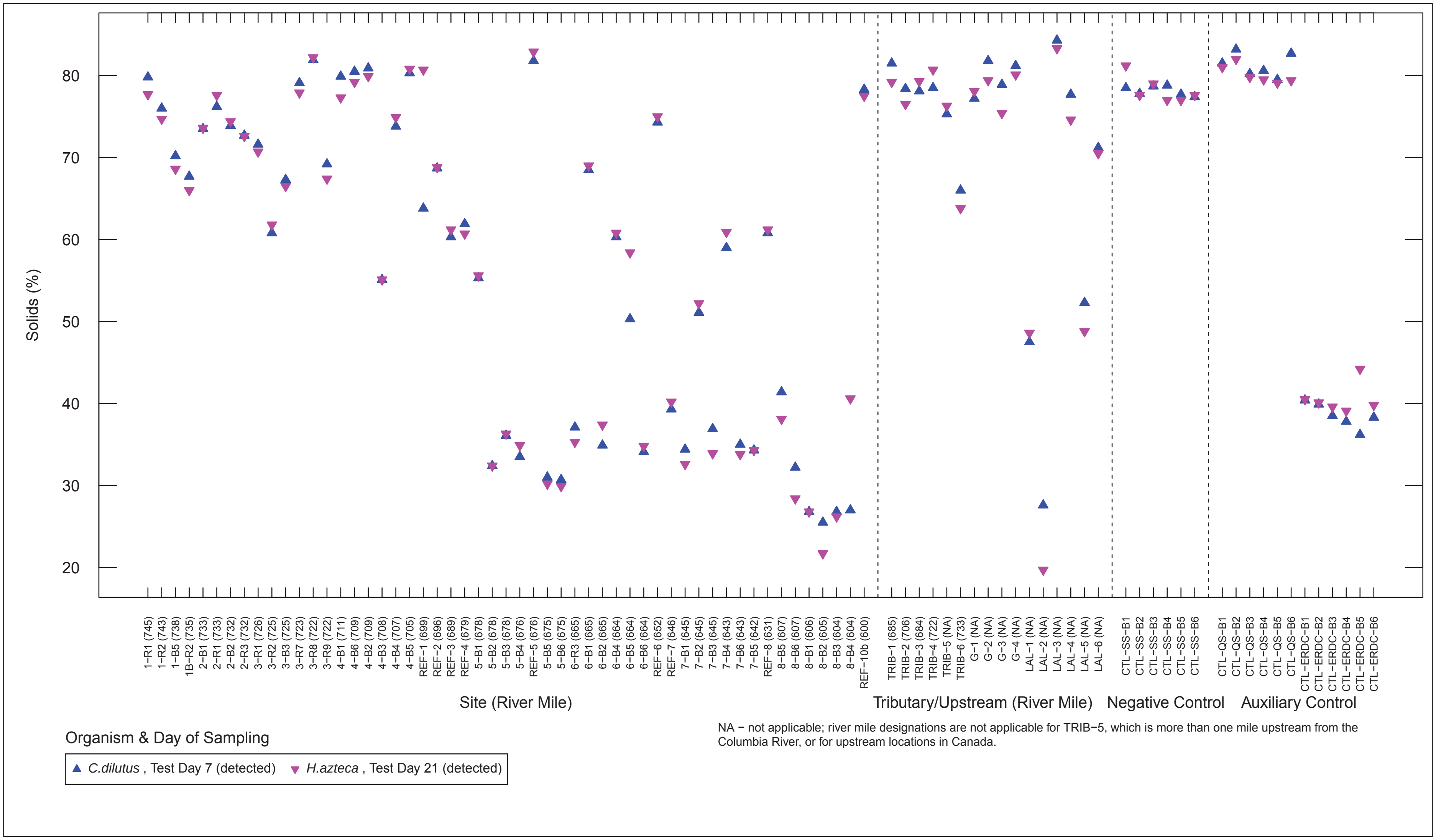


Figure 5−2b. Solids in Sediment from Short−Term Bioassays

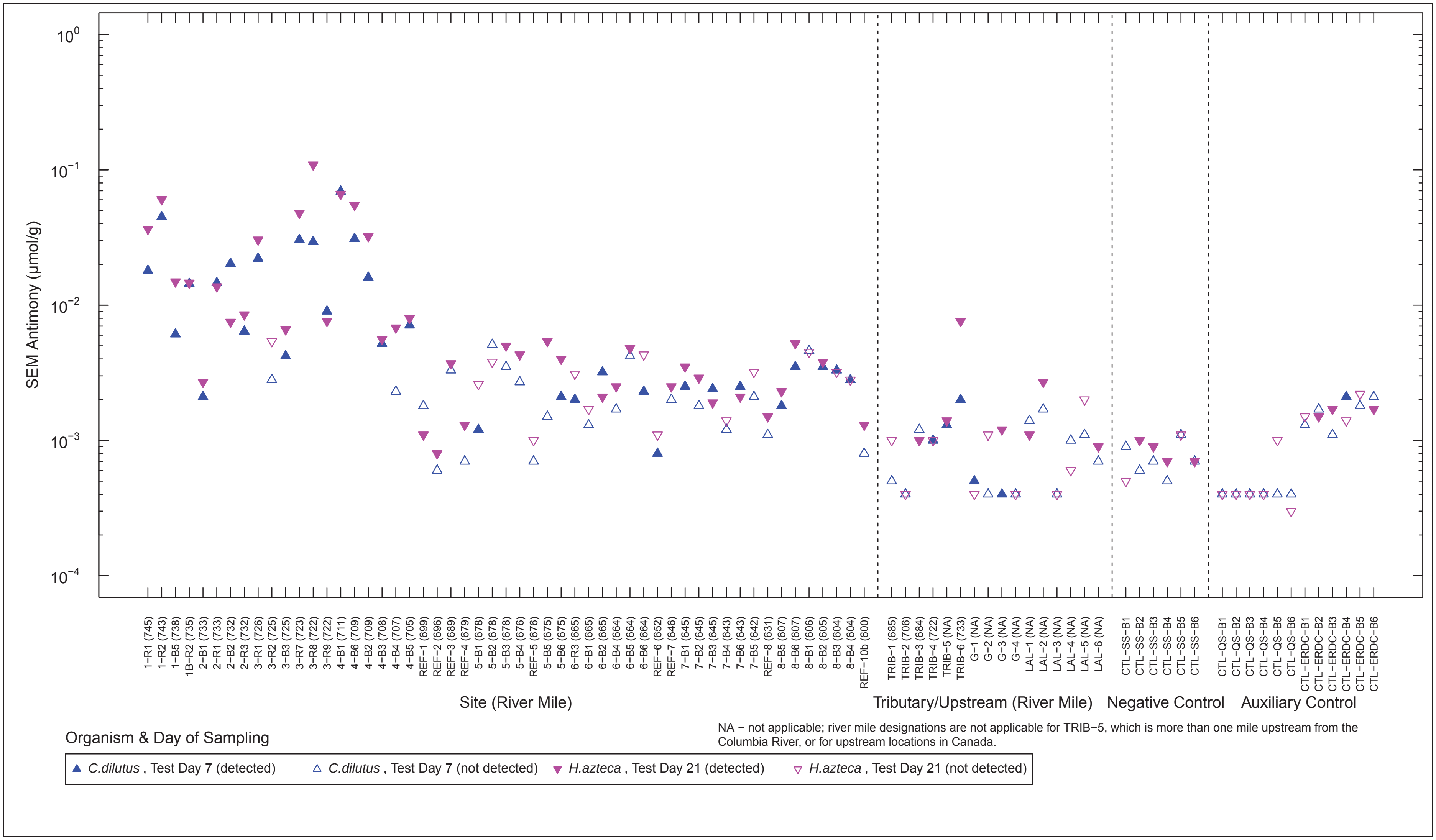
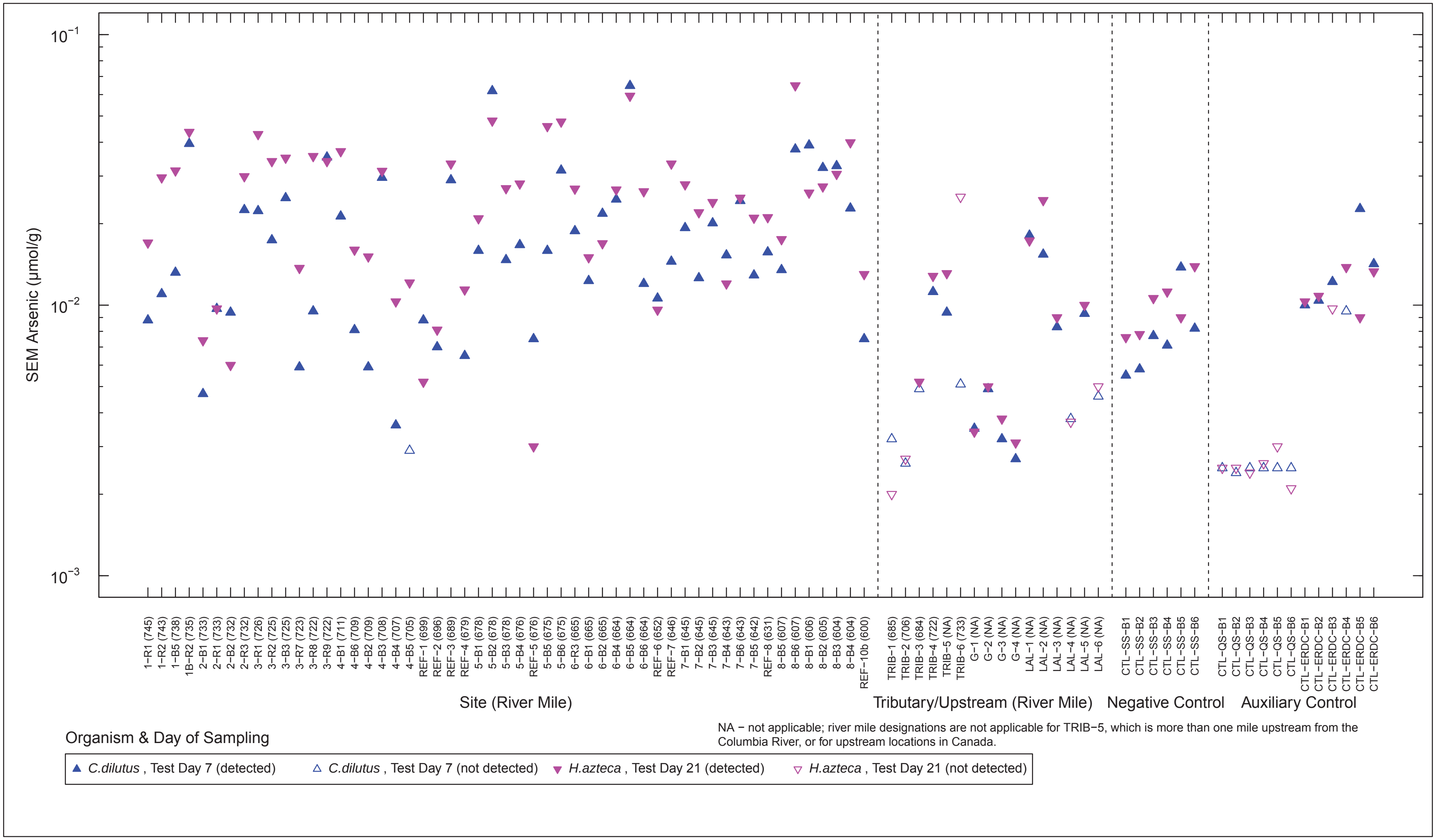


Figure 5−2c. SEM Antimony in Sediment from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−2d. SEM Arsenic in Sediment from Short−Term Bioassays

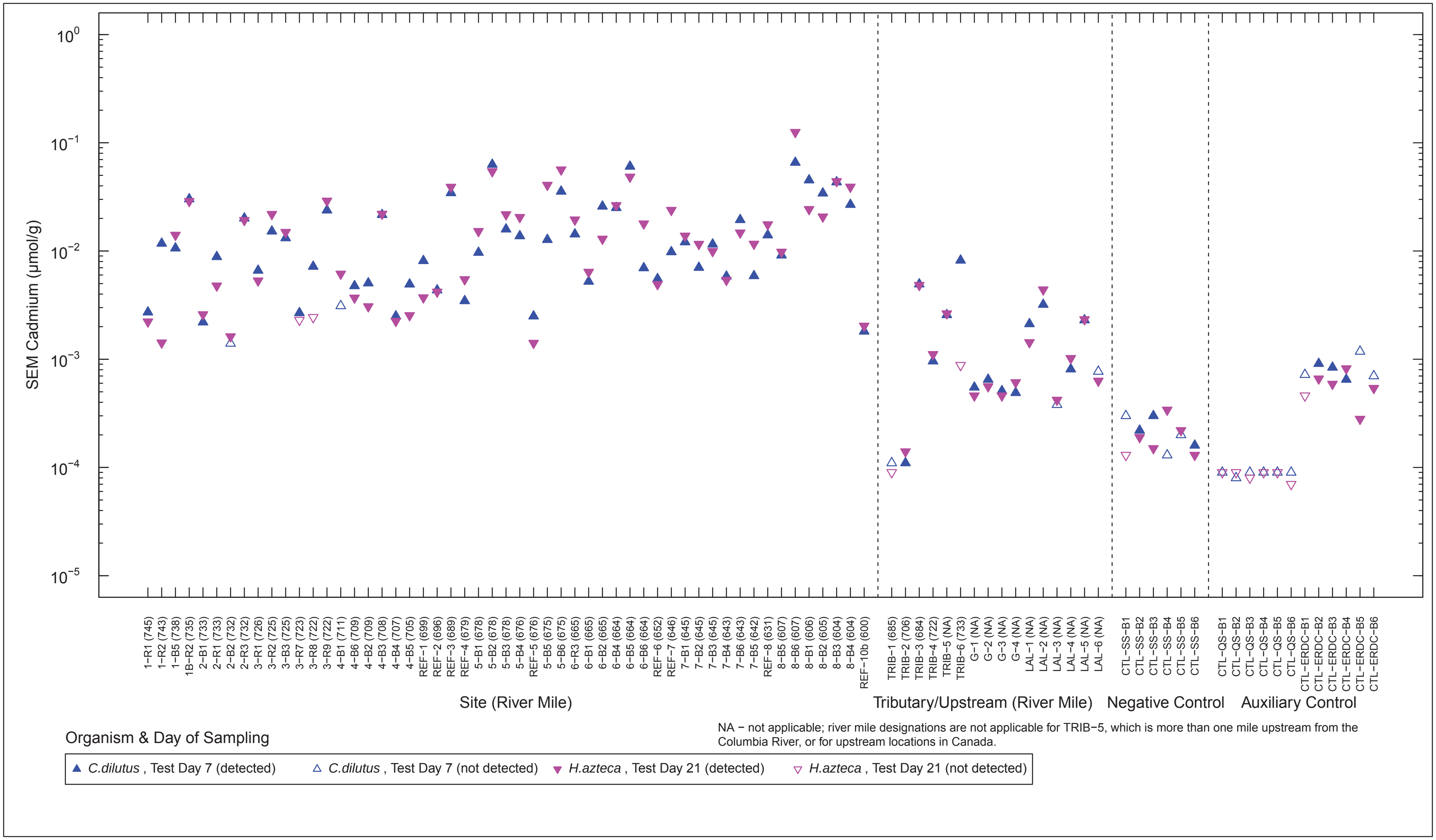


Figure 5−2e. SEM Cadmium in Sediment from Short−Term Bioassays

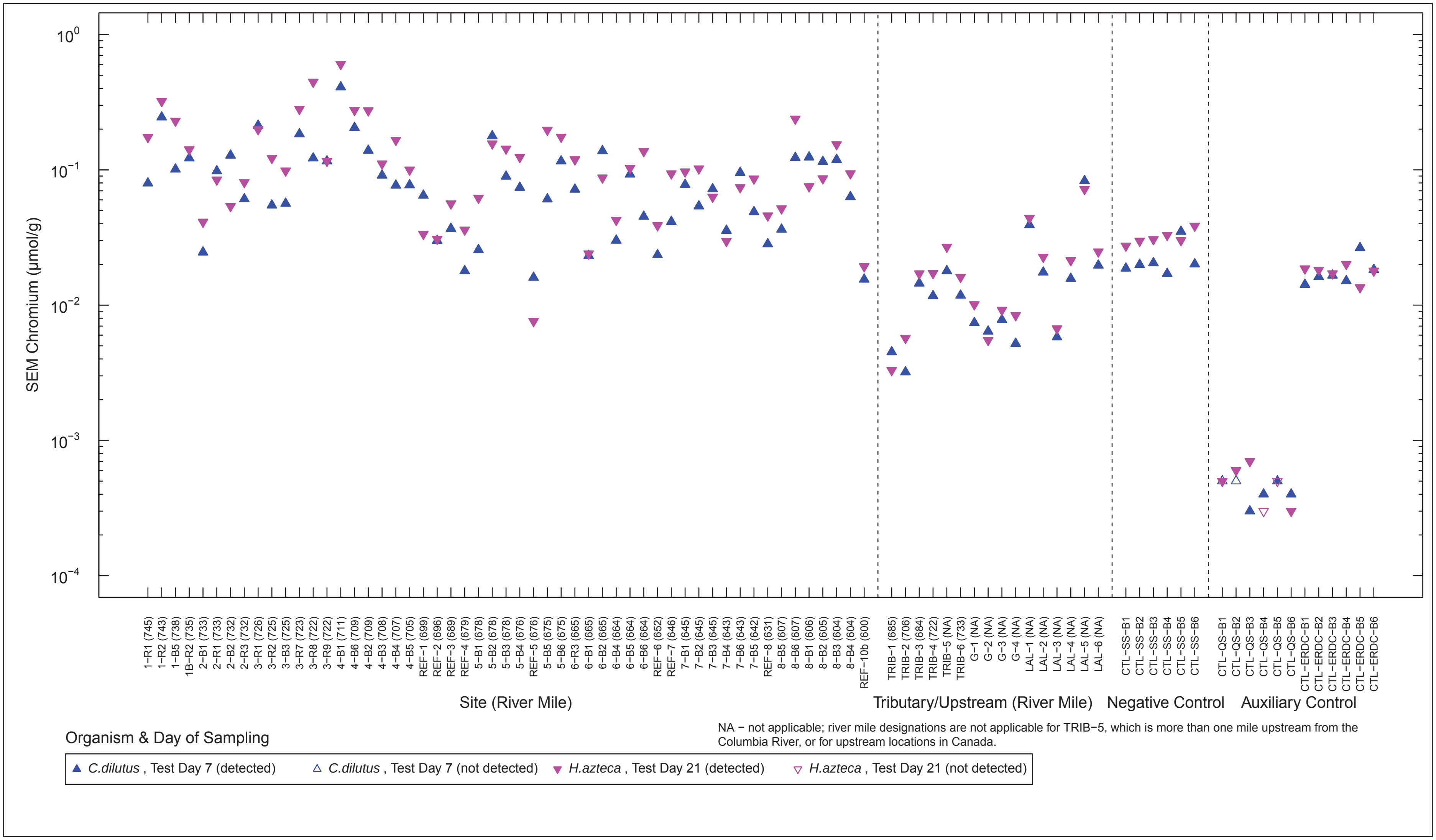


Figure 5−2f. SEM Chromium in Sediment from Short−Term Bioassays

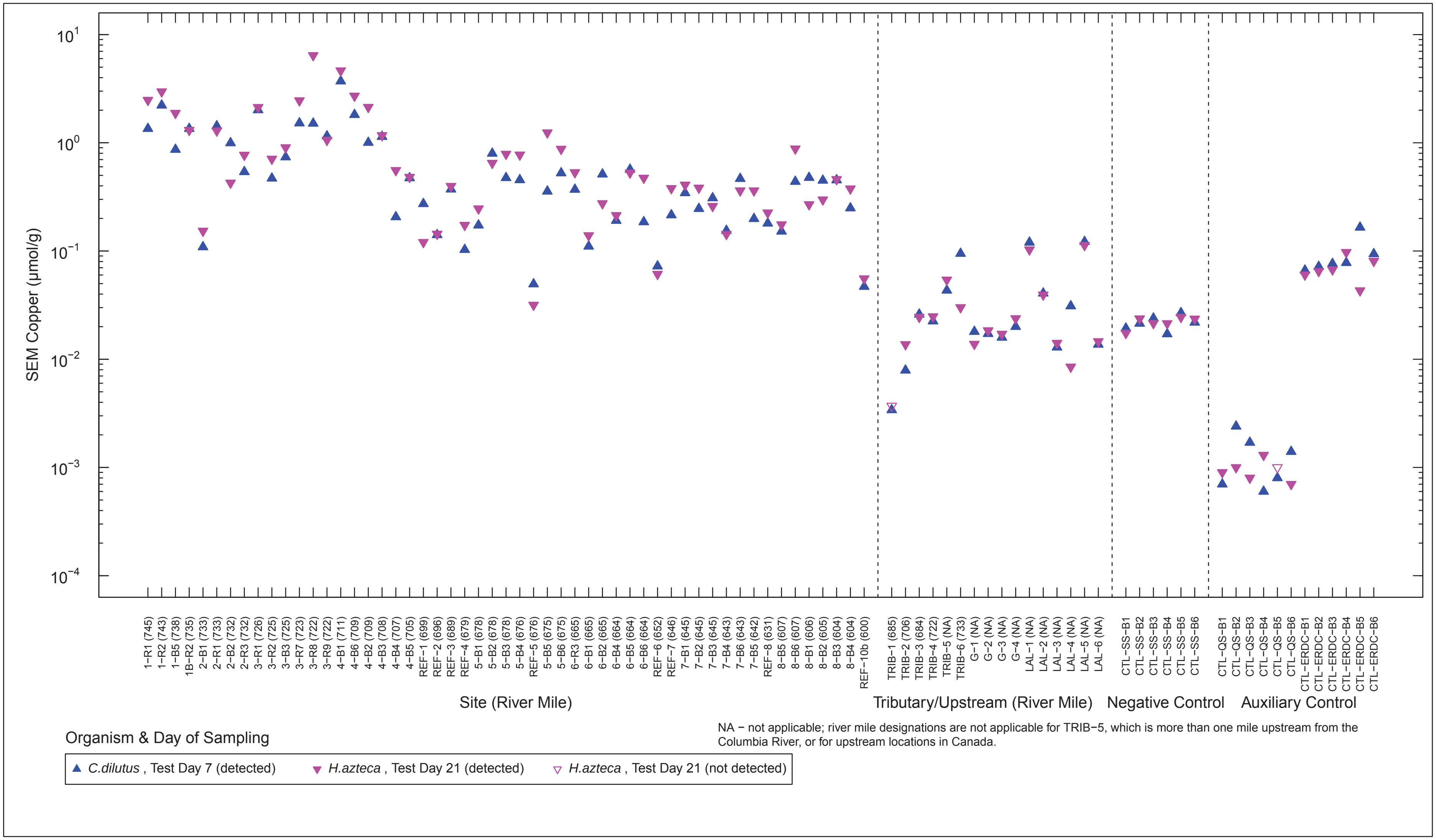


Figure 5−2g. SEM Copper in Sediment from Short−Term Bioassays

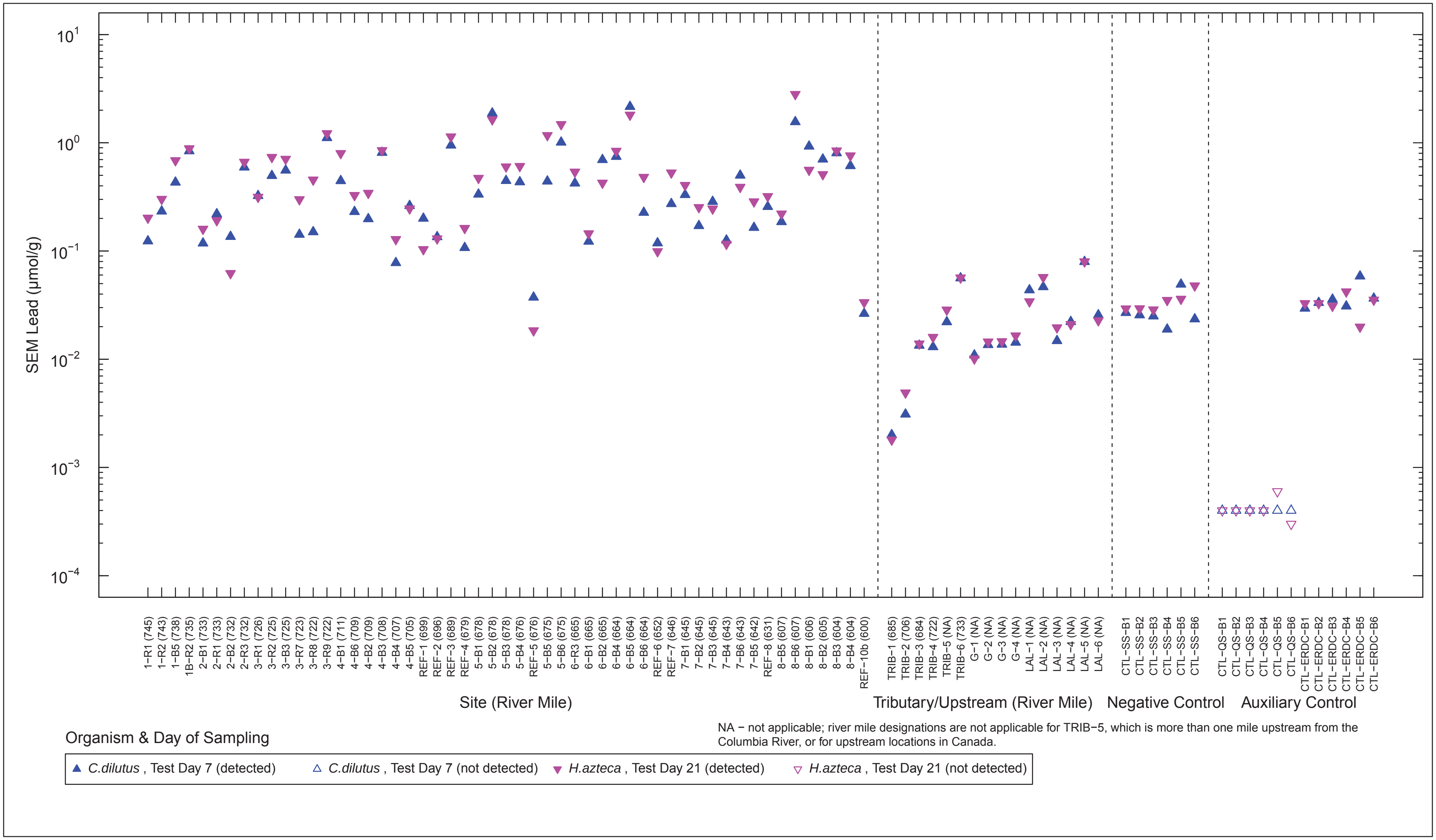


Figure 5−2h. SEM Lead in Sediment from Short−Term Bioassays

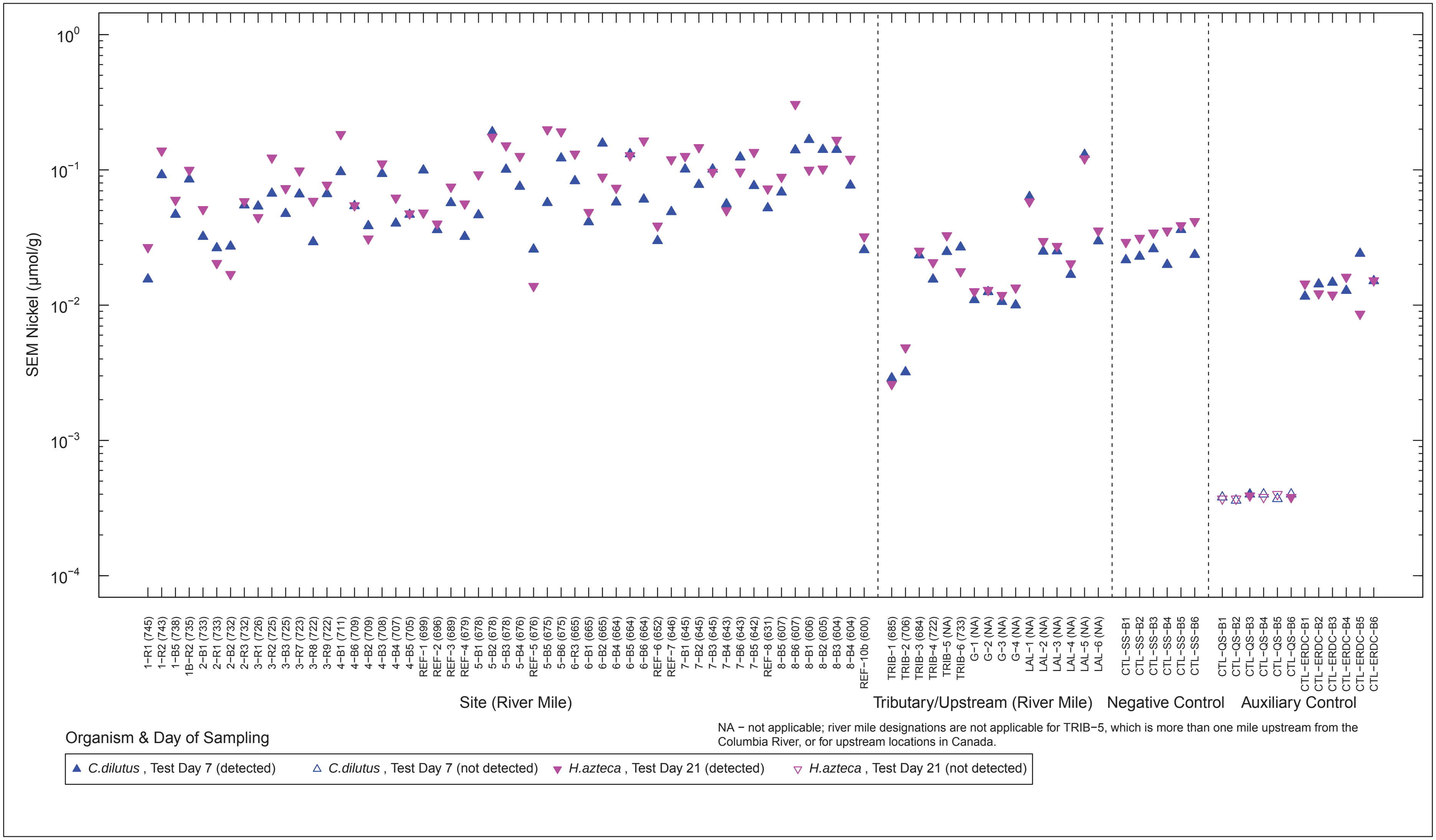


Figure 5−2i. SEM Nickel in Sediment from Short−Term Bioassays

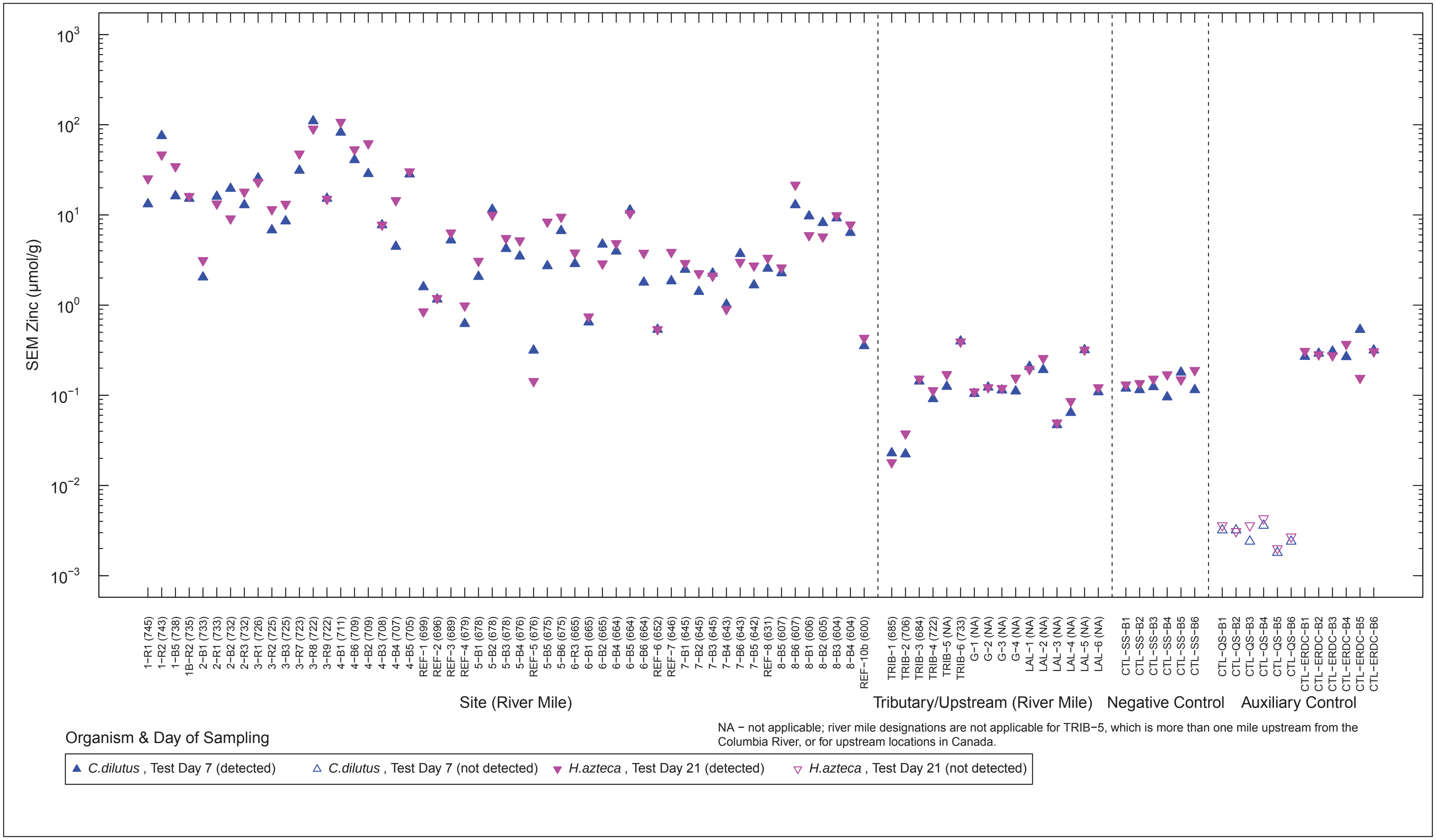


Figure 5−2j. SEM Zinc in Sediment from Short−Term Bioassays

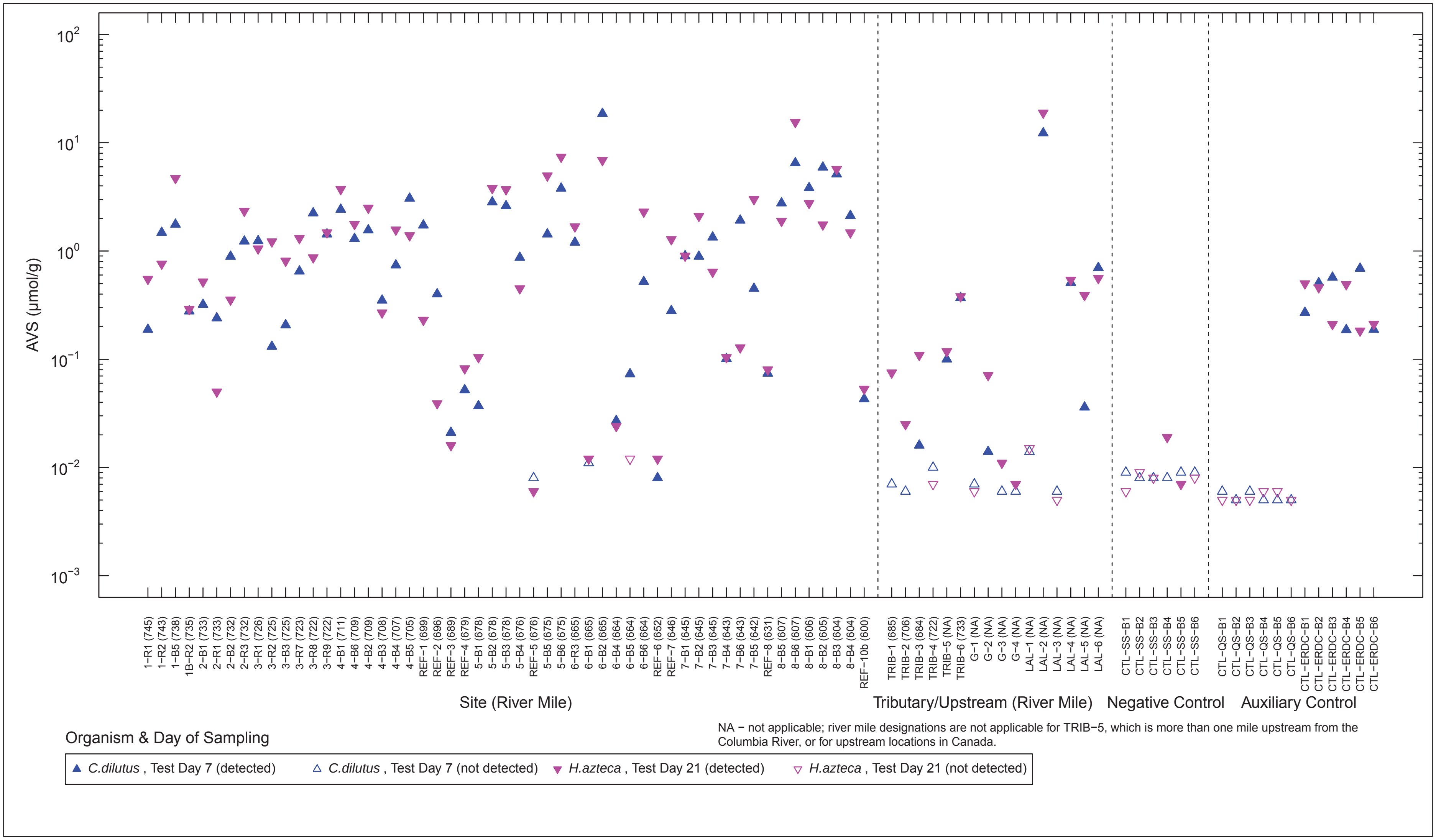


Figure 5−2k. AVS in Sediment from Short−Term Bioassays

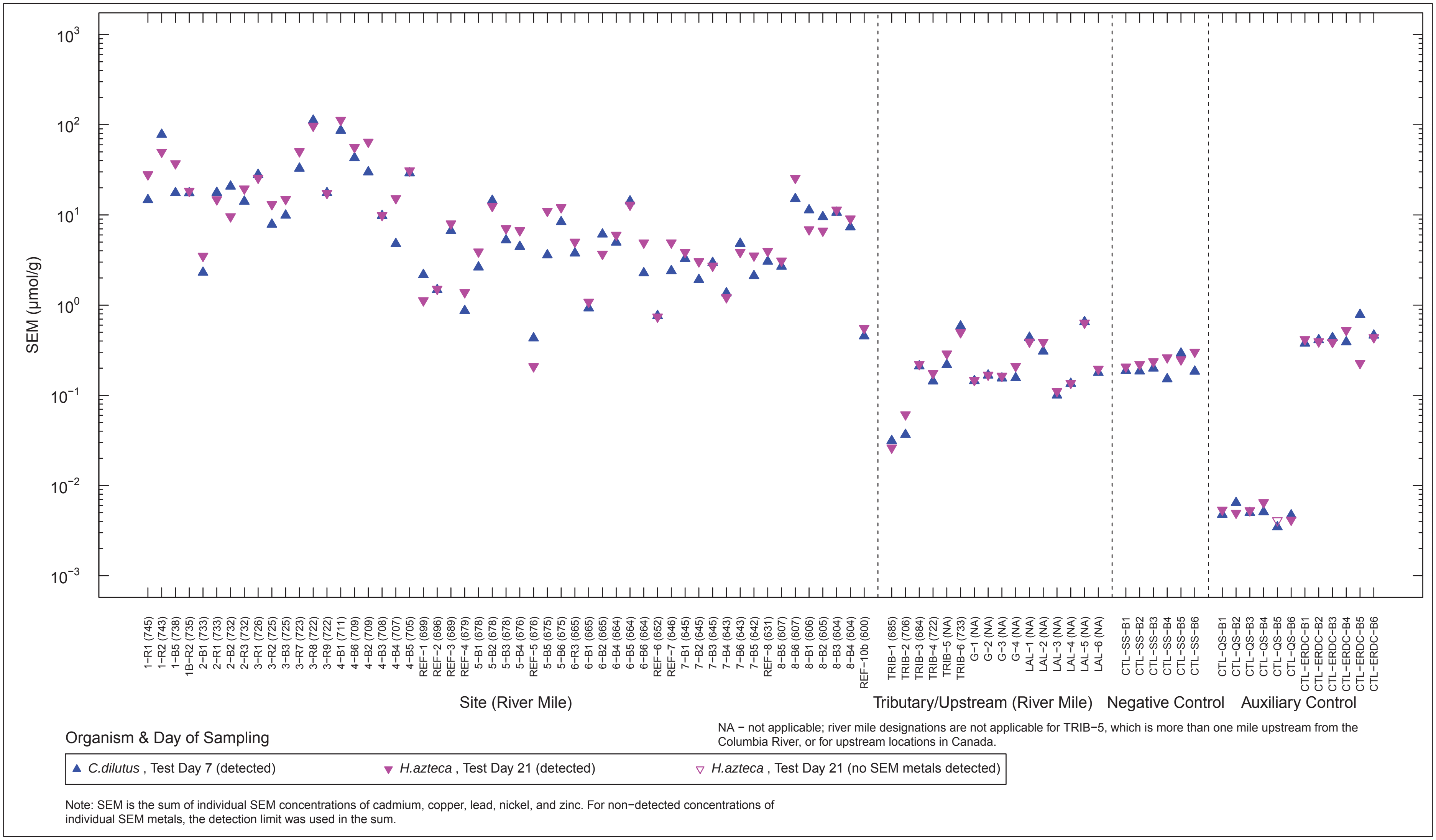


Figure 5−2l. SEM in Sediment from Short−Term Bioassays

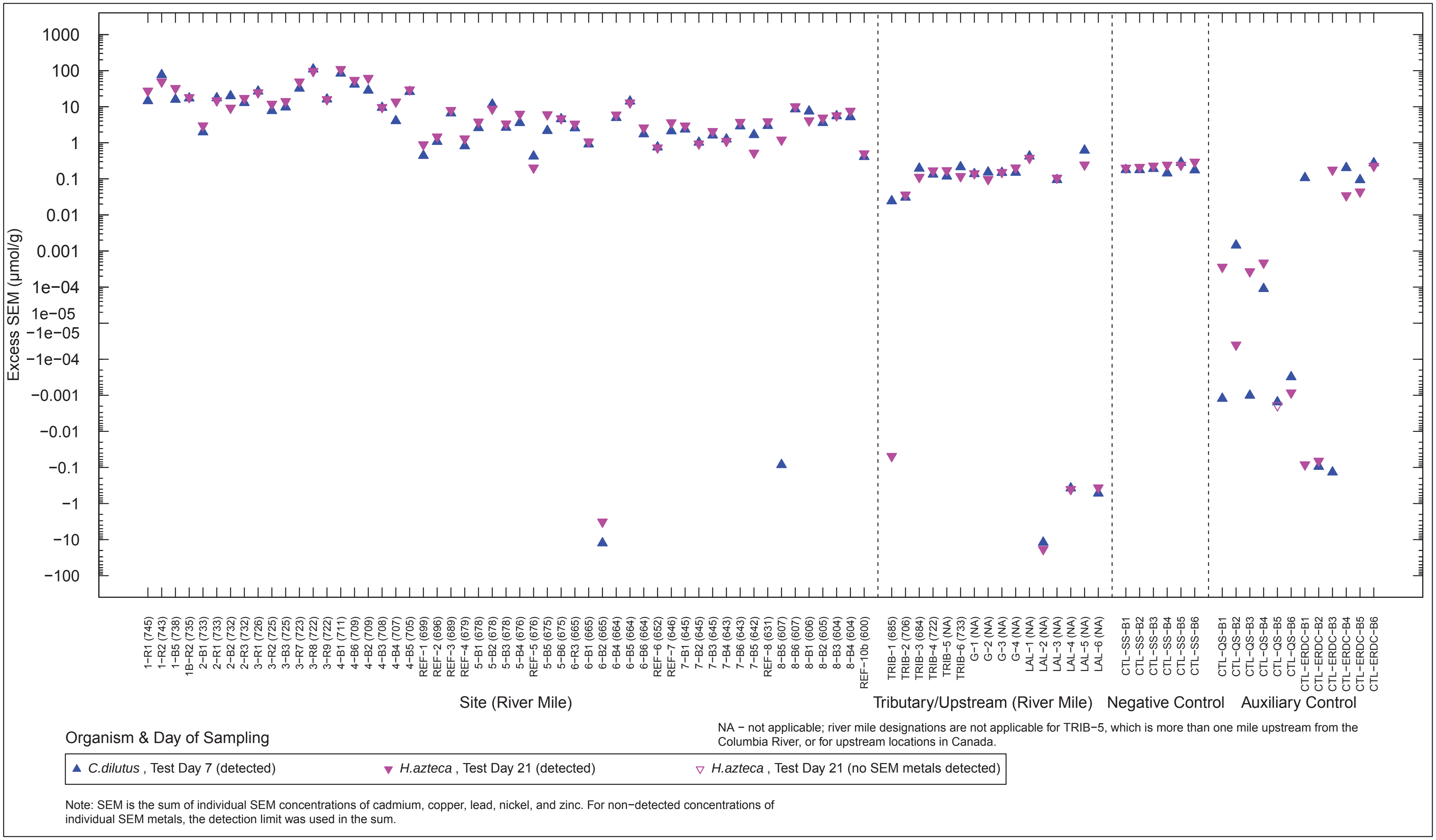


Figure 5−2m. Excess SEM in Sediment from Short−Term Bioassays

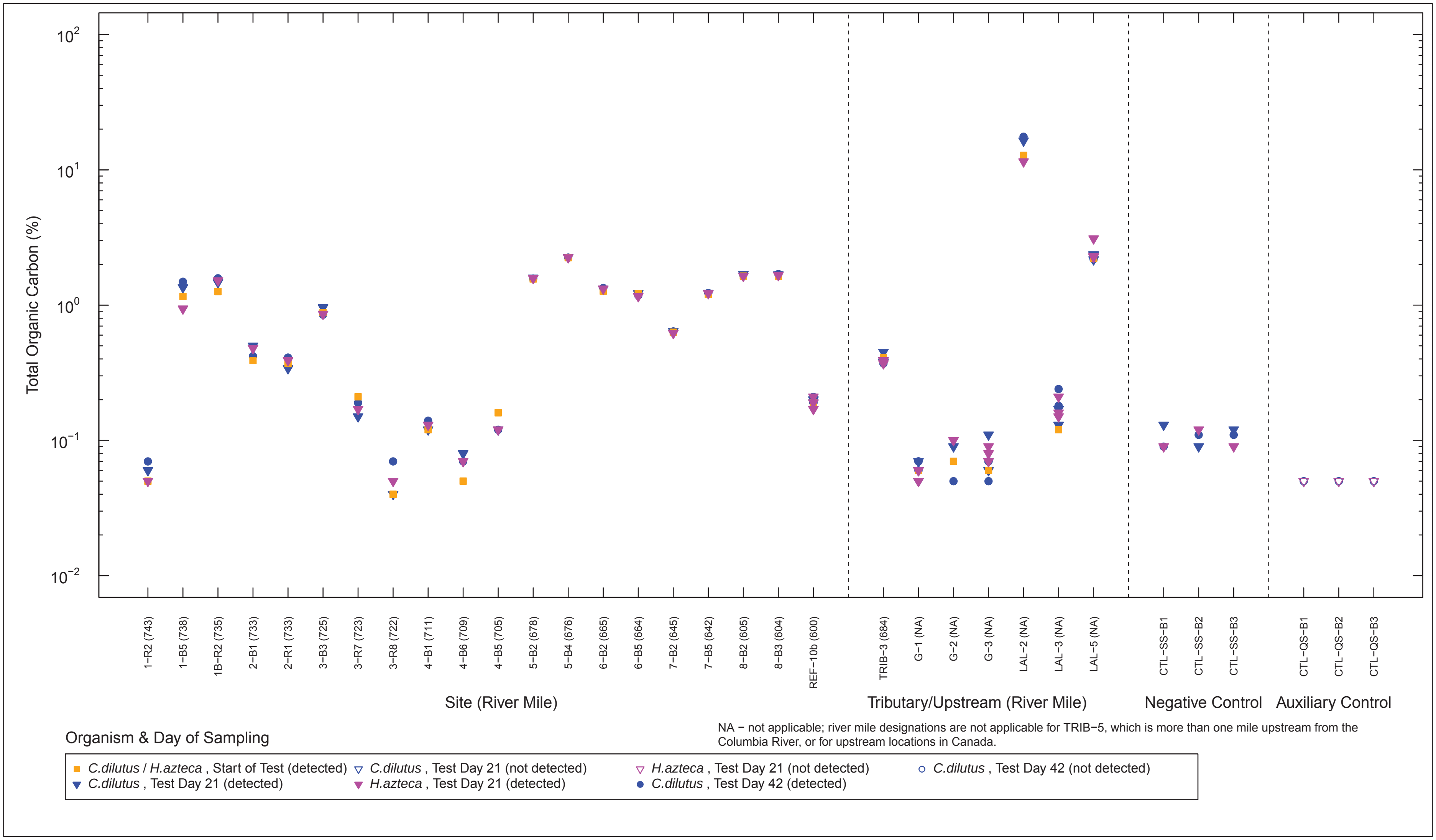


Figure 5−3a. Total Organic Carbon in Sediment from Long−Term Bioassays

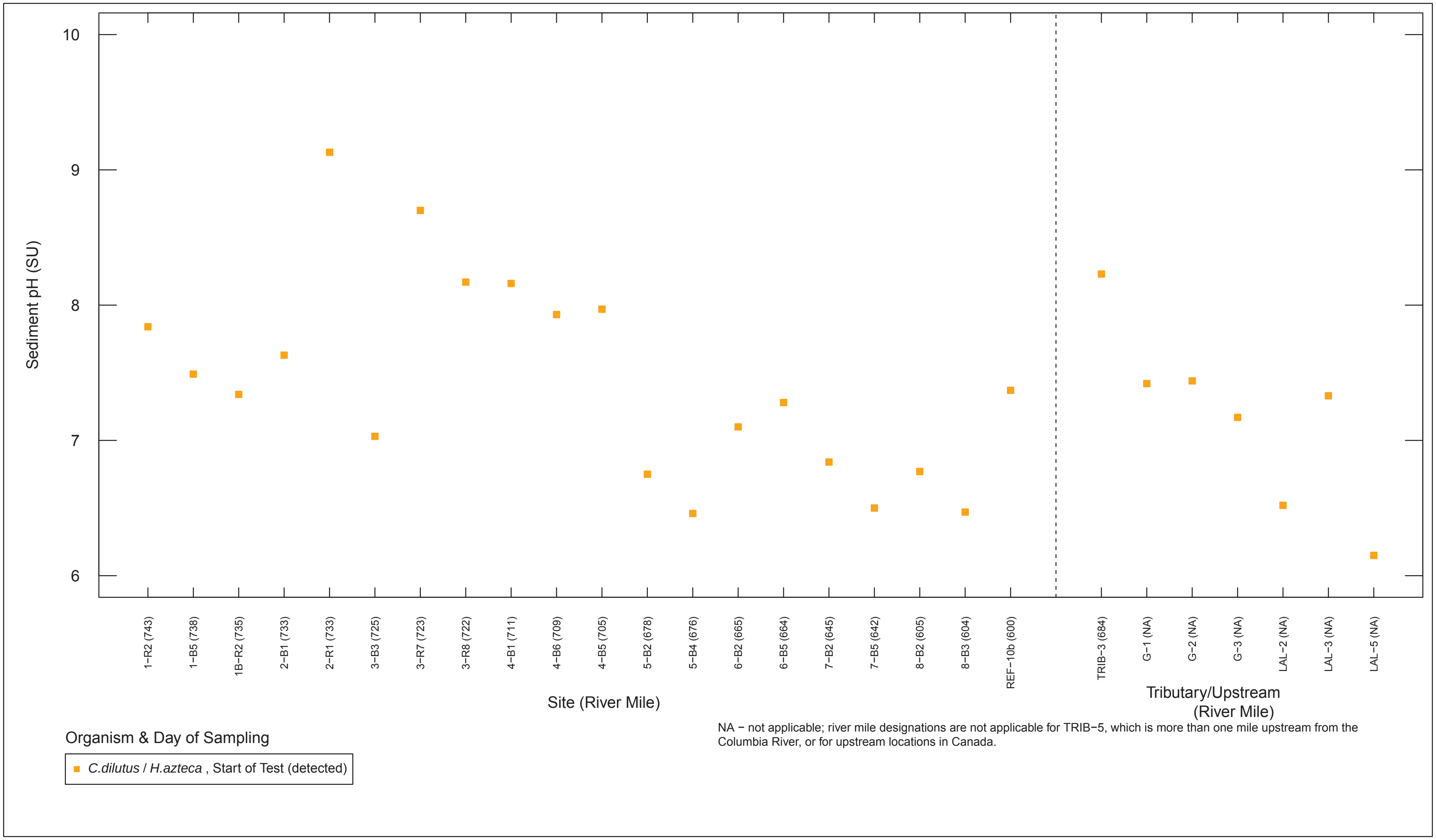


Figure 5−3b. pH in Sediment from Long−Term Bioassays

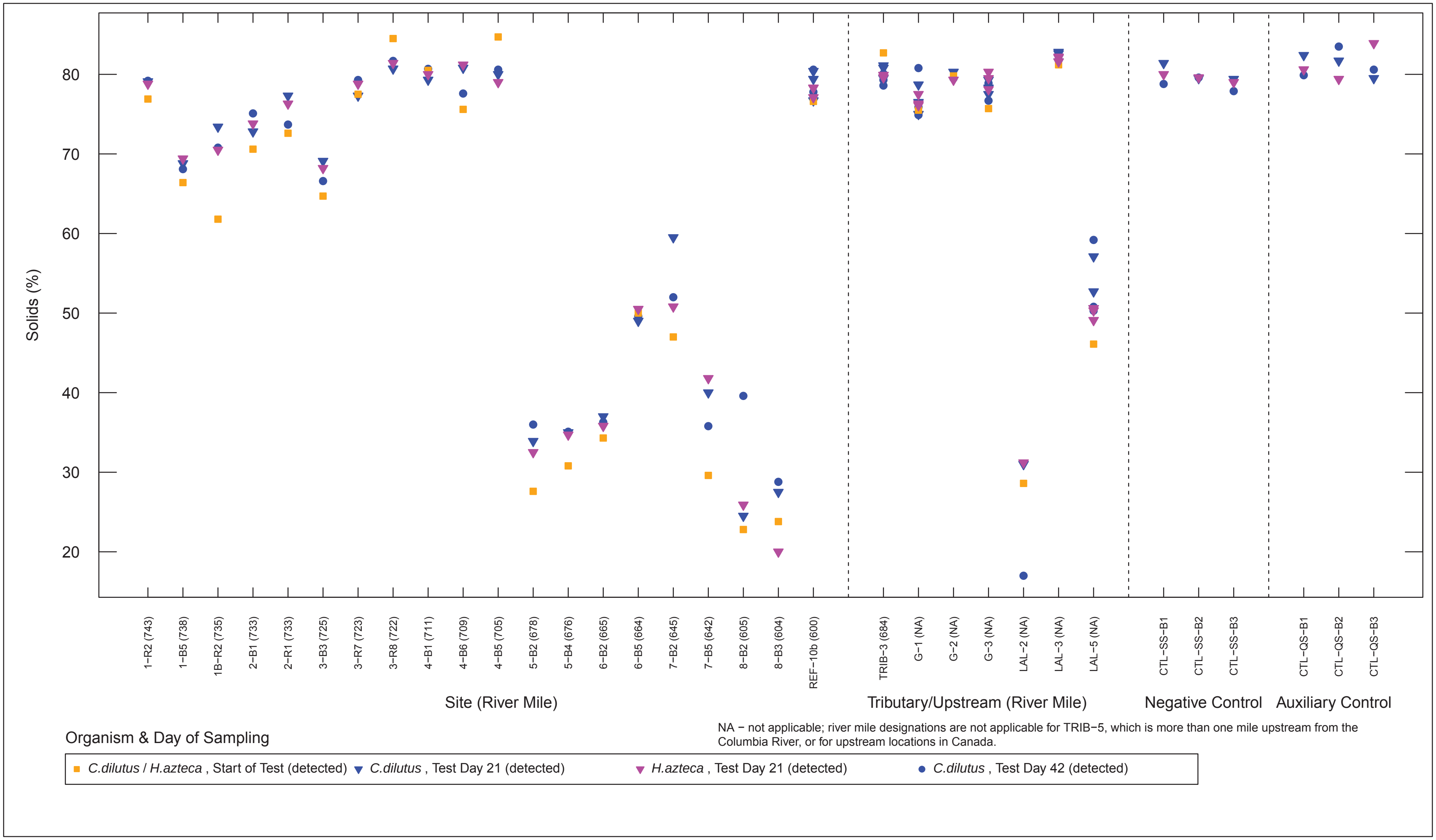


Figure 5−3c. Solids in Sediment from Long−Term Bioassays

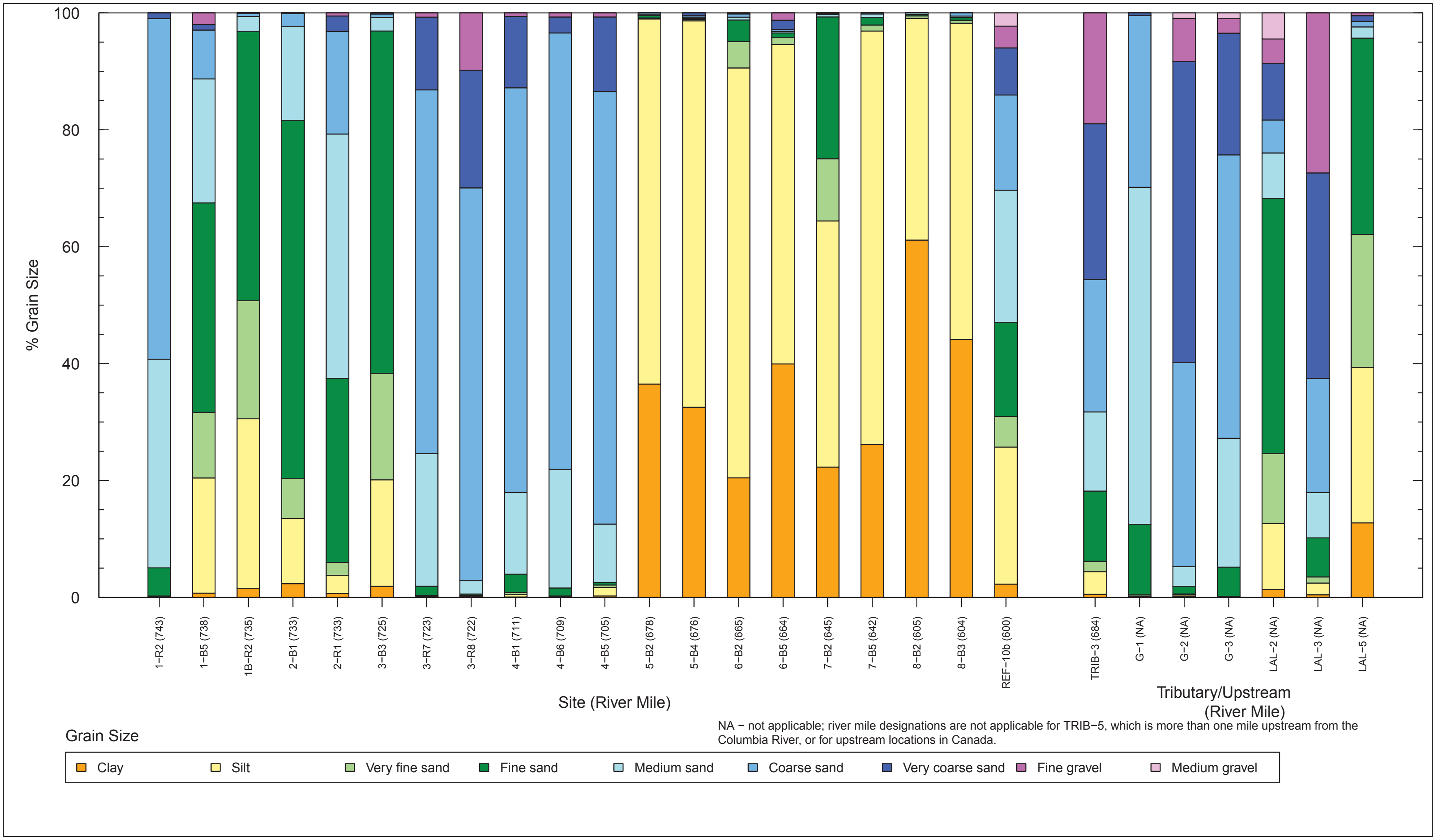


Figure 5−3d. Grain Size Distribution in Sediment from Long−Term Bioassays Analyzed at the Start of Test

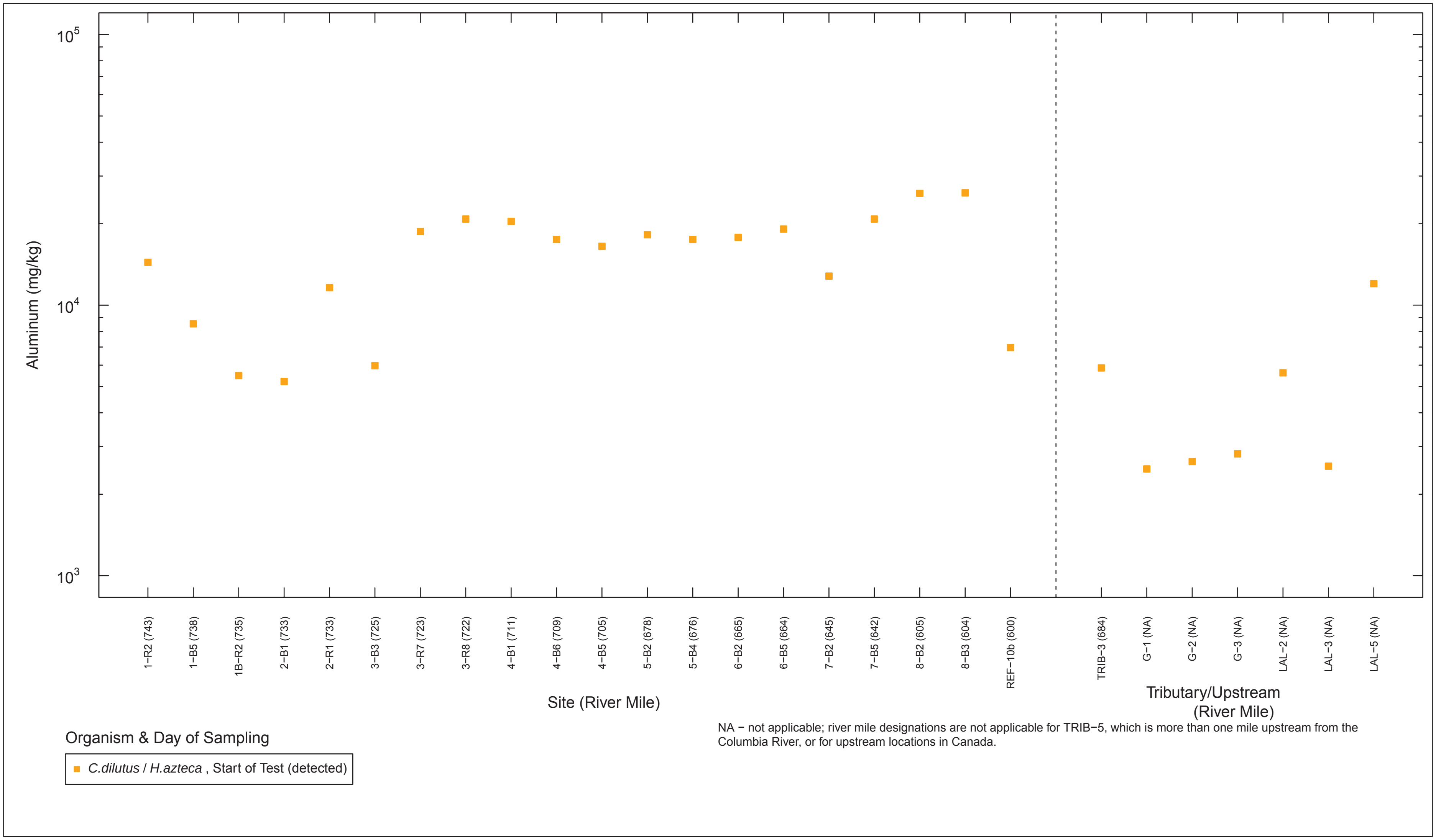
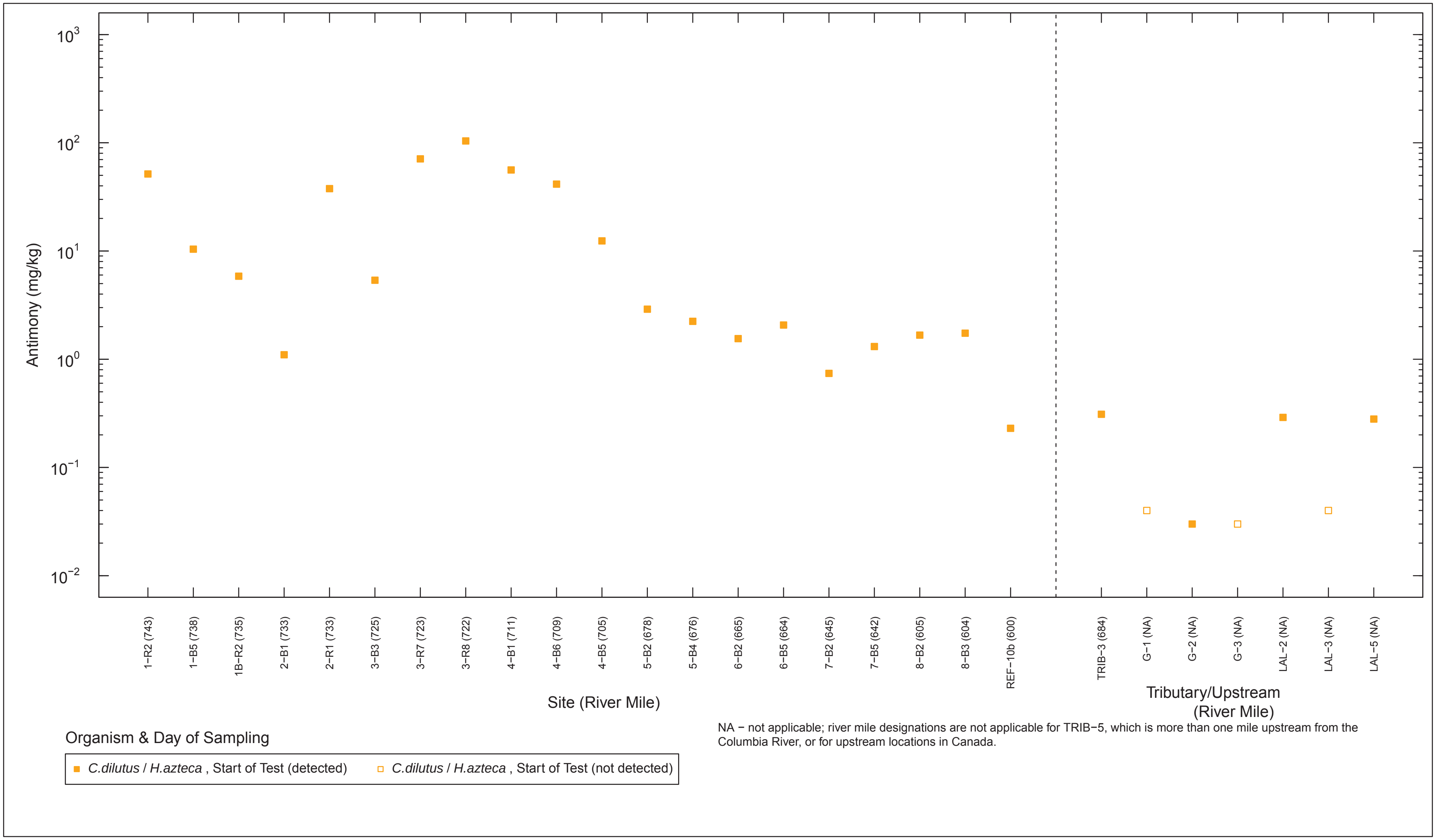


Figure 5−3e. Aluminum in Sediment from Long−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−3f. Antimony in Sediment from Long−Term Bioassays

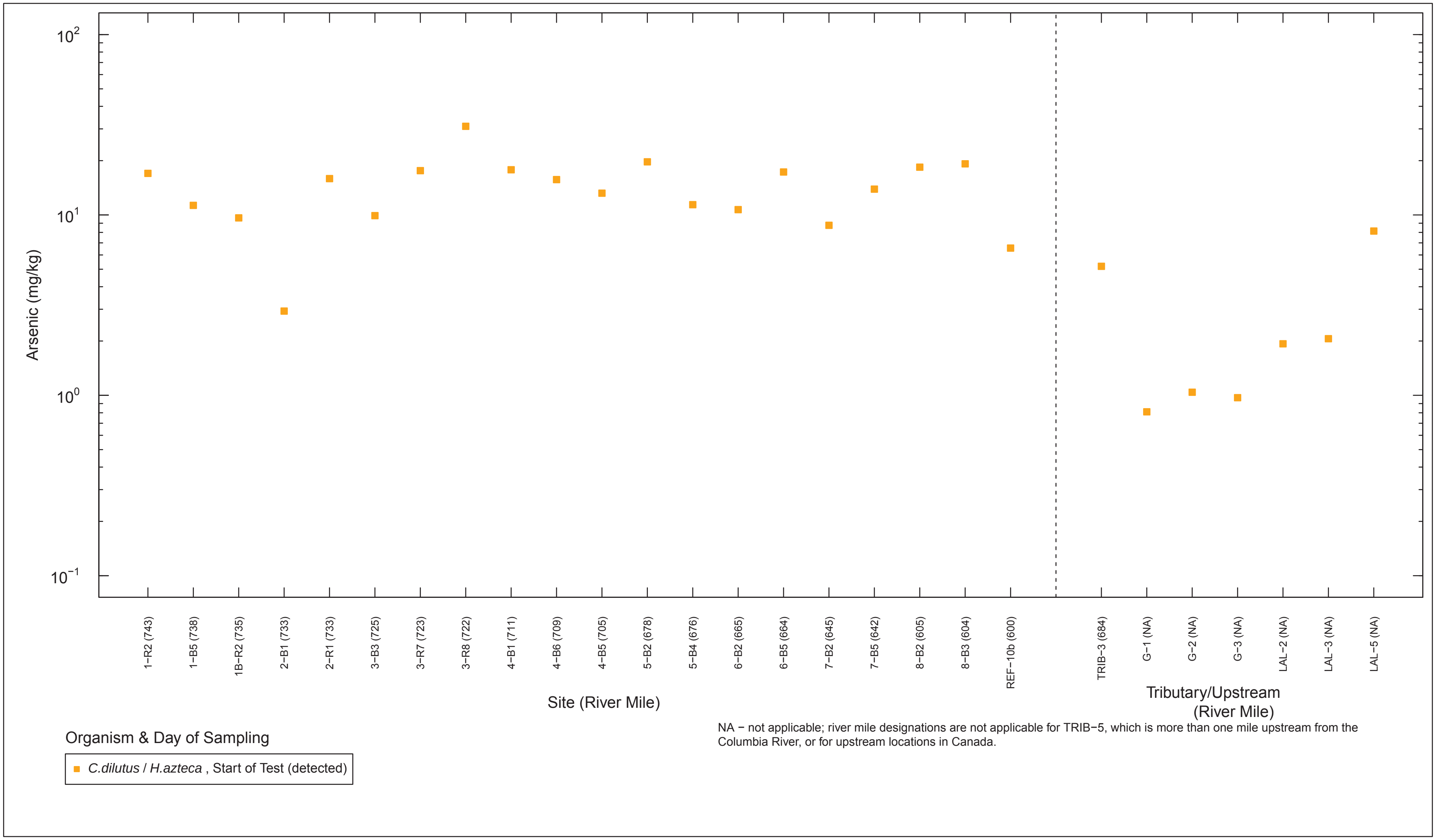


Figure 5−3g. Arsenic in Sediment from Long−Term Bioassays

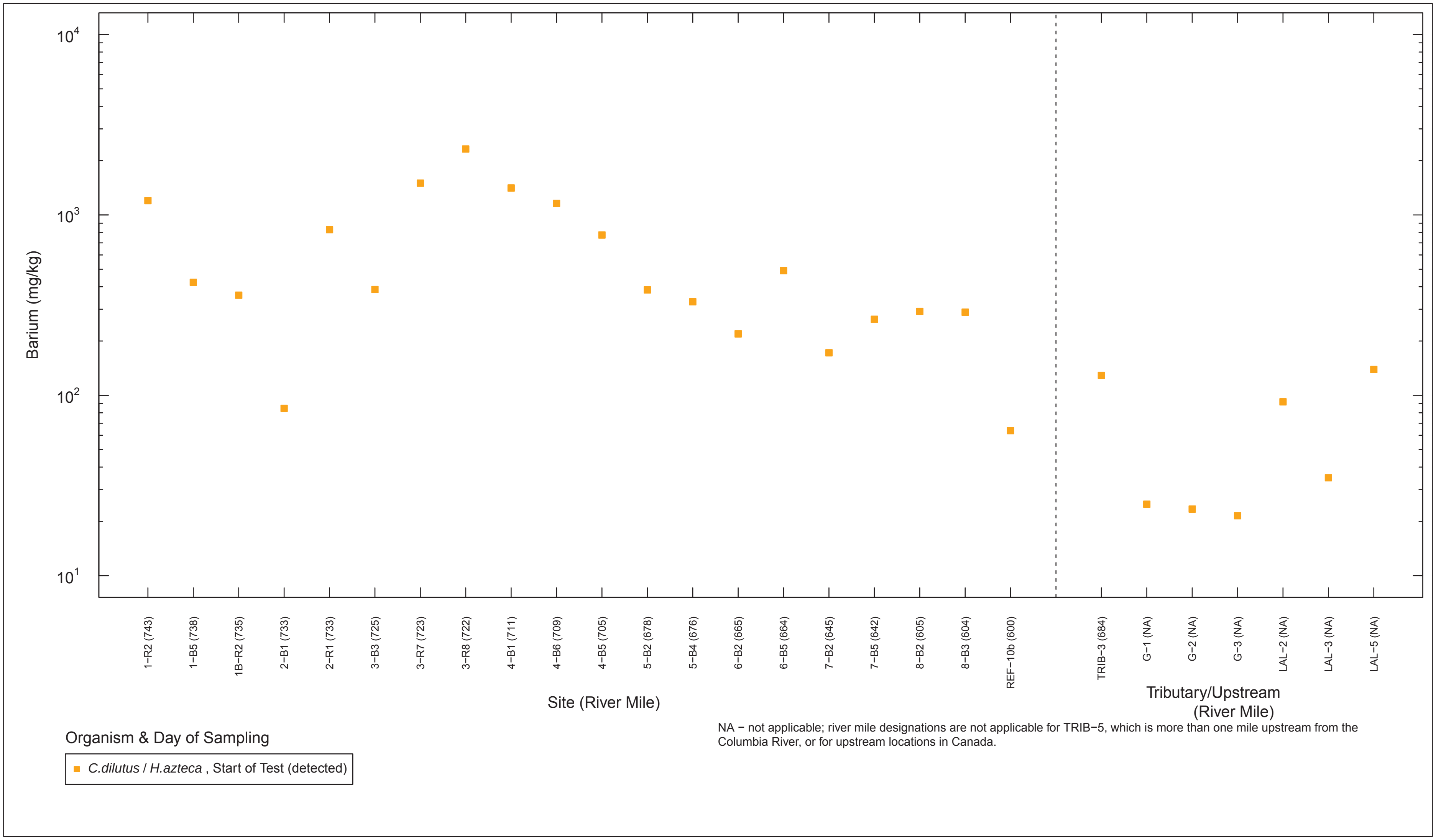


Figure 5−3h. Barium in Sediment from Long−Term Bioassays

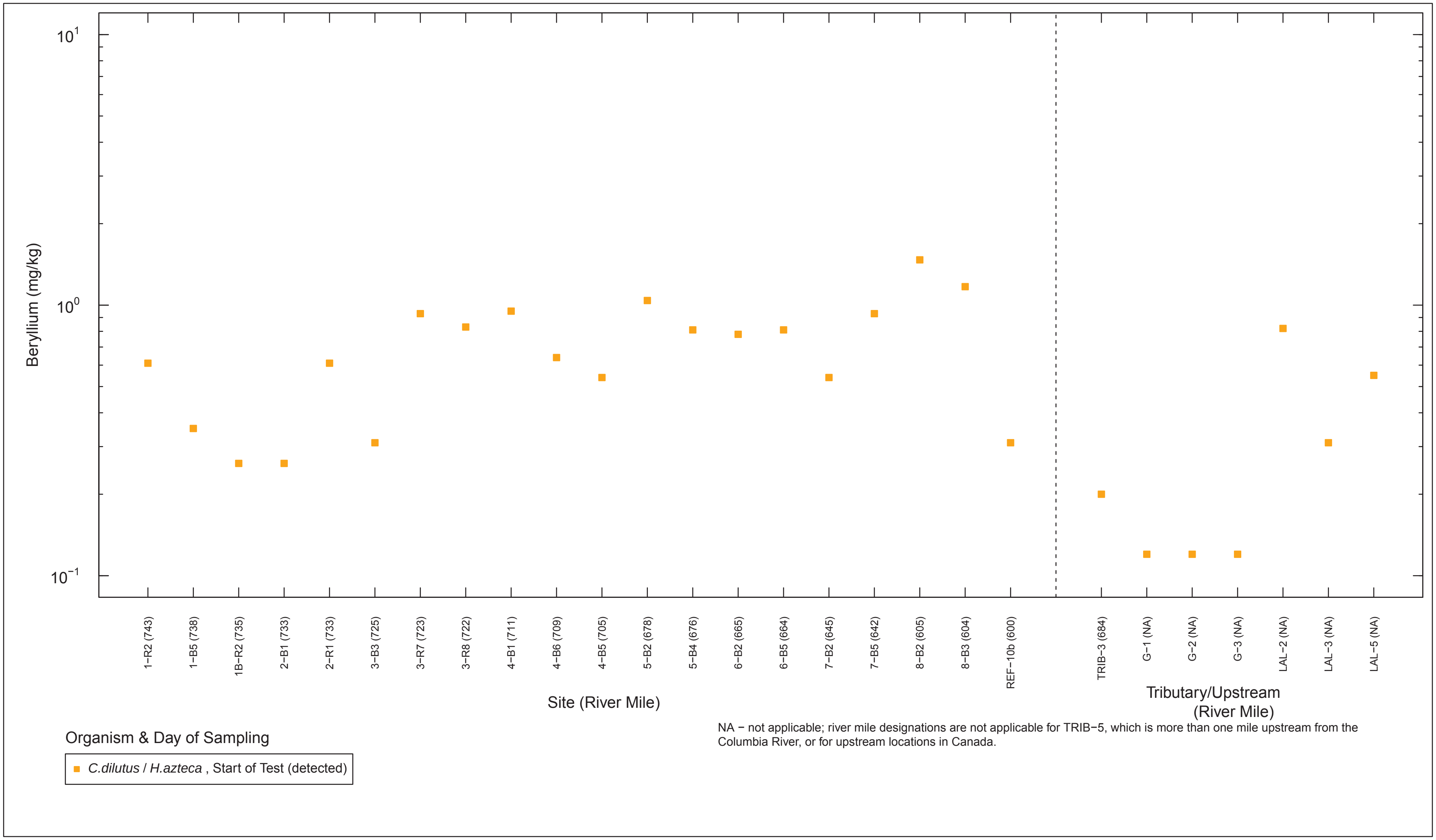


Figure 5−3i. Beryllium in Sediment from Long−Term Bioassays

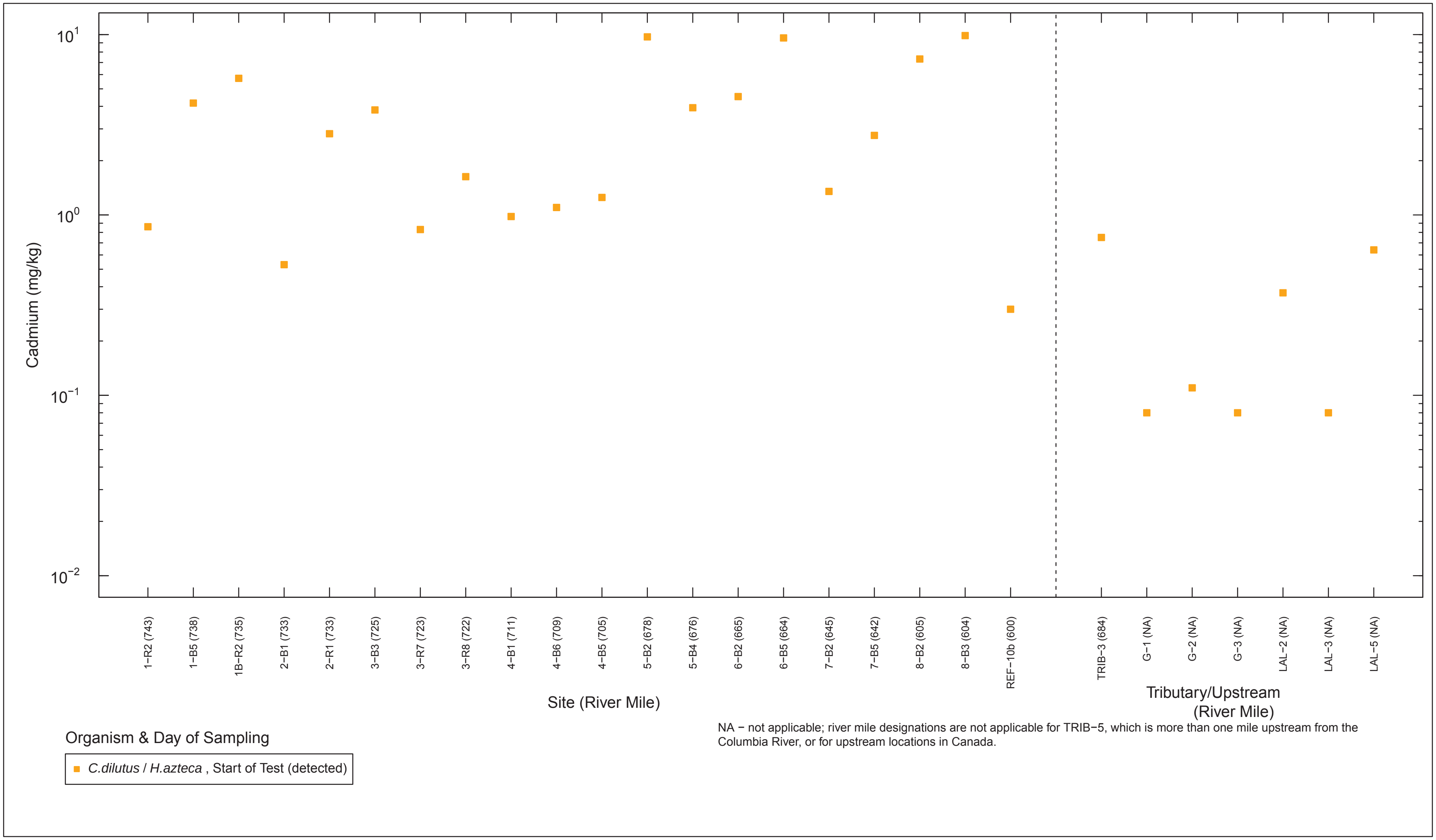


Figure 5−3j. Cadmium in Sediment from Long−Term Bioassays

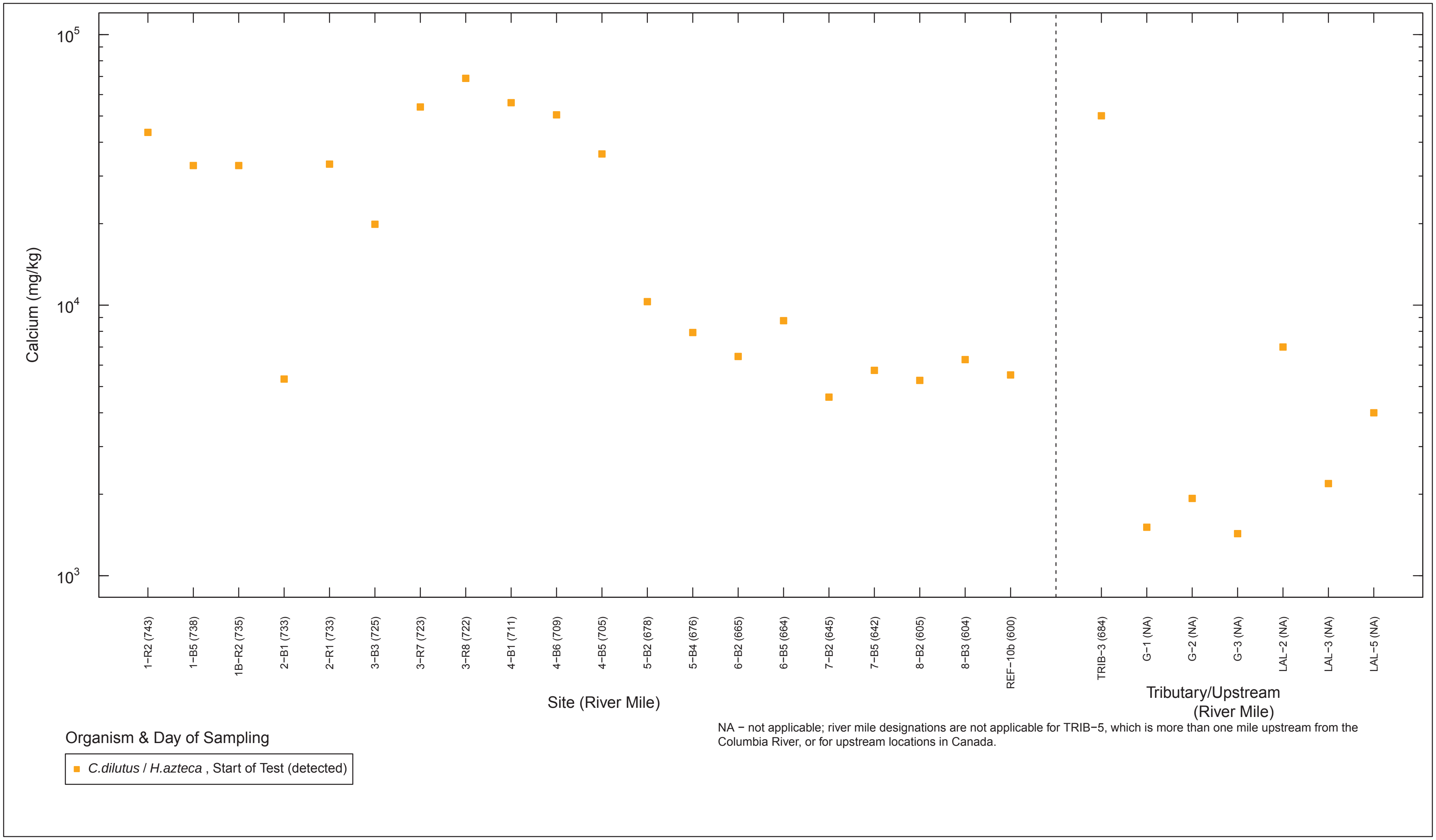


Figure 5−3k. Calcium in Sediment from Long−Term Bioassays

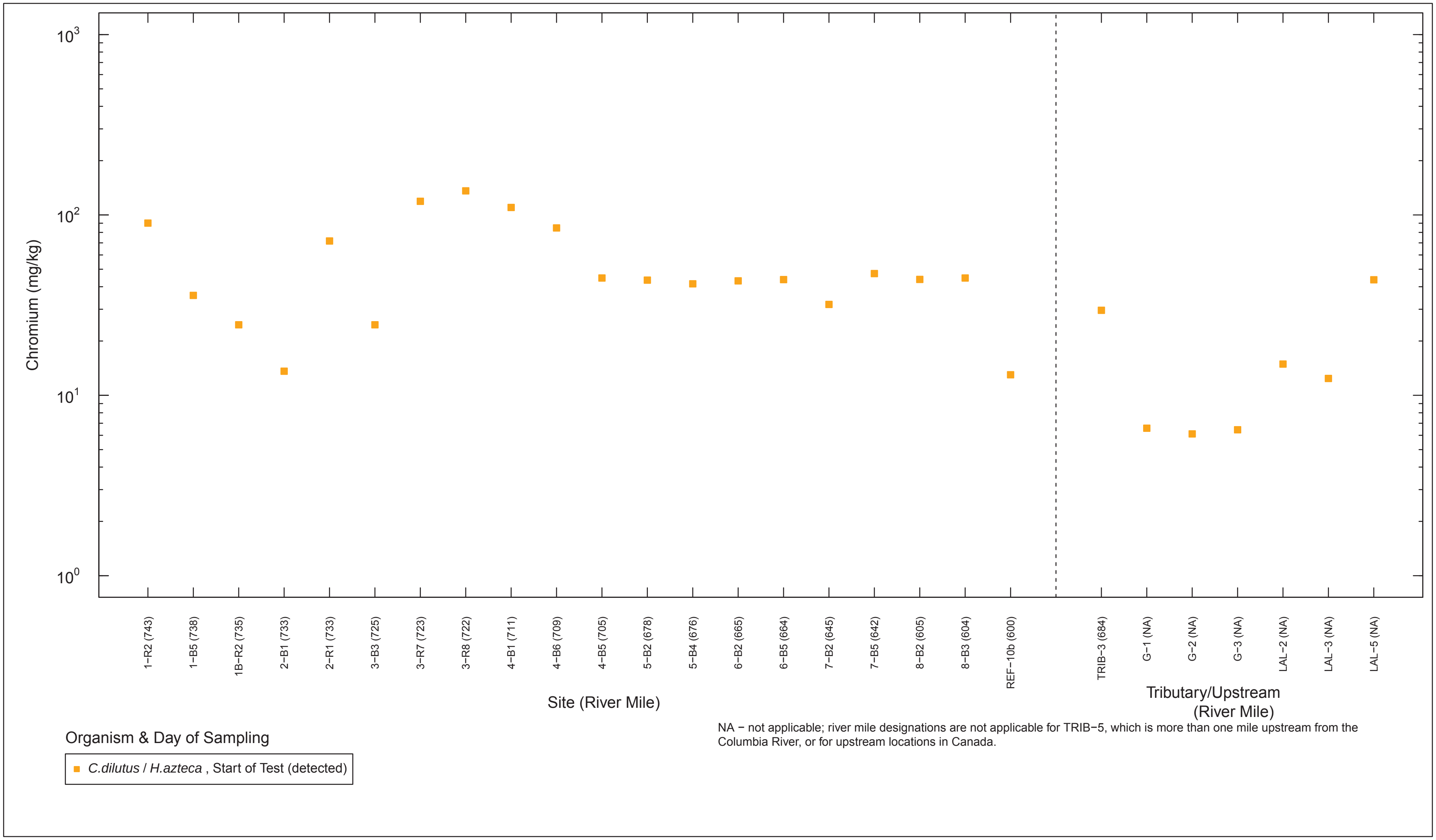


Figure 5−3l. Chromium in Sediment from Long−Term Bioassays

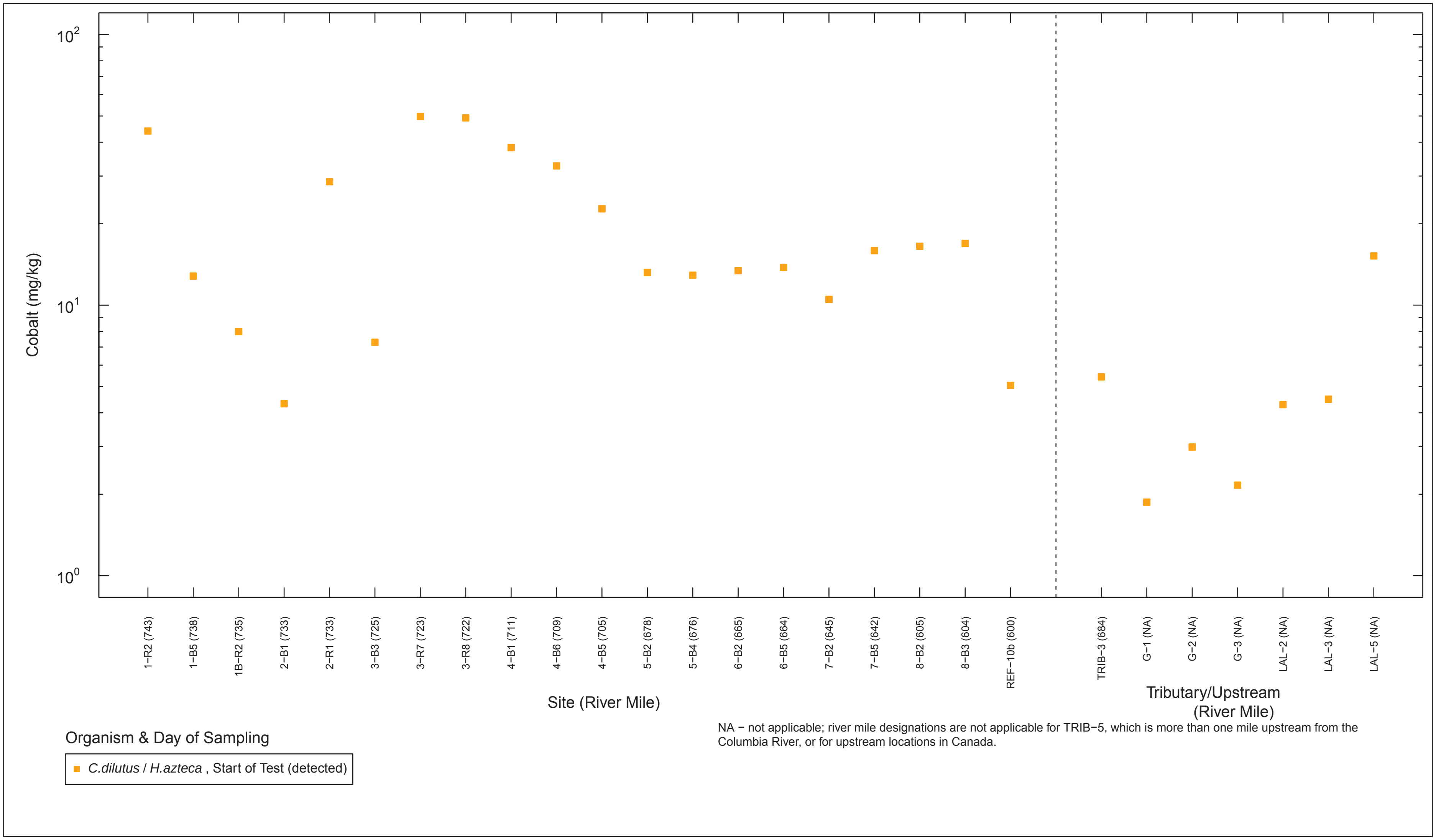


Figure 5−3m. Cobalt in Sediment from Long−Term Bioassays

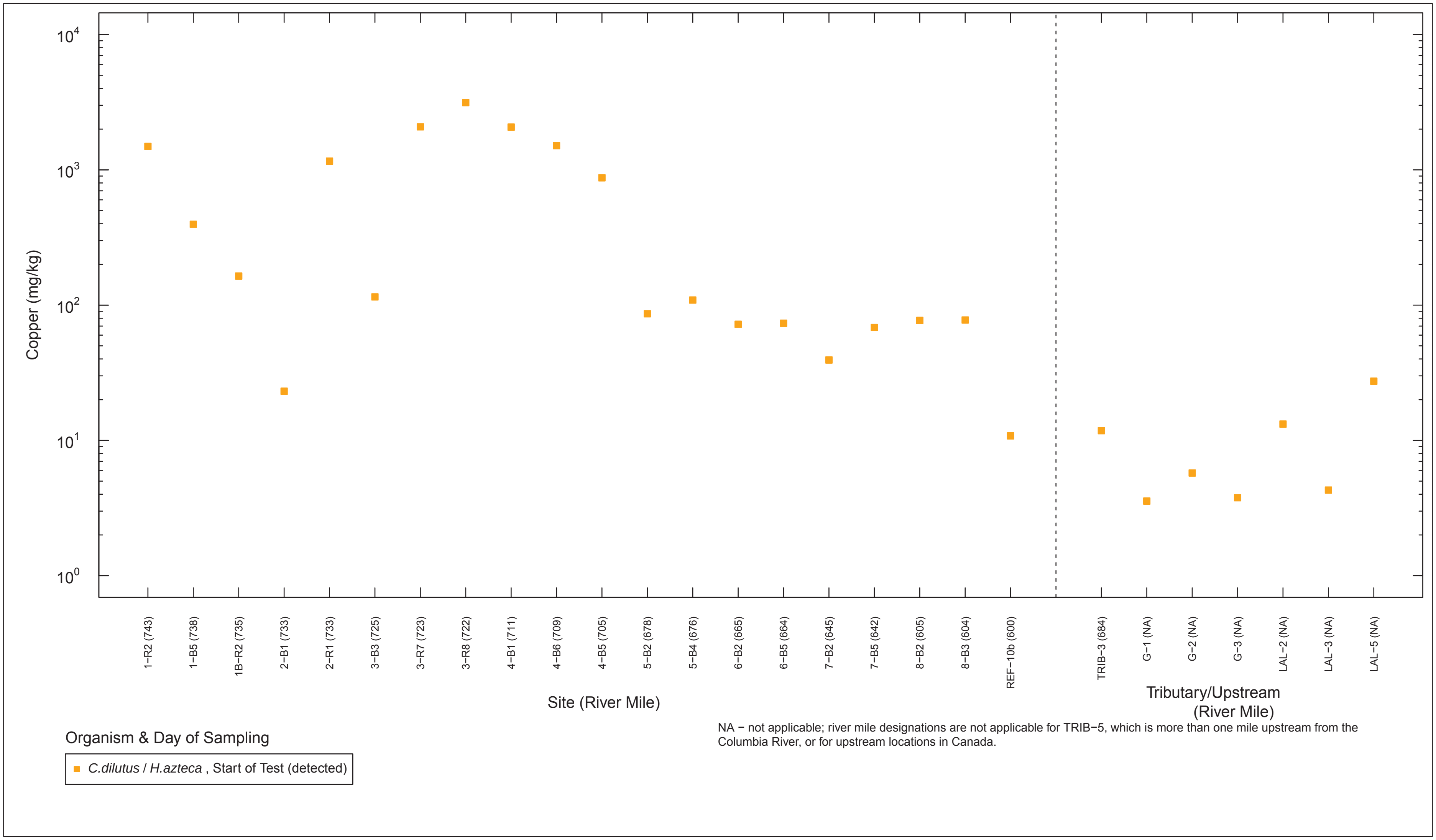


Figure 5−3n. Copper in Sediment from Long−Term Bioassays

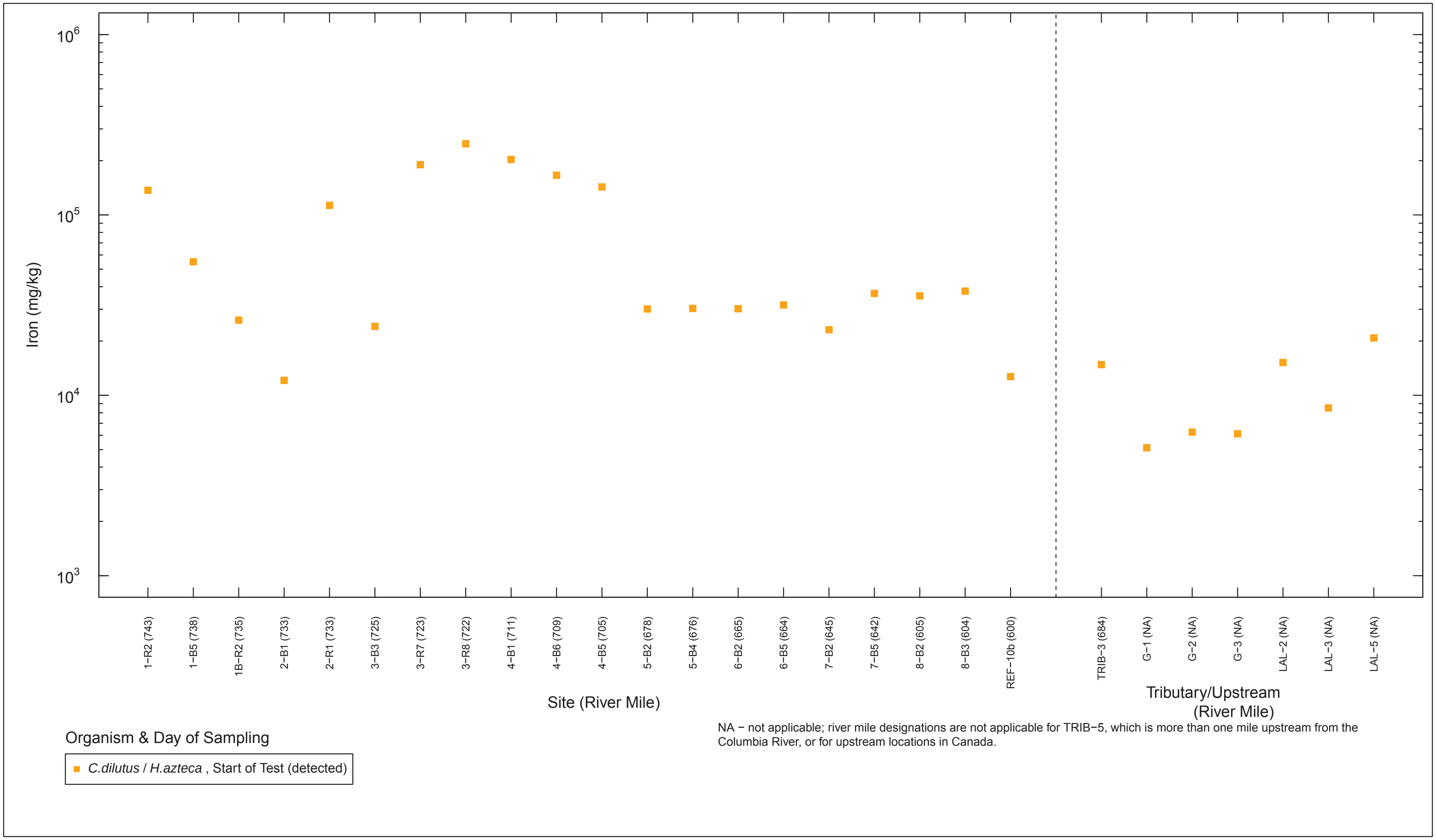


Figure 5−3o. Iron in Sediment from Long−Term Bioassays

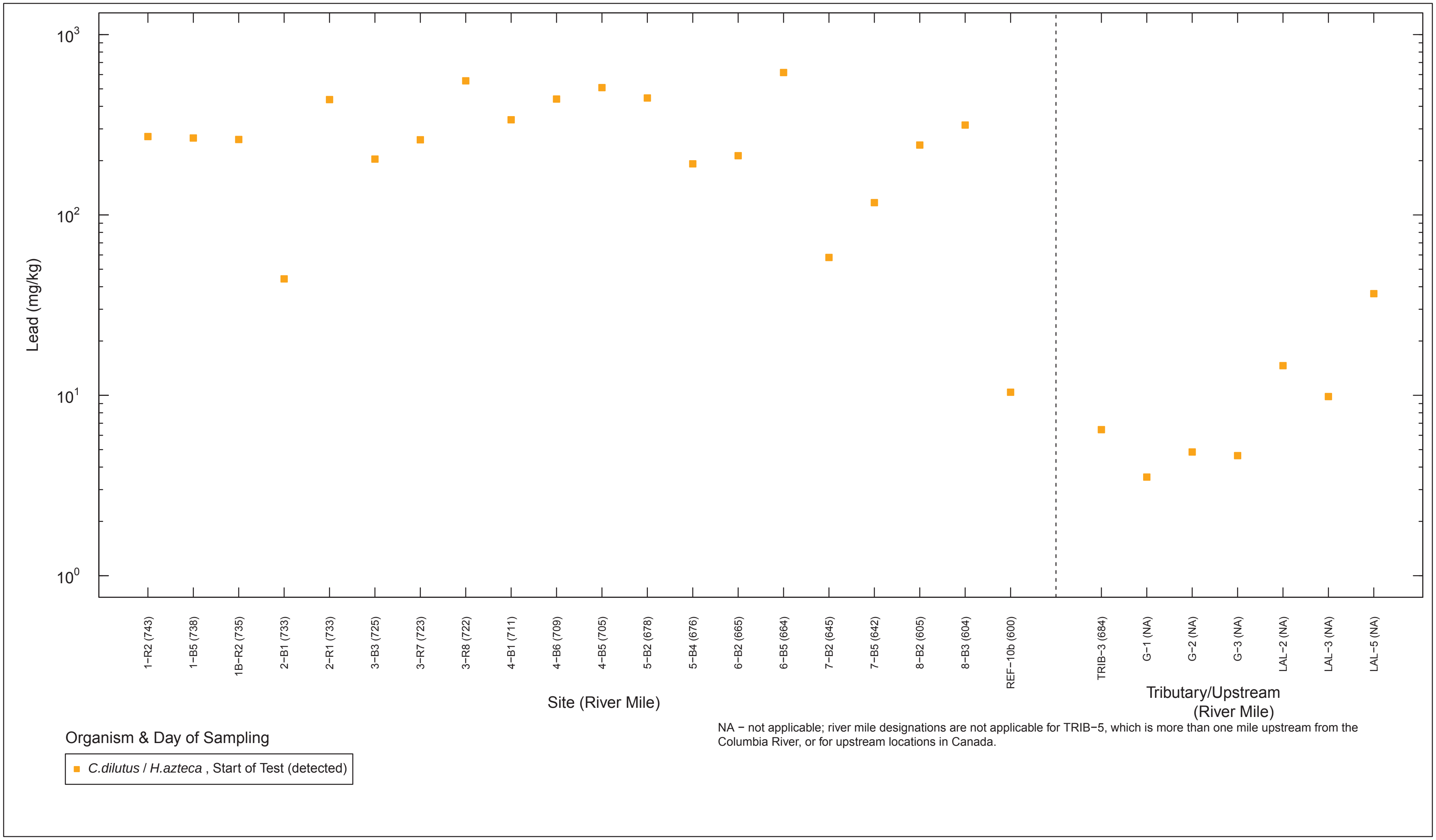


Figure 5−3p. Lead in Sediment from Long−Term Bioassays

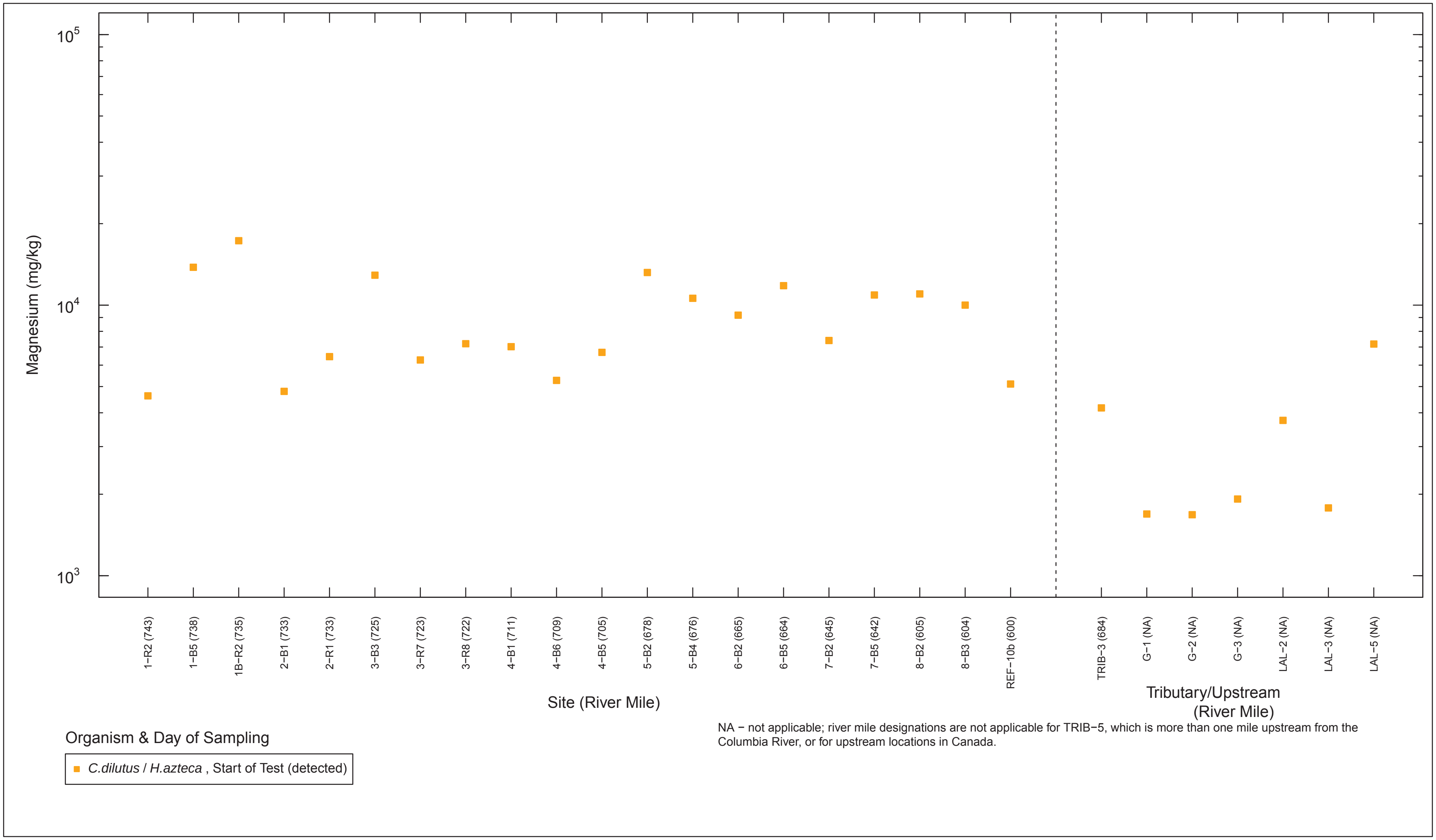


Figure 5−3q. Magnesium in Sediment from Long−Term Bioassays

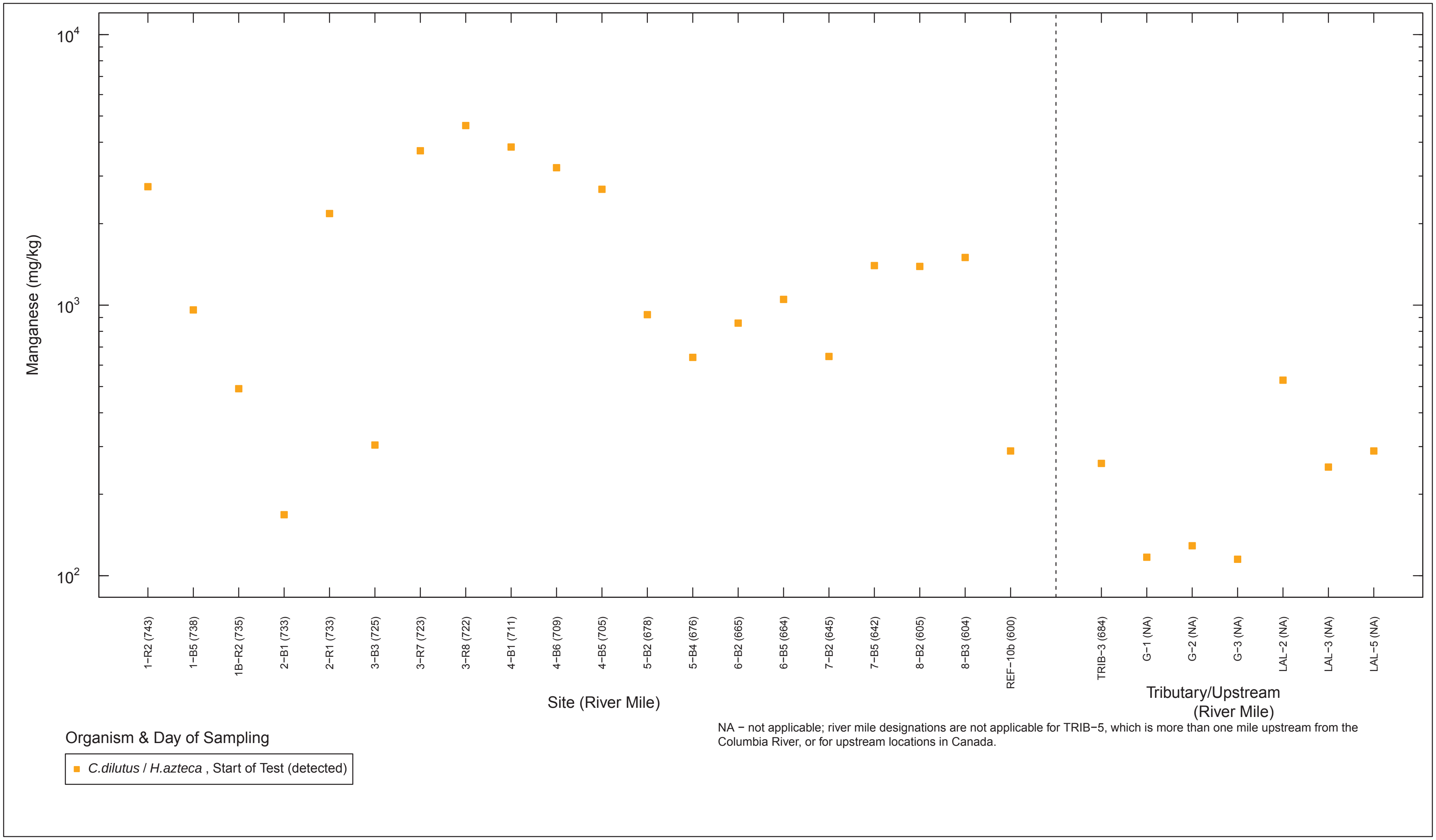
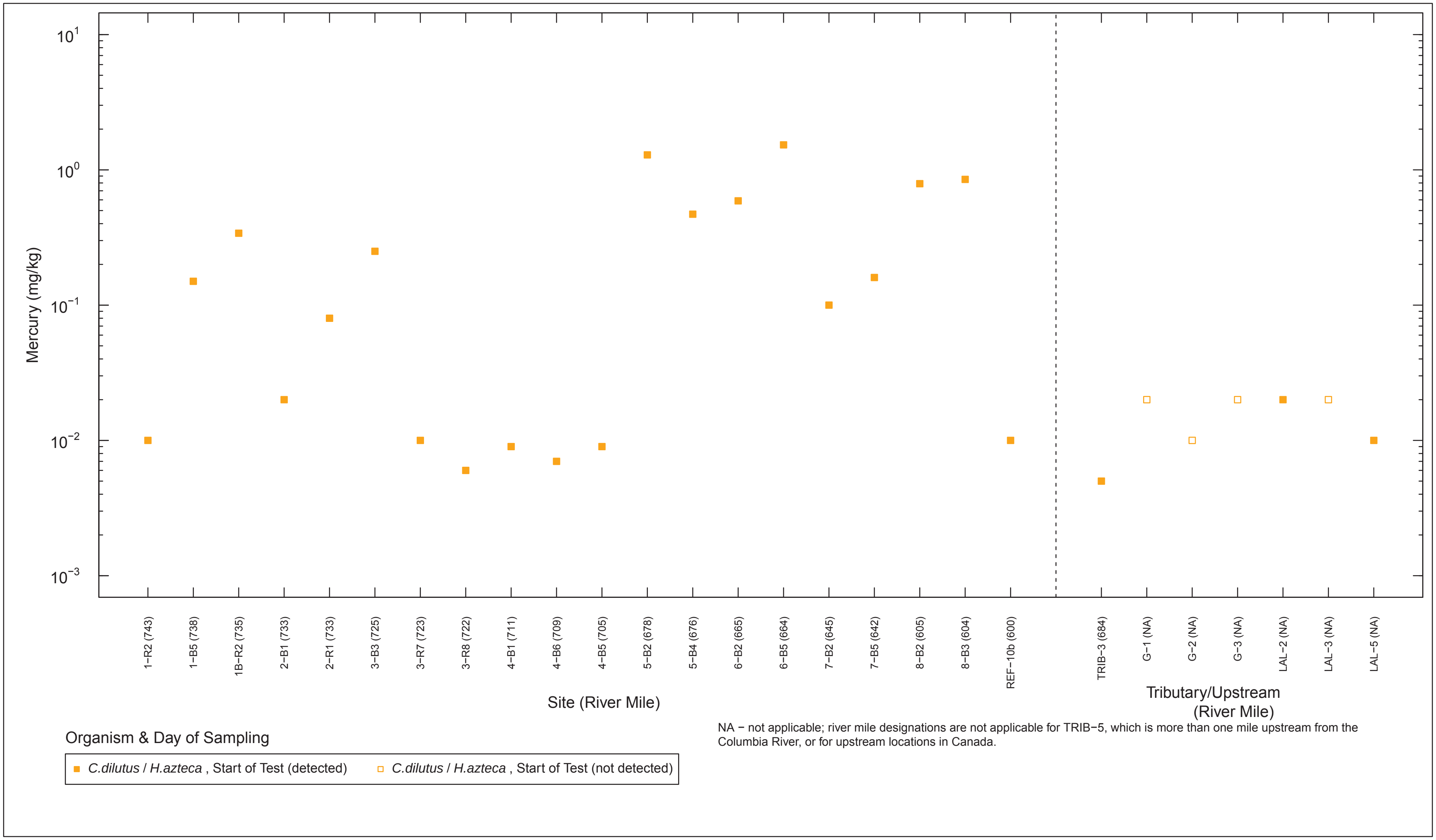


Figure 5−3r. Manganese in Sediment from Long−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−3s. Mercury in Sediment from Long−Term Bioassays

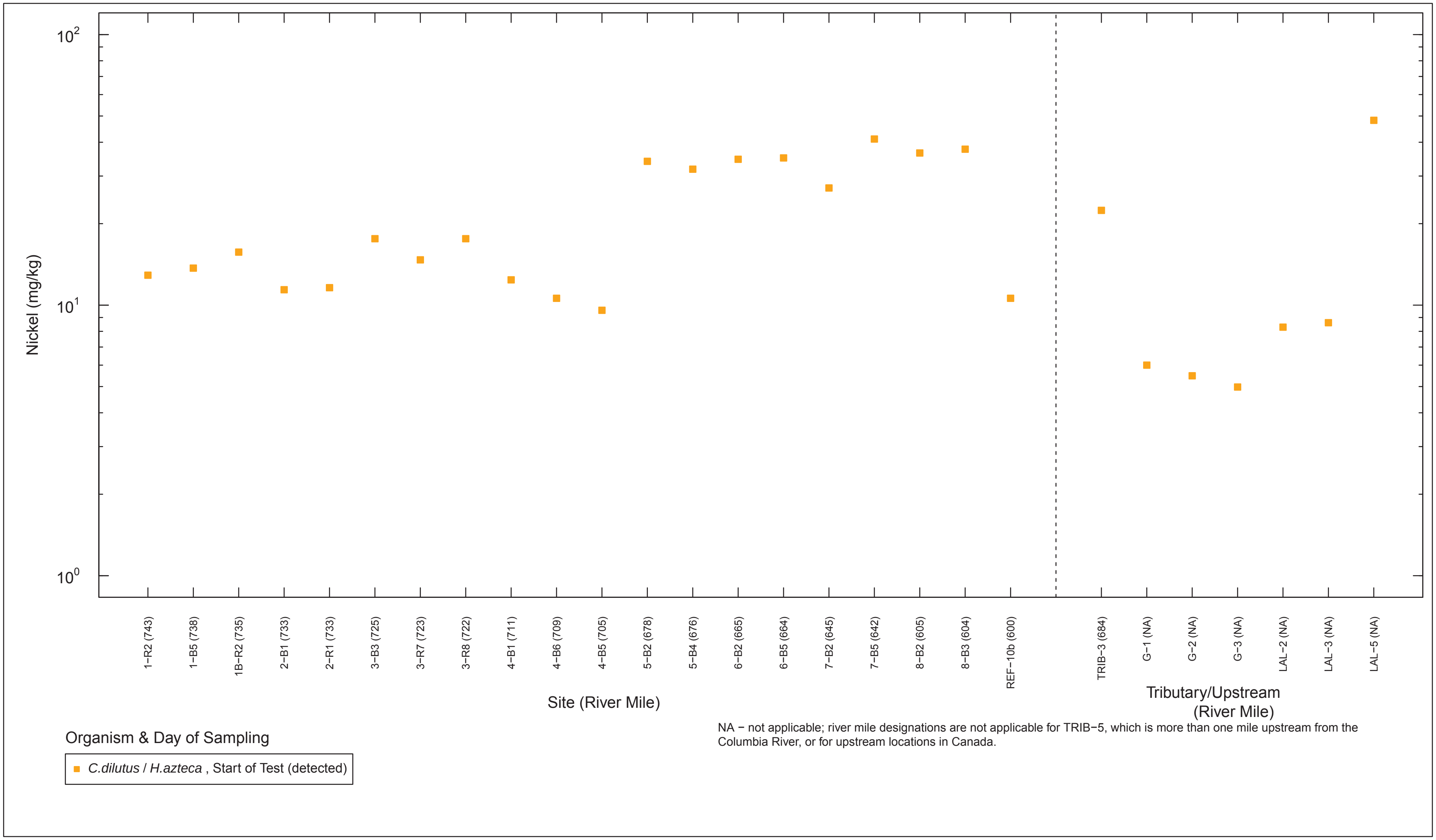


Figure 5−3t. Nickel in Sediment from Long−Term Bioassays

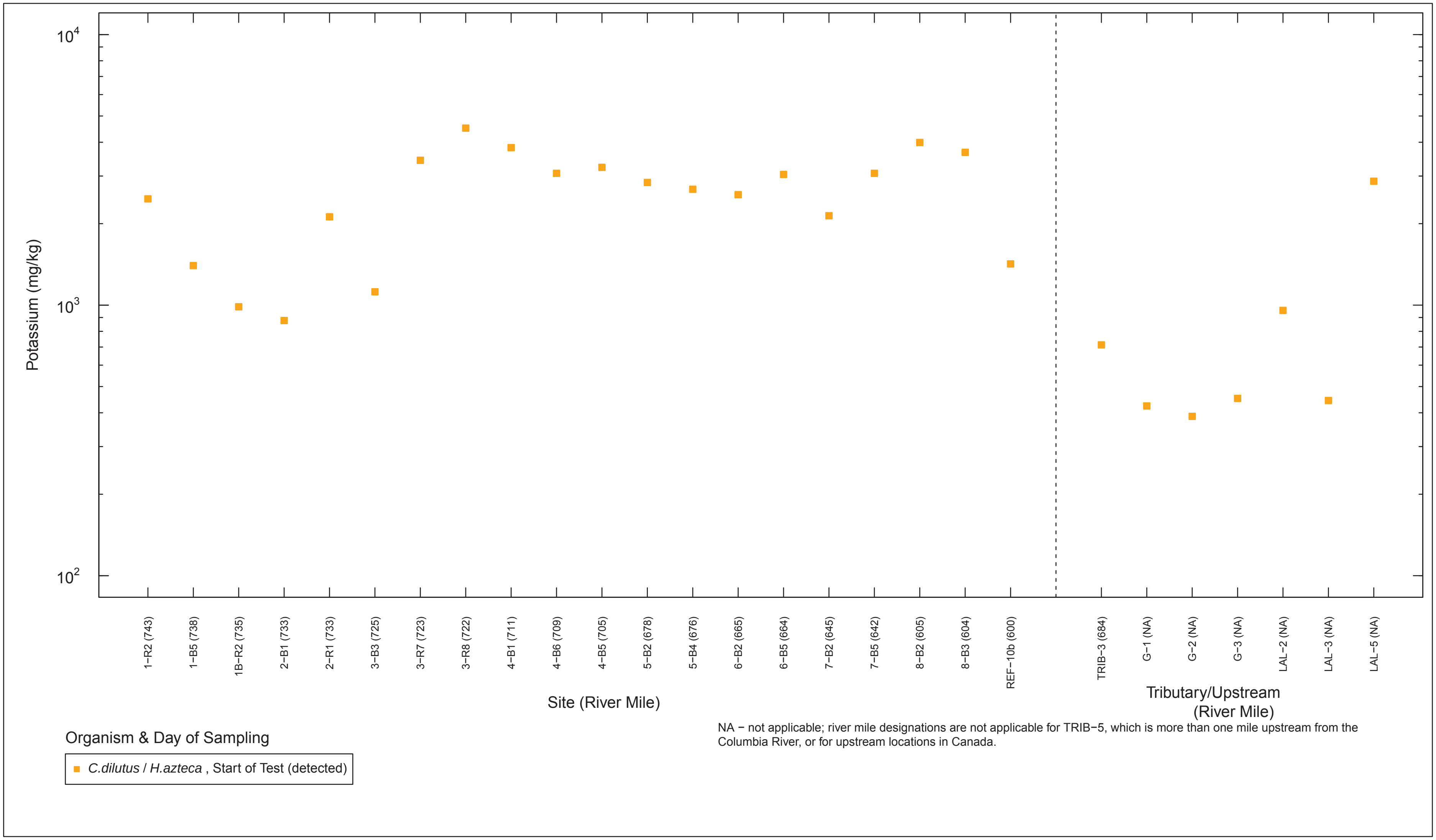


Figure 5−3u. Potassium in Sediment from Long−Term Bioassays

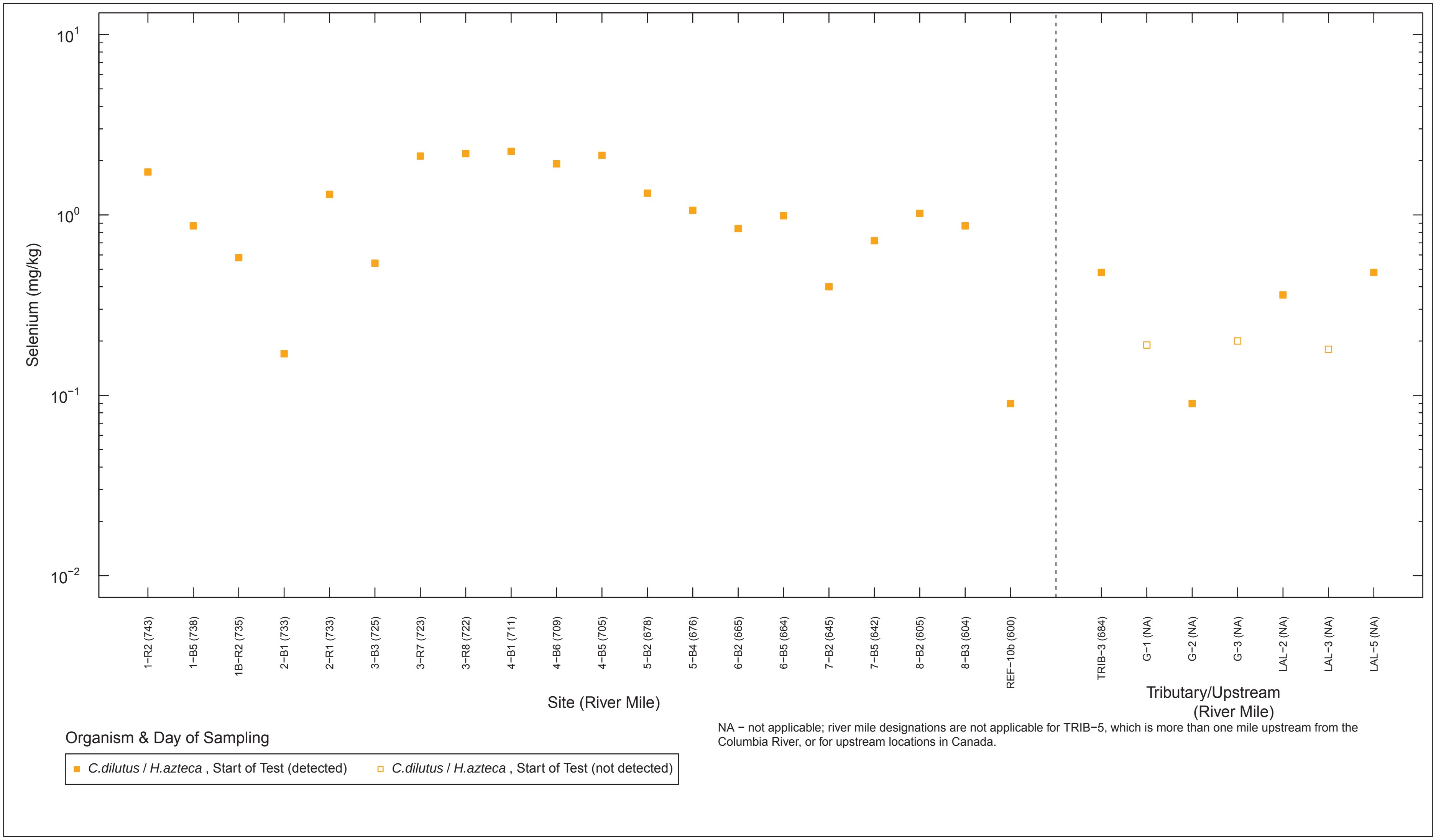


Figure 5−3v. Selenium in Sediment from Long−Term Bioassays

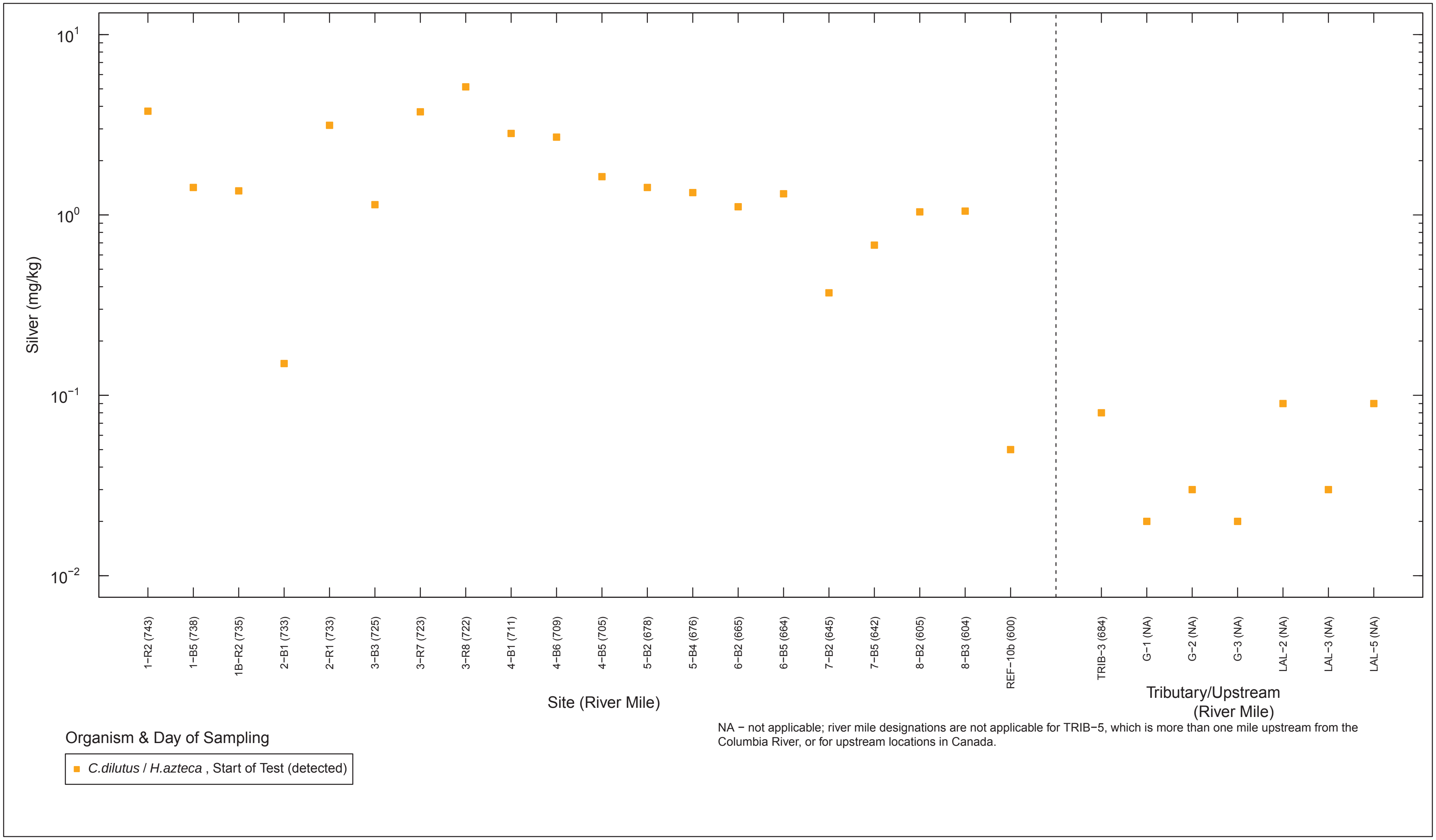


Figure 5−3w. Silver in Sediment from Long−Term Bioassays

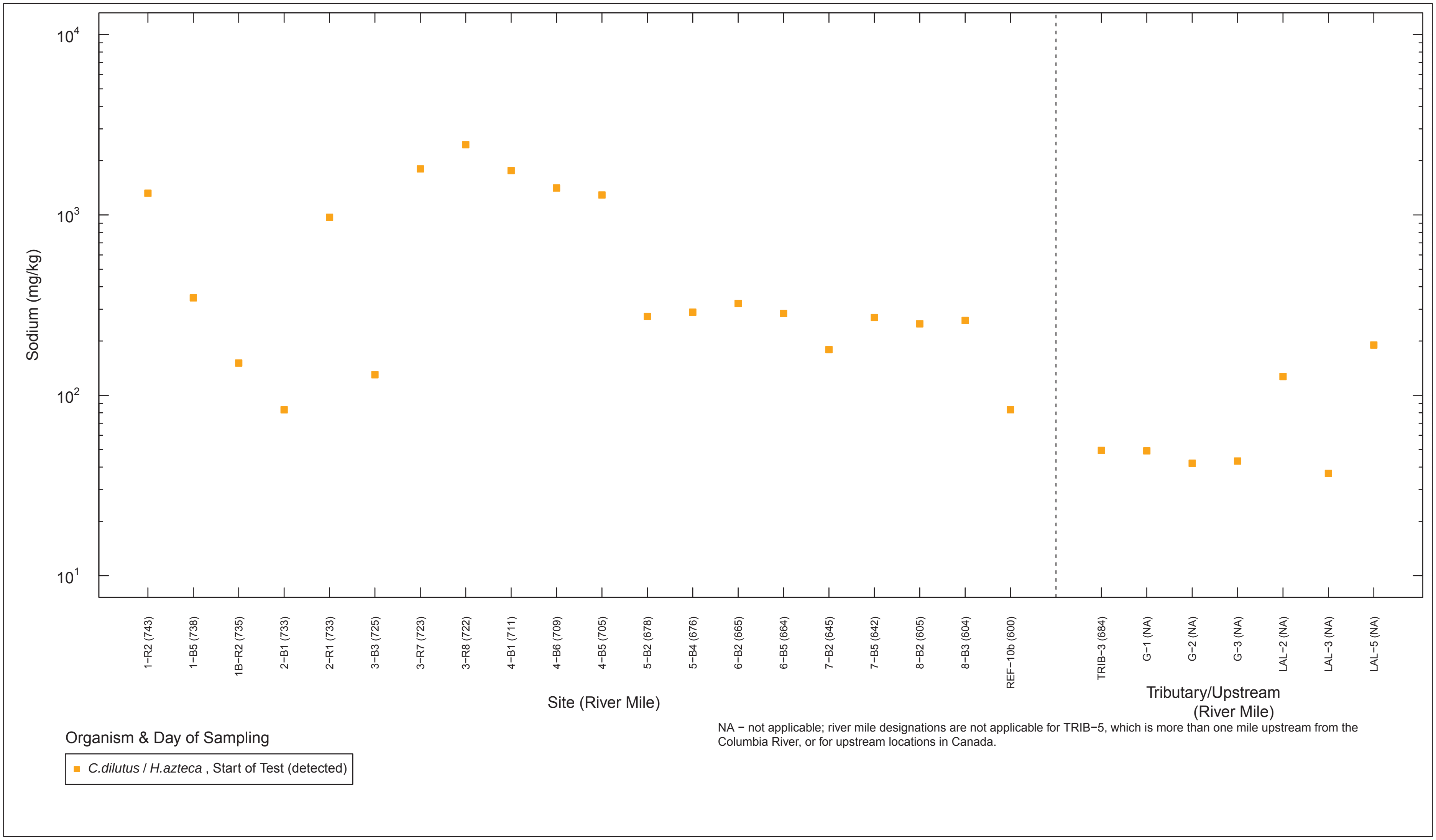


Figure 5−3x. Sodium in Sediment from Long−Term Bioassays

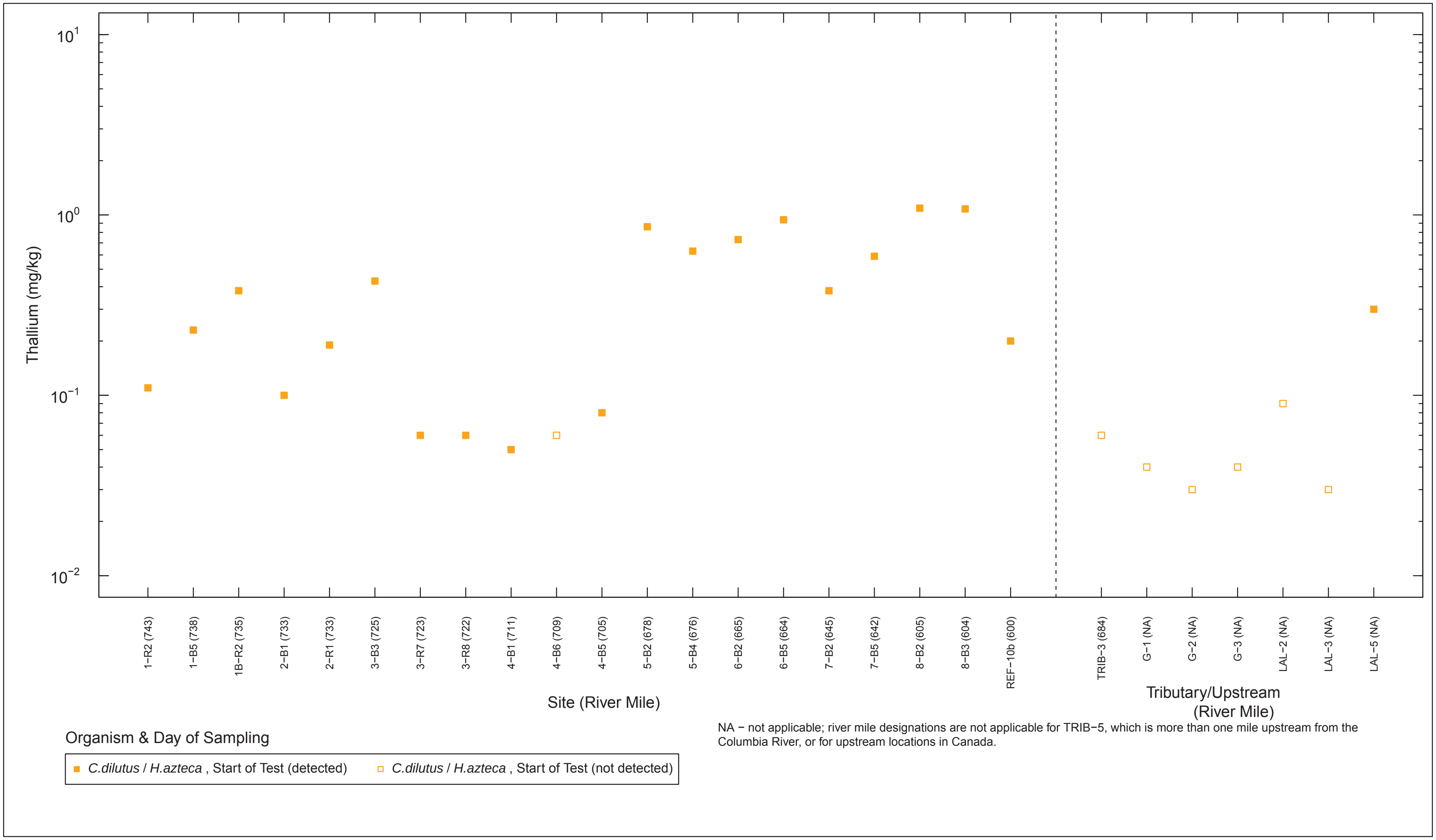


Figure 5−3y. Thallium in Sediment from Long−Term Bioassays

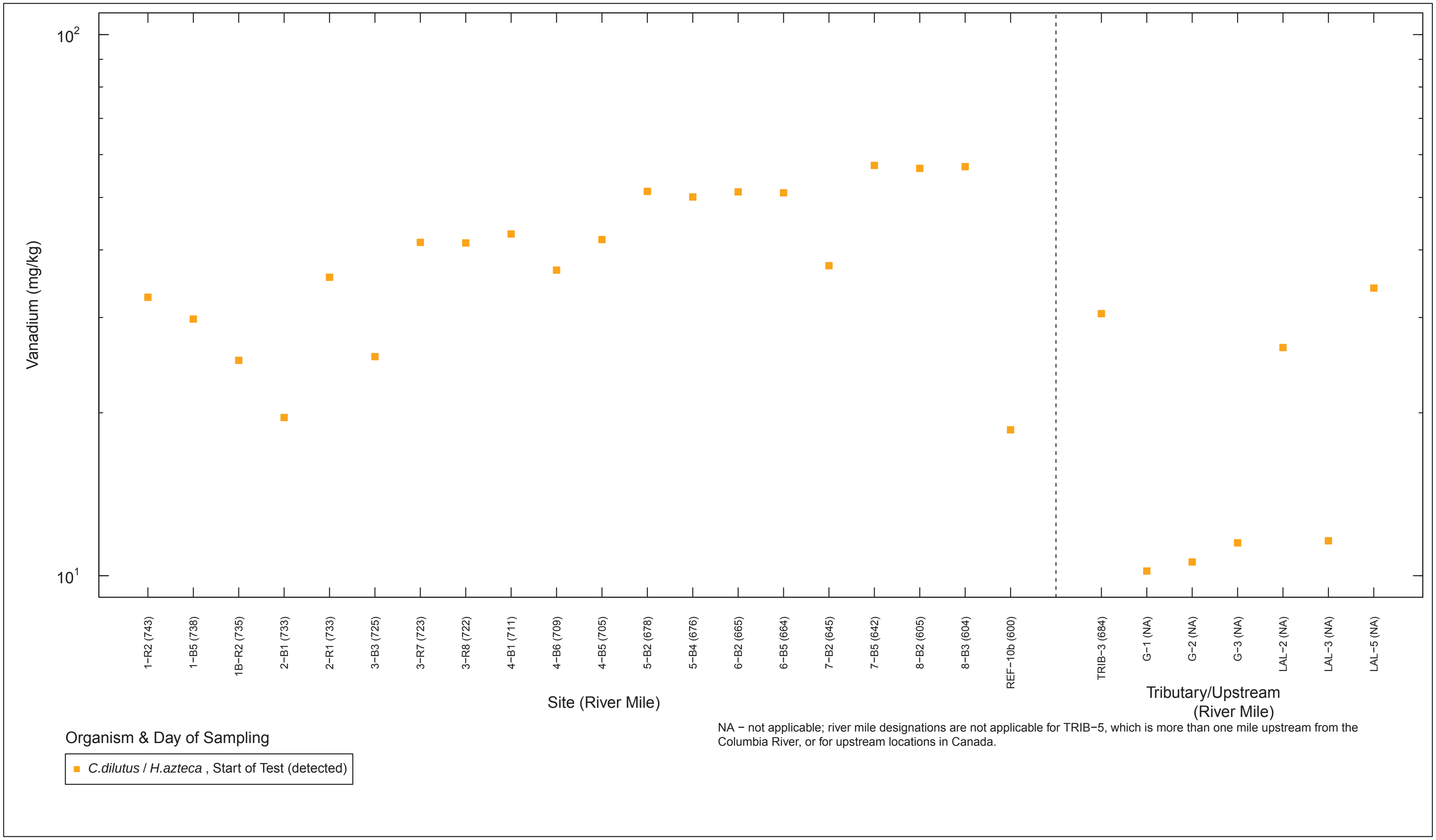


Figure 5−3z. Vanadium in Sediment from Long−Term Bioassays

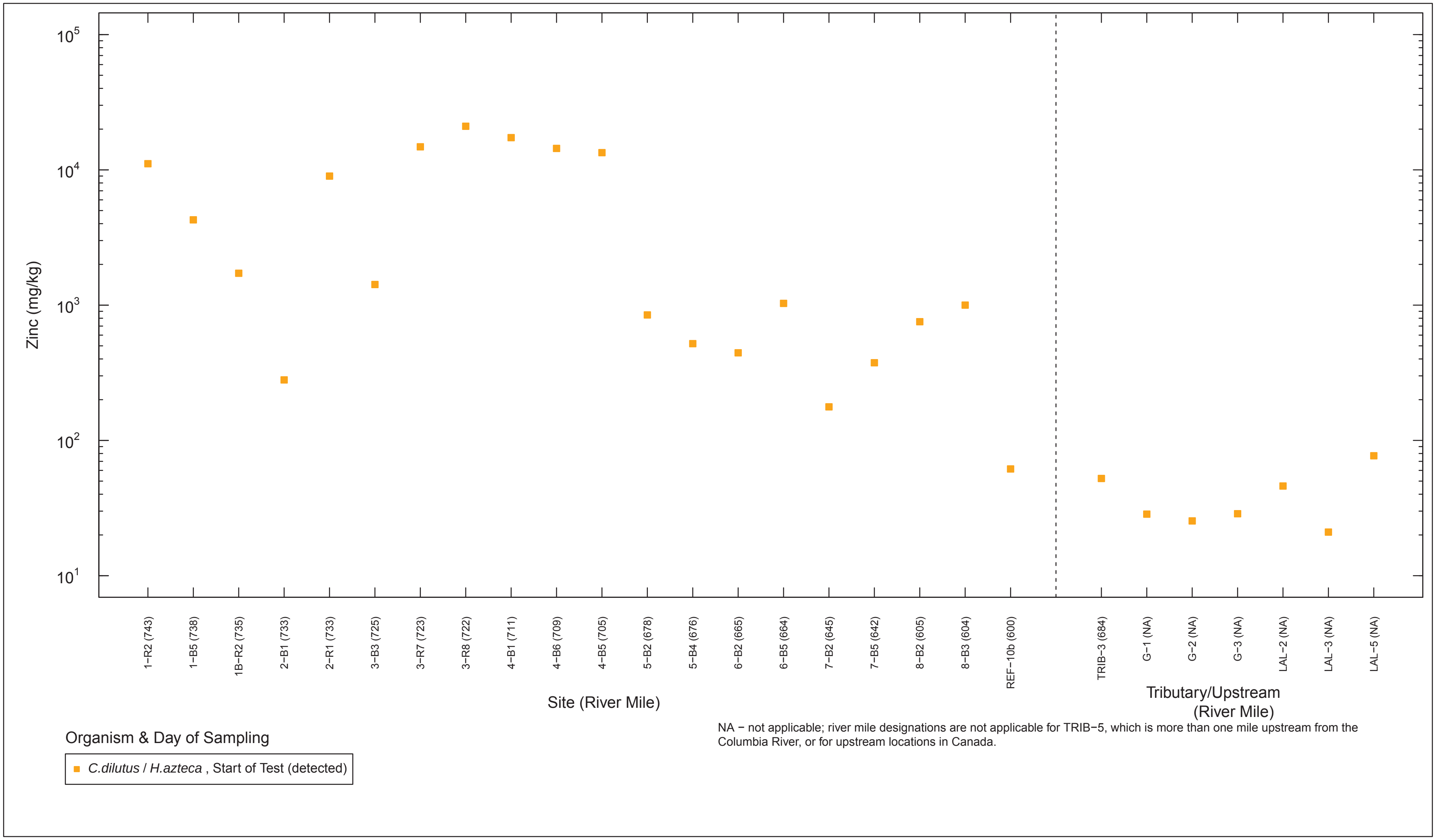


Figure 5−3aa. Zinc in Sediment from Long−Term Bioassays

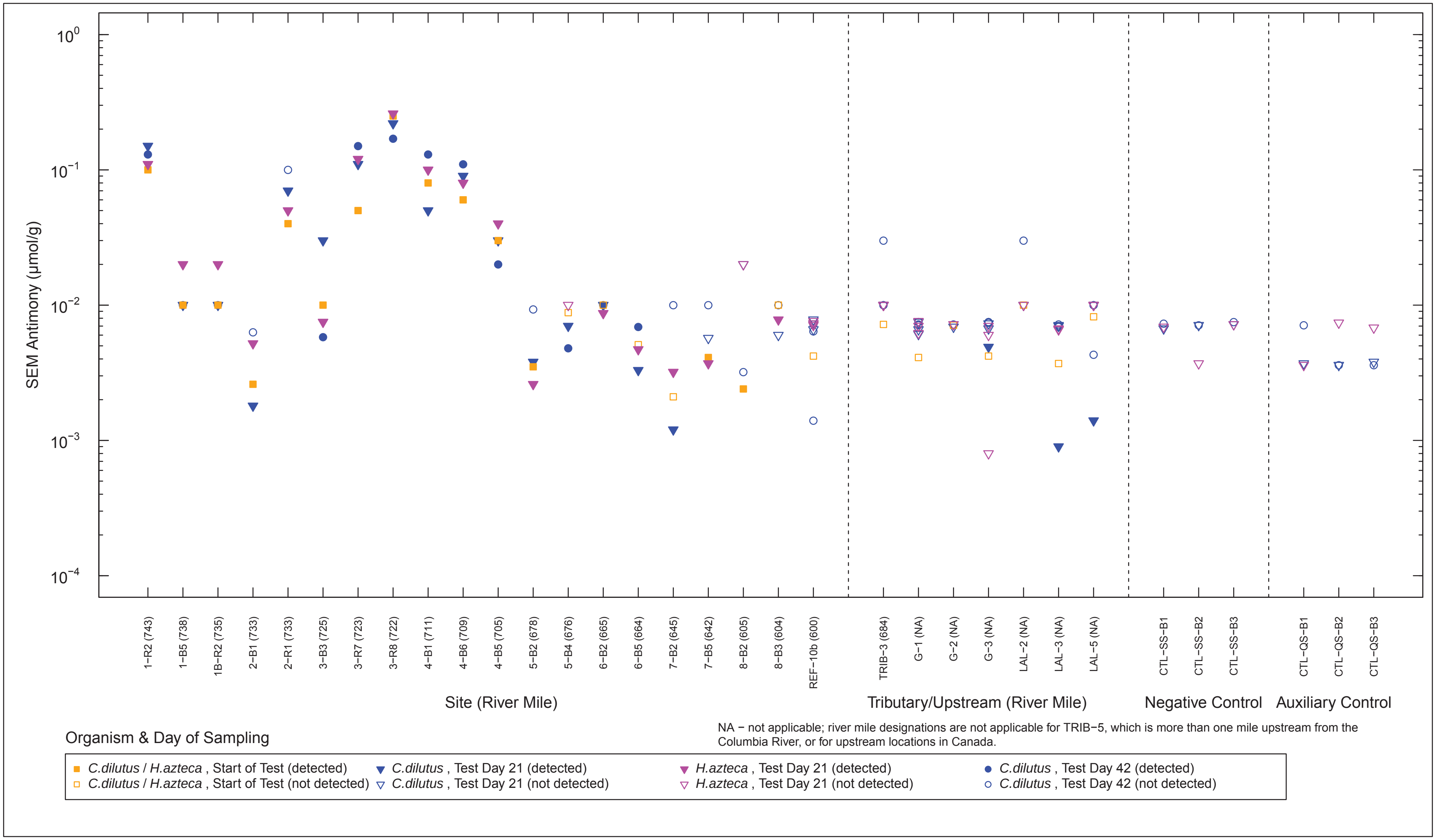


Figure 5−3ab. SEM Antimony in Sediment from Long−Term Bioassays

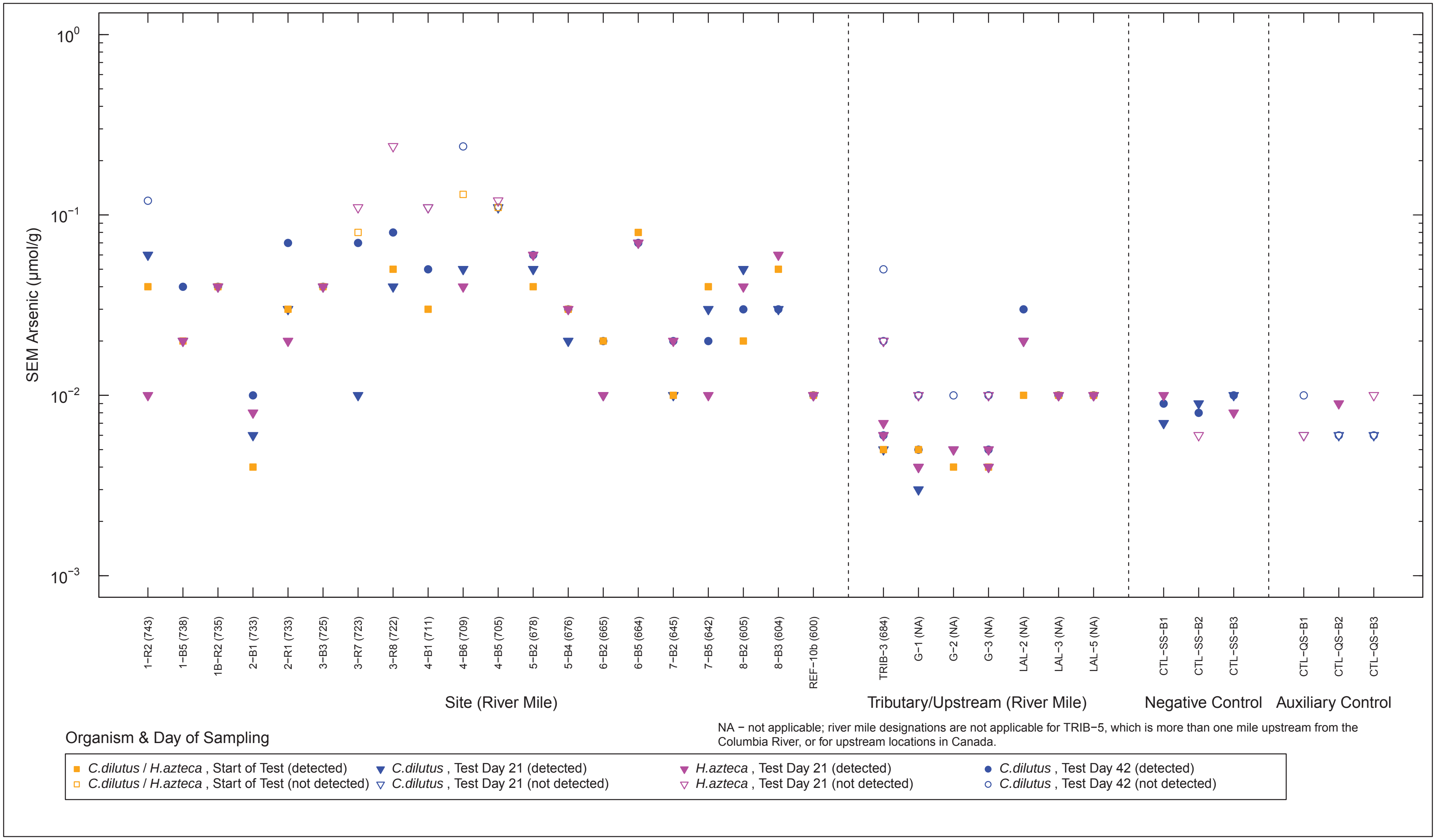


Figure 5−3ac. SEM Arsenic in Sediment from Long−Term Bioassays

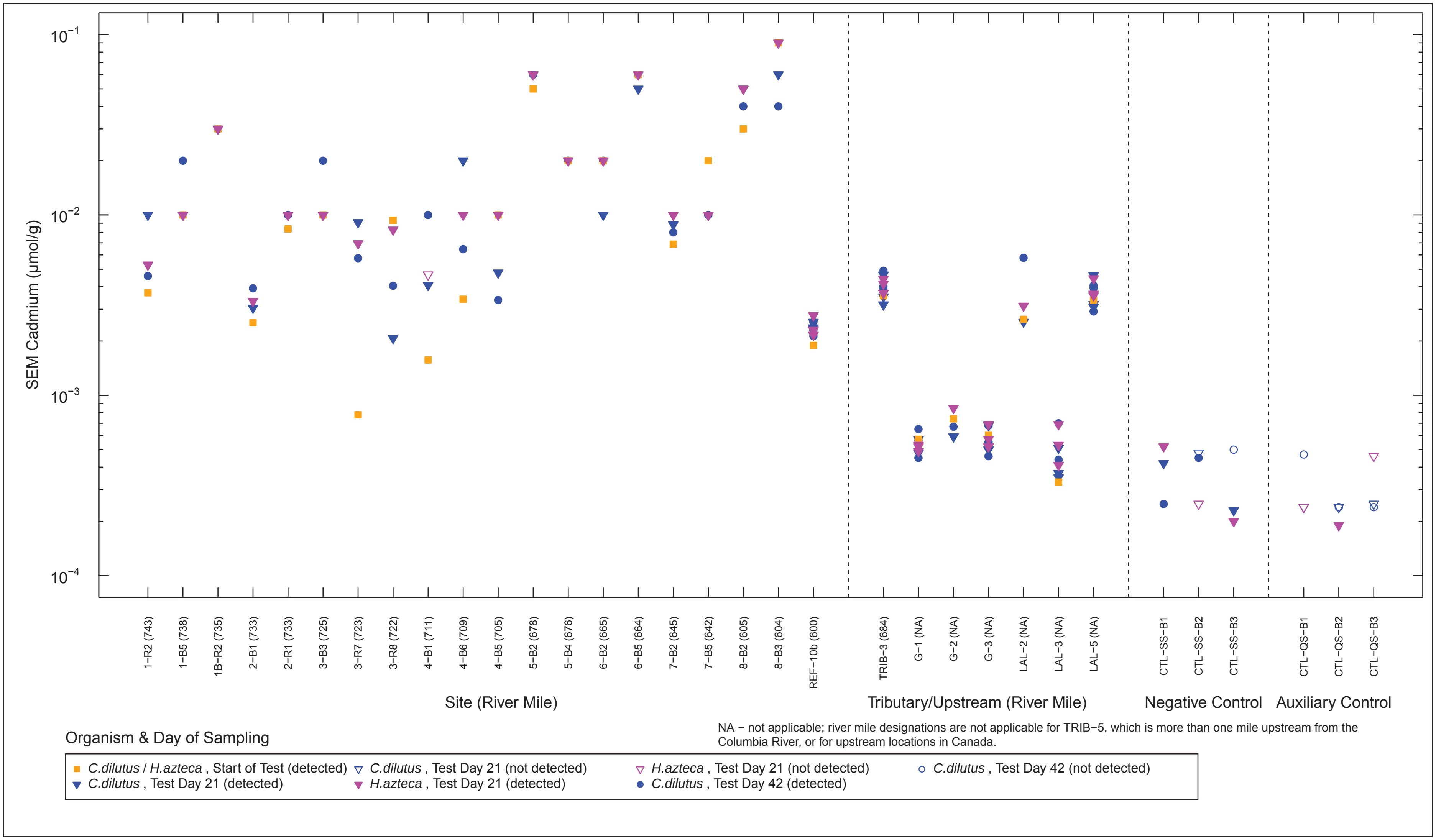


Figure 5−3ad. SEM Cadmium in Sediment from Long−Term Bioassays

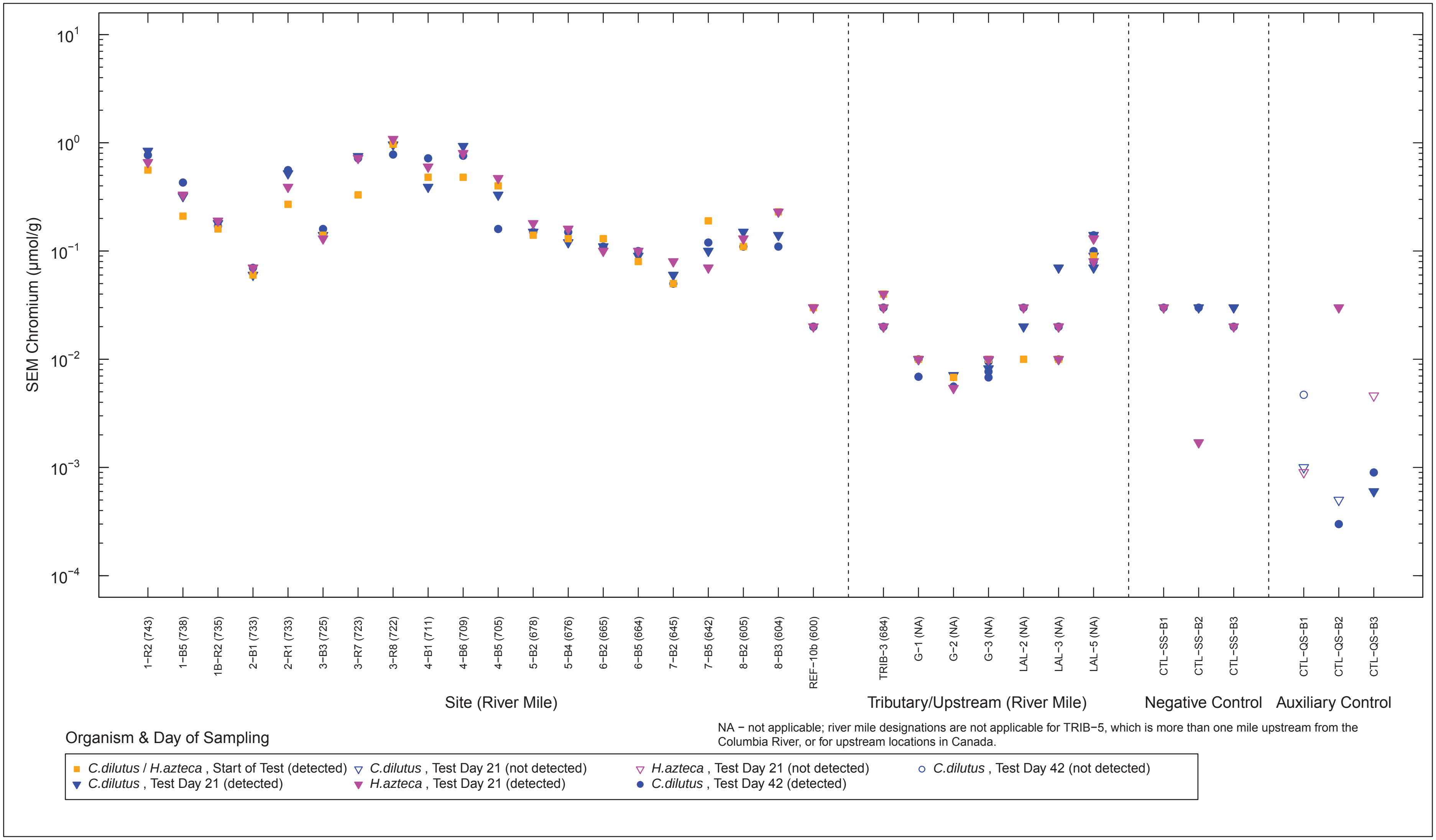


Figure 5−3ae. SEM Chromium in Sediment from Long−Term Bioassays

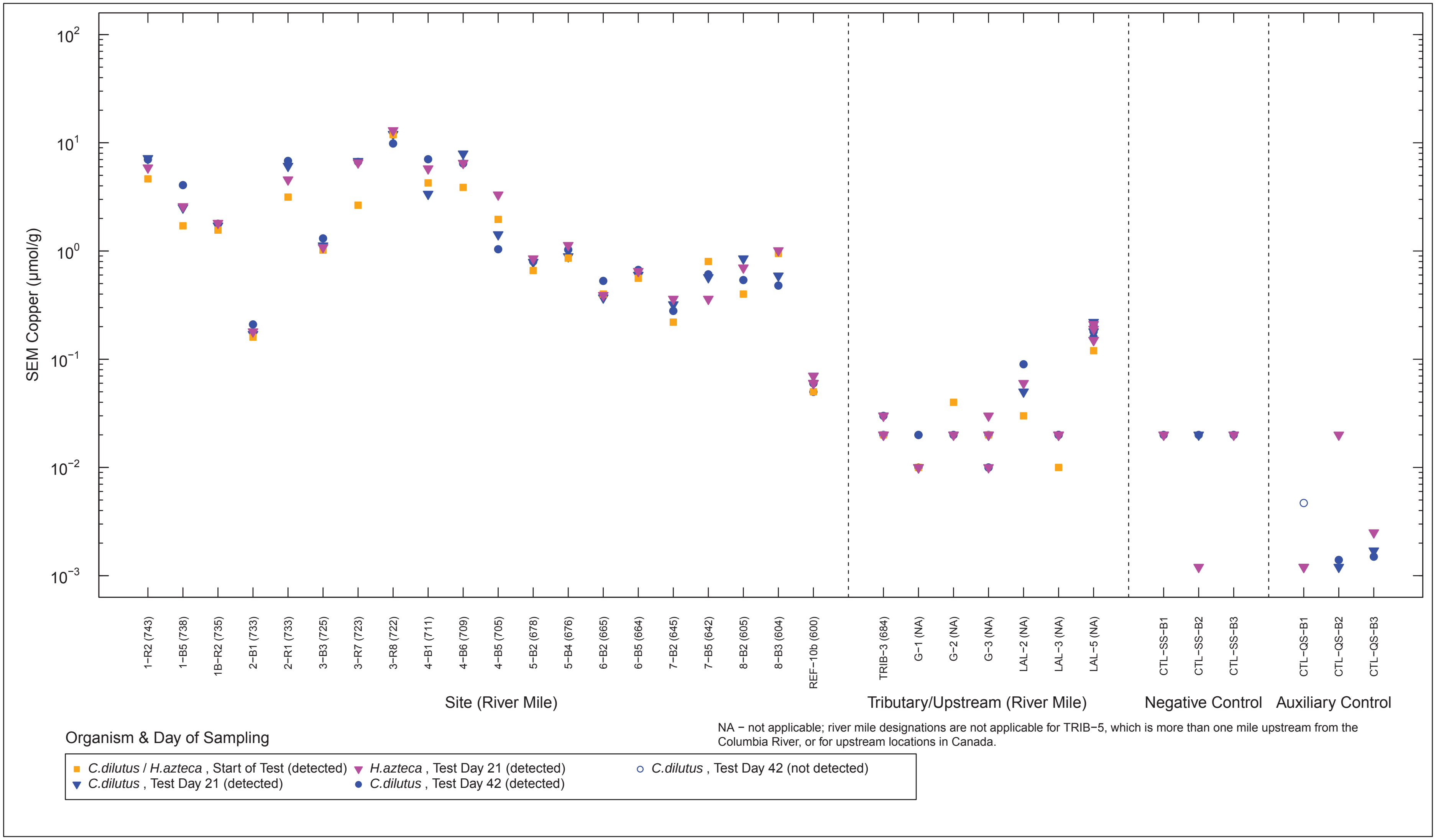


Figure 5−3af. SEM Copper in Sediment from Long−Term Bioassays

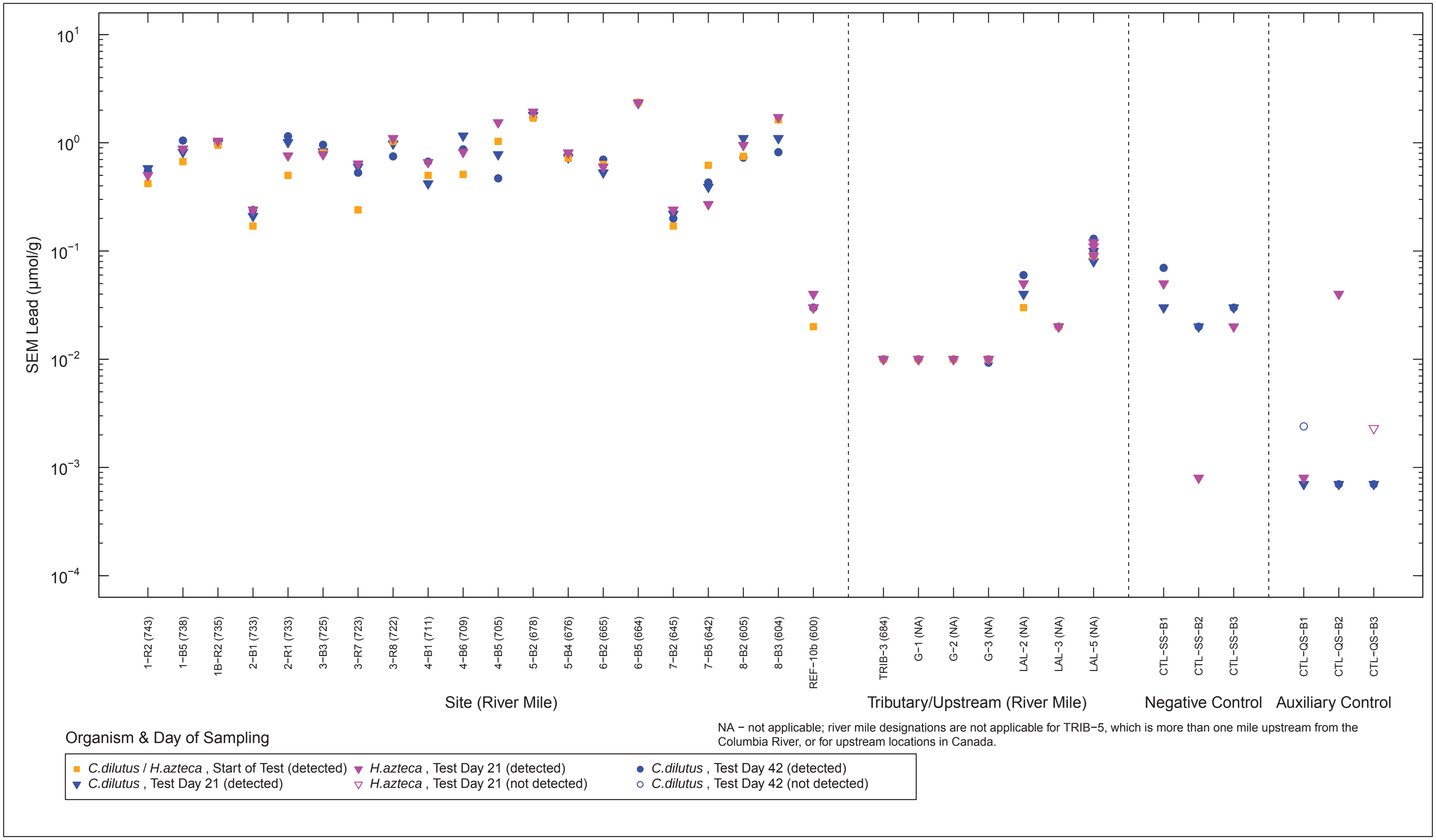


Figure 5−3ag. SEM Lead in Sediment from Long−Term Bioassays

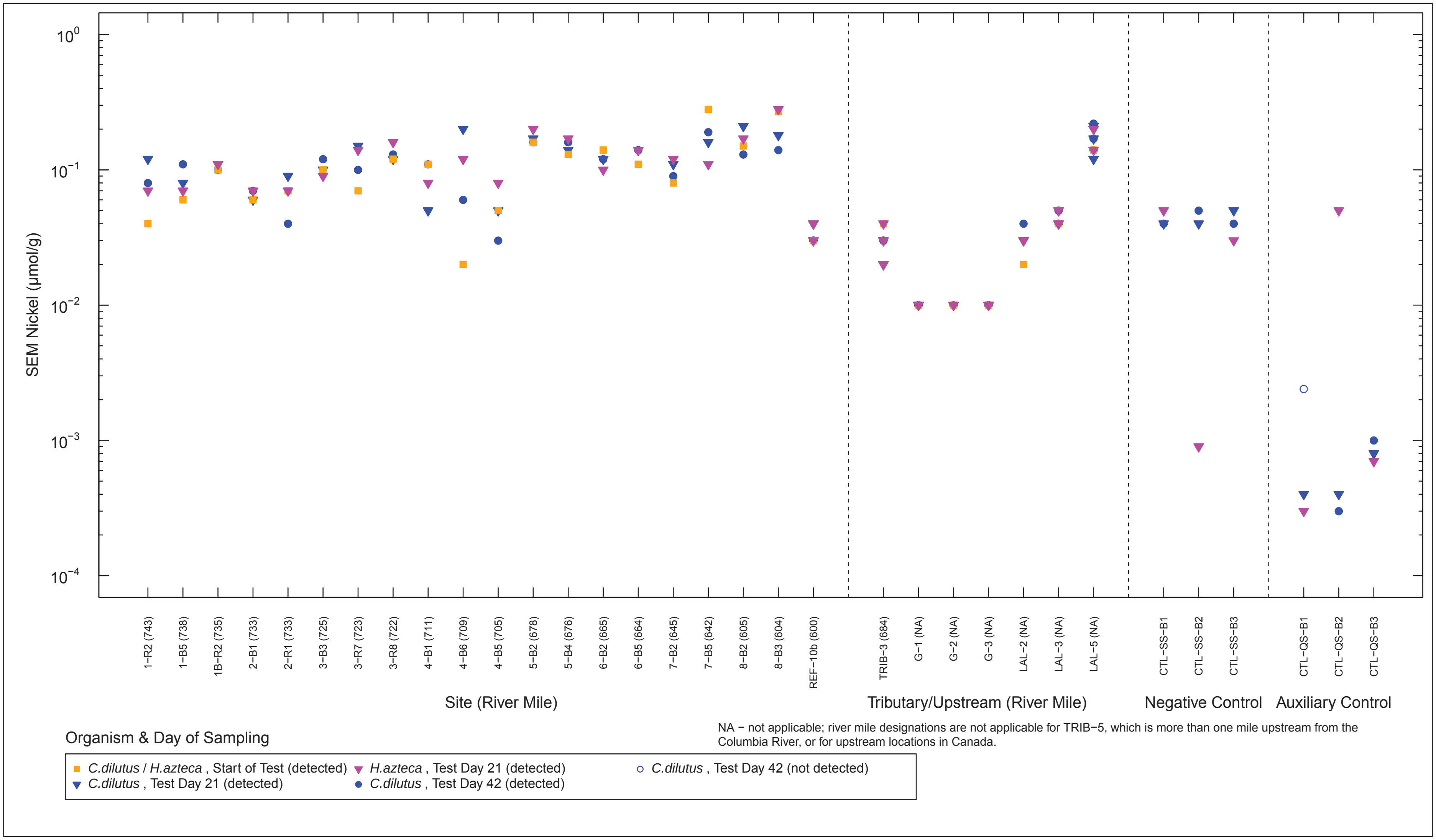


Figure 5−3ah. SEM Nickel in Sediment from Long−Term Bioassays

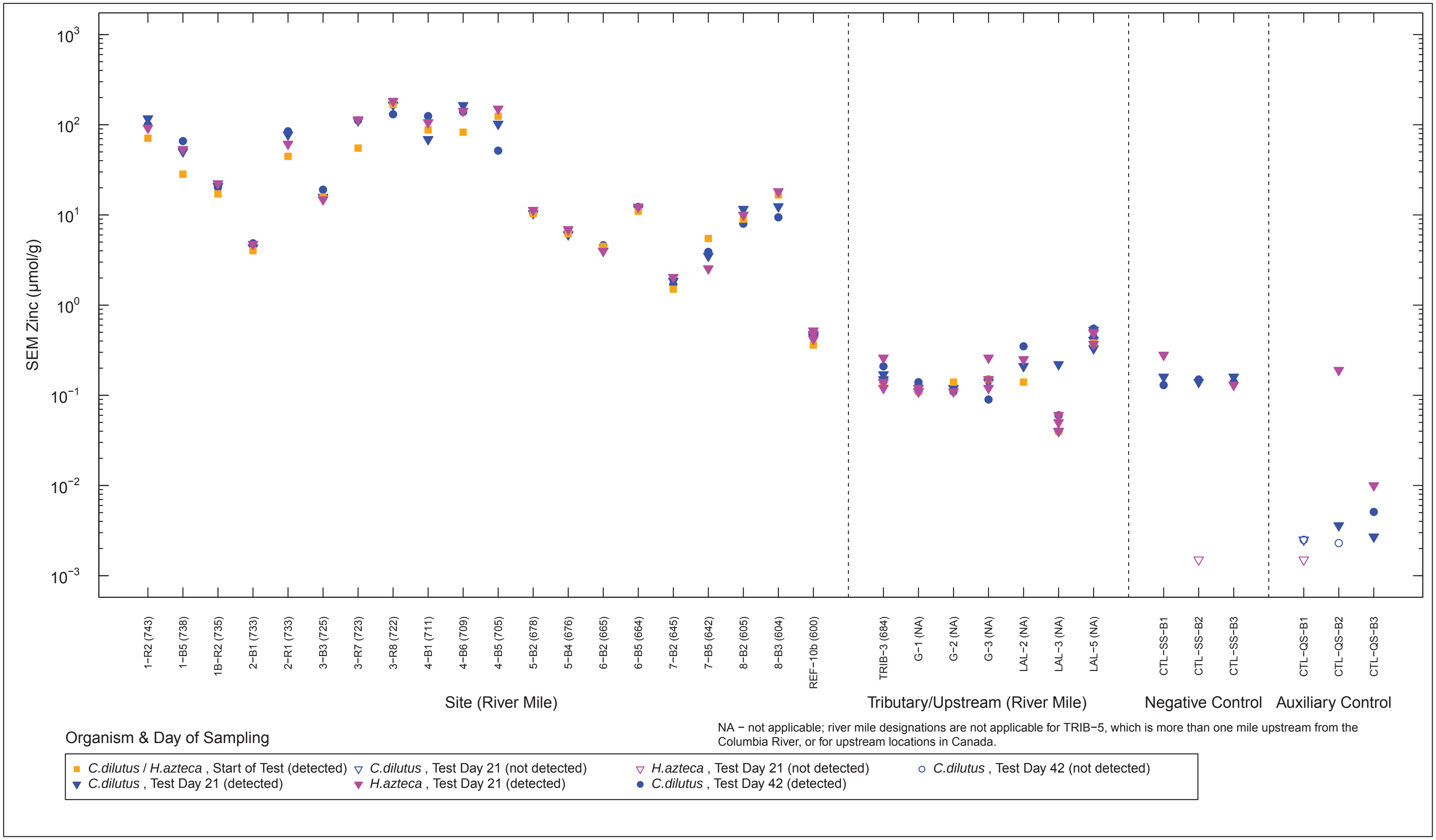


Figure 5−3ai. SEM Zinc in Sediment from Long−Term Bioassays

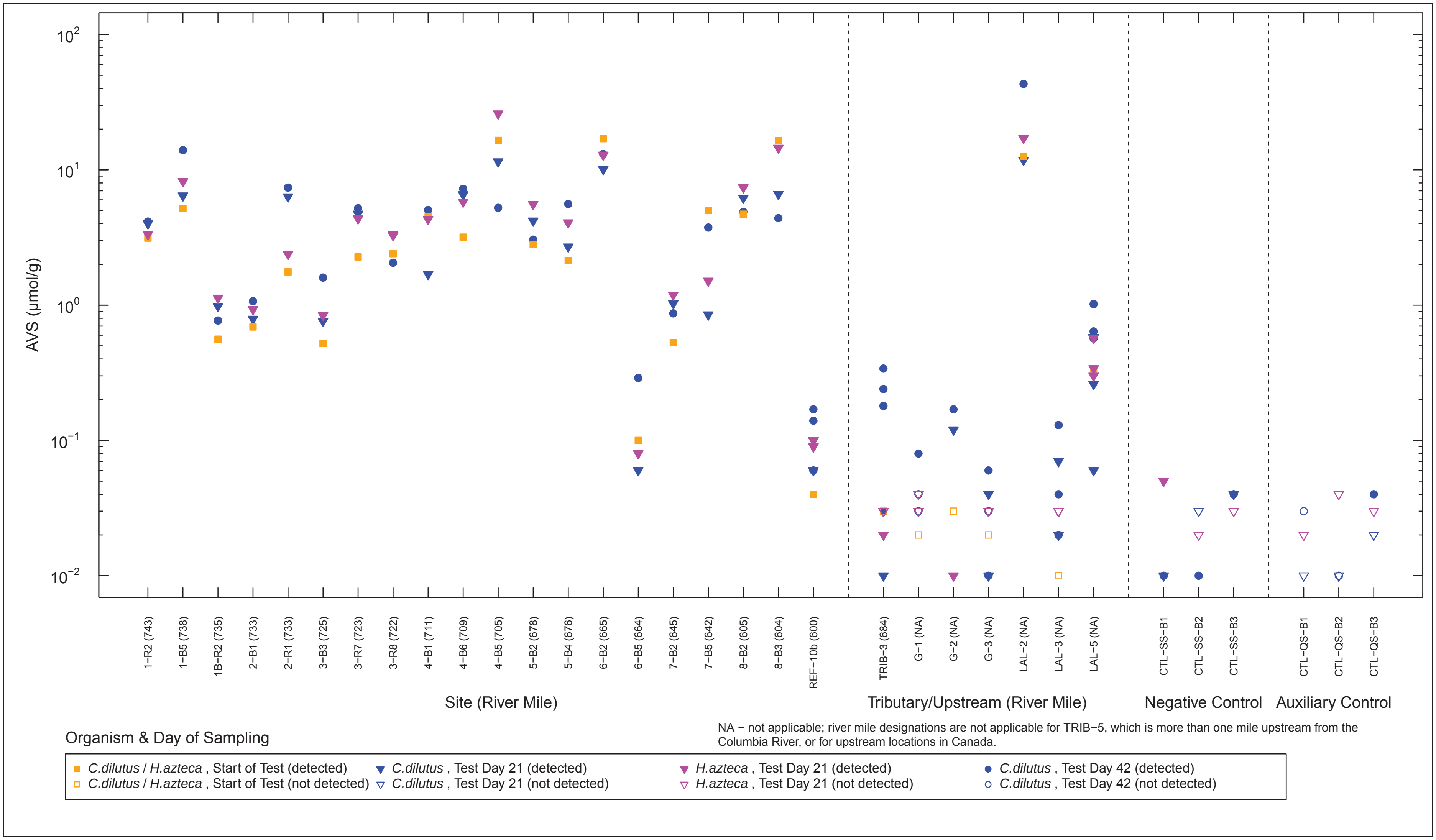
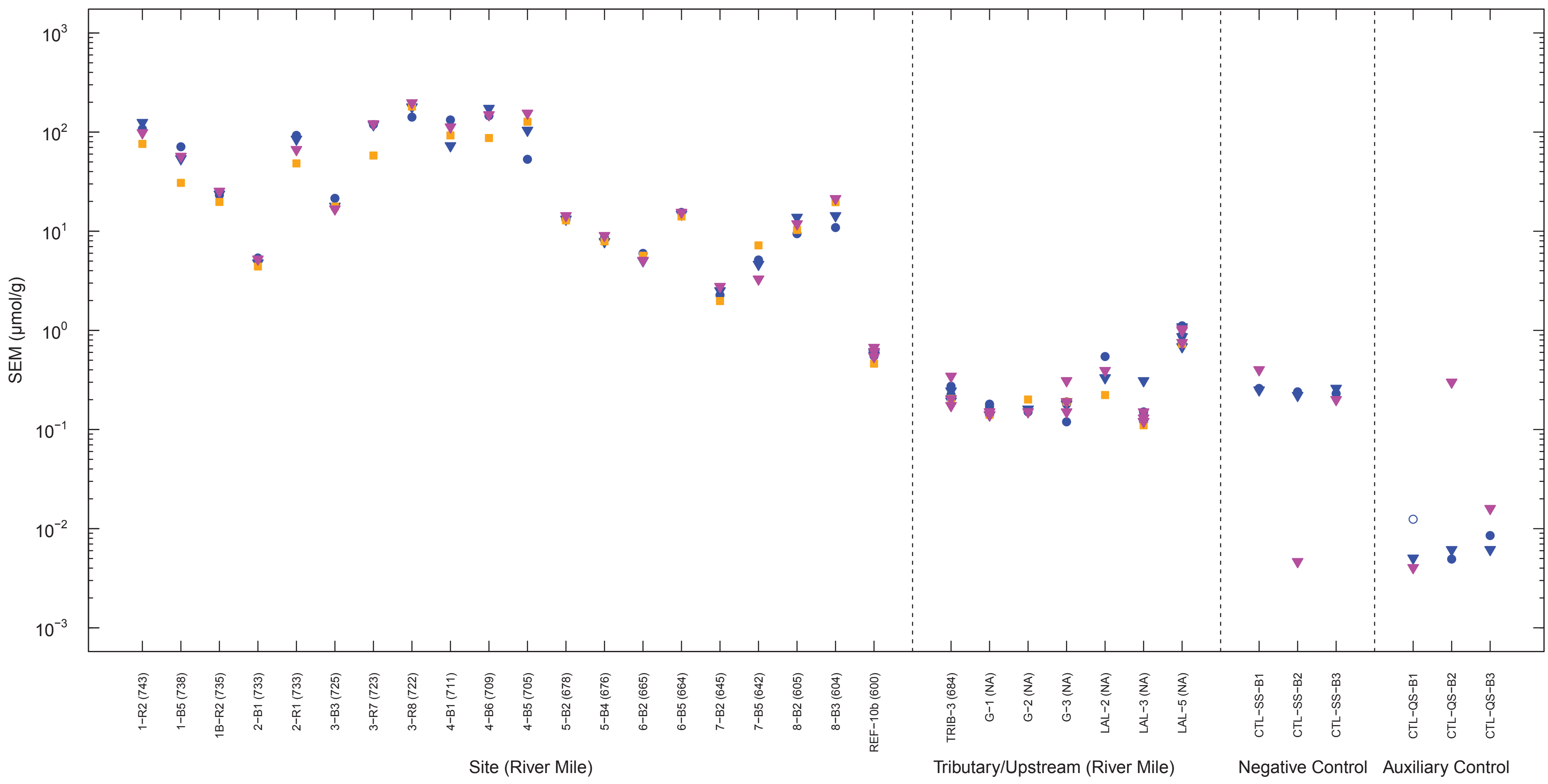


Figure 5−3aj. AVS in Sediment from Long−Term Bioassays



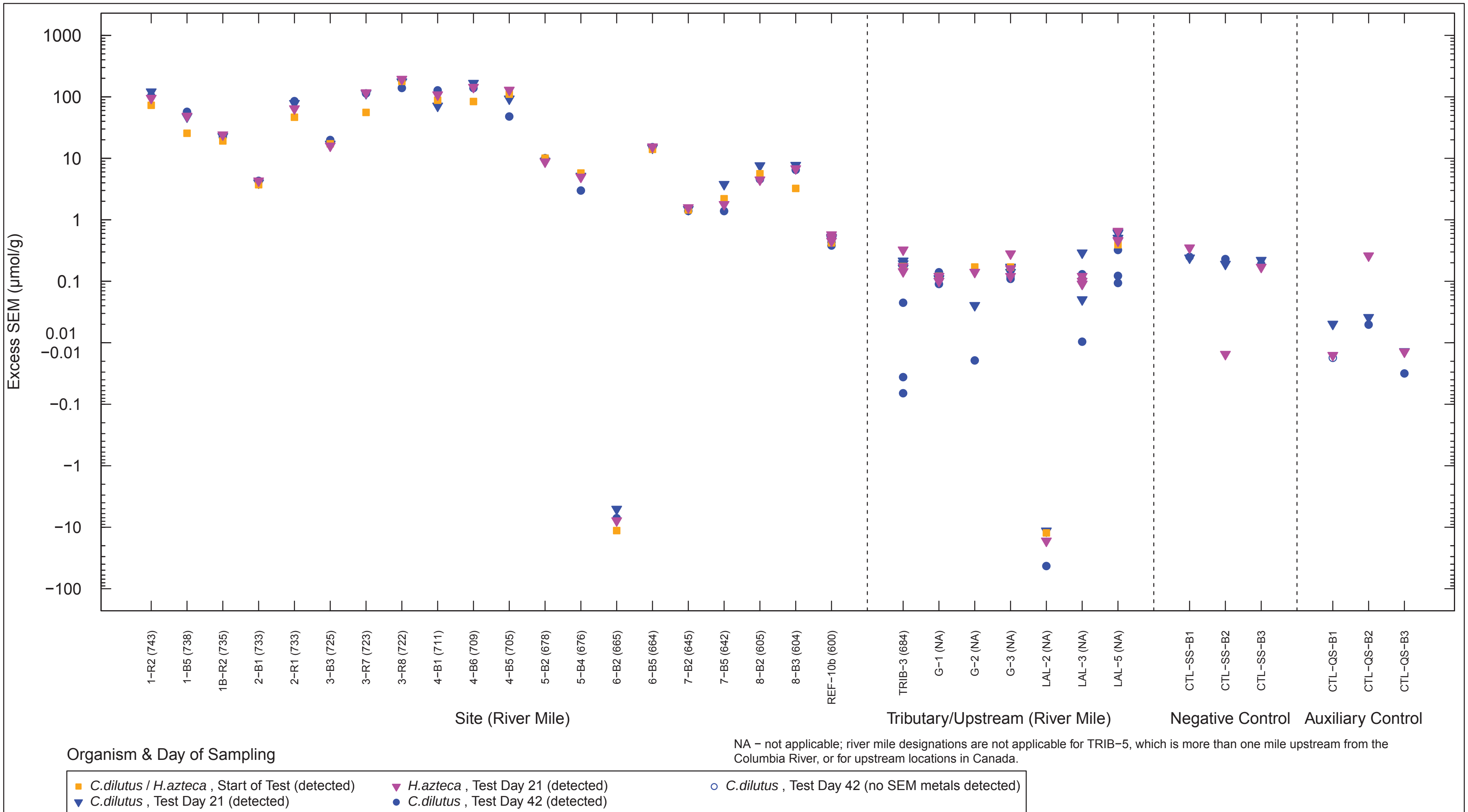
NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Organism & Day of Sampling

C.dilutus / *H.azteca* , Start of Test (detected)
C.dilutus , Test Day 21 (detected)
H.azteca , Test Day 21 (detected)
C.dilutus , Test Day 42 (detected)
C.dilutus , Test Day 42 (no SEM metals detected)

Note: SEM is the sum of individual SEM concentrations of cadmium, copper, lead, nickel, and zinc. For non−detected concentrations of individual SEM metals, the detection limit was used in the sum.

Figure 5−3ak. SEM in Sediment from Long−Term Bioassays



Note: SEM is the sum of individual SEM concentrations of cadmium, copper, lead, nickel, and zinc. For non−detected concentrations of individual SEM metals, the detection limit was used in the sum.

Figure 5−3al. Excess SEM in Sediment from Long−Term Bioassays

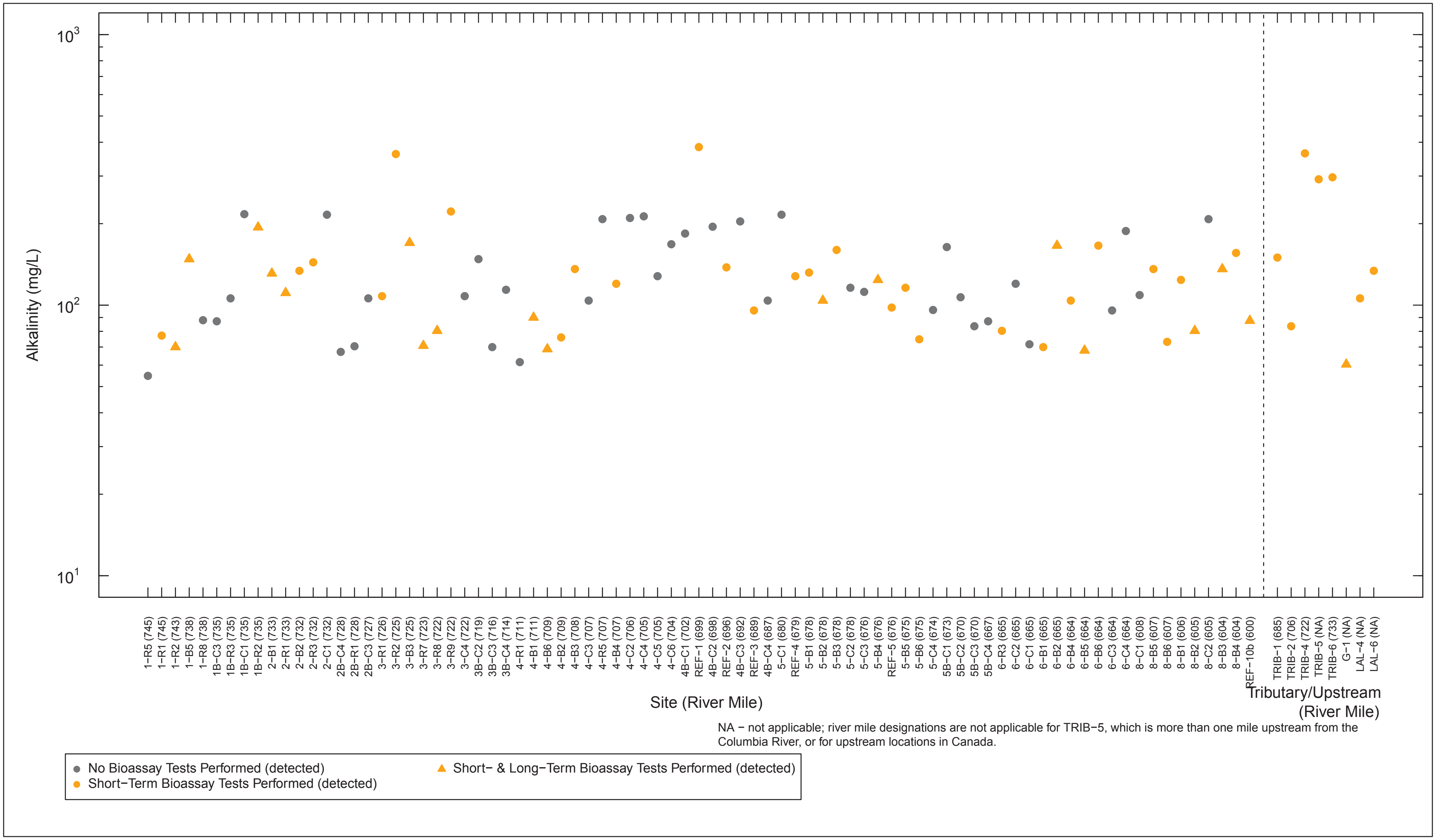


Figure 5−4a. Alkalinity in Field Porewater

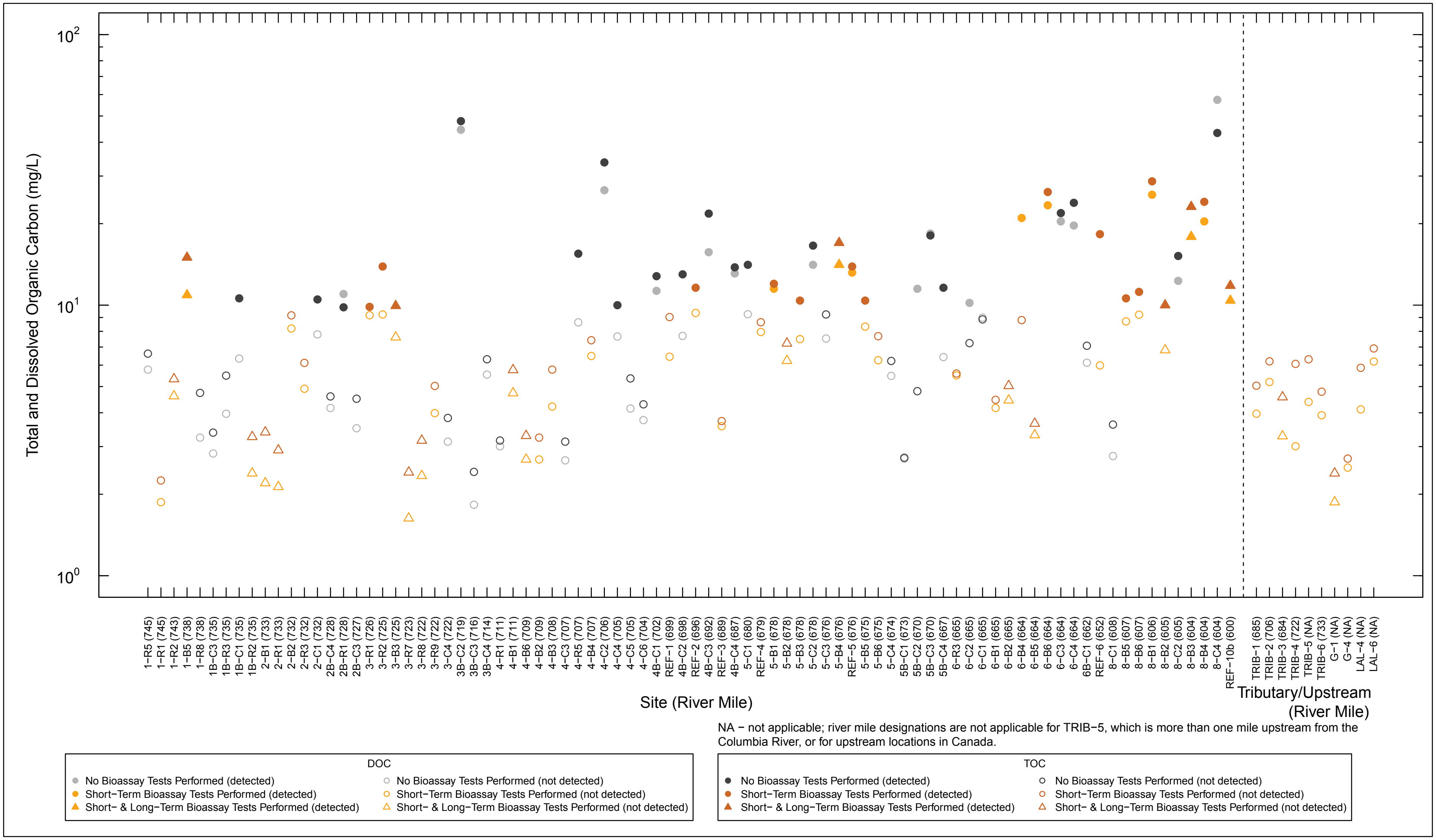


Figure 5−4b. Total and Dissolved Organic Carbon in Field Porewater

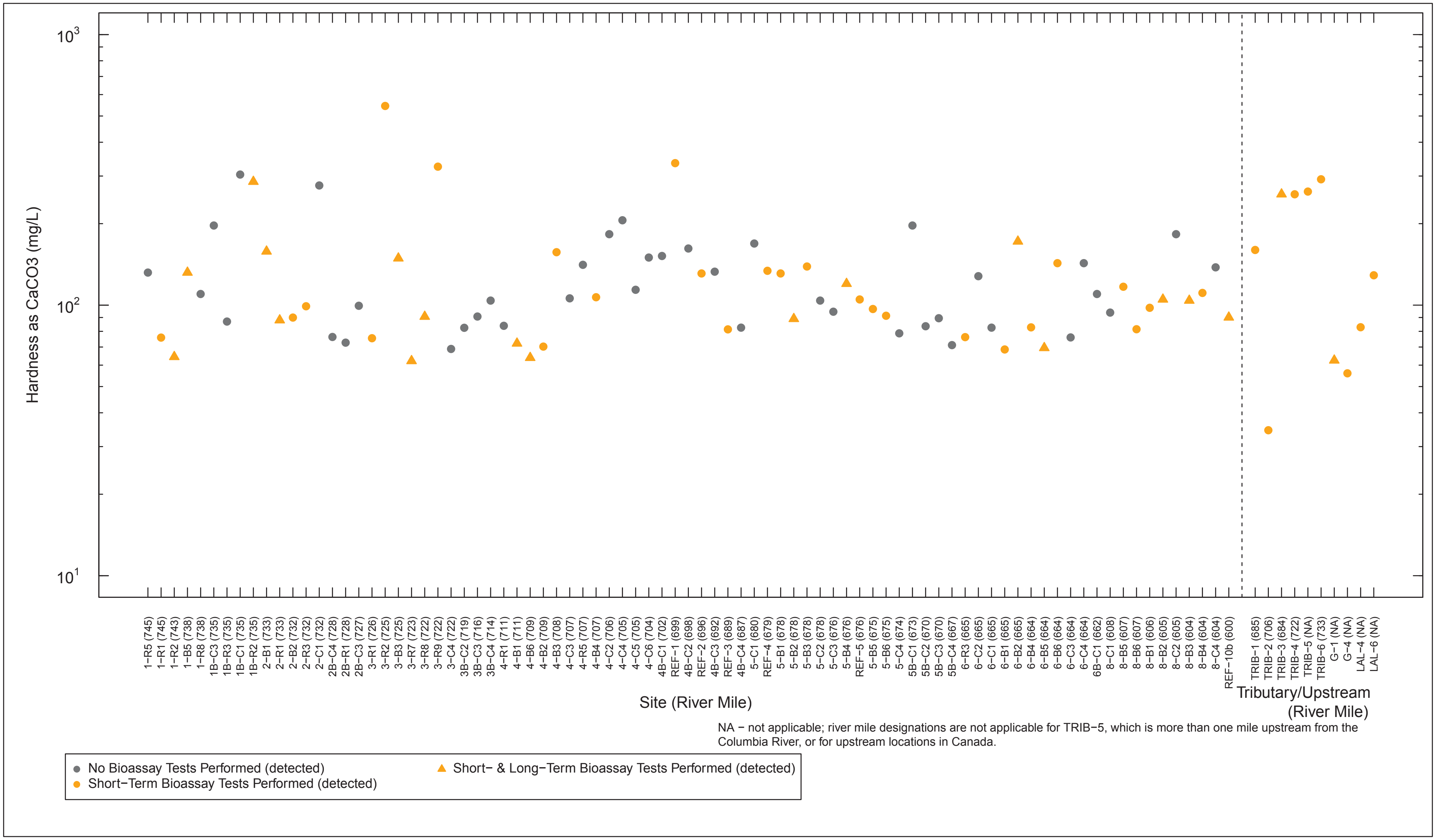


Figure 5−4c. Hardness as CaCO3 in Field Porewater

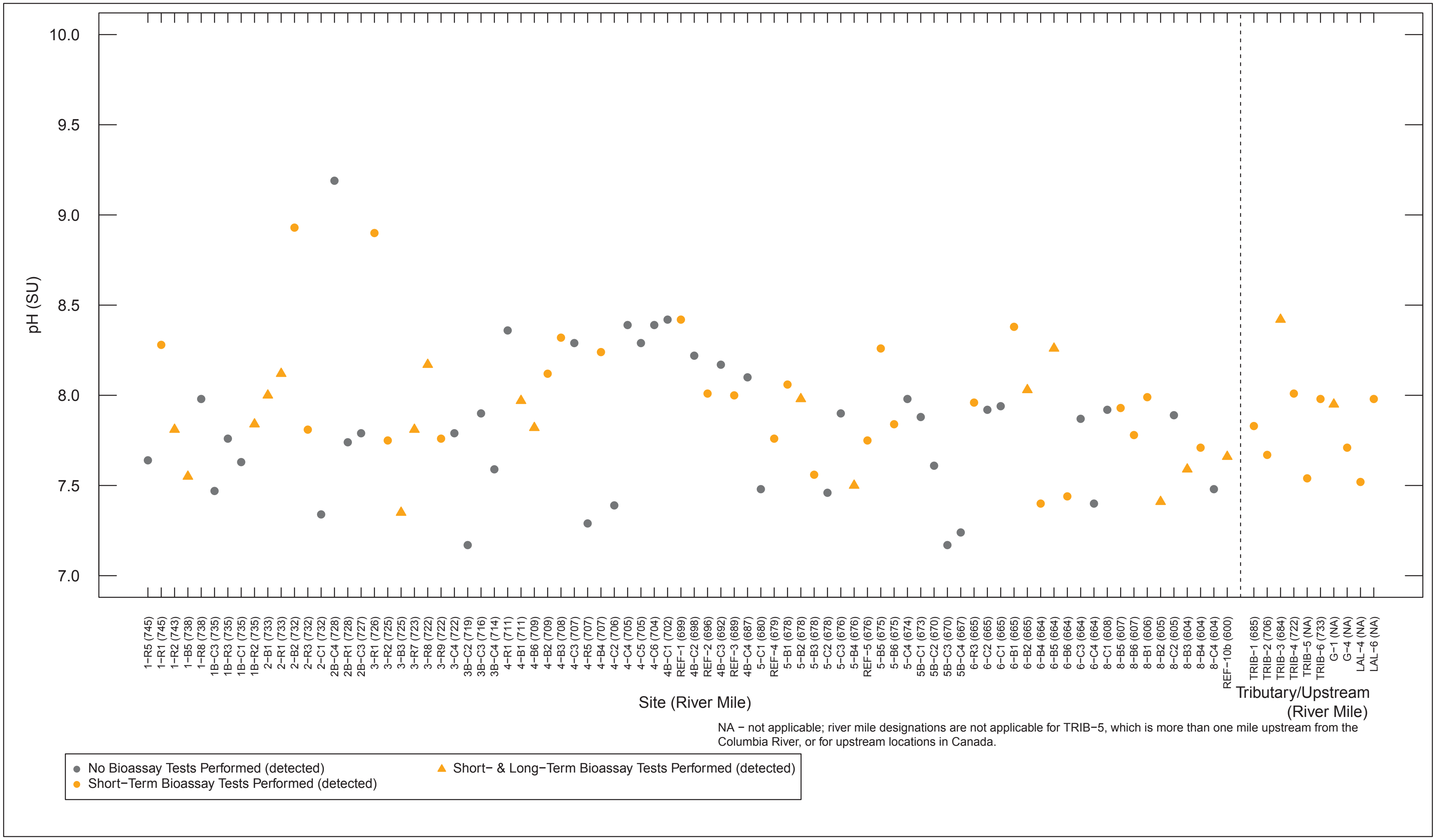


Figure 5−4d. pH in Field Porewater

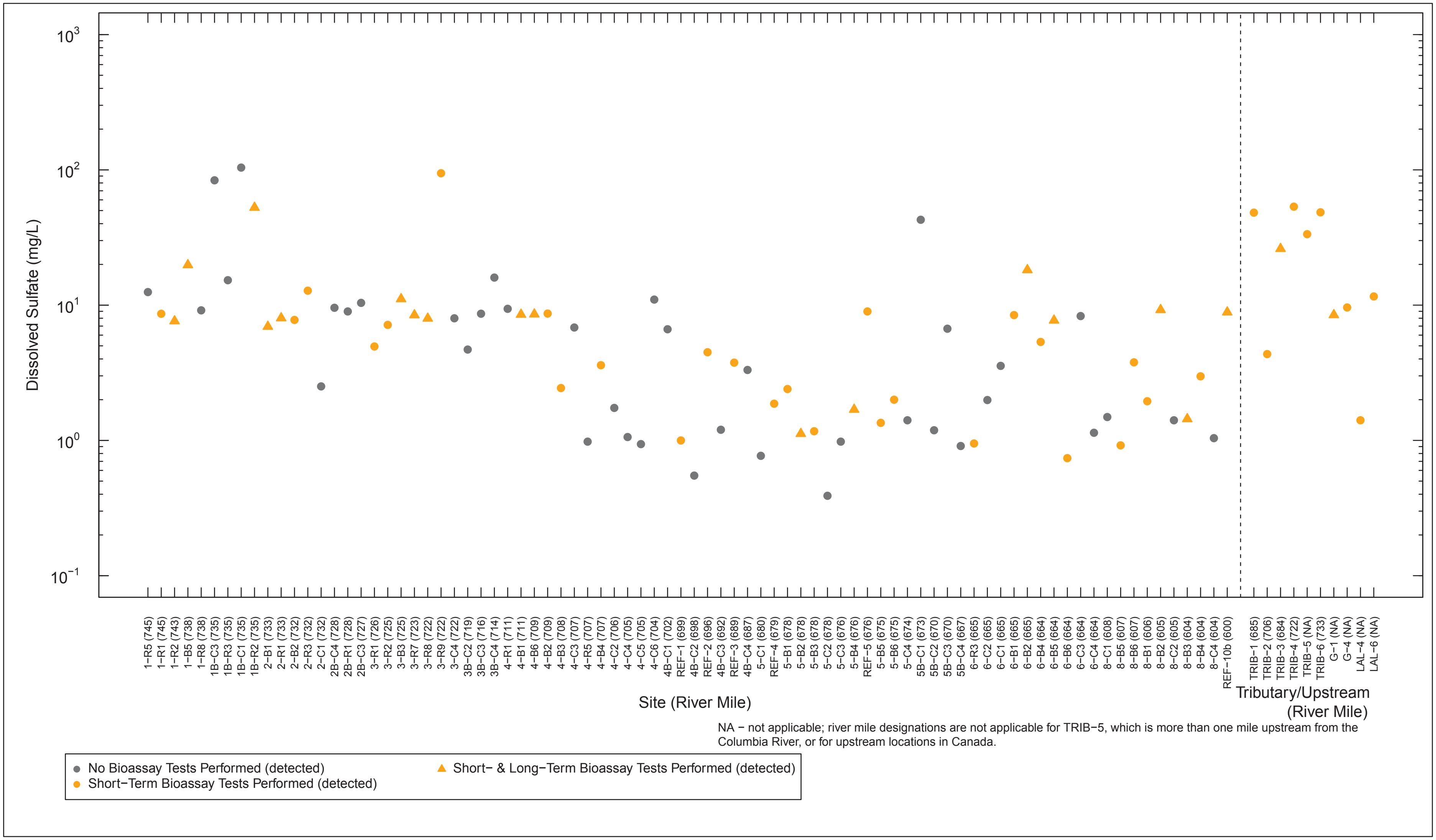


Figure 5-4e. Dissolved Sulfate in Field Porewater

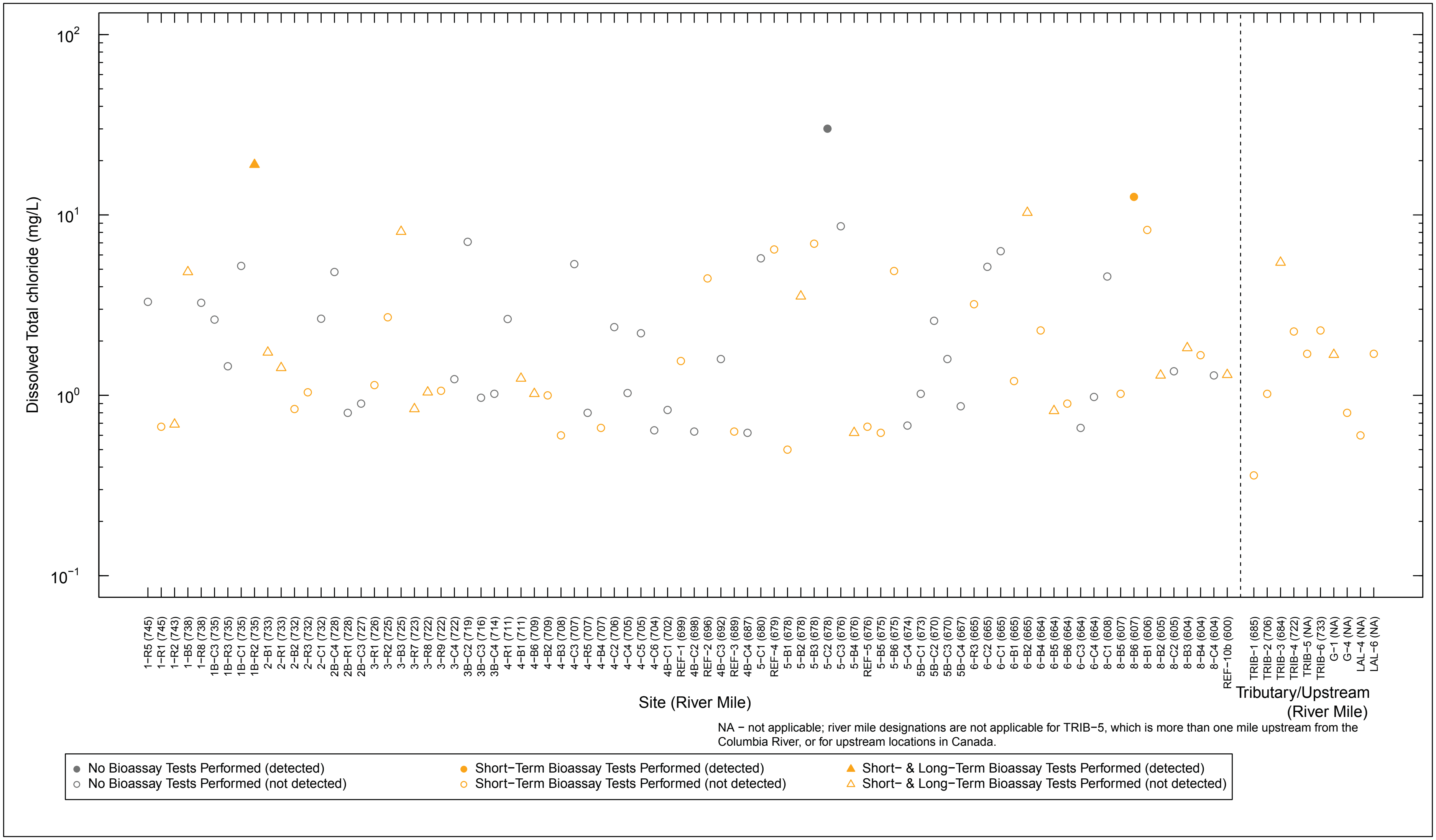


Figure 5−4f. Dissolved Total Chloride in Field Porewater

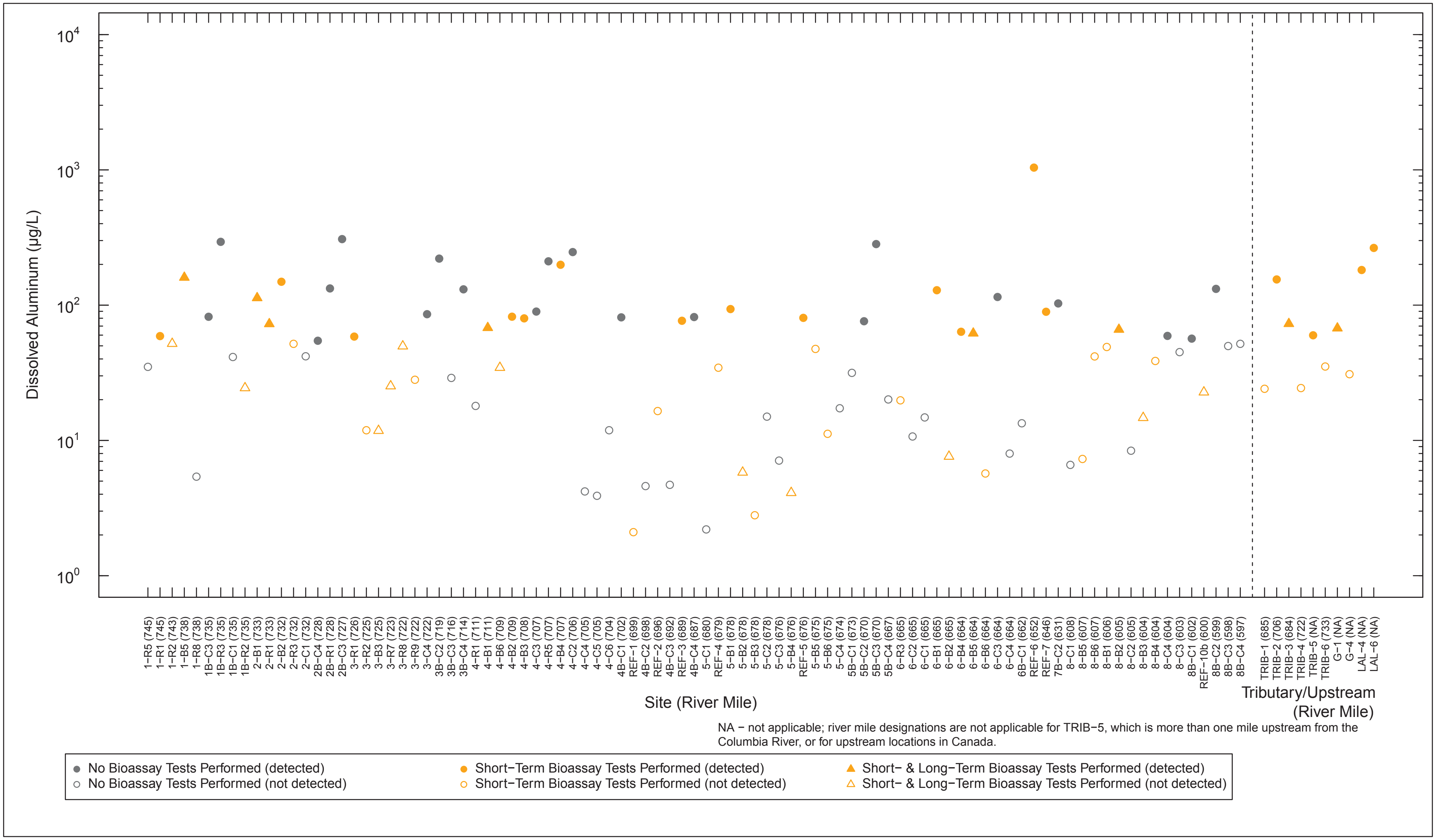


Figure 5−4g. Dissolved Aluminum in Field Porewater

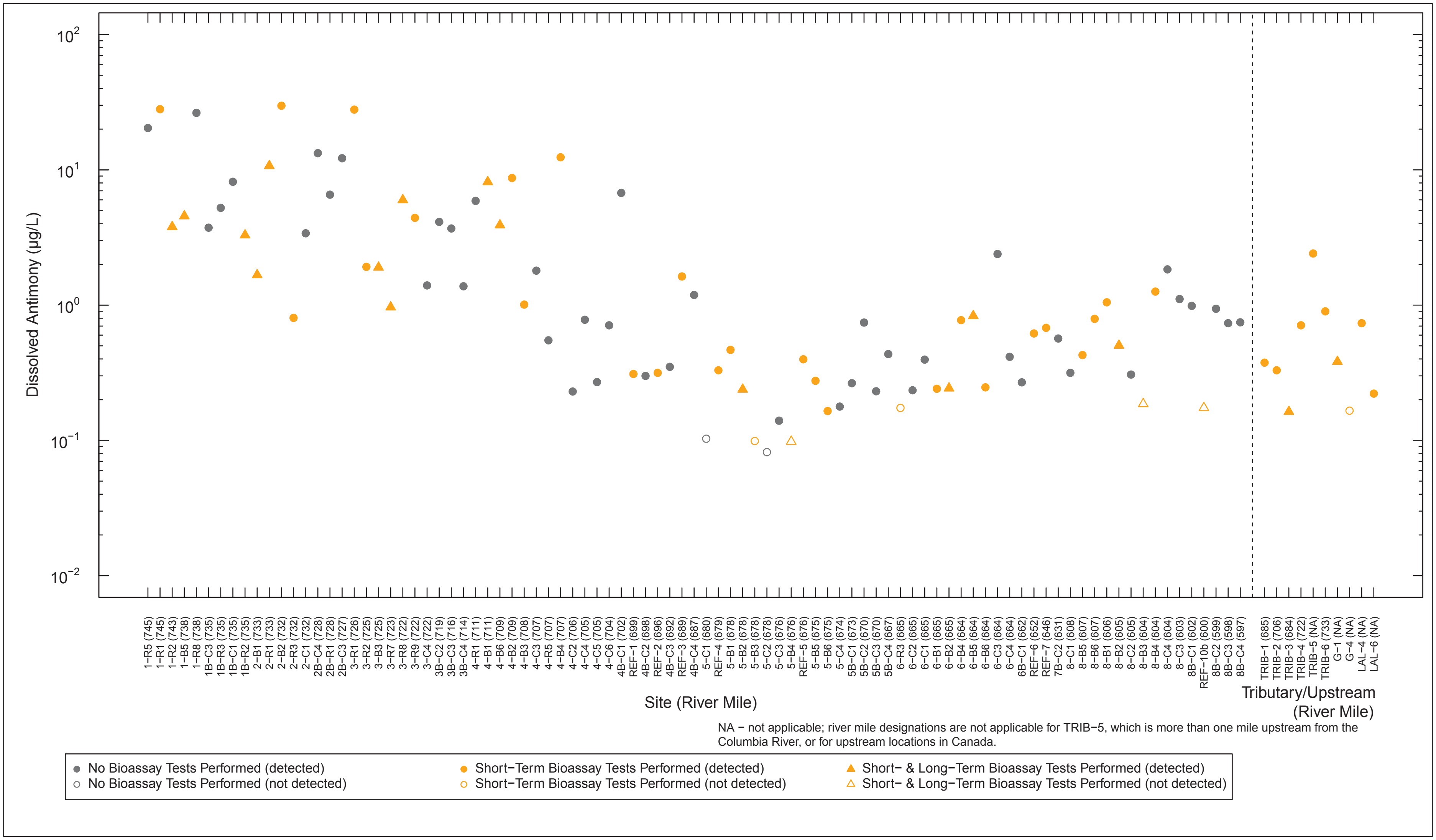


Figure 5−4h. Dissolved Antimony in Field Porewater

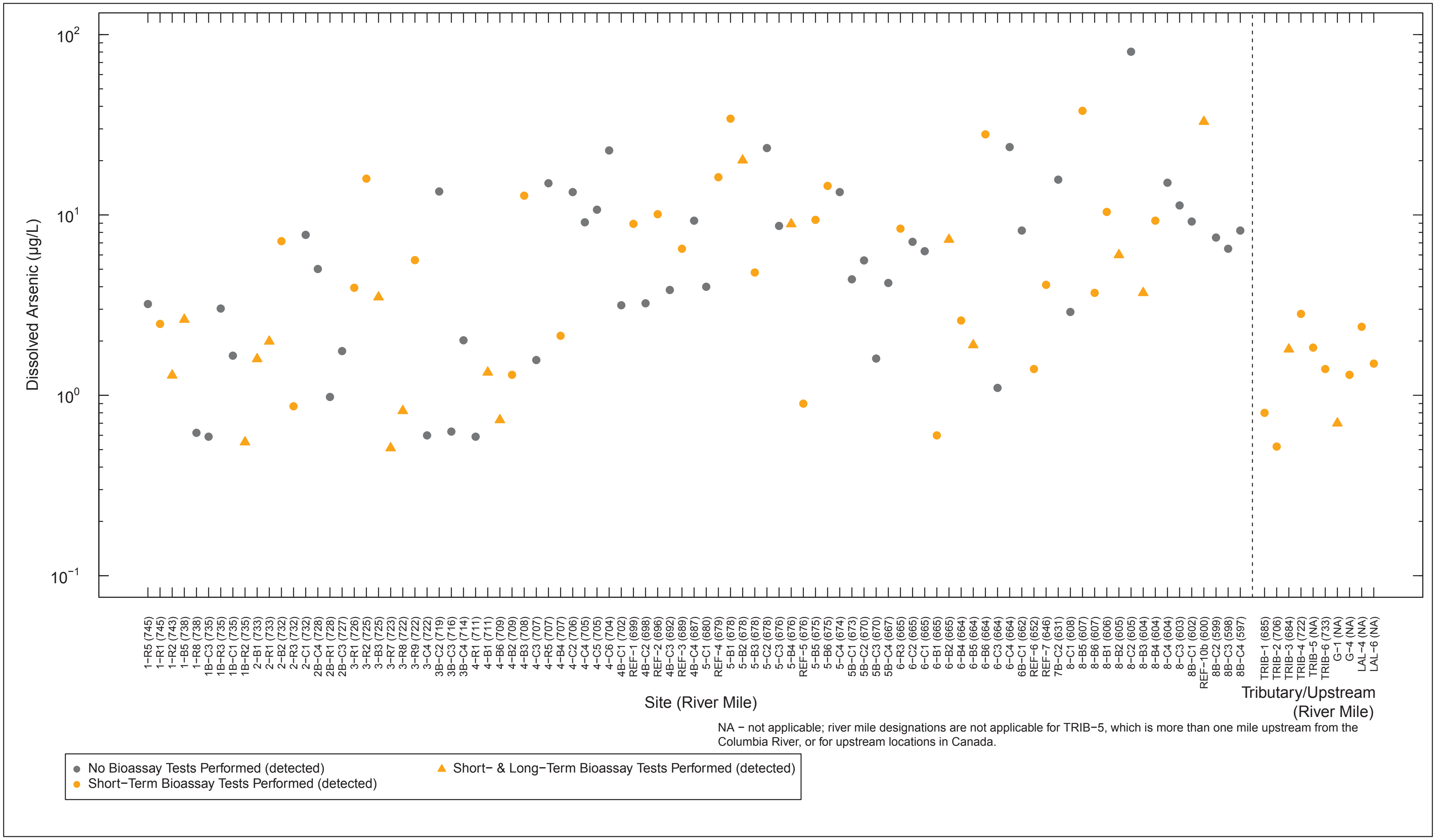


Figure 5−4i. Dissolved Arsenic in Field Porewater

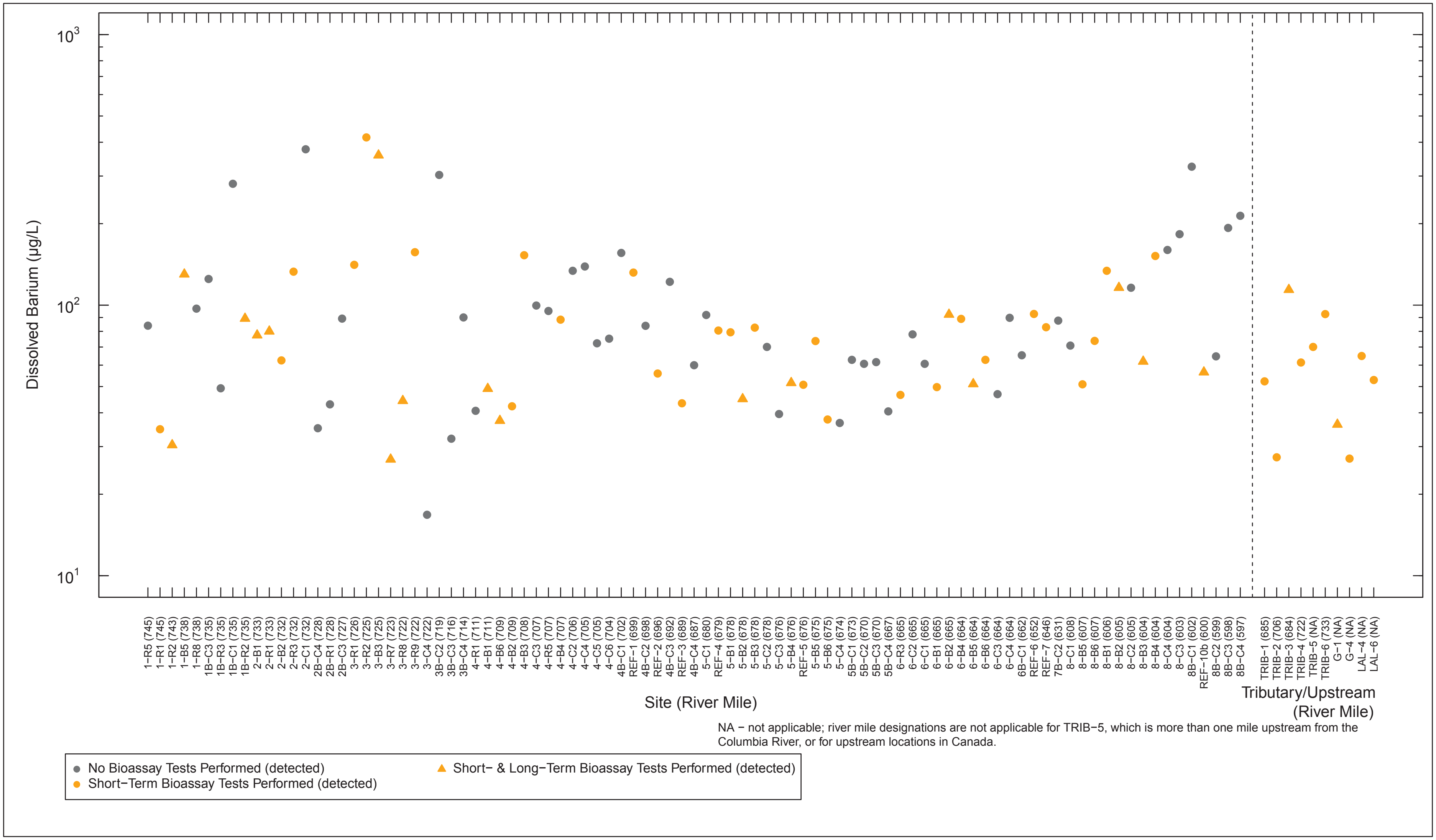


Figure 5−4j. Dissolved Barium in Field Porewater

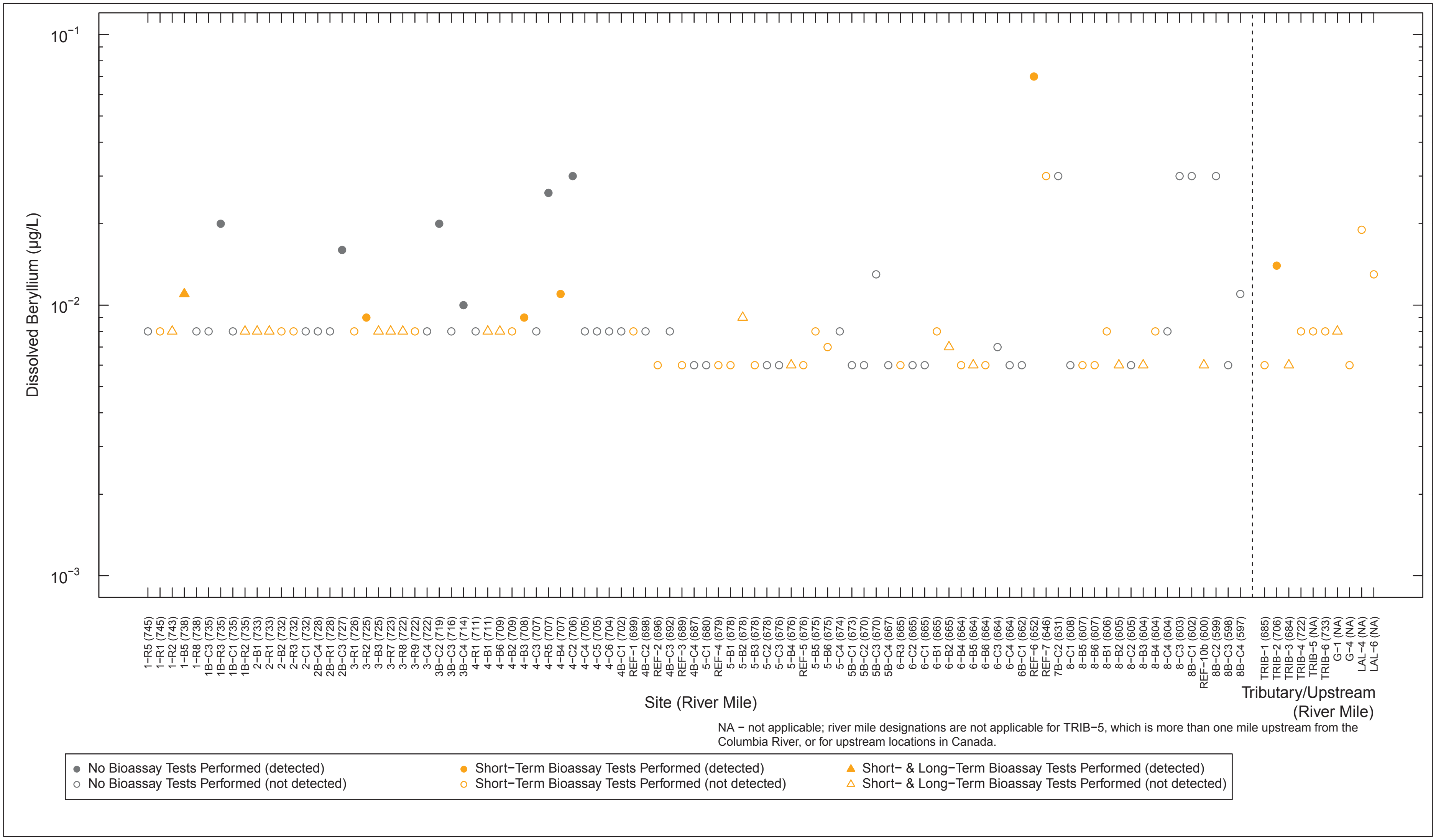


Figure 5−4k. Dissolved Beryllium in Field Porewater

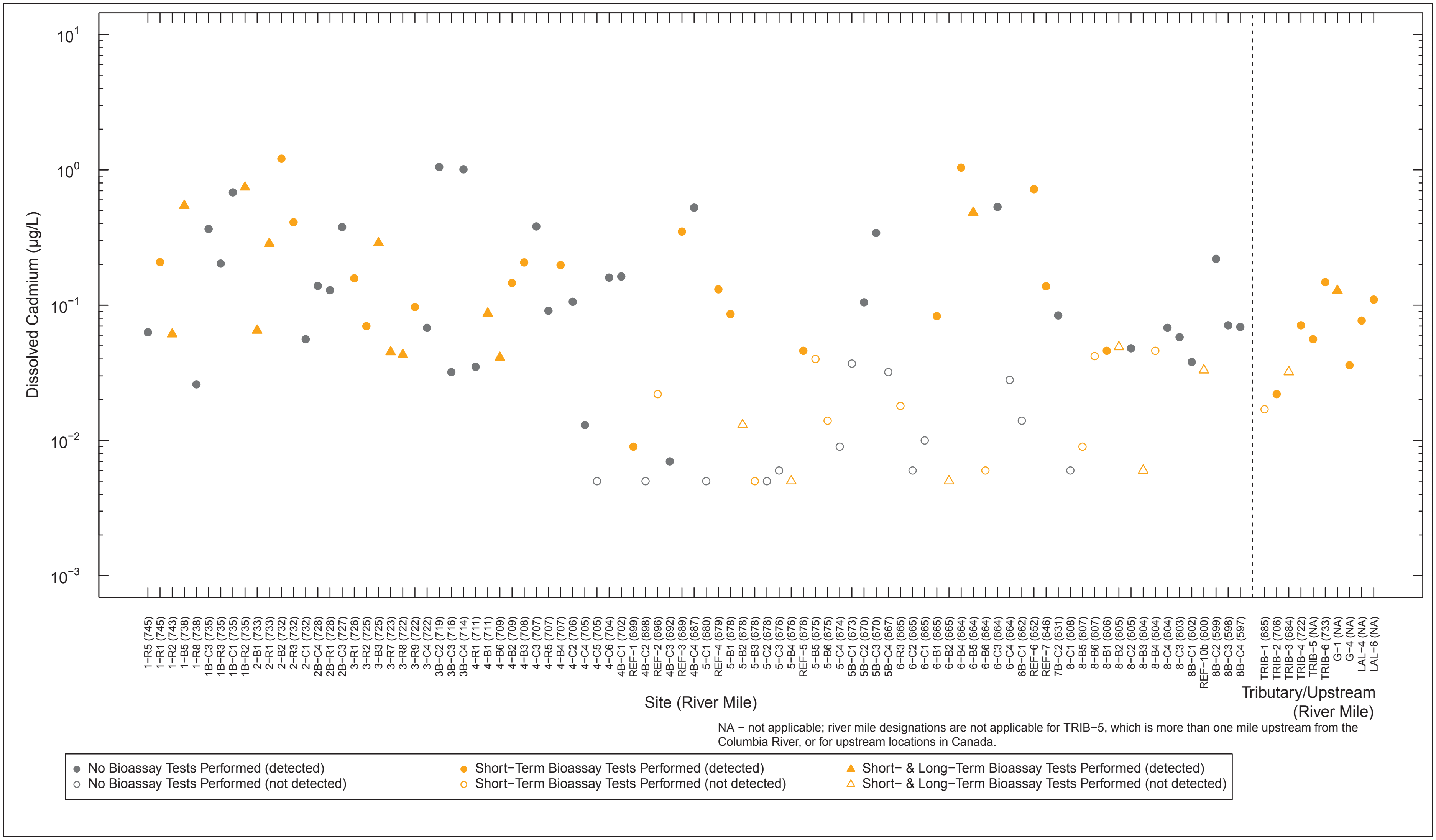


Figure 5−4l. Dissolved Cadmium in Field Porewater

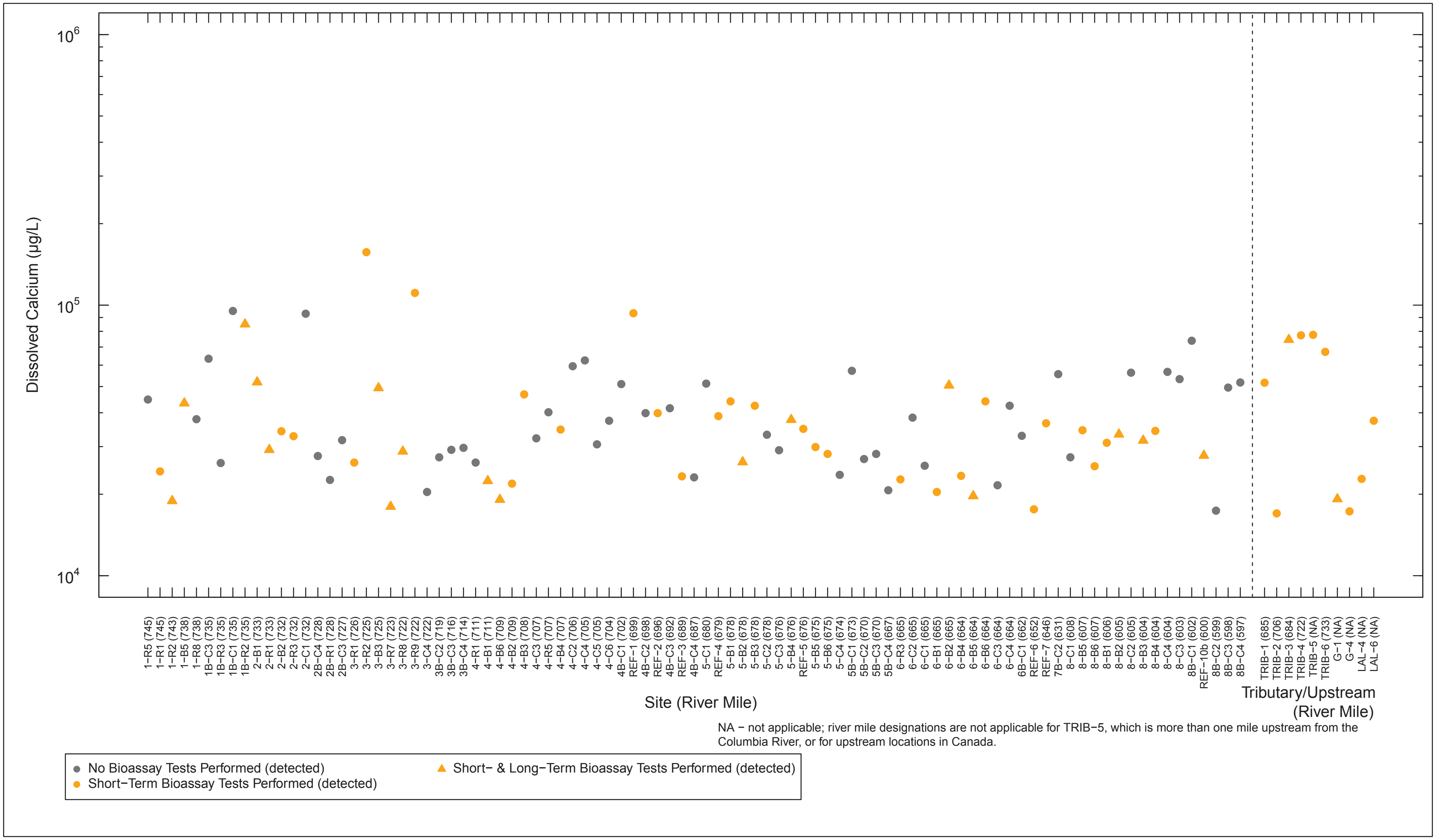


Figure 5−4m. Dissolved Calcium in Field Porewater

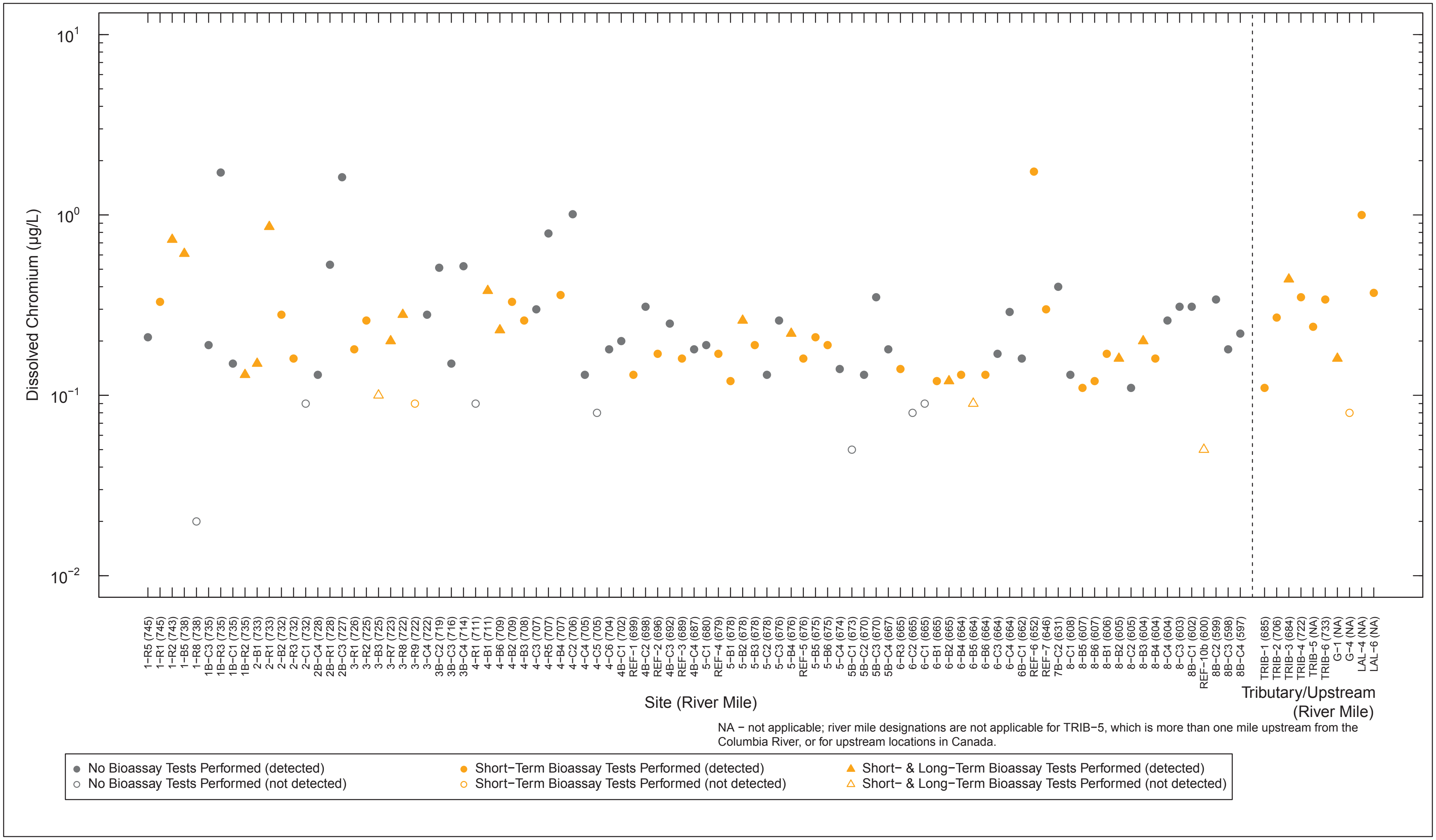


Figure 5−4n. Dissolved Chromium in Field Porewater

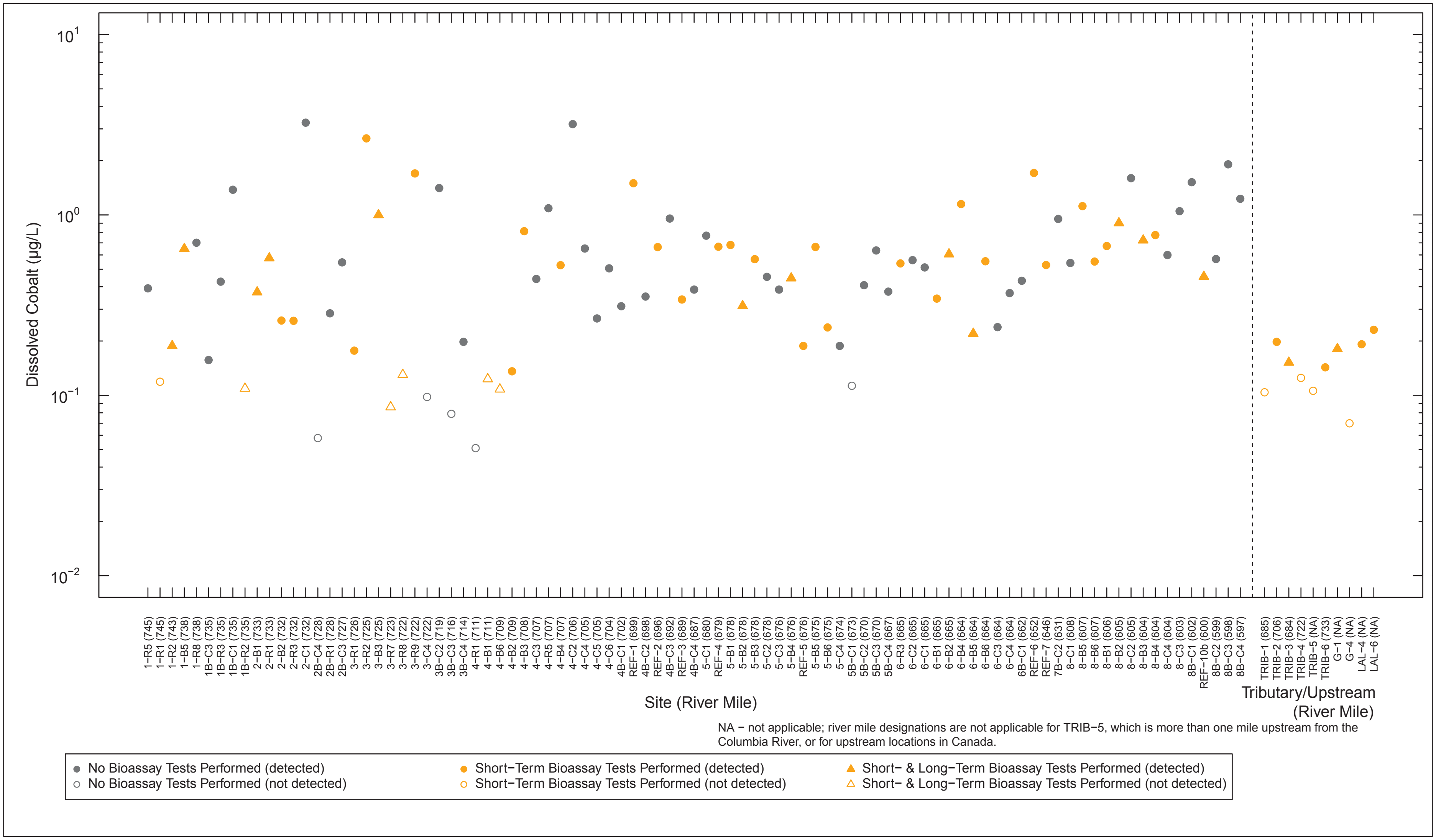


Figure 5−4o. Dissolved Cobalt in Field Porewater

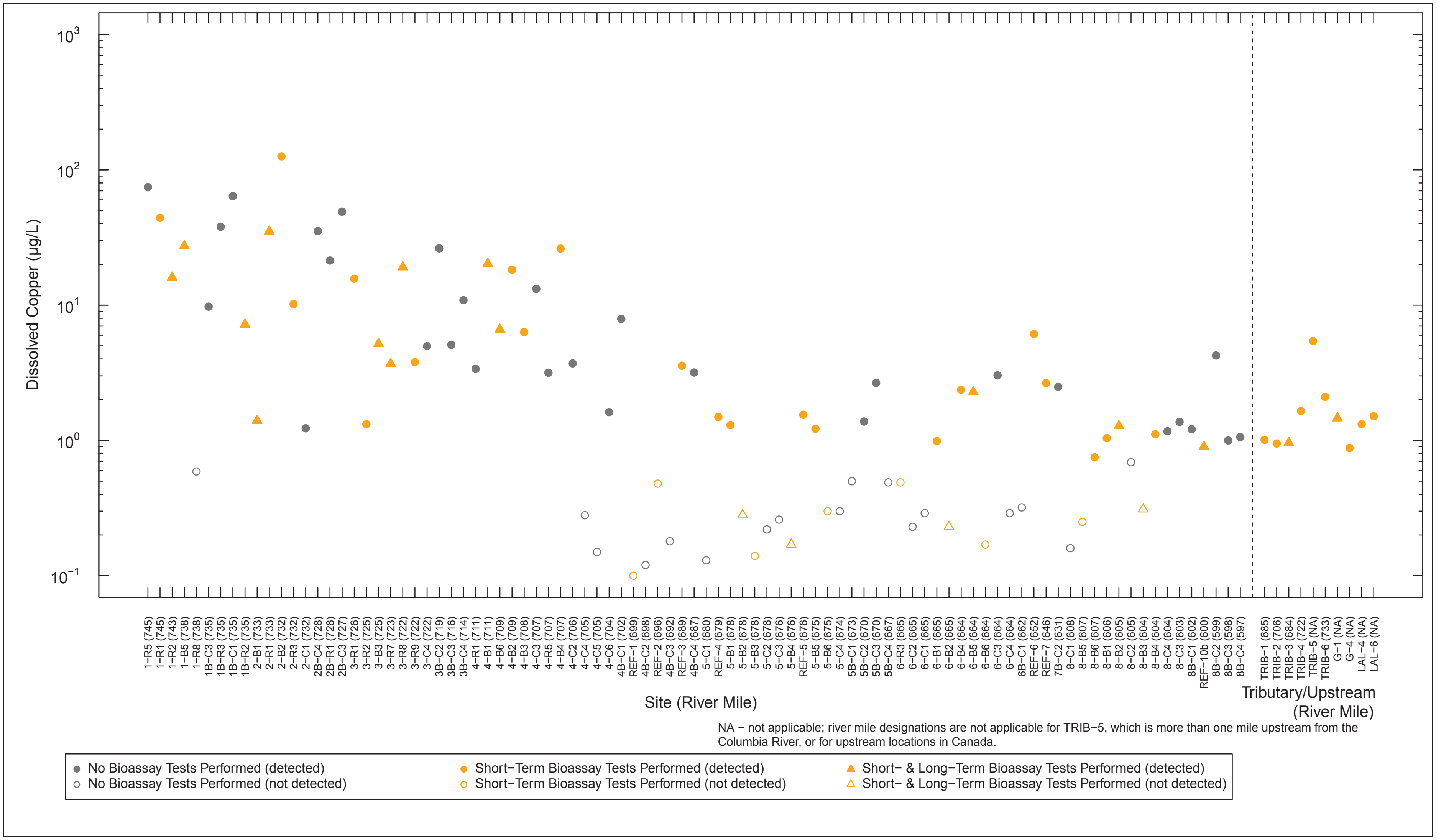


Figure 5−4p. Dissolved Copper in Field Porewater

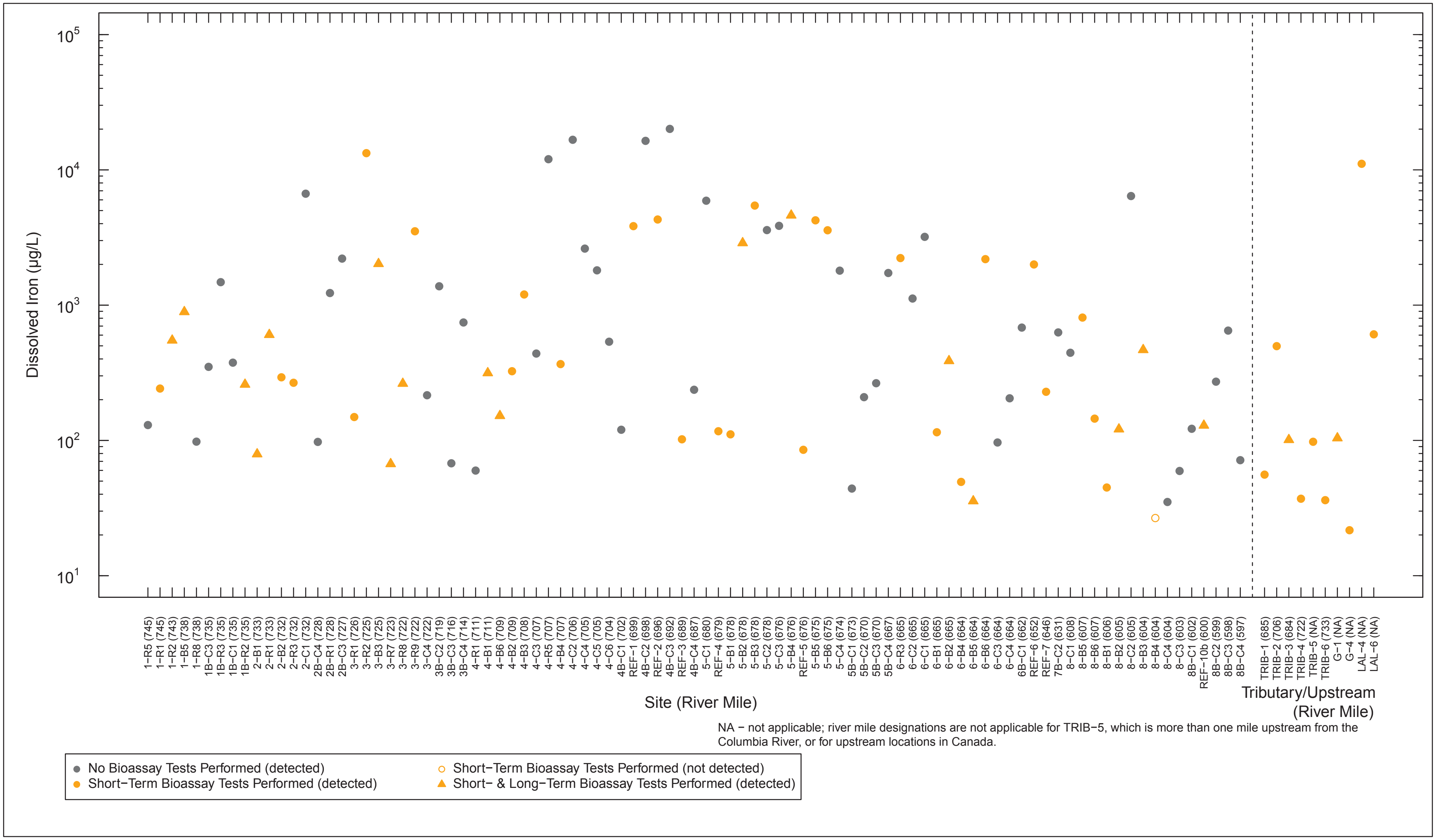


Figure 5−4q. Dissolved Iron in Field Porewater

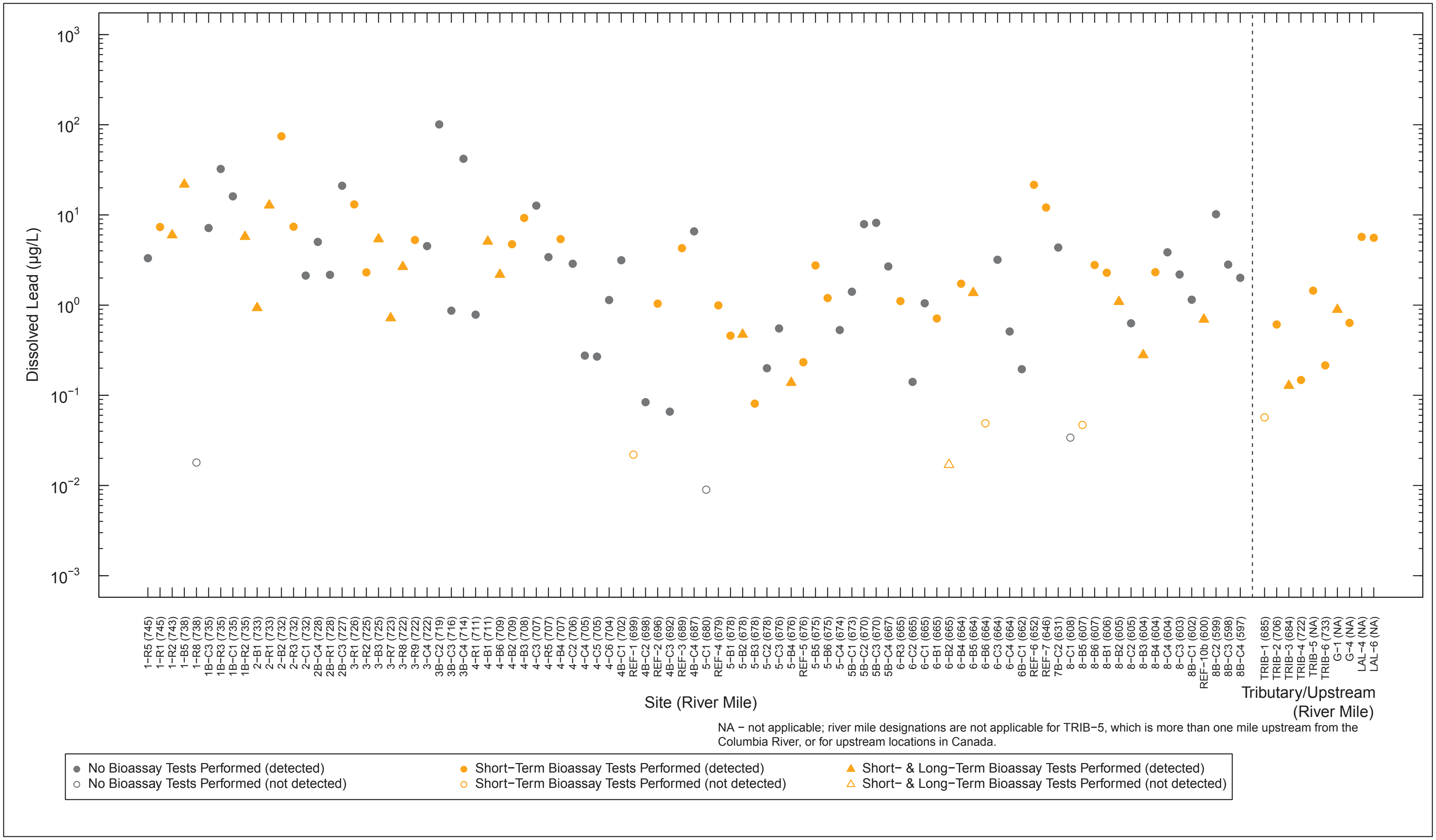


Figure 5−4r. Dissolved Lead in Field Porewater

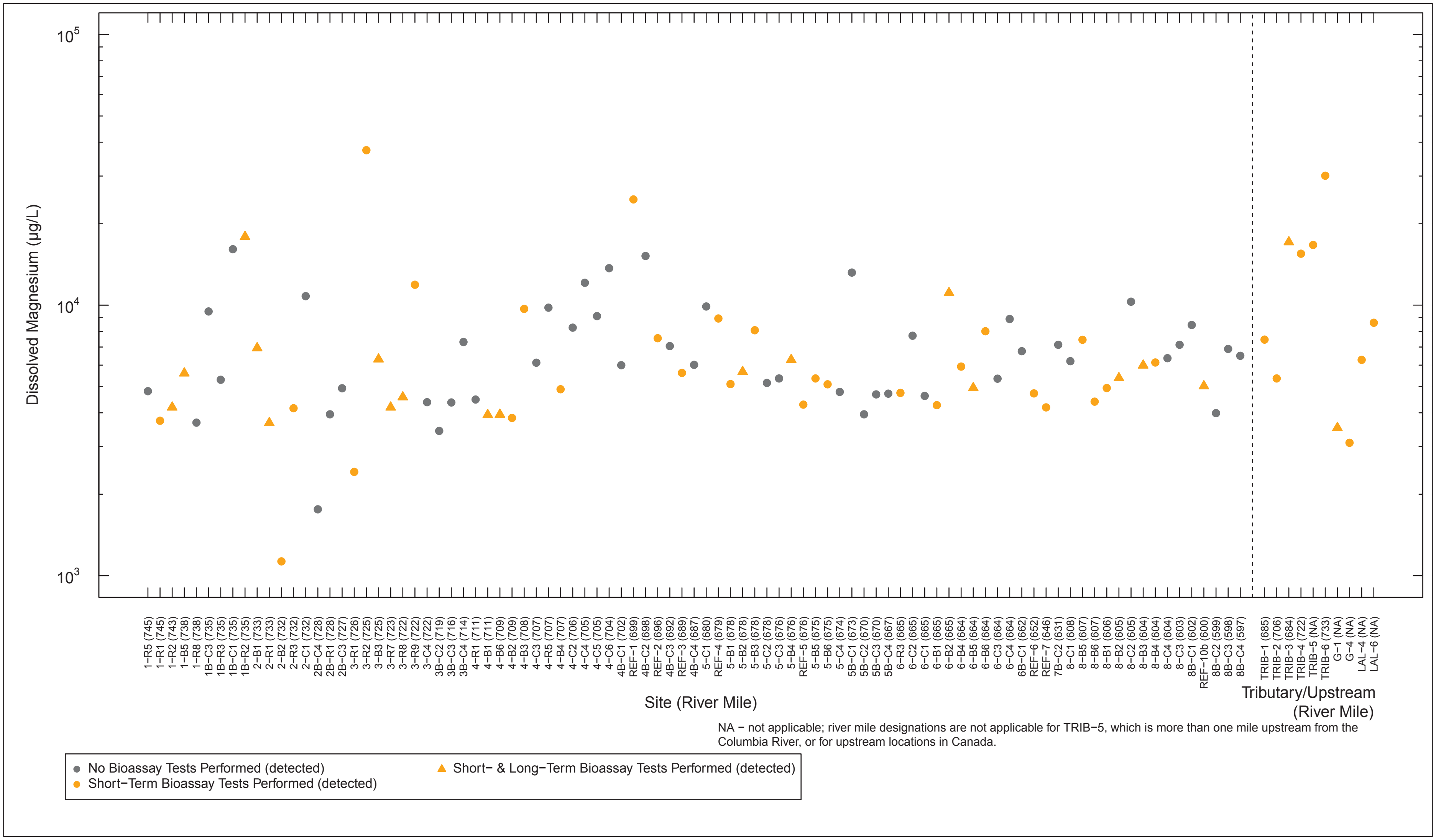


Figure 5−4s. Dissolved Magnesium in Field Porewater

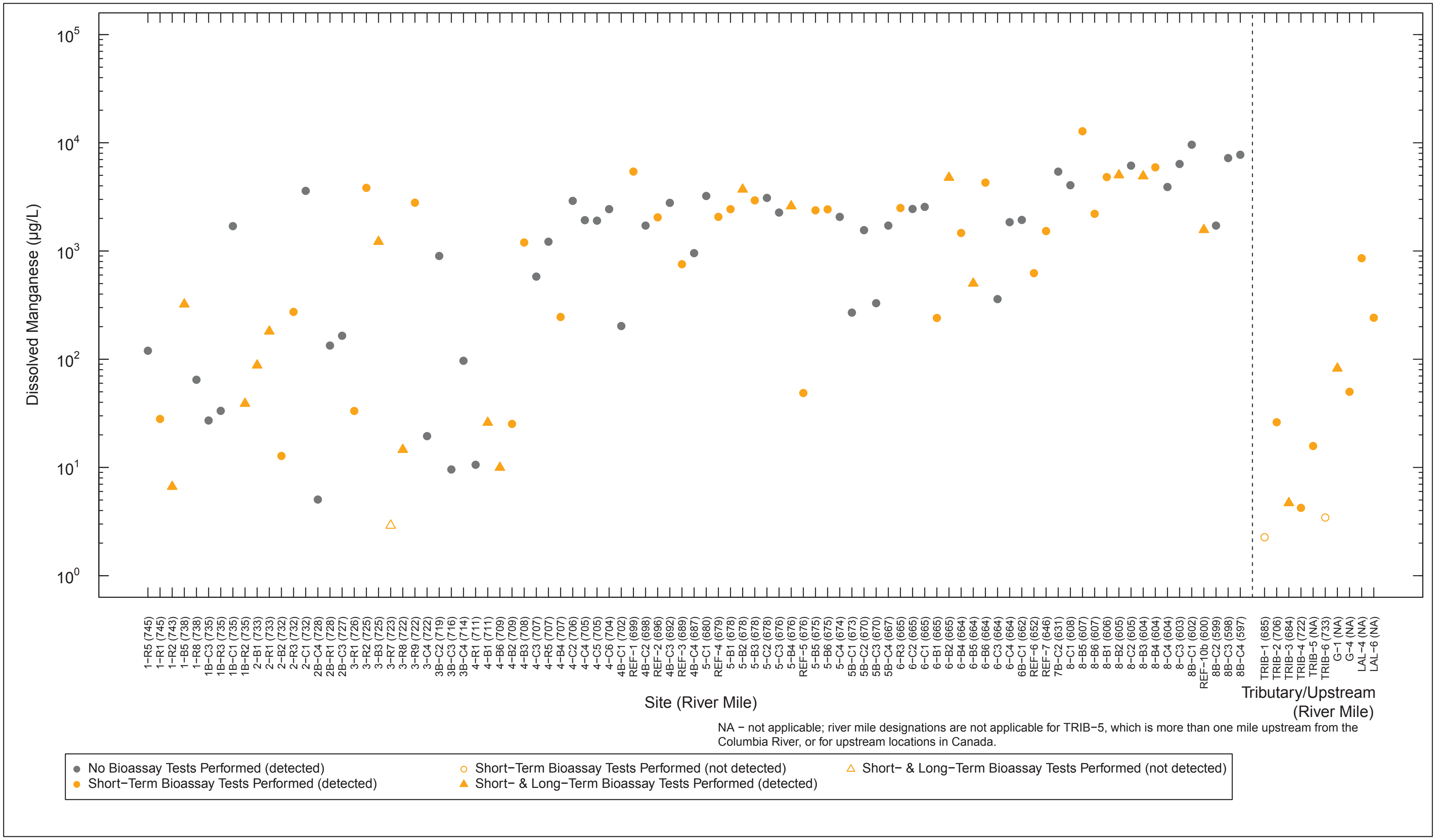


Figure 5−4t. Dissolved Manganese in Field Porewater

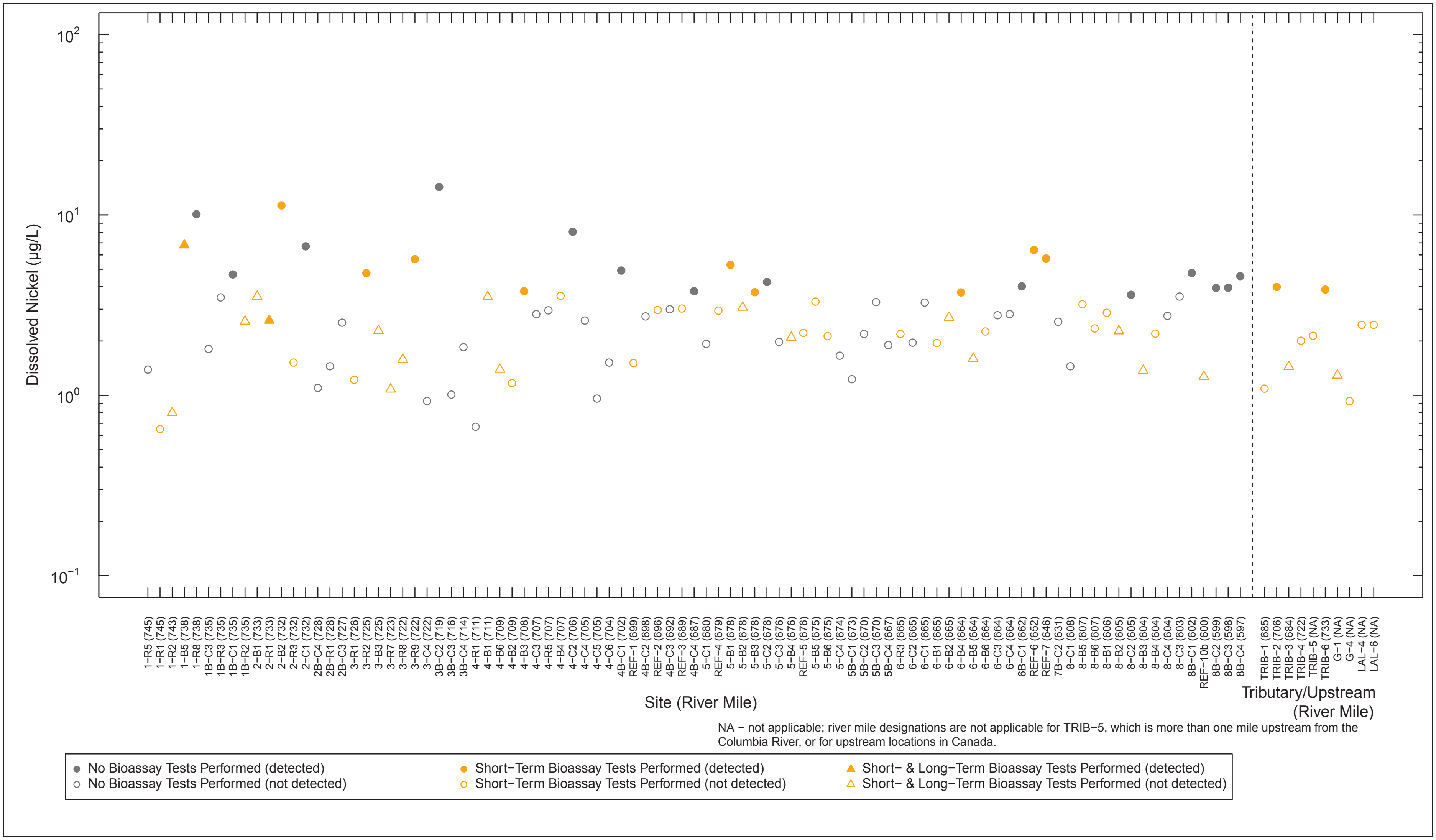


Figure 5−4u. Dissolved Nickel in Field Porewater

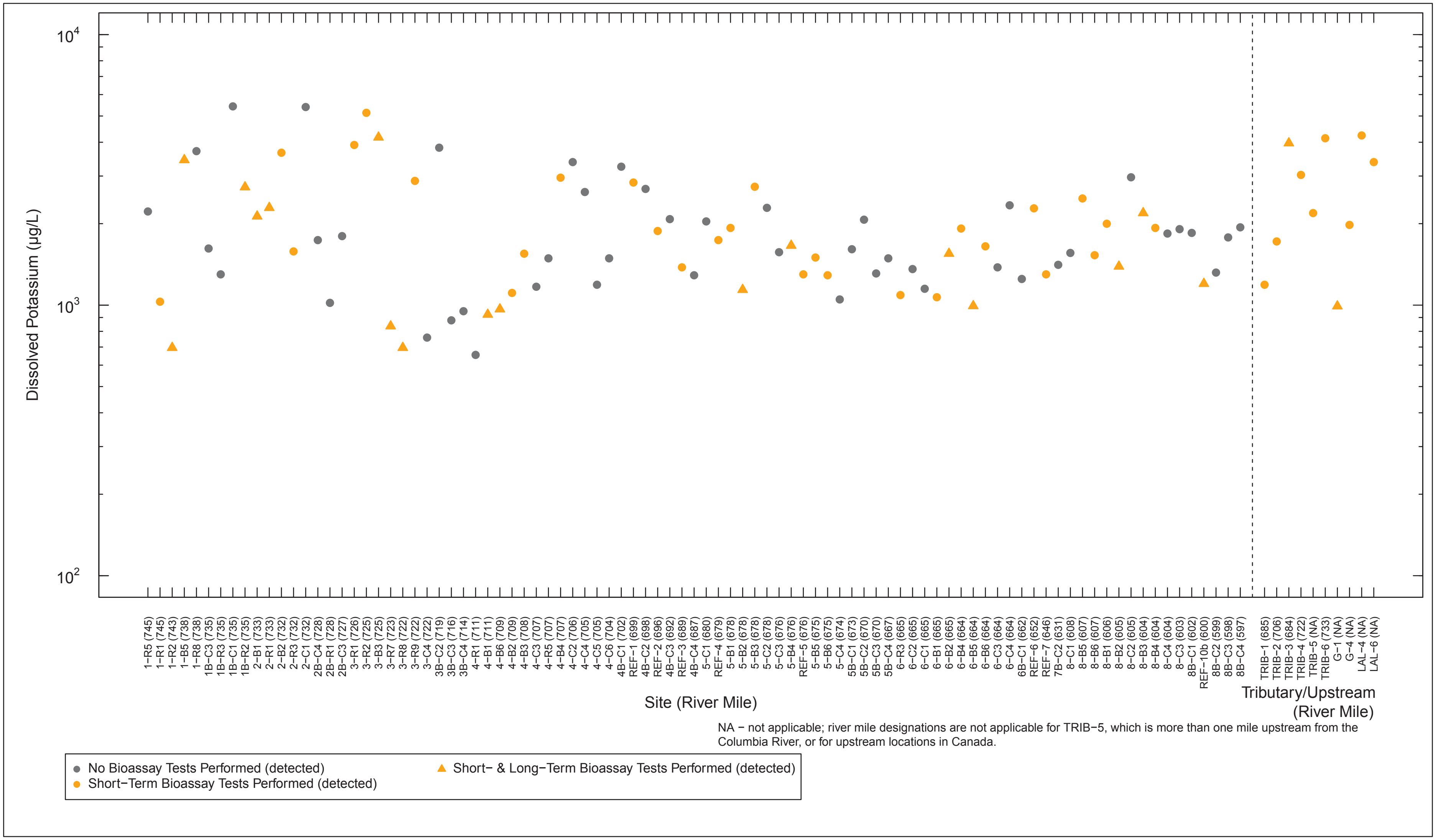


Figure 5−4v. Dissolved Potassium in Field Porewater

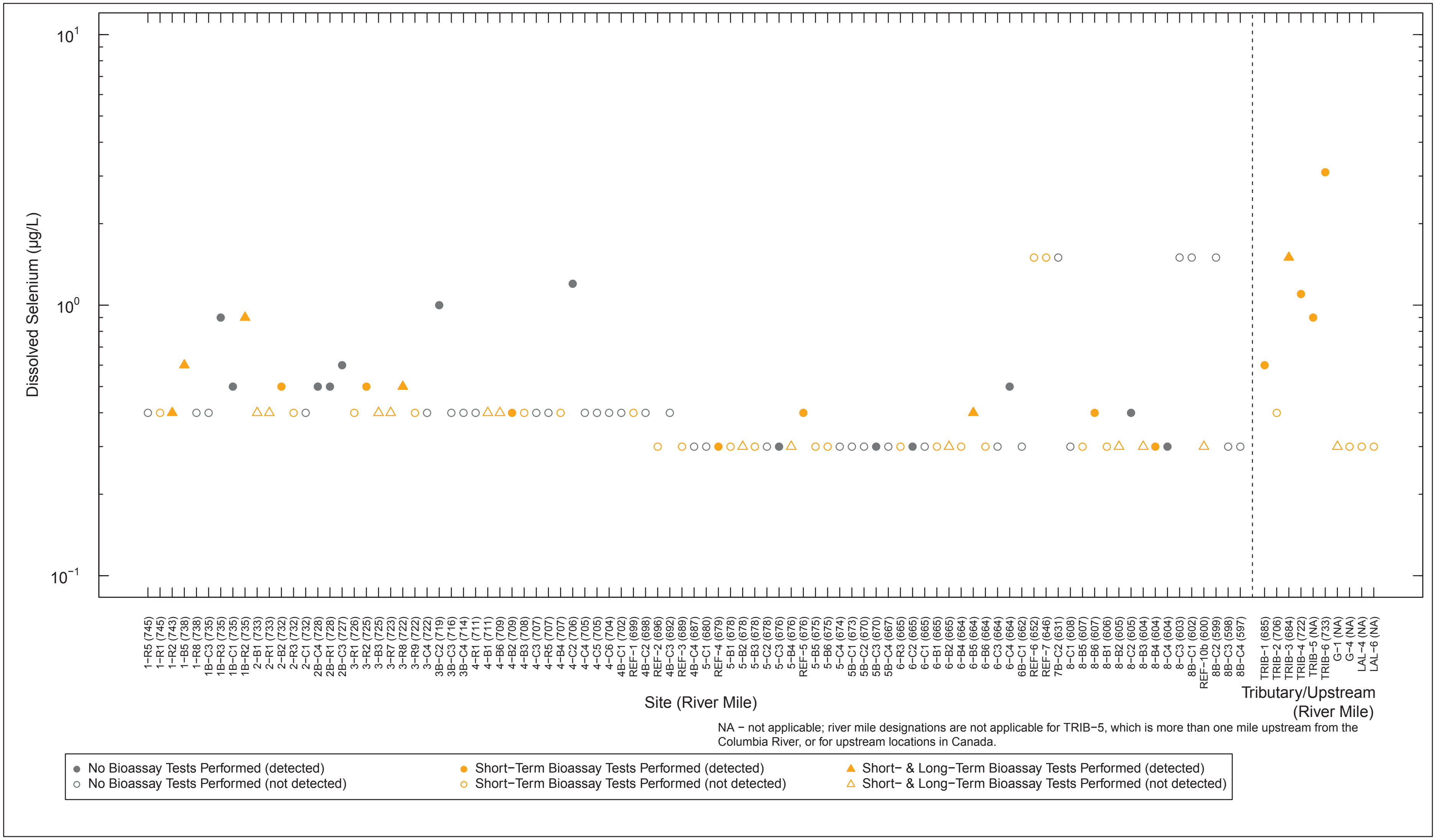


Figure 5−4w. Dissolved Selenium in Field Porewater

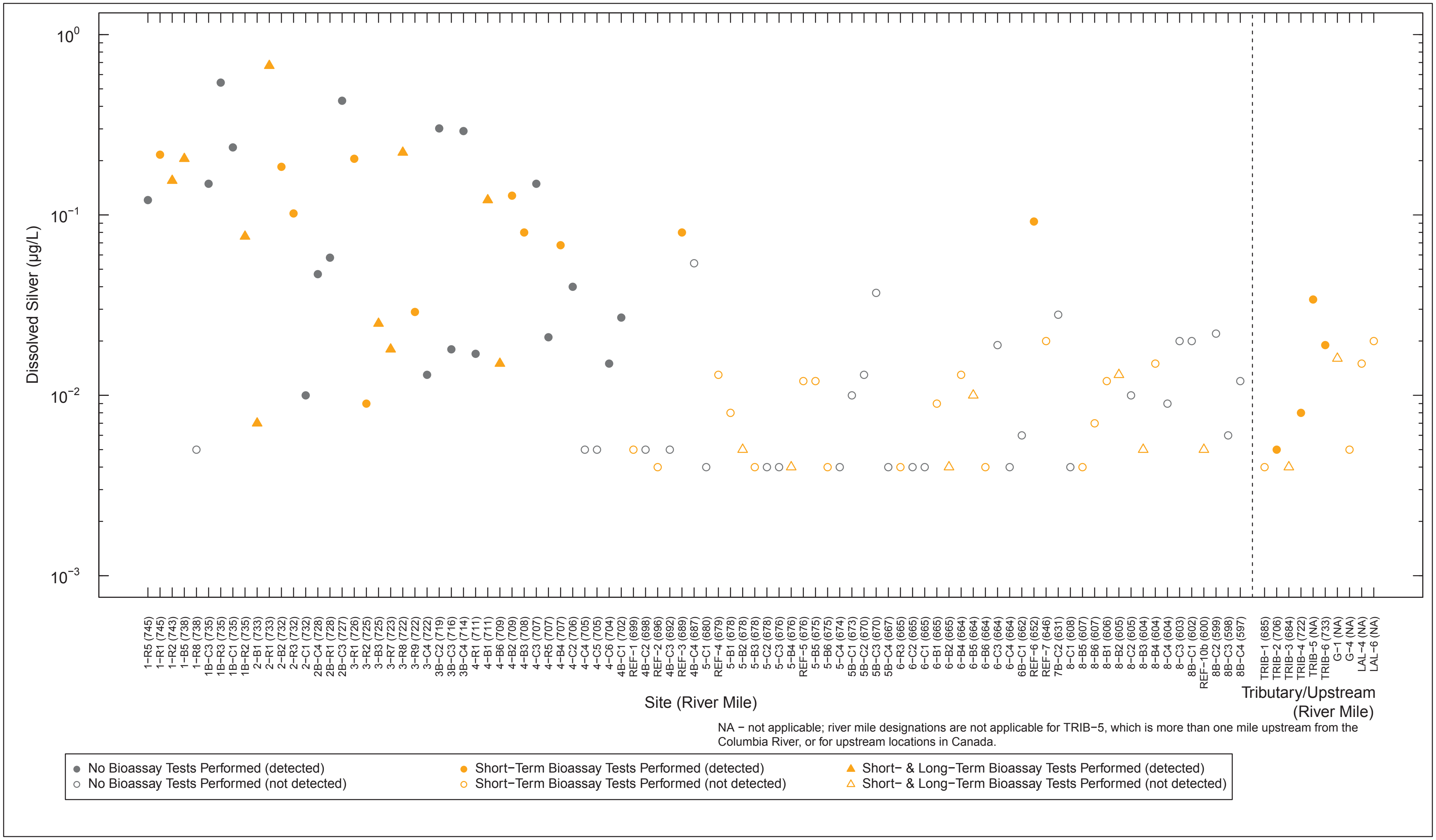


Figure 5−4x. Dissolved Silver in Field Porewater

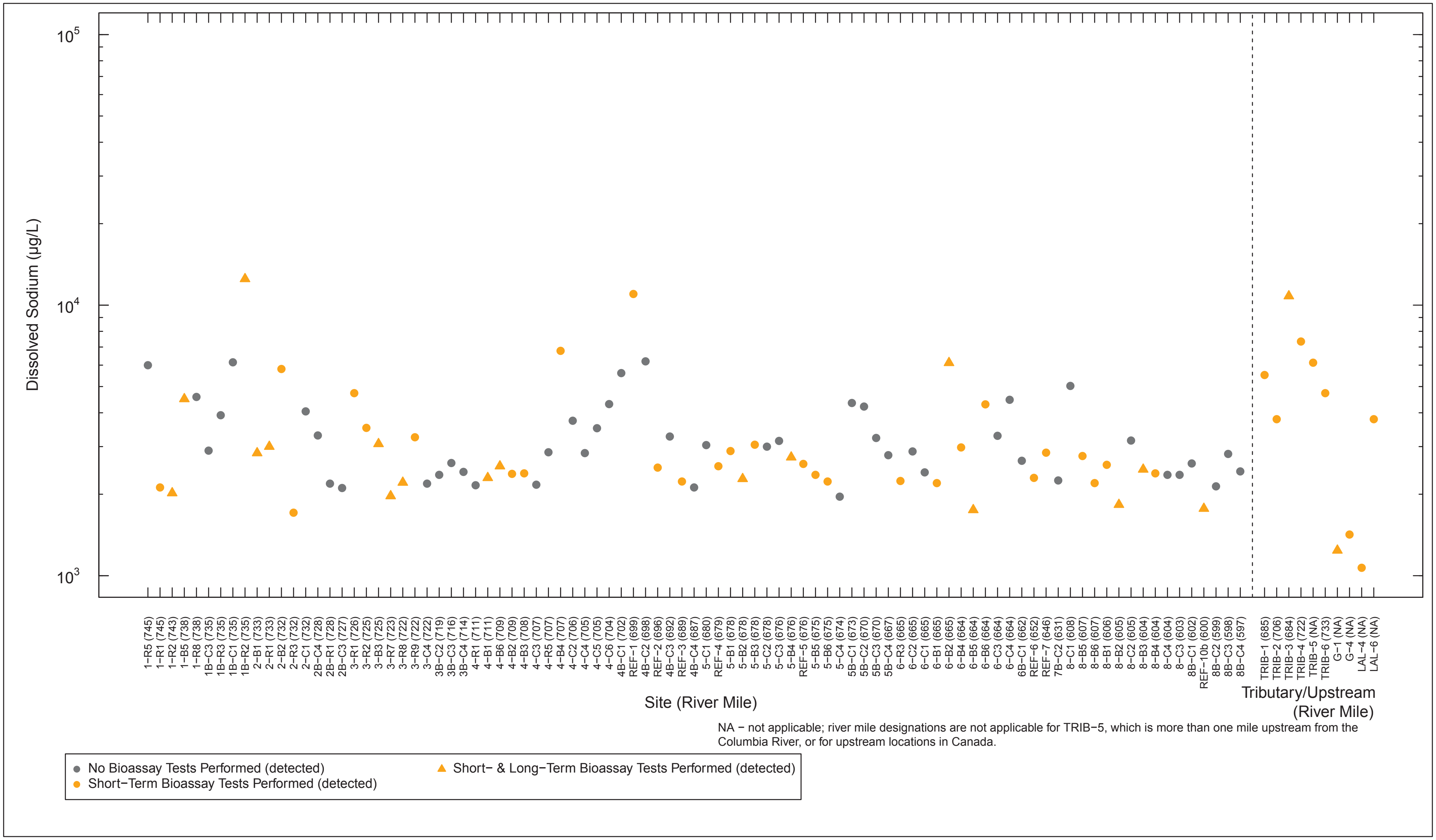


Figure 5−4y. Dissolved Sodium in Field Porewater

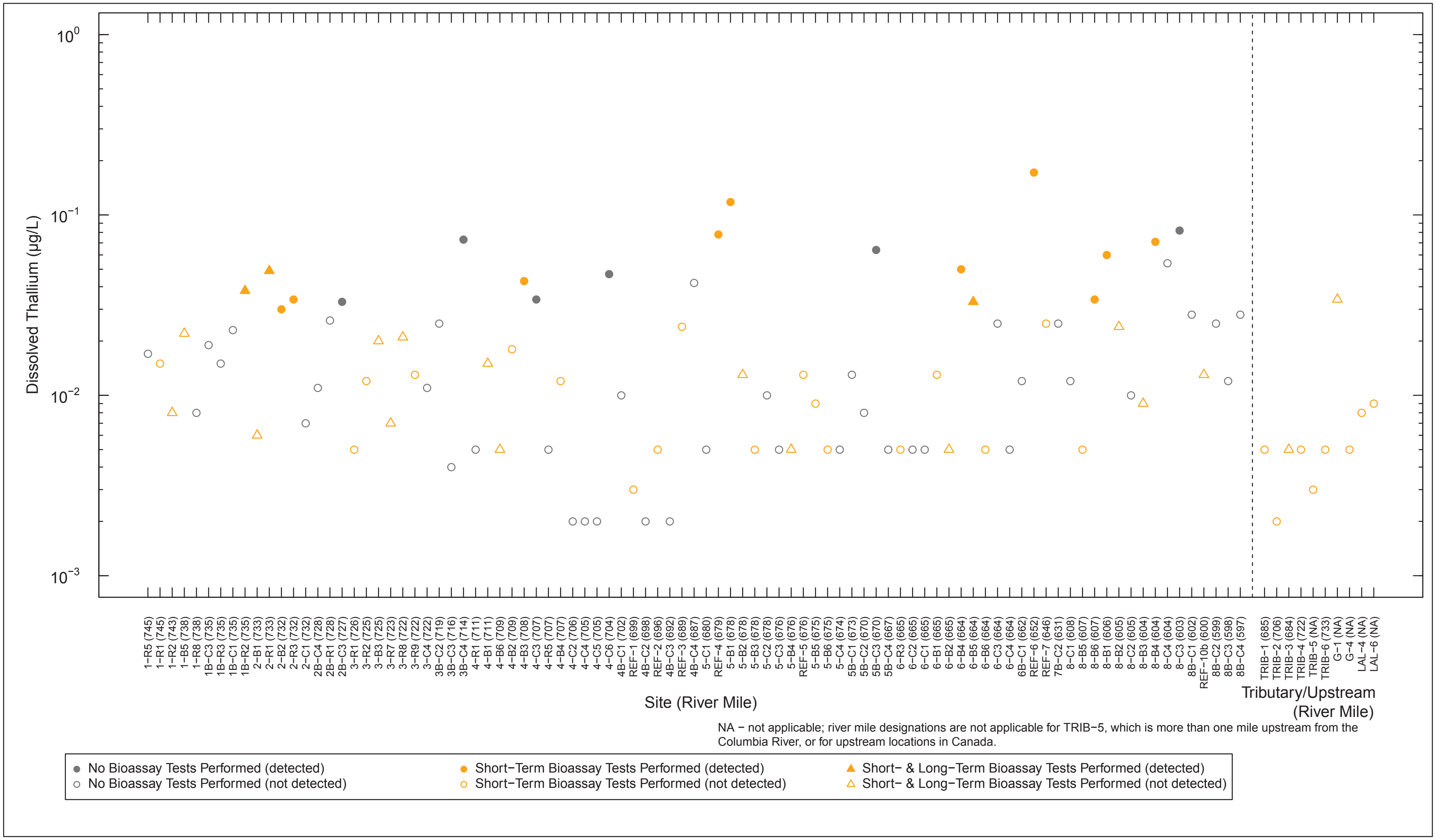


Figure 5−4z. Dissolved Thallium in Field Porewater

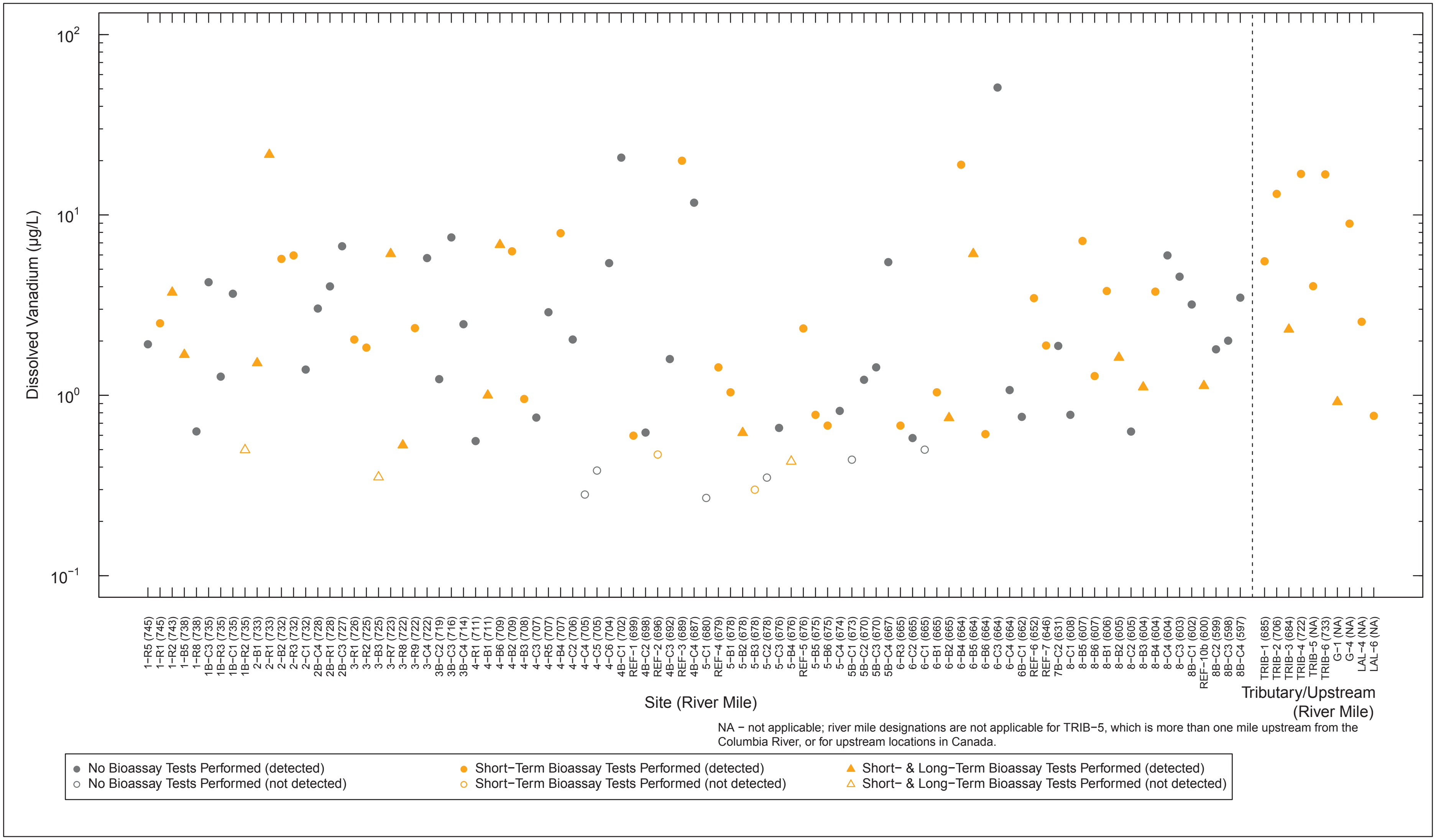


Figure 5−4aa. Dissolved Vanadium in Field Porewater

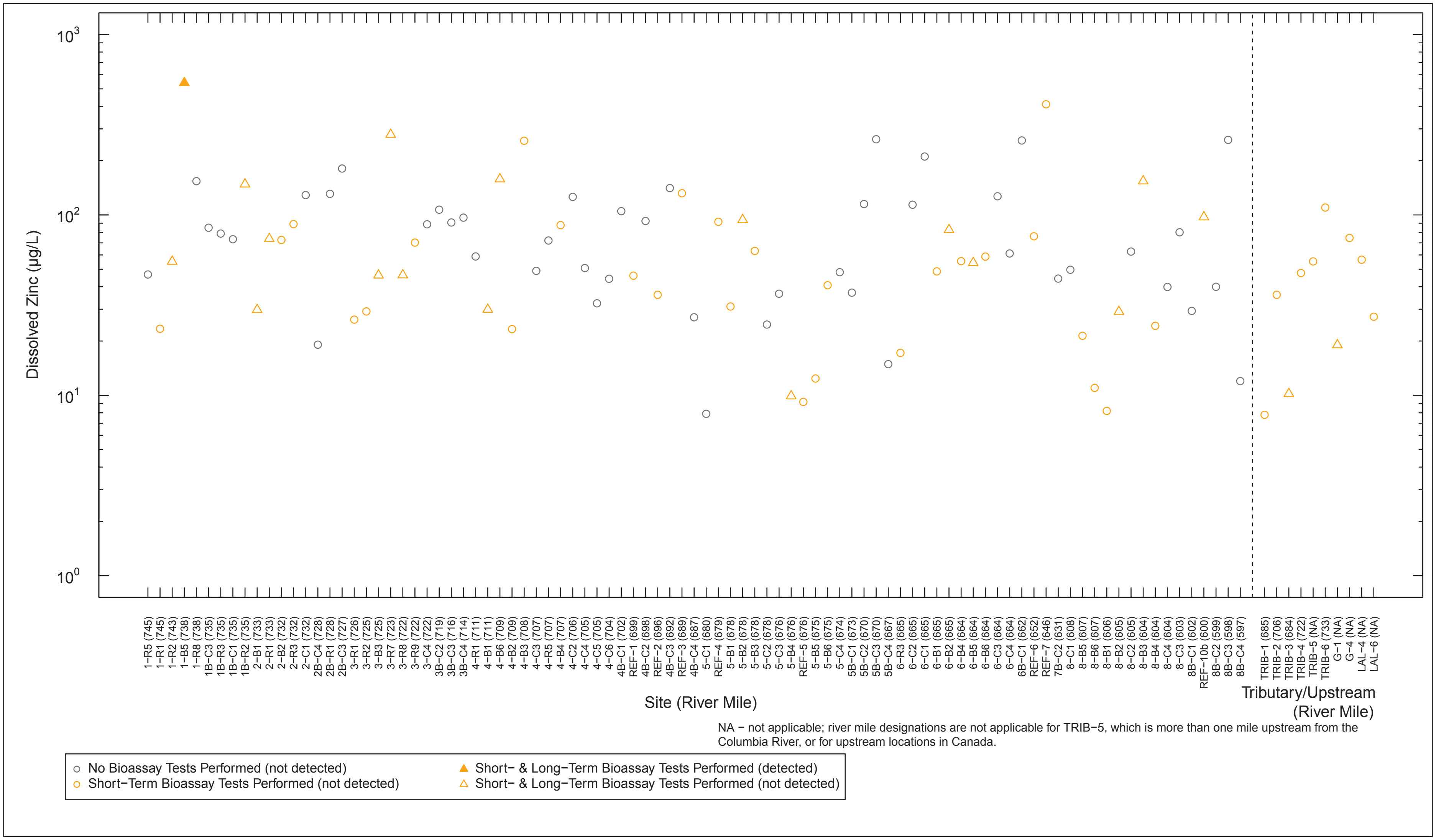
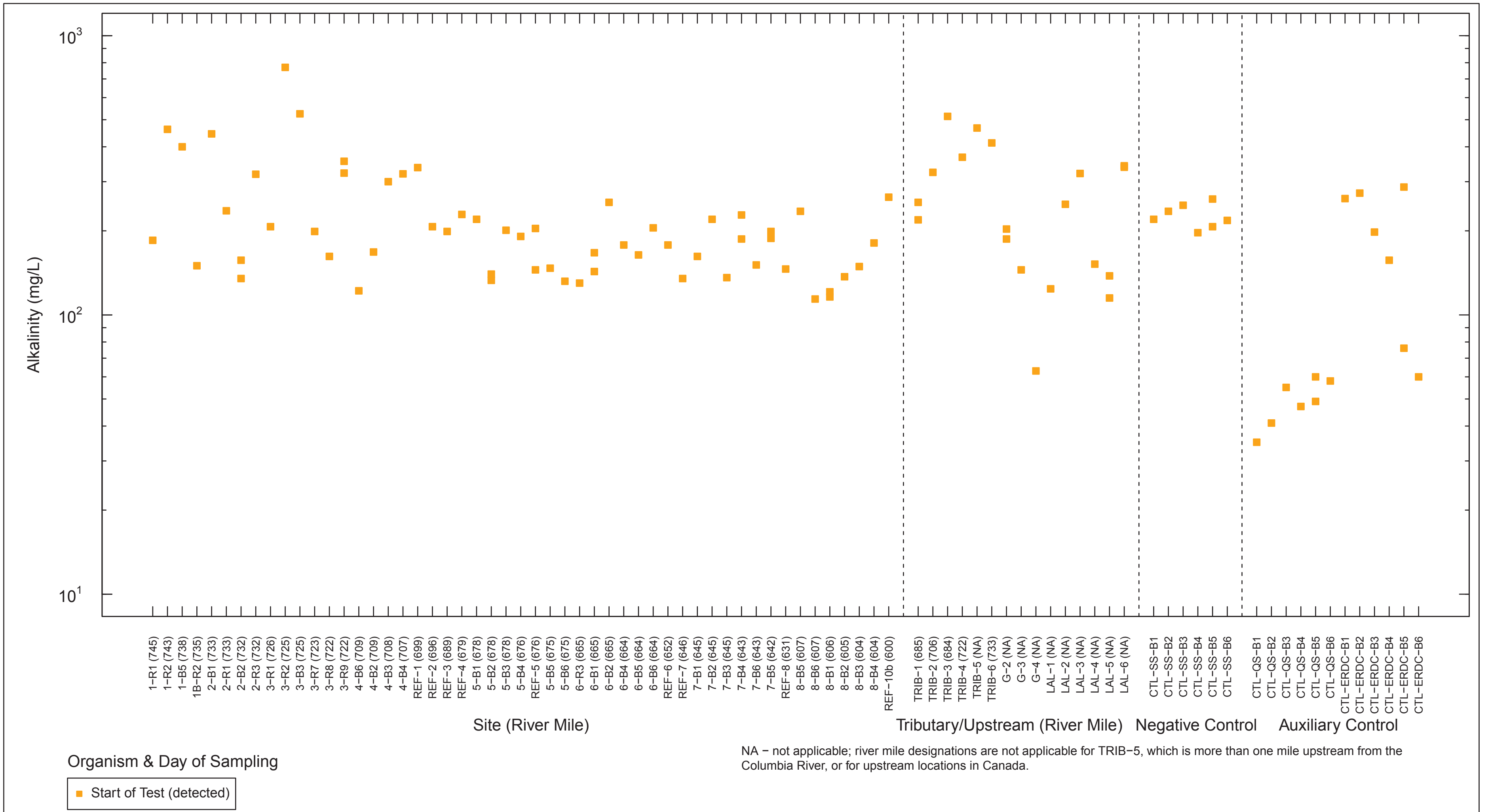


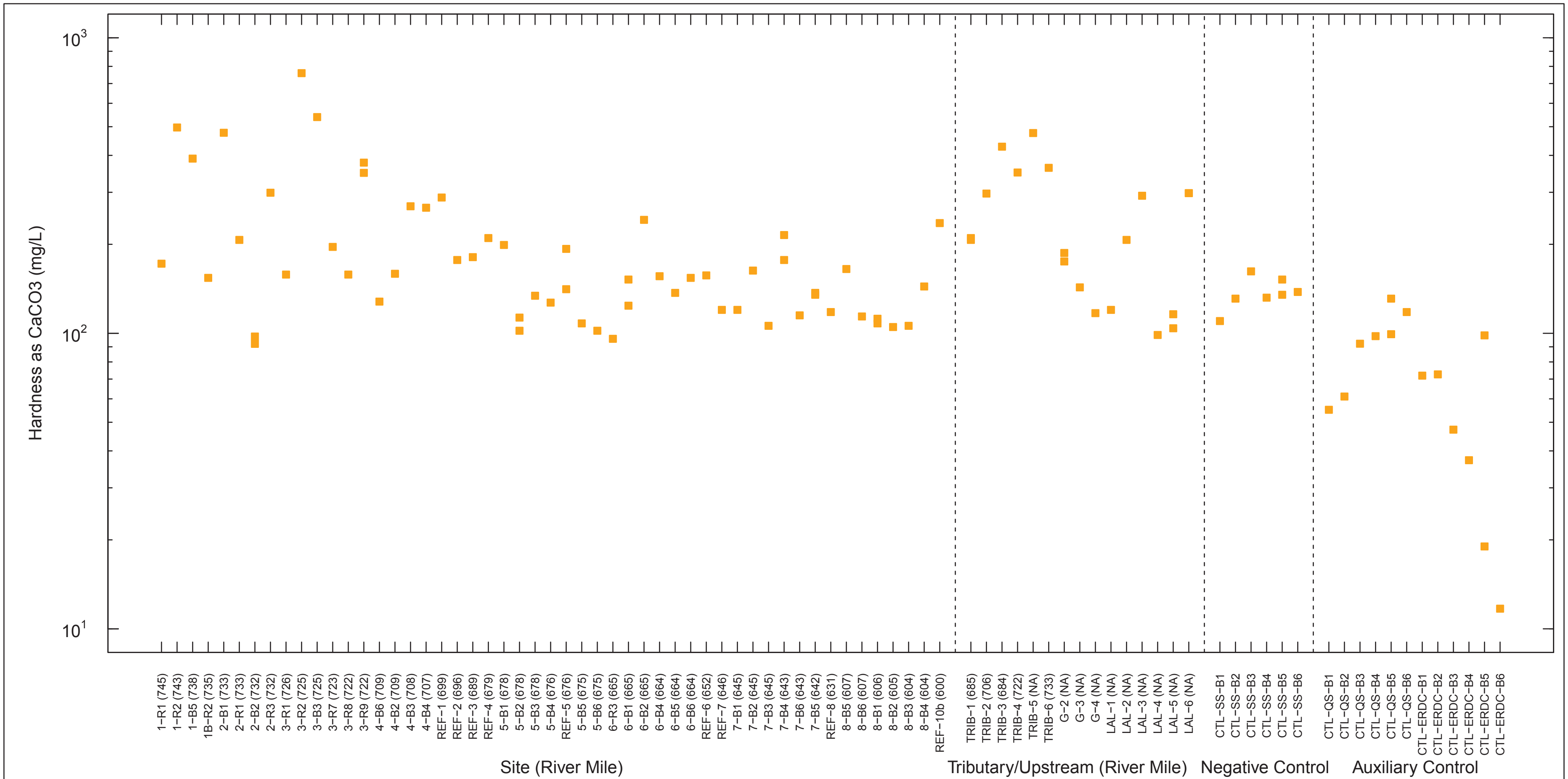
Figure 5−4ab. Dissolved Zinc in Field Porewater



One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5a. Alkalinity in Porewater from Short−Term Bioassays

Figure 5−5b. Dissolved Organic Carbon in Porewater from Short−Term Bioassays



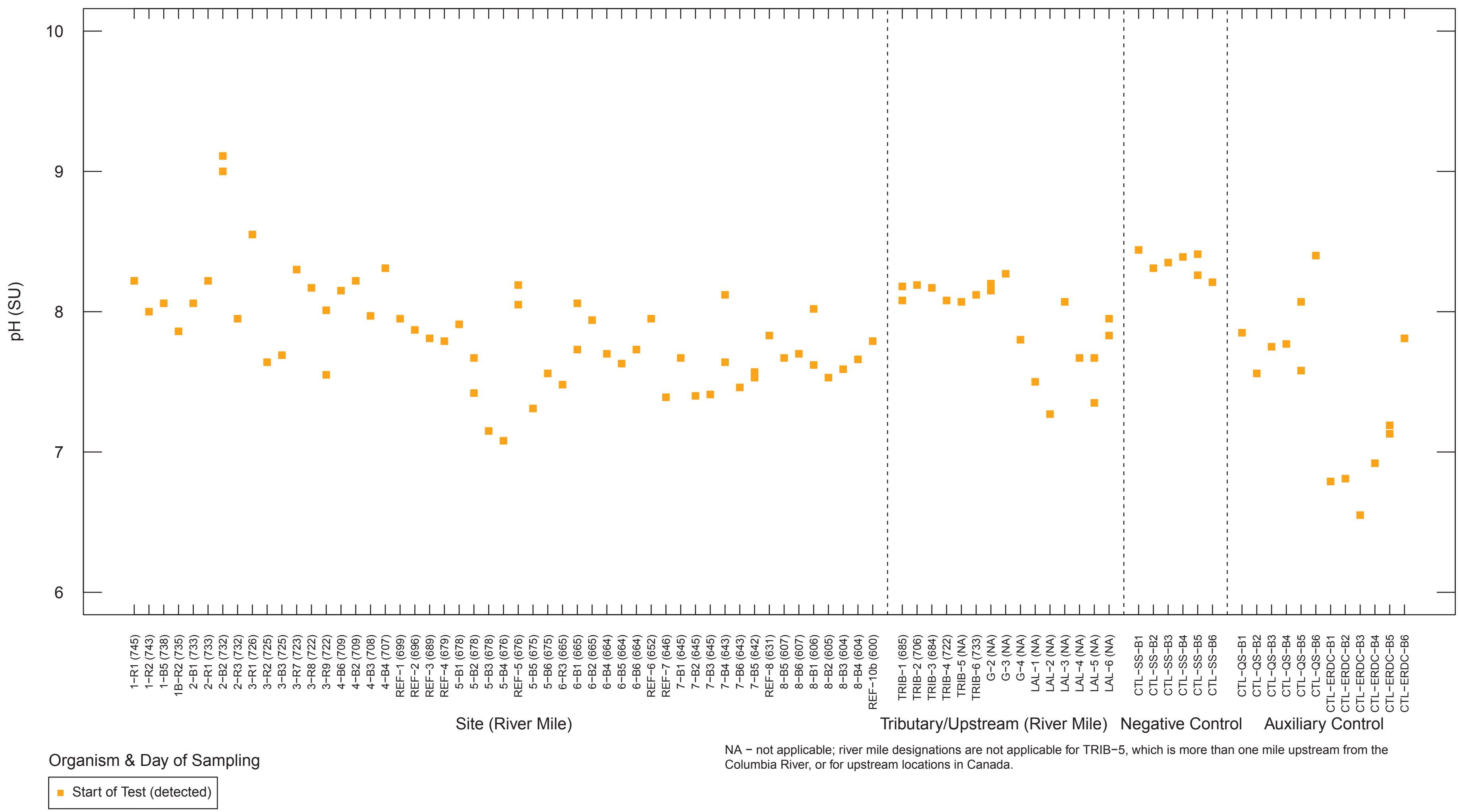
NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Organism & Day of Sampling

■ Start of Test (detected)

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

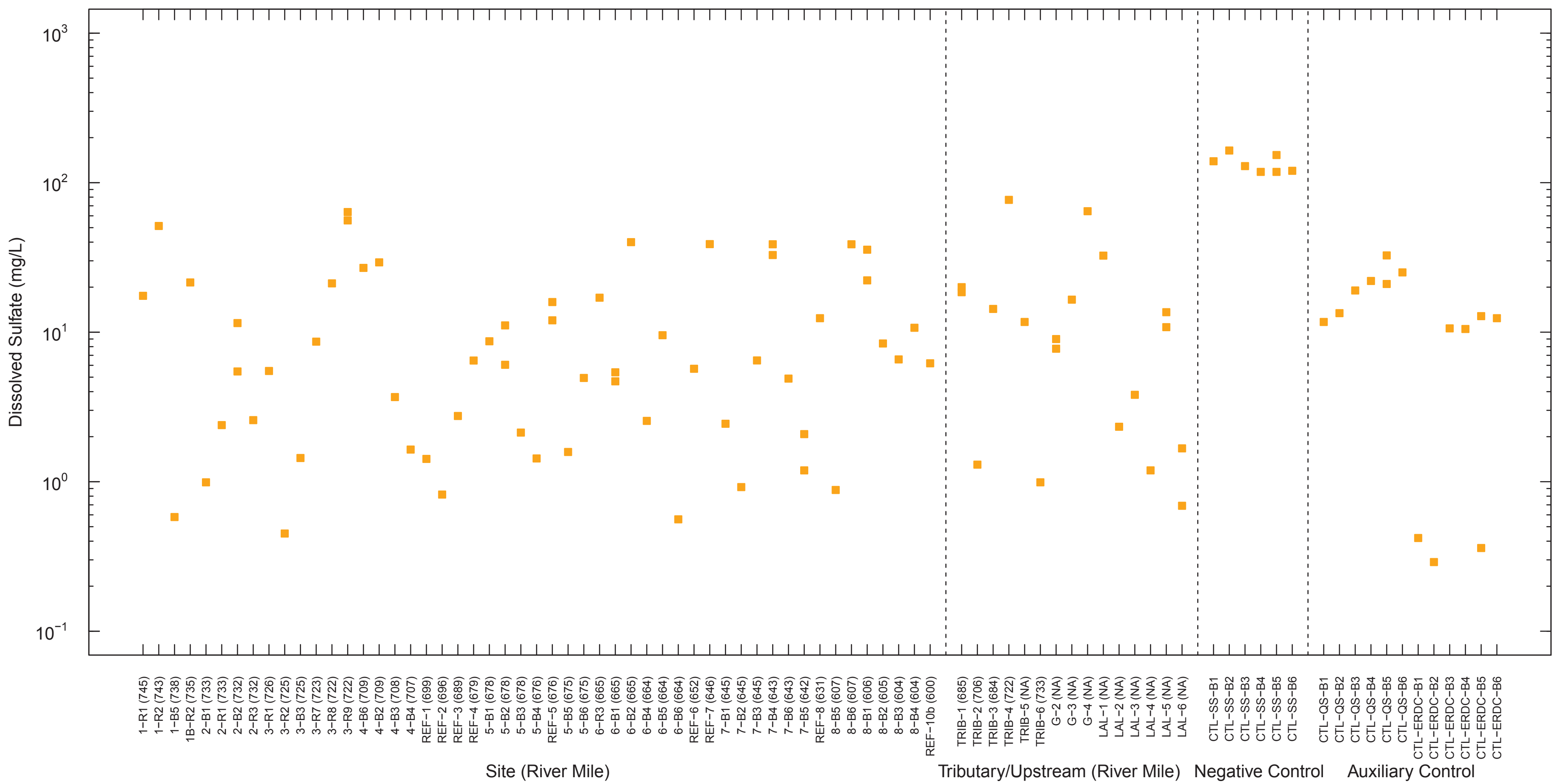
Figure 5−5c. Hardness as CaCO3 in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5d. pH in Porewater from Short−Term Bioassays



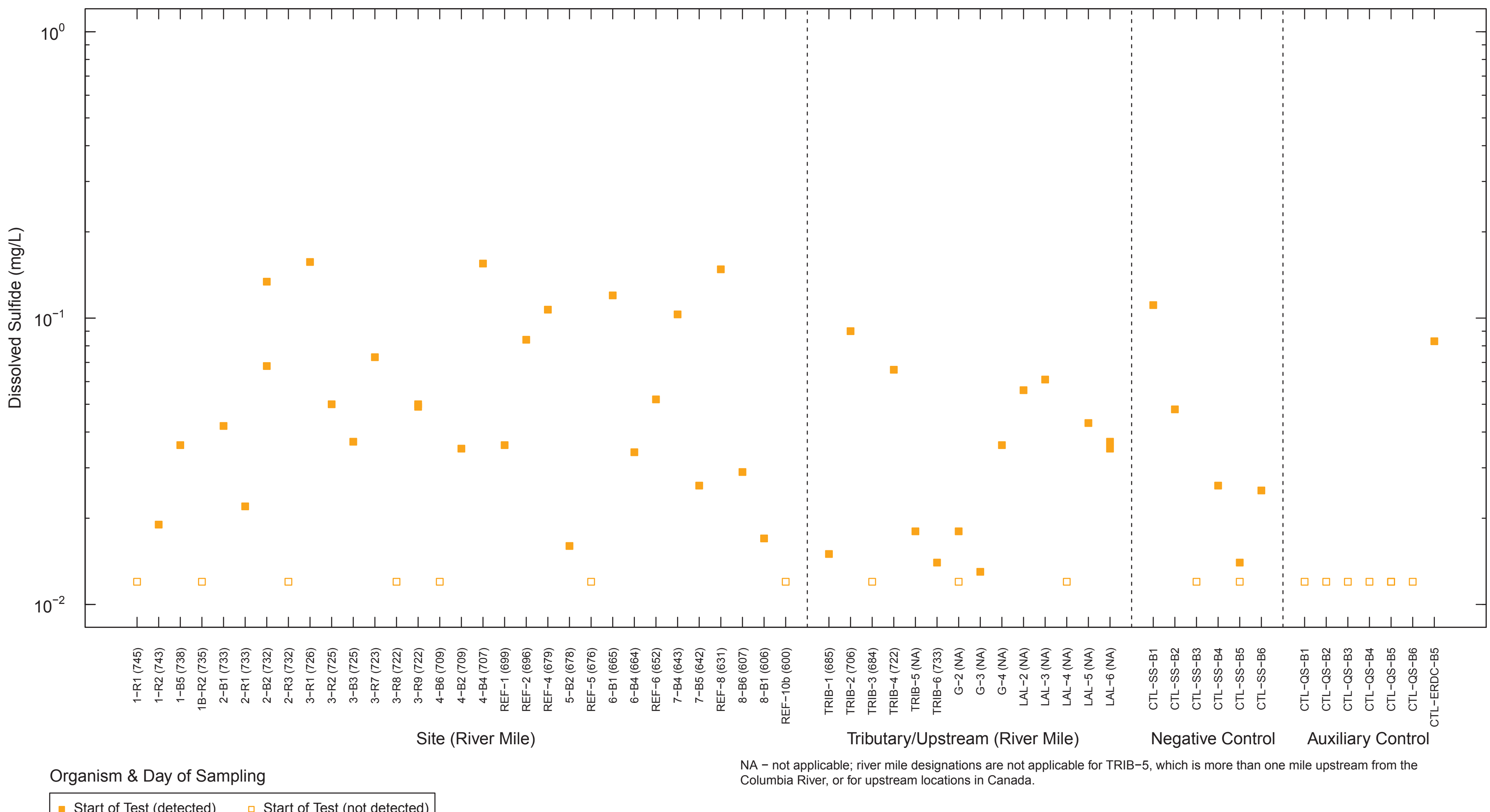
Organism & Day of Sampling

Start of Test (detected)

NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

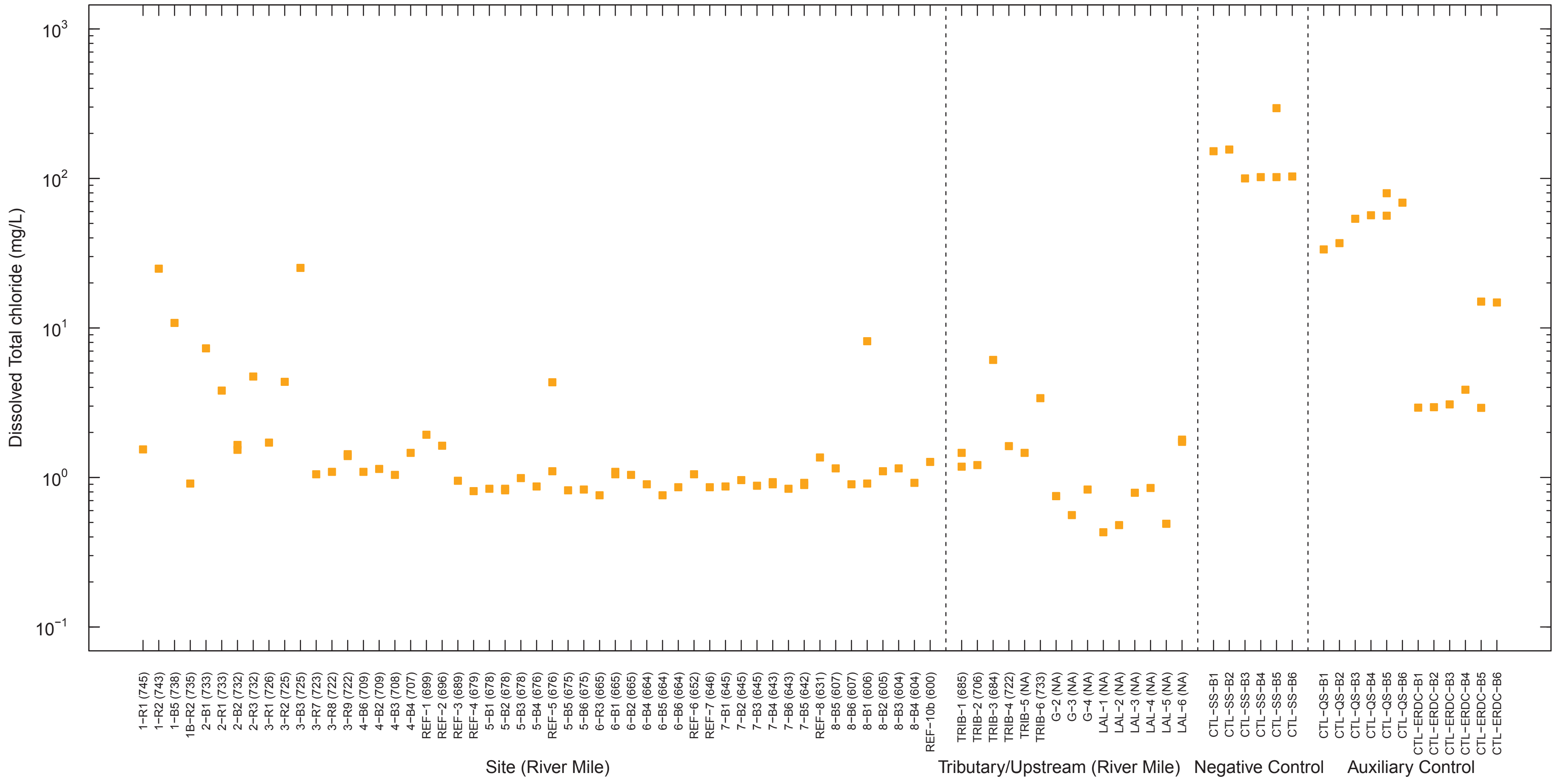
Figure 5−5e. Dissolved Sulfate in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

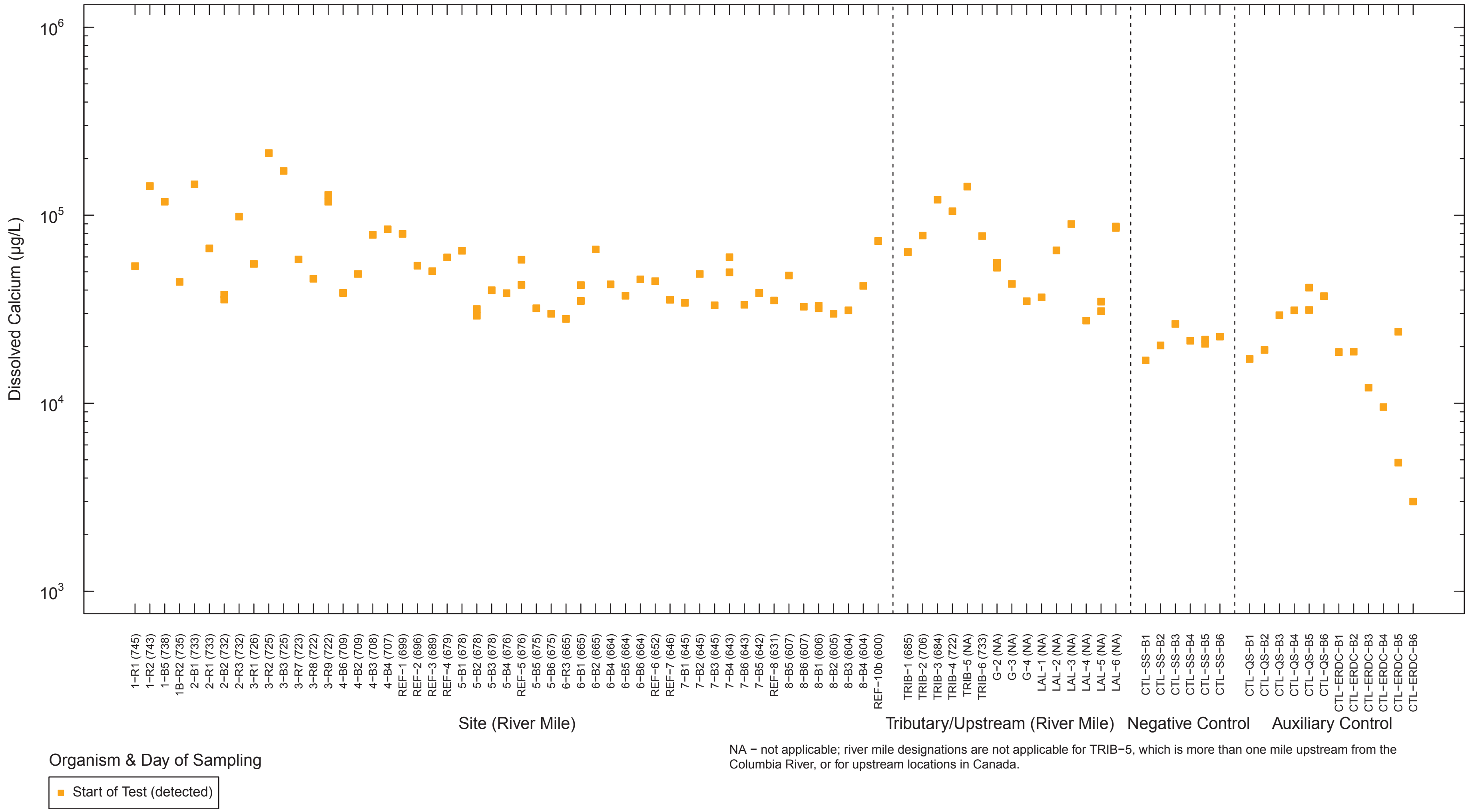
One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5f. Dissolved Sulfide in Porewater from Short−Term Bioassays



One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

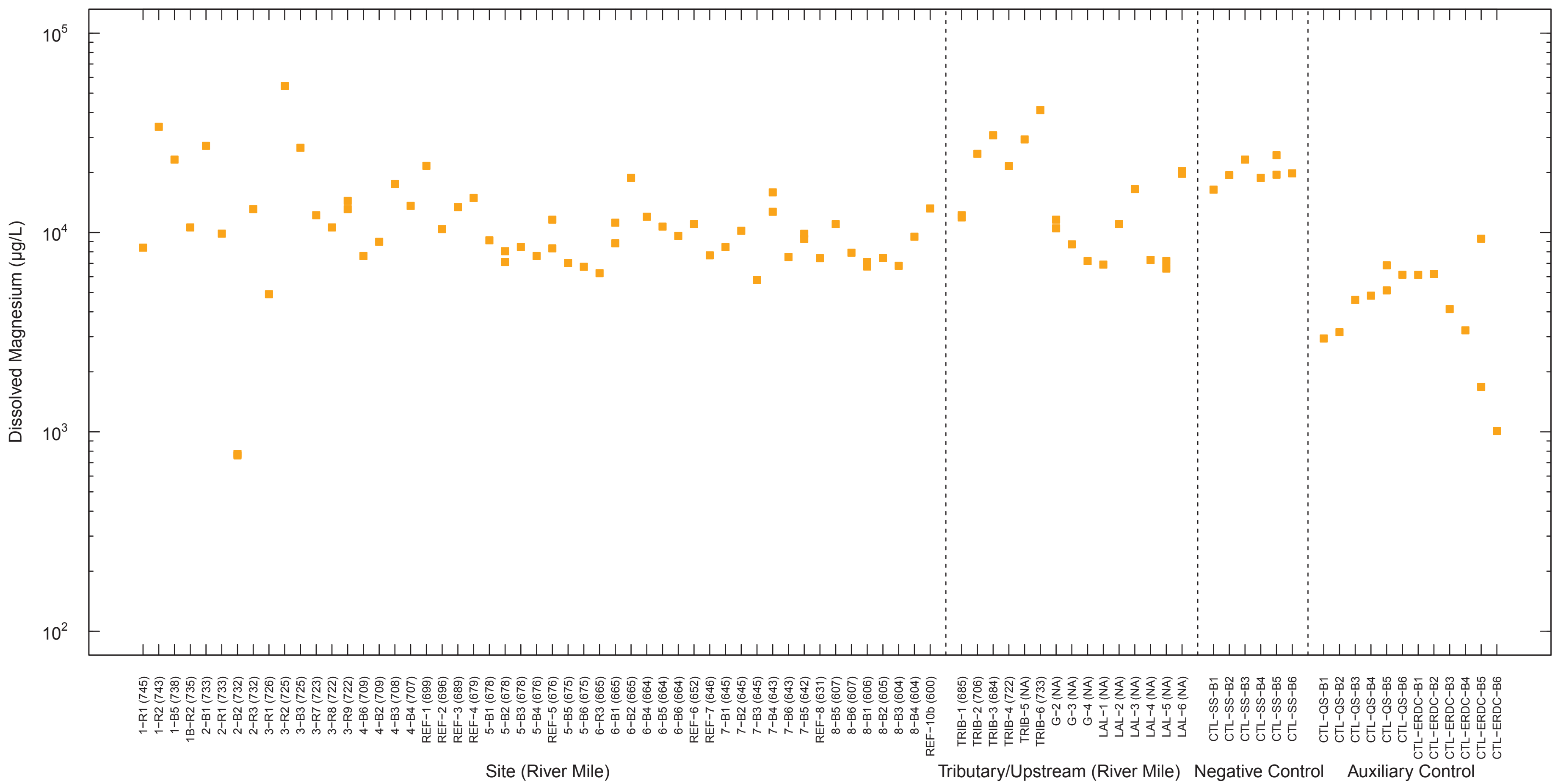
Figure 5−5g. Dissolved Total Chloride in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5h. Dissolved Calcium in Porewater from Short−Term Bioassays



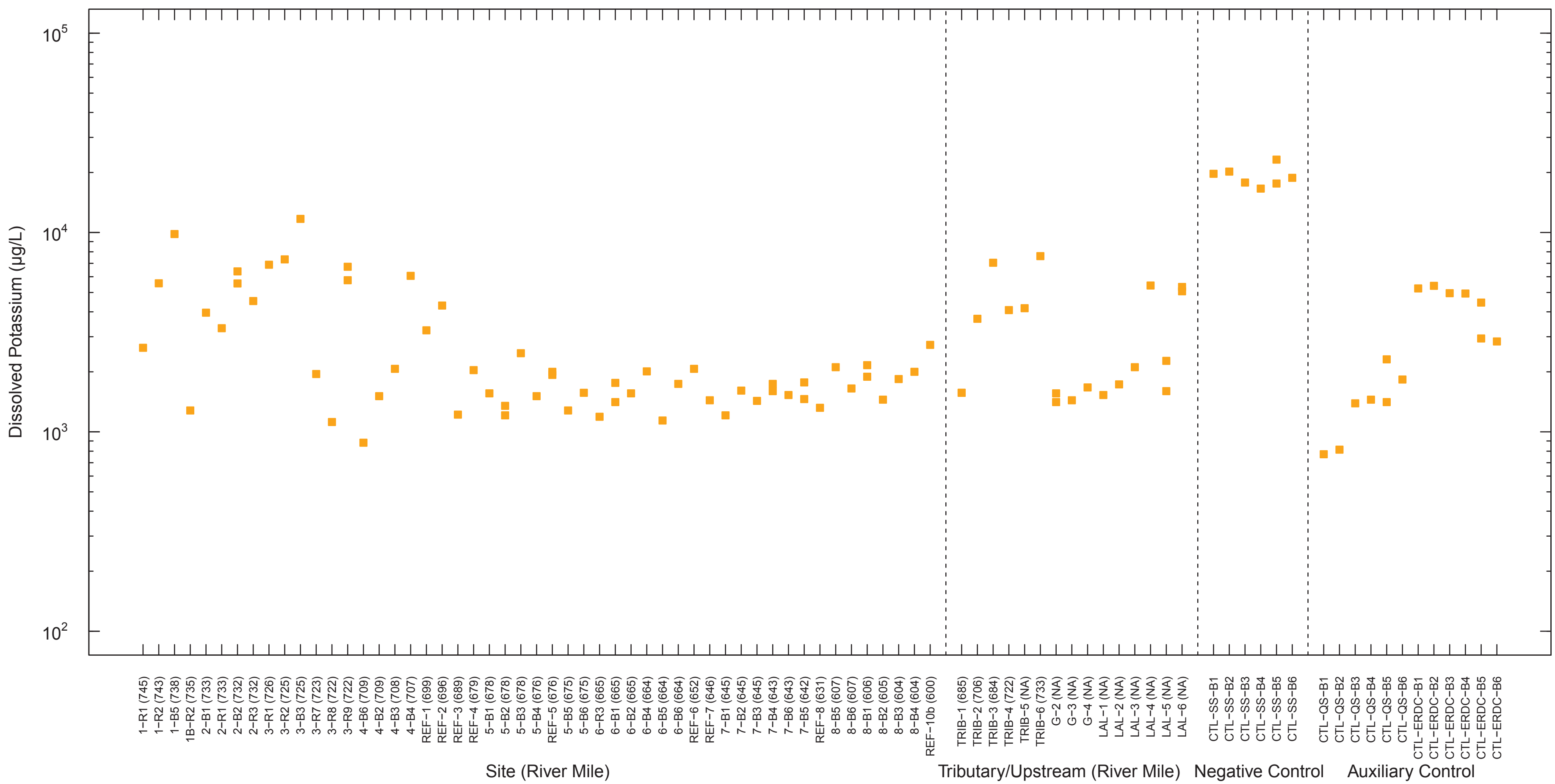
NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Organism & Day of Sampling

■ Start of Test (detected)

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

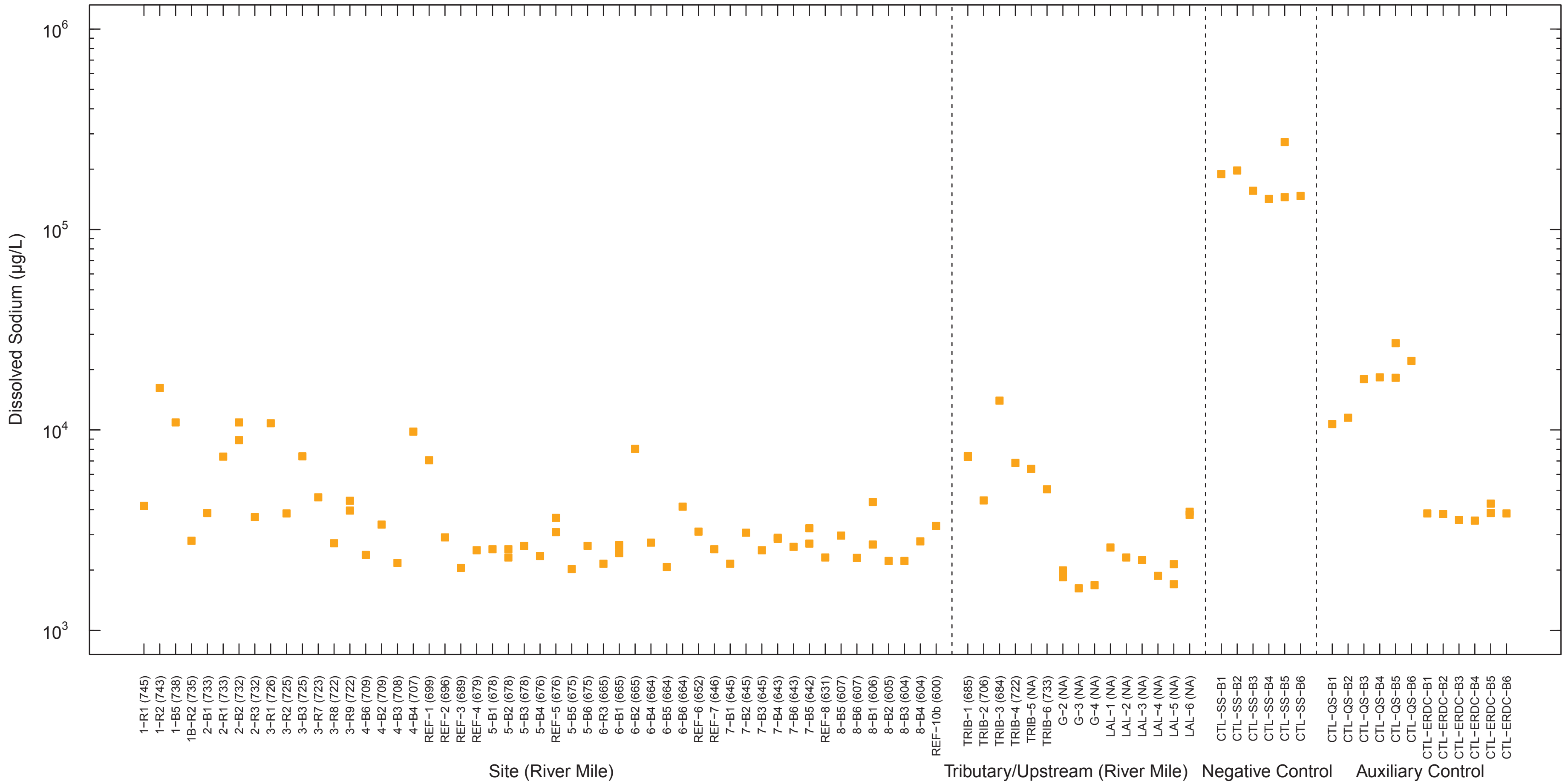
Figure 5−5i. Dissolved Magnesium in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5j. Dissolved Potassium in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Organism & Day of Sampling

Start of Test (detected)

One result is presented for a location if *C. dilutus* and *H. azteca* bioassays were initiated on the same day. Two results are presented for a location if the *C. dilutus* and *H. azteca* bioassays were started on different days. Locations with two results are: 1) the 12 locations included in Batch 5 bioassays (G−2, LAL−5, REF−5, TRIB−1, 2−B2, 3−R9, 4−B1, 5−B2, 6− B1, 7−B4, 7−B5, 8−B1), which were rerun for *H. azteca* (see Section 4.4.1), and 2) LAL−6, which was run in Batch 2 for *C. dilutus* and Batch 6 for *H. azteca*.

Figure 5−5k. Dissolved Sodium in Porewater from Short−Term Bioassays

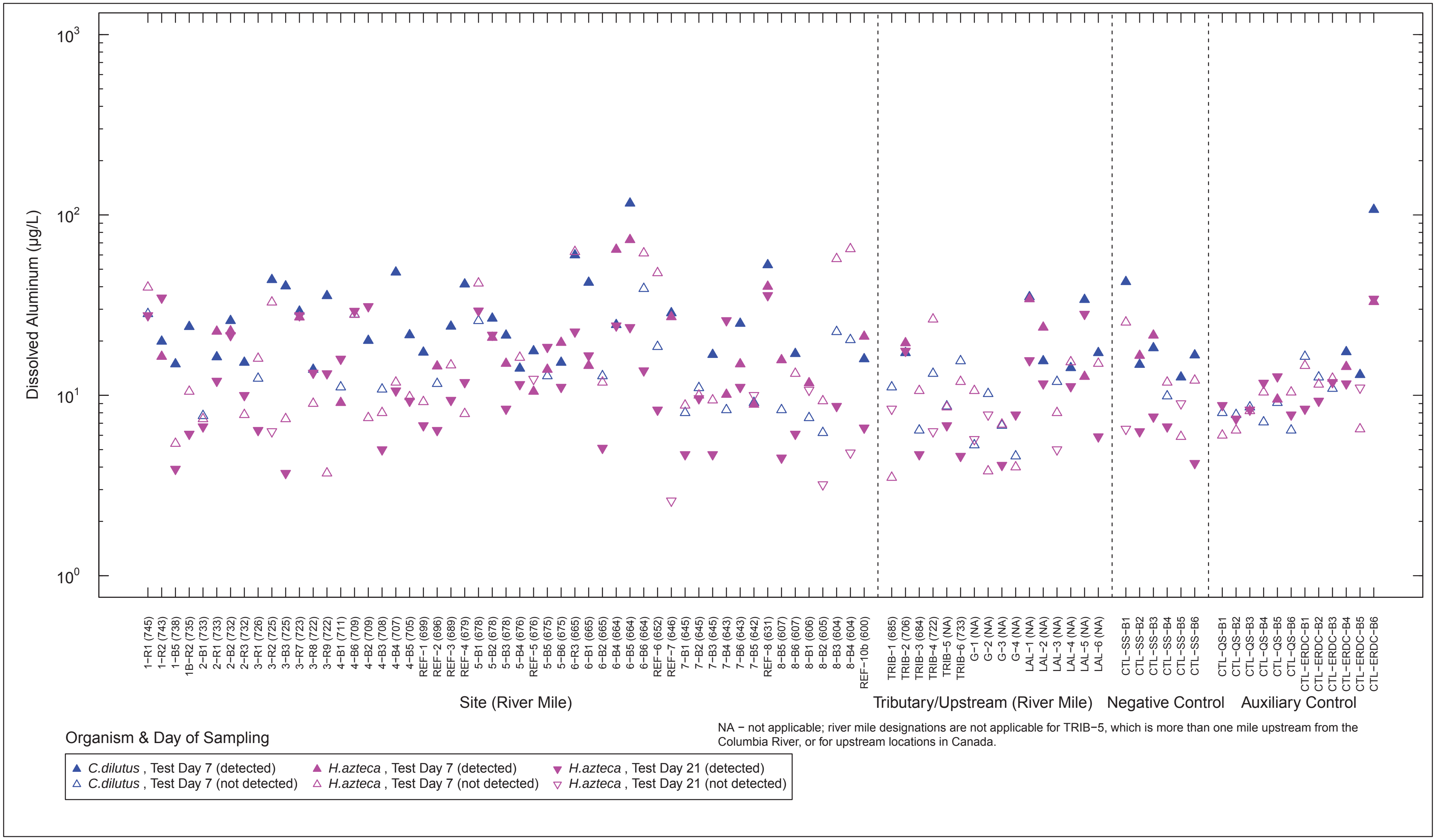


Figure 5−5l. Dissolved Aluminum in Porewater from Short−Term Bioassays

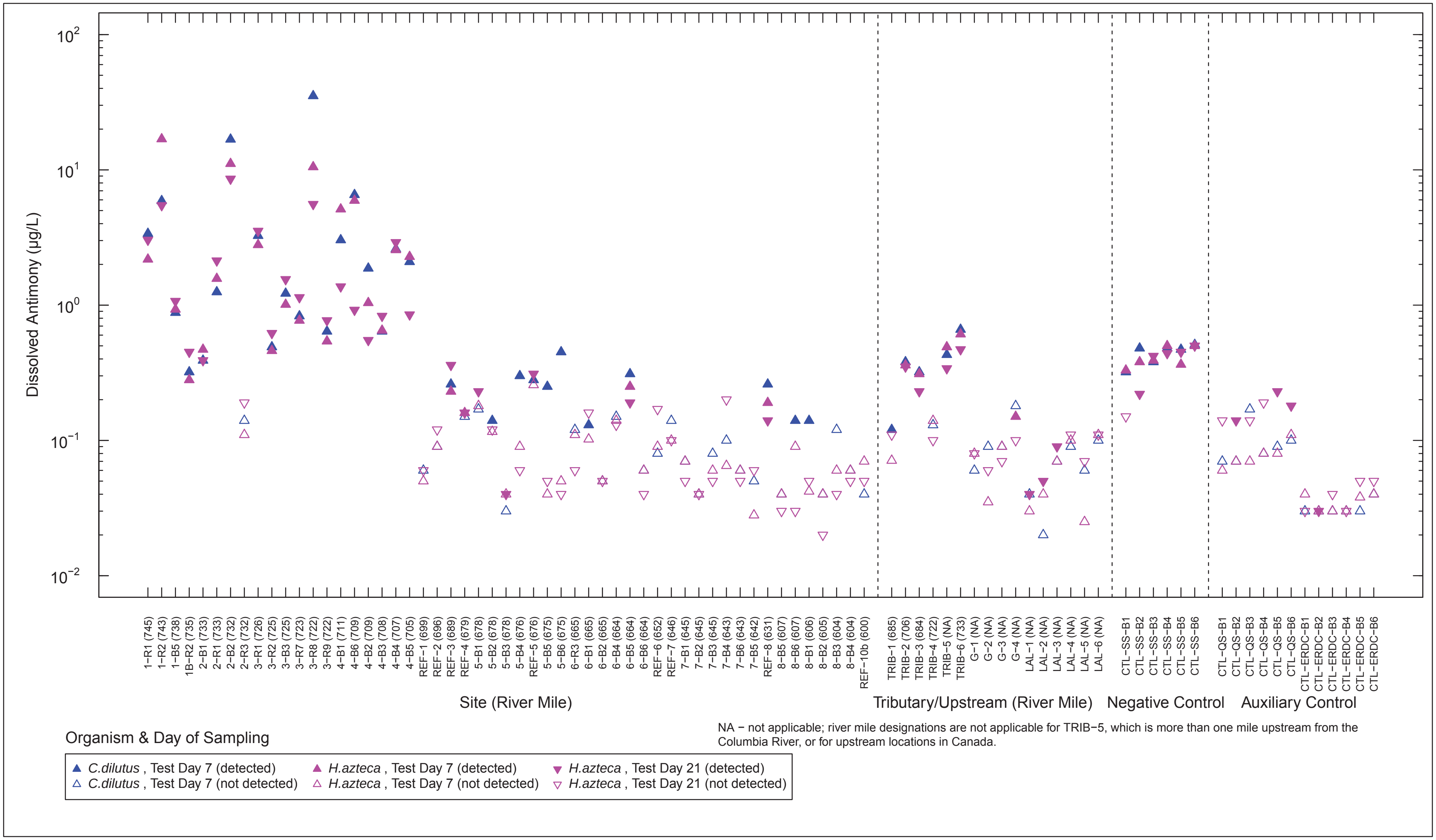


Figure 5−5m. Dissolved Antimony in Porewater from Short−Term Bioassays

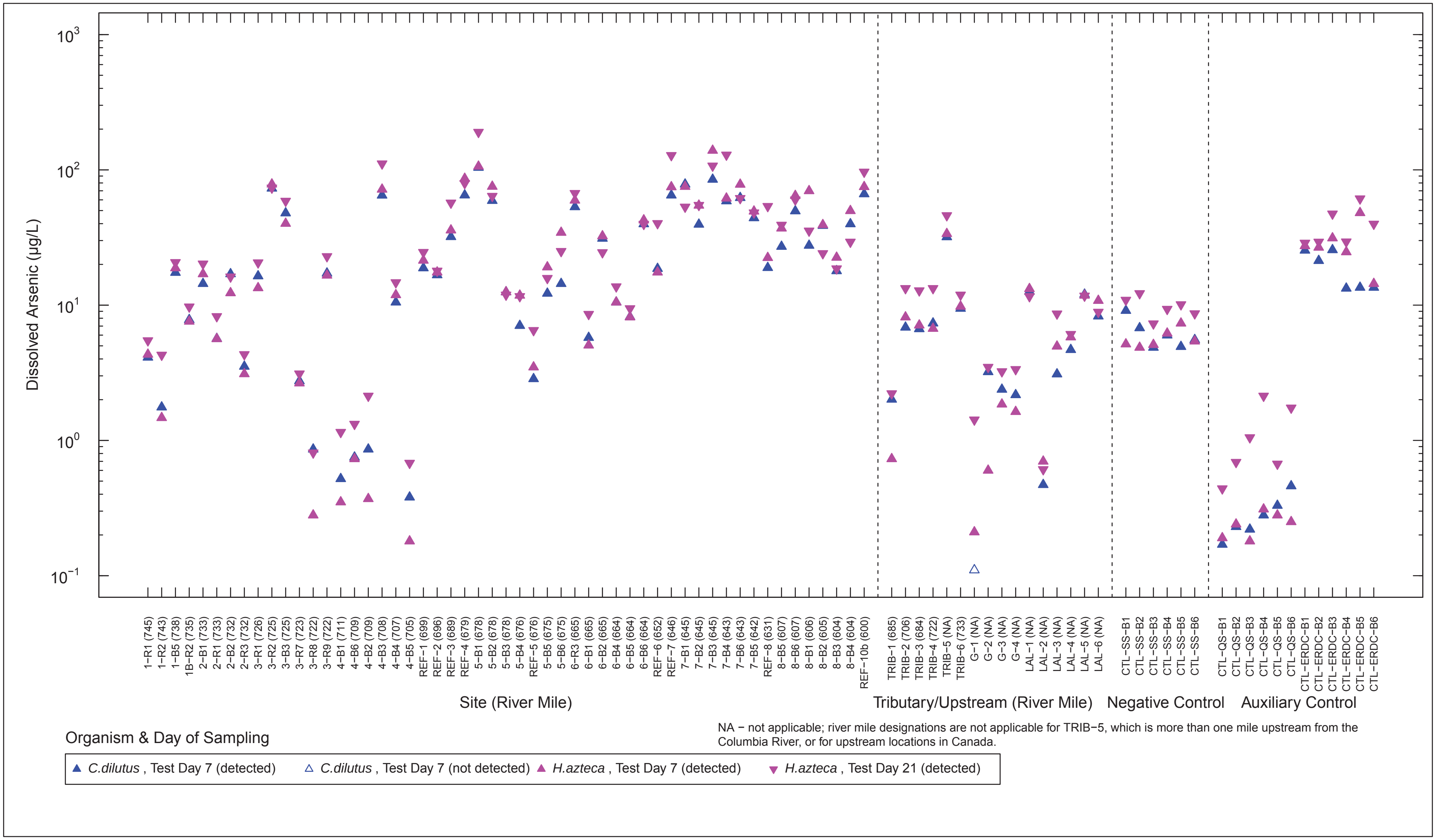


Figure 5−5n. Dissolved Arsenic in Porewater from Short−Term Bioassays

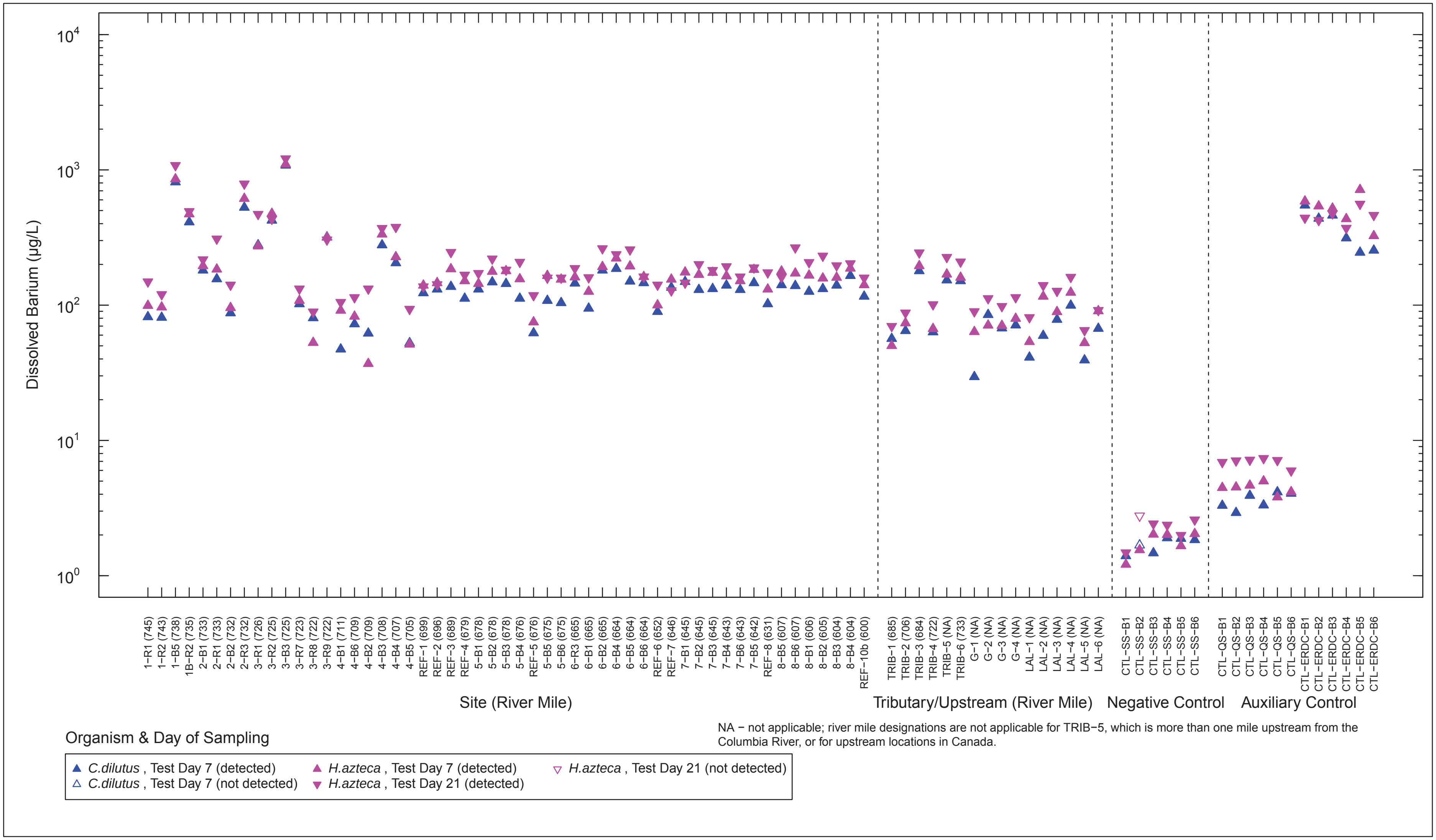


Figure 5−5o. Dissolved Barium in Porewater from Short−Term Bioassays

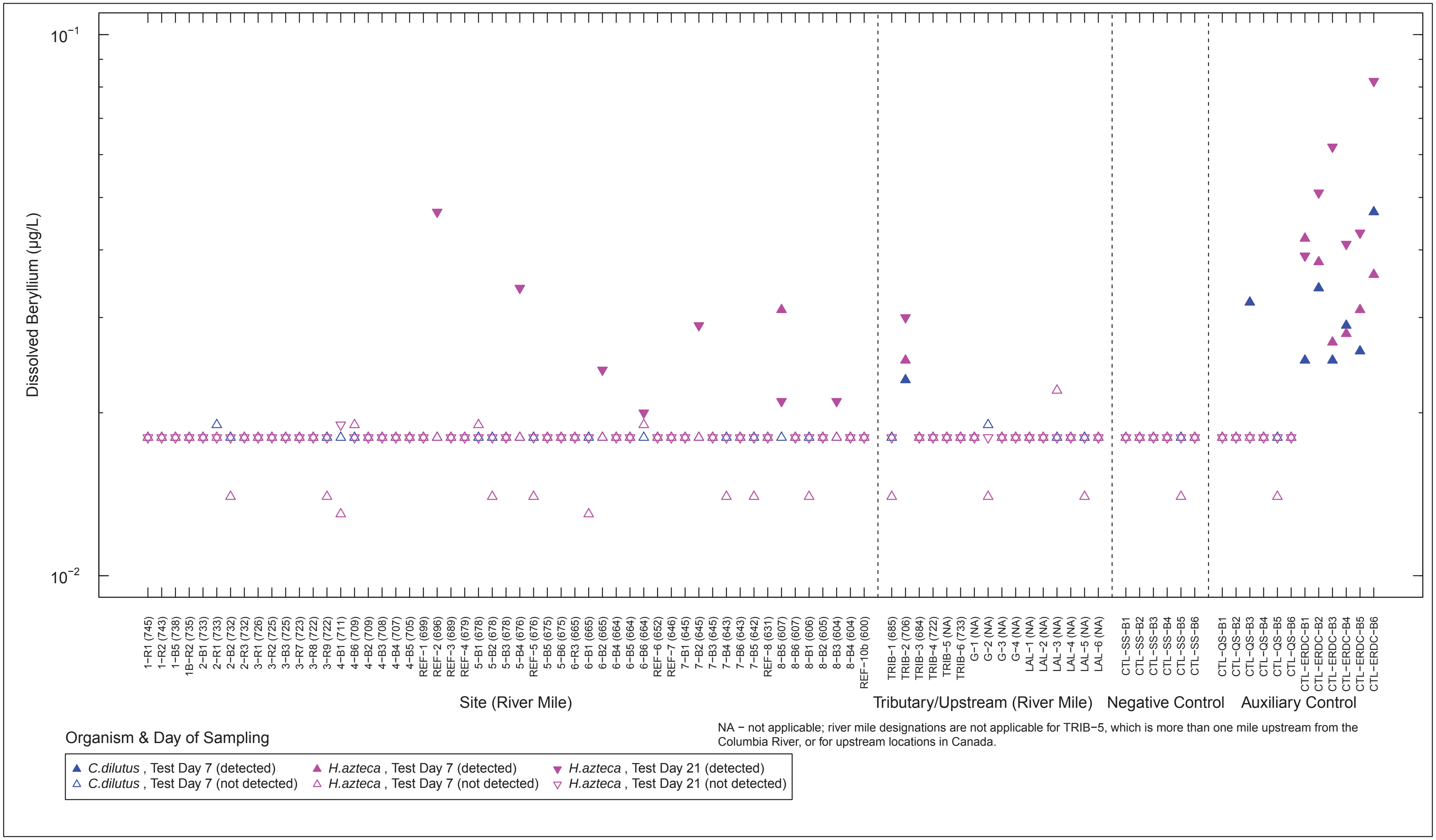


Figure 5−5p. Dissolved Beryllium in Porewater from Short−Term Bioassays

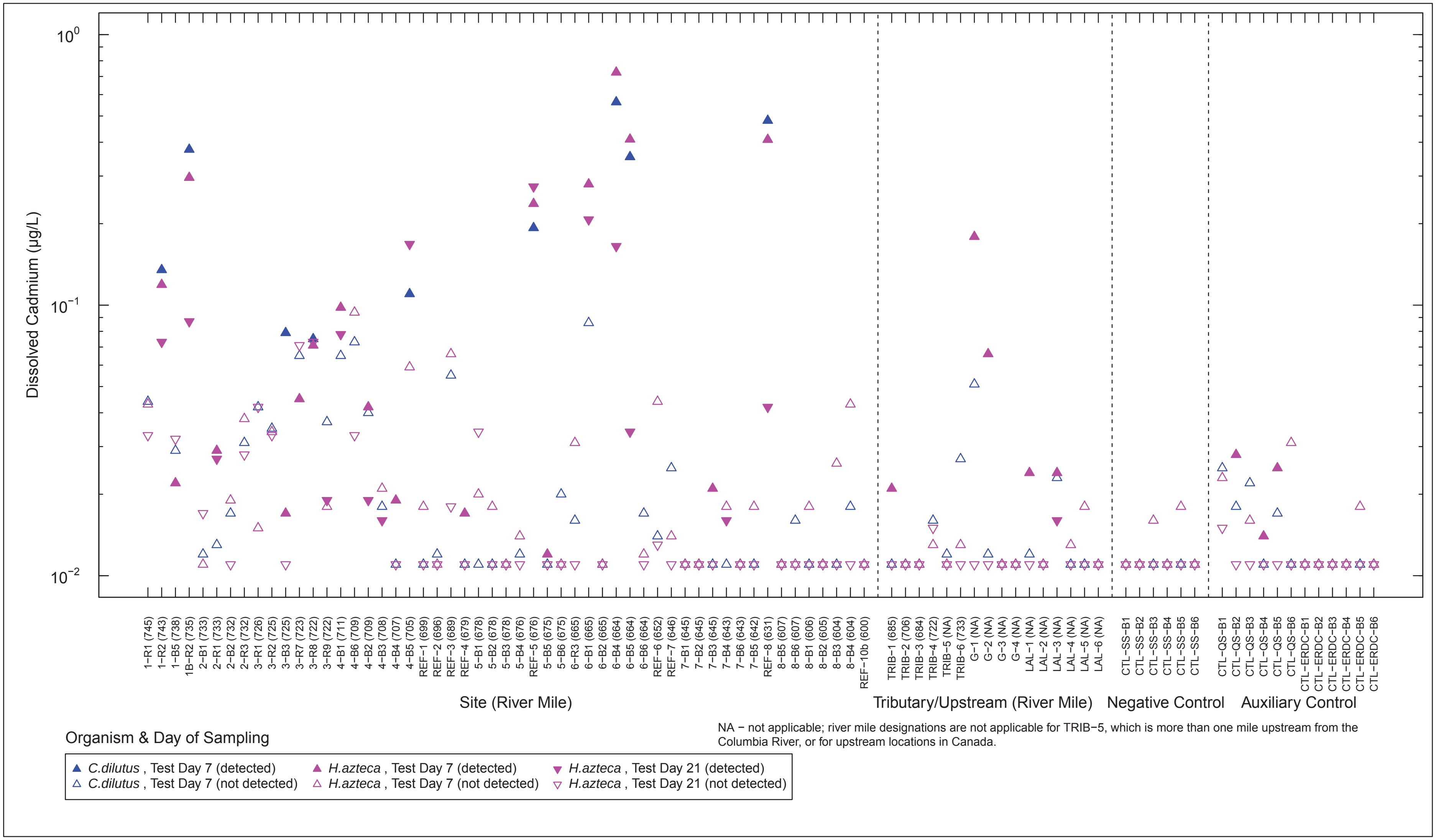


Figure 5−5q. Dissolved Cadmium in Porewater from Short−Term Bioassays

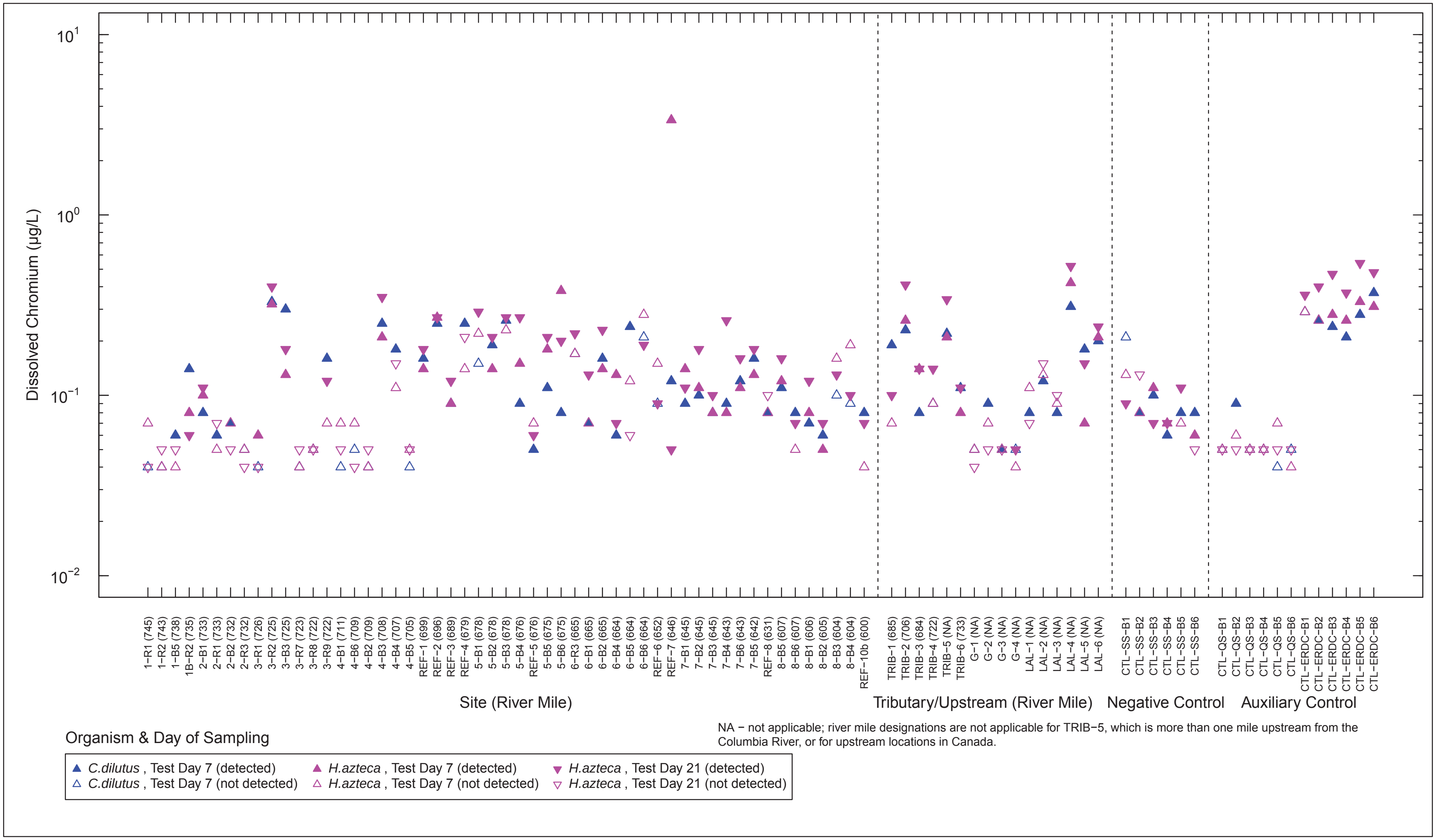


Figure 5–5r. Dissolved Chromium in Porewater from Short–Term Bioassays

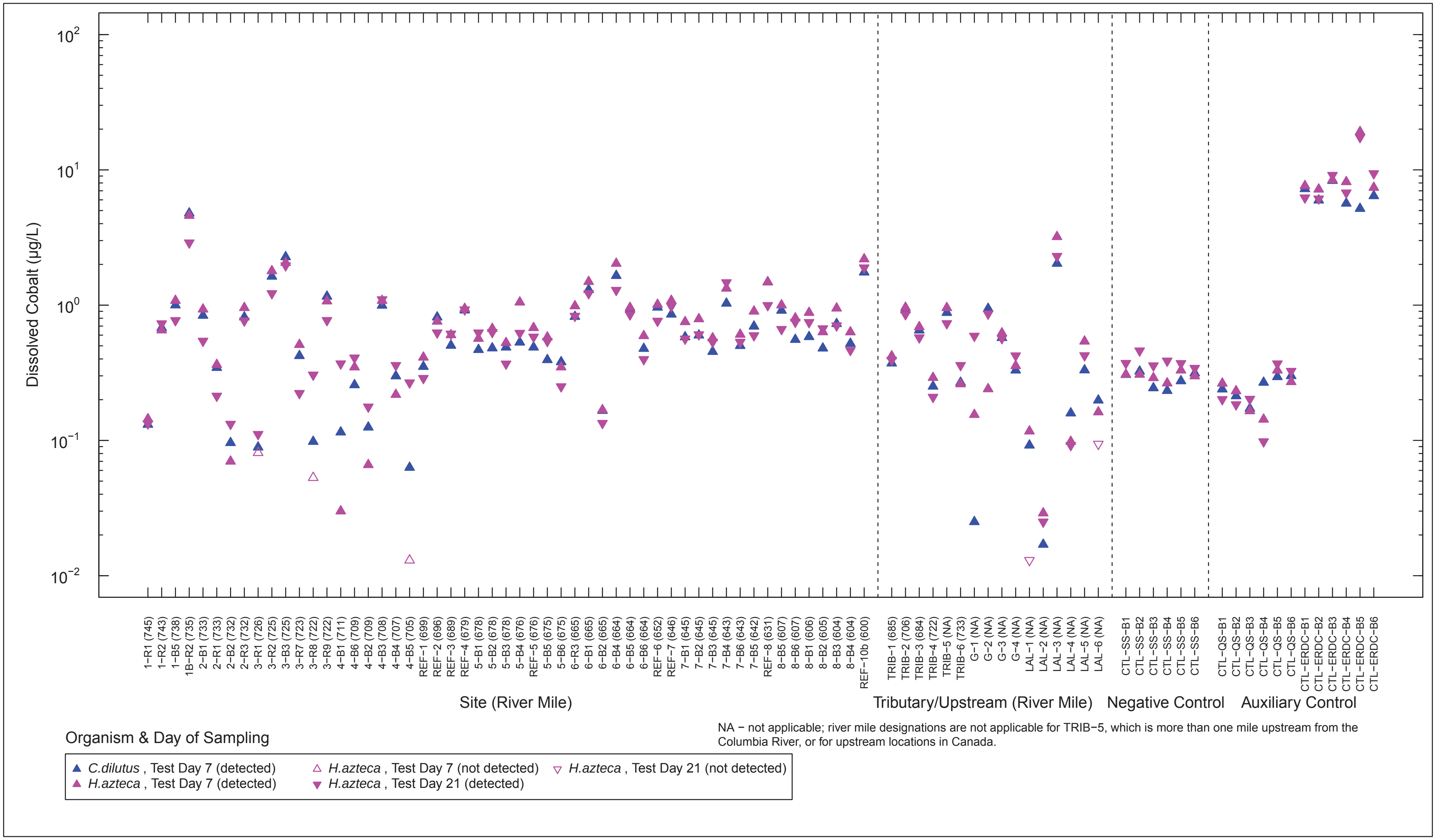


Figure 5−5s. Dissolved Cobalt in Porewater from Short−Term Bioassays

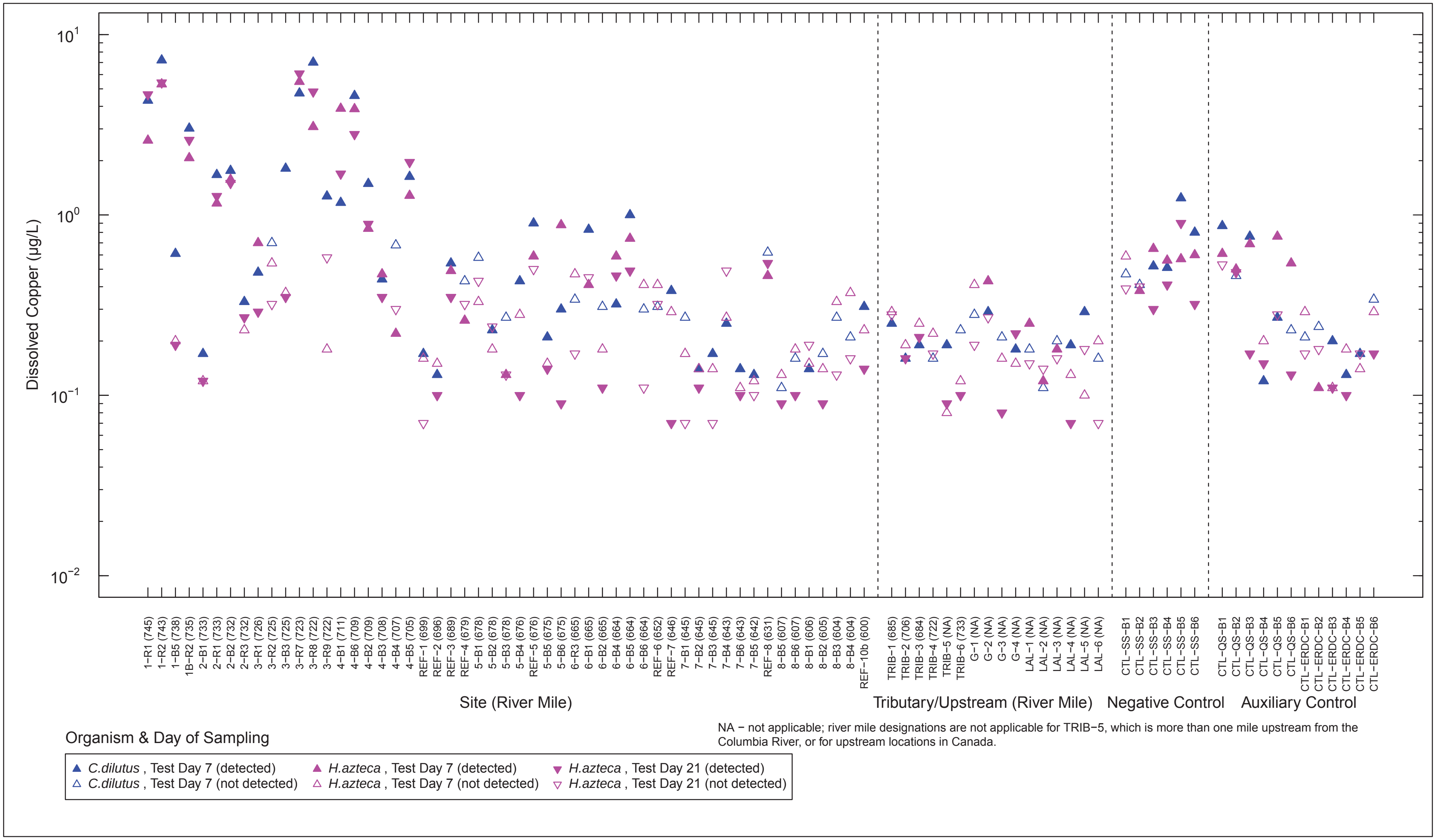


Figure 5−5t. Dissolved Copper in Porewater from Short−Term Bioassays

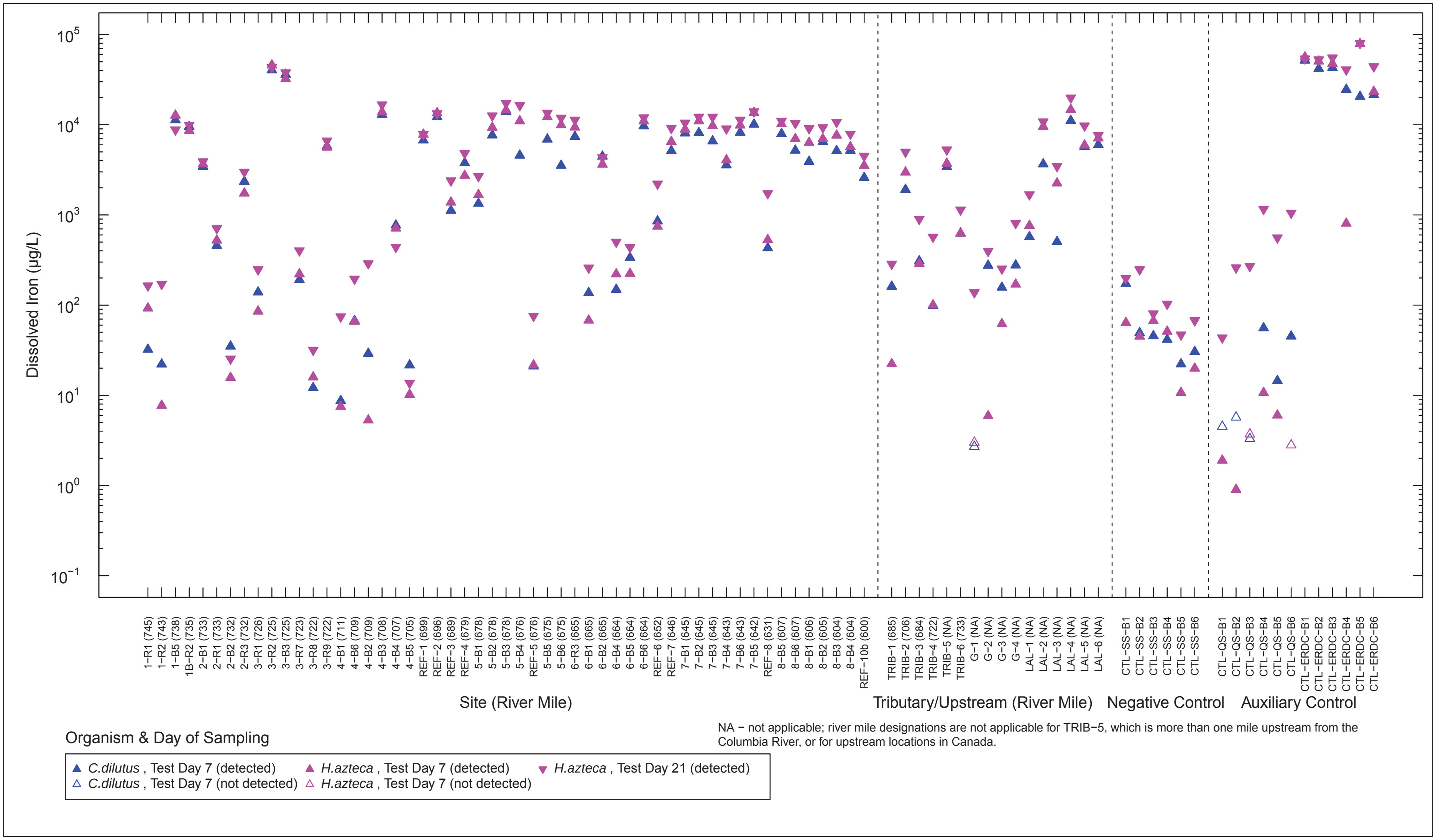
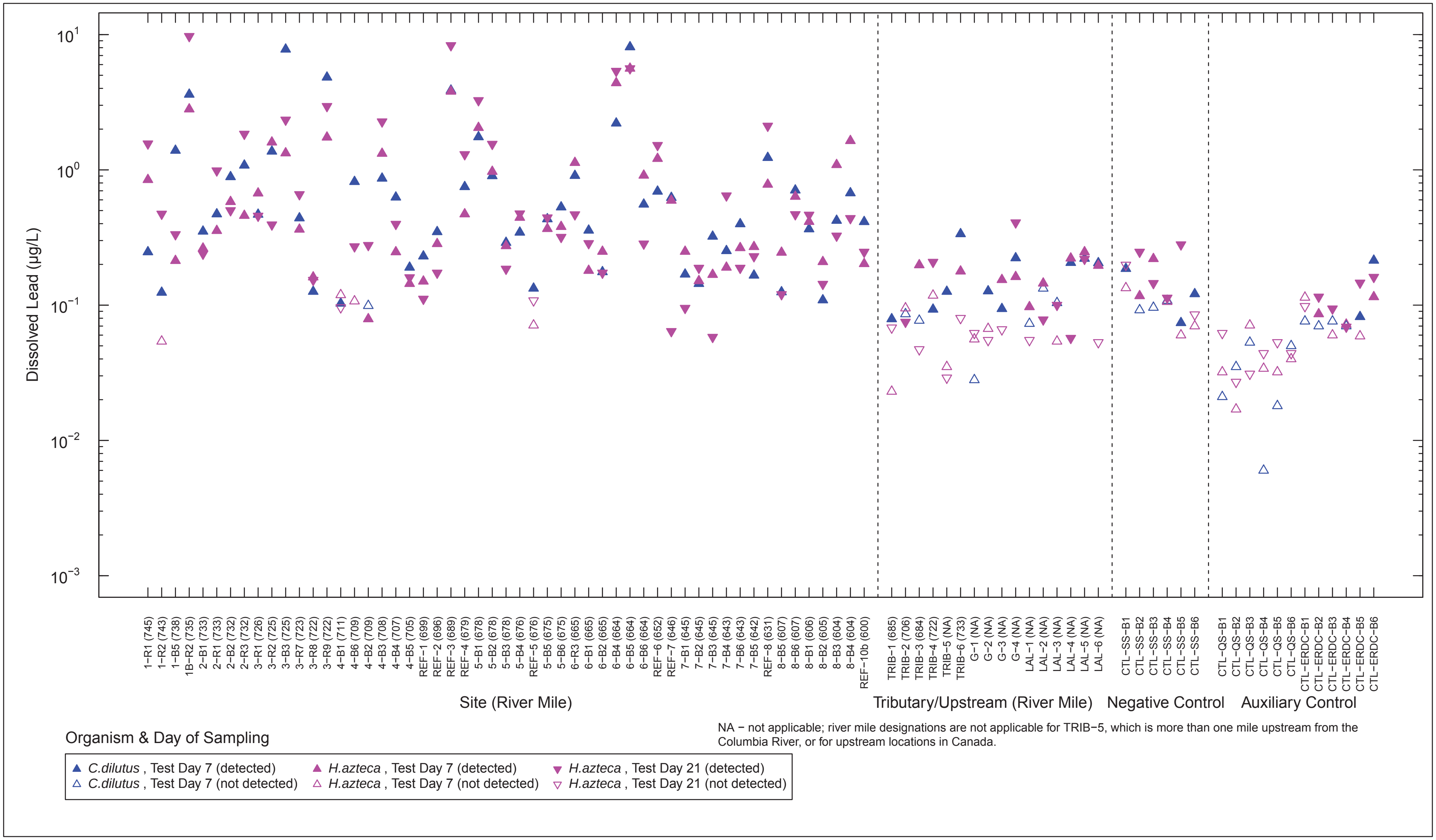


Figure 5−5u. Dissolved Iron in Porewater from Short−Term Bioassays



NA − not applicable; river mile designations are not applicable for TRIB−5, which is more than one mile upstream from the Columbia River, or for upstream locations in Canada.

Figure 5−5v. Dissolved Lead in Porewater from Short−Term Bioassays

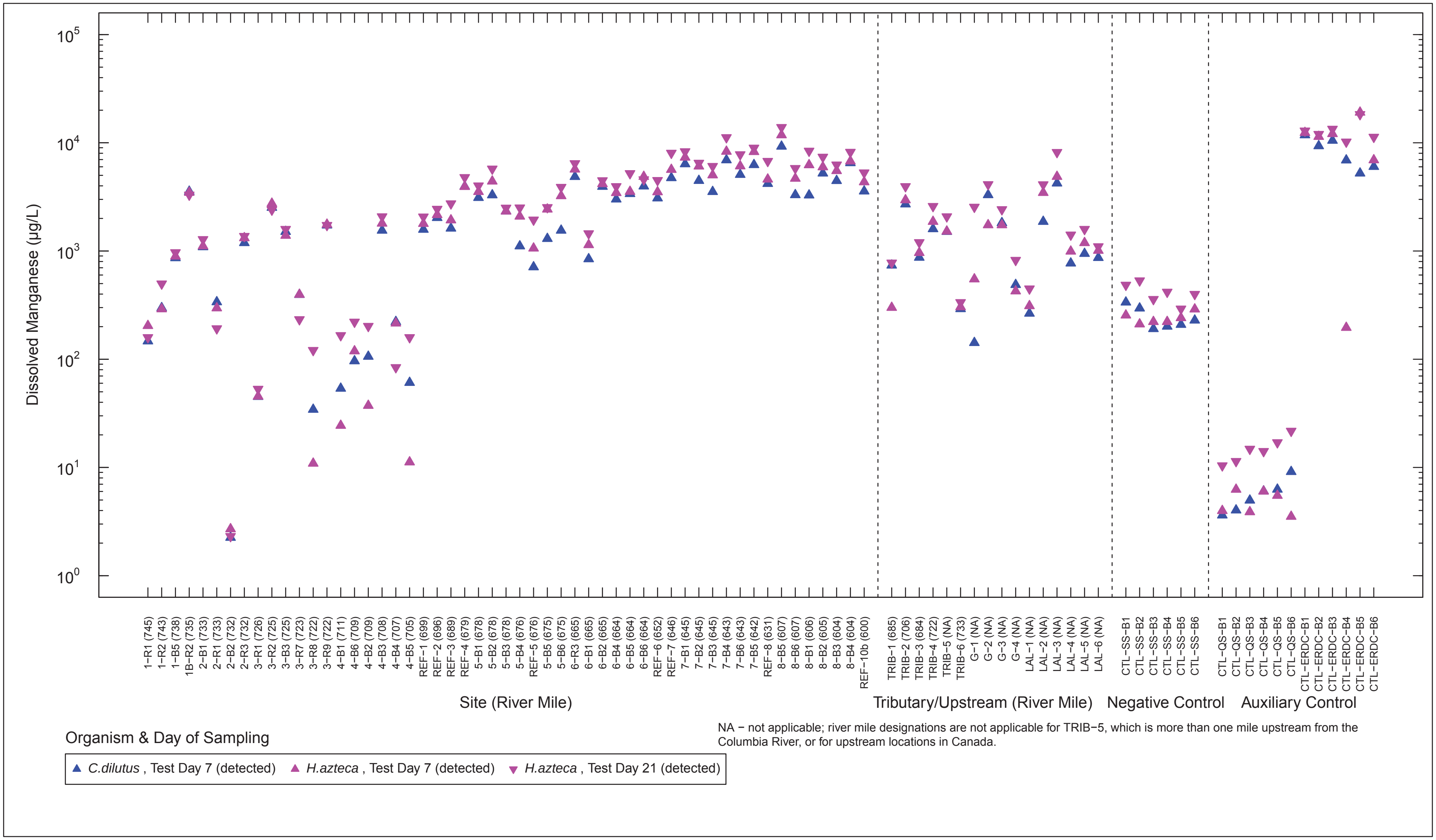


Figure 5−5w. Dissolved Manganese in Porewater from Short−Term Bioassays

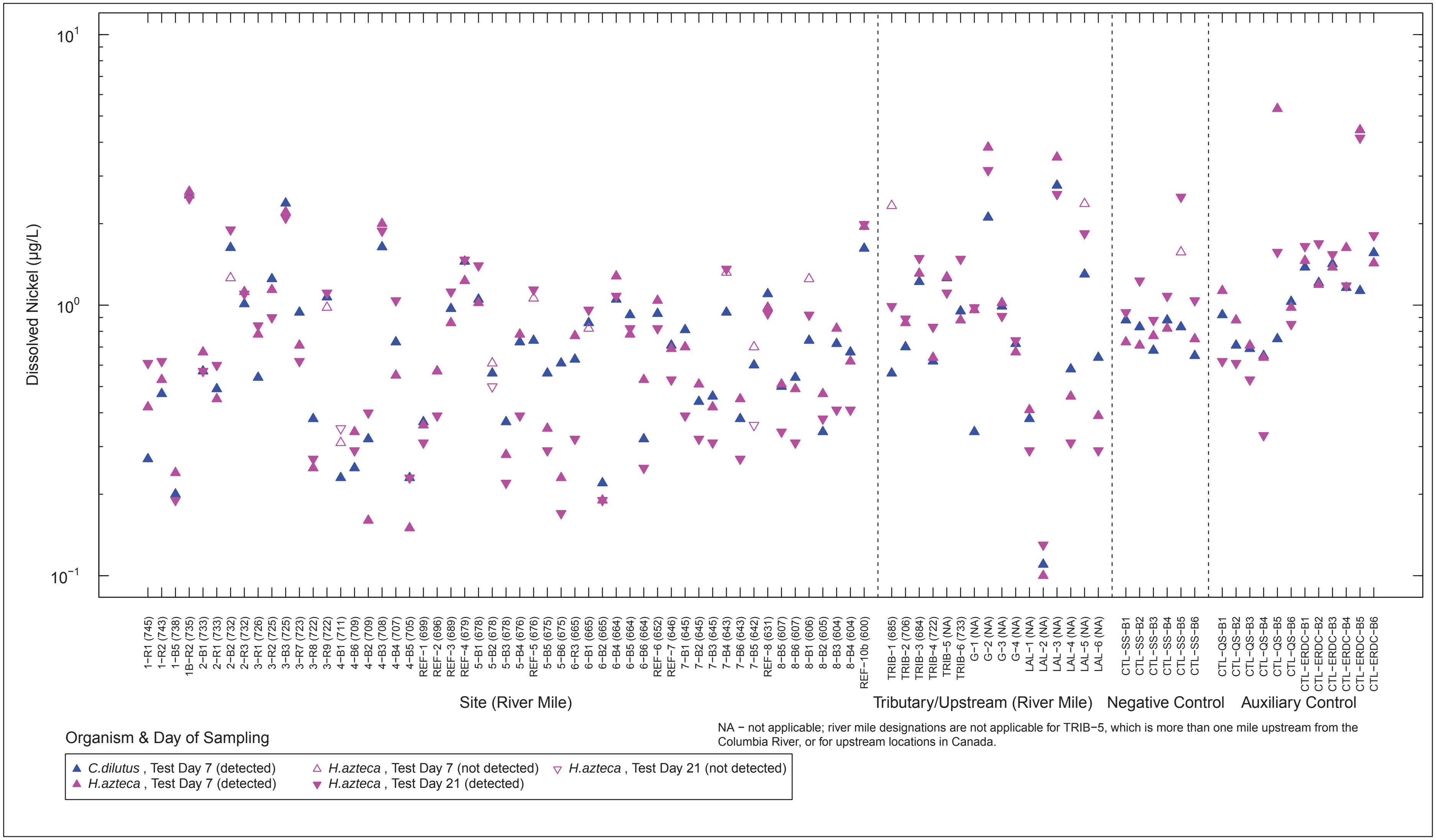


Figure 5−5x. Dissolved Nickel in Porewater from Short−Term Bioassays

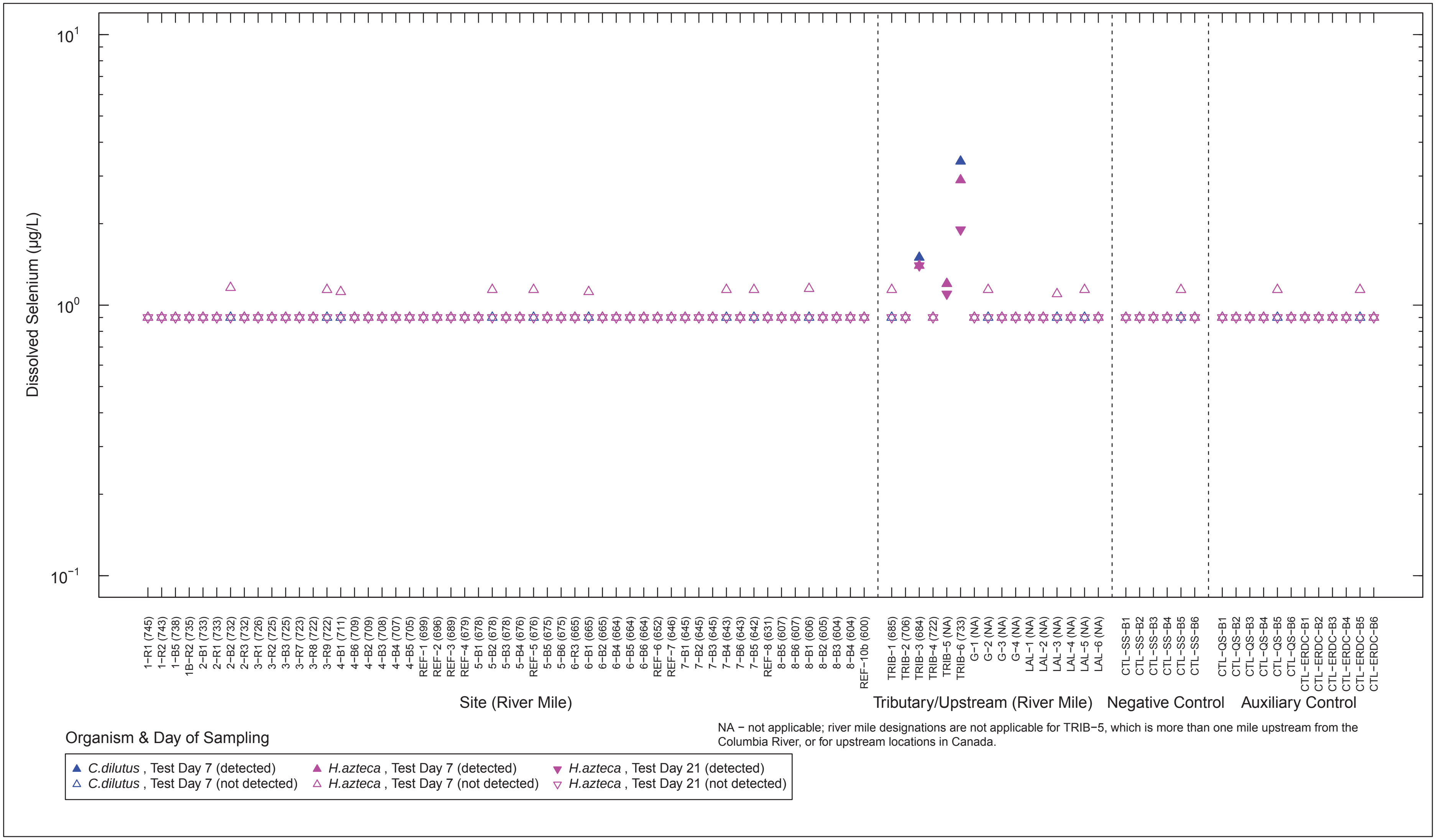


Figure 5−5y. Dissolved Selenium in Porewater from Short−Term Bioassays

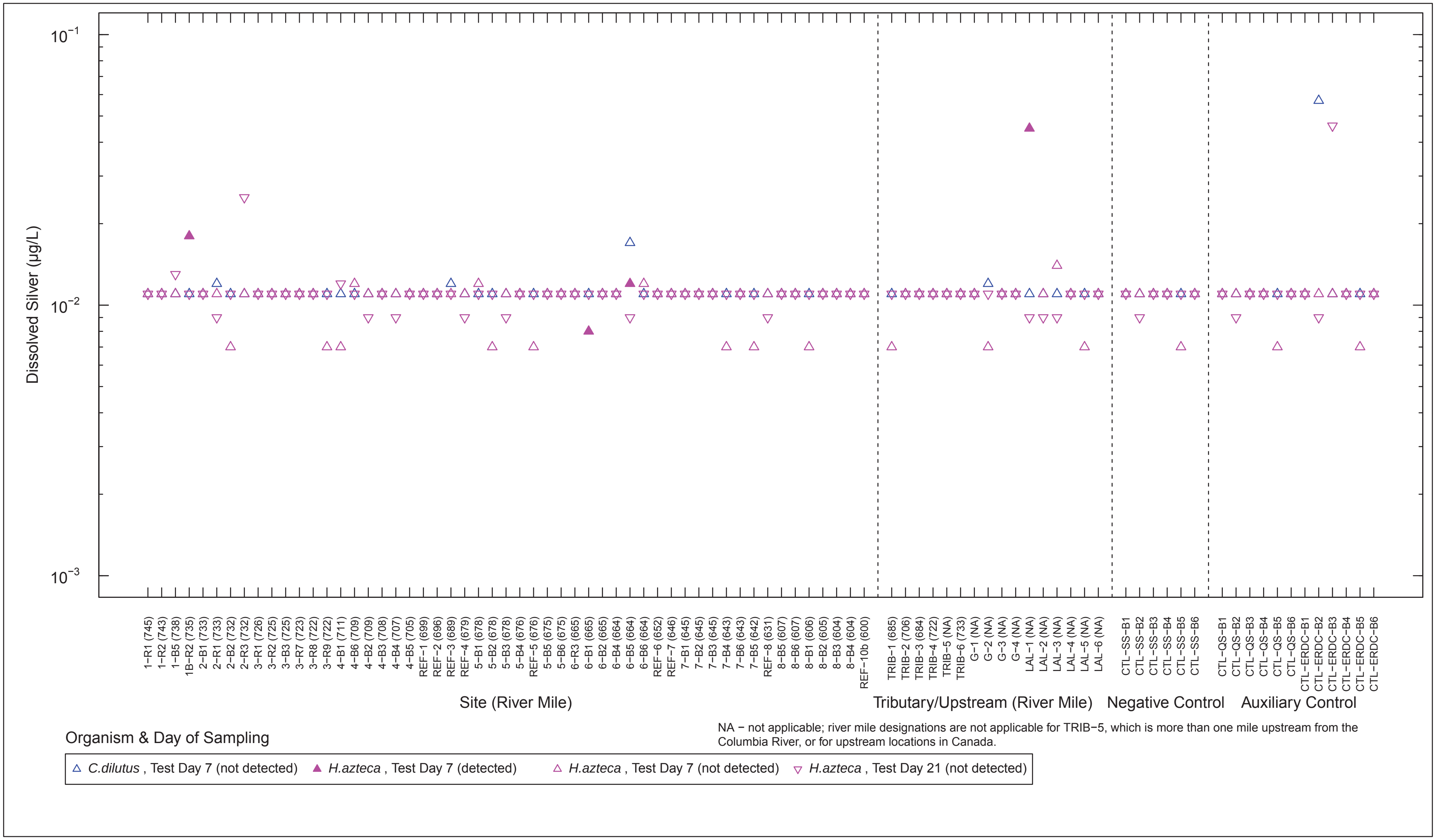


Figure 5−5z. Dissolved Silver in Porewater from Short−Term Bioassays

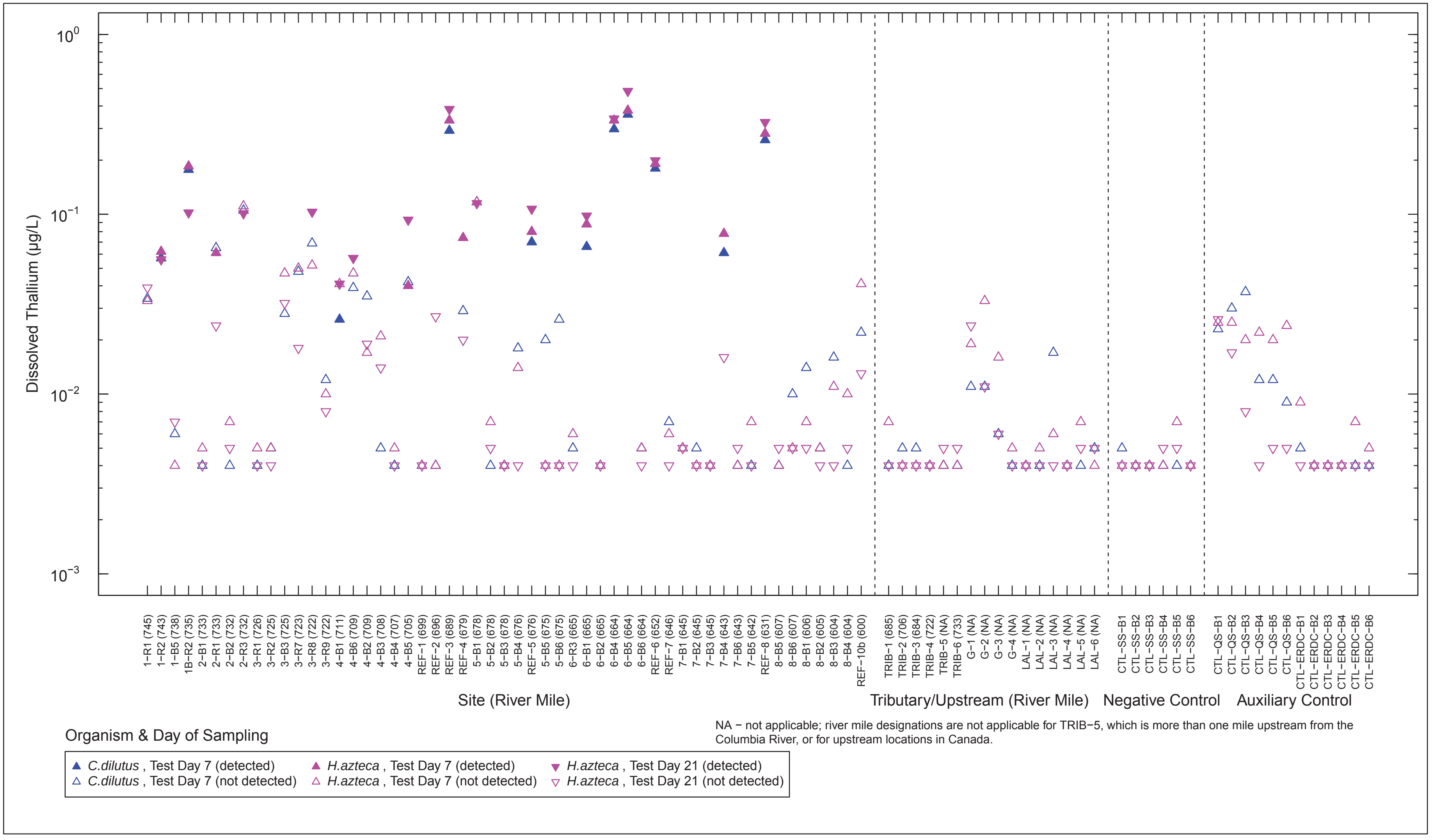


Figure 5−5aa. Dissolved Thallium in Porewater from Short−Term Bioassays

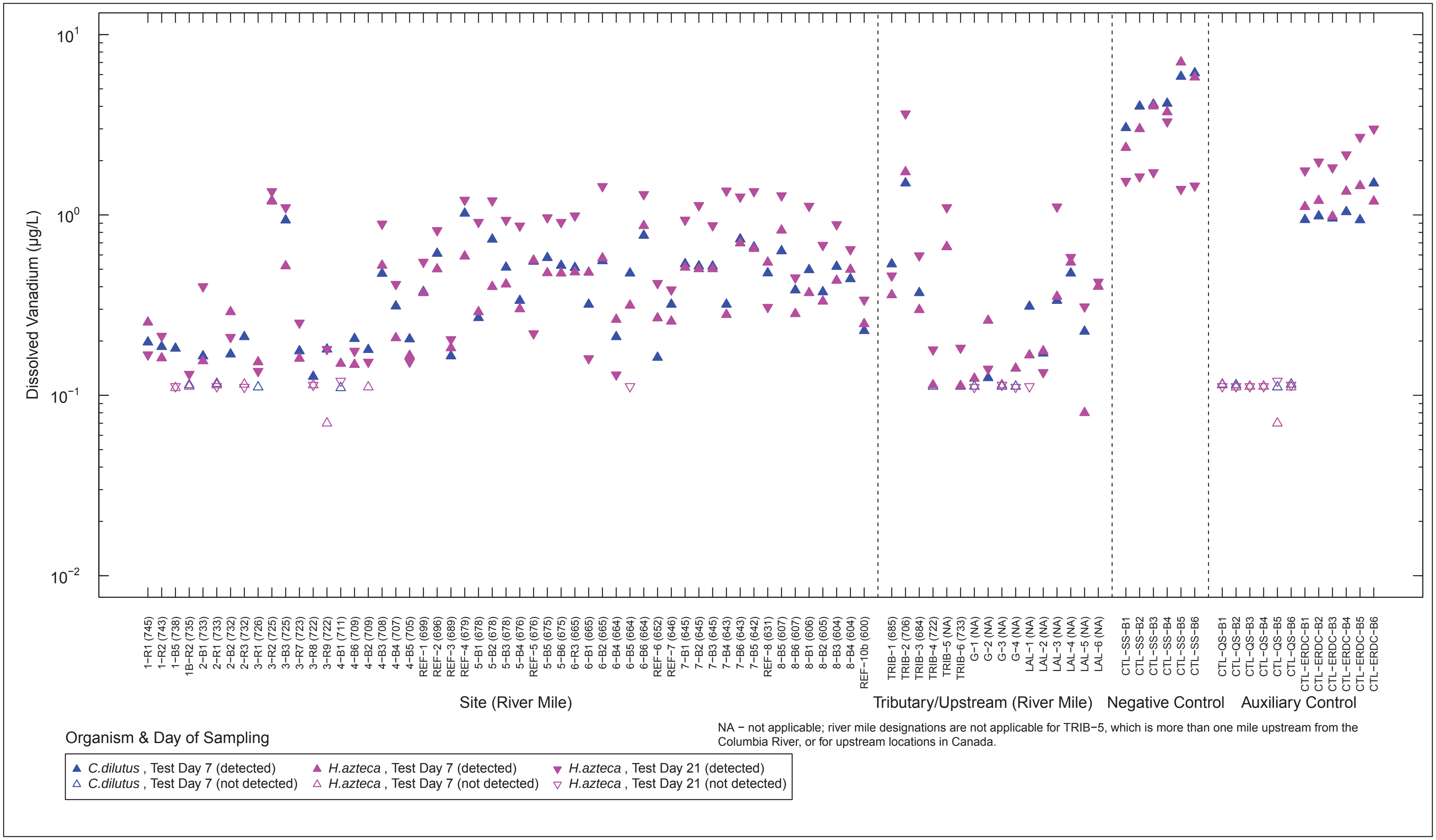


Figure 5−5ab. Dissolved Vanadium in Porewater from Short−Term Bioassays

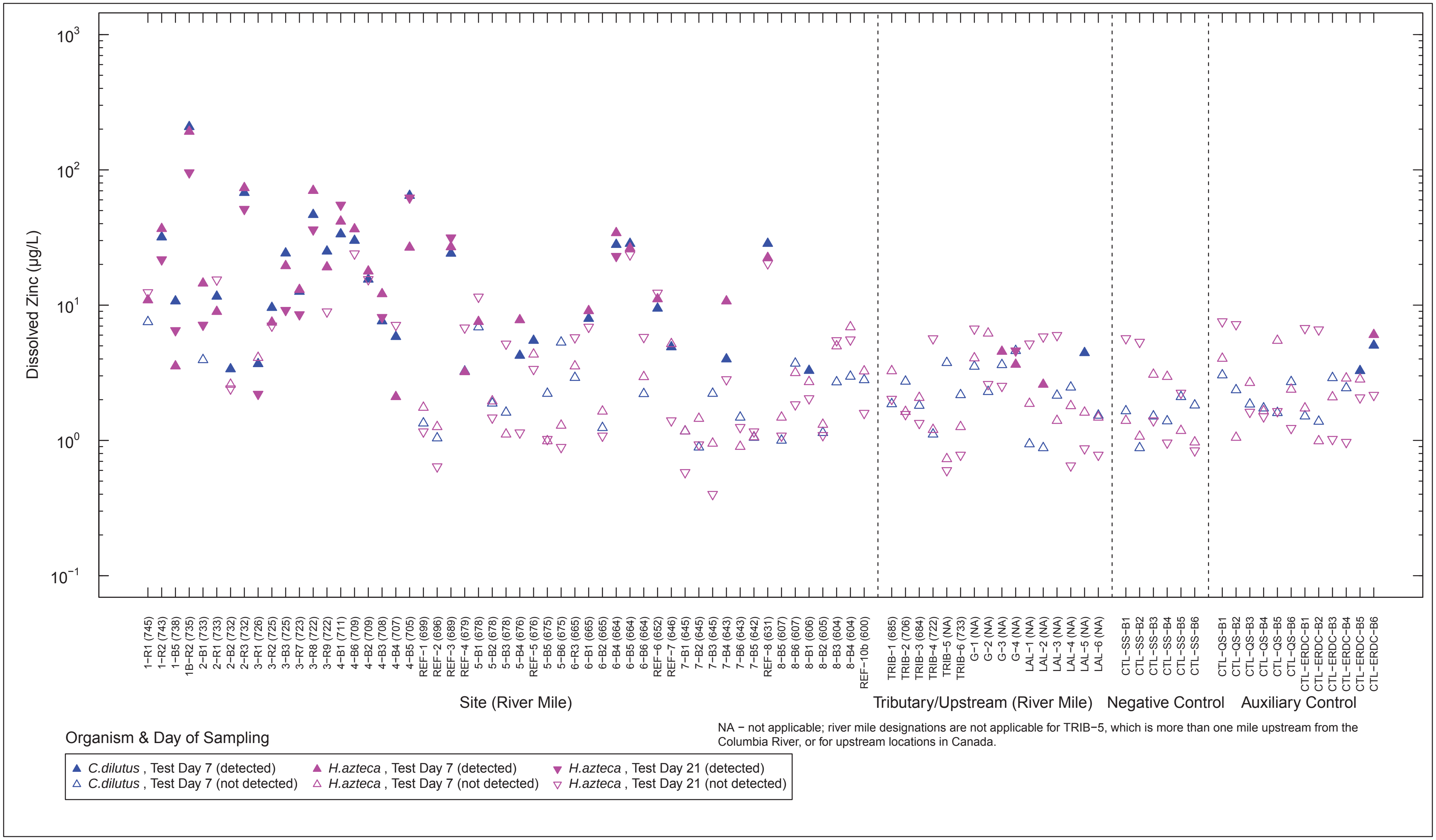


Figure 5−5ac. Dissolved Zinc in Porewater from Short−Term Bioassays

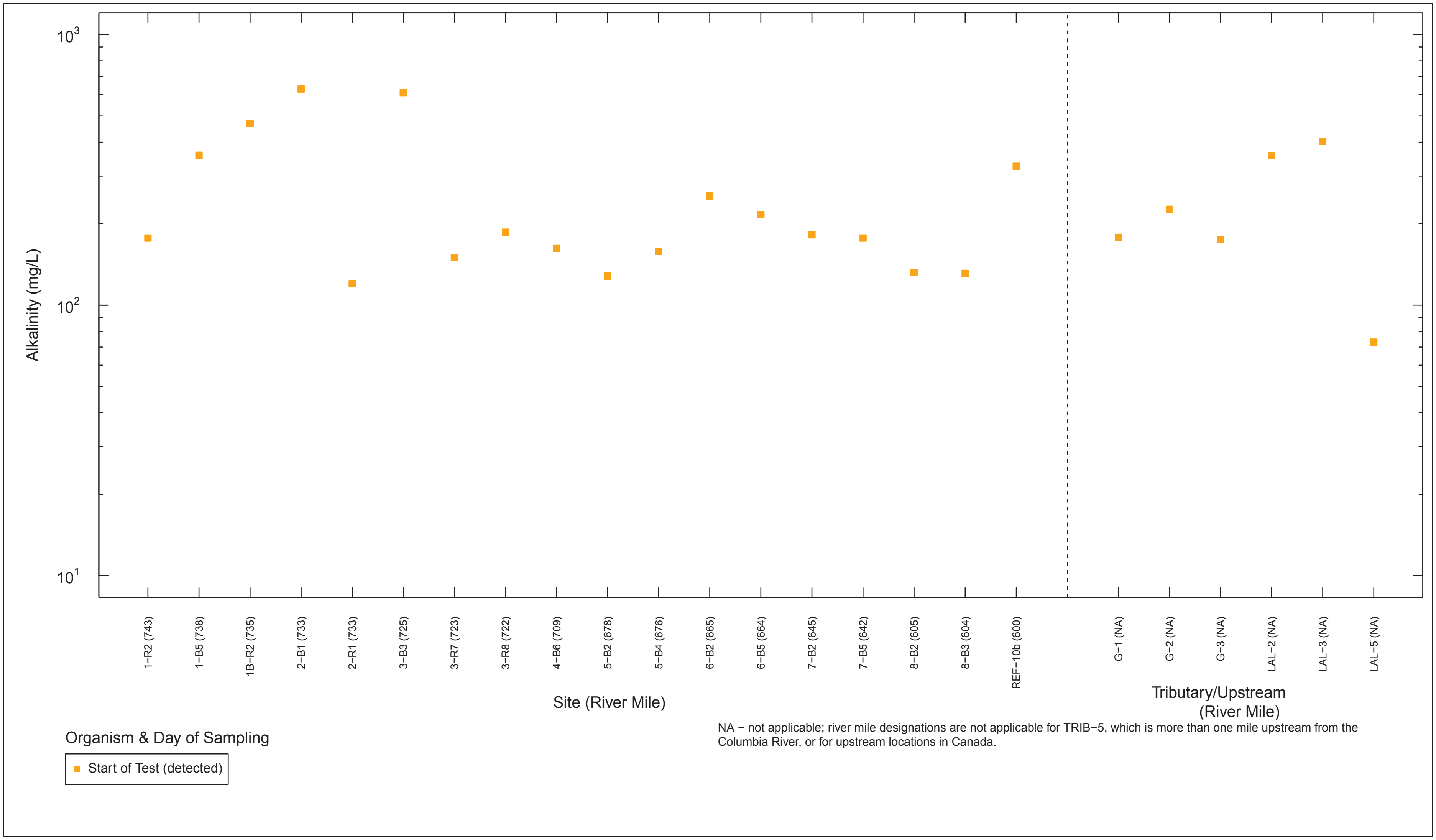


Figure 5−6a. Alkalinity in Porewater from Long−Term Bioassays

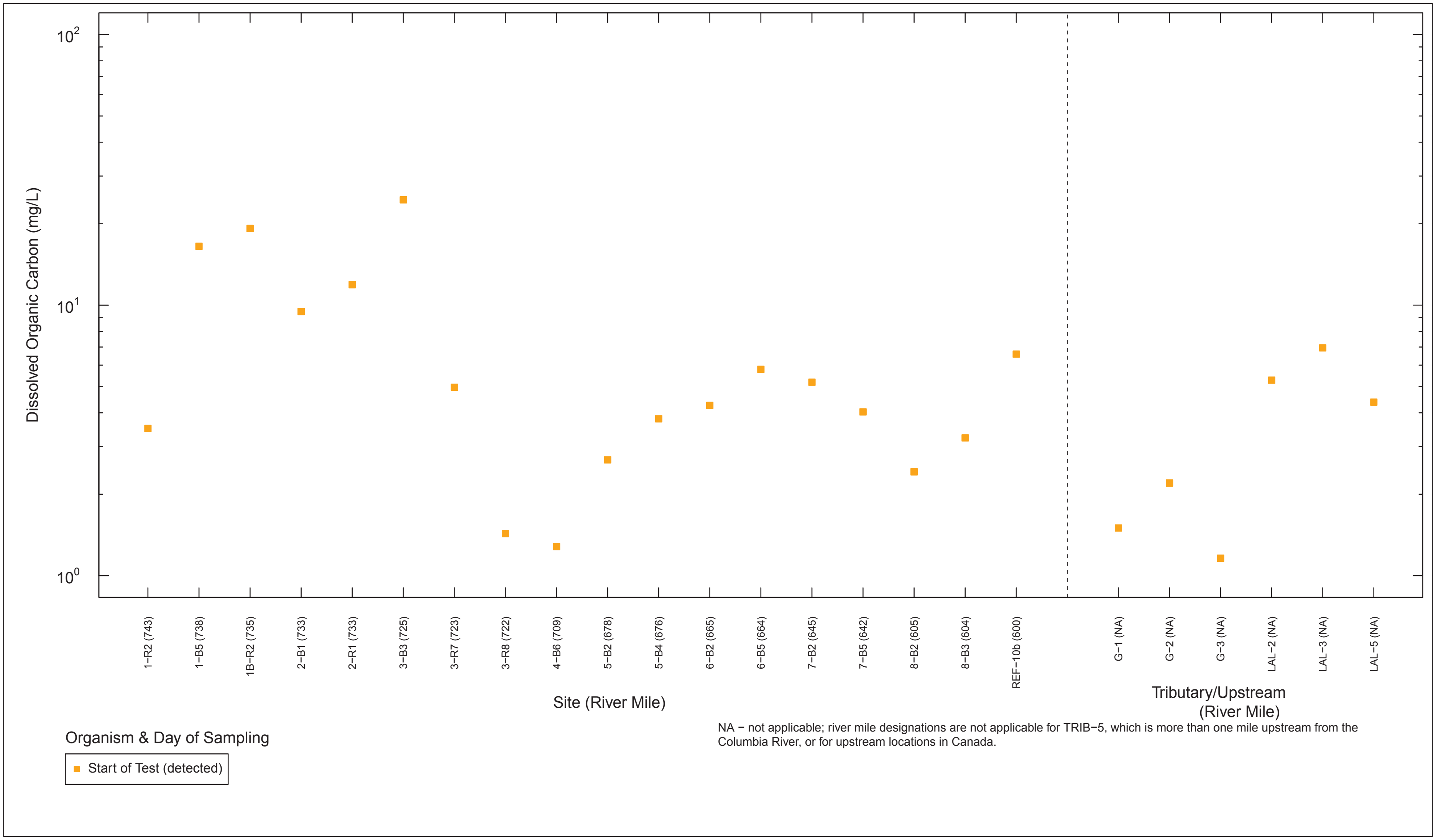


Figure 5−6b. Dissolved Organic Carbon in Porewater from Long−Term Bioassays

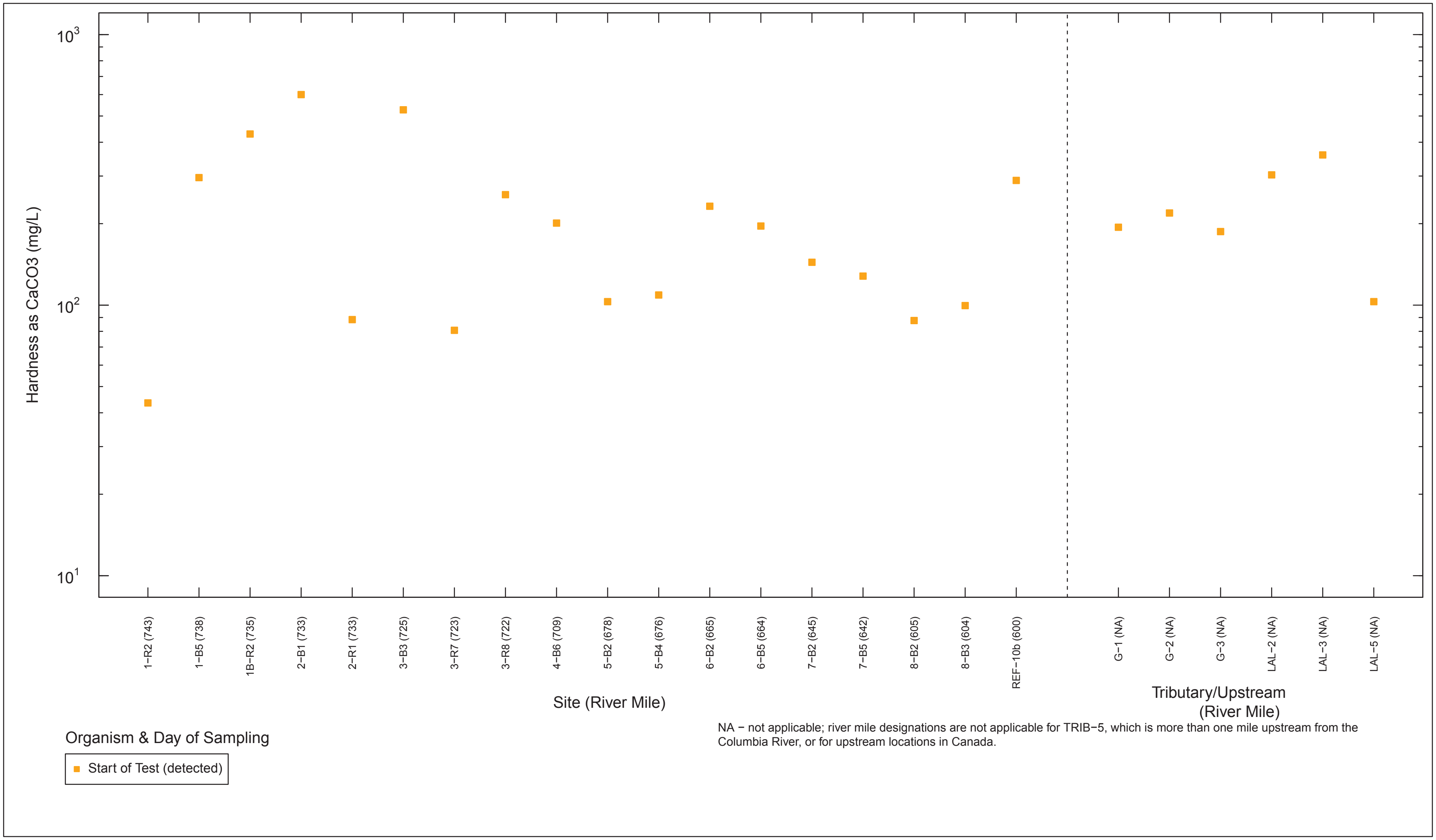


Figure 5−6c. Hardness as CaCO3 in Porewater from Long−Term Bioassays

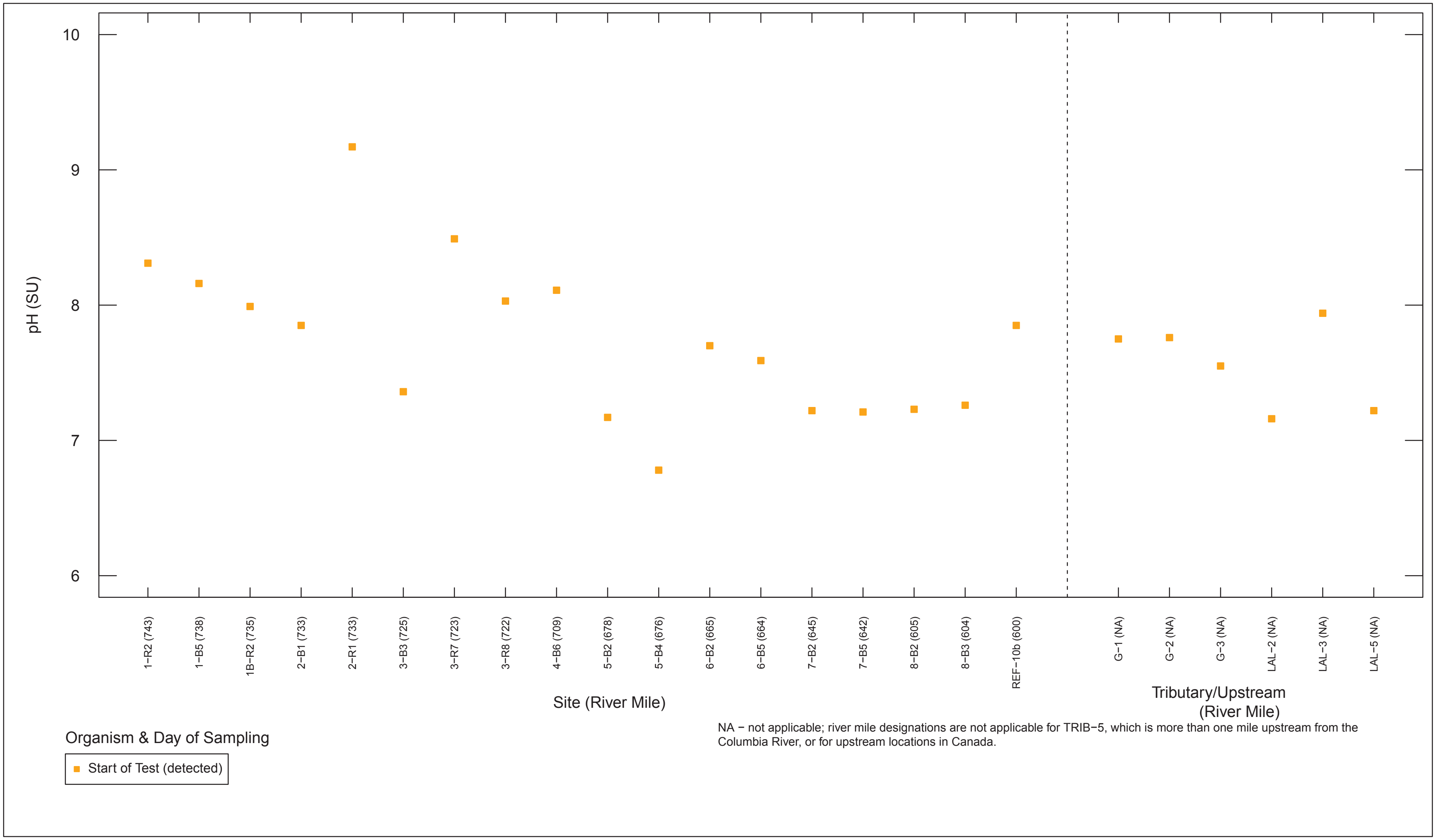


Figure 5−6d. pH in Porewater from Long−Term Bioassays

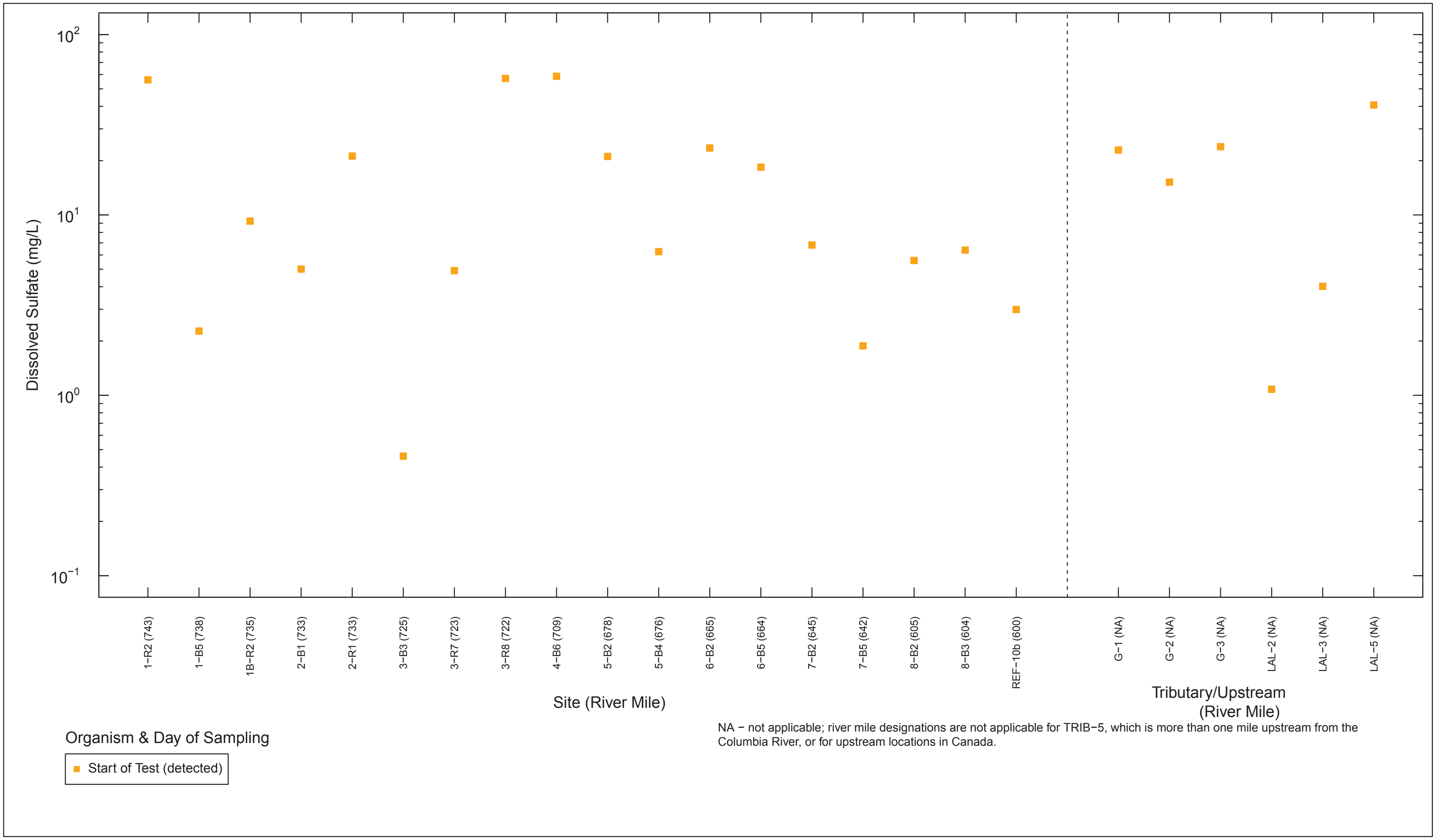


Figure 5−6e. Dissolved Sulfate in Porewater from Long−Term Bioassays

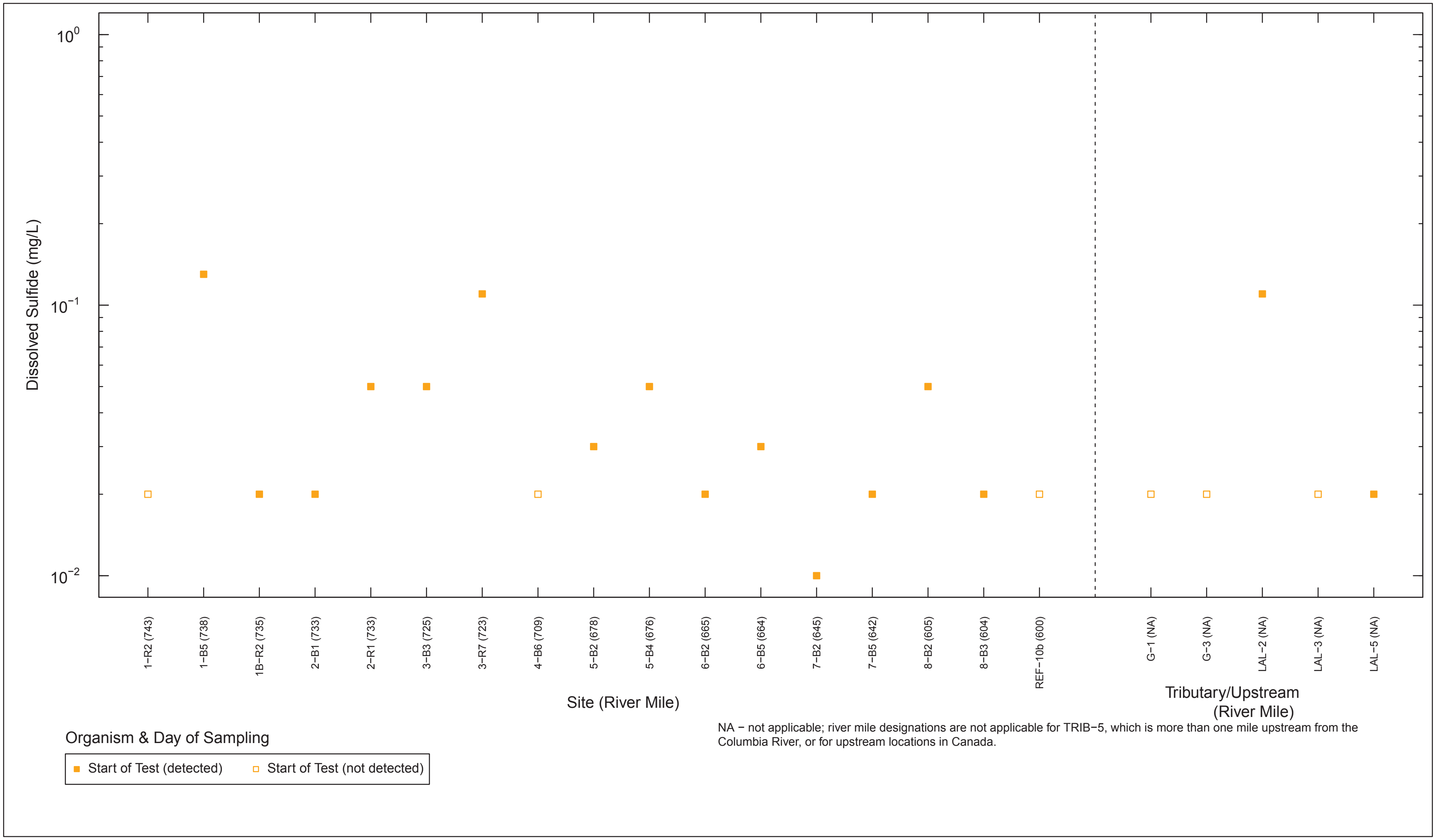


Figure 5−6f. Dissolved Sulfide in Porewater from Long−Term Bioassays

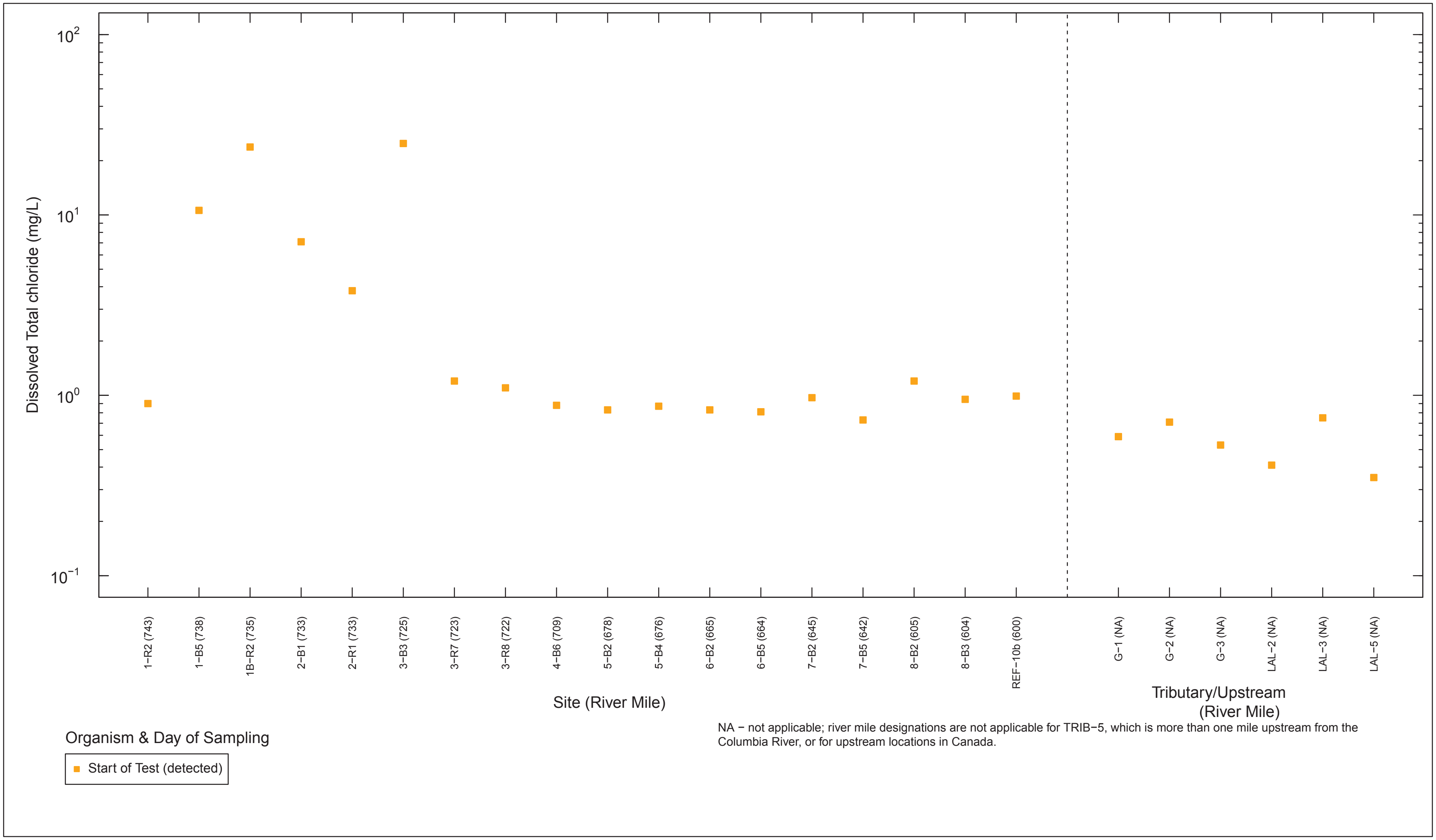


Figure 5−6g. Dissolved Total Chloride in Porewater from Long−Term Bioassays

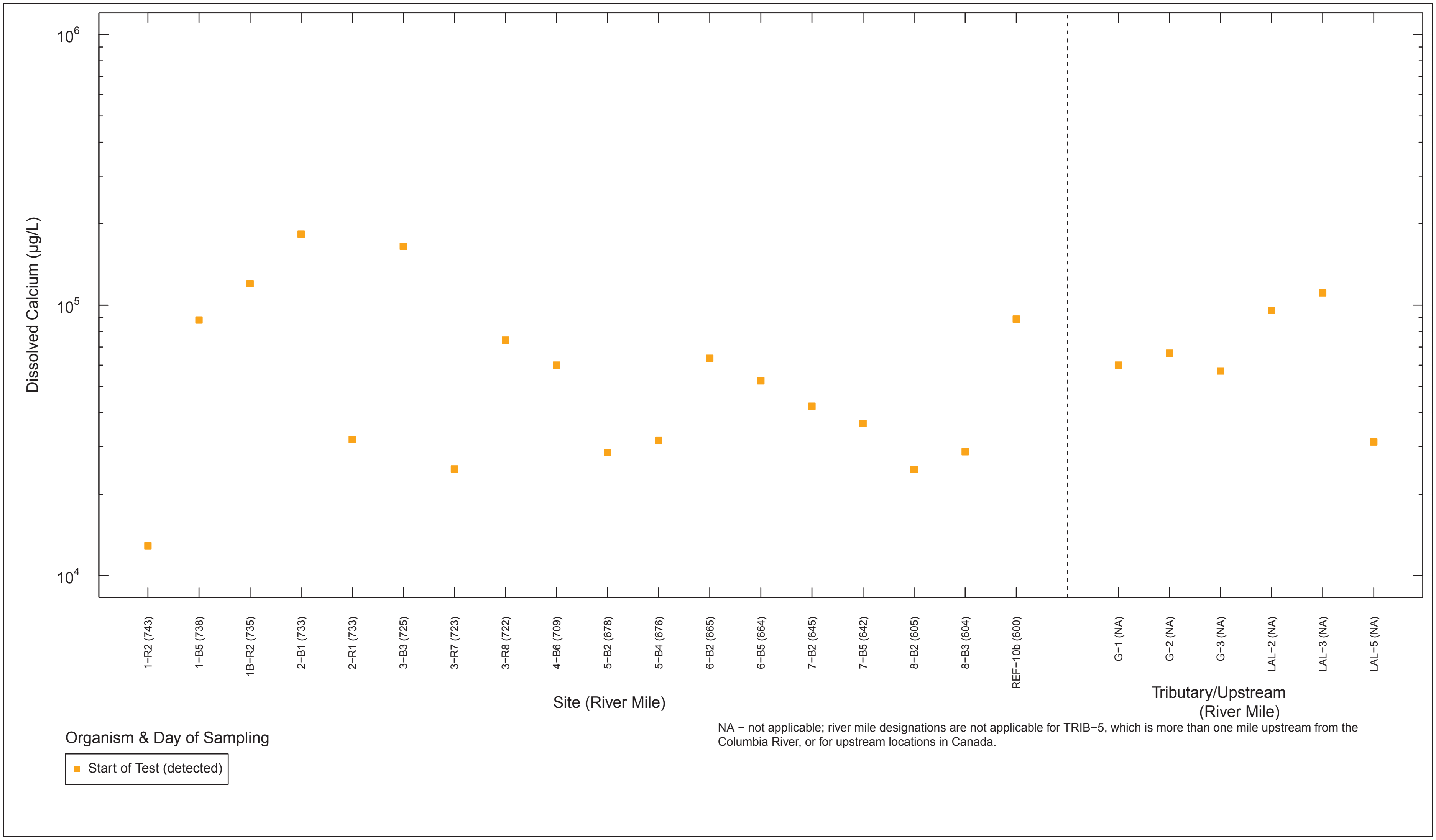


Figure 5−6h. Dissolved Calcium in Porewater from Long−Term Bioassays

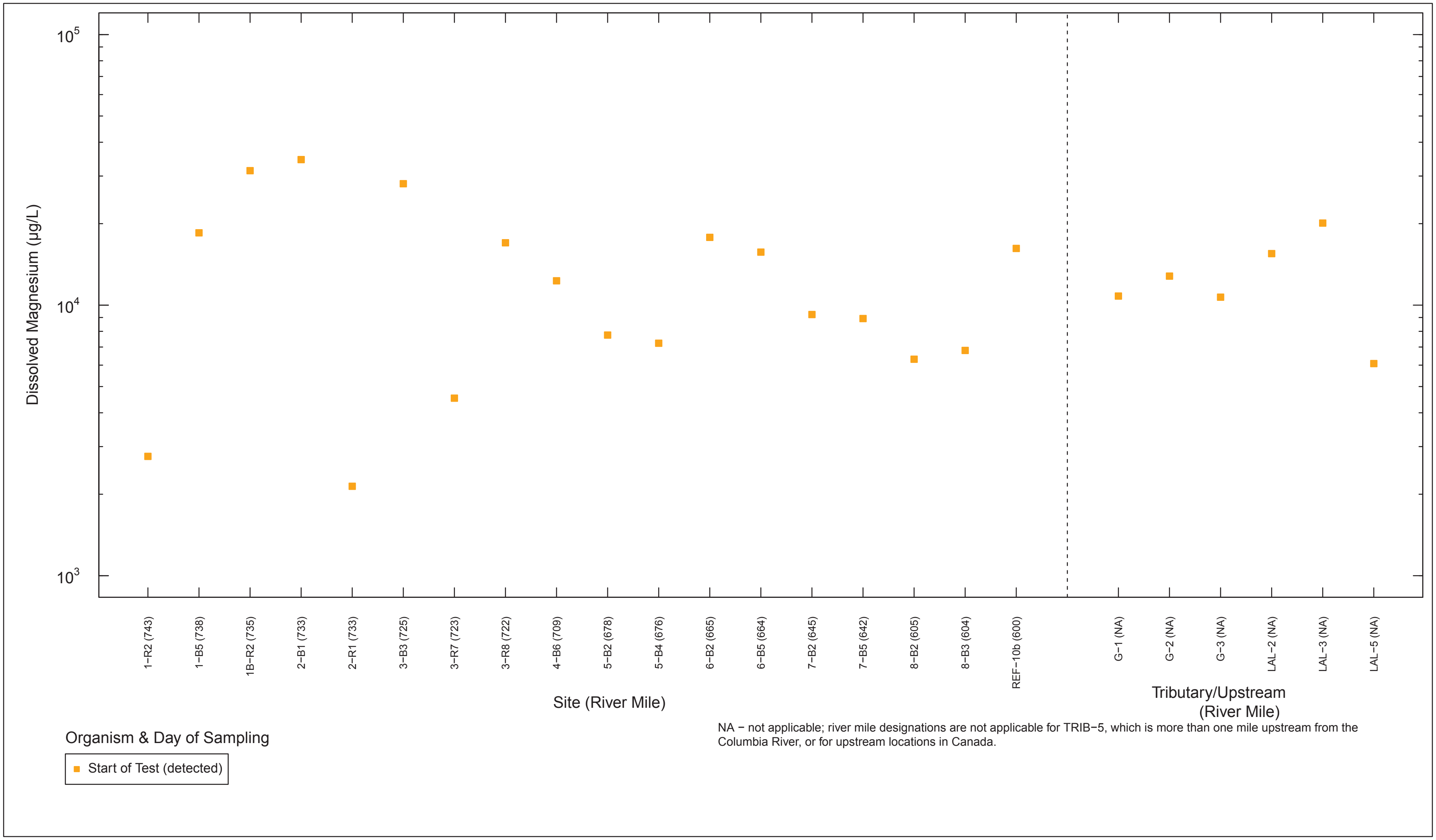


Figure 5−6i. Dissolved Magnesium in Porewater from Long−Term Bioassays

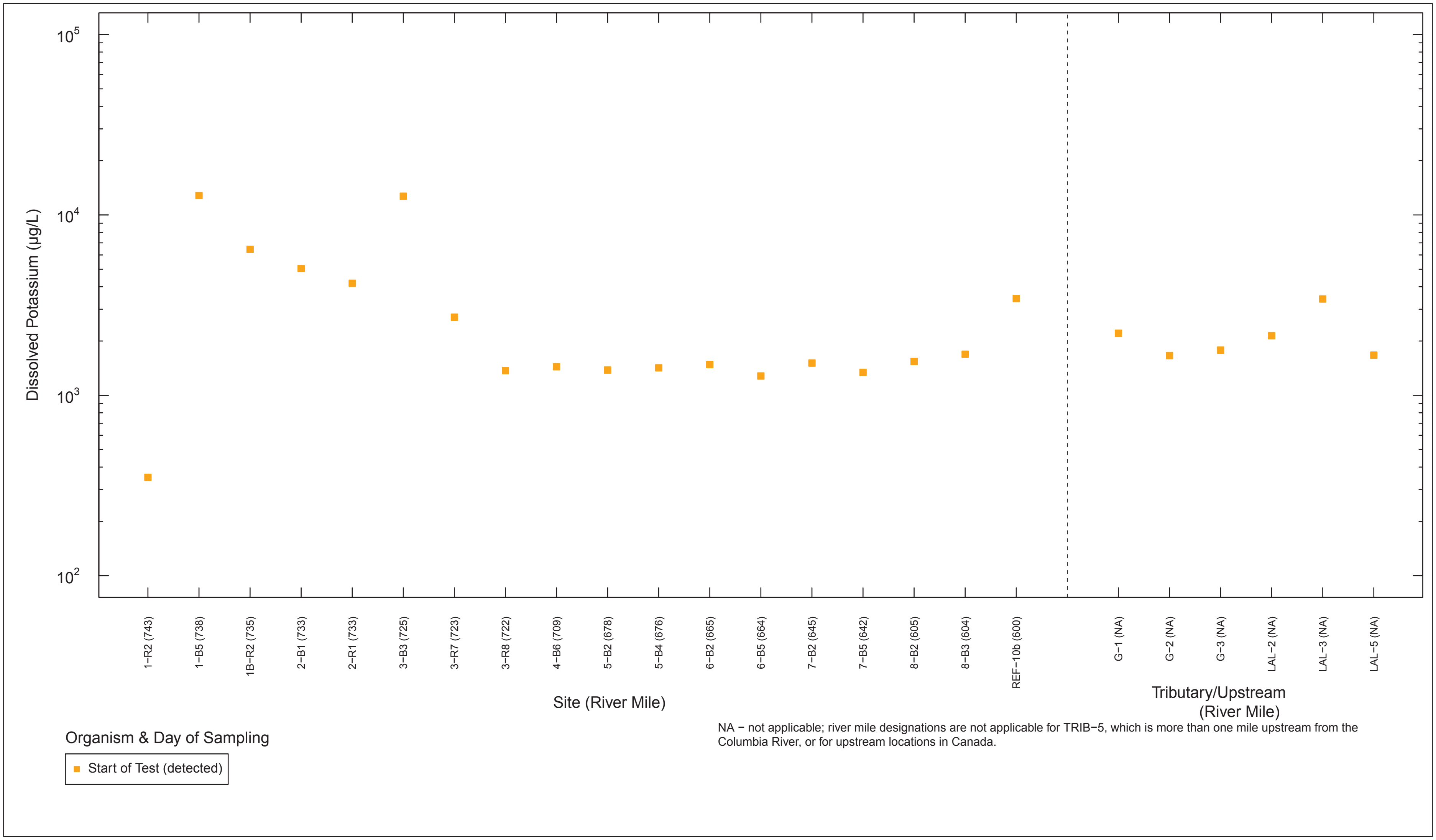


Figure 5−6j. Dissolved Potassium in Porewater from Long−Term Bioassays

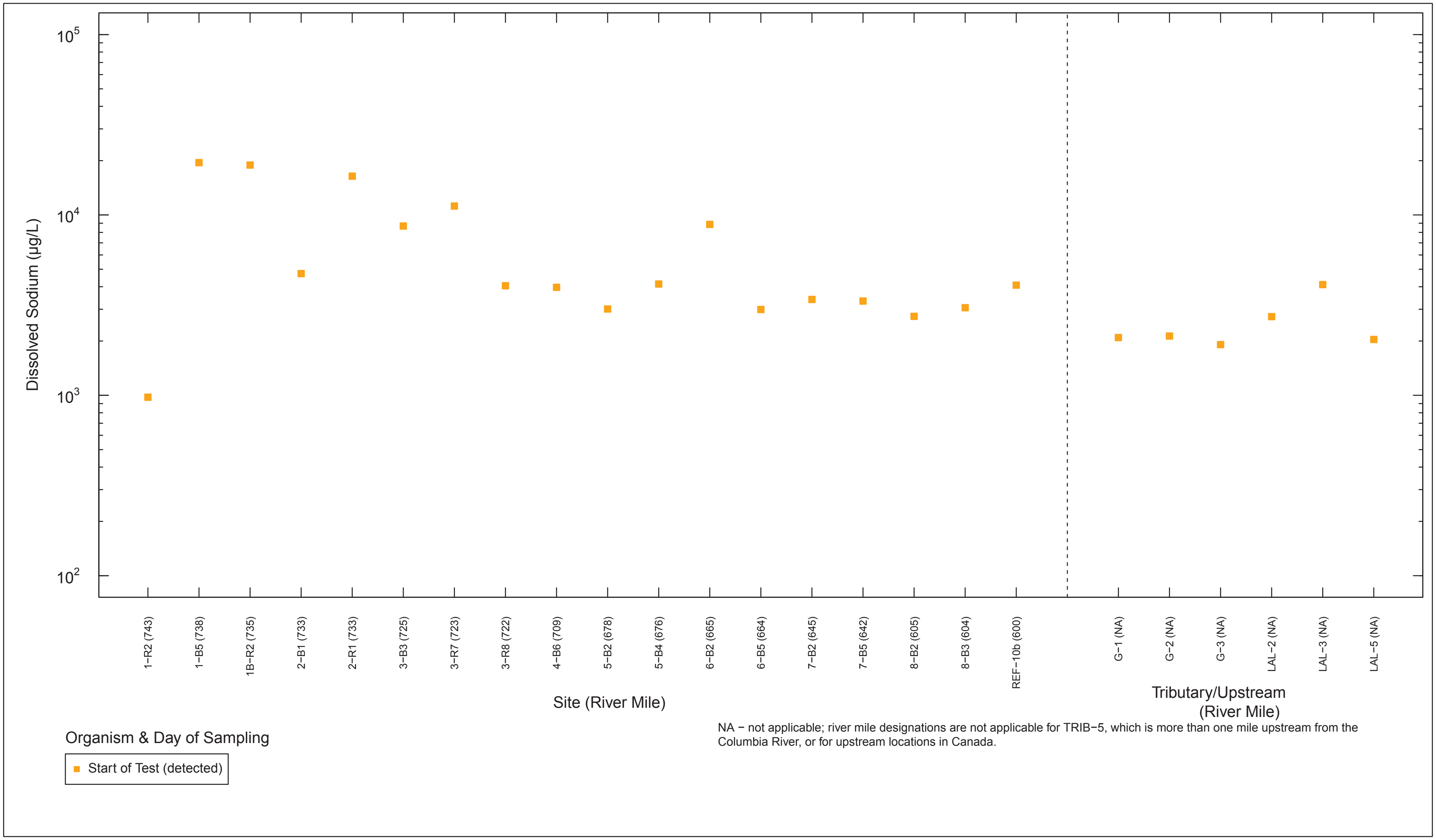


Figure 5−6k. Dissolved Sodium in Porewater from Long−Term Bioassays

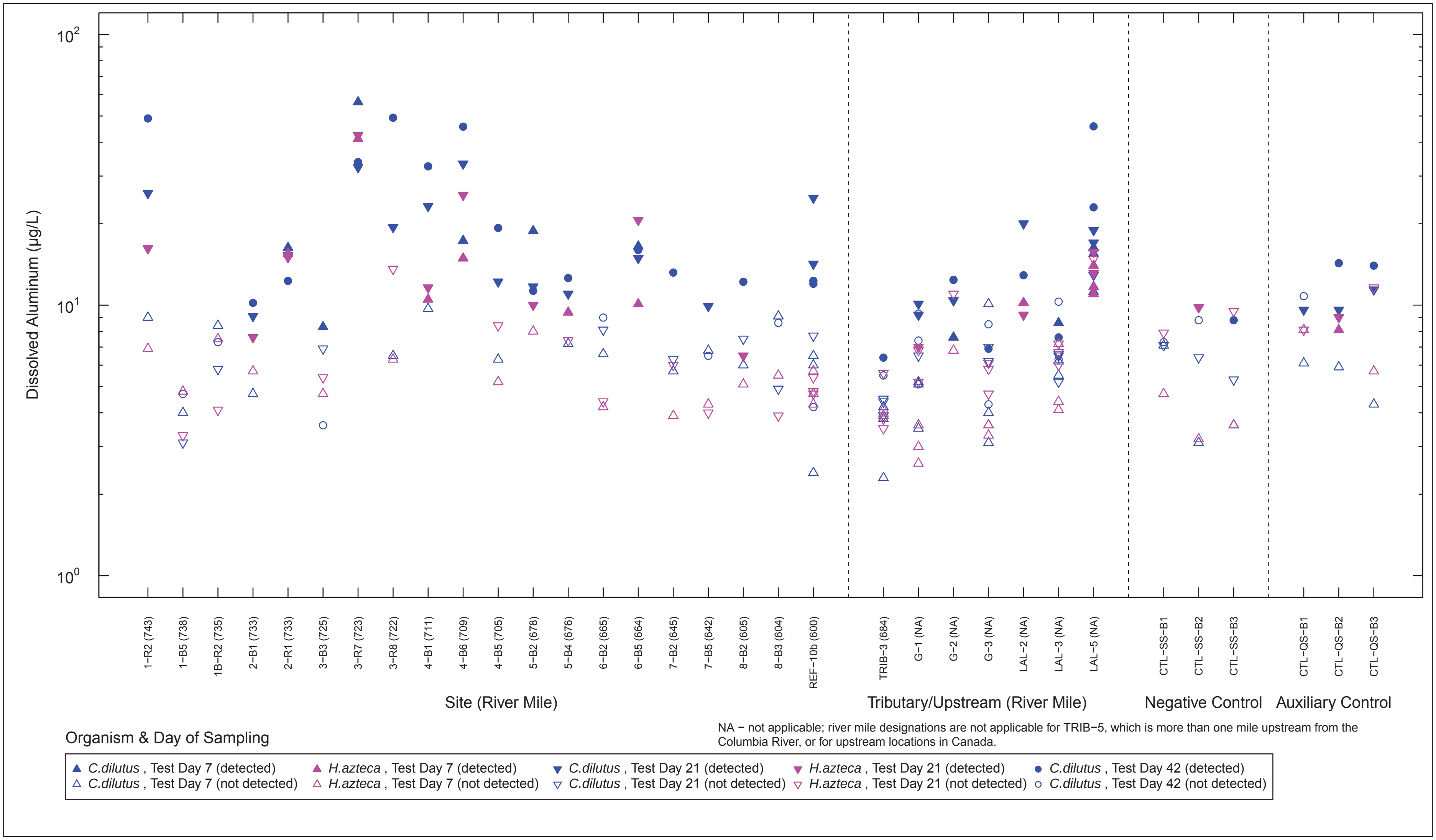


Figure 5−6l. Dissolved Aluminum in Porewater from Long−Term Bioassays

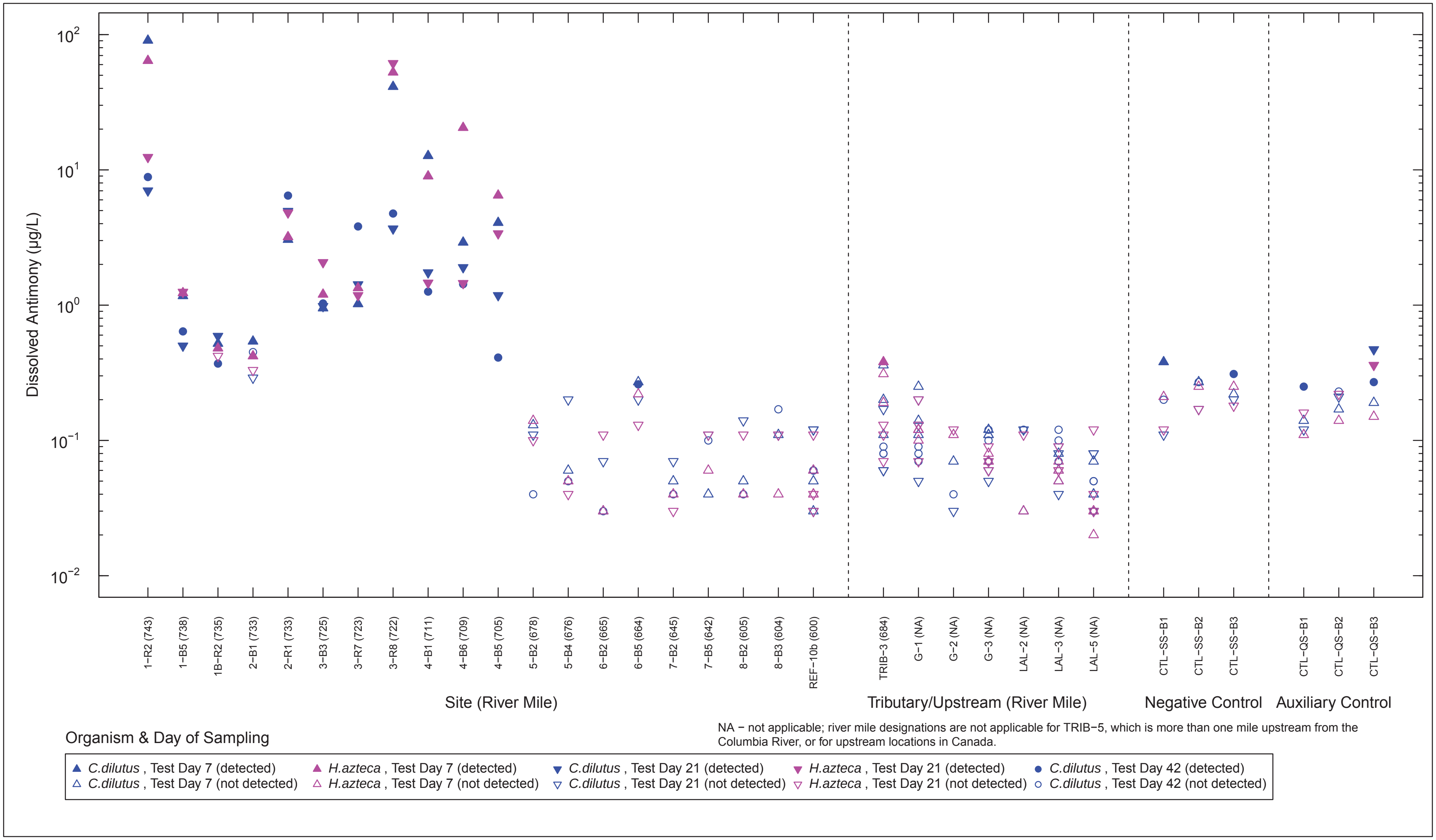


Figure 5−6m. Dissolved Antimony in Porewater from Long−Term Bioassays

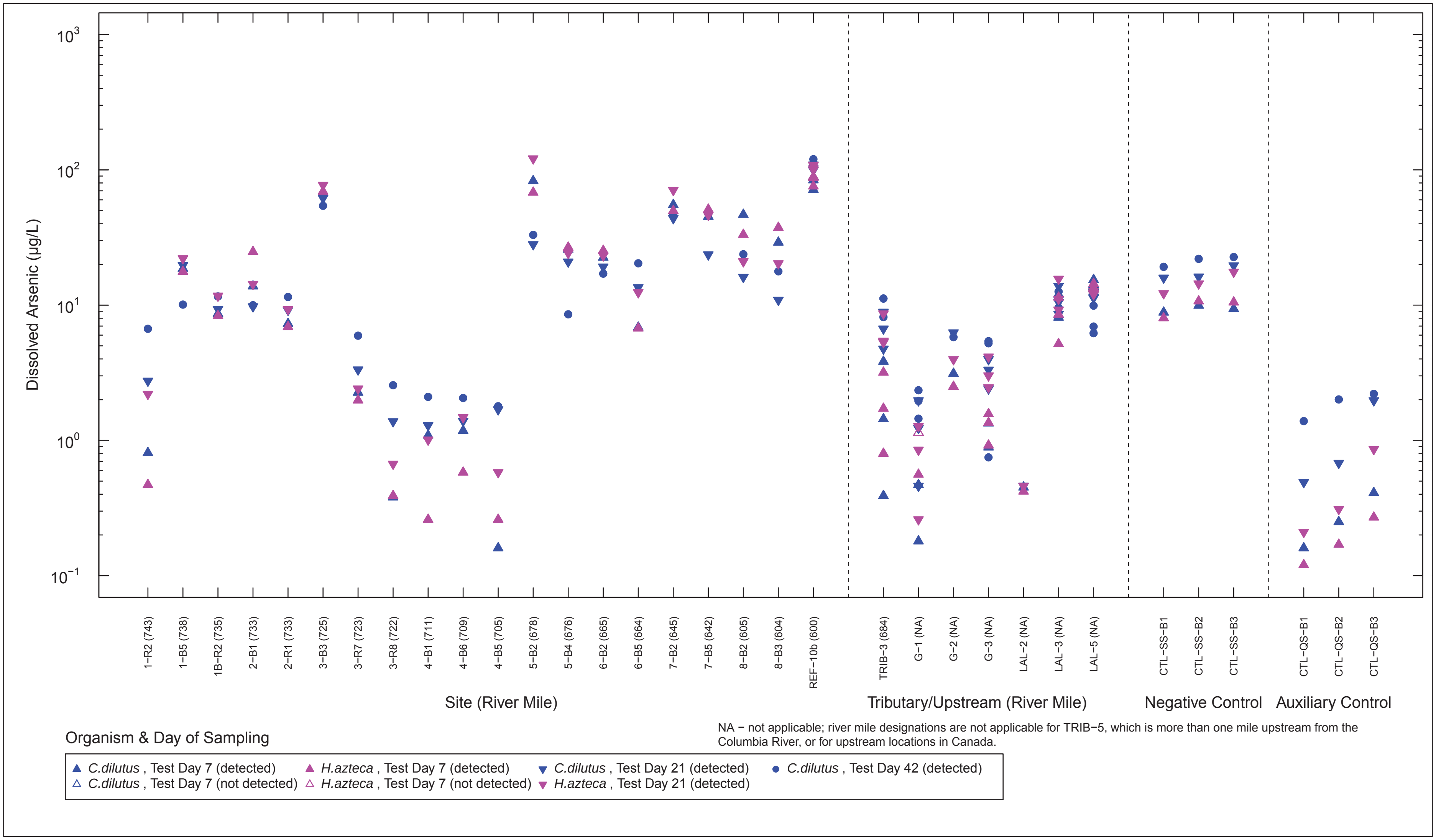


Figure 5−6n. Dissolved Arsenic in Porewater from Long−Term Bioassays

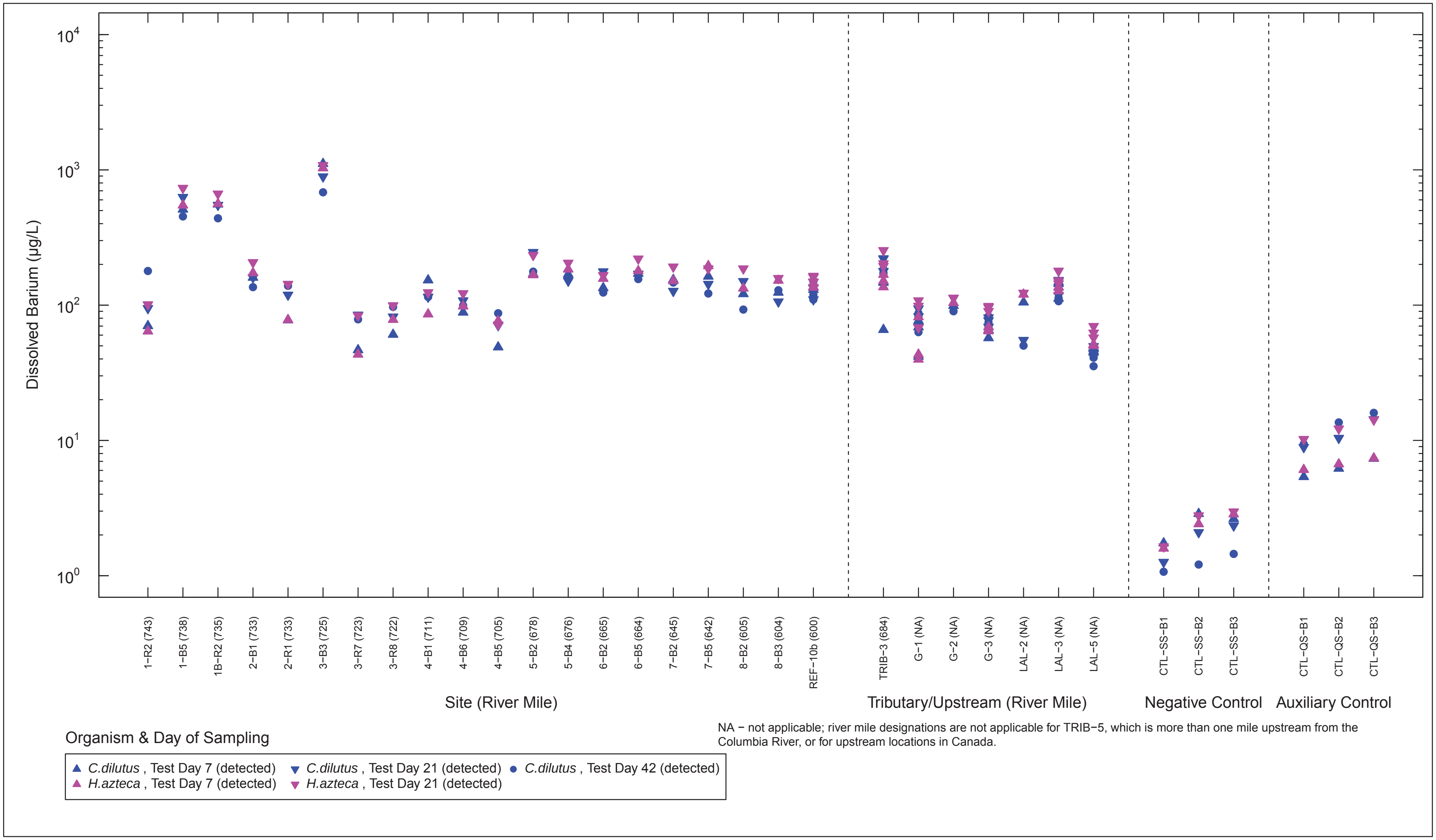


Figure 5−6o. Dissolved Barium in Porewater from Long−Term Bioassays

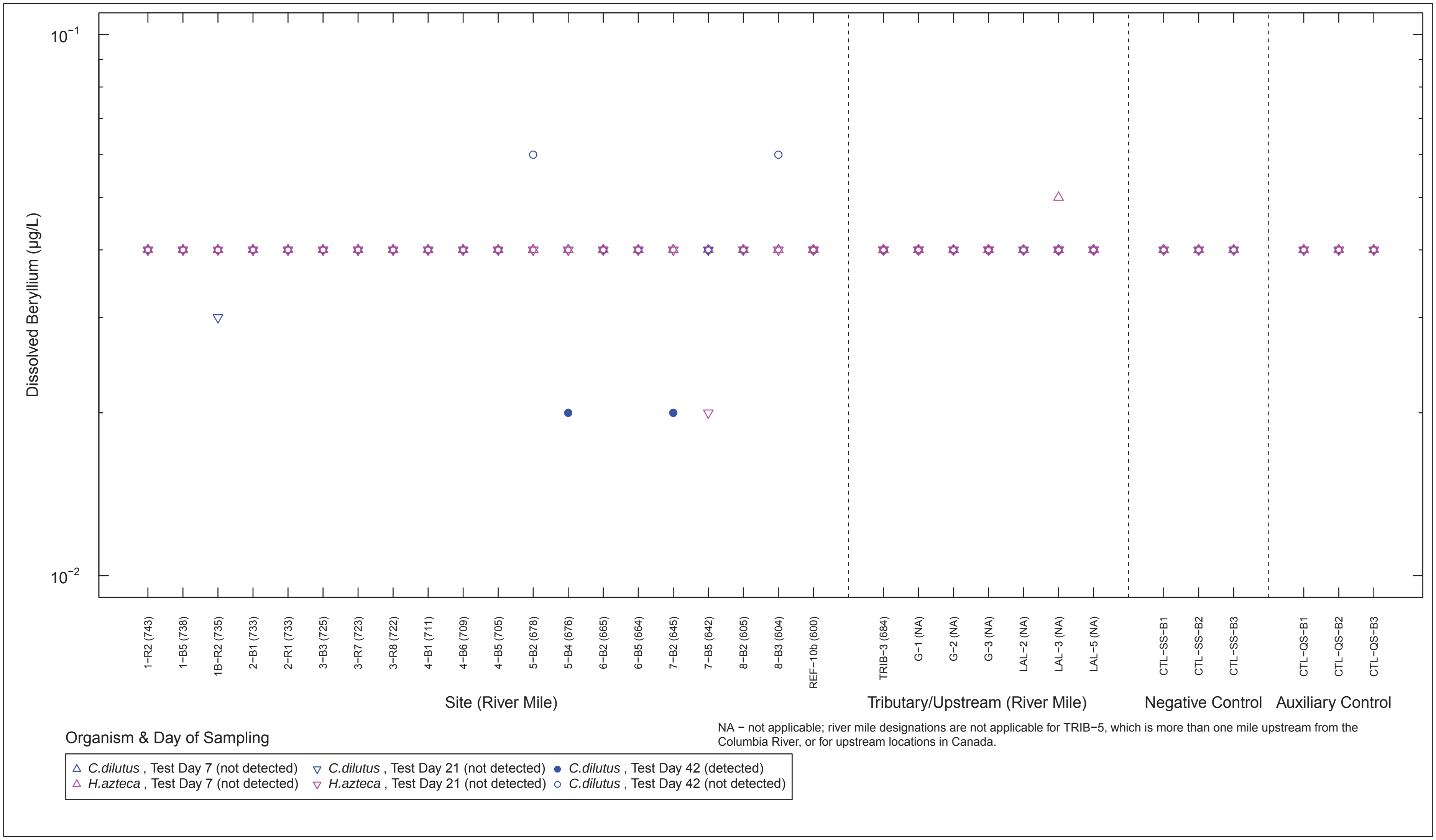


Figure 5−6p. Dissolved Beryllium in Porewater from Long−Term Bioassays

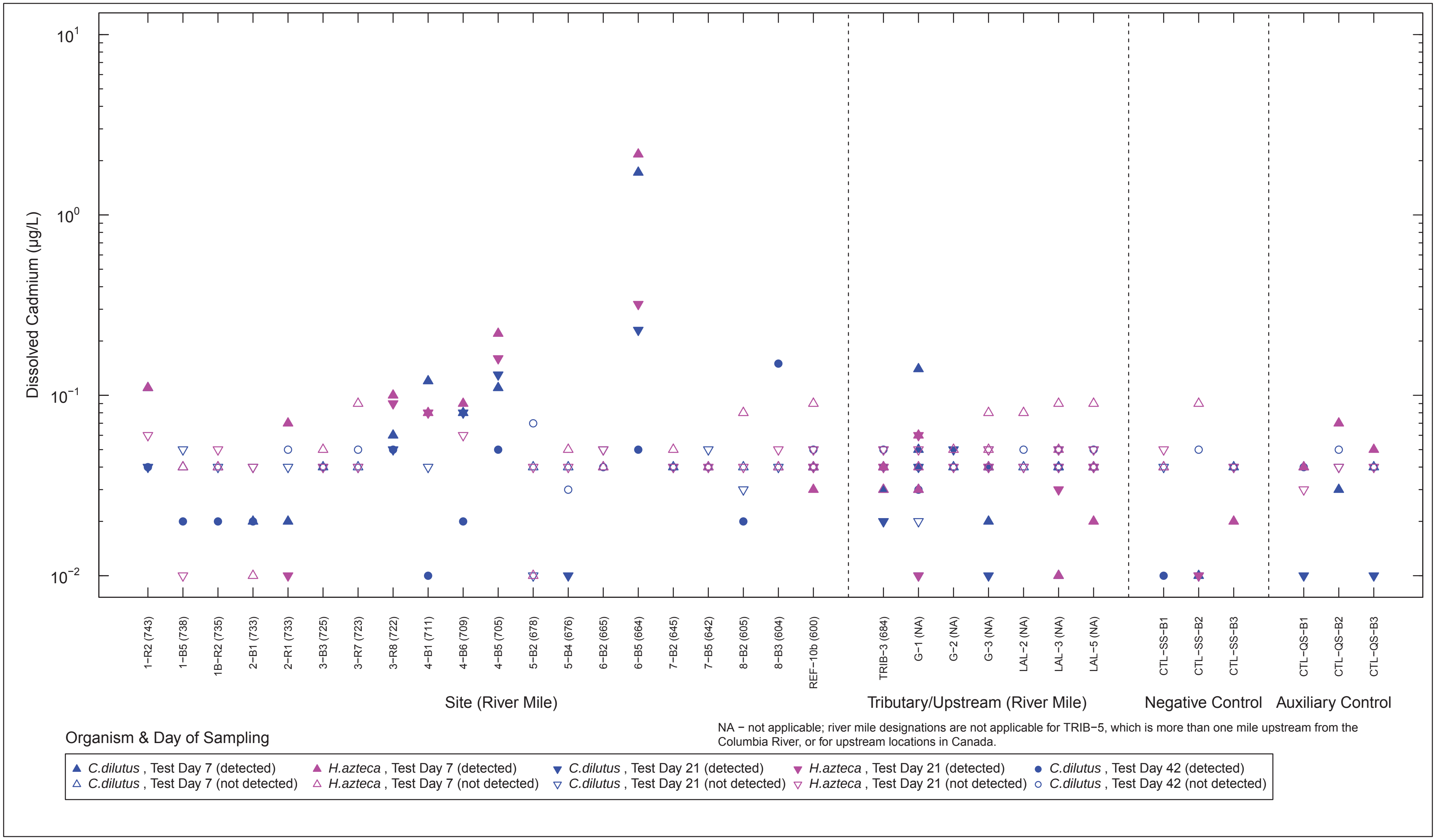


Figure 5−6q. Dissolved Cadmium in Porewater from Long−Term Bioassays

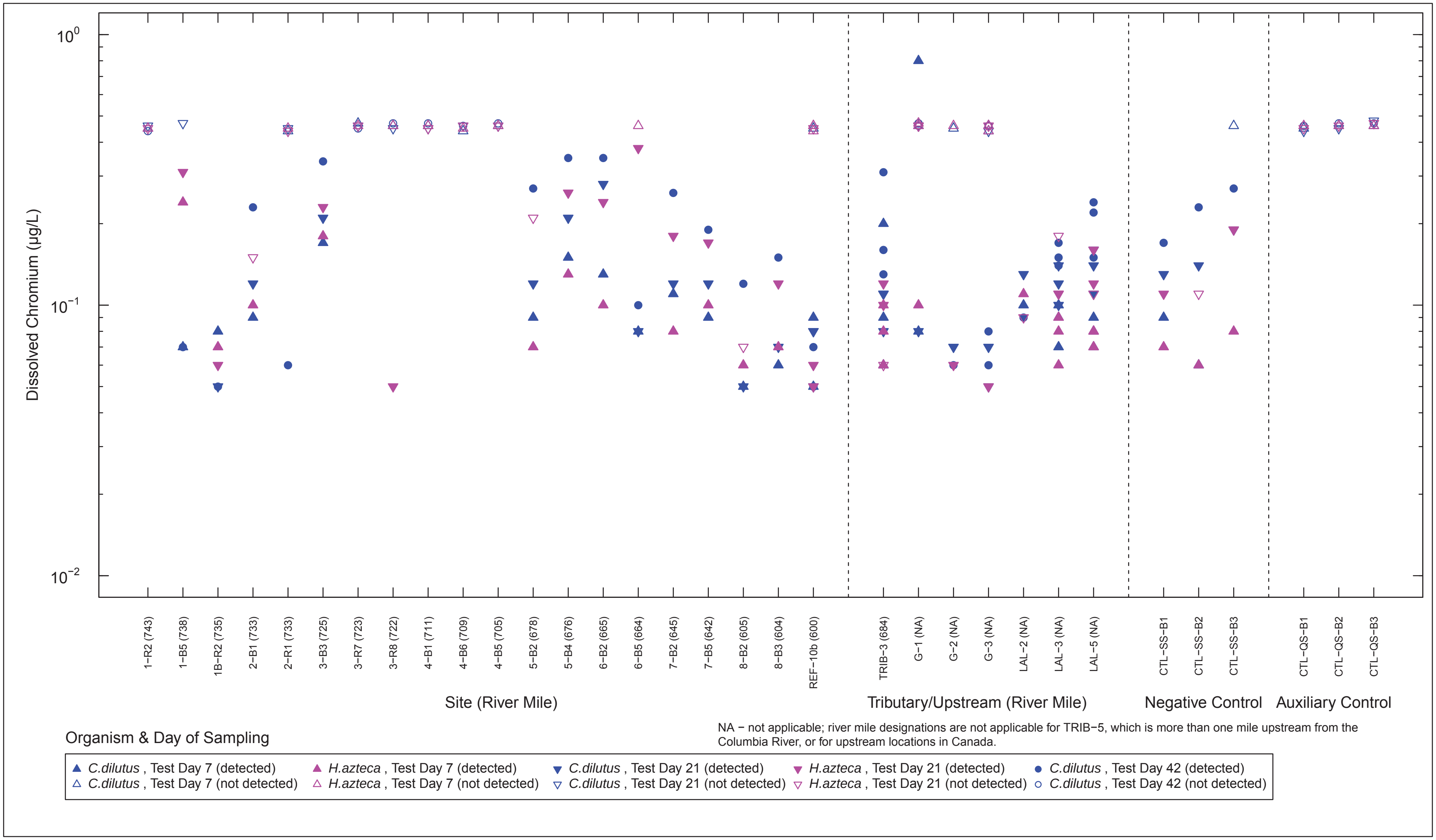


Figure 5−6r. Dissolved Chromium in Porewater from Long−Term Bioassays

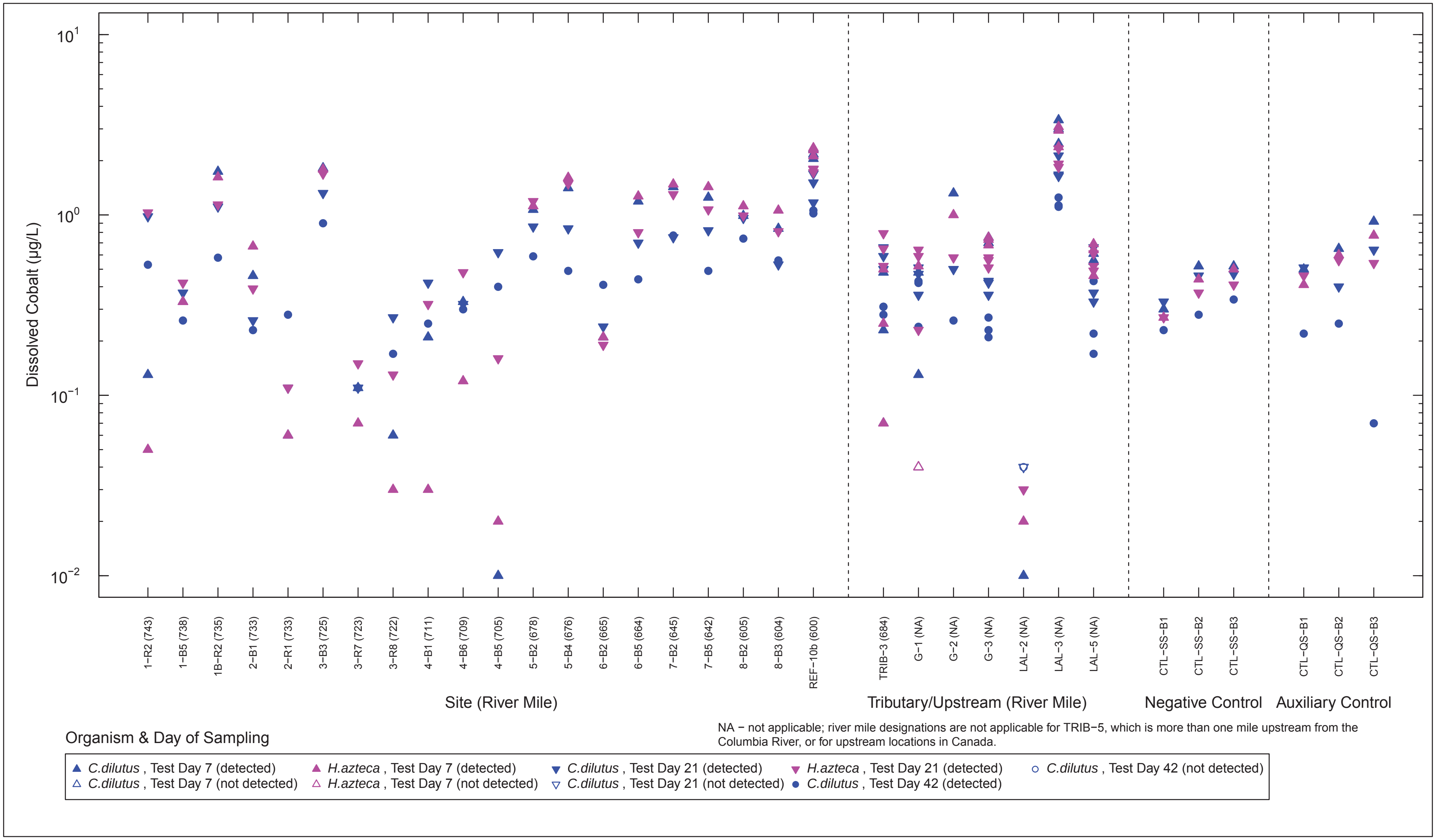


Figure 5−6s. Dissolved Cobalt in Porewater from Long−Term Bioassays

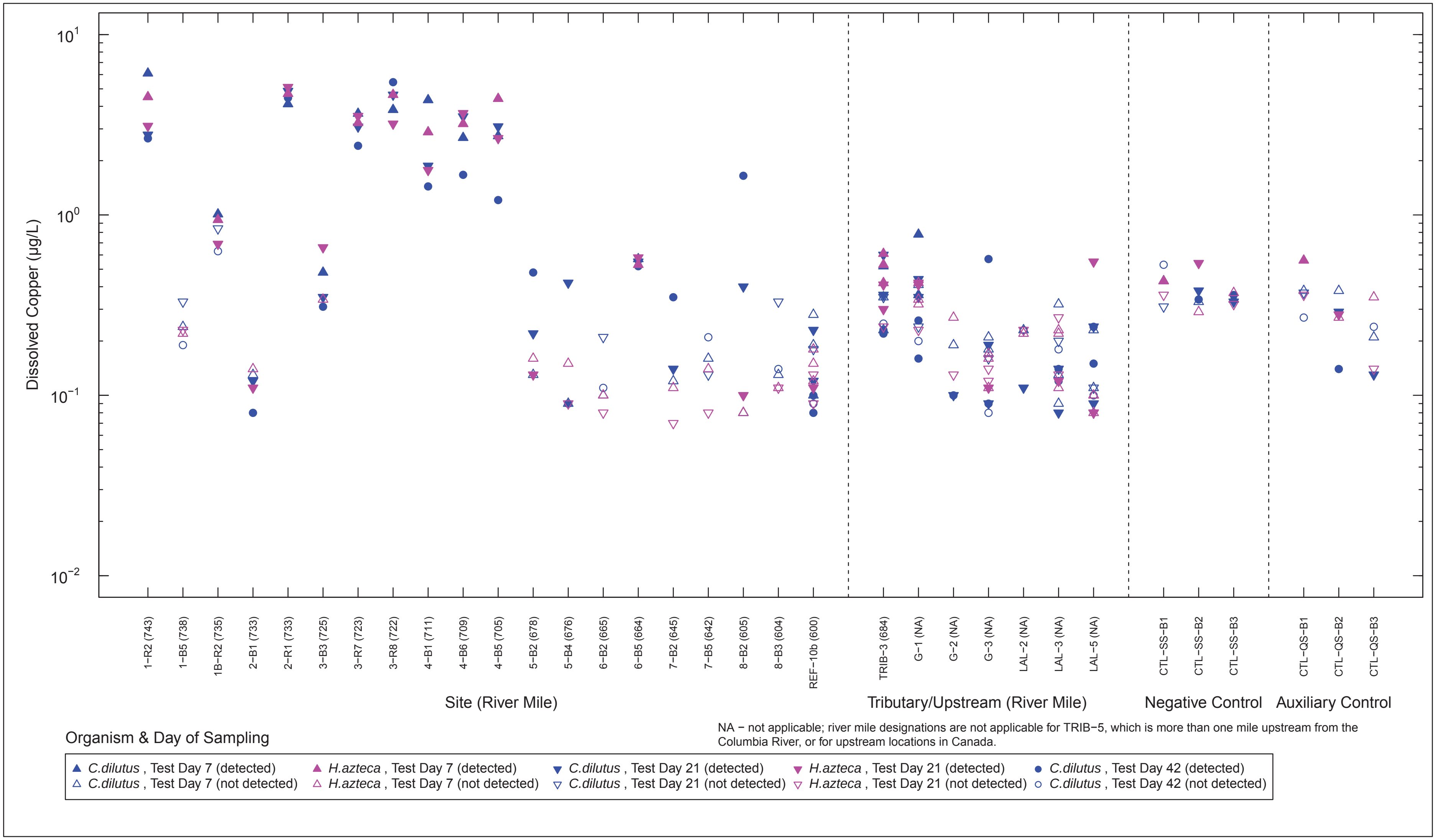


Figure 5−6t. Dissolved Copper in Porewater from Long−Term Bioassays

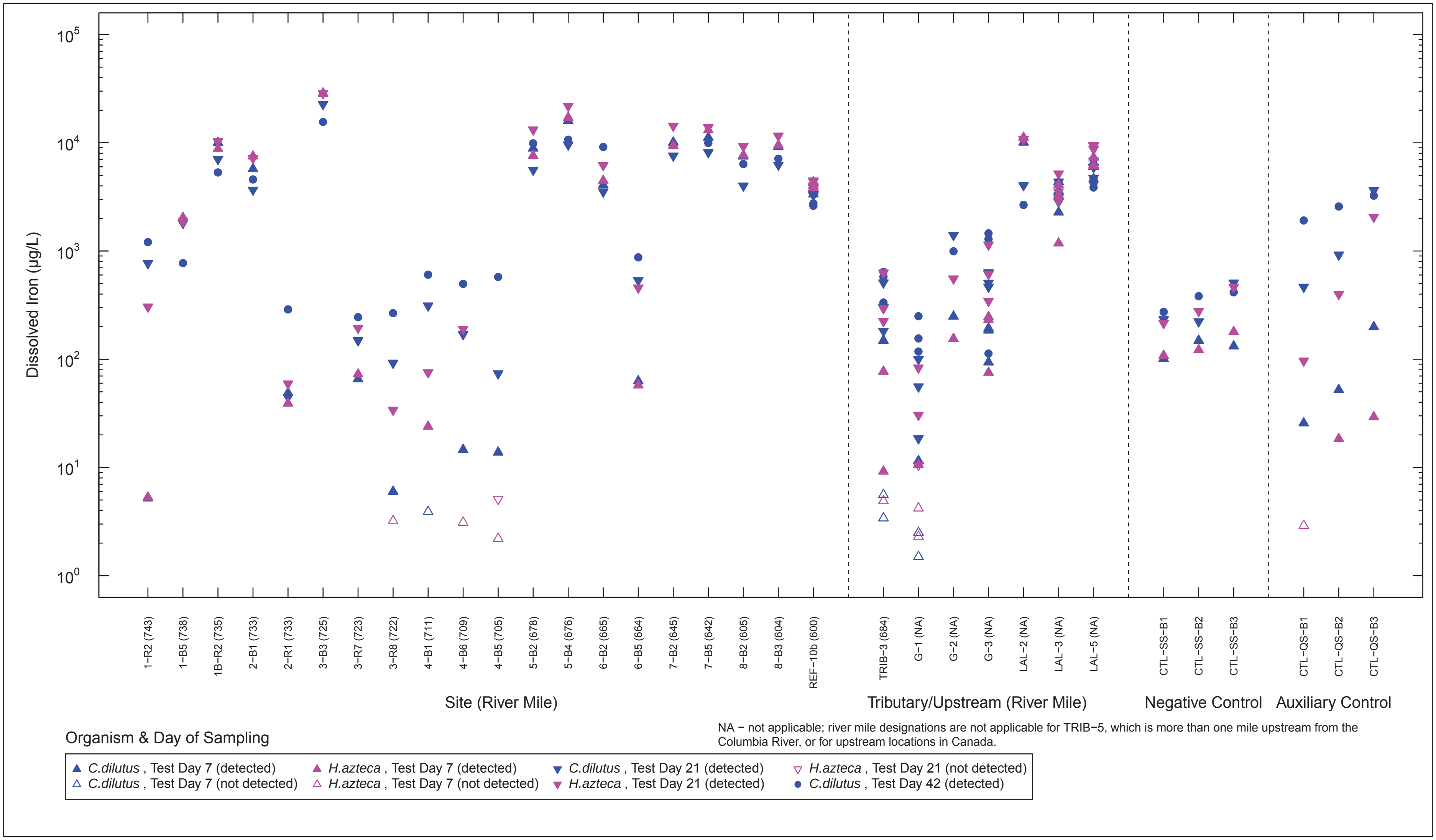


Figure 5−6u. Dissolved Iron in Porewater from Long−Term Bioassays

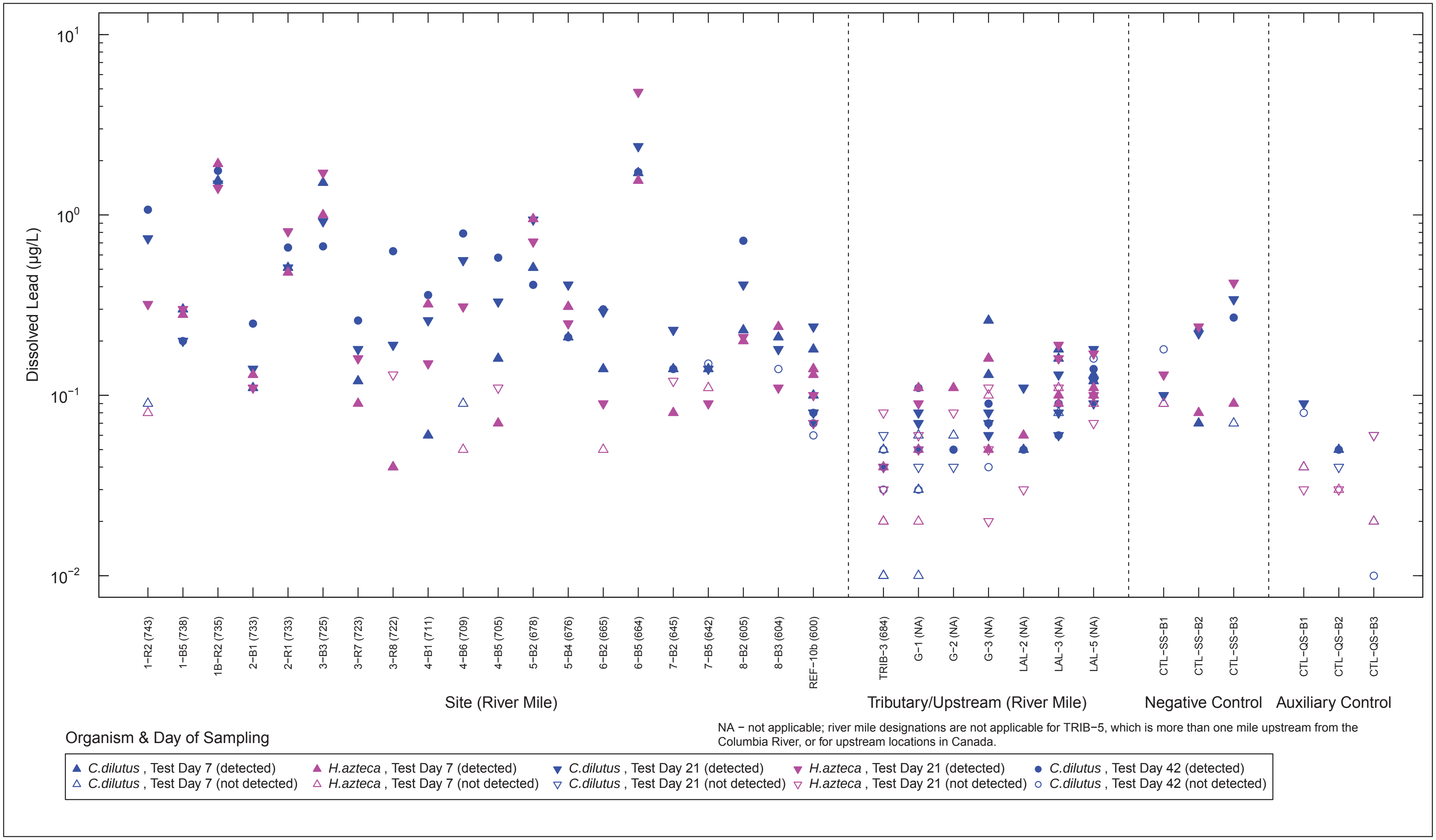


Figure 5−6v. Dissolved Lead in Porewater from Long−Term Bioassays

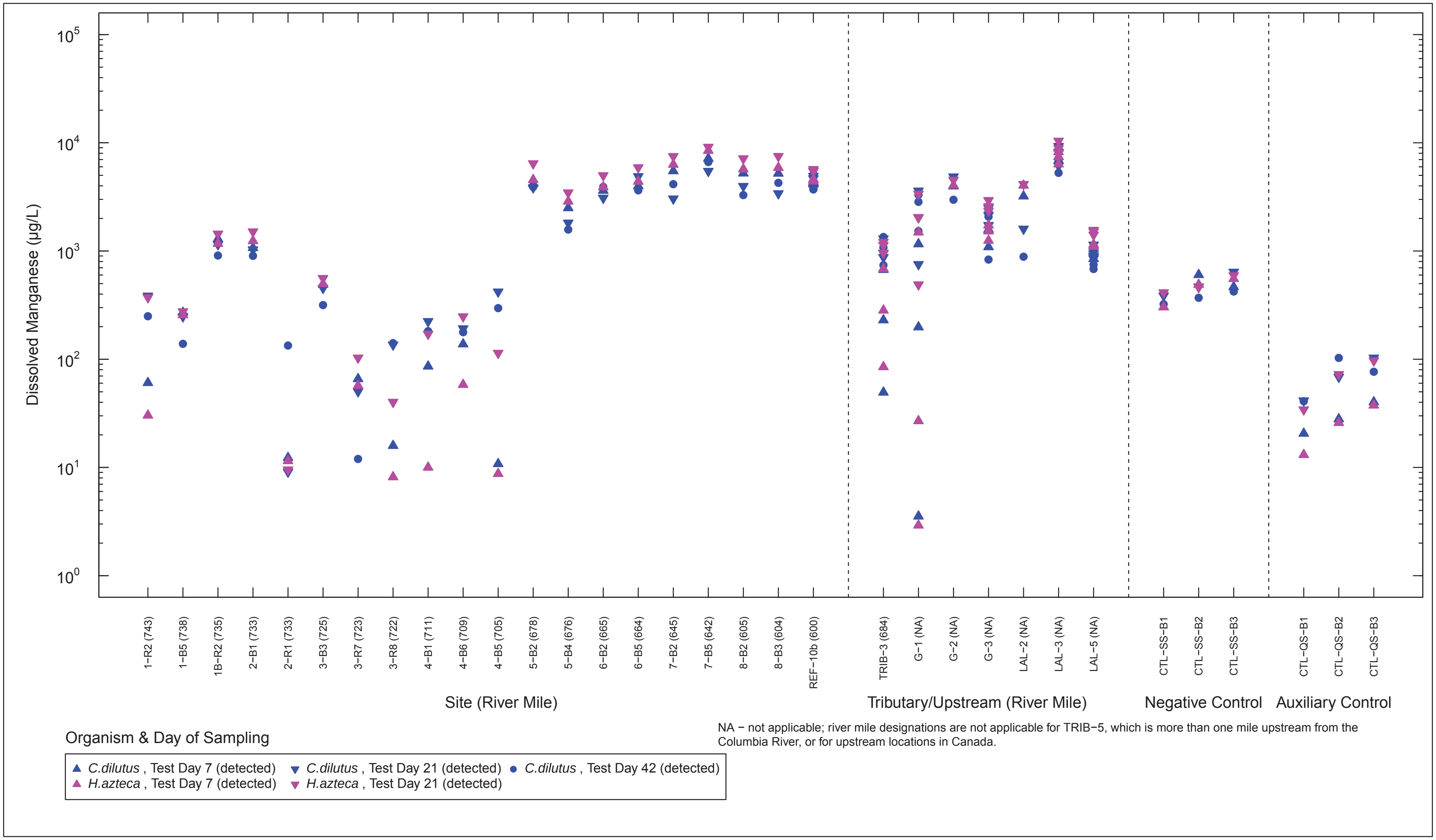


Figure 5−6w. Dissolved Manganese in Porewater from Long−Term Bioassays

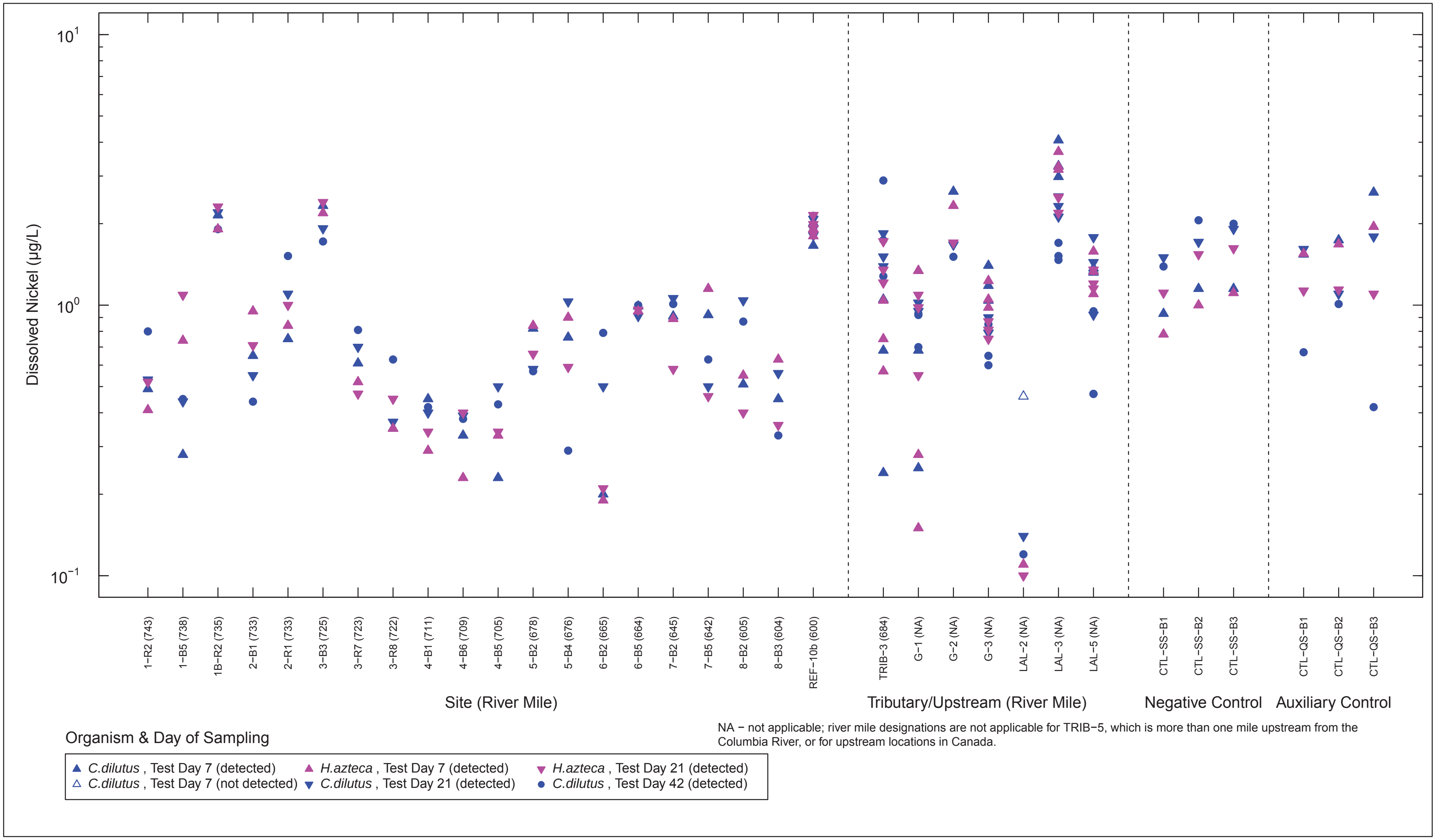


Figure 5−6x. Dissolved Nickel in Porewater from Long−Term Bioassays

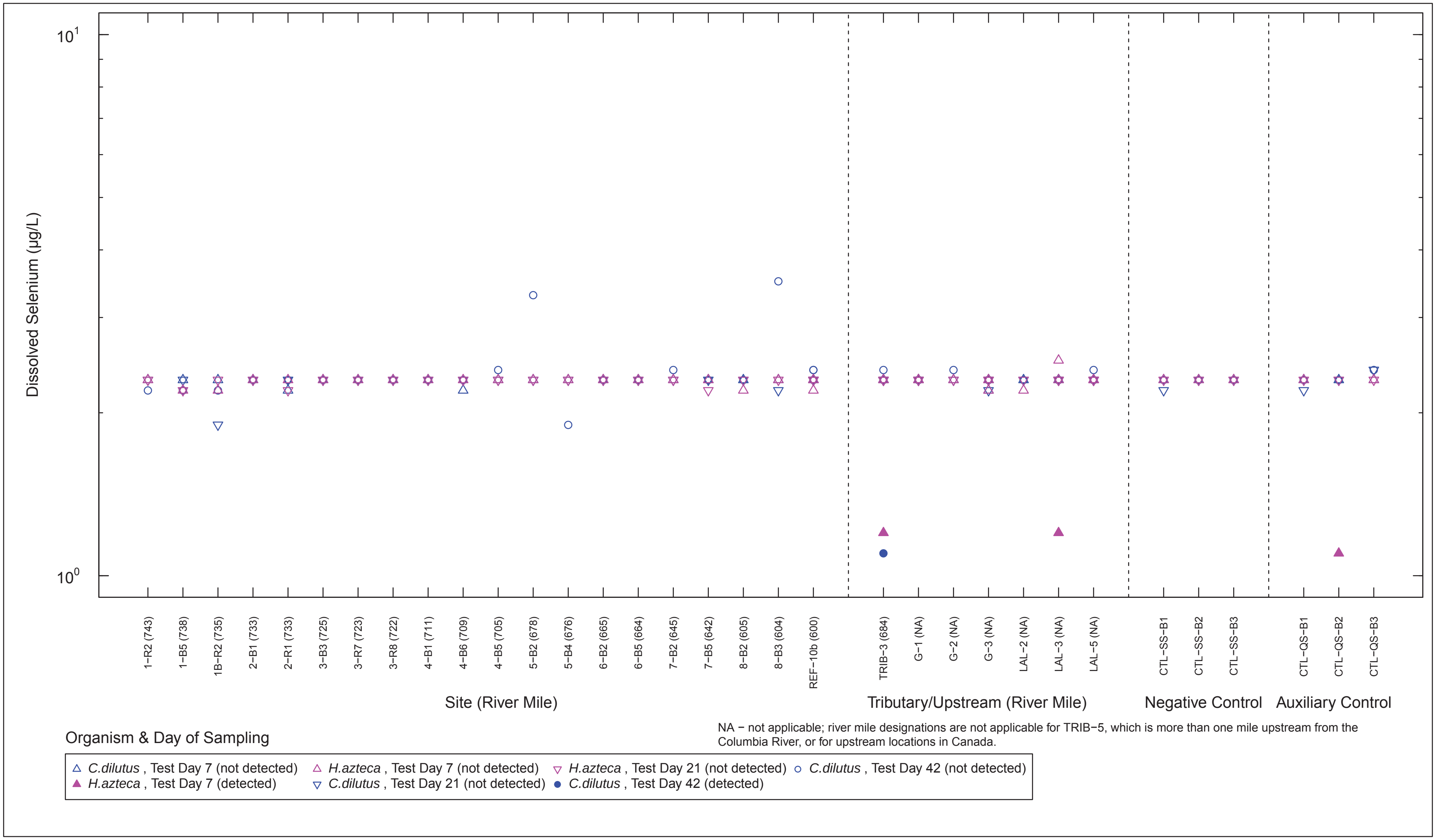


Figure 5−6y. Dissolved Selenium in Porewater from Long−Term Bioassays

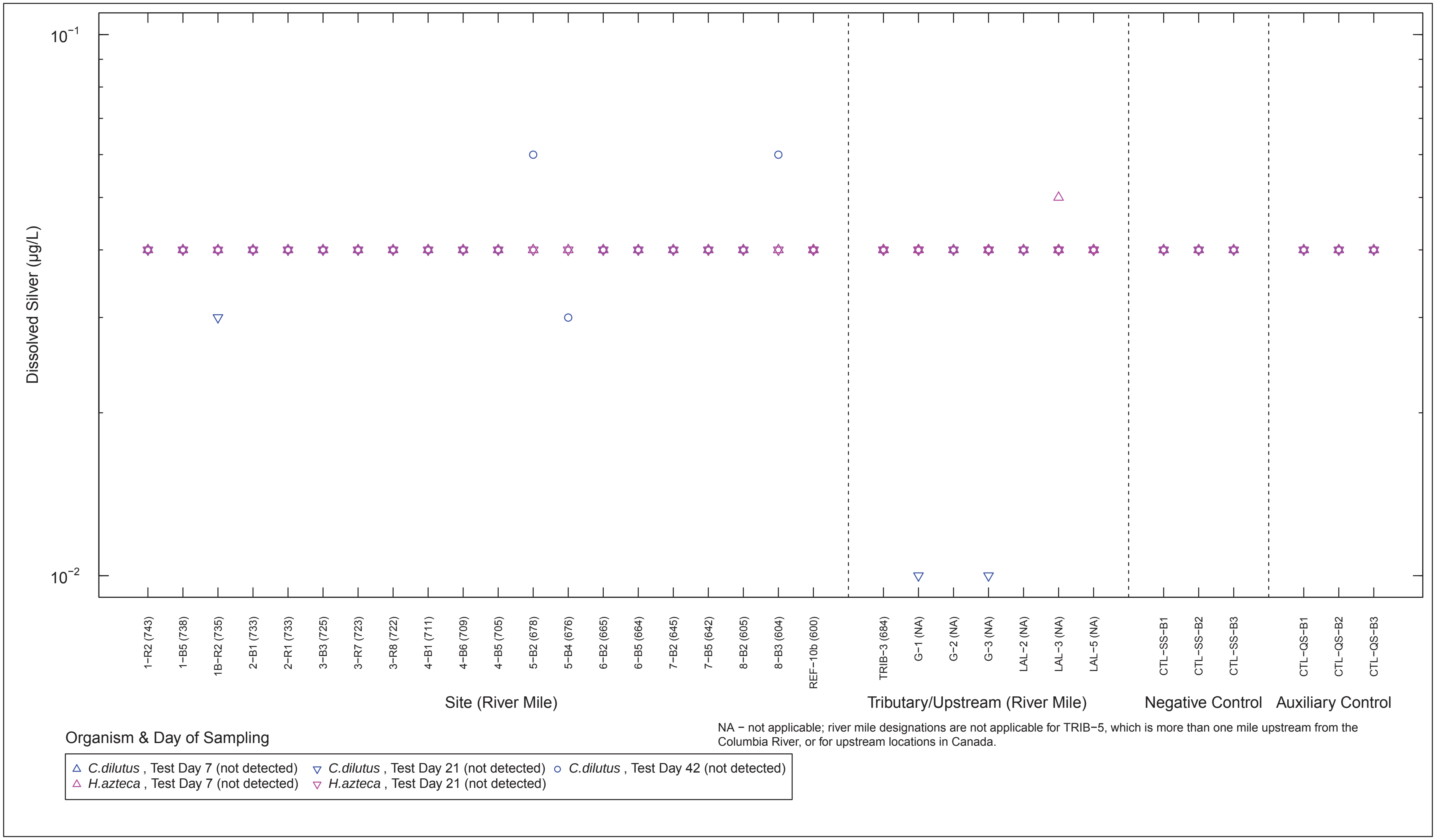


Figure 5−6z. Dissolved Silver in Porewater from Long−Term Bioassays

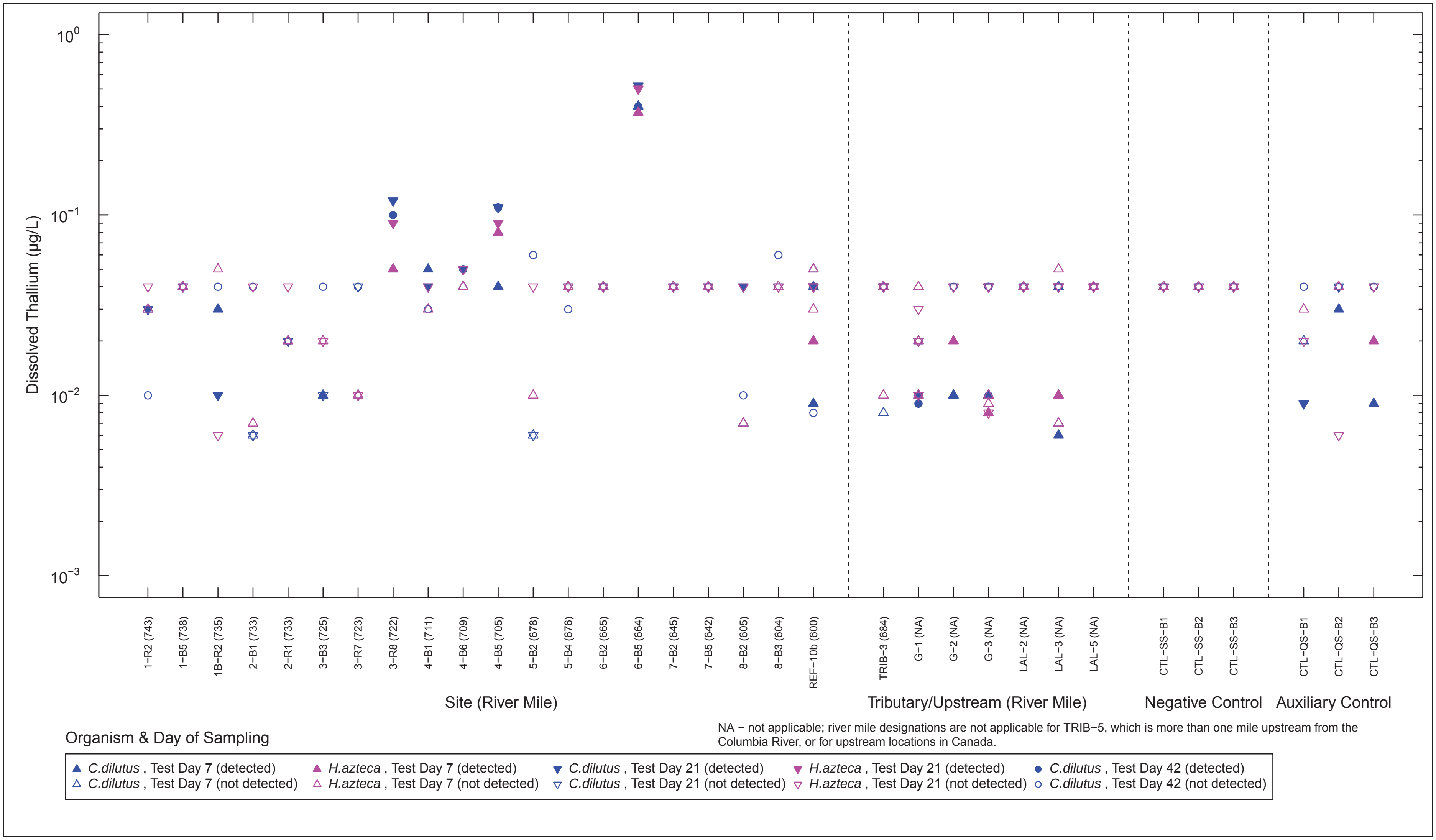


Figure 5−6aa. Dissolved Thallium in Porewater from Long−Term Bioassays

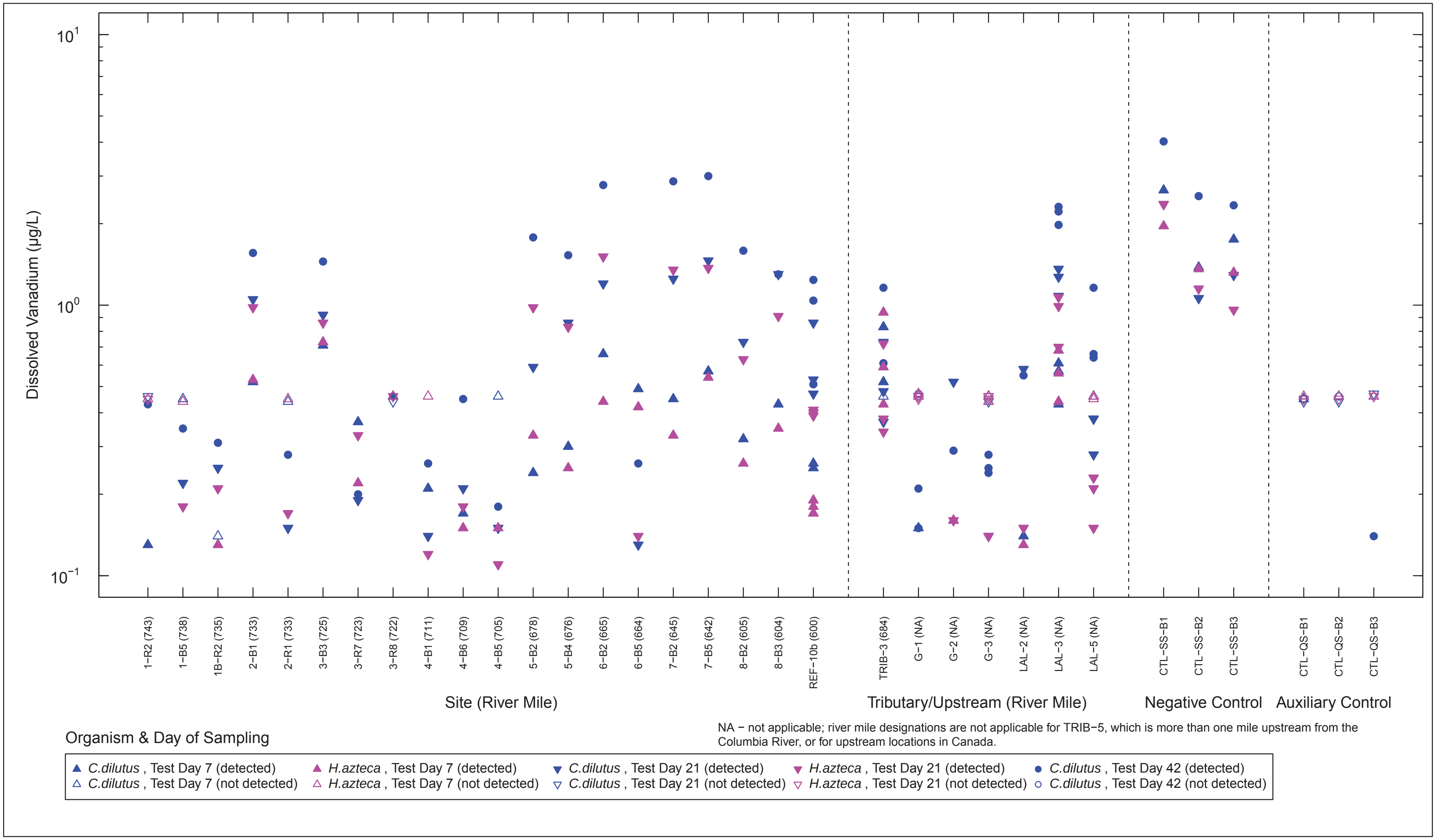


Figure 5−6ab. Dissolved Vanadium in Porewater from Long−Term Bioassays

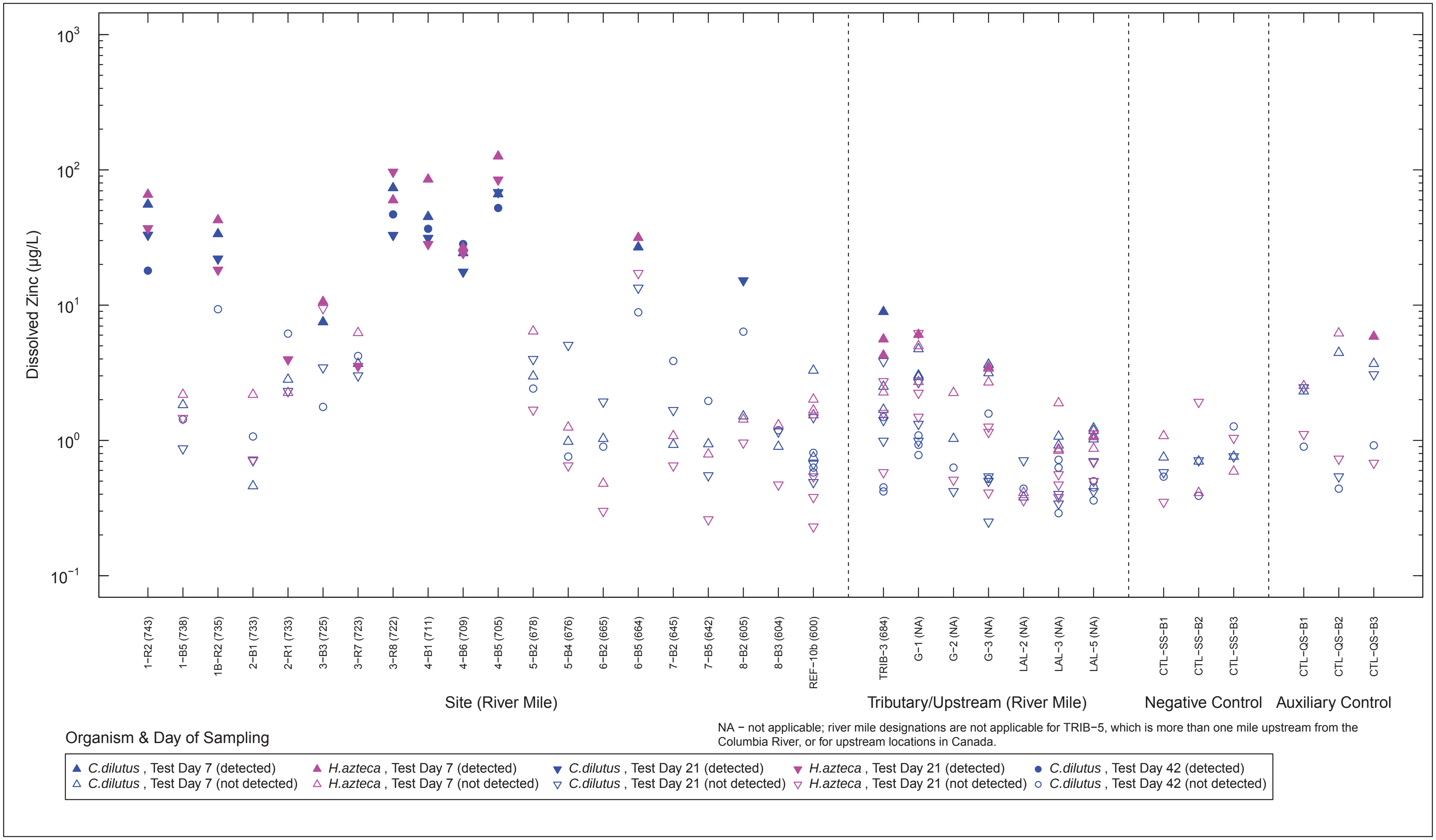


Figure 5−6ac. Dissolved Zinc in Porewater from Long−Term Bioassays

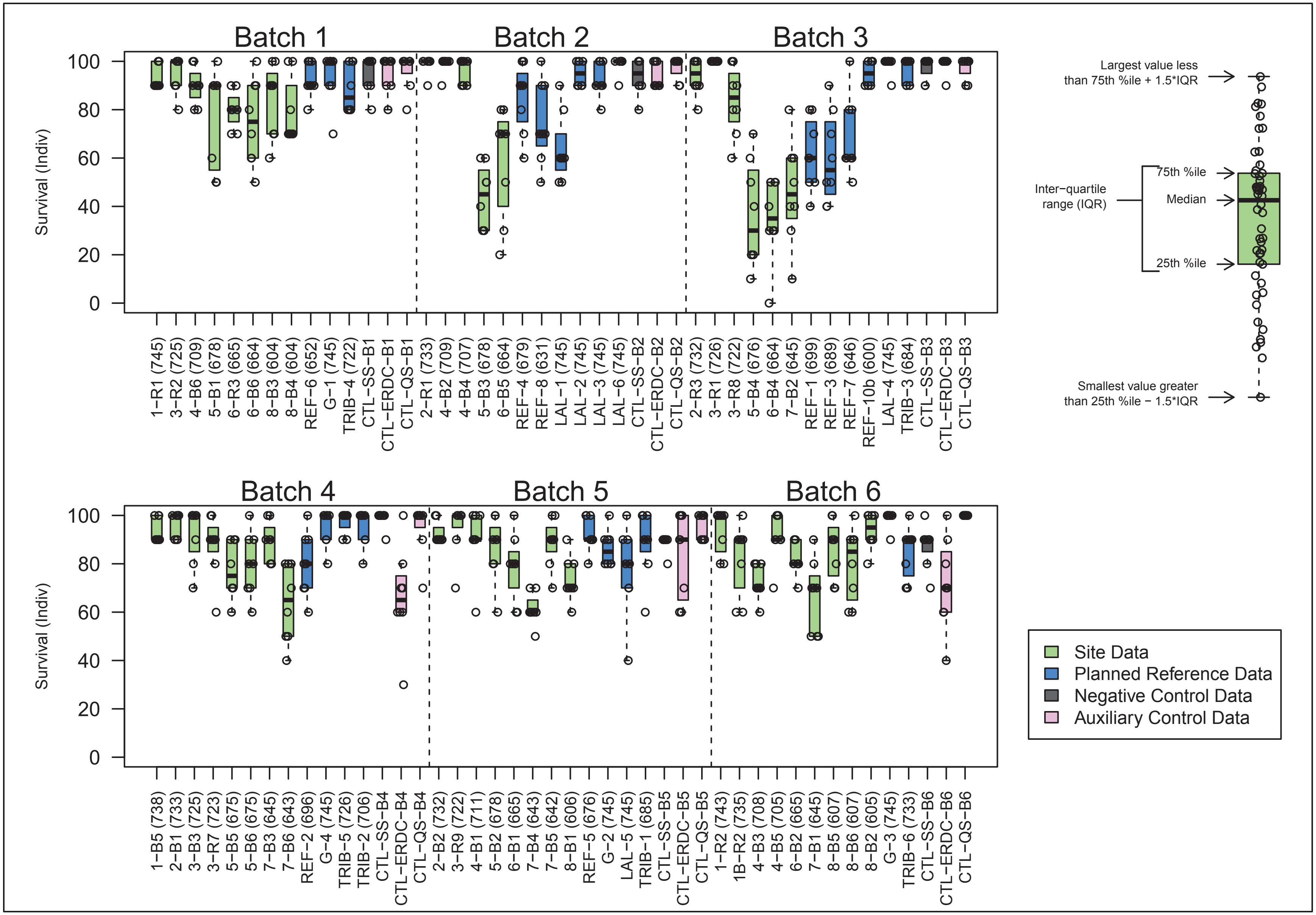


Figure 5−7a. Results for 10−Day Survival in the *Chironomus dilutus* Short−Term Bioassays

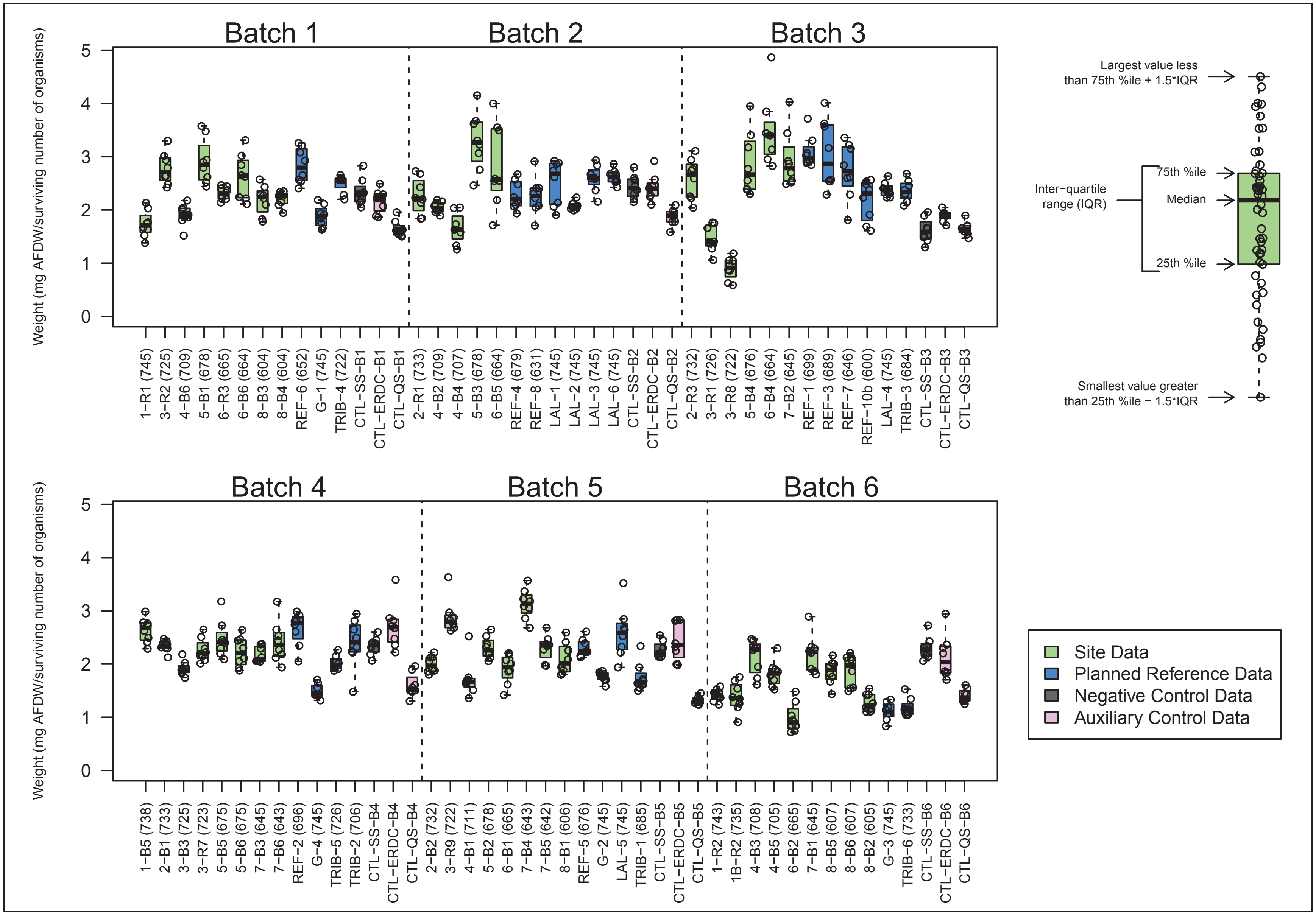


Figure 5−7b. Results for 10−Day Weight (AFDW) in the *Chironomus dilutus* Short−Term Bioassays

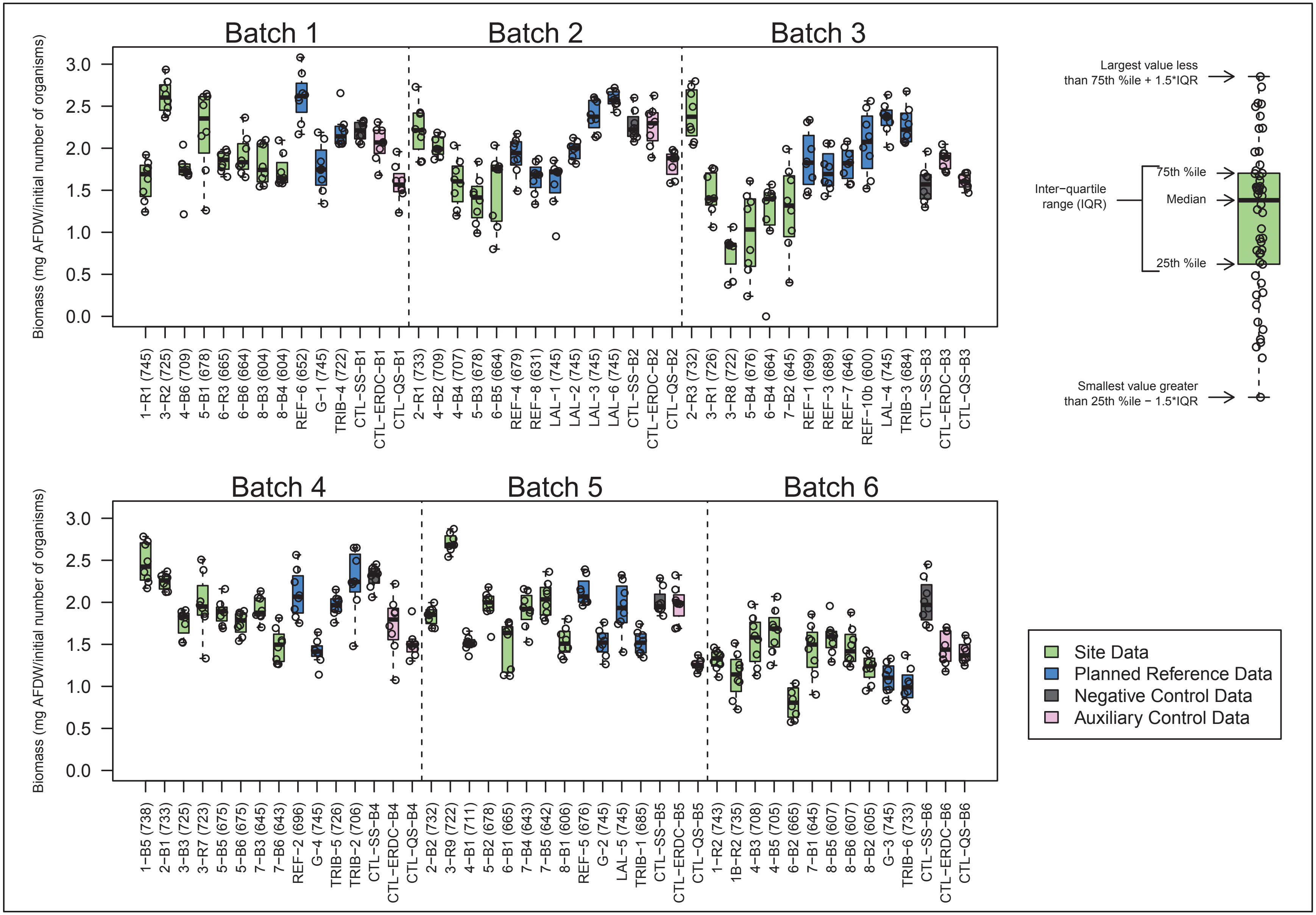


Figure 5−7c. Results for 10−Day Biomass (AFDW) in the *Chironomus dilutus* Short−Term Bioassays

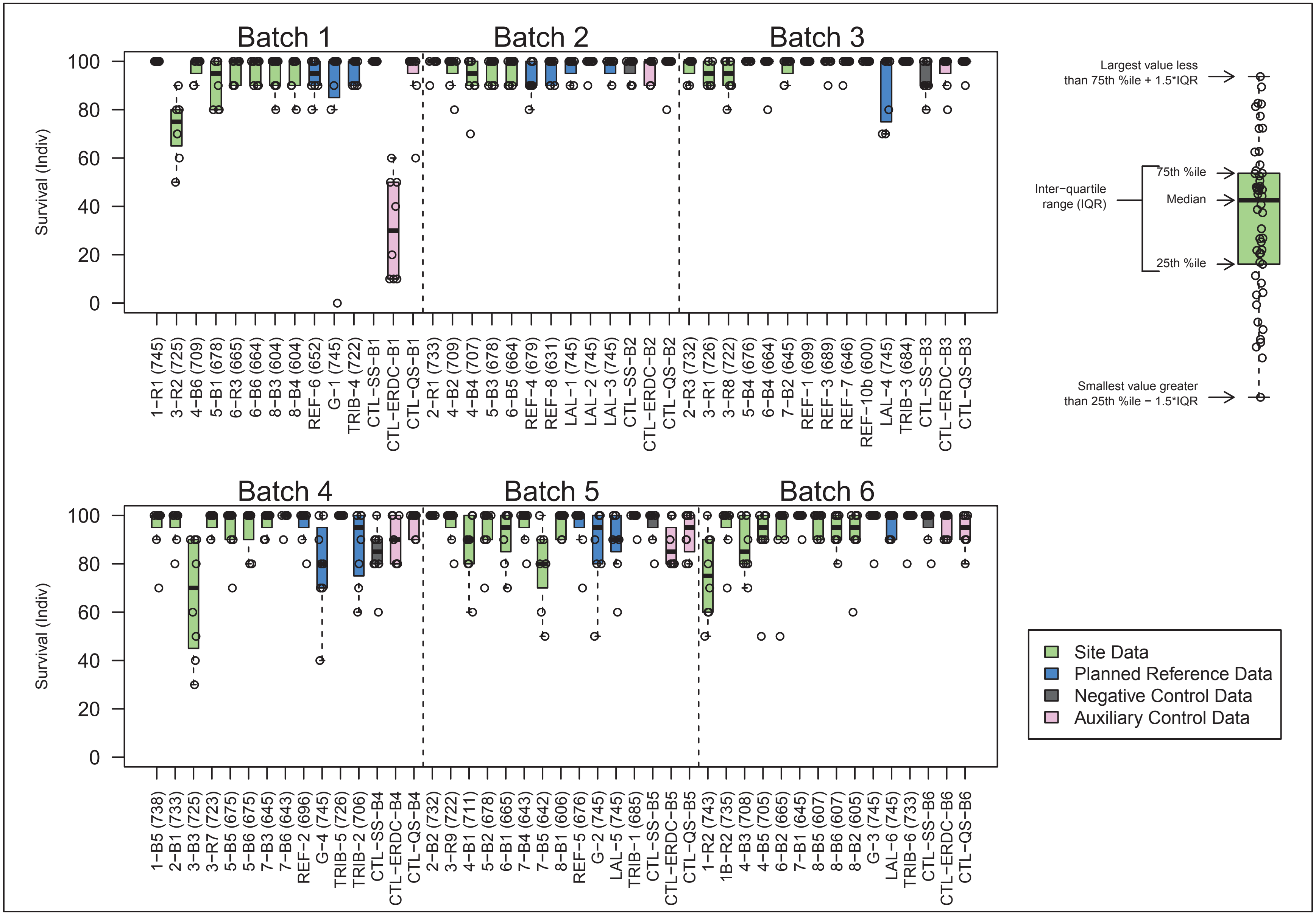


Figure 5−8a. Results for 28−Day Survival in the *Hyalella azteca* Short−Term Bioassays

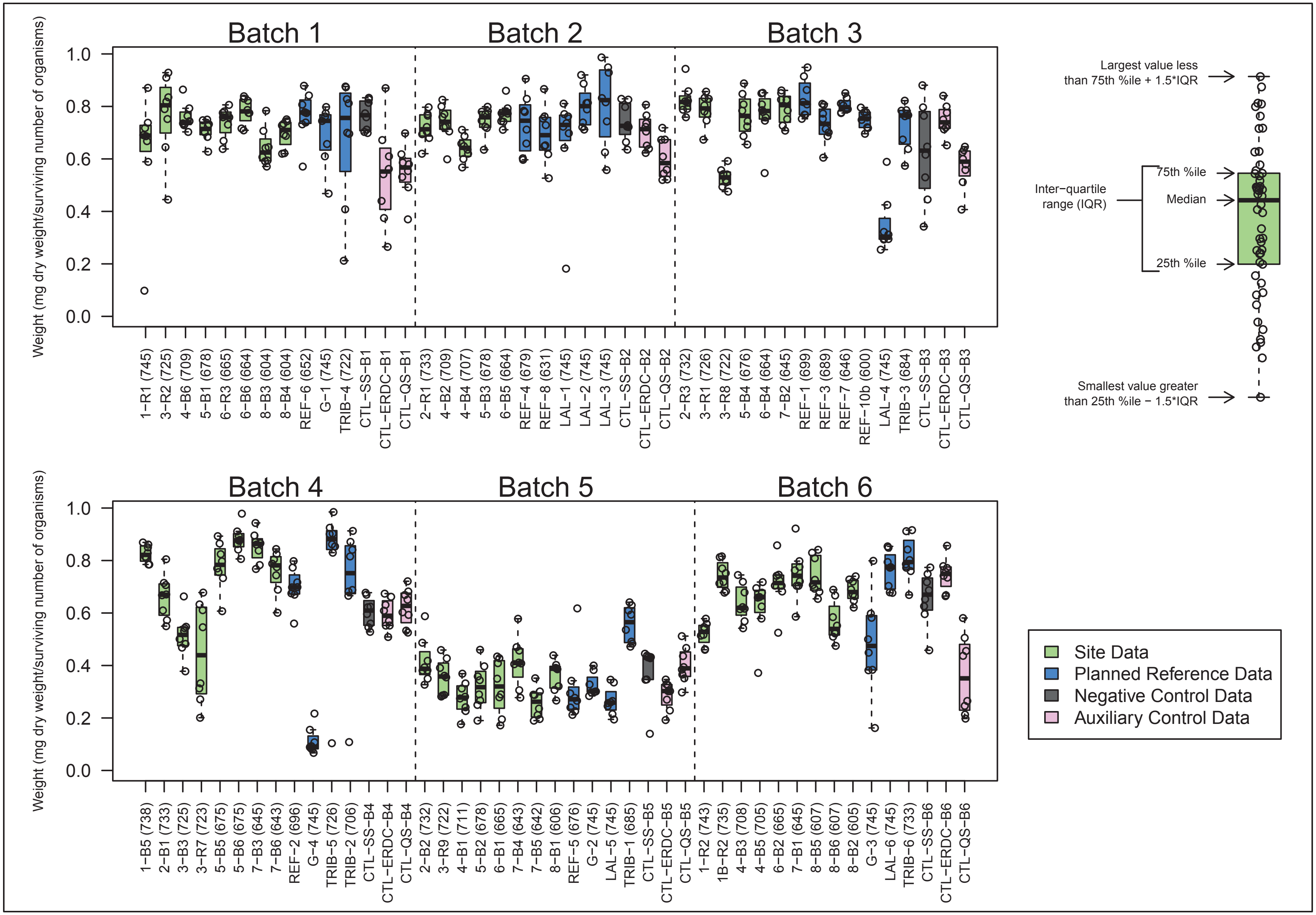


Figure 5−8b. Results for 28−Day Weight in the *Hyalella azteca* Short−Term Bioassays

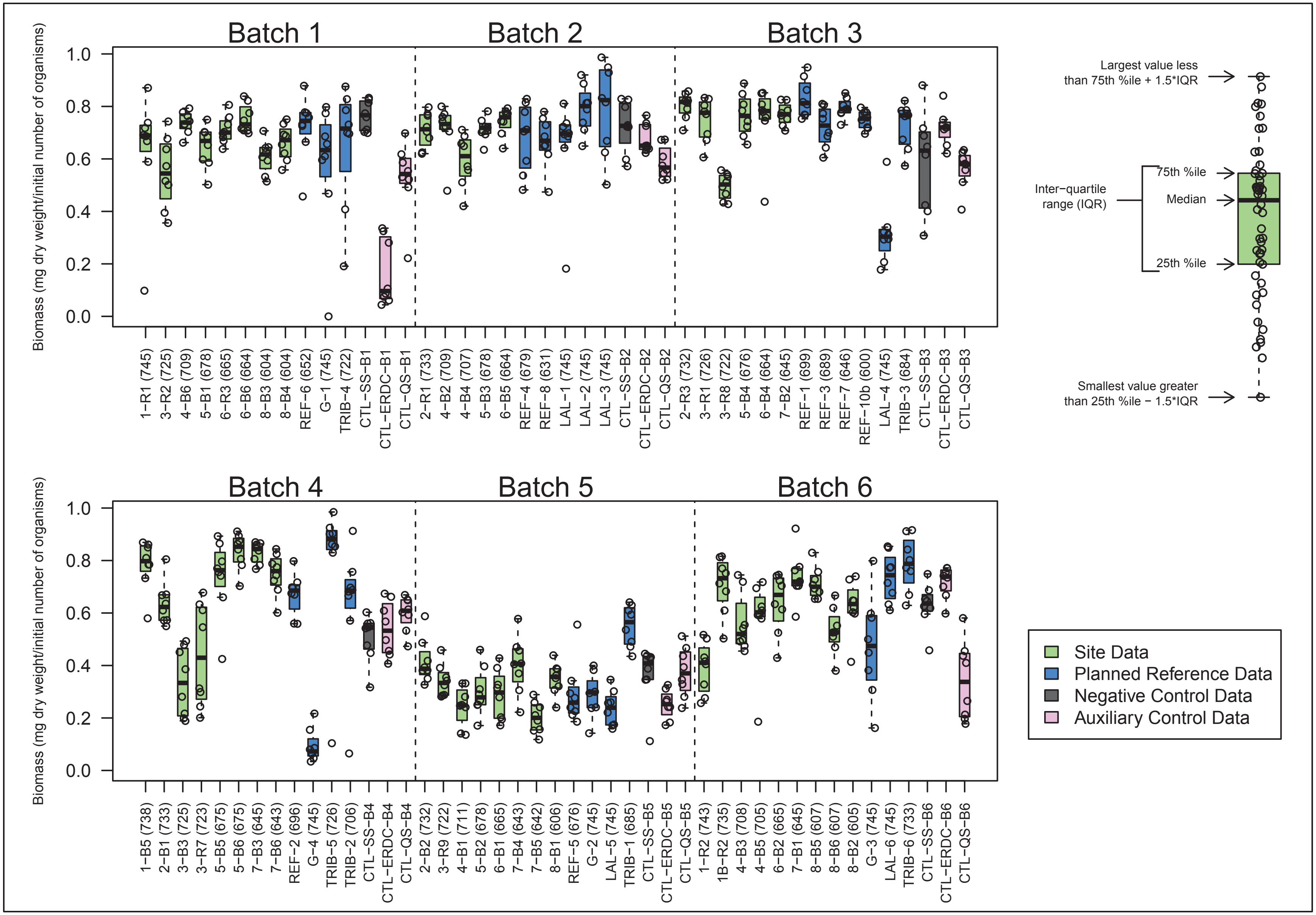


Figure 5−8c. Results for 28−Day Biomass in the *Hyalella azteca* Short−Term Bioassays

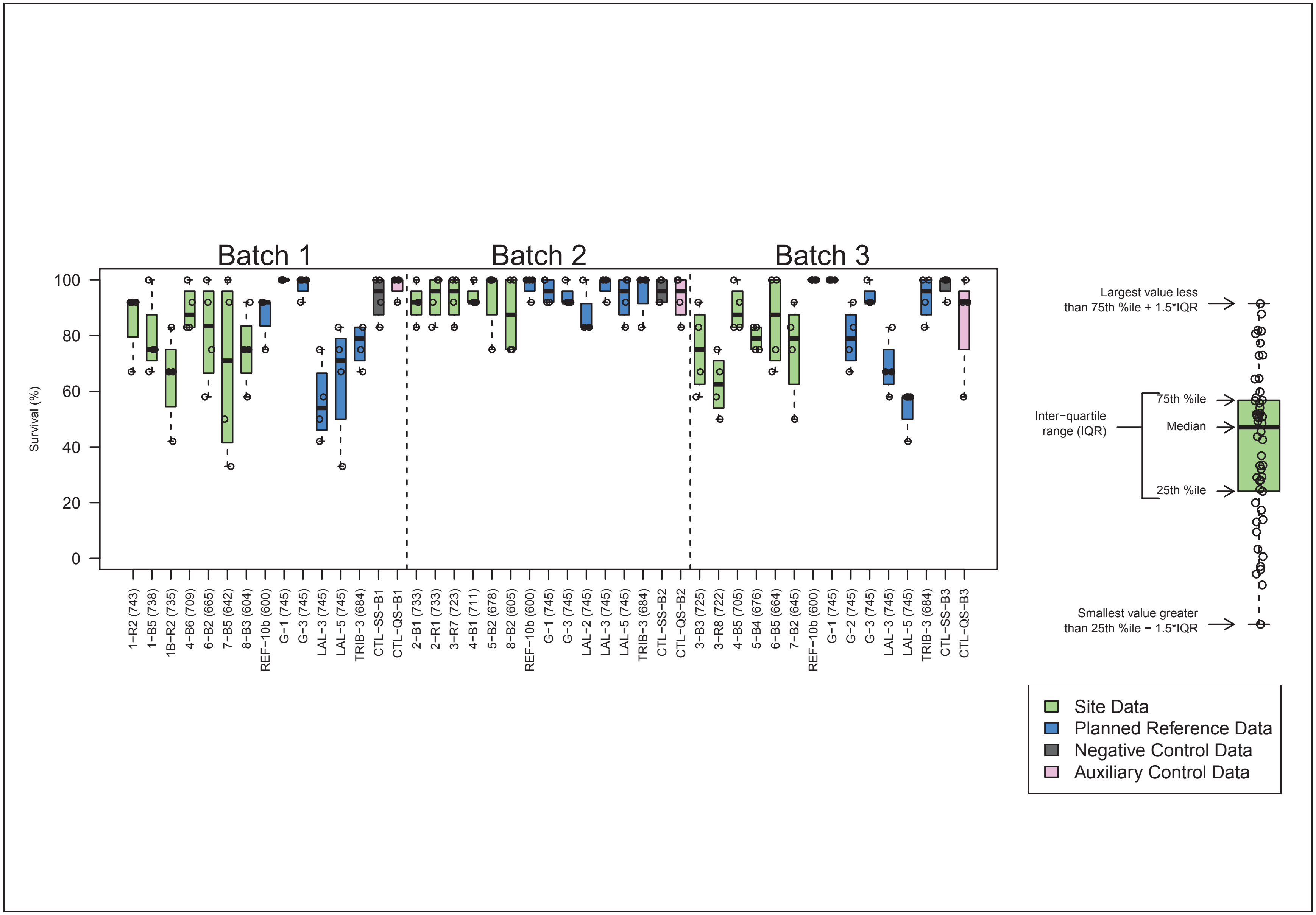


Figure 5−9a. Results for 16−Day Survival in the *Chironomus dilutus* Long−Term Bioassays

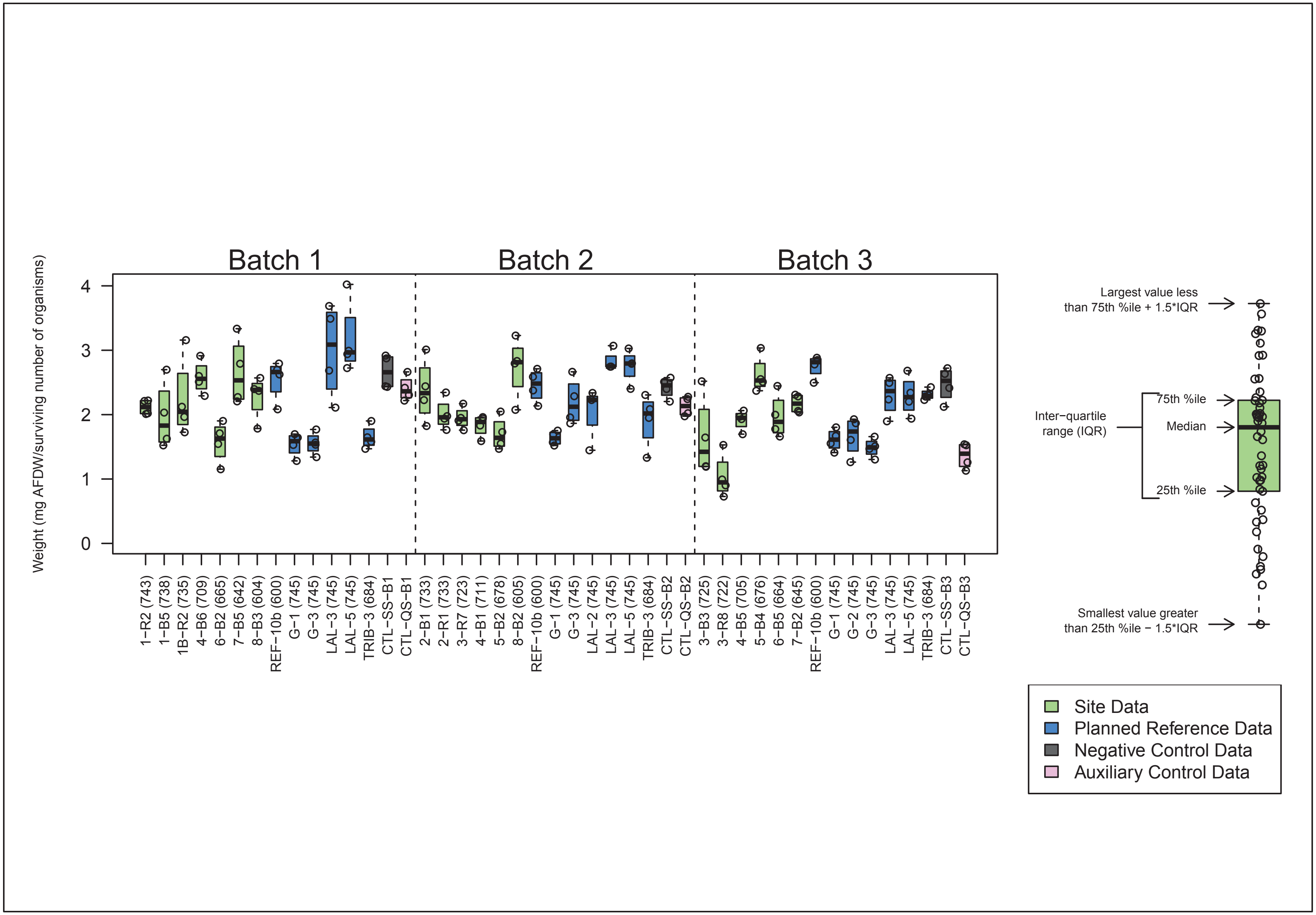


Figure 5−9b. Results for 16−Day Weight (AFDW) in the *Chironomus dilutus* Long−Term Bioassays

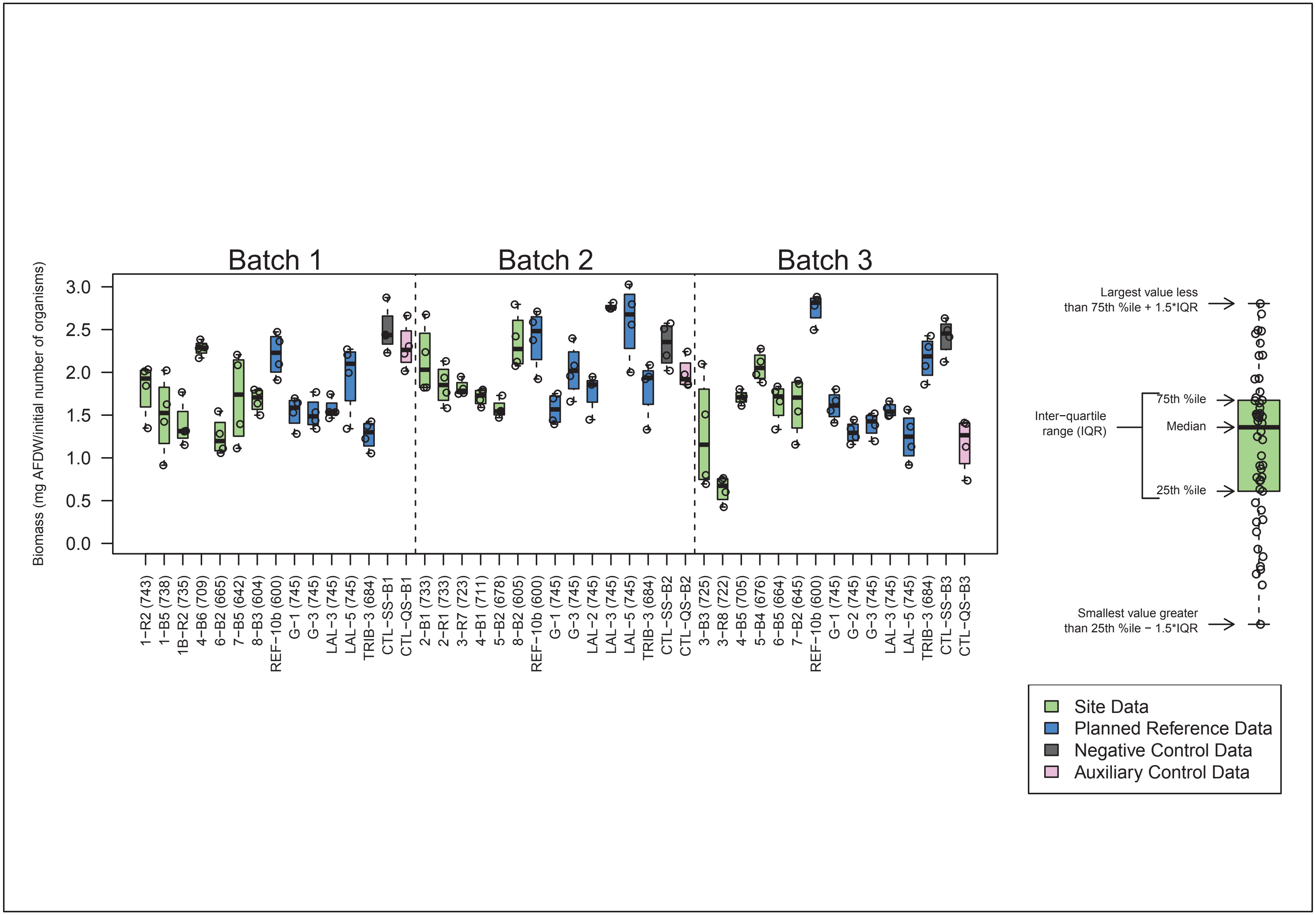


Figure 5−9c. Results for 16−Day Biomass (AFDW) in the *Chironomus dilutus* Long−Term Bioassays

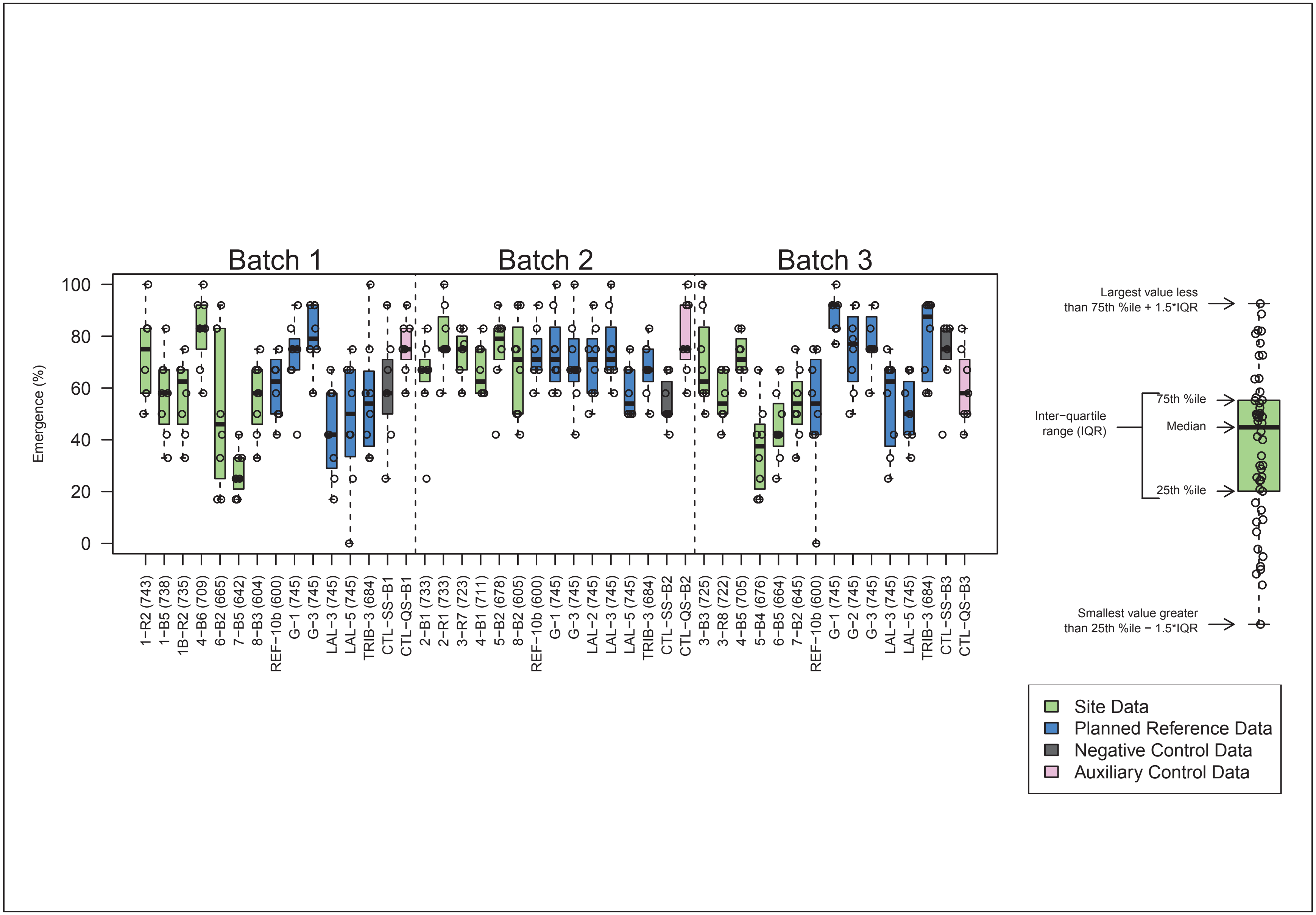


Figure 5−9d. Results for Emergence in the *Chironomus dilutus* Long−Term Bioassays

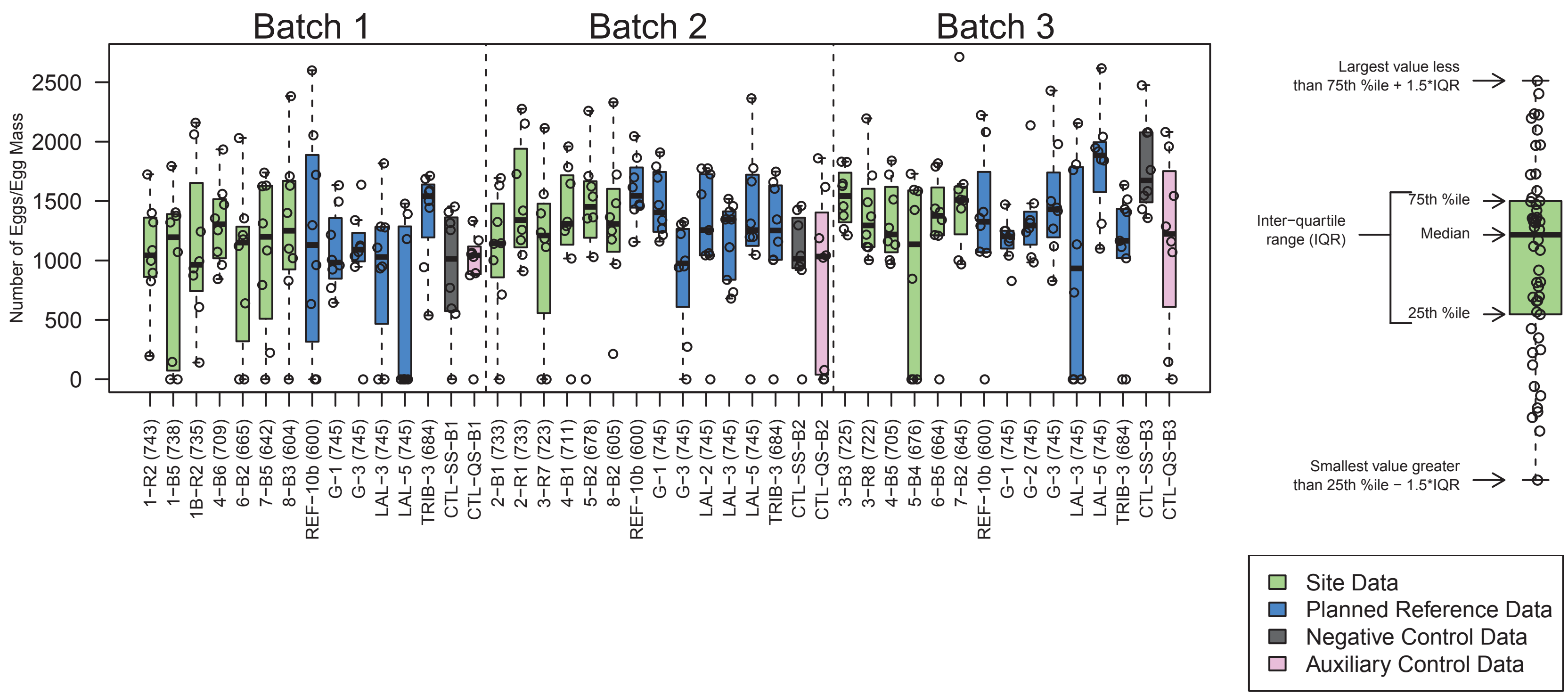


Figure 5−9e. Results for Eggs per Egg Mass in the *Chironomus dilutus* Long−Term Bioassays

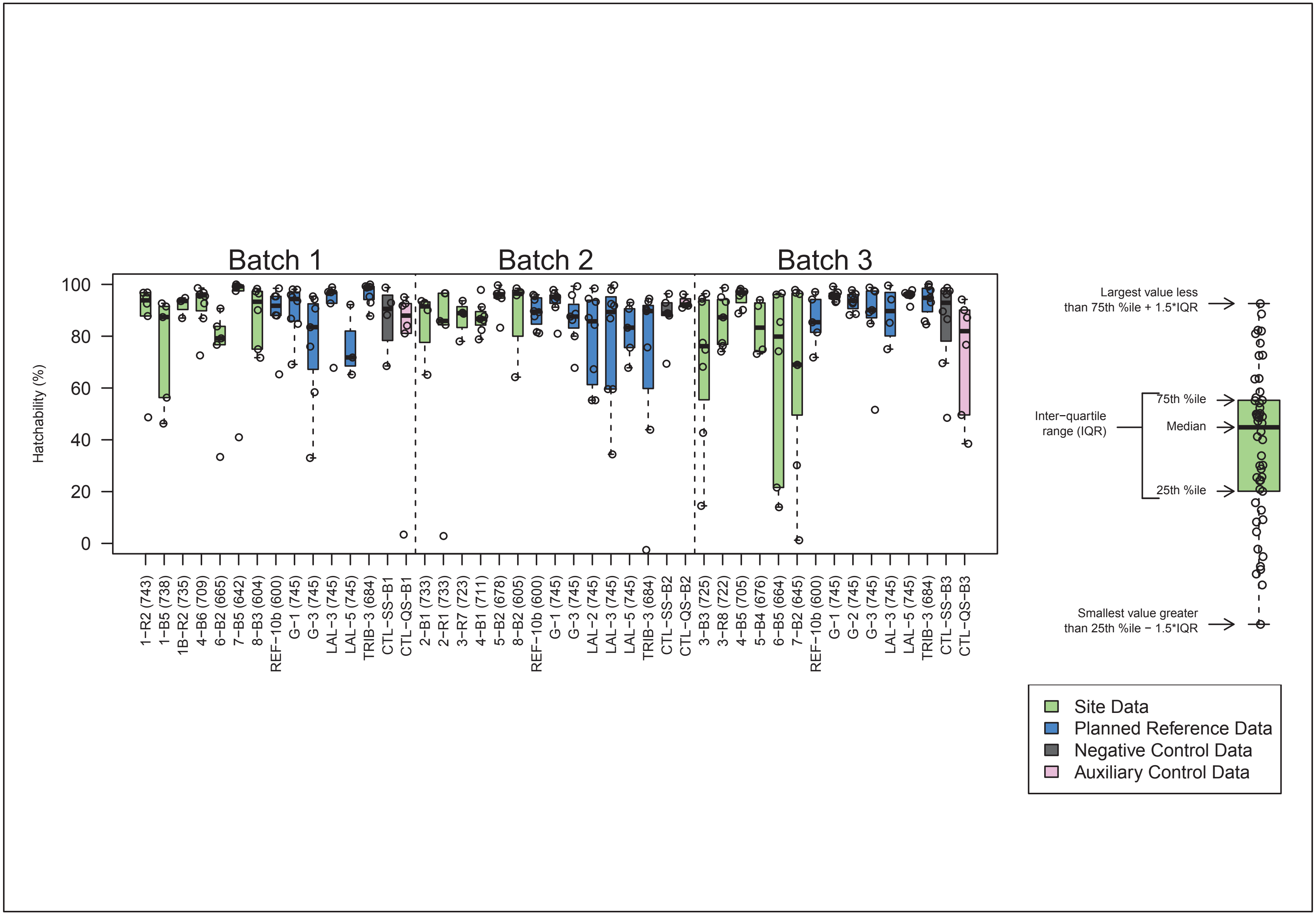


Figure 5−9f. Results for Hatchability in the *Chironomus dilutus* Long−Term Bioassays

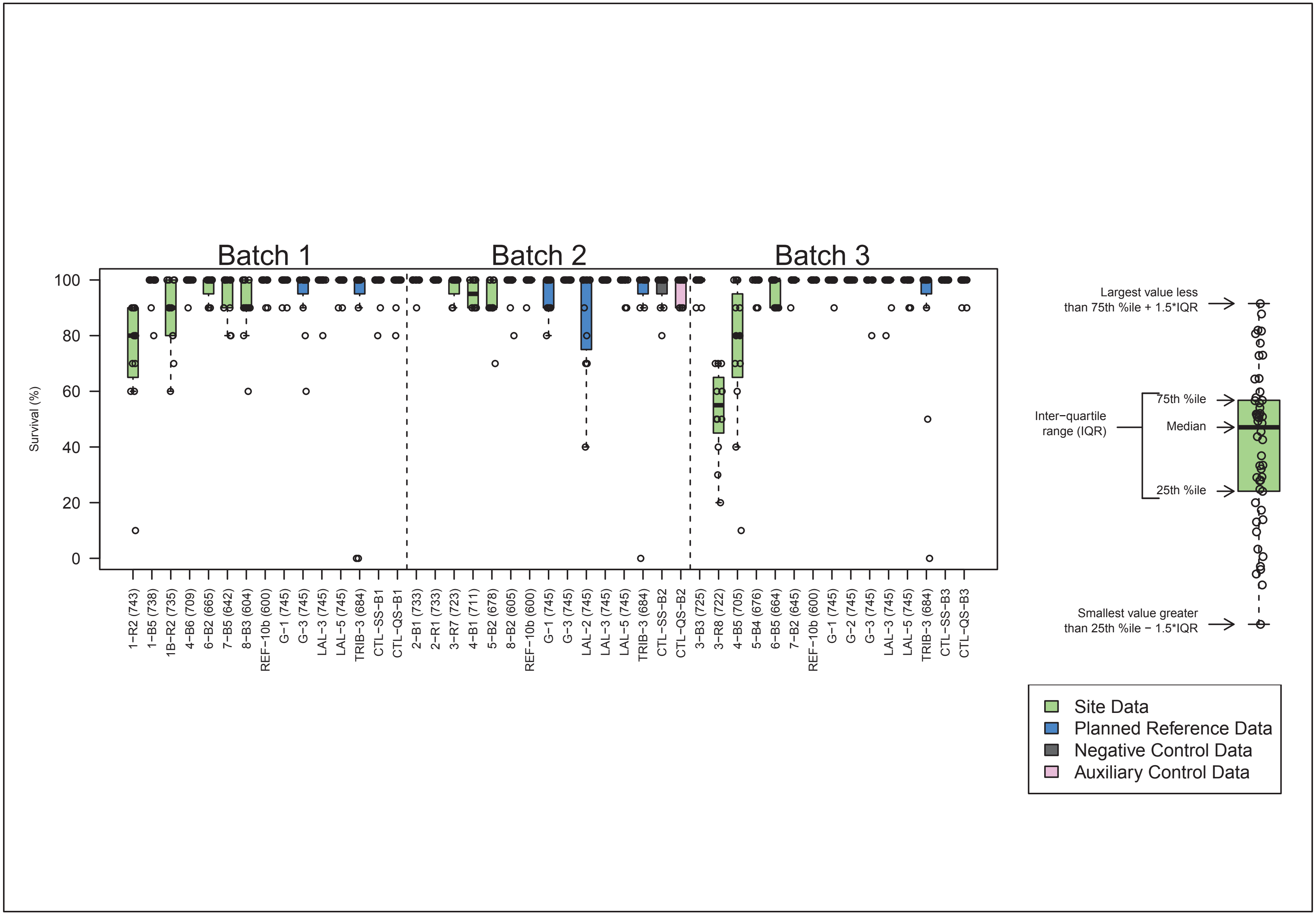


Figure 5−10a. Results for 28−Day Survival in the *Hyalella azteca* Long−Term Bioassay

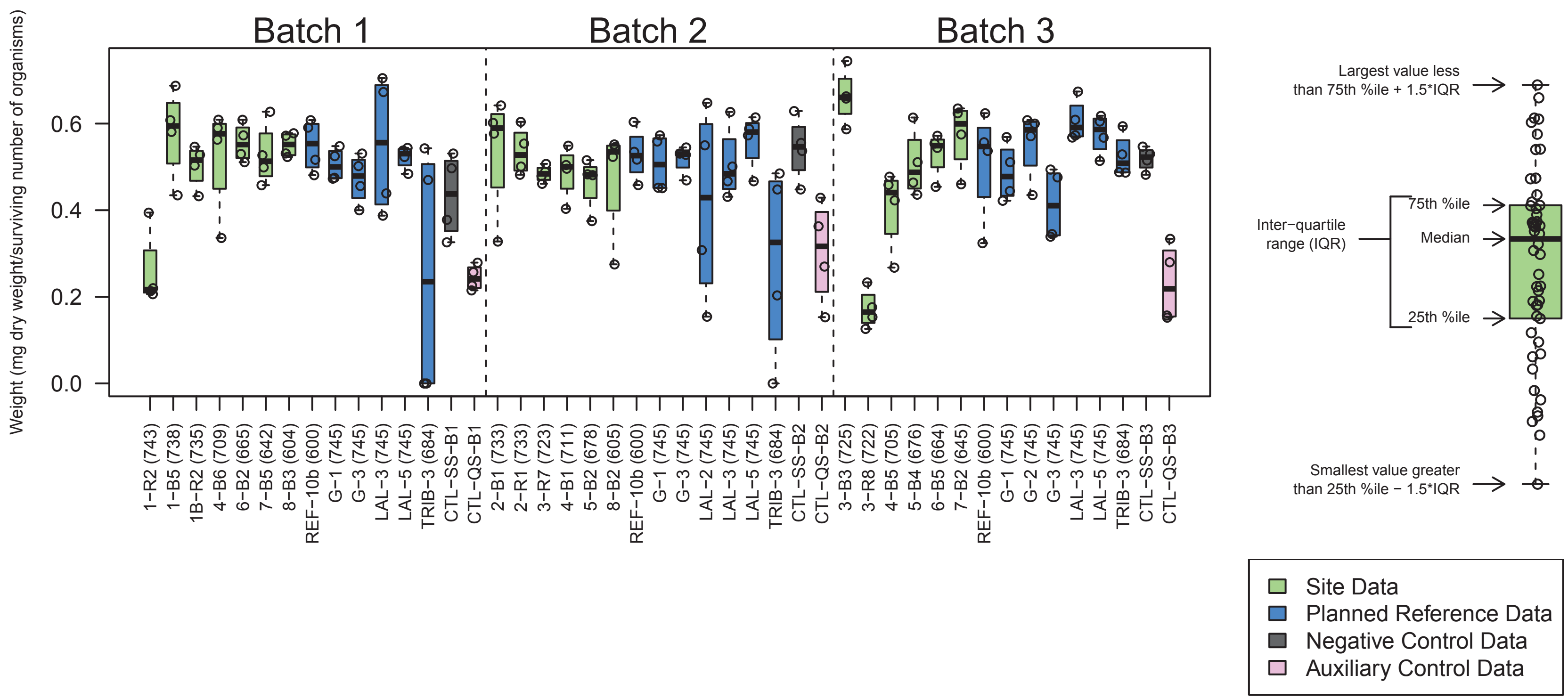


Figure 5−10b. Results for 28−Day Weight in the *Hyalella azteca* Long−Term Bioassay

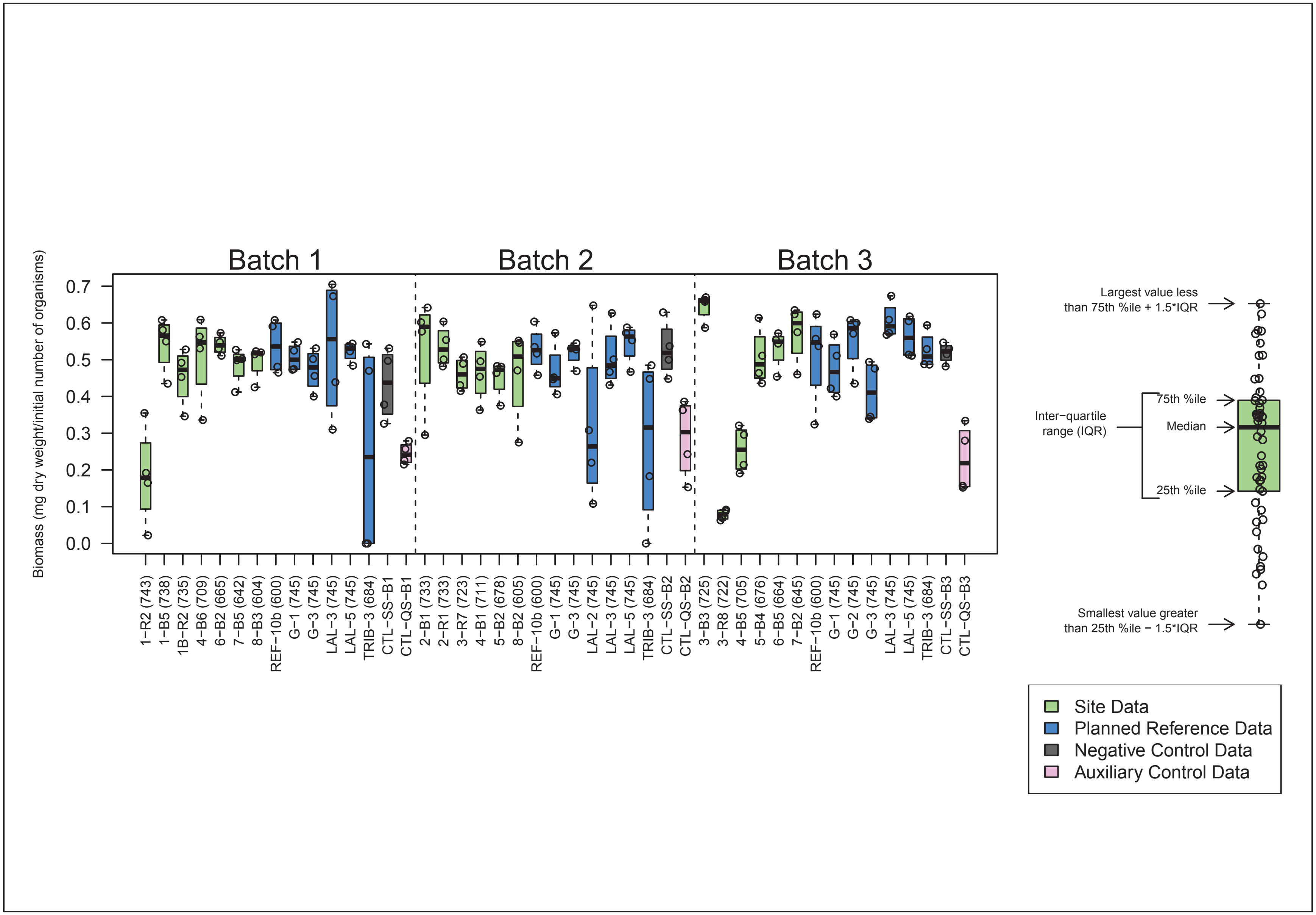


Figure 5−10c. Results for 28−Day Biomass in the *Hyalella azteca* Long−Term Bioassay

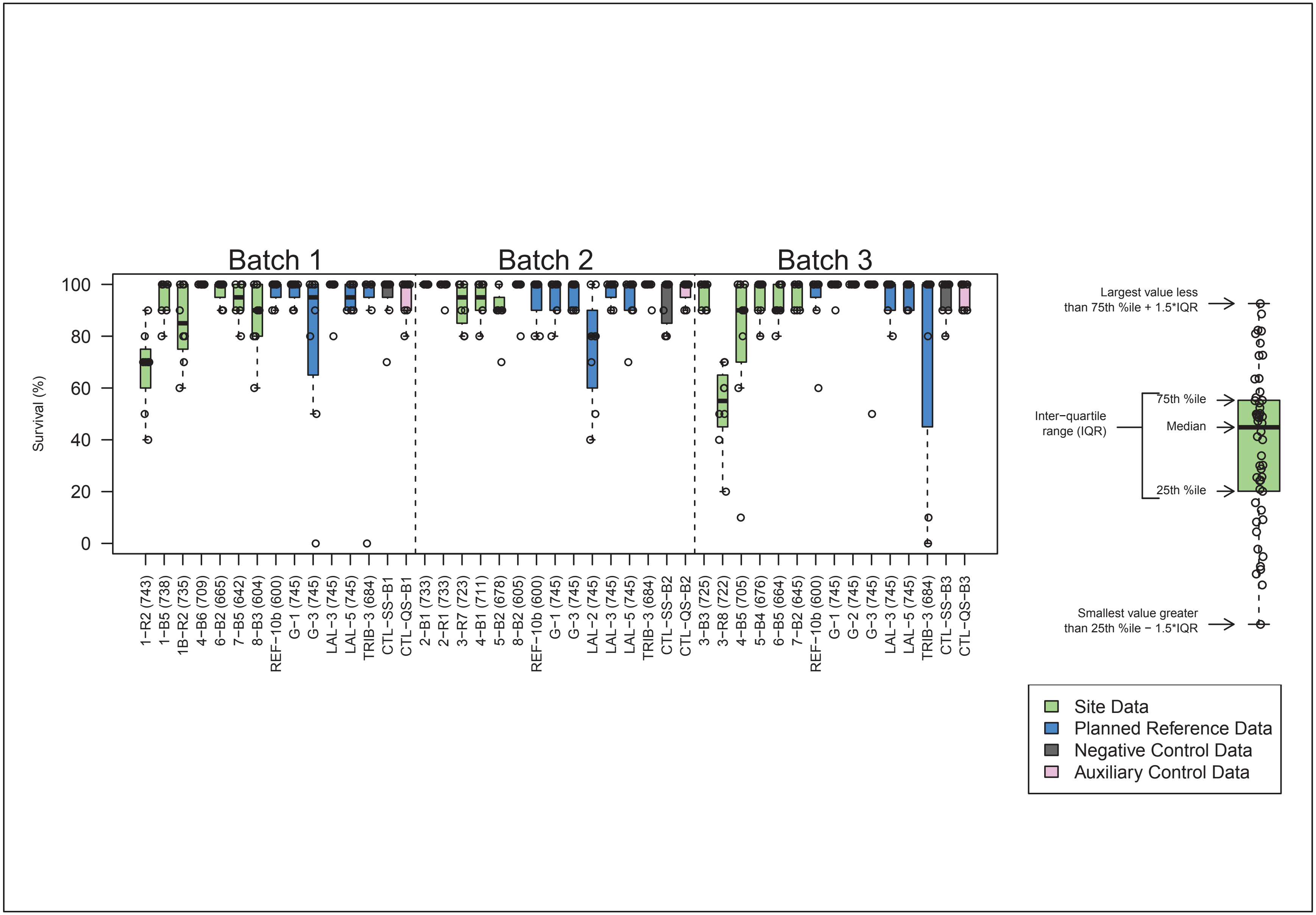


Figure 5−10d. Results for 42−Day Survival in the *Hyalella azteca* Long−Term Bioassay

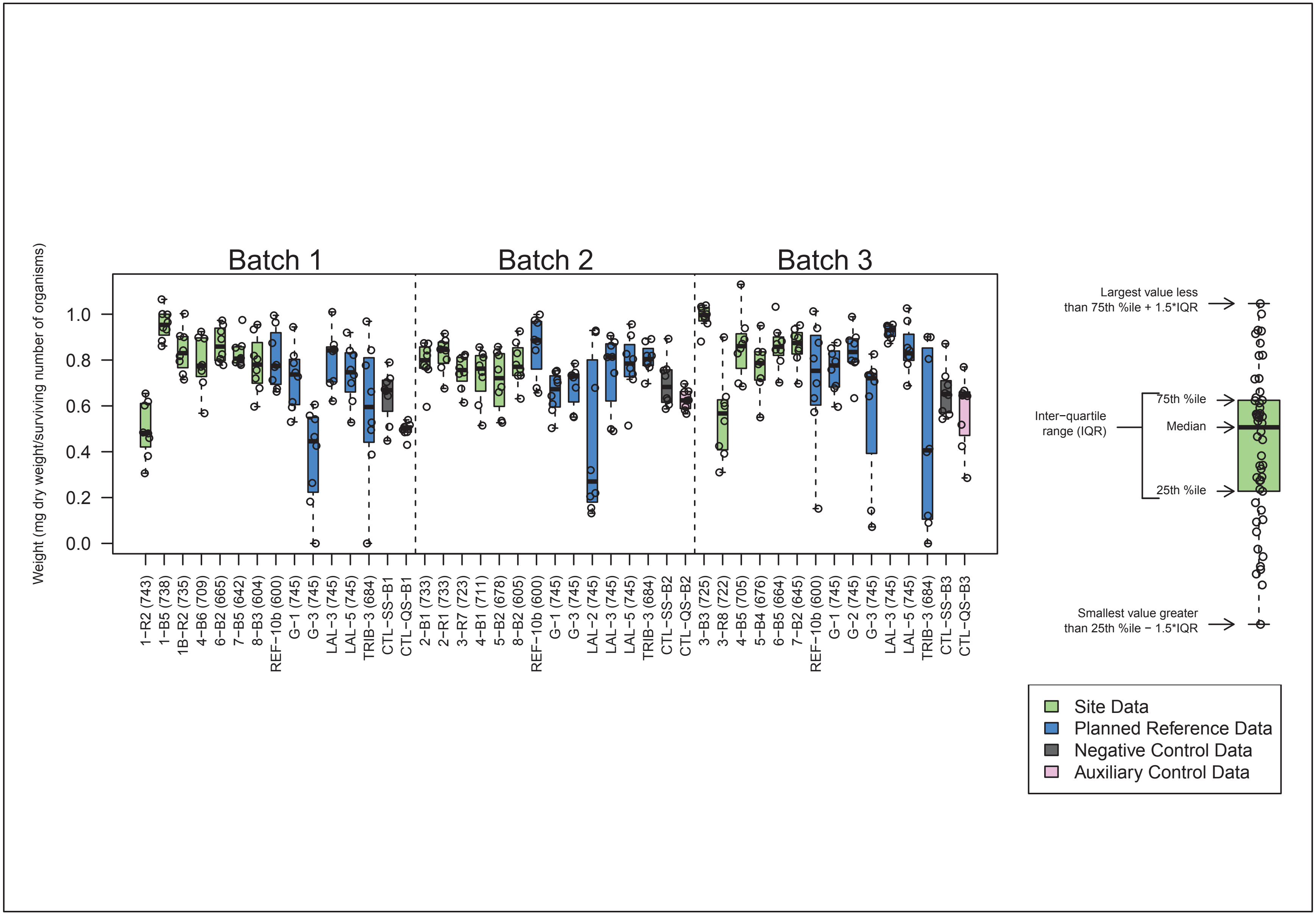


Figure 5−10e. Results for 42−Day Weight in the *Hyalella azteca* Long−Term Bioassay

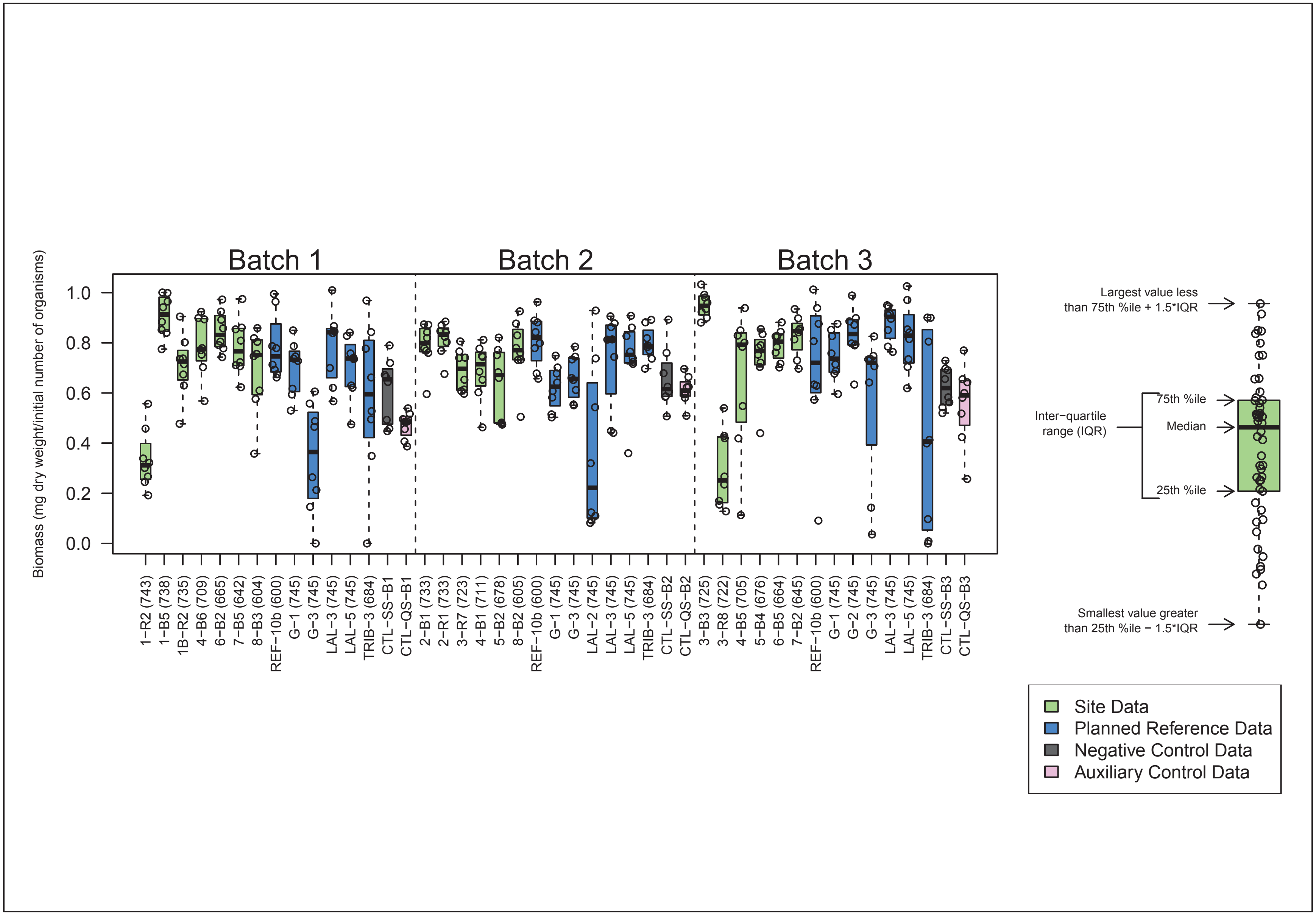


Figure 5−10f. Results for 42−Day Biomass in the *Hyalella azteca* Long−Term Bioassay

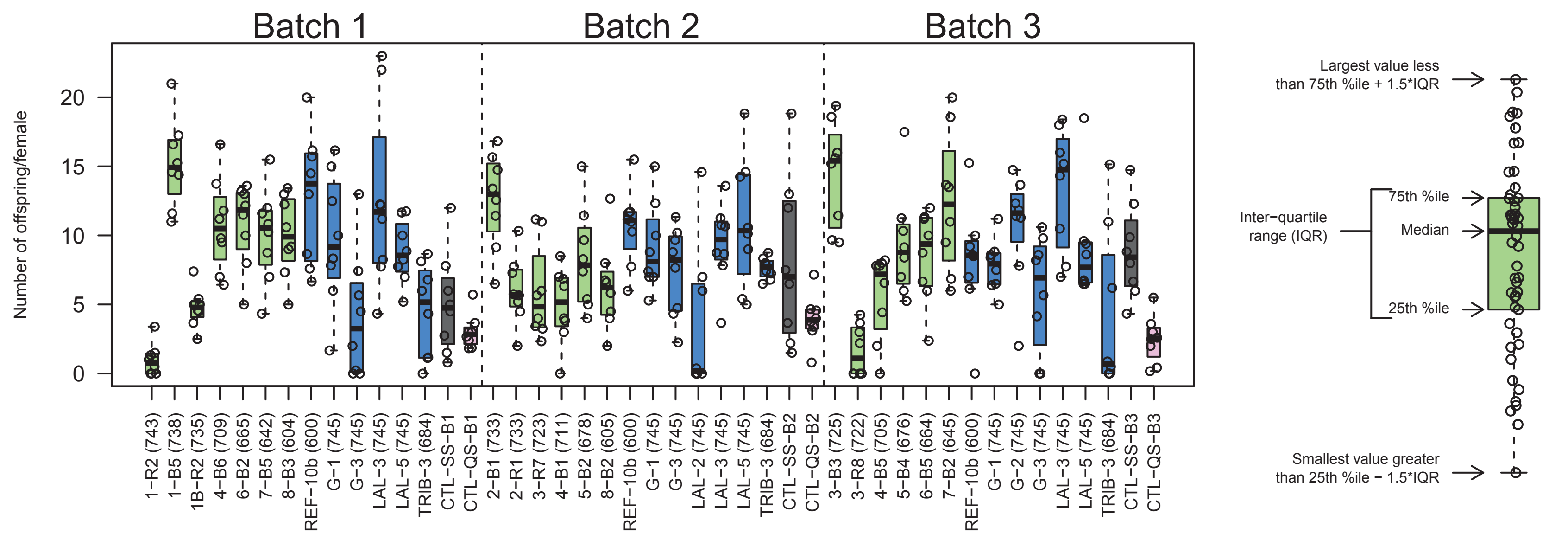


Figure 5−10g. Results for Offspring per Female in the *Hyalella azteca* Long−Term Bioassay

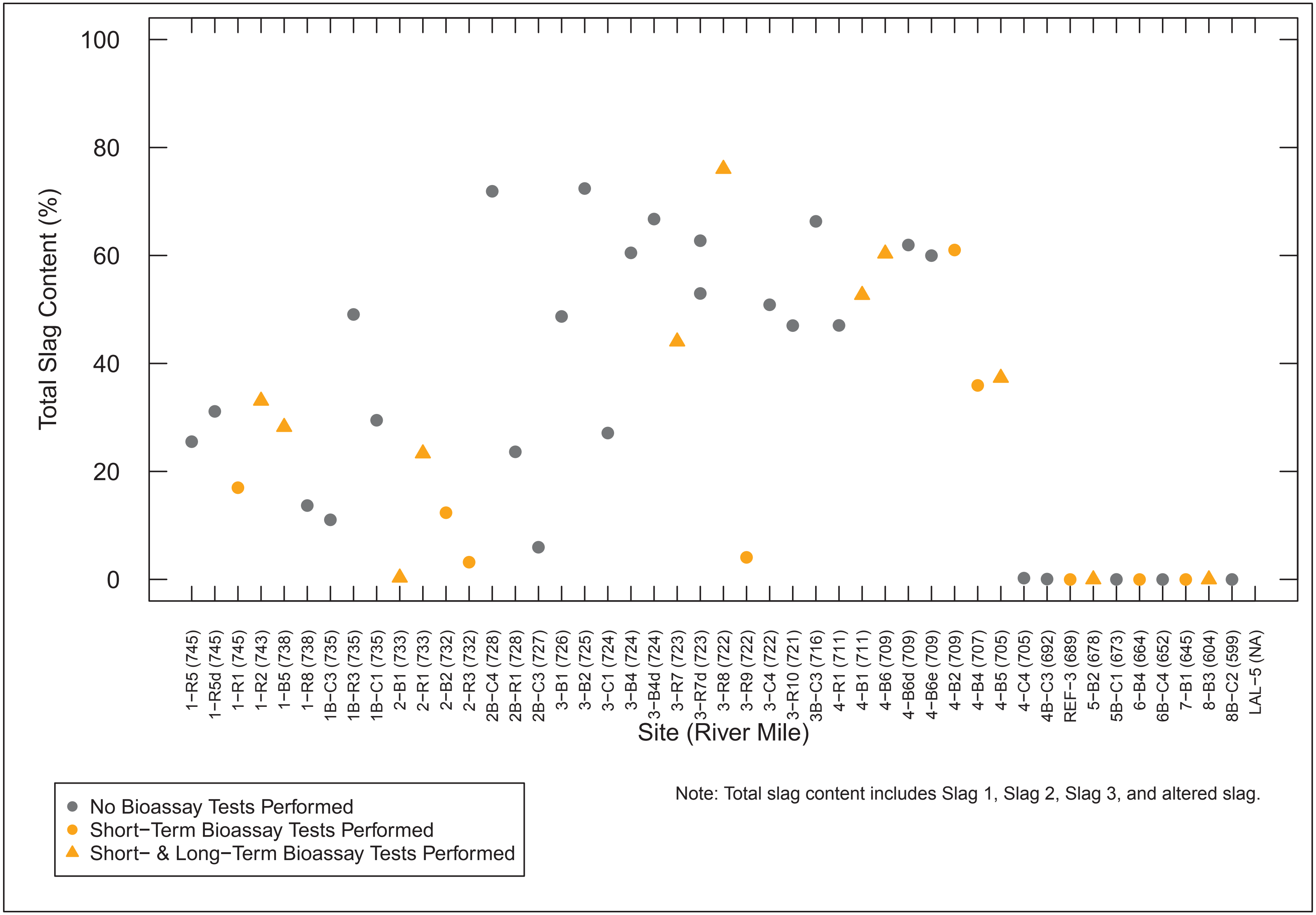


Figure 5−11. Total Slag Content in Field Sediment

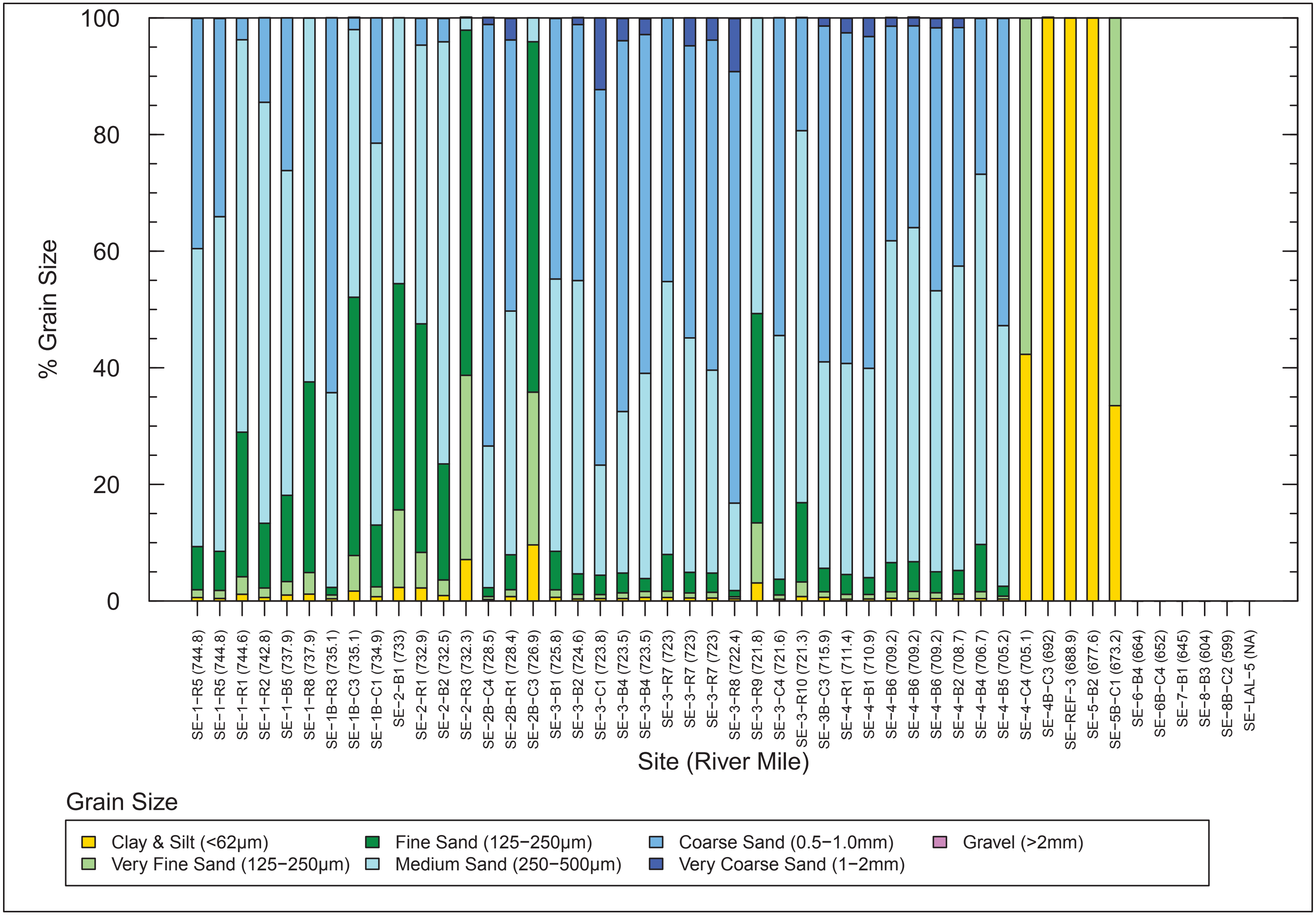
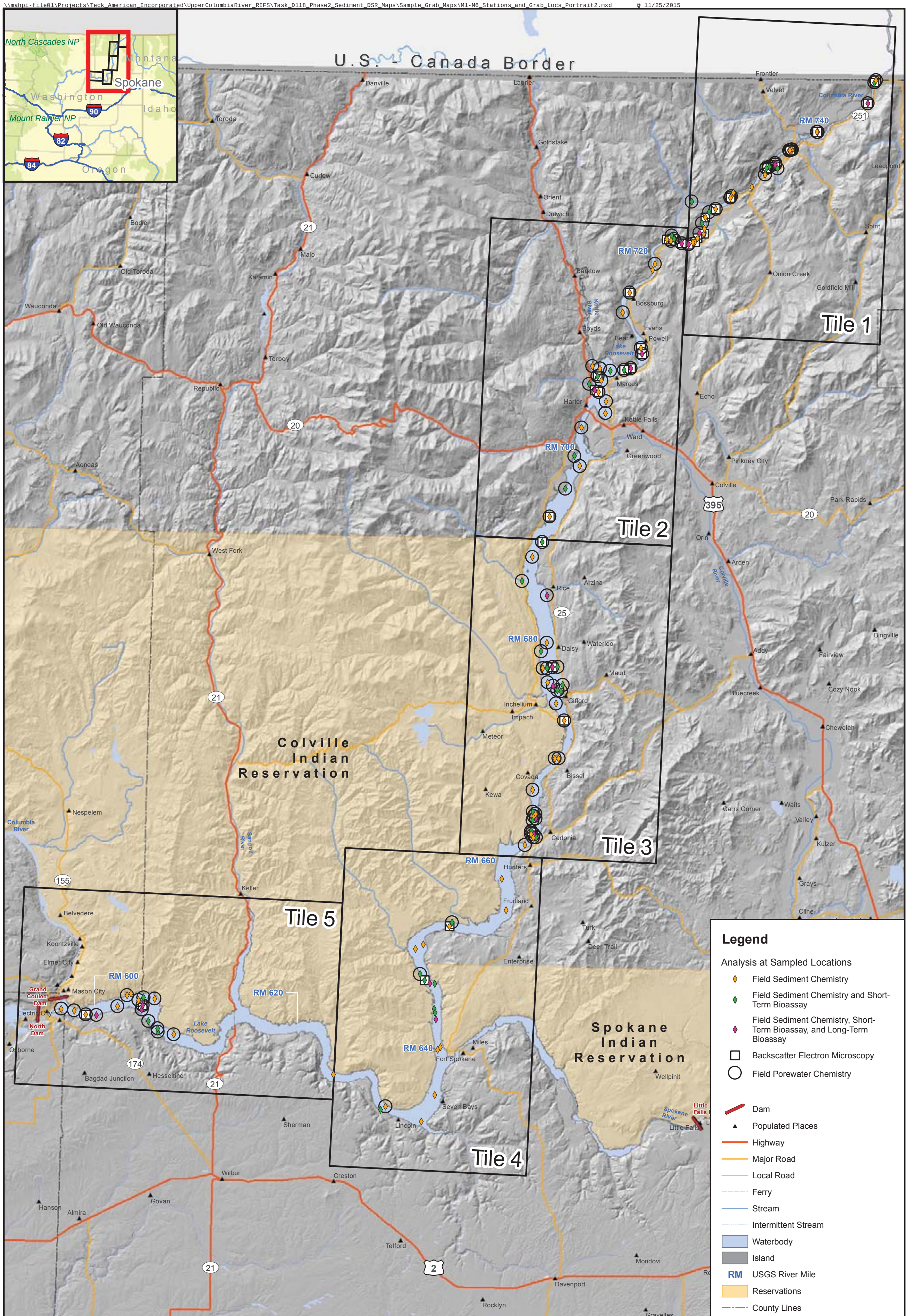


Figure 5−12. Grain Size Distribution of Slag 1 Particles

MAPS

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



HDR

Km 0 5 10

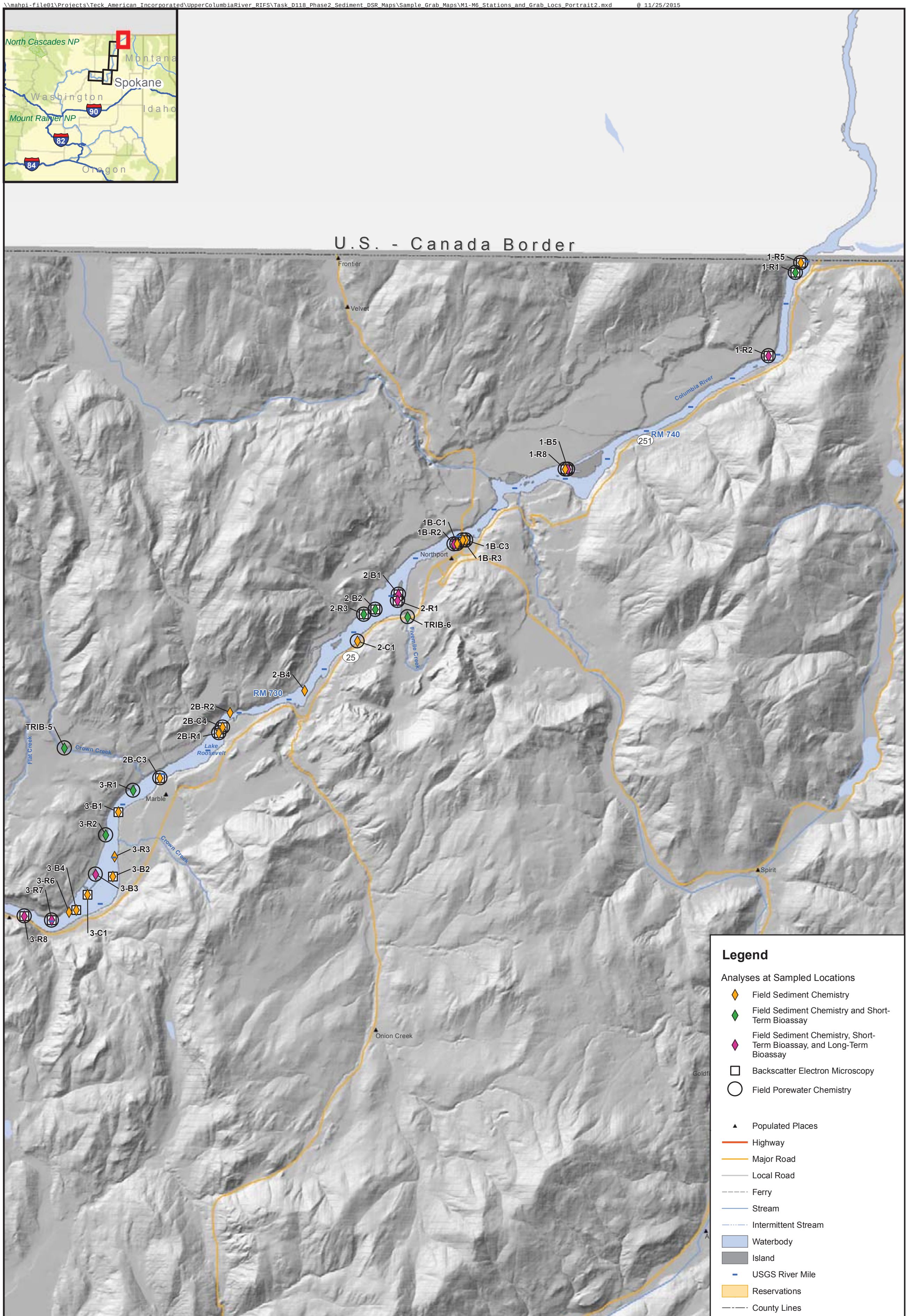
Miles 0 5 10

N

Map 2-1a. Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 596 – 745

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



HDR

Km 0 1.25 2.5

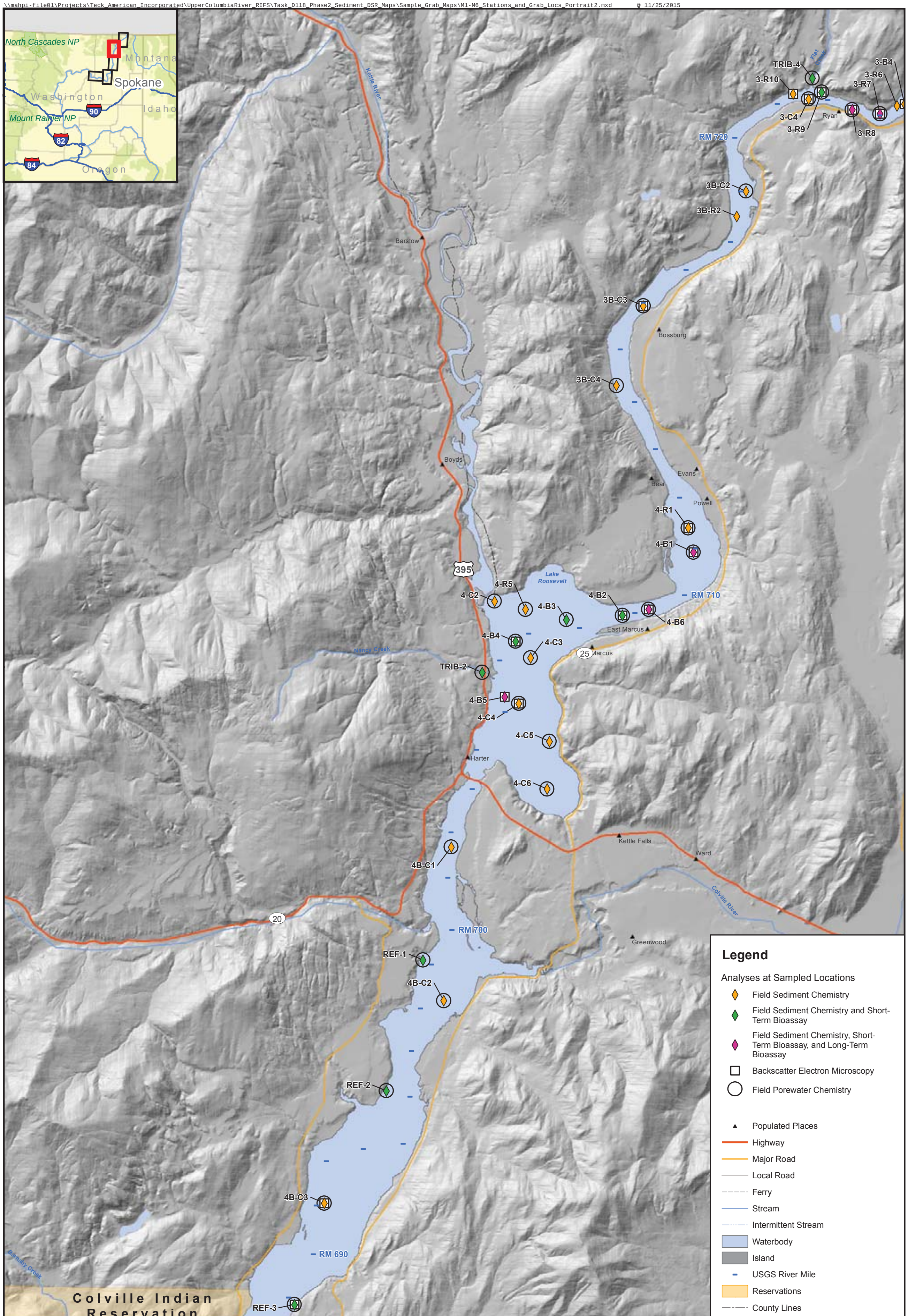
Miles 0 1.25 2.5

N

Map 2-1b. Tile 1 - Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 723 – 745

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015

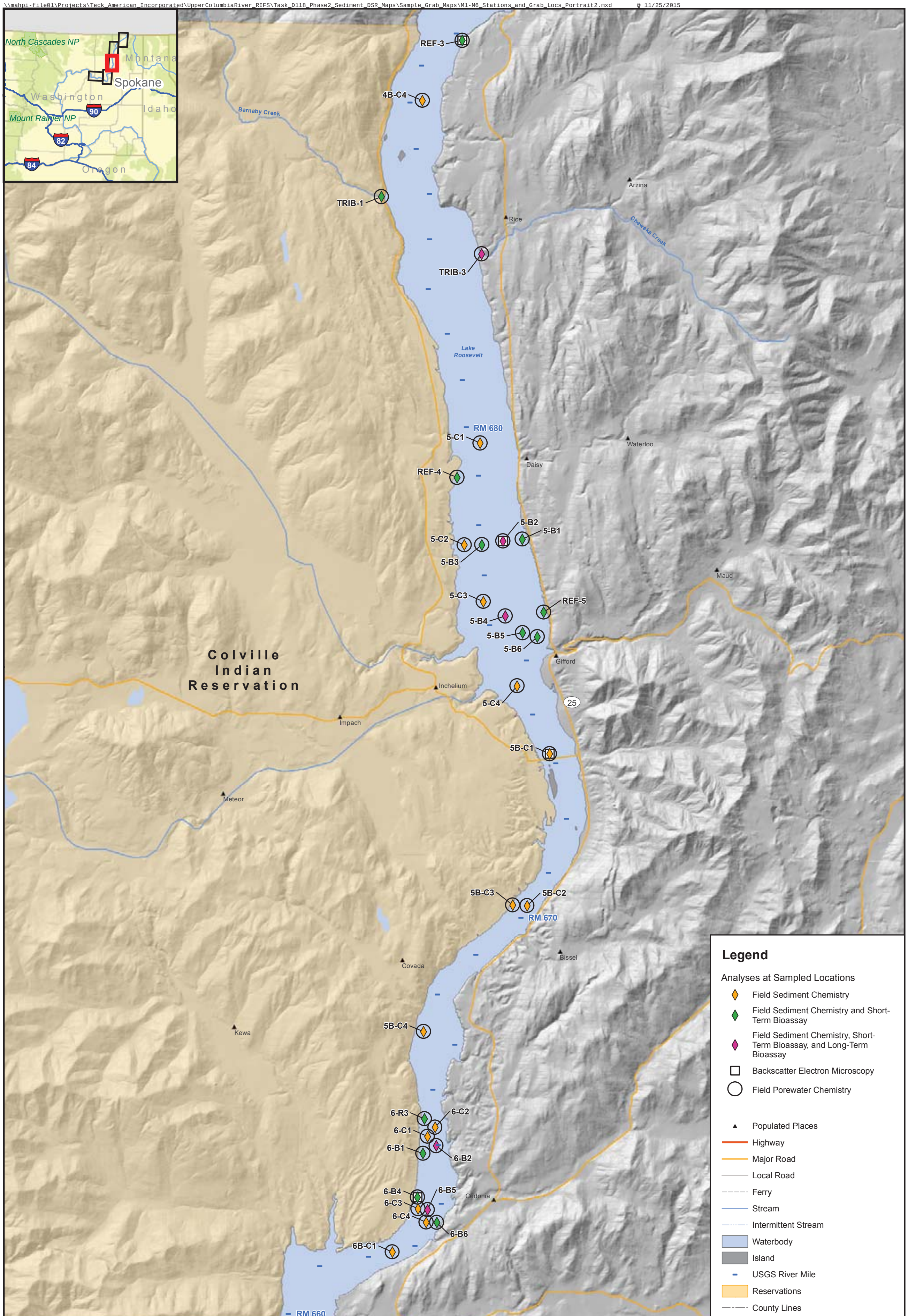


HDR

Map 2-1c. Tile 2 - Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 689 – 723

Upper Columbia River, WA

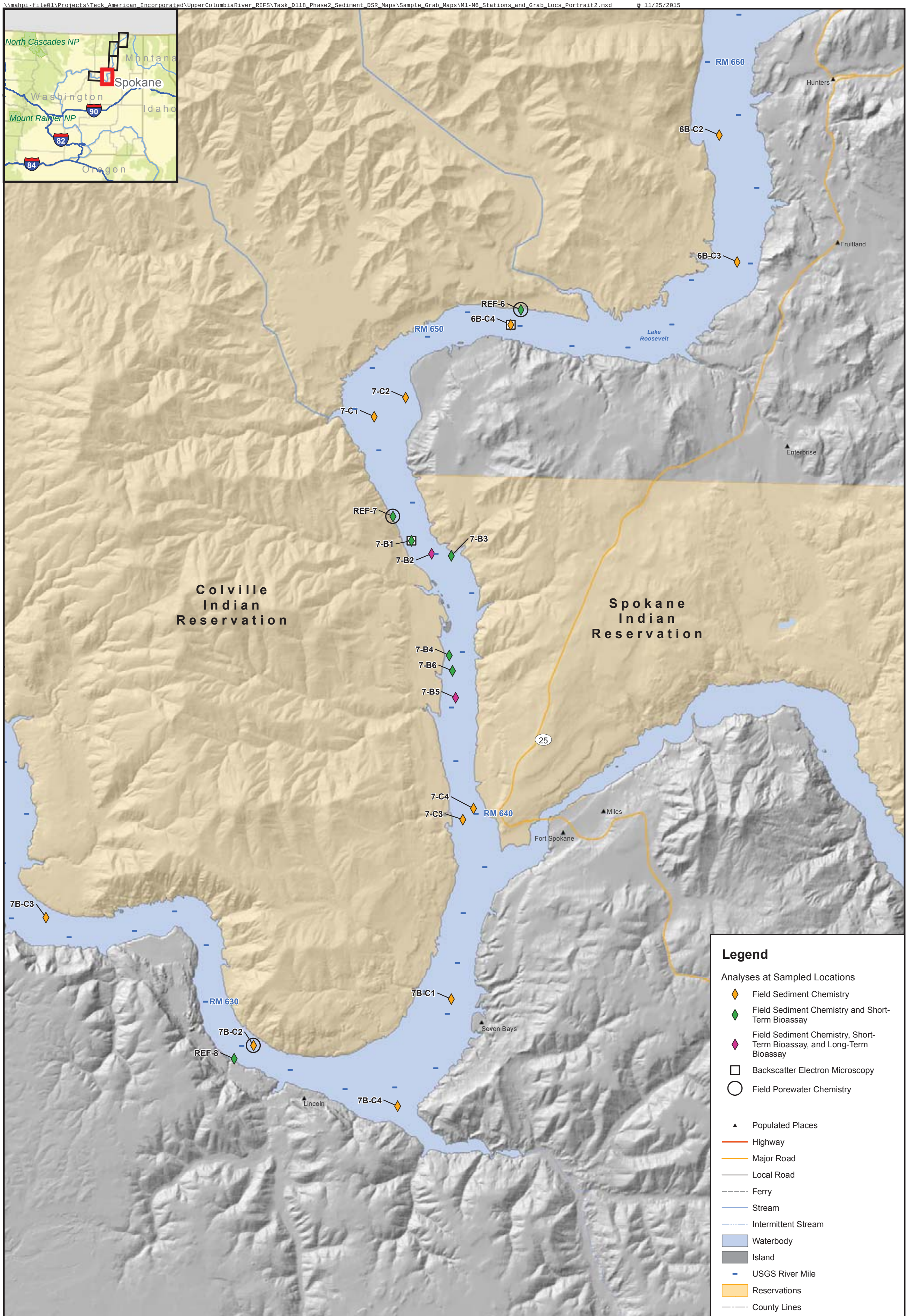
\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



HDR

Map 2-1d. Tile 3 - Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 661 – 689

Upper Columbia River, WA

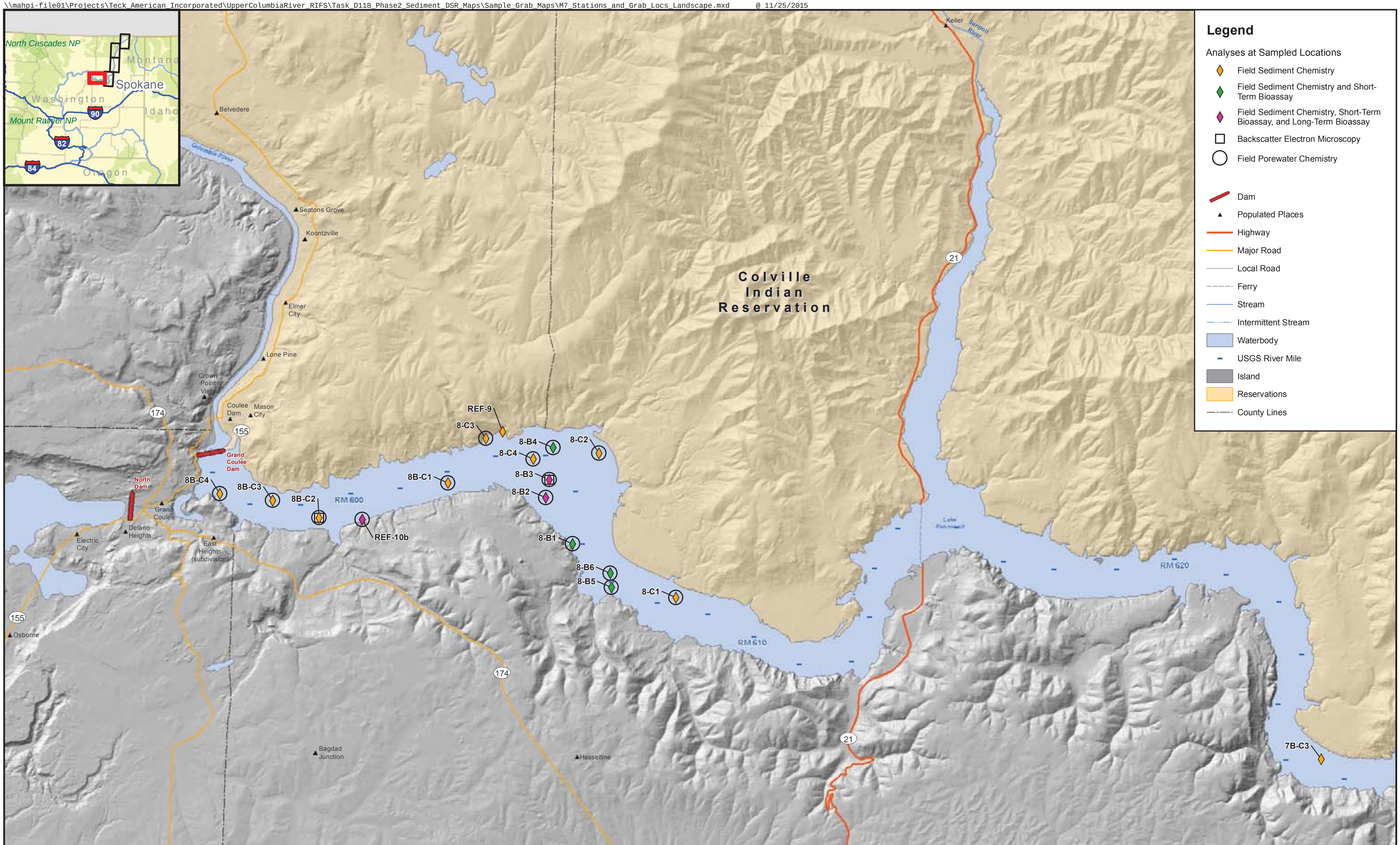


HDR

Map 2-1e. Tile 4 - Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 626 – 661

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M7_Stations_and_Grab_Locs_Landscape.mxd @ 11/25/2015



HDR

0 1.25 2.5 Km

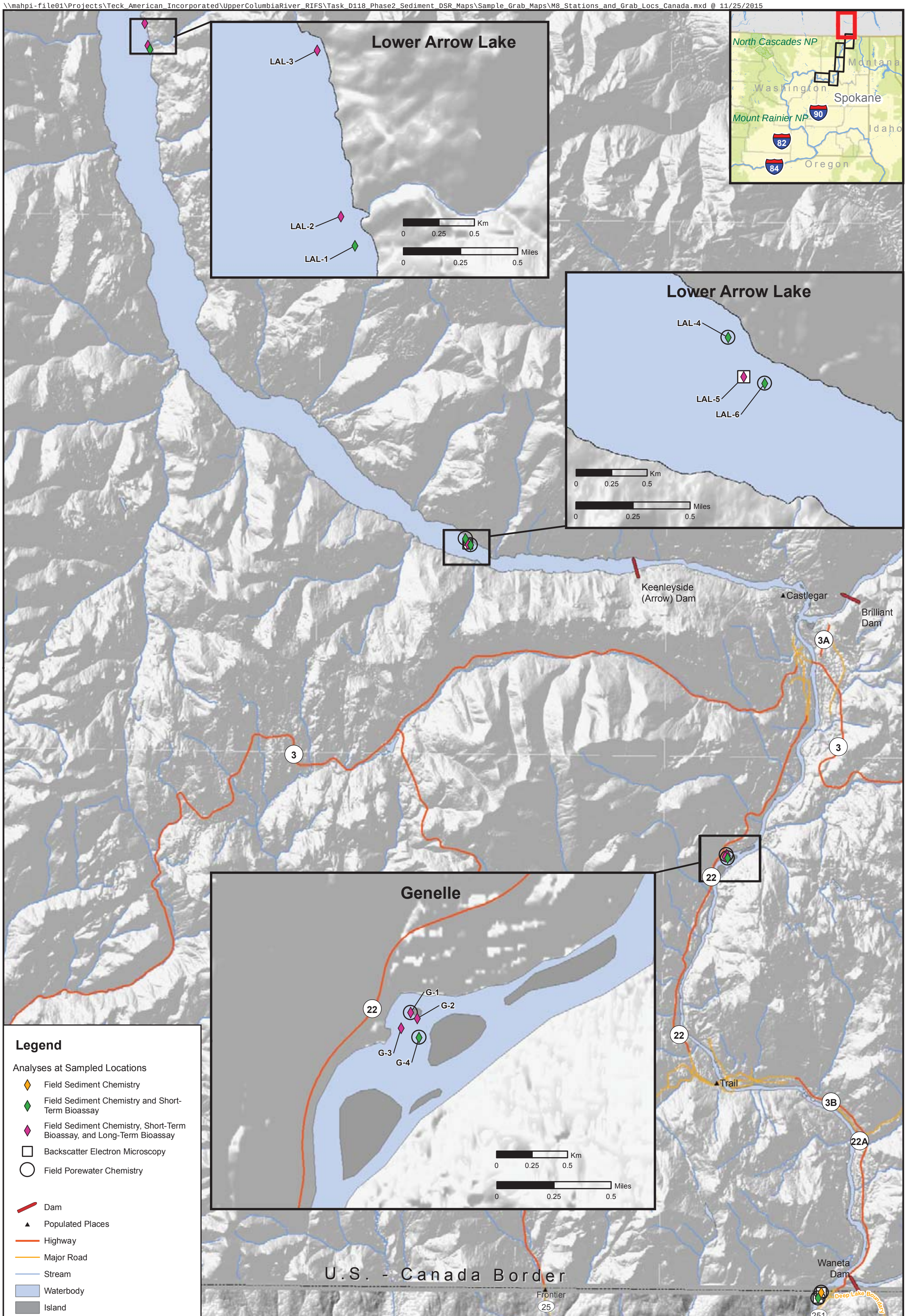
0 1.25 2.5 Miles

N

Map 2-1f. Tile 5 - Locations of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study, River Miles 596 - 626

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M8_Stations_and_Grab_Locs_Canada.mxd @ 11/25/2015



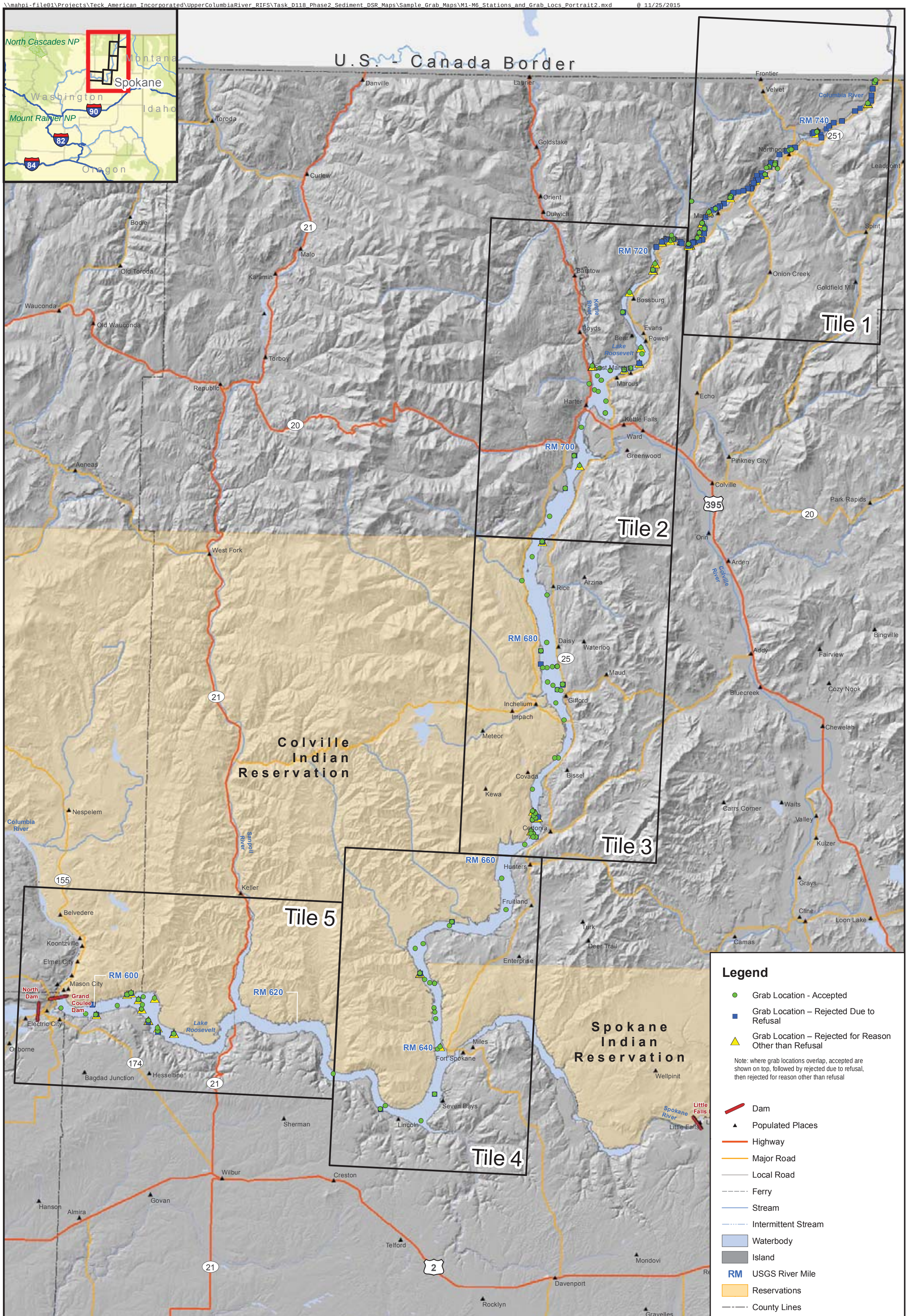
HDR

Km 0 2 4
Miles 0 2 4
N

Map 2-2. Locations in Canada of Sediment Samples Analyzed for the UCR Phase 2 Sediment Study

Columbia River, BC

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



HDR

0 5 10 Km

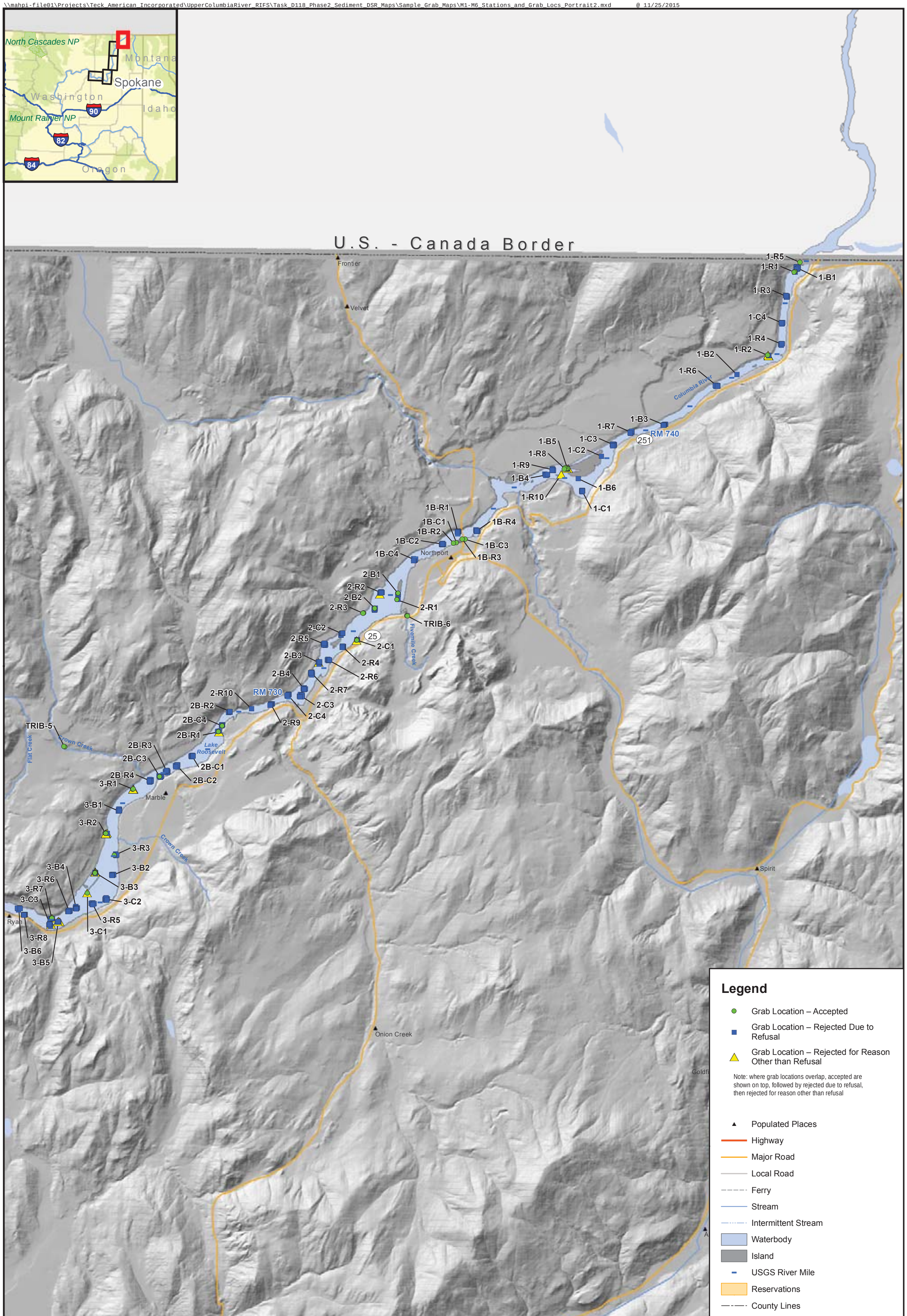
0 5 10 Miles

N

Map 2-3a. Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 596 – 745

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



HDR

0 1.25 2.5 Km

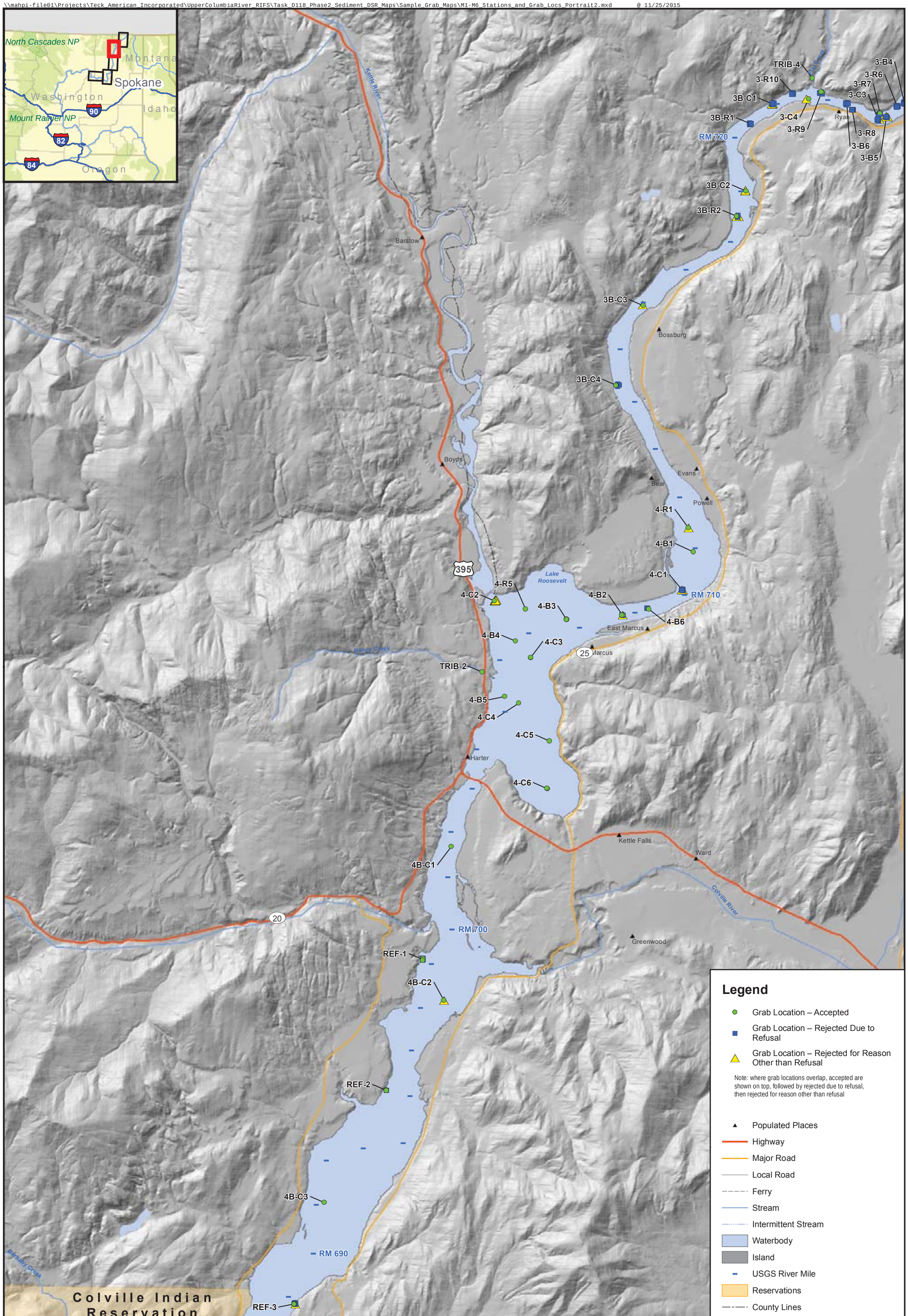
0 1.25 2.5 Miles

N

Map 2-3b. Tile 1 - Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 723 – 745

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015



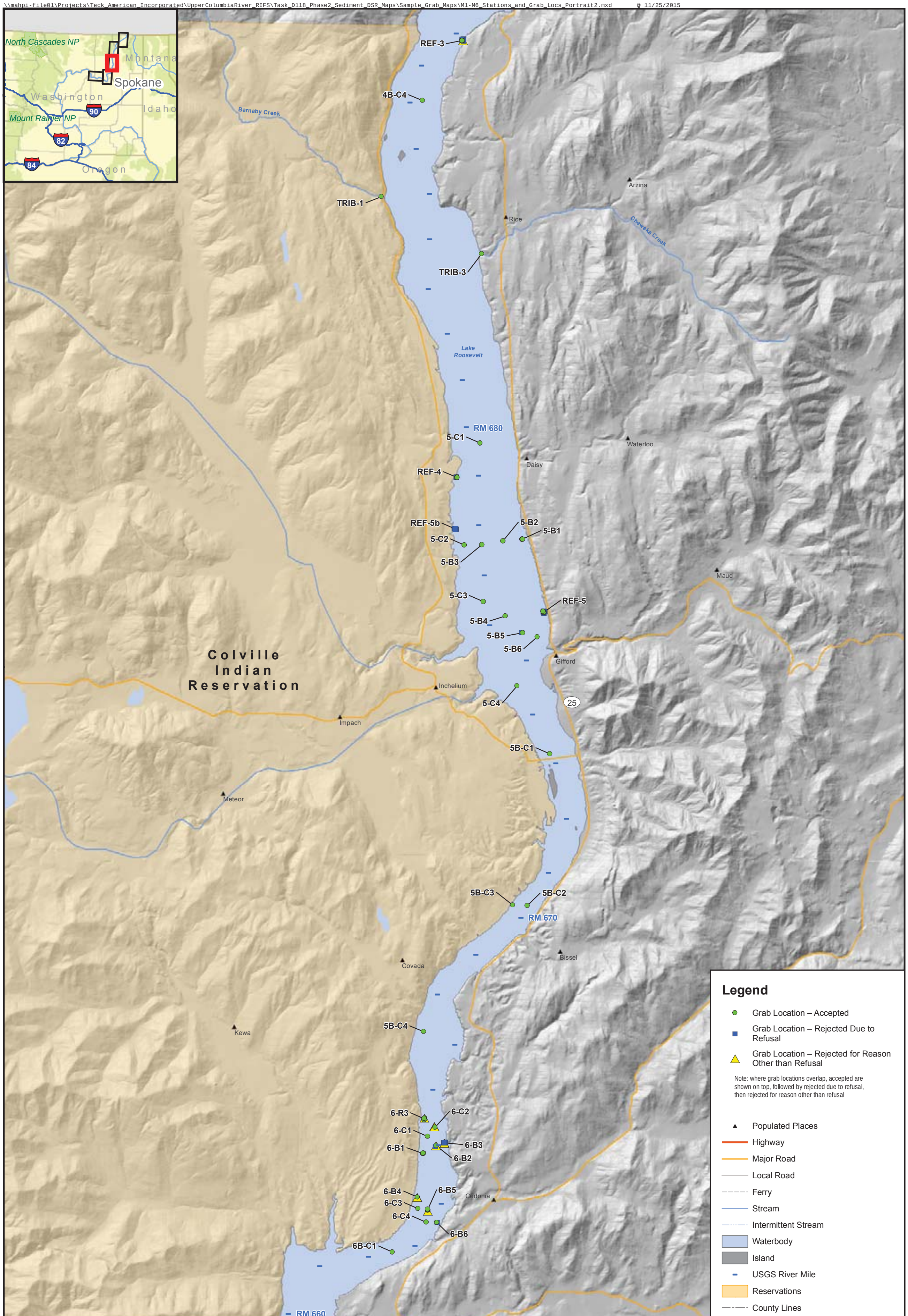
HDR

Km 0 1.25 2.5
Miles 0 1.25 2.5
N

Map 2-3c. Tile 2 - Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 689 – 723

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015

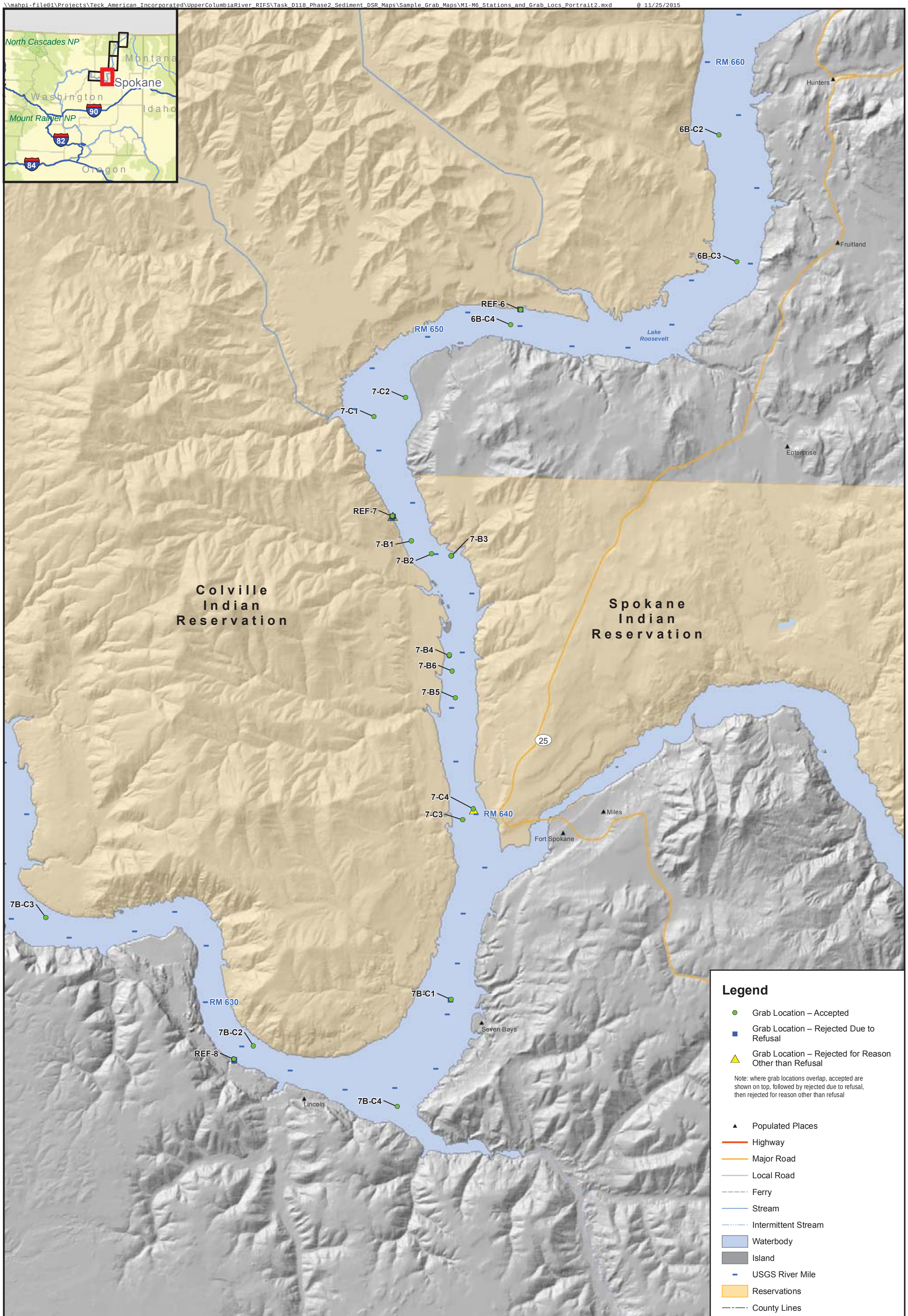


HDR

Map 2-3d. Tile 3 - Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 661 – 689

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M1-M6_Stations_and_Grab_Locs_Portrait2.mxd @ 11/25/2015

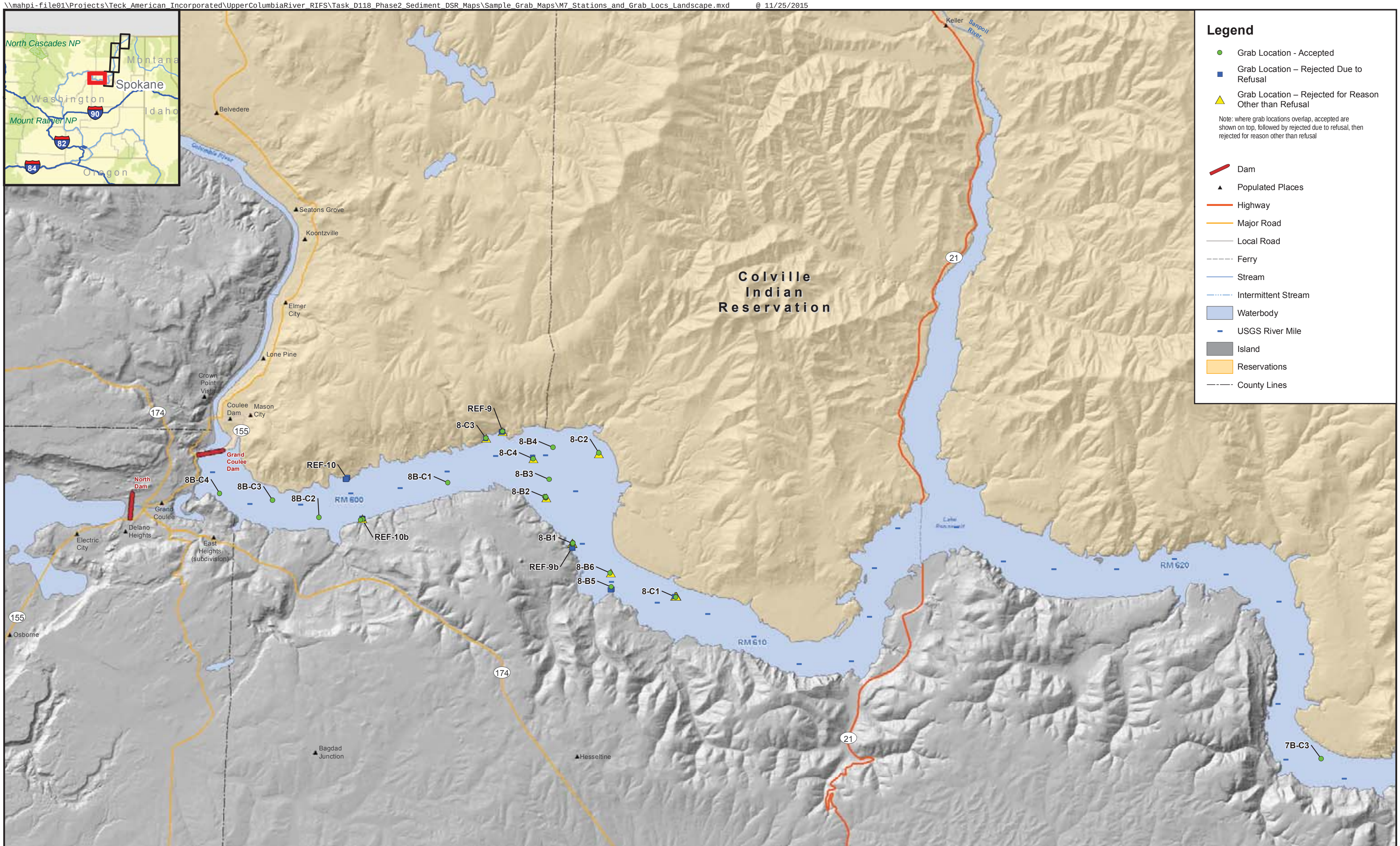


HDR

Map 2-3e. Tile 4 - Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 626 – 661

Upper Columbia River, WA

\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M7_Stations_and_Grab_Locs_Landscape.mxd @ 11/25/2015

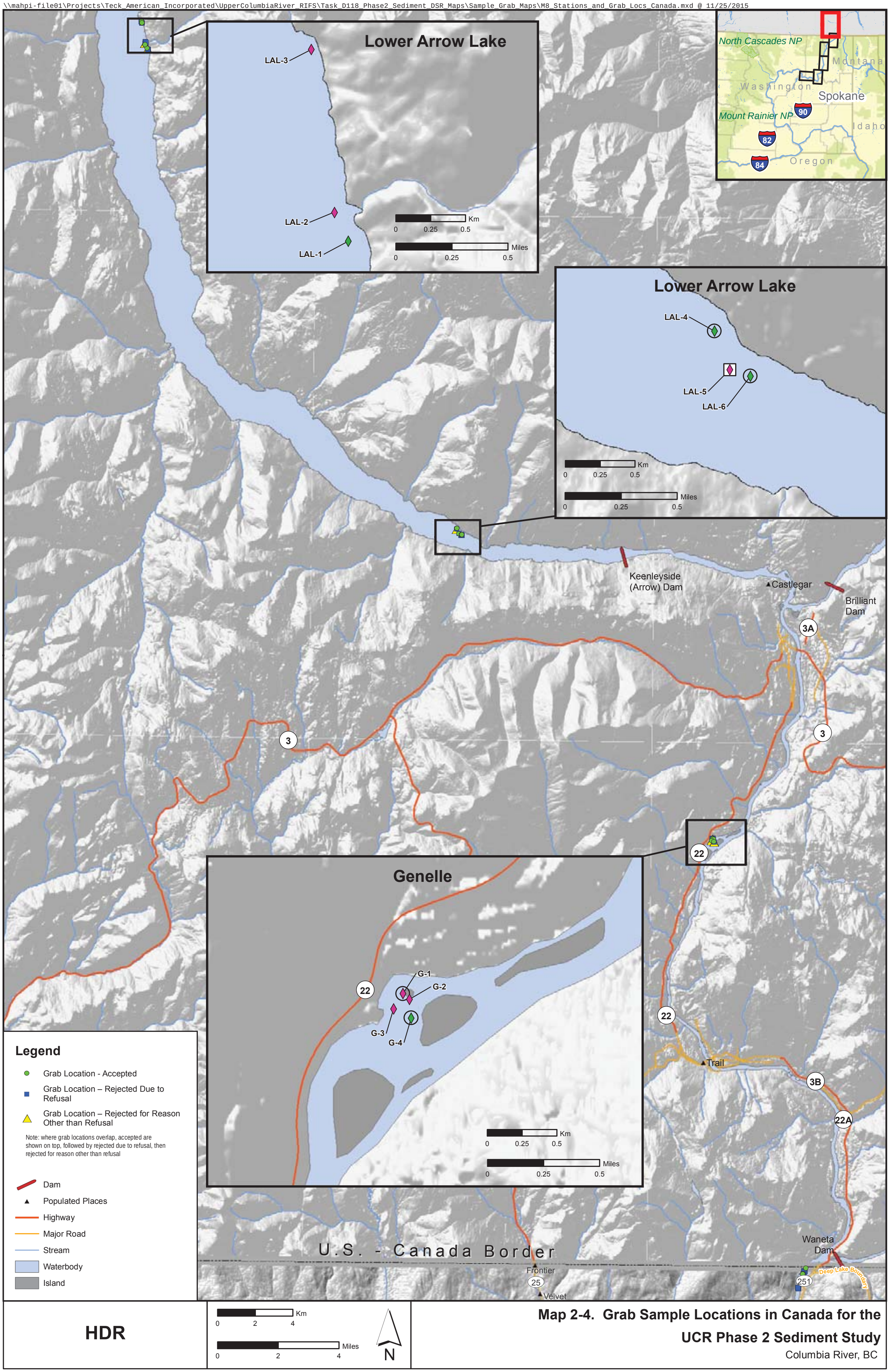


HDR

Map 2-3f. Tile 5 - Grab Sample Locations for the UCR Phase 2 Sediment Study, River Miles 596 - 626

Upper Columbia River, WA

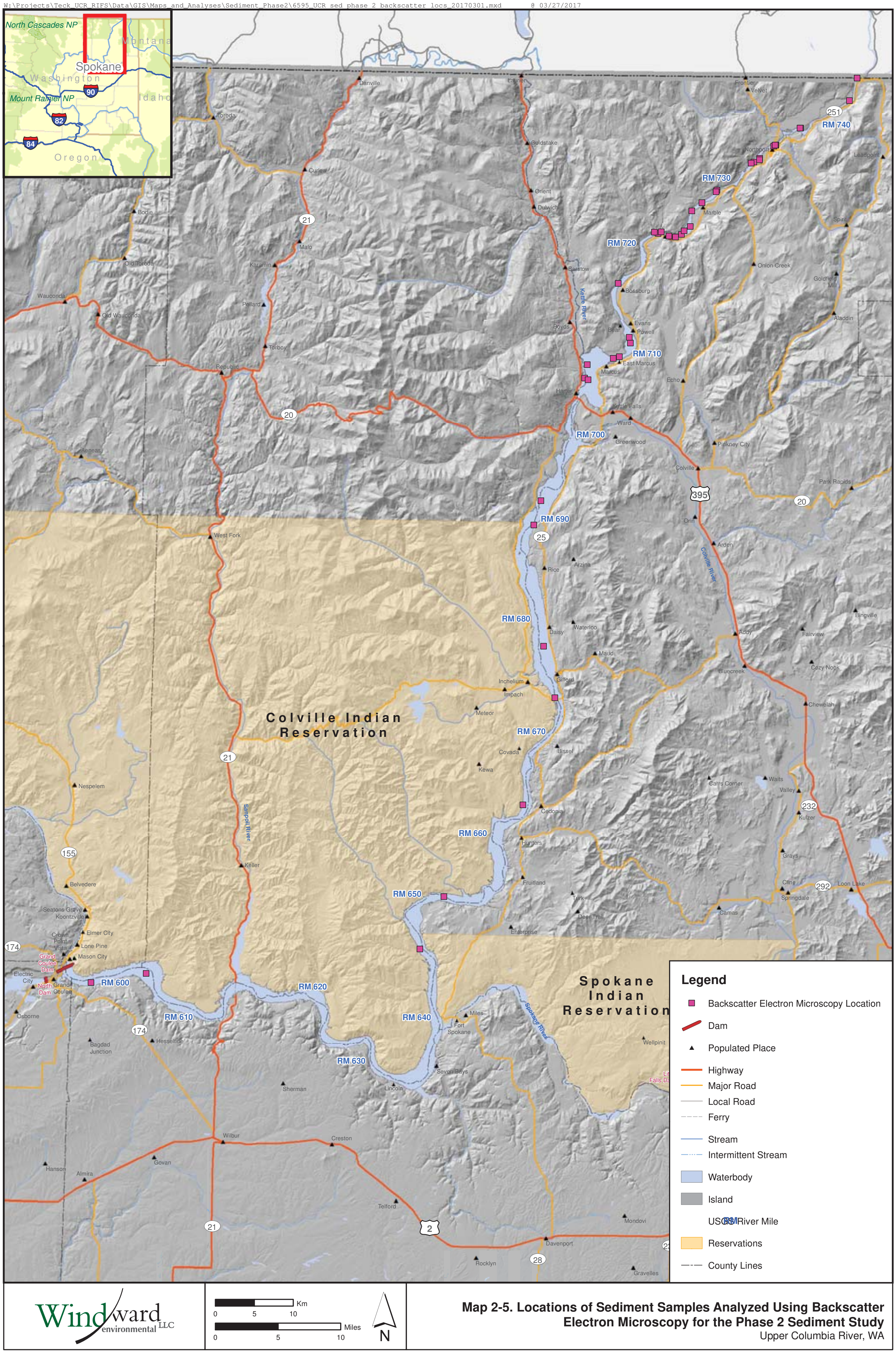
\\mahpi-file01\Projects\Teck_American_Incorporated\UpperColumbiaRiver_RIFS\Task_D118_Phase2_Sediment_DSR_Maps\Sample_Grab_Maps\M8_Stations_and_Grab_Locs_Canada.mxd @ 11/25/2015



Map 2-4. Grab Sample Locations in Canada for the UCR Phase 2 Sediment Study

Columbia River, BC

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment_Phase2\6595_UCR sed phase 2 backscatter locs_20170301.mxd @ 03/27/2017



Map 2-5. Locations of Sediment Samples Analyzed Using Backscatter Electron Microscopy for the Phase 2 Sediment Study
Upper Columbia River, WA

TABLES

Table 2-1. Locations Sampled for the Phase 2 Sediment Study

Sampling Location	River Mile	Sample Type	Sample Coordinates[a] Easting	Northing	Sediment Split Samples
Site Locations					
1-R5[b]	745	chemistry only	453606	5427596	EPA
1-R1[b]	745	chemistry and bioassay	453443	5427291	EPA
1-R2[b]	743	chemistry and bioassay	452607	5424703	EPA
1-B5	738	chemistry and bioassay	446362	5421170	
1-R8[b]	738	chemistry only	446280	5421175	EPA
1B-C3	735	chemistry only	443176	5418972	
1B-R3[b]	735	chemistry only	443090	5418974	
1B-C1	735	chemistry only	442912	5418855	
1B-R2	735	chemistry and bioassay	442818	5418846	EPA
2-B1	733	chemistry and bioassay	441087	5417286	EPA
2-R1[b]	733	chemistry and bioassay	441060	5417085	EPA
2-B2	733	chemistry and bioassay	440369	5416813	EPA
2-R3[b]	732	chemistry and bioassay	440007	5416667	EPA
2-C1	732	chemistry only	439808	5415828	
2-B4	730	chemistry only	438170	5414293	
2B-R2[b]	729	chemistry only	435849	5413606	
2B-C4	729	chemistry only	435613	5413154	
2B-R1[b]	728	chemistry only	435499	5412970	
2B-C3	727	chemistry only	433666	5411568	
3-R1[b]	726	chemistry and bioassay	432831	5411179	
3-B1	726	chemistry only	432375	5410510	
3-R2[b]	725	chemistry and bioassay	431977	5409802	NPS
3-R3[b]	725	chemistry only	432257	5409127	
3-B2	725	chemistry only	432199	5408503	
3-B3	725	chemistry and bioassay	431659	5408579	EPA, NPS
3-C1	724	chemistry only	431411	5407941	
3-B4	724	chemistry only	431063	5407461	
3-R6[b]	723	chemistry only	430836	5407398	
3-R7[b]	723	chemistry and bioassay	430299	5407152	NPS
3-R8[b]	722	chemistry and bioassay	429442	5407277	NPS
3-R9[b]	722	chemistry and bioassay	428489	5407829	NPS
3-C4	722	chemistry only	428079	5407611	EPA
3-R10[b]	721	chemistry only	427599	5407778	
3B-C2	719	chemistry only	426134	5404745	
3B-R2[b]	719	chemistry only	425849	5403961	
3B-C3	716	chemistry only	422938	5401182	
3B-C4	714	chemistry only	422097	5398703	
4-R1[b]	711	chemistry only	424340	5394268	
4-B1	711	chemistry and bioassay	424499	5393517	NPS
4-B6	709	chemistry and bioassay	423102	5391739	NPS
4-B2	709	chemistry and bioassay	422289	5391549	NPS
4-B3	708	chemistry and bioassay	420546	5391417	EPA, NPS
4-R5[b]	707	chemistry only	419268	5391736	
4-C3	707	chemistry only	419430	5390225	
4-B4	707	chemistry and bioassay	418964	5390736	NPS
4-C2	707	chemistry only	418306	5391991	
4-B5	705	chemistry and bioassay	418623	5389013	NPS
4-C4	705	chemistry only	419068	5388804	
4-C5	705	chemistry only	420013	5387633	
4-C6	704	chemistry only	419944	5386149	EPA

Table 2-1. Locations Sampled for the Phase 2 Sediment Study

Sampling Location	River Mile	Sample Type	Sample Coordinates[a] Easting	Northing	Sediment Split Samples
Site Locations (continued)					
4B-C1	702	chemistry only	416961	5384343	
REF-1	699	chemistry and bioassay	416077	5380829	NPS
4B-C2	698	chemistry only	416725	5379563	
REF-2	696	chemistry and bioassay	414938	5376760	NPS
4B-C3	692	chemistry only	413004	5373264	
REF-3	689	chemistry and bioassay	412079	5370108	NPS
4B-C4	687	chemistry only	410842	5368240	
5-C1	680	chemistry only	412643	5357586	
REF-4	679	chemistry and bioassay	411920	5356518	EPA, CCT
5-B1	678	chemistry and bioassay	413953	5354594	NPS
5-B2	678	chemistry and bioassay	413351	5354542	EPA, NPS
5-B3	678	chemistry and bioassay	412691	5354422	CCT
5-C2	678	chemistry only	412149	5354419	
5-C3	677	chemistry only	412739	5352655	EPA
5-B4	676	chemistry and bioassay	413421	5352207	NPS
5-B5	675	chemistry and bioassay	413958	5351688	EPA, NPS
5-B6	675	chemistry and bioassay	414417	5351559	EPA, NPS
5-C4	675	chemistry only	413790	5350031	
5B-C1	673	chemistry only	414804	5347923	
5B-C2	670	chemistry only	414102	5343194	
5B-C3	670	chemistry only	413656	5343212	EPA
5B-C4	667	chemistry only	410882	5339276	
6-R3[b]	665	chemistry and bioassay	410903	5336566	EPA, NPS
6-C2	665	chemistry only	411236	5336306	
6-C1	665	chemistry only	411008	5336020	
6-B1	665	chemistry and bioassay	410865	5335491	CCT
6-B2	665	chemistry and bioassay	411273	5335725	CCT
6-B4	664	chemistry and bioassay	410686	5334129	CCT
6-B5	664	chemistry and bioassay	411006	5333732	NPS
6-B6	664	chemistry and bioassay	411293	5333336	NPS
6-C3	664	chemistry only	410709	5333769	
6-C4	664	chemistry only	410959	5333350	
6B-C1	663	chemistry only	409907	5332428	
6B-C2	659	chemistry only	407027	5328228	EPA
6B-C3	657	chemistry only	407583	5324288	
REF-5	656	chemistry and bioassay	414617	5352322	
6B-C4	652	chemistry only	400539	5322330	
REF-6	652	chemistry and bioassay	400853	5322794	CCT
7-C2	649	chemistry only	397270	5320065	
7-C1	648	chemistry only	396293	5319468	
REF-7	646	chemistry and bioassay	396874	5316362	CCT
7-B1	645	chemistry and bioassay	397452	5315603	CCT
7-B2	645	chemistry and bioassay	398078	5315204	CCT
7-B3	645	chemistry and bioassay	398694	5315139	CCT
7-B4	643	chemistry and bioassay	398630	5312043	CCT
7-B6	643	chemistry and bioassay	398724	5311550	CCT
7-B5	642	chemistry and bioassay	398830	5310722	EPA, CCT
7-C4	640	chemistry only	399383	5307269	
7-C3	640	chemistry only	399051	5306929	
7B-C1	636	chemistry only	398694	5301339	
7B-C4	634	chemistry only	397023	5298005	
7B-C2	631	chemistry only	392535	5299893	
REF-8	631	chemistry and bioassay	391932	5299478	EPA, NPS

Table 2-1. Locations Sampled for the Phase 2 Sediment Study

Sampling Location	River Mile	Sample Type	Sample Coordinates[a]		Sediment Split Samples
			Easting	Northing	
Site Locations (continued)					
7B-C3	625	chemistry only	386079	5303883	
8-C1	608	chemistry only	366218	5308848	
8-B5	607	chemistry and bioassay	364228	5309157	NPS
8-B6	607	chemistry and bioassay	364197	5309595	NPS
8-B1	606	chemistry and bioassay	363041	5310496	NPS
8-B2	605	chemistry and bioassay	362207	5311915	NPS
8-C2	605	chemistry only	363849	5313282	
8-B3	604	chemistry and bioassay	362315	5312467	NPS
8-B4	604	chemistry and bioassay	362435	5313452	CCT
8-C4	604	chemistry only	361822	5313108	EPA
REF-9	603	chemistry only	360881	5313941	CCT
8-C3	603	chemistry only	360369	5313738	
8B-C1	602	chemistry only	359197	5312371	
REF-10b	600	chemistry and bioassay	356558	5311244	CCT
8B-C2	599	chemistry only	355225	5311304	
8B-C3	598	chemistry only	353797	5311827	
8B-C4	597	chemistry only	352174	5312039	
Tributary Locations					
TRIB-1	685	chemistry and bioassay	409565	5365250	NPS
TRIB-2	706	chemistry and bioassay	417919	5389776	NPS
TRIB-3	684	chemistry and bioassay	412684	5363469	EPA, NPS
TRIB-4	722	chemistry and bioassay	428199	5408256	NPS
TRIB-5	NA[c]	chemistry and bioassay	430696	5412505	
TRIB-6	733	chemistry and bioassay	441374	5416578	
Upstream Locations					
G-1	NA	chemistry and bioassay	448664	5450379	EPA
G-2	NA	chemistry and bioassay	448711	5450339	
G-3	NA	chemistry and bioassay	448597	5450270	
G-4	NA	chemistry and bioassay	448724	5450204	
LAL-1	NA	chemistry and bioassay	418638	5492298	EPA
LAL-2	NA	chemistry and bioassay	418537	5492507	
LAL-3	NA	chemistry and bioassay	418371	5493674	
LAL-4	NA	chemistry and bioassay	435078	5466832	
LAL-5	NA	chemistry and bioassay	435187	5466555	EPA
LAL-6	NA	chemistry and bioassay	435336	5466507	

Notes:

Sample locations with “REF” in the ID are planned reference locations within the site. Upstream sample locations with “G” in the ID are from Genelle and locations with “LAL” are from Lower Arrow Lake.

[a] For samples containing a composite of two or more grab samples, the location coordinates in the table represent an average of the grab sample coordinates.

[b] Reserve sampling location.

[c] Not applicable because TRIB-5 was located more than one mile upstream from the UCR.

CCT - Confederated Colville Tribes

NA - not applicable

NPS - National Park Service

Table 2-2. Summary of Accepted and Rejected Grab Samples

Sampling Location (Both Targeted and Reserve)	River Mile	Number of Grabs				Successful Sample Collection (i.e., Sample Analyzed)?
		Total	Accepted	Rejected Based on Refusal[a]	Rejected for Reasons Other than Refusal[b]	
Site Locations						
1-B1	745	9		9		No
1-R1	745	4	2	2		Yes
1-R10	745	1			1	No
1-R3	744	9		9		No
1-C4	744	9		9		No
1-R5	743	1	1			Yes
1-R4	743	9		9		No
1-R2	743	6	1	2	3	Yes
1-B2	742	1		1		No
1-R6	742	9		9		No
1-B3	740	9		9		No
1-R7	740	9		9		No
1-R8	740	2	2			Yes
1-C3	739	9		9		No
1-C2	739	1		1		No
1-C1	738	9		9		No
1-B6	738	1		1		No
1-B5	738	12	3	7	2	Yes
1-R9	738	9		9		No
1-B4	738	9		9		No
1B-R4	735	9		9		No
1B-C3	735	1	1			Yes
1B-C4	735	9		9		No
1B-R1	735	9		9		No
1B-R3	735	1	1			Yes
1B-R2	735	1	1			Yes
1B-C1	735	1	1			Yes
1B-C2	735	9		9		No
2-R2	733	9		8	1	No
2-R3	733	2	2			Yes
2-B1	733	5	2	3		Yes
2-B2	733	9	1	8		Yes
2-C1	732	7	3	3	1	Yes
2-C2	732	9		9		No
2-R4	732	9		9		No
2-R5	731	9		9		No
2-R6	731	9		9		No
2-B3	731	10		9	1	No
2-R7	731	9		9		No
2-B4[c]	730	9		9[d]		Yes
2-C3	730	9		9		No
2-R1	730	3	2	1		Yes
2-C4	730	9		9		No
2-R9	730	9		9		No
2-R10	729	1		1		No
2B-R2[c]	729	10		10[d]		Yes
2B-C4	729	6	1	5		Yes
2B-R1	728	5	2	2	1	Yes
2B-C1	728	9		9		No
2B-C2	727	9		9		No
2B-R3	727	9		9		No
2B-C3	727	9	1	8		Yes
2B-R4	727	9		9		No

Table 2-2. Summary of Accepted and Rejected Grab Samples

Sampling Location (Both Targeted and Reserve)	River Mile	Number of Grabs: Total	Number of Grabs: Accepted	Number of Grabs: Rejected Based on Refusal[a]	Number of Grabs: Rejected for Reasons Other than Refusal[b]	Successful Sample Collection (i.e., Sample Analyzed)?
Site Locations (continued)						
3-B1[c]	726	9		9[e]		Yes
3-R2	725	7	3	1	3	Yes
3-R3	725	5	1	4		Yes
3-B2[c]	725	9		9[e]		Yes
3-B3	725	11	4	5	2	Yes
3-C2	724	9		9		No
3-C1	724	2	1		1	Yes
3-R5	724	9		9		No
3-B4[c]	724	9		9[e]		Yes
3-R6[c]	723	9		9[d]		Yes
3-B5	723	9		6	3	No
3-R7	723	11	5	5	1	Yes
3-C3	723	9		8	1	No
3-R8[c]	722	9		9[f]		Yes
3-B6	722	9		9		No
3-R9	722	5	2	3		Yes
4-B1	722	1	1			Yes
3-R1	722	5	2		3	Yes
3-C4	722	2	1		1	Yes
3-R10[c]	721	9		9[e]		Yes
3B-C1	721	9		6	3	No
3B-R1	720	9		9		No
3B-C2	719	4	1		3	Yes
3B-R2	719	7	2	3	2	Yes
3B-C3	716	2	1		1	Yes
3B-C4	714	6	2	4		Yes
4-R1	711	2	1		1	Yes
4-R5	711	1	1			Yes
4-R6	711	3	3			No
5-B1	711	4	4			Yes
5-B2	711	1	1			Yes
5-B3	711	1	1			Yes
5-B4	711	1	1			Yes
4-C1	710	9		7	2	No
4-B6	709	4	1	3		Yes
4B-C1	709	1	1			Yes
4-B2	709	5	2	2	1	Yes
4-B3	709	5	5			Yes
4-B4	709	1	1			Yes
4-B5	709	1	1			Yes
4-C2	707	9	1		8	Yes
4-C3	707	2	2			Yes
4-C4	707	1	1			Yes
4-C5	707	1	1			Yes
4-C6	707	3	3			Yes
REF-1	699	8	2	6		Yes
REF-10	699	9		9		No
REF-10B	699	14	4	9	1	Yes
4B-C3	698	1	1			Yes
4B-C2	698	2	1		1	Yes
4B-C4	698	1	1			Yes
REF-2	696	3	2	1		Yes
REF-3	689	11	4	6	1	Yes

Table 2-2. Summary of Accepted and Rejected Grab Samples

Sampling Location (Both Targeted and Reserve)	River Mile	Number of Grabs: Total	Accepted	Rejected Based on Refusal[a]	Rejected for Reasons Other than Refusal[b]	Successful Sample Collection (i.e., Sample Analyzed)?
Site Locations (continued)						
REF-4	679	6	4	2		Yes
Ref-5B	678	9		9		No
Ref-5	678	9	3	6		Yes
5-C1	675	1	1			Yes
5-C2	675	1	1			Yes
5-C3	675	1	1			Yes
5-B5	675	2	1	1		Yes
5-B6	675	1	1			Yes
5-C4	675	1	1			Yes
5B-C1	675	1	1			Yes
5B-C2	675	1	1			Yes
5B-C3	675	1	1			Yes
5B-C4	675	1	1			Yes
6-B1	675	4	4			Yes
6-R3	665	5	4		1	Yes
7-B1	665	1	1			Yes
7-B2	665	1	1			Yes
7-B3	665	3	3			Yes
7-B4	665	2	2			Yes
7-B5	665	1	1			Yes
7-B6	665	1	1			Yes
6-C2	665	4	1		3	Yes
6-C3	665	1	1			Yes
6-C4	665	1	1			Yes
6-B3	665	10		7	3	No
6-B2	665	4	1	1	2	Yes
6-B4	664	4	2		2	Yes
6-B5	664	5	4		1	Yes
6-C1	664	1	1			Yes
6-B6	664	2	1	1		Yes
6B-C1	664	1	1			Yes
6B-C2	664	1	1			Yes
6B-C3	664	1	1			Yes
6B-C4	664	1	1			Yes
Ref-6	652	7	3	4		Yes
REF-7	646	14	4	7	3	Yes
7-C4	640	2	1		1	Yes
7-C2	636	1	1			Yes
7-C1	636	1	1			Yes
7-C3	636	1	1			Yes
7B-C1	636	3	1	2		Yes
7B-C4	636	1	1			Yes
7B-C2	636	1	1			Yes
7B-C3	636	1	1			Yes
REF-8	631	7	4	3		Yes
8-C1	608	5	1	1	3	Yes
8-B5	607	5	1	4		Yes
8-B6	607	2	1		1	Yes
8B-C1	607	1	1			Yes
8B-C2	607	1	1			Yes
8B-C3	607	1	1			Yes
8B-C4	607	1	1			Yes
REF-9B	606	3		3		No

Table 2-2. Summary of Accepted and Rejected Grab Samples

Sampling Location (Both Targeted and Reserve)	River Mile	Number of Grabs				Successful Sample Collection (i.e., Sample Analyzed)?
		Total	Accepted	Rejected Based on Refusal[a]	Rejected for Reasons Other than Refusal [b]	
Site Locations (continued)						
8-B1	606	8	5		3	Yes
8-B2	605	5	4		1	Yes
8-B3	605	1	1			Yes
8-B4	605	1	1			Yes
8-C2	605	2	1		1	Yes
8-C4	604	3	1	1	1	Yes
REF-9	603	13	1	11	1	Yes
8-C3	603	3	1	1	1	Yes
Tributary Locations						
Trib-1	685	1	1			Yes
Trib-2	706	1	1			Yes
Trib-3	684	1	1			Yes
Trib-4	722	1	1			Yes
Trib-5	NA[g]	2	2			Yes
Trib-6	733	2	2			Yes
Upstream Locations						
G-1	NA	6	1	4	1	Yes
G-2	NA	2	1	1		Yes
G-3	NA	2	1		1	Yes
G-4	NA	4	1	1	2	Yes
LAL-1	NA	7	1	5	1	Yes
LAL-2	NA	9	1	6	2	Yes
LAL-3	NA	10	4	6		Yes
LAL-4	NA	4	2	1	1	Yes
LAL-5	NA	2	1	1		Yes
LAL-6	NA	10	3	7		Yes

Notes:

Sample locations with "REF" in the ID are planned reference locations within the site. Upstream sample locations with "G" in the ID are from Genelle and locations with "LAL" are from Lower Arrow Lake.

[a] Refusal was defined as the inability to collect a sample because of rocks, cobble and/or gravel, resulting in no sample recovery or a very low sediment penetration depth.

[b] Other reasons for rejection of grabs included winnowing of sample, no overlying water, lack of desired penetration, and/or interference from vegetation or woody debris.

[c] Rejected grabs from eight sampling locations (2-B4, 2B-R2, 3-B1, 3-B2, 3-B4, 3-R10, 3-R6, and 3-R8) did not meet sample acceptability, but in accordance with the QAPP (Exponent et al. 2013), these samples were analyzed because the material collected would enable at least some evaluation of the area.

[d] One rejected grab was submitted for chemical analysis.

[e] Two rejected grabs were submitted for chemical analysis.

[f] Three rejected grabs were submitted for chemical analysis.

[g] Not applicable because TRIB-5 was located more than one mile upstream from the UCR.

NA - not applicable

Table 2-3. Analyses Conducted at Phase 2 Sediment Locations

		Field-Collected Analyses		Bioassay-Associated Analyses				Archived Sediment Analyses	Quality Control Analyses	
Sampling Location	River Mile	Sediment Chemistry	Porewater Chemistry	Short-term Bioassay	Long-term Bioassay	Sediment Chemistry	Porewater Chemistry	BSEM	Field Duplicate Sediment Chemistry	Equipment Rinsate Blanks
Site Locations										
1-R5	745	X	X					X		X
1-R1	745	X	X	X		X	X	X		
1-R2	743	X	X	X	X	X	X	X	X	X
1-B5	738	X	X	X	X	X	X	X		X
1-R8	738	X	X					X		X
1B-C3	735	X	X					X		
1B-R3	735	X	X					X	X	
1B-C1	735	X	X					X		X
1B-R2	735	X	X	X	X	X	X			
2-B1	733	X	X	X	X	X	X	X		
2-R1	733	X	X	X	X	X	X	X	X	
2-B2	733	X	X	X		X	X	X		X
2-R3	732	X	X	X		X	X	X		
2-C1	732	X	X						X	X
2-B4	730	X								X
2B-R2	729	X								
2B-C4	729	X	X					X		
2B-R1	728	X	X					X		
2B-C3	727	X	X					X		X
3-R1	726	X	X	X		X	X			
3-B1	726	X						X		X
3-R2	725	X	X	X		X	X			
3-R3	725	X							X	
3-B2	725	X						X		
3-B3	725	X	X	X	X	X	X			
3-C1	724	X						X		X
3-B4	724	X						X		X
3-R6	723	X								
3-R7	723	X	X	X	X	X	X	X		X
3-R8	722	X	X	X	X	X	X	X		
3-R9	722	X	X	X		X	X	X		X
3-C4	722	X	X					X		X
3-R10	721	X						X		
3B-C2	719	X	X							X
3B-R2	719	X								X
3B-C3	716	X	X					X		
3B-C4	714	X	X							

Table 2-3. Analyses Conducted at Phase 2 Sediment Locations

Sampling Location	River Mile	Field-Collected Analyses		Bioassay-Associated Analyses				Archived Sediment Analyses	Quality Control Analyses	
		Sediment Chemistry	Porewater Chemistry	Short-term Bioassay	Long-term Bioassay	Sediment Chemistry	Porewater Chemistry	BSEM	Field Duplicate Sediment Chemistry	Equipment Rinsate Blanks
Site Locations (continued)										
4-R1	711	X	X					X		X
4-B1	711	X	X	X	X	X	X	X		X
4-B6	709	X	X	X	X	X	X	X	X	
4-B2	709	X	X	X		X	X	X		
4-B3	708	X	X	X		X	X			
4-R5	707	X	X							
4-C3	707	X	X							X
4-B4	707	X	X	X		X	X	X		X
4-C2	707	X	X							
4-B5	705	X		X	X	X	X	X		
4-C4	705	X	X					X		
4-C5	705	X	X							X
4-C6	704	X	X							
4B-C1	702	X	X						X	X
REF-1	699	X	X	X		X	X			
4B-C2	698	X	X						X	
REF-2	696	X	X	X		X	X			X
4B-C3	692	X	X					X		
REF-3	689	X	X	X		X	X	X		X
4B-C4	687	X	X							
5-C1	680	X	X							
REF-4	679	X	X	X		X	X			X
5-B1	678	X	X	X		X	X			X
5-B2	678	X	X	X	X	X	X	X		X
5-B3	678	X	X	X		X	X			X
5-C2	678	X	X							
5-C3	677	X	X							
5-B4	676	X	X	X	X	X	X			X
5-B5	675	X	X	X		X	X			
5-B6	675	X	X	X		X	X			
5-C4	675	X	X						X	
5B-C1	673	X	X					X		
5B-C2	670	X	X							
5B-C3	670	X	X							X
5B-C4	667	X	X							
6-R3	665	X	X	X		X	X			X
6-C2	665	X	X						X	X

Table 2-3. Analyses Conducted at Phase 2 Sediment Locations

		Field-Collected Analyses		Bioassay-Associated Analyses				Archived Sediment Analyses	Quality Control Analyses	
Sampling Location	River Mile	Sediment Chemistry	Porewater Chemistry	Short-term Bioassay	Long-term Bioassay	Sediment Chemistry	Porewater Chemistry	BSEM	Field Duplicate Sediment Chemistry	Equipment Rinsate Blanks
Site Locations (continued)										
6-C1	665	X	X							
6-B1	665	X	X	X		X	X			
6-B2	665	X	X	X	X	X	X			
6-B4	664	X	X	X		X	X	X		
6-B5	664	X	X	X	X	X	X			
6-B6	664	X	X	X		X	X			X
6-C3	664	X	X							X
6-C4	664	X	X							
6B-C1	663	X	X							
6B-C2	659	X								
6B-C3	657	X								
REF-5	656	X	X	X		X	X			
6B-C4	652	X						X		
REF-6	652	X	X	X		X	X			X
7-C2	649	X								
7-C1	648	X								
REF-7	646	X	X	X		X	X			X
7-B1	645	X		X		X	X	X		X
7-B2	645	X		X	X	X	X			
7-B3	645	X		X		X	X			
7-B4	643	X		X		X	X			
7-B6	643	X		X		X	X			
7-B5	642	X		X	X	X	X			
7-C4	640	X								X
7-C3	640	X								X
7B-C1	636	X								X
7B-C4	634	X								
7B-C2	631	X	X							
REF-8	631	X		X		X	X			X
7B-C3	625	X								
8-C1	608	X	X						X	X
8-B5	607	X	X	X		X	X			X
8-B6	607	X	X	X		X	X			
8-B1	606	X	X	X		X	X			X
8-B2	605	X	X	X	X	X	X			
8-C2	605	X	X							
8-B3	604	X	X	X	X	X	X	X		X

Table 2-3. Analyses Conducted at Phase 2 Sediment Locations

Sampling Location	River Mile	Field-Collected Analyses		Bioassay-Associated Analyses				Archived Sediment Analyses	Quality Control Analyses	
		Sediment Chemistry	Porewater Chemistry	Short-term Bioassay	Long-term Bioassay	Sediment Chemistry	Porewater Chemistry	BSEM	Field Duplicate Sediment Chemistry	Equipment Rinsate Blanks
Site Locations (continued)										
8-B4	604	X	X	X		X	X			
8-C4	604	X	X							
REF-9	603	X								X
8-C3	603	X	X							X
8B-C1	602	X	X							
REF-10b	600	X	X	X	X	X	X			X
8B-C2	599	X	X					X	X	
8B-C3	598	X	X							
8B-C4	597	X	X							
Tributary Locations										
TRIB-1	685	X	X	X		X	X		X	X
TRIB-2	706	X	X	X		X	X			
TRIB-3	684	X	X	X	X	X	X			
TRIB-4	722	X	X	X		X	X			X
TRIB-5	NA[a]	X	X	X		X	X			X
TRIB-6	733	X	X	X		X	X			X
Upstream Locations										
G-1	NA	X	X	X	X	X	X			
G-2	NA	X		X	X	X	X			X
G-3	NA	X		X	X	X	X			
G-4	NA	X	X	X		X	X			X
LAL-1	NA	X		X		X	X			
LAL-2	NA	X		X	X	X	X			
LAL-3	NA	X		X	X	X	X		X	X
LAL-4	NA	X	X	X		X	X			
LAL-5	NA	X		X	X	X	X	X		
LAL-6	NA	X	X	X		X	X			X

Notes:

Sample locations with “REF” in the ID are planned reference locations within the site. Upstream sample locations with “G” in the ID are from Genelle and locations with “LAL” are from Lower Arrow Lake.

[a] Not applicable because TRIB-5 was located more than one mile upstream from the UCR.

BSEM - backscattered scanning electron microscopy

NA - not applicable

Table 2-4. Analytes by Sample Matrix

	Field		Bioassay				Blanks		
Analyte	Sediment	Porewater[a]	Sediment (Start of Test)[b]	Sediment (During Test)	Porewater (Start of Test)	Porewater (During Test)	Sediment Field Equipment Rinsate Blanks	Porewater Field Equipment Blank	Porewater Laboratory Equipment Blanks
TAL metals[c]	X		X				X		
Dissolved TAL metals[c] except mercury		X				X		X	X
AVS and SEM	X		X	X					
TOC	X	X	X	X				X	
Grain size	X		X						
pH	X	X	X		X			X	
DOC		X			X			X	
Alkalinity		X			X				
Hardness		X			X			X	
Chloride		X			X			X	
Sulfate		X			X			X	
Sulfide					X				

Notes:

[a] Volume permitting, field-collected porewater samples were tested for the indicated analytes. If sample volume was limited, dissolved TAL metals were given priority, followed by DOC and TOC.

[b] Bulk sediment from the bioassay laboratory was subsampled and submitted for analysis prior to initiation of the long-term bioassays but not the short-term bioassays.

[c] TAL metals include: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

AVS - acid volatile sulfide

DOC - dissolved organic carbon

SEM - simultaneously extracted metals

TAL - target analyte list

TOC - total organic carbon

Table 2-5. Analytical Methods for Sediment and Porewater Samples

Analytes	Sample Preparation		Quantitative Analysis	
	Protocol	Procedure	Protocol	Procedure
Sediment Samples				
TAL metals: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn)	EPA 3050B	Acid Digestion	EPA 6020A	ICP/MS
TAL metals: calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), and sodium (Na)	EPA 3050B	Acid Digestion	EPA 6010C	ICP/AES
Mercury (total)	EPA 7471B	Acid Digestion	EPA 7471B	Cold Vapor AA
AVS and SEM[a]	USEPA (1991)	NA	EPA 6010C/AVS-SEM	ICP/AES
TOC	NA	NA	ASTM D4129-05	Coulometric
pH	NA	NA	EPA 9045D	Electrometric
Grain Size	NA	NA	ASTM D422	Gravimetric
Porewater Samples				
Dissolved TAL metals: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn)[b]	EPA CLP	Acid Digestion	EPA 6020A	ICP/MS
Dissolved TAL metals: calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), and sodium (Na)	EPA CLP	Acid Digestion	EPA 6010C	ICP/AES
TOC and DOC	NA	NA	EPA 9060A	NA
pH	NA	NA	SM 4500 H+ B	Electrometric
Alkalinity as $CaCO_3$	NA	NA	SM 2320 B	Titration
Hardness as $CaCO_3$	NA	NA	SM 2340B	Calculated
Chloride, sulfate	NA	NA	EPA 300	Ion Chromatography
Sulfide	NA	NA	SM 4500 S^{2-} D	Colorimetric

Notes:

[a] SEM analyses were conducted for eight metals: Sb, As, Cd, Cr, Cu, Pb, Ni, and Zn. Total SEM calculations included only Cd, Cu, Pb, Ni, and Zn.
[b] Metals were reported by EPA Method 6010C rather than EPA Method 6020A depending on analyte concentration.

AA - atomic absorption
AES - atomic emission spectrometry
ASTM - American Society for Testing and Materials
AVS - acid volatile sulfide
$CaCO_3$ - calcium carbonate
CLP - Contract Laboratory Program
DOC - dissolved organic carbon
ICP - inductively coupled plasma
MS - mass spectrometry
NA - not applicable
SEM - simultaneously extracted metals
SM - Standard Methods for the Examination of Water and Wastewater
TAL - target analyte list
TOC - total organic carbon

Table 2-6. Test Conditions for the Short-Term *Chironomus dilutus* Bioassay

Parameter	Test Conditions
Test type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 °C ± 1 °C
Light quality	Wide-spectrum fluorescent lights
Illuminance	Approximately 500 lux
Photoperiod	16L:8D
Test chamber	300-mL high-form lipless glass beaker
Sediment volume	100 mL
Overlying water volume	175 mL
Renewal of overlying water	Day 0: Renewal immediately prior to the introduction of test organisms Daily for duration of test: two volume additions: continuous or intermittent (e.g., one volume addition every 12 hours)
Test organism	*Chironomus dilutus*
Test organism source	Pacific EcoRisk cultures
Age of organisms[a]	Second- and third-instar larvae (about 10-day-old larvae; all organisms must be third instar or younger with approximately 50% of the organisms at second instar and approximately 50% of the organisms at third instar
Number of organisms/chamber	10
Number of replicate chambers/sample[a]	11 replicates: 8 for biological endpoints and 3 for chemistry evaluation (i.e., sediment and porewater)
Feeding[a]	6 mg/L suspension of TetraMin® fish food added daily to each test chamber
Aeration	None, unless DO in overlying water drops below 2.5 mg/L
Overlying water[a]	Reformulated moderately hard reconstituted water (as specified in USEPA [2000] page 25)
Test chamber cleaning	Cleaned if screens become clogged during test; outside of screen gently brushed
Overlying water quality	Hardness, alkalinity, conductivity, pH, and ammonia at the beginning and end of a test; temperature daily and DO twice daily
Test duration	10 days
Endpoints	Survival, weight (AFDW), and biomass (AFDW)
Reference toxicant	Sodium chloride (NaCl)

Notes:

Source: modified from USEPA (2000)

[a] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

AFDW - ash-free dry weight

DO - dissolved oxygen

Table 2-7. Test Conditions for the Short-Term *Hyalella azteca* Bioassay

Parameter	Test Conditions
Test type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 °C ± 1 °C
Light quality	Wide-spectrum fluorescent lights
Illuminance	Approximately 500 lux
Photoperiod	16L:8D
Test chamber	300-mL high-form lipless glass beaker
Sediment volume	100 mL
Overlying water volume	175 mL
Renewal of overlying water	Day 0: Renewal immediately prior to the introduction of test organisms Daily for duration of test: two volume additions: continuous or intermittent (e.g., one volume addition every 12 hours)
Test organism	*Hyalella azteca*
Test organism source	Aquatic BioSystems, Fort Collins, Colorado
Age of organisms[a]	7 to 8 days old at the start of the test
Number of organisms/chamber	10
Number of replicate chambers/sample[a]	14 replicates: 8 for biological endpoints and 6 for chemistry only
Feeding[a]	1.0 mL YCT mixture added to each test chamber daily during Days 0 to 13, and 2 mL YCT added to each test chamber daily during the remaining exposure (Days 14 to 27)
Aeration	None, unless DO in overlying water drops below 2.5 mg/L
Overlying water[a]	Reconstituted water as specified in Borgmann (1996) but modified to contain 0.4 mg/L bromide
Test chamber cleaning	Cleaned if screens become clogged during test; outside of screen gently brushed
Overlying water quality	Hardness, alkalinity, conductivity, pH, and ammonia at the beginning and end of a test; temperature daily and DO twice daily; conductivity weekly; pH three times/week
Test duration	28 days
Endpoints	Survival, weight, and biomass
Reference toxicant	Potassium chloride (KCl)

Notes:

Source: modified from USEPA (2000)

[a] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

DO - dissolved oxygen

YCT - Yeast-Cerophyll®-Trout

Table 2-8. Test Conditions for the Long-Term *Chironomus dilutus* Bioassay

Parameter	Test Conditions
Test type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 °C ± 1 °C
Light quality	Wide-spectrum fluorescent lights
Illuminance	Approximately 500 lux
Photoperiod	16L:8D
Test chamber	300-mL high-form lipless glass beaker
Sediment volume	100 mL
Overlying water volume	175 mL
Renewal of overlying water	On Day 0, renewal immediately prior to the introduction of test organisms; during test, two volume additions/day; continuous or intermittent (e.g., one volume addition every 12 hours)
Test organism source	Pacific EcoRisk cultures
Age of organisms[a]	4-day-old larvae
Number of organisms/chamber	12
Number of replicate chambers/sample[a]	25 replicates: 16 for biological endpoints and 9 for chemistry only; of the 16 replicates for biological endpoints, 4 replicates are for production of auxiliary males only; biological endpoints not evaluated
Feeding [a]	6 mg/L suspension of TetraMin® fish food added daily to each test chamber
Aeration	None, unless DO in overlying water drops below 2.5 mg/L
Overlying water[a]	Reformulated moderately hard reconstituted water (as specified in USEPA [2000] page 25)
Test chamber cleaning	Cleaned if screens become clogged during test; outside of screen gently brushed
Overlying water quality	Hardness, alkalinity, conductivity, pH, and ammonia at the beginning and end of a test; temperature once daily and DO twice daily; hardness, alkalinity, conductivity, and ammonia at the beginning, on Day 20, and at the end of a test; temperature daily (ideally continuously); DO and pH three times/week; conductivity weekly
Test duration	About 50 to 65 days; each treatment is ended separately when no additional emergence has been recorded for 7 consecutive days. When no emergence is recorded from a treatment, termination of that treatment should be based on the control sediment using this 7-day criterion
Endpoints	16-day survival, weight (AFDW), and biomass (AFDW);[b] female and male emergence; adult mortality; the number of egg cases oviposited, the number of eggs produced, and the number of hatched eggs
Reference toxicant	Sodium chloride (NaCl)

Notes:

Source: modified from USEPA (2000)

[a] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

[b] The *C. dilutus* life cycle test method was revised from the QAPP and USEPA (2000) protocols to use 4-day old larvae at the start of the test rather than <24-hour old larvae and to obtain survival, weight, and biomass data at Day 16 rather than Day 20. The change was incorporated into the test design it has been shown that older organisms (i.e., 4-day-old larvae) have better success in the life-cycle test. This change has been documented in Change Request No. 3 (Appendix D).

AFDW - ash-free dry weight
DO - dissolved oxygen

Table 2-9. Test Conditions for the Long-Term *Hyalella azteca* Bioassay

Parameter	Test Conditions
Test type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 °C ± 1 °C
Light quality	Wide-spectrum fluorescent lights
Illuminance	Approximately 500 lux
Photoperiod	16L:8D
Test chamber	300-mL high-form lipless glass beaker
Sediment volume	100 mL
Overlying water volume	175 mL in the sediment exposure from Day 0 to Day 28 (275 mL in the water-only exposure from Day 28 to Day 42)
Renewal of overlying water	On Day 0, renewal immediately prior to the introduction of test organisms. During test, two volume additions/day; continuous or intermittent (e.g., one volume addition every 12 hours)
Test organism source	Aquatic BioSystems; Fort Collins, Colorado
Age of organisms[a]	7 to 8 days old at the start of the test
Number of organisms/chamber	10
Number of replicate chambers/sample[a]	18 replicates: 12 for biological endpoints and 6 for chemistry only. Of the 12 replicates for biological endpoints, 4 replicates are for 28-day survival and growth and 8 replicates are for 35- and 42-day survival, growth, and reproduction.
Feeding[a]	1.0 mL YCT mixture added to each test chamber daily during Days 0 to 13, and 2 mL YCT added to each test chamber daily during the remaining exposure (Days 14 to 41).
Aeration	None, unless DO in overlying water drops below 2.5 mg/L
Overlying water[a]	Reconstituted water as specified in Borgmann (1996) but modified to contain 0.4 mg/L bromide
Test chamber cleaning	Cleaned if screens become clogged during test; outside of screen gently brushed
Overlying water quality	Hardness, alkalinity, conductivity, and ammonia at the beginning and end of a sediment exposure (Days 0 and 28); temperature daily; conductivity weekly; DO and pH three times/week
Test duration	42 days
Endpoints	28-day survival, weight, and biomass; 35-day survival and reproduction; and 42-day survival, weight, biomass, and reproduction, and number of adult males and females on Day 42
Reference toxicant	Potassium chloride (KCl)

Notes:

Source: modified from USEPA (2000)

[a] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

DO - dissolved oxygen

YCT - Yeast-Cerophyll®-Trout

Table 2-10. Test Acceptability Requirements for the Short-Term Bioassays

Parameter	*Chironomus dilutus*	*Hyalella azteca*
Organism Age	**Test must be started with 2nd to 3rd instar larvae (about 10-day-old larvae)**	Test should be started with 7- to 8-day old organisms
	At least 50% of the organisms must be 3rd instar	
Starting Weight	Starting average weight goal of 0.12 mg/individual[a]	Starting average weight goal in the range of 0.02 to 0.035 mg/individual[a]
Water Quality	Hardness, alkalinity, and ammonia in overlying water should not vary by more than 50%	Hardness, alkalinity, and ammonia in overlying water should not vary by more than 50%
	DO should be maintained above 2.5 mg/L in overlying water	DO should be maintained above 2.5 mg/L in overlying water
Control survival	**Mean control survival must be ≥ 70%**	**Mean control survival should be ≥ 80% on Day 28**
Control Growth	**Mean control weight must be ≥ 0.48 mg AFDW/individual on Day 10**	Mean control weight should be ≥ 0.4 mg/individual on Day 28[a]
Additional Test Requirements [b]		
Organisms	**All organisms must be from the same source and source must be reported**	
Test chambers	Test chambers should be identical and contain same volumes of sediment and water	
Controls	**Test must include standard negative control sediment, quartz sand auxiliary control,[a] and appropriate solvent controls**	
Culturing	**Test organisms must be cultured at 23 °C ± 1 °C**	
Temperature	**Daily temperature must be 23 °C ± 1 °C. Instantaneous temperature must be 23 °C ± 3 °C**	
Sediment characteristics	Physio-chemical characteristics of field-collected test sediment should be within the tolerance limit of the test organisms	
Overlying water/control sediments	**Source of overlying water and control sediments must be documented and reported**	

Notes:

Bold indicates test acceptability requirement that must be met in order for a test to be considered acceptable (i.e., a test acceptability criterion). All other requirements are performance goals.

Source: modified from USEPA (2000)

[a] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

[b] The additional test requirements are the same for both the *C. dilutus* and *H. azteca* bioassays.

AFDW - ash-free dry weight

DO - dissolved oxygen

Table 2-11. Test Acceptability Requirements for the Long-Term Bioassays

Parameter	*Chironomus dilutus*	*Hyalella azteca*
Organism Age	**Test must be started < 4-day-old larvae**[a]	Test should be started with 7- to 8-day old organisms
Starting Weight	No starting average weight goal	Starting average weight goal in the range of 0.02 to 0.035 mg/individual[b]
Water Quality	Hardness, alkalinity, and ammonia in overlying water should not vary by more than 50%	Hardness, alkalinity, and ammonia in overlying water should not vary by more than 50%
	DO should be maintained above 2.5 mg/L in overlying water	DO should be maintained above 2.5 mg/L in overlying water
Control survival	**Mean control survival must be ≥ 70% on Day 16, and > 65% at end of test**[a]	**Mean control survival should be ≥ 80% on Day 28**
		Mean QS control survival should be ≥ 80% on Day 28[c]
Control weight	**Mean control weight must be ≥ 0.6 mg/individual, or 0.48 mg AFDW/individual, on Day 16**[a]	Mean control weight should be ≥0.4 mg/individual on Day 28 and ≥0.5 mg/individual on Day 42
		Mean QS control weight should be > 0.3 mg/individual on Day 28 and > 0.5 mg/individual on Day 42[c]
Control emergence	Emergence should be ≥ 50%	NA
Time to death after emergence	Typically, < 6.5 days for males and < 5.1 days for females	NA
Control Reproduction	Mean number of eggs/egg case in controls should be ≥ 800	Control reproduction of ≥ 2 young/female between Day 28 to 42
	Percent hatch in controls should be ≥ 80%	Mean QS control reproduction should be > 4 young/female[c]
Additional Test Requirements[d]		
Organisms	**All organisms must be from the same source and source must be reported**	
Test chambers	Test chambers should be identical and contain same volumes of sediment and water	
Controls	**Test must include standard negative control sediment, quartz sand auxiliary control,**[b] **and appropriate solvent controls**	
Culturing	**Test organisms must be cultured at 23 °C ± 1 °C**	
Temperature	**Daily temperature must be 23 °C ± 1 °C. Instantaneous temperature must be 23 °C ± 3 °C**	
Sediment characteristics	Physio-chemical characteristics of field-collected test sediment should be within the tolerance limit of the test organisms	
Overlying water/control sediments	**Source of overlying water and control sediments must be documented and reported**	

Notes:

Bold indicates test acceptability requirement that must be met in order for a test to be considered acceptable (i.e., a test acceptability criterion). All other requirements are performance goals.

Source: modified from USEPA (2000)

[a] The *C. dilutus* life cycle test method was revised from the QAPP (Exponent et al. 2013) and USEPA (2000) protocols to use 4-day-old larvae at the start of the test rather than <24-hour-old larvae and to obtain survival, weight, and biomass data at Day 16 rather than Day 20. The change was incorporated into the test design it has been shown that older organisms (i.e., 4-day-old larvae) have better success in the life-cycle test. This change has been documented in Change Request No. 3 (Appendix D of this data summary report).

[b] Modified from EPA standard method as directed by EPA (letters from Shawn D. Blocker on June 21, 2012, and Dr. Laura Buelow on August 24, 2012 in the QAPP [Exponent et al. 2013]).

[c] Performance goal from Mount (2011b).

[d] The additional test requirements are the same for both the *C. dilutus* and *H. azteca* bioassays.

AFDW - ash-free dry weight

DO - dissolved oxygen

NA - not applicable

QS - quartz sand

Table 2-12. Sample Batches for the Short-Term Bioassays

Sampling Location	Sample Type
Batch 1	
1-R1	Site
3-R2	Site
4-B6	Site
5-B1	Site
6-B6	Site
6-R3	Site
8-B3	Site
8-B4	Site
REF-6	Site[a]
TRIB-4	Tributary
G-1	Upstream
Batch 2	
2-R1	Site
4-B2	Site
4-B4	Site
5-B3	Site
6-B5	Site
REF-4	Site[a]
REF-8	Site[a]
LAL-1	Upstream
LAL-2	Upstream
LAL-3	Upstream
LAL-6 (*C. dilutus*)	Upstream
Batch 3	
2-R3	Site
3-R1	Site
3-R8	Site
5-B4	Site
6-B4	Site
7-B2	Site
REF-1	Site[a]
REF-10b	Site[a]
REF-3	Site[a]
REF-7	Site[a]
TRIB-3	Tributary
LAL-4	Upstream
Batch 4	
1-B5	Site
2-B1	Site
3-B3	Site
3-R7	Site
5-B5	Site
5-B6	Site
7-B3	Site
7-B6	Site
REF-2	Site[a]
TRIB-2	Tributary
TRIB-5	Tributary
G-4	Upstream

Table 2-12. Sample Batches for the Short-Term Bioassays

Sampling Location	Sample Type
Batch 5	
2-B2	Site
3-R9	Site
4-B1	Site
5-B2	Site
6-B1	Site
7-B4	Site
7-B5	Site
8-B1	Site
REF-5	Site[a]
TRIB-1	Tributary
G-2	Upstream
LAL-5	Upstream
Batch 6	
1B-R2	Site
1-R2	Site
4-B3	Site
4-B5	Site
6-B2	Site
7-B1	Site
8-B2	Site
8-B5	Site
8-B6	Site
TRIB-6	Tributary
G-3	Upstream
LAL-6 (*H. azteca*)	Upstream

Notes:

The *Chironomus dilutus* and *Hyalella azteca* bioassay samples were batched the same way except for LAL-6, as noted.

[b] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

Table 2-13. Sample Batches for the Long-Term Bioassays

Sampling Location	Sample Type
Batch 1	
1-B5	Site
1B-R2	Site
1-R2	Site
4-B6[a]	Site
6-B2	Site
7-B5	Site
8-B3[a]	Site
REF-10b[a, b]	Site
G-1[a]	Upstream
G-3[a]	Upstream
LAL-3[a]	Upstream
LAL-5[a]	Upstream
TRIB-3[a]	Tributary
Batch 2	
2-B1	Site
2-R1	Site
3-R7	Site
4-B1	Site
5-B2	Site
8-B2	Site
REF-10b[a, b]	Site
G-1[a]	Upstream
G-3[a]	Upstream
LAL-2[a]	Upstream
LAL-3[a]	Upstream
LAL-5[a]	Upstream
TRIB-3[a]	Tributary
Batch 3	
3-B3	Site
3-R8	Site
4-B5	Site
5-B4	Site
6-B5[a]	Site
7-B2	Site
REF-10b[a, b]	Site
G-1[a]	Upstream
G-2[a]	Upstream
G-3[a]	Upstream
LAL-3[a]	Upstream
LAL-5[a]	Upstream
TRIB-3[a]	Tributary

Notes:

The batching of samples in this table applies to both *Chironomus dilutus* and *Hyalella azteca* bioassays.

[a] Additional sediment shipped from ALS Environmental (ALS) to Pacific EcoRisk (PER) before start of long-term test to supplement remaining sediment.

[b] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

Table 4-1.Summary of Qualifiers for Field Sediment Results

Analyte	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags									Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags									Percent of Accepted Results with Validator Flags			
					*	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ	*	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ
Conventional Parameters																														
Organic carbon	150	0 (0%)	150 (100%)	148	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
pH	150	0 (0%)	150 (100%)	42	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	72	0	0	0
Solids	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfide (AVS)	149	0 (0%)	149 (100%)	73	0	6	0	0	0	0	21	0	0	55	18	0	3	0	4	0	0	0	0	14	0	0	37	12	0	2
Grain size																														
Clay	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silt	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Very fine sand	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fine sand	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium sand	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coarse sand	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Very coarse sand	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fine gravel	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium gravel	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metals/Metalloids																														
Aluminum	150	0 (0%)	150 (100%)	136	14	0	0	0	0	0	0	0	0	14	0	0	0	9	0	0	0	0	0	0	0	0	9	0	0	0
Antimony	150	0 (0%)	150 (100%)	7	0	6	0	3	121	11	1	0	1	132	1	9	1	0	4	0	2	81	7	1	0	1	88	1	6	1
Arsenic	150	0 (0%)	150 (100%)	130	0	4	0	0	0	0	0	0	0	20	0	0	0	0	3	0	0	0	0	0	0	0	13	0	0	0
Barium	150	0 (0%)	150 (100%)	128	8	0	0	0	12	0	0	0	0	13	0	0	0	5	0	0	0	8	0	0	0	0	9	0	0	0
Beryllium	150	0 (0%)	150 (100%)	32	11	0	0	0	40	0	0	0	0	118	0	0	0	7	0	0	0	27	0	0	0	0	79	0	0	0
Cadmium	150	0 (0%)	150 (100%)	111	11	2	0	0	0	0	0	0	0	37	0	2	0	7	1	0	0	0	0	0	0	0	25	0	1	0
Calcium	150	0 (0%)	150 (100%)	148	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Chromium	150	0 (0%)	150 (100%)	111	0	0	0	0	38	0	0	0	0	39	0	0	0	0	0	0	0	25	0	0	0	0	26	0	0	0
Cobalt	150	0 (0%)	150 (100%)	136	11	0	0	0	0	0	0	0	0	14	0	0	0	7	0	0	0	0	0	0	0	0	9	0	0	0
Copper	150	0 (0%)	150 (100%)	123	0	1	0	0	24	0	1	0	0	26	1	0	0	0	1	0	0	16	0	1	0	0	17	1	0	0
Iron	150	0 (0%)	150 (100%)	136	14	0	0	0	0	0	0	0	0	14	0	0	0	9	0	0	0	0	0	0	0	0	9	0	0	0
Lead	150	0 (0%)	150 (100%)	101	11	2	0	0	20	12	2	0	0	46	2	1	0	7	1	0	0	13	8	1	0	0	31	1	1	0
Magnesium	150	0 (0%)	150 (100%)	139	11	0	0	0	0	0	0	0	0	3	0	0	0	7	0	0	0	0	0	0	0	0	2	0	0	0
Manganese	150	0 (0%)	150 (100%)	136	0	0	0	0	14	0	0	0	0	14	0	0	0	0	0	0	0	9	0	0	0	0	9	0	0	0
Mercury	150	0 (0%)	150 (100%)	99	0	37	0	0	0	0	10	0	0	41	10	0	0	0	25	0	0	0	0	7	0	0	27	7	0	0
Nickel	150	0 (0%)	150 (100%)	147	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Potassium	150	0 (0%)	150 (100%)	147	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Selenium	150	0 (0%)	150 (100%)	64	0	73	0	0	0	0	13	0	0	73	13	0	0	0	49	0	0	0	0	9	0	0	49	9	0	0
Silver	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	150	0 (0%)	150 (100%)	145	0	4	0	0	0	0	0	0	0	3	0	2	0	0	3	0	0	0	0	0	0	0	2	0	1	0
Thallium	150	0 (0%)	150 (100%)	120	12	3	0	0	0	0	0	0	0	11	0	18	0	8	2	0	0	0	0	0	0	0	7	0	12	0
Vanadium	150	0 (0%)	150 (100%)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	150	0 (0%)	150 (100%)	124	0	0	0	0	23	0	0	0	0	26	0	0	0	0	0	0	0	15	0	0	0	0	17	0	0	0

Table 4-1.Summary of Qualifiers for Field Sediment Results

Analyte	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags									Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags									Percent of Accepted Results with Validator Flags			
					*	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ	*	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ
SEM																														
Antimony	149	0 (0%)	149 (100%)	21	0	91	0	0	0	0	32	0	0	40	32	56	0	0	61	0	0	0	0	21	0	0	27	21	38	0
Arsenic	149	0 (0%)	149 (100%)	106	12	7	2	0	0	0	12	8	0	11	19	0	1	8	5	1	0	0	0	8	5	0	7	13	0	1
Cadmium	149	0 (0%)	149 (100%)	122	15	3	0	0	0	0	3	0	0	24	3	0	0	10	2	0	0	0	0	2	0	0	16	2	0	0
Chromium	149	0 (0%)	149 (100%)	135	3	1	0	0	0	0	0	0	0	11	0	0	0	2	1	0	0	0	0	0	0	0	7	0	0	0
Copper	149	0 (0%)	149 (100%)	114	15	0	0	0	10	0	0	1	0	32	0	2	1	10	0	0	0	7	0	0	1	0	21	0	1	1
Lead	149	0 (0%)	149 (100%)	128	0	0	0	0	10	0	0	0	0	21	0	0	0	0	0	0	0	7	0	0	0	0	14	0	0	0
Nickel	149	0 (0%)	149 (100%)	124	16	5	0	0	0	0	0	0	0	11	0	0	0	11	3	0	0	0	0	0	0	0	7	0	0	0
Zinc	149	0 (0%)	149 (100%)	130	0	0	0	0	10	0	0	0	0	19	0	0	0	0	0	0	0	7	0	0	0	0	13	0	0	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

Laboratory Flags

* * The result is an outlier. See case narrative.
* J The result is an estimated value that was detected outside the quantitation range.
* N The Matrix Spike sample recovery is not within control limits. See case narrative.
* U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).

Validator Flags

* J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).
* U This analyte was not detected at or above the associated detection limit.
* U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.
* UJ This analyte was not detected, but the detection limit is considered estimated due to bias identified during the QA review.

AVS - acid volatile sulfide

SEM - simultaneously extracted metals

Table 4-2. Summary of Qualifiers for Field Equipment Blank Results

Analyte	Basis	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags		Number of Accepted Results with Validator Flags		Percent of Accepted Results with Laboratory Flags		Percent of Accepted Results with Validator Flags	
						J	U	J	U	J	U	J	U
Sediment Equipment Rinsate Blanks													
Metals/Metalloids													
Aluminum	Total	240	0 (0%)	240 (100%)	140	85	0	100	0	35	0	42	0
Antimony	Total	240	0 (0%)	240 (100%)	26	85	129	85	129	35	54	35	54
Arsenic	Total	240	0 (0%)	240 (100%)	2	39	199	39	199	16	83	16	83
Barium	Total	240	0 (0%)	240 (100%)	195	38	7	38	7	16	3	16	3
Beryllium	Total	240	0 (0%)	240 (100%)	4	7	229	7	229	3	95	3	95
Cadmium	Total	240	0 (0%)	240 (100%)	18	62	160	62	160	26	67	26	67
Calcium	Total	240	0 (0%)	240 (100%)	130	85	1	109	1	35	0	45	0
Chromium	Total	240	0 (0%)	240 (100%)	83	152	5	152	5	63	2	63	2
Cobalt	Total	240	0 (0%)	240 (100%)	64	54	122	54	122	23	51	23	51
Copper	Total	240	0 (0%)	240 (100%)	106	79	55	79	55	33	23	33	23
Iron	Total	240	0 (0%)	240 (100%)	99	97	44	97	44	40	18	40	18
Lead	Total	240	0 (0%)	240 (100%)	170	55	15	55	15	23	6	23	6
Magnesium	Total	240	0 (0%)	240 (100%)	124	104	2	114	2	43	1	48	1
Manganese	Total	240	0 (0%)	240 (100%)	200	29	0	40	0	12	0	17	0
Mercury	Total	240	0 (0%)	240 (100%)	0	3	237	3	237	1	99	1	99
Nickel	Total	240	0 (0%)	240 (100%)	86	96	58	96	58	40	24	40	24
Potassium	Total	240	0 (0%)	240 (100%)	2	15	223	15	223	6	93	6	93
Selenium	Total	240	0 (0%)	240 (100%)	0	0	240	0	240	0	100	0	100
Silver	Total	240	0 (0%)	240 (100%)	3	24	213	24	213	10	89	10	89
Sodium	Total	240	0 (0%)	240 (100%)	2	100	138	100	138	42	58	42	58
Thallium	Total	240	0 (0%)	240 (100%)	5	14	221	14	221	6	92	6	92
Vanadium	Total	240	0 (0%)	240 (100%)	9	95	136	95	136	40	57	40	57
Zinc	Total	240	0 (0%)	240 (100%)	166	66	8	66	8	28	3	28	3
Porewater Equipment Blank													
Conventional Parameters													
Hardness as $CaCO_3$	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Organic carbon	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Organic carbon	Total	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
pH	Total	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Sulfate	Total	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Total chloride	Total	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Metals/Metalloids													
Aluminum	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Antimony	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Arsenic	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Barium	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Beryllium	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Cadmium	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100

Table 4-2. Summary of Qualifiers for Field Equipment Blank Results

Analyte	Basis	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags		Number of Accepted Results with Validator Flags		Percent of Accepted Results with Laboratory Flags		Percent of Accepted Results with Validator Flags	
						J	U	J	U	J	U	J	U
Porewater Equipment Blank (continued)													
Metals/Metalloids													
Calcium	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Chromium	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Cobalt	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Copper	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Iron	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Lead	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Magnesium	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Manganese	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Nickel	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0
Potassium	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Selenium	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Silver	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Sodium	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Thallium	Dissolved	1	0 (0%)	1 (100%)	0	0	1	0	1	0	100	0	100
Vanadium	Dissolved	1	0 (0%)	1 (100%)	0	1	0	1	0	100	0	100	0
Zinc	Dissolved	1	0 (0%)	1 (100%)	1	0	0	0	0	0	0	0	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

Laboratory Flags

J The result is an estimated value that was detected outside the quantitation range.

U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).

Validator Flags

J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).

U This analyte was not detected at or above the associated detection limit.

$CaCO_3$ - calcium carbonate

Table 4-3. Summary of Qualifiers for Field Porewater Results

Analyte	Basis	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags				Number of Accepted Results with Validator Flags			Percent of Accepted Results with Laboratory Flags				Percent of Accepted Results with Validator Flags		
						J	N	U	X	J	U	U*	J	N	U	X	J	U	U*
Conventional Parameters																			
Alkalinity	Total	89	0 (0%)	89 (100%)	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness as $CaCO_3$	Dissolved	93	0 (0%)	93 (100%)	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Organic carbon	Dissolved	94	0 (0%)	94 (100%)	24	0	0	0	0	0	0	70	0	0	0	0	0	0	74
Organic carbon	Total	94	0 (0%)	94 (100%)	38	0	0	0	0	0	0	56	0	0	0	0	0	0	60
pH	Total	92	0 (0%)	92 (100%)	91	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Sulfate	Total	92	0 (0%)	92 (100%)	75	0	0	0	0	17	0	0	0	0	0	0	18	0	0
Total chloride	Total	92	0 (0%)	92 (100%)	2	3	0	0	0	1	0	89	3	0	0	0	1	0	97
Metals/Metalloids																			
Aluminum	Dissolved	101	0 (0%)	101 (100%)	45	0	0	0	0	0	0	56	0	0	0	0	0	0	55
Antimony	Dissolved	101	0 (0%)	101 (100%)	63	0	0	0	0	30	0	8	0	0	0	0	30	0	8
Arsenic	Dissolved	101	0 (0%)	101 (100%)	100	1	0	0	0	1	0	0	1	0	0	0	1	0	0
Barium	Dissolved	101	0 (0%)	101 (100%)	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium	Dissolved	101	0 (0%)	101 (100%)	2	27	0	72	0	10	72	17	27	0	71	0	10	71	17
Cadmium	Dissolved	101	0 (0%)	101 (100%)	48	19	0	7	0	23	7	23	19	0	7	0	23	7	23
Calcium	Dissolved	101	0 (0%)	101 (100%)	81	0	20	0	0	20	0	0	0	20	0	0	20	0	0
Chromium	Dissolved	101	0 (0%)	101 (100%)	42	58	0	1	0	47	1	11	57	0	1	0	47	1	11
Cobalt	Dissolved	101	0 (0%)	101 (100%)	86	0	0	0	0	0	0	15	0	0	0	0	0	0	15
Copper	Dissolved	101	0 (0%)	101 (100%)	73	0	0	0	0	0	0	28	0	0	0	0	0	0	28
Iron	Dissolved	101	0 (0%)	101 (100%)	99	1	0	0	0	1	0	1	1	0	0	0	1	0	1
Lead	Dissolved	101	0 (0%)	101 (100%)	93	3	0	0	0	0	0	8	3	0	0	0	0	0	8
Magnesium	Dissolved	101	0 (0%)	101 (100%)	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	Dissolved	101	0 (0%)	101 (100%)	98	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Nickel	Dissolved	101	0 (0%)	101 (100%)	21	0	0	0	0	6	0	74	0	0	0	0	6	0	73
Potassium	Dissolved	101	0 (0%)	101 (100%)	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium	Dissolved	101	0 (0%)	101 (100%)	5	25	0	71	0	25	71	0	25	0	70	0	25	70	0
Silver	Dissolved	101	0 (0%)	101 (100%)	30	44	0	24	0	13	24	34	44	0	24	0	13	24	34
Sodium	Dissolved	101	0 (0%)	101 (100%)	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thallium	Dissolved	101	0 (0%)	101 (100%)	18	44	0	26	0	1	26	56	44	0	26	0	1	26	55
Vanadium	Dissolved	101	0 (0%)	101 (100%)	86	0	0	0	0	4	0	11	0	0	0	0	4	0	11
Zinc	Dissolved	101	0 (0%)	101 (100%)	1	0	0	0	0	0	0	100	0	0	0	0	0	0	99

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

Laboratory Flags

J The result is an estimated value that was detected outside the quantitation range.
N The Matrix Spike sample recovery is not within control limits. See case narrative.
U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).
X The laboratory report case narrative contained additional information about this result.

Validator Flags

J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).
U This analyte was not detected at or above the associated detection limit.
U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.

$CaCO_3$ - calcium carbonate

Table 4-4. Summary of Qualifiers for Short-Term Bioassay Sediment Results

Analyte	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags							Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags							Percent of Accepted Results with Validator Flags			
					*	J	J,*	J,X	U	U,*	X	J	U	U*	UJ	*	J	J,*	J,X	U	U,*	X	J	U	U*	UJ
Conventional Parameters																										
Organic carbon	174	0 (0%)	174 (100%)	161	0	1	0	0	12	0	0	1	12	0	0	0	1	0	0	7	0	0	1	7	0	0
Solids	174	0 (0%)	174 (100%)	174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfide (AVS)	174	0 (0%)	174 (100%)	83	0	15	0	0	37	0	0	54	27	0	10	0	9	0	0	21	0	0	31	16	0	6
SEM																										
Antimony	174	0 (0%)	174 (100%)	27	0	103	0	0	44	0	0	65	44	38	0	0	59	0	0	25	0	0	37	25	22	0
Arsenic	174	0 (0%)	174 (100%)	119	8	21	0	0	26	0	0	29	26	0	0	5	12	0	0	15	0	0	17	15	0	0
Cadmium	174	0 (0%)	174 (100%)	103	14	19	5	0	16	3	0	42	16	10	3	8	11	3	0	9	2	0	24	9	6	2
Chromium	174	0 (0%)	174 (100%)	108	53	7	4	0	1	1	0	62	1	2	1	30	4	2	0	1	1	0	36	1	1	1
Copper	174	0 (0%)	174 (100%)	131	32	7	3	0	0	0	0	41	0	2	0	18	4	2	0	0	0	0	24	0	1	0
Lead	174	0 (0%)	174 (100%)	140	21	0	0	0	10	2	0	22	10	0	2	12	0	0	0	6	1	0	13	6	0	1
Nickel	174	0 (0%)	174 (100%)	137	14	2	1	0	9	0	0	28	9	0	0	8	1	1	0	5	0	0	16	5	0	0
Zinc	174	0 (0%)	174 (100%)	111	43	6	3	2	0	0	8	43	0	12	0	25	3	2	1	0	0	5	25	0	7	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

Laboratory Flags

- * The result is an outlier. See case narrative.
- J The result is an estimated value that was detected outside the quantitation range.
- U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).
- X The laboratory report case narrative contained additional information about these results.

Validator Flags

- J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).
- U This analyte was not detected at or above the associated detection limit.
- U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.
- UJ This analyte was not detected, but the detection limit is considered estimated due to bias identified during the QA review.

AVS - acid volatile sulfide

SEM - simultaneously extracted metals

Table 4-5. Summary of Qualifiers for Short-Term Bioassay Porewater Results

Analyte	Basis	Number of Samples	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags			Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags			Percent of Accepted Results with Validator Flags			
						J	U	X	J	U	U*	UJ	J	U	X	J	U	U*	UJ
Conventional Parameters																			
Alkalinity	Total	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness as $CaCO_3$	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Organic carbon	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pH	Total	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	Total	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfide[a]	Total	99	35 (35%)	64 (65%)	29	9	19	4	16	19	0	0	14	30	6	25	30	0	0
Total chloride	Total	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metals/Metalloids																			
Aluminum	Dissolved	261	0 (0%)	261 (100%)	144	11	0	0	5	0	112	0	4	0	0	2	0	43	0
Antimony	Dissolved	261	0 (0%)	261 (100%)	112	121	2	0	5	2	142	0	46	1	0	2	1	54	0
Arsenic	Dissolved	261	0 (0%)	261 (100%)	212	35	1	0	48	1	0	0	13	0	0	18	0	0	0
Barium	Dissolved	261	0 (0%)	261 (100%)	244	0	0	0	15	0	2	0	0	0	0	6	0	1	0
Beryllium	Dissolved	261	0 (0%)	261 (100%)	5	25	231	0	25	231	0	0	10	89	0	10	89	0	0
Cadmium	Dissolved	261	0 (0%)	261 (100%)	27	84	138	0	23	138	73	0	32	53	0	9	53	28	0
Calcium	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium	Dissolved	261	0 (0%)	261 (100%)	5	191	65	0	151	65	40	0	73	25	0	58	25	15	0
Cobalt	Dissolved	261	0 (0%)	261 (100%)	241	5	2	0	15	2	3	0	2	1	0	6	1	1	0
Copper	Dissolved	261	0 (0%)	261 (100%)	95	108	4	0	50	4	112	0	41	2	0	19	2	43	0
Iron	Dissolved	261	0 (0%)	261 (100%)	237	2	0	0	17	0	7	0	1	0	0	7	0	3	0
Lead	Dissolved	261	0 (0%)	261 (100%)	183	18	0	0	13	0	65	0	7	0	0	5	0	25	0
Magnesium	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	Dissolved	261	0 (0%)	261 (100%)	228	0	0	0	33	0	0	0	0	0	0	13	0	0	0
Nickel	Dissolved	261	0 (0%)	261 (100%)	185	64	0	0	61	0	15	0	25	0	0	23	0	6	0
Potassium	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium	Dissolved	261	0 (0%)	261 (100%)	2	7	252	0	7	252	0	0	3	97	0	3	97	0	0
Silver	Dissolved	261	0 (0%)	261 (100%)	0	8	251	0	4	251	6	0	3	96	0	2	96	2	0
Sodium	Dissolved	99	0 (0%)	99 (100%)	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thallium	Dissolved	261	0 (0%)	261 (100%)	33	76	138	0	6	131	84	7	29	53	0	2	50	32	3
Vanadium	Dissolved	261	0 (0%)	261 (100%)	118	98	45	0	98	45	0	0	38	17	0	38	17	0	0
Zinc	Dissolved	261	0 (0%)	261 (100%)	75	36	0	0	4	0	182	0	14	0	0	2	0	70	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

[a] Sulfide by standard method (SM) 4500 S^{2-}D

Laboratory Flags

J The result is an estimated value that was detected outside the quantitation range.

U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).

X The laboratory report case narrative contained additional information about these results.

Validator Flags

J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).

U This analyte was not detected at or above the associated detection limit.

U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.

UJ This analyte was not detected, but the detection limit is considered estimated due to bias identified during the QA review.

$CaCO_3$ - calcium carbonate

Table 4-6. Summary of Qualifiers for Long-Term Bioassay Sediment Results

Analyte	Number of Samples Analyzed	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags										Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags										Percent of Accepted Results with Validator Flags			
					*	H	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ	*	H	J	J,*	J,N	N	N*	U	U,*	U,N	J	U	U*	UJ
Conventional Parameters																																
Organic carbon	164	0 (0%)	164 (100%)	152	0	0	2	0	0	0	0	10	0	0	2	10	0	0	0	0	1	0	0	0	0	6	0	0	1	6	0	0
pH	29	0 (0%)	29 (100%)	0	0	29	0	0	0	0	0	0	0	0	22	0	0	0	0	100	0	0	0	0	0	0	0	0	76	0	0	0
Solids	164	0 (0%)	164 (100%)	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfide (AVS)	164	0 (0%)	164 (100%)	89	0	0	11	0	0	0	0	38	0	0	37	32	0	6	0	0	7	0	0	0	0	23	0	0	23	20	0	4
Grain size																																
Clay	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silt	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Very fine sand	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fine sand	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Very coarse sand	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium sand	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coarse sand	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fine gravel	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium gravel	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metals/Metalloids																																
Aluminum	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antimony	29	0 (0%)	29 (100%)	0	0	0	0	0	5	16	7	0	0	1	24	0	4	1	0	0	0	0	17	55	24	0	0	3	83	0	14	3
Arsenic	29	0 (0%)	29 (100%)	28	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0
Barium	29	0 (0%)	29 (100%)	14	0	0	0	0	0	0	0	1	0	0	14	0	0	1	0	0	0	0	0	0	0	3	0	0	48	0	0	3
Beryllium	29	0 (0%)	29 (100%)	28	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0
Cadmium	29	0 (0%)	29 (100%)	28	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0
Calcium	29	0 (0%)	29 (100%)	28	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Chromium	29	0 (0%)	29 (100%)	28	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0
Cobalt	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper	29	0 (0%)	29 (100%)	22	7	0	0	0	0	0	0	0	0	0	7	0	0	0	24	0	0	0	0	0	0	0	0	0	24	0	0	0
Iron	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead	29	0 (0%)	29 (100%)	28	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0
Magnesium	29	0 (0%)	29 (100%)	16	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Manganese	29	0 (0%)	29 (100%)	22	0	0	0	0	0	0	4	0	0	0	7	0	0	0	0	0	0	0	0	0	14	0	0	0	24	0	0	0
Mercury	29	0 (0%)	29 (100%)	13	0	0	11	0	0	0	0	5	0	0	11	5	0	0	0	0	38	0	0	0	0	17	0	0	38	17	0	0
Nickel	29	0 (0%)	29 (100%)	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	29	0 (0%)	29 (100%)	14	0	0	0	0	0	14	0	0	0	1	14	0	0	1	0	0	0	0	0	48	0	0	0	3	48	0	0	3
Selenium	29	0 (0%)	29 (100%)	19	0	0	5	0	0	0	0	5	0	0	5	4	0	0	0	0	17	0	0	0	0	17	0	0	17	14	0	0
Silver	29	0 (0%)	29 (100%)	20	7	0	1	0	0	0	0	1	0	0	8	1	0	0	24	0	3	0	0	0	0	3	0	0	28	3	0	0
Sodium	29	0 (0%)	29 (100%)	13	0	0	2	0	0	0	0	0	0	0	15	0	1	0	0	0	7	0	0	0	0	0	0	0	52	0	3	0
Thallium	29	0 (0%)	29 (100%)	20	0	0	1	0	0	0	0	0	0	0	0	0	9	0	0	0	3	0	0	0	0	0	0	0	0	0	31	0
Vanadium	29	0 (0%)	29 (100%)	21	7	0	1	0	0	0	0	0	0	0	1	0	0	0	24	0	3	0	0	0	0	0	0	0	3	0	0	0
Zinc	29	0 (0%)	29 (100%)	14	0	0	1	0	0	0	7	0	0	0	14	0	1	0	0	0	3	0	0	0	24	0	0	0	48	0	3	0
SEM																																
Antimony	164	0 (0%)	164 (100%)	7	0	0	49	0	0	0	0	91	0	0	53	91	13	0	0	0	30	0	0	0	0	55	0	0	32	55	8	0
Arsenic	164	0 (0%)	164 (100%)	44	0	0	83	0	0	0	0	34	0	0	86	34	0	0	0	0	51	0	0	0	0	21	0	0	52	21	0	0
Cadmium	164	0 (0%)	164 (100%)	22	12	0	23	1	0	0	0	12	2	0	128	7	0	7	7	0	14	1	0	0	0	7	1	0	78	4	0	4
Chromium	164	0 (0%)	164 (100%)	87	0	0	8	0	0	0	0	2	0	0	72	2	3	0	0	0	5	0	0	0	0	1	0	0	44	1	2	0
Copper	164	0 (0%)	164 (100%)	83	0	0	9	0	0	0	0	1	0	0	80	1	0	0	0	0	5	0	0	0	0	1	0	0	49	1	0	0
Lead	164	0 (0%)	164 (100%)	151	0	0	8	0	0	0	0	2	0	0	11	2	0	0	0	0	5	0	0	0	0	1	0	0	7	1	0	0
Nickel	164	0 (0%)	164 (100%)	117	0	0	9	0	0	0	0	1	0	0	46	1	0	0	0	0	5	0	0	0	0	1	0	0	28	1	0	0
Zinc	164	0 (0%)	164 (100%)	157	0	0	7	0	0	0	0	0	0	0	1	0	6	0	0	0	4	0	0	0	0	0	0	0	1	0	4	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

Laboratory Flags

* The result is an outlier. See case narrative.
H The sample was analyzed as soon as possible after collection to minimize holding time.
J The result is an estimated value that was detected outside the quantitation range.
N The Matrix Spike sample recovery is not within control limits. See case narrative.
U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).

Validator Flags

J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).
U This analyte was not detected at or above the associated detection limit.
U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.
UJ This analyte was not detected, but the detection limit is considered estimated due to bias identified during the QA review.

AVS - acid volatile sulfide
SEM - simultaneously extracted metals

Table 4-7. Summary of Qualifiers for Long-Term Bioassay Porewater Results

Analyte	Basis	Number of Samples Analyzed	Number of Rejected Results	Number of Accepted Results	Number of Results with No Flags	Number of Accepted Results with Laboratory Flags				Number of Accepted Results with Validator Flags				Percent of Accepted Results with Laboratory Flags				Percent of Accepted Results with Validator Flags			
						H	J	U	Ui	J	U	U*	UJ	H	J	U	Ui	J	U	U*	UJ
Conventional Parameters																					
Alkalinity	Total	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness as $CaCO_3$	Dissolved	26	0 (0%)	26 (100%)	12	0	0	0	0	14	0	0	0	0	0	0	0	54	0	0	0
Organic carbon	Dissolved	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pH	Total	26	0 (0%)	26 (100%)	0	26	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Sulfate	Total	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfide[a]	Total	26	2 (8%)	24 (92%)	6	0	1	0	8	10	8	0	0	0	4	0	33	42	33	0	0
Total chloride	Total	26	0 (0%)	26 (100%)	12	0	2	0	0	14	0	0	0	0	8	0	0	54	0	0	0
Metals/Metalloids																					
Aluminum	Dissolved	225	0 (0%)	225 (100%)	87	0	42	0	0	0	0	138	0	0	19	0	0	0	0	61	0
Antimony	Dissolved	225	0 (0%)	225 (100%)	50	0	101	16	0	9	15	150	1	0	45	7	0	4	7	67	0
Arsenic	Dissolved	225	0 (0%)	225 (100%)	183	0	39	3	0	39	3	0	0	0	17	1	0	17	1	0	0
Barium	Dissolved	225	0 (0%)	225 (100%)	225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium	Dissolved	225	0 (0%)	225 (100%)	0	0	3	222	0	2	222	1	0	0	1	99	0	1	99	0	0
Cadmium	Dissolved	225	0 (0%)	225 (100%)	25	0	49	142	0	44	119	14	23	0	22	63	0	20	53	6	10
Calcium	Dissolved	26	0 (0%)	26 (100%)	12	0	0	0	0	14	0	0	0	0	0	0	0	54	0	0	0
Chromium	Dissolved	225	0 (0%)	225 (100%)	1	0	145	79	0	137	79	8	0	0	64	35	0	61	35	4	0
Cobalt	Dissolved	225	0 (0%)	225 (100%)	212	0	7	4	0	7	4	2	0	0	3	2	0	3	2	1	0
Copper	Dissolved	225	0 (0%)	225 (100%)	79	0	101	7	0	33	7	106	0	0	45	3	0	15	3	47	0
Iron	Dissolved	225	0 (0%)	225 (100%)	211	0	2	0	0	0	0	14	0	0	1	0	0	0	0	6	0
Lead	Dissolved	225	0 (0%)	225 (100%)	137	0	29	0	0	14	0	74	0	0	13	0	0	6	0	33	0
Magnesium	Dissolved	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	Dissolved	225	0 (0%)	225 (100%)	210	0	0	0	0	15	0	0	0	0	0	0	0	7	0	0	0
Nickel	Dissolved	225	0 (0%)	225 (100%)	183	0	41	1	0	41	1	0	0	0	18	0	0	18	0	0	0
Potassium	Dissolved	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium	Dissolved	225	0 (0%)	225 (100%)	0	0	4	221	0	4	221	0	0	0	2	98	0	2	98	0	0
Silver	Dissolved	225	0 (0%)	225 (100%)	0	0	2	223	0	0	223	2	0	0	1	99	0	0	99	1	0
Sodium	Dissolved	26	0 (0%)	26 (100%)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thallium	Dissolved	225	0 (0%)	225 (100%)	18	0	76	124	0	20	118	63	6	0	34	55	0	9	52	28	3
Vanadium	Dissolved	225	0 (0%)	225 (100%)	85	0	84	56	0	83	56	1	0	0	37	25	0	37	25	0	0
Zinc	Dissolved	225	0 (0%)	225 (100%)	42	0	100	3	0	0	3	180	0	0	44	1	0	0	1	80	0

Notes:

Data excludes laboratory quality control (QC) sample data.

Accepted results are those deemed usable by the data validator.

[a] Sulfide by standard method (SM) 4500 S^{2-}D

Laboratory Flags

H The sample was analyzed as soon as possible after collection to minimize holding time.

J The result is an estimated value that was detected outside the quantitation range.

U The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit (MRL/MDL).

i The MRL/MDL is elevated due to matrix interference.

Validator Flags

J Quantitation is approximate due to limitations identified during the quality assurance (QA) review (data validation).

U This analyte was not detected at or above the associated detection limit.

U* This analyte should be considered nondetected because it was detected in an associated blank at a similar level.

UJ This analyte was not detected, but the detection limit is considered estimated due to bias identified during the QA review.

$CaCO_3$ - calcium carbonate

Table 4-8a. Summary of PER Negative Control Sediment (CTL-SS) Performance for the Short-Term Bioassays

		Chironomus dilutus		*Hyalella azteca*	
Batch	Sample ID	Mean Survival (%)	Mean AFDW (mg/individual)	Mean Survival (%)	Mean Dry Weight (mg/individual)
Test Acceptability Requirements		***≥ 70***	***≥ 0.48***	***≥ 80***	***≥ 0.4*** [a]
1	CTL-SS-B1	95	1.65	100	0.8
2	CTL-SS-B2	94	1.53	98	0.7
3	CTL-SS-B3	98	1.06	93	0.6
4	CTL-SS-B4	99	1.41	84	0.6
5	CTL-SS-B5	89	1.50	73[b]	0.6[b]
5-RE[b]	CTL-SS-B5-RE	NA	NA	96	0.4
6	CTL-SS-B6	88	1.41	96	0.7

Notes:

[a] The test acceptability requirement for *H. azteca* mean weight in the PER negative control sediment is a performance goal, not a criterion that must be met in order for a test to be considered acceptable.

[b] PER negative control results for Batch 5 of the *H. azteca* short-term bioassay did not meet test acceptability criteria because mean control survival was less than the minimum control survival of 70% needed for a test to be determined acceptable. Fresh aliquots of the sediments were re-tested in Batch 5-RE. Batch 5-RE met test acceptability criteria and those data are presented in this data summary report.

AFDW - ash free dry weight

CTL-SS - PER negative control sediment

NA - not applicable

Table 4-8b. Summary of Auxiliary Control Results for the Short-Term Bioassays

		Chironomus dilutus		*Hyalella azteca*	
Batch	Sample ID	Mean Survival (%)	Mean AFDW (mg/individual)	Mean Survival (%)	Mean Dry Weight (mg/individual)
QS Auxiliary Control					
1	CTL-QS-B1	96	1.38	94	0.6
2	CTL-QS-B2	98	1.46	98	0.6
3	CTL-QS-B3	98	1.29	99	0.6
4	CTL-QS-B4	95	1.23	96	0.6
5	CTL-QS-B5	96	1.06	99[a]	0.6[a]
5-RE[a]	CTL-QS-B5-RE	NA	NA	93	0.4
6	CTL-QS-B6	100	1.14	94	0.4
ERDC Auxiliary Control					
1	CTL-ERDC-B1	95	1.49	31	0.5
2	CTL-ERDC-B2	94	1.62	96	0.7
3	CTL-ERDC-B3	99	1.26	96	0.7
4	CTL-ERDC-B4	66	1.87	90	0.6
5	CTL-ERDC-B5	84	1.66	81[a]	0.6[a]
5-RE[a]	CTL-ERDC-B5-RE	NA	NA	88	0.3
6	CTL-ERDC-B6	71	1.51	96	0.7

Notes:

[a] PER negative control results for Batch 5 of the *H. azteca* short-term bioassay did not meet test acceptability criteria because mean control survival was less than the minimum control survival of 70% needed for a test to be determined acceptable. Fresh aliquots of the sediments were re-tested in Batch 5-RE. Batch 5-RE met test acceptability criteria and those data are presented in this data summary report.

AFDW - ash free dry weight

NA - not applicable

Table 4-9. Summary of Organism Starting Weights (mg/individual)

		Short-term Bioassays				Long term-term Bioassays[a]	
		Chironomus dilutus		*Hyalella azteca*		*Hyalella azteca*	
		Mean	SD	Mean	SD	Mean	SD
Test Acceptability Requirements[b]		**0.12**		**0.02-0.035**		**0.02-0.035**	
1	10	0.30	0.29	0.013	0.002	0.017	0.004
2	10	0.11	0.021	0.011	0.002	0.011	0.003
3	10	0.09	0.022	0.016	0.005	0.010	0.002
4	10	0.18	0.086	0.012	0.004	NA	NA
5	10	0.13	0.049	NA[c]	NA[c]	NA	NA
5-RE[c]	10	NA	NA	**0.025**	0.007	NA	NA
6	10	0.058	0.015	**0.026**	0.016	NA	NA

Notes:

Bold indicates that the performance goal for mean starting weight was met.

[a] There is no test acceptability requirement for starting weight in the long-term *C. dilutus* bioassay.

[b] The test acceptability requirement for average starting weight are performance goals, not a criterion that must be met in order for a test to be considered acceptable.

[c] PER negative control results for Batch 5 of the *H. azteca* short-term bioassay did not meet test acceptability criteria because mean control survival was less than the minimum control survival of 70% needed for a test to be determined acceptable. Fresh aliquots of the sediments were re-tested in Batch 5-RE.

NA - not applicable

SD - standard deviation

Table 4-10. Summary of DO Results for the Short-Term Bioassays

	Chironomus dilutus				*Hyalella azteca*			
	DO (mg/L)			Aeration Trigger	DO (mg/L)			Aeration Trigger
Sample ID	Min	Max	Mean	DO[a] (mg/L)	Min	Max	Mean	DO[a] (mg/L)
Batch 1 (Initiated 1/22/2014)								
Site Locations								
1-R1	4.7	8.9	6.9	1.9	4.7	8.5	6.9	None
3-R2	4.6	8.5	7	2.5	4.9	8.5	7	None
4-B6	4.4	8.8	6.9	2.5	4.6	8.8	7.1	None
5-B1	4.7	8.6	7	2.4	4.5	8.9	7.2	None
6-B6	4.1	8.6	6.8	2.3	4.8	8.6	7.1	None
6-R3	4.2	8.7	6.5	NA	4.7	8.6	6.9	None
8-B3	4.2	8.7	6.9	2.4	4.9	8.8	7	None
8-B4	4.5	8.5	6.6	2.1	4.6	8.5	6.9	None
REF-6[b]	4.4	8.7	6.4	NA	5	8.8	7	None
Tributary and Upstream Locations								
TRIB-4	3.7	8.7	6.6	2	5.7	8.6	7.3	None
G-1	4.2	9	6.5	2.2	4.8	9	7.1	None
Negative Control (CTL-SS)								
CTL-SS-B1	4.2	8.6	6.6	1.9	5.1	8.6	7.1	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B1	4	8.9	6.8	1.3	4.4	8.8	7	None
CRL-ERDC-B1	4.3	8.7	6.7	1.7	5.5	8.5	7.1	None
Batch 2 (Initiated 1/23/2014)								
Site Locations								
2-R1	4.4	8.7	7.1	1.6	5.3	8.7	7	None
4-B2	4.5	8.8	7.1	1.6	4.5	8.8	6.9	None
4-B4	4	8.6	6.5	NA	5.3	8.7	7	None
5-B3	4.1	8.5	6.6	2.2	5.2	8.6	6.9	None
6-B5	4.7	8.5	6.7	1.8	5.4	8.7	7	None
REF-4[b]	4.1	8.6	7	1.7	5.4	8.6	7.1	None
REF-8[b]	3.8	8.6	6.2	NA	5.4	8.7	7	None
Tributary and Upstream Locations								
LAL-1	4.4	8.7	6.6	2.2	5.1	8.7	6.9	None
LAL-2	3.7	8.6	7	2.3	5.3	8.6	6.8	None
LAL-3	3.6	8.6	6.9	1.8	5.2	8.6	7	None
LAL-6	3.7	8.7	7.1	1.4	NA	NA	NA	NA
Negative Control (CTL-SS)								
CTL-SS-B2	4.7	8.6	7.1	2.3	4.9	8.6	7.1	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B2	4.2	8.8	6.9	1.9	5.4	8.8	7.1	None
CRL-ERDC-B2	3.5	8.8	7	1.3	5.4	8.7	7	None
Batch 3 (Initiated 1/24/2014)								
Site Locations								
2-R3	4.5	8.7	6.9	1.8	5.8	8.6	7.1	None
3-R1	4	8.7	7.1	1.4	4.9	8.5	7	None
3-R8	5.1	8.7	6.9	1.9	5.4	8.6	7.1	None
5-B4	4.9	8.6	7.1	2.5	5.2	8.6	7.1	None
6-B4	3.7	8.3	6.4	NA	5.6	8.4	7.1	None
7-B2	4.1	8.4	6.8	1.9	5	8.6	7	None
REF-1[b]	4.7	8.6	6.9	2.2	4.8	8.6	6.9	None
REF-10b[b]	5.6	8.6	7.1	1.9	4.6	8.6	7	None
REF-3[b]	5	8.8	7	1.7	4.9	8.6	7.2	None
REF-7[b]	4.7	8.8	7	1.9	5.1	8.6	7.1	None

Table 4-10. Summary of DO Results for the Short-Term Bioassays

	Chironomus dilutus				*Hyalella azteca*			
	DO (mg/L)			Aeration Trigger	DO (mg/L)			Aeration Trigger
Sample ID	Min	Max	Mean	DO[a] (mg/L)	Min	Max	Mean	DO[a] (mg/L)
Batch 3 (Initiated 1/24/2014) (continued)								
Tributary and Upstream Locations								
TRIB-3	4.2	8.6	7	2.2	5.2	8.6	7.1	None
LAL-4	4.7	8.6	7.2	2.2	4.5	8.4	7	None
Negative Control (CTL-SS)								
CTL-SS-B3	5.3	8.4	7.1	1.6	5.5	8.6	7.2	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B3	4.4	8.7	6.9	1	5.2	8.7	7.1	None
CTL-ERDC-B3	4.9	8.8	7	1.6	4.8	8.6	7	None
Batch 4 (Initiated 1/29/2014)								
Site Locations								
1-B5	4.9	8.4	7.4	1.5	4.7	8.5	7	None
2-B1	3.8	8.6	7.3	2.2	4.9	8.5	7	None
3-B3	4	8.3	7	1.6	4.9	8.3	7	None
3-R7	4.5	8.7	7.4	2.1	4.9	8.5	7	None
5-B5	4.4	8.6	6.9	1.5	5	8.5	7	None
5-B6	4.2	8.4	7.3	2.5	4.7	8.3	6.9	None
7-B3	5.2	8.6	7.3	1.8	5	8.4	6.9	None
7-B6	3.9	8.4	6.5	NA	5.3	8.6	7	None
REF-2[b]	5.3	8.6	7.4	1.9	5	8.7	6.9	None
Tributary and Upstream Locations								
TRIB-2	4.4	8.6	7.5	2.4	4.8	8.5	6.9	None
TRIB-5	4.9	8.4	7.2	2.3	5.1	8.5	7.1	None
G-4	4.4	8.6	6.7	NA	5.2	8.6	7.1	None
Negative Control (CTL-SS)								
CTL-SS-B4	4.6	8.5	7.2	1.6	4.9	8.5	7	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B4	4.4	8.7	6.8	NA	4.7	8.7	7	None
CTL-ERDC-B4	4.4	8.4	7.1	1.8	5	8.5	6.9	None
Batch 5 (Initiated 1/30/2014) [c]								
Site Locations								
2-B2	4.6	8.9	7.4	2.1	3.9	8.6	6.7	None
3-R9	3.9	8.9	7.1	1.3	4.4	8.6	6.7	None
4-B1	4	8.4	6.9	1.9	4	8.8	6.8	None
5-B2	4	8.6	7	1.2	3.9	8.7	6.7	None
6-B1	4.1	8.2	6.4	NA	4	8.8	6.8	None
7-B4	4.7	9	7.2	1.6	3.8	8.7	6.8	None
7-B5	5.1	8.9	7.3	1.9	4	8.8	6.7	None
8-B1	4.3	8.3	6.6	NA	3.9	8.6	6.7	None
REF-5[b]	3.8	8.9	7	2.5	4	8.9	6.7	None
Tributary and Upstream Locations								
TRIB-1	4.2	8.5	7	NA	3.8	8.9	6.7	None
G-2	4.5	8.7	7.2	1.5	4.2	9	6.8	None
LAL-5	4.4	8.9	7.2	1.5	3.9	8.8	6.6	None
Negative Control (CTL-SS)								
CTL-SS-B5	4.3	8.9	7.2	1.6	4.1	8.7	6.8	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B5	4.6	9	6.8	NA	3.5	9.1	6.6	None
CTL-ERDC-B5	4.5	9	7.2	2.2	4.5	8.7	6.7	None

Table 4-10. Summary of DO Results for the Short-Term Bioassays

	Chironomus dilutus				*Hyalella azteca*			
	DO (mg/L)			Aeration Trigger	DO (mg/L)			Aeration Trigger
Sample ID	Min	Max	Mean	DO[a] (mg/L)	Min	Max	Mean	DO[a] (mg/L)
Batch 6 (Initiated 1/31/2014)								
Site Locations								
1B-R2	4	9.2	6.9	1.3	4.9	8.6	7.2	None
1-R2	3.8	8.6	6.8	2	5.4	8.9	7.2	None
4-B3	4.6	9	7.4	1.5	5.1	8.5	7.2	None
4-B5	4	9	7	2.3	5.1	8.4	7.1	None
6-B2	4	8.7	6.8	1	5	8.5	7.1	None
7-B1	4.5	8.6	7	1.7	4.6	8.5	6.9	None
8-B2	3.8	8.7	7.1	1.3	5.2	8.5	7.1	None
8-B5	3.9	9.1	7.3	2.4	4.8	8.6	7.1	None
8-B6	4.1	8.5	7.1	2.2	5.2	8.6	7.2	None
Tributary and Upstream Locations								
TRIB-6	4.1	8.8	7.1	1.2	5.3	8.4	7.2	None
G-3	3.7	8.8	6.9	1.8	5.4	8.6	7.1	None
LAL-6	NA	NA	NA	NA	5.2	8.4	7	None
Negative Control (CTL-SS)								
CTL-SS-B6	4.1	8.7	7.1	2.3	5	8.7	7.1	None
Auxiliary Controls (CTL-QS and CTL-ERDC)								
CTL-QS-B6	3.4	8.7	6.9	1.6	5.4	8.5	7.2	None
CTL-ERDC-B6	4.4	8.6	6.9	1.8	4.9	8.4	7	None

Notes:

[a] Dissolved Oxygen (DO) value reported here is the lowest replicate DO recorded for the treatment on the day that the aeration trigger level was exceeded and aeration was initiated. Aeration triggers were observed at the daily evening DO check. See Appendix RR to Appendix E of this data summary report for a summary of DO readings for each replicate.

[b] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

[c] PER negative control results for Batch 5 did not meet test acceptability criteria because mean control survival was less than the minimum control survival of 70% needed for a test to be determined acceptable. Fresh aliquots of the sediments were re-tested in Batch 5-RE.

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

DO - dissolved oxygen

NA – not applicable

Table 4-11a. Summary of PER Negative Control Sediment (CTL-SS) Performance for the Long-Term *Chironomus dilutus* Bioassay

		Mean Survival (%)			Mean AFDW (mg/individual)	Mean Emergence (%)	Time to Death		Mean Number of Eggs/Egg Case	Mean Hatchability (%)
Batch	Sample ID	Day 16	Pupae - End of Test	Adult - End of Test	Day 16	End of Test	Males	Females	End of Test	End of Test
Test Acceptability Requirements		**≥ 70**	**> 83[a]**	**≥ 65**	**≥ 0.48**	**≥ 50[a]**	**< 6.5[a]**	**< 5.1[a]**	**≥ 800[a]**	**≥ 80[a]**
1	CTL-SS-B1	94	94	100	1.55	63	3.4	2.9	1051	88
2	CTL-SS-B2	96	94	96	1.56	57	3.4	1.9	1154	87
3	CTL-SS-B3	100	99	100	1.61	71	3.5	2.4	1789	90

Notes:

[a] This test acceptability requirement is a performance goal, not a criterion that must be met in order for a test to be considered acceptable.

AFDW - ash free dry weight

CTL-SS - PER negative control sediment

Table 4-11b. Summary of Auxiliary Control (CTL-QS) Results for the Long-Term *Chironomus dilutus* Bioassay

		Mean Survival (%)			Mean AFDW (mg/individual)	Mean Emergence (%)	Time to Death		Mean Number of Eggs/Egg Case	Mean Hatchability (%)
Batch	Sample ID	Day 16	Pupae - End of Test	Adult - End of Test	Day 16	End of Test	Males	Females	End of Test	End of Test
1	CTL-QS-B1	98	90	96	1.77	76	4.1	2.8	1060	75
2	CTL-QS-B2	94	95	98	1.63	82	3.2	2.3	1013	94
3	CTL-QS-B3	86	94	100	1.05	63	3.5	2.9	1321	74

Notes:
AFDW - ash free dry weight
CTL-QS - quartz sand auxiliary control

Table 4-12a. Summary of PER Negative Control Sediment (CTL-SS) Performance for the Long-Term *Hyalella azteca* Bioassay

		Mean Survival (%)		Mean Dry Weight (mg/individual)		Number of Offspring/Female
Batch	Sample ID	Day 28	Day 42	Day 28	Day 42	Day 42
Test Acceptability Requirements		***≥ 80***	***NC***	***≥ 0.4*** [a]	***≥ 0.5*** [a]	***> 2*** [a]
1	CTL-SS-B1	98	95	0.4	0.6	5
2	CTL-SS-B2	97	94	0.5	0.7	9
3	CTL-SS-B3	100	95	0.5	0.7	9

Notes:

[a] This test acceptability requirement is a performance goal, not a criterion that must be met in order for a test to be considered acceptable.

CTL-SS - PER negative control sediment

NC - no criteria

Table 4-12b. Summary of Auxiliary Control (CTL-QS) Results for the Long-Term *Hyalella azteca* Bioassay

		Mean Survival (%)		Mean Dry Weight (mg/individual)		Number of Offspring/Female
Batch	Sample ID	Day 28	Day 42	Day 28	Day 42	Day 42
1	CTL-QS-B1	98	95	0.2	0.5	3
2	CTL-QS-B2	97	98	0.3	0.6	4
3	CTL-QS-B3	98	96	0.2	0.6	2

Notes:
CTL-QS - quartz sand auxiliary control

Table 4-13. Summary of DO Results for the Long-Term Bioassays

	Chironomus dilutus				*Hyalella azteca*			
	Morning DO (mg/L)			Aeration Trigger	Morning DO (mg/L)			Aeration Trigger
Sample ID	Min	Max	Mean	DO[a] (mg/L)	Min	Max	Mean	DO[a] (mg/L)
Batch 1 (Initiated 2/13/2015)								
Site Locations								
1-B5	4.9	8.5	7.3	0.9	1.5	8.7	6.8	1.5
1B-R2	4.8	8.6	7.5	2	2	8.6	6.8	2
1-R2	5.1	8.6	7.2	2.4	2.4	8.6	6.9	2.4
4-B6	4.2	8.6	7.3	2.2	2.4	8.6	6.9	2.4
6-B2	3.6	8.6	7.1	1.1	2.4	8.7	7.1	2.4
7-B5	4.5	8.6	7.4	2.7	2.3	8.9	6.9	2.3
8-B3	0.8	8.5	7.1	0.8	1.9	9	6.7	1.9
REF-10b[b]	4.2	8.5	7.4	2.4	1.9	8.7	7.1	1.9
Tributary and Upstream Locations								
TRIB-3	3.8	8.7	7.2	1.6	2.2	8.7	7.3	2.2
G-1	3.3	8.5	7	1.4	2.1	8.9	7.1	2.1
G-3	4.5	8.7	7.6	1.5	2.3	8.8	7.2	2.3
LAL-3	4.9	8.7	7.6	2.1	2.3	8.6	6.9	2.3
LAL-5	3.4	8.5	7.1	1.7	2.4	8.8	6.8	2.4
Negative Control (CTL-SS)								
CTL-SS-B1	3.9	8.6	7	1.7	3.7	8.6	7	NA
Auxiliary Controls (CTL-QS)								
CTL-QS-B1	4.3	8.8	7.5	2.2	2.8	8.6	6.9	NA
Batch 2 (Initiated 2/25/2015)								
Site Locations								
2-B1	4.3	8.9	7.6	1.9	3.2	8.9	6.8	NA
2-R1	1.7	8.8	7.5	1.7	3.2	8.7	6.7	NA
3-R7	3.2	8.7	7.3	1.3	2.7	8.9	6.8	NA
4-B1	3.3	8.7	7.5	1.5	2.4	8.8	7.3	2.4
5-B2	1.4	8.7	7.3	1.4	3	9	6.9	NA
8-B2	3.2	8.8	7.6	1.5	3.4	8.9	6.8	NA
REF-10b[b]	3.3	8.7	7.3	0.7	2.8	9.2	6.9	NA
Tributary and Upstream Locations								
TRIB-3	1.3	8.8	7.2	1.3	2.4	9	7	2.4
G-1	4.1	8.9	7.7	2.4	2.7	8.8	7	NA
G-3	5	8.8	7.7	1.8	3	8.8	6.8	NA
LAL-2	3.9	8.8	7.7	1.3	2	8.7	7	2
LAL-3	1.4	8.7	7.4	1.4	2.3	9	7	2.3
LAL-5	3.3	8.8	7.3	1.8	3	8.9	6.9	NA
Negative Control (CTL-SS)								
CTL-SS-B2	1.5	8.7	7.2	1.5	3.1	8.8	6.9	NA
Auxiliary Controls (CTL-QS)								
CTL-QS-B2	1.4	8.7	7.5	1.4	3.1	9	7	NA
Batch 3 (Initiated 3/5/2015)								
Site Locations								
3-B3	4.3	8.5	7.5	1.6	2.2	8.8	6.8	2.2
3-R8	0.5	8.9	6.9	0.5	3.1	8.9	7	NA
4-B5	3	8.6	7.1	2.2	3.7	8.9	7	NA
5-B4	0.7	8.8	7.2	0.7	1.7	8.8	6.7	1.7
6-B5	0.9	8.9	6.9	0.9	3.1	8.7	6.8	NA
7-B2	3.3	8.5	7.1	1.2	2.2	8.8	6.9	2.2
REF-10b[b]	3.4	8.3	7.1	1.9	3.2	8.8	7.1	NA

Table 4-13. Summary of DO Results for the Long-Term Bioassays

Sample ID	*Chironomus dilutus* Morning DO (mg/L) Min	Max	Mean	Aeration Trigger DO[a] (mg/L)	*Hyalella azteca* Morning DO (mg/L) Min	Max	Mean	Aeration Trigger DO[a] (mg/L)
Batch 3 (Initiated 3/5/2015) (continued)								
Tributary and Upstream Locations								
TRIB-3	3.6	8.5	7.2	1.2	3.5	8.9	7.1	NA
G-1	0.7	8.5	6.7	0.7	3.2	8.9	7	NA
G-2	0.9	8.4	6.8	0.9	1.8	8.9	6.8	1.8
G-3	3.3	8.7	7.1	1.8	3	8.9	7	NA
LAL-3	3.6	8.6	7.2	1.2	3.1	8.8	6.9	NA
LAL-5	0.2	8.5	6.6	0.2	3.4	8.9	6.9	NA
Negative Control (CTL-SS)								
CTL-SS-B3	3.6	8.5	7.2	1.3	3.4	8.8	7.2	NA
Auxiliary Controls (CTL-QS)								
CTL-QS-B3	3.2	8.5	6.9	1.9	3.7	8.8	7.1	NA

Notes:

[a] Dissolved Oxygen (DO) value reported here is the lowest replicate DO recorded for the treatment on the day that the aeration trigger level was exceeded and aeration was initiated.The majority of aeration triggers were observed at the daily evening DO check. See Appendix RR to Appendix E of this data summary report for a summary of DO readings for each replicate.

[b] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

NA – not applicable

Table 5-1. Field-Collected Sediment Summary Statistics

Analyte	Number of Results[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Valueb	Mean Nondetected Valueb	Maximum Nondetected Valueb	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Organic carbon (%)	120	120	0.0775	1.02	3.59	--	--	--	0.0775	1.02	3.59
pH	120	120	6.37	7.36	9.37	--	--	--	6.37	7.36	9.37
Solids (%)	120	120	21.6	54.6	93	--	--	--	21.6	54.6	93
Sulfide (AVS; µmol/g)	119	111	0.013	2.29	25.5	0.0025	0.00475	0.007	0.0025	2.14	25.5
Grain size (%)											
Clay	120	120	0	17.5	67.7	--	--	--	0	17.5	67.7
Silt	120	120	0.1	35.8	81.53	--	--	--	0.1	35.8	81.53
Very fine sand	120	120	0.02	4.62	26.97	--	--	--	0.02	4.62	26.97
Fine sand	120	120	0.18	13.2	63.4	--	--	--	0.18	13.2	63.4
Medium sand	120	120	0.03	9.09	63	--	--	--	0.03	9.09	63
Coarse sand	120	120	0	13.8	78.77	--	--	--	0	13.8	78.77
Very coarse sand	120	120	0	4.05	42.45	--	--	--	0	4.05	42.45
Fine gravel	120	120	0	1.6	27.55	--	--	--	0	1.6	27.55
Medium gravel	120	120	0	0.0569	2.87	--	--	--	0	0.0569	2.87
Metals/Metalloids (mg/kg)											
Aluminum	120	120	4670	16800	29500	--	--	--	4670	16800	29500
Antimony	120	119	0.091	13	98	0.0185	0.0185	0.0185	0.0185	12.9	98
Arsenic	120	120	0.91	11.1	36.8	--	--	--	0.91	11.1	36.8
Barium	120	120	37.5	523	2390	--	--	--	37.5	523	2390
Beryllium	120	120	0.133	0.605	1.2	--	--	--	0.133	0.605	1.2
Cadmium	120	120	0.07	3.4	13.1	--	--	--	0.07	3.4	13.1
Calcium	120	120	1840	19400	85200	--	--	--	1840	19400	85200
Chromium	120	120	2.28	42.7	146	--	--	--	2.28	42.7	146
Cobalt	120	120	2.74	17.8	70.4	--	--	--	2.74	17.8	70.4
Copper	120	120	3.88	445	3370	--	--	--	3.88	445	3370
Iron	120	120	10100	59900	291000	--	--	--	10100	59900	291000
Lead	120	120	2.9	235	1080	--	--	--	2.9	235	1080
Magnesium	120	120	1940	9320	23300	--	--	--	1940	9320	23300
Manganese	120	120	148	1340	5710	--	--	--	148	1340	5710
Mercury	120	119	0.003	0.402	1.9	0.001	0.001	0.001	0.001	0.399	1.9
Nickel	120	120	2.38	22.2	38.8	--	--	--	2.38	22.2	38.8
Potassium	120	120	861	2620	5090	--	--	--	861	2620	5090
Selenium	120	119	0.2	1.22	5	0.1	0.1	0.1	0.1	1.21	5
Silver	120	120	0.042	1.43	7.32	--	--	--	0.042	1.43	7.32
Sodium	120	118	112	600	2740	23.3	38.2	53	23.3	591	2740
Thallium	120	110	0.044	0.477	1.23	0.0215	0.0356	0.048	0.0215	0.441	1.23
Vanadium	120	120	14.9	39.4	57.1	--	--	--	14.9	39.4	57.1
Zinc	120	120	32.1	3870	28200	--	--	--	32.1	3870	28200
SEM (µmol/g)											
Antimony	119	52	0.0016	0.0196	0.121	0.0003	0.00325	0.02375	0.0003	0.0104	0.121
Arsenic	119	109	0.0029	0.0255	0.088	0.00535	0.0134	0.017	0.0029	0.0245	0.088
Cadmium	119	119	0.000378	0.0129	0.05622	--	--	--	0.000378	0.0129	0.05622
Chromium	119	119	0.0019	0.103	0.868	--	--	--	0.0019	0.103	0.868
Copper	119	119	0.0131	0.837	9.73	--	--	--	0.0131	0.837	9.73
Lead	119	119	0.0072	0.395	1.73	--	--	--	0.0072	0.395	1.73
Nickel	119	119	0.00454	0.0559	0.146	--	--	--	0.00454	0.0559	0.146
Zinc	119	119	0.0679	14.3	134	--	--	--	0.0679	14.3	134
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	16	16	0.061	0.758	2.67	--	--	--	0.061	0.758	2.67
pH	16	16	5.27	7.19	8.44	--	--	--	5.27	7.19	8.44
Solids (%)	16	16	37.8	73.7	93.2	--	--	--	37.8	73.7	93.2
Sulfide (AVS; µmol/g)	16	5	0.02	0.253	0.65	0.0025	0.00405	0.009	0.0025	0.0818	0.65
Grain size (%)											
Clay	16	16	0	2.66	19.25	--	--	--	0	2.66	19.25
Silt	16	16	0.11	6.01	28.51	--	--	--	0.11	6.01	28.51
Very fine sand	16	16	0.16	6.49	25.95	--	--	--	0.16	6.49	25.95
Fine sand	16	16	1.85	19.1	55.91	--	--	--	1.85	19.1	55.91
Medium sand	16	16	1.27	16	55.49	--	--	--	1.27	16	55.49
Coarse sand	16	16	0.9	21.5	49.57	--	--	--	0.9	21.5	49.57
Very coarse sand	16	16	0.37	17.5	50.82	--	--	--	0.37	17.5	50.82
Fine gravel	16	16	0	8.92	35.1	--	--	--	0	8.92	35.1
Medium gravel	16	16	0	0.787	7.46	--	--	--	0	0.787	7.46

Table 5-1. Field-Collected Sediment Summary Statistics

Analyte	Number of Results[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Valueb	Mean Nondetected Valueb	Maximum Nondetected Valueb	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Tributary and Upstream Samples (continued)											
Metals/Metalloids (mg/kg)											
Aluminum	16	16	1750	5310	12100	--	--	--	1750	5310	12100
Antimony	16	8	0.064	0.206	0.428	0.003	0.00969	0.022	0.003	0.108	0.428
Arsenic	16	16	0.2	1.8	6.51	--	--	--	0.2	1.8	6.51
Barium	16	16	12.7	74.6	183	--	--	--	12.7	74.6	183
Beryllium	16	16	0.05	0.239	0.769	--	--	--	0.05	0.239	0.769
Cadmium	16	15	0.025	0.241	0.736	0.0075	0.0075	0.0075	0.0075	0.226	0.736
Calcium	16	16	667	19900	208000	--	--	--	667	19900	208000
Chromium	16	16	2.25	13.8	33.7	--	--	--	2.25	13.8	33.7
Cobalt	16	16	0.906	4.24	13.2	--	--	--	0.906	4.24	13.2
Copper	16	16	0.8	8.56	23.6	--	--	--	0.8	8.56	23.6
Iron	16	16	2740	11400	24800	--	--	--	2740	11400	24800
Lead	16	14	1.2	9.06	20.8	0.55	2.25	3.95	0.55	8.21	20.8
Magnesium	16	16	800	3570	6670	--	--	--	800	3570	6670
Manganese	16	16	42.6	221	719	--	--	--	42.6	221	719
Mercury	16	9	0.003	0.0102	0.029	0.001	0.001	0.001	0.001	0.00619	0.029
Nickel	16	16	1.98	12.2	38.5	--	--	--	1.98	12.2	38.5
Potassium	16	16	309	890	2980	--	--	--	309	890	2980
Selenium	16	6	0.3	0.533	1.2	0.05	0.085	0.1	0.05	0.253	1.2
Silver	16	16	0.013	0.105	0.348	--	--	--	0.013	0.105	0.348
Sodium	16	16	26.3	96.5	249	--	--	--	26.3	96.5	249
Thallium	16	11	0.0255	0.0885	0.271	0.014	0.0231	0.049	0.014	0.0681	0.271
Vanadium	16	16	3.75	17.1	43.6	--	--	--	3.75	17.1	43.6
Zinc	16	16	7.55	36.9	67.7	--	--	--	7.55	36.9	67.7
SEM (µmol/g)											
Antimony	16	4	0.0005	0.000825	0.0016	0.0002	0.000417	0.0009	0.0002	0.000519	0.0016
Arsenic	16	11	0.003	0.00977	0.019	0.001	0.0022	0.0045	0.001	0.00741	0.019
Cadmium	16	14	0.0003	0.00161	0.00739	0.000045	0.00005	0.000055	0.000045	0.00141	0.00739
Chromium	16	16	0.0029	0.0127	0.0482	--	--	--	0.0029	0.0127	0.0482
Copper	16	14	0.0059	0.03	0.085	0.00115	0.00125	0.00135	0.00115	0.0264	0.085
Lead	16	16	0.0019	0.0209	0.0563	--	--	--	0.0019	0.0209	0.0563
Nickel	16	16	0.0024	0.0213	0.0823	--	--	--	0.0024	0.0213	0.0823
Zinc	16	16	0.0161	0.116	0.361	--	--	--	0.0161	0.116	0.361

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Data were replicate-averaged (detected values were averaged; if no detected values, the minimum detection limit was reported).

Averaged results have three significant figures applied.

[a] There was not enough sample collected to analyze site location 2-B4 for sulfide or SEM.

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

SEM - simultaneously extracted metals

Table 5-2a. Short-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* on Test Day 7

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Conventional Parameters											
Organic carbon (%)	53	53	0.092	0.972	2.24	--	--	--	0.092	0.972	2.24
Solids (%)	53	53	25.5	56.5	81.9	--	--	--	25.5	56.5	81.9
Sulfide (AVS; µmol/g)	53	51	0.008	1.73	18.6	0.004	0.00475	0.0055	0.004	1.66	18.6
SEM (µmol/g)											
Antimony	53	32	0.0008	0.012	0.0693	0.0003	0.00109	0.00255	0.0003	0.00768	0.0693
Arsenic	53	52	0.0036	0.0193	0.0647	0.00145	0.00145	0.00145	0.00145	0.0189	0.0647
Cadmium	53	51	0.00181	0.0167	0.06571	0.0007	0.00113	0.001555	0.0007	0.0161	0.06571
Chromium	53	53	0.0155	0.0903	0.409	--	--	--	0.0155	0.0903	0.409
Copper	53	53	0.0469	0.655	3.71157	--	--	--	0.0469	0.655	3.71157
Lead	53	53	0.0264	0.47	2.15715	--	--	--	0.0264	0.47	2.15715
Nickel	53	53	0.01554	0.0732	0.19052	--	--	--	0.01554	0.0732	0.19052
Zinc	53	53	0.3151	13	110	--	--	--	0.3151	13	110
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	16	16	0.051	1.59	14.2	--	--	--	0.051	1.59	14.2
Solids (%)	16	16	27.6	71.1	84.3	--	--	--	27.6	71.1	84.3
Sulfide (AVS; µmol/g)	16	8	0.014	1.76	12.3	0.003	0.00388	0.007	0.003	0.88	12.3
SEM (µmol/g)											
Antimony	16	5	0.0004	0.00104	0.002	0.0002	0.000418	0.00085	0.0002	0.000613	0.002
Arsenic	16	10	0.0027	0.0086	0.0181	0.0013	0.00202	0.00255	0.0013	0.00613	0.0181
Cadmium	16	13	0.00011	0.00211	0.0082	0.000055	0.00021	0.000385	0.000055	0.00175	0.0082
Chromium	16	16	0.0032	0.017	0.0829	--	--	--	0.0032	0.017	0.0829
Copper	16	16	0.0034	0.0381	0.1219	--	--	--	0.0034	0.0381	0.1219
Lead	16	16	0.002	0.0247	0.0796	--	--	--	0.002	0.0247	0.0796
Nickel	16	16	0.00289	0.0269	0.12954	--	--	--	0.00289	0.0269	0.12954
Zinc	16	16	0.0223	0.137	0.398	--	--	--	0.0223	0.137	0.398
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	6	6	0.098	0.125	0.155	--	--	--	0.098	0.125	0.155
Solids (%)	6	6	77.4	78.2	78.8	--	--	--	77.4	78.2	78.8
Sulfide (AVS; µmol/g)	6	0	--	--	--	0.004	0.00425	0.0045	0.004	0.00425	0.0045
SEM (µmol/g)											
Antimony	6	0	--	--	--	0.00025	0.000375	0.00055	0.00025	0.000375	0.00055
Arsenic	6	6	0.0055	0.00802	0.0138	--	--	--	0.0055	0.00802	0.0138
Cadmium	6	3	0.00016	0.000227	0.0003	0.000065	0.000105	0.00015	0.000065	0.000166	0.0003
Chromium	6	6	0.0171	0.0219	0.035	--	--	--	0.0171	0.0219	0.035
Copper	6	6	0.0171	0.0217	0.0268	--	--	--	0.0171	0.0217	0.0268
Lead	6	6	0.0189	0.0282	0.0492	--	--	--	0.0189	0.0282	0.0492
Nickel	6	6	0.0199	0.025	0.03607	--	--	--	0.0199	0.025	0.03607
Zinc	6	6	0.0955	0.125	0.1798	--	--	--	0.0955	0.125	0.1798
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Conventional Parameters											
Organic carbon (%)	12	6	4.12	4.26	4.4	0.01	0.01	0.01	0.01	2.14	4.4
Solids (%)	12	12	36.2	59.9	83.2	--	--	--	36.2	59.9	83.2
Sulfide (AVS; µmol/g)	12	6	0.187	0.402	0.69	0.0025	0.00267	0.003	0.0025	0.202	0.69
SEM (µmol/g)											
Antimony	12	1	0.0021	0.0021	0.0021	0.0002	0.000473	0.00105	0.0002	0.000608	0.0021
Arsenic	12	5	0.01	0.0139	0.0227	0.0012	0.00174	0.00475	0.0012	0.00681	0.0227
Cadmium	12	3	0.00065	0.0008	0.00091	0.00004	0.000174	0.00059	0.00004	0.00033	0.00091
Chromium	12	10	0.0003	0.0109	0.0265	0.00025	0.00025	0.00025	0.00025	0.00908	0.0265
Copper	12	12	0.0006	0.0466	0.1653	--	--	--	0.0006	0.0466	0.1653
Lead	12	6	0.0295	0.0374	0.0585	0.0002	0.0002	0.0002	0.0002	0.0188	0.0585
Nickel	12	7	0.0004	0.0133	0.02406	0.00018	0.000191	0.0002	0.00018	0.00783	0.02406
Zinc	12	6	0.267	0.331	0.5346	0.0009	0.00138	0.0018	0.0009	0.166	0.5346

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-2b. Short-Term Bioassay Sediment Summary Statistics for *Hyalella azteca* on Test Day 21

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Conventional Parameters											
Organic carbon (%)	53	53	0.04	0.959	2.24	--	--	--	0.04	0.959	2.24
Solids (%)	53	53	21.7	56.8	82.9	--	--	--	21.7	56.8	82.9
Sulfide (AVS; µmol/g)	53	52	0.006	1.86	15.5	0.006	0.006	0.006	0.006	1.82	15.5
SEM (µmol/g)											
Antimony	53	40	0.0008	0.0149	0.109	0.0005	0.00147	0.0027	0.0005	0.0116	0.109
Arsenic	53	53	0.003	0.0256	0.0648	--	--	--	0.003	0.0256	0.0648
Cadmium	53	51	0.00141	0.0188	0.1252	0.00115	0.00119	0.00122	0.00115	0.0181	0.1252
Chromium	53	53	0.0076	0.128	0.604	--	--	--	0.0076	0.128	0.604
Copper	53	53	0.0317	0.931	6.41568	--	--	--	0.0317	0.931	6.41568
Lead	53	53	0.0184	0.561	2.8081	--	--	--	0.0184	0.561	2.8081
Nickel	53	53	0.0138	0.0949	0.30546	--	--	--	0.0138	0.0949	0.30546
Zinc	53	53	0.143	15	107	--	--	--	0.143	15	107
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	16	16	0.073	1.88	19.8	--	--	--	0.073	1.88	19.8
Solids (%)	16	16	19.7	69.6	83.3	--	--	--	19.7	69.6	83.3
Sulfide (AVS; µmol/g)	16	12	0.007	1.77	18.9	0.0025	0.00413	0.0075	0.0025	1.33	18.9
SEM (µmol/g)											
Antimony	16	7	0.0009	0.00227	0.0076	0.0002	0.000406	0.001	0.0002	0.00122	0.0076
Arsenic	16	11	0.0031	0.00974	0.0244	0.001	0.00385	0.01255	0.001	0.0079	0.0244
Cadmium	16	14	0.00014	0.0015	0.00483	0.000045	0.000243	0.00044	0.000045	0.00134	0.00483
Chromium	16	16	0.0033	0.0194	0.0719	--	--	--	0.0033	0.0194	0.0719
Copper	16	15	0.0085	0.0342	0.113	0.00185	0.00185	0.00185	0.00185	0.0322	0.113
Lead	16	16	0.0018	0.0258	0.0798	--	--	--	0.0018	0.0258	0.0798
Nickel	16	16	0.0026	0.0279	0.121	--	--	--	0.0026	0.0279	0.121
Zinc	16	16	0.018	0.151	0.3921	--	--	--	0.018	0.151	0.3921
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	6	6	0.107	0.124	0.161	--	--	--	0.107	0.124	0.161
Solids (%)	6	6	77	78.2	81.2	--	--	--	77	78.2	81.2
Sulfide (AVS; µmol/g)	6	2	0.007	0.013	0.019	0.003	0.00388	0.0045	0.003	0.00692	0.019
SEM (µmol/g)											
Antimony	6	4	0.0007	0.000825	0.001	0.00025	0.0004	0.00055	0.00025	0.000683	0.001
Arsenic	6	6	0.0076	0.01	0.0139	--	--	--	0.0076	0.01	0.0139
Cadmium	6	5	0.00013	0.000206	0.00034	0.000065	0.000065	0.000065	0.000065	0.000183	0.00034
Chromium	6	6	0.0274	0.0316	0.0385	--	--	--	0.0274	0.0316	0.0385
Copper	6	6	0.0174	0.022	0.0245	--	--	--	0.0174	0.022	0.0245
Lead	6	6	0.0287	0.0344	0.0478	--	--	--	0.0287	0.0344	0.0478
Nickel	6	6	0.02919	0.0351	0.04164	--	--	--	0.02919	0.0351	0.04164
Zinc	6	6	0.131	0.154	0.1893	--	--	--	0.131	0.154	0.1893
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Conventional Parameters											
Organic carbon (%)	12	6	3.5	4.18	4.39	0.01	0.01	0.01	0.01	2.1	4.39
Solids (%)	12	12	39.1	60.3	82	--	--	--	39.1	60.3	82
Sulfide (AVS; µmol/g)	12	6	0.183	0.343	0.5	0.0025	0.00267	0.003	0.0025	0.173	0.5
SEM (µmol/g)											
Antimony	12	3	0.0015	0.00163	0.0017	0.00015	0.000444	0.0011	0.00015	0.000742	0.0017
Arsenic	12	5	0.009	0.0114	0.0138	0.00105	0.00177	0.00485	0.00105	0.0058	0.0138
Cadmium	12	5	0.00028	0.000578	0.00082	0.000035	0.0000693	0.00023	0.000035	0.000281	0.00082
Chromium	12	10	0.0003	0.0108	0.0201	0.00015	0.0002	0.00025	0.00015	0.00899	0.0201
Copper	12	11	0.0007	0.038	0.0973	0.0005	0.0005	0.0005	0.0005	0.0349	0.0973
Lead	12	6	0.0199	0.0323	0.0421	0.00015	0.000208	0.0003	0.00015	0.0163	0.0421
Nickel	12	8	0.00038	0.00989	0.01613	0.000185	0.00019	0.0002	0.000185	0.00666	0.01613
Zinc	12	6	0.155	0.283	0.3692	0.001	0.00161	0.00215	0.001	0.142	0.3692

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-3a. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at Start of the Test

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Conventional Parameters											
Organic carbon (%)	20	20	0.04	0.814	2.24	--	--	--	0.04	0.814	2.24
pH	20	20	6.46	7.45	9.13	--	--	--	6.46	7.45	9.13
Solids (%)	20	20	22.8	57.9	84.7	--	--	--	22.8	57.9	84.7
Sulfide (AVS; µmol/g)	20	20	0.04	4.47	17	--	--	--	0.04	4.47	17
Grain size (%)											
Clay	20	20	0	14.9	62.62	--	--	--	0	14.9	62.62
Silt	20	20	0.03	28.7	73.91	--	--	--	0.03	28.7	73.91
Very fine sand	20	20	0.04	4.16	19.92	--	--	--	0.04	4.16	19.92
Fine sand	20	20	0.17	14.5	61.57	--	--	--	0.17	14.5	61.57
Medium sand	20	20	0.23	10.8	42.54	--	--	--	0.23	10.8	42.54
Coarse sand	20	20	0	22.8	74.72	--	--	--	0	22.8	74.72
Very coarse sand	20	20	0	3.8	20.22	--	--	--	0	3.8	20.22
Fine gravel	20	20	0	1.01	9.84	--	--	--	0	1.01	9.84
Medium gravel	20	20	0	0.112	2.24	--	--	--	0	0.112	2.24
Metals/Metalloids (mg/kg)											
Aluminum	20	20	5220	15500	26000	--	--	--	5220	15500	26000
Antimony	20	20	0.23	20.6	104	--	--	--	0.23	20.6	104
Arsenic	20	20	2.93	14.4	31	--	--	--	2.93	14.4	31
Barium	20	20	63.7	647	2320	--	--	--	63.7	647	2320
Beryllium	20	20	0.26	0.708	1.47	--	--	--	0.26	0.708	1.47
Cadmium	20	20	0.3	3.65	9.87	--	--	--	0.3	3.65	9.87
Calcium	20	20	4570	24700	68900	--	--	--	4570	24700	68900
Chromium	20	20	13	55.4	136	--	--	--	13	55.4	136
Cobalt	20	20	4.32	20.8	49.8	--	--	--	4.32	20.8	49.8
Copper	20	20	10.8	682	3140	--	--	--	10.8	682	3140
Iron	20	20	12100	79300	248000	--	--	--	12100	79300	248000
Lead	20	20	10.4	290	616	--	--	--	10.4	290	616
Magnesium	20	20	4620	9080	17300	--	--	--	4620	9080	17300
Manganese	20	20	168	1680	4610	--	--	--	168	1680	4610
Mercury	20	20	0.006	0.334	1.53	--	--	--	0.006	0.334	1.53
Nickel	20	20	9.57	21.8	41.1	--	--	--	9.57	21.8	41.1
Potassium	20	20	877	2620	4510	--	--	--	877	2620	4510
Selenium	20	20	0.09	1.16	2.25	--	--	--	0.09	1.16	2.25
Silver	20	20	0.05	1.77	5.13	--	--	--	0.05	1.77	5.13
Sodium	20	20	83.1	696	2450	--	--	--	83.1	696	2450
Thallium	20	19	0.05	0.431	1.09	0.03	0.03	0.03	0.03	0.411	1.09
Vanadium	20	20	18.6	40.1	57.3	--	--	--	18.6	40.1	57.3
Zinc	20	20	61.5	5690	21000	--	--	--	61.5	5690	21000
SEM (µmol/g)											
Antimony	20	14	0.0024	0.0466	0.25	0.00105	0.00335	0.005	0.00105	0.0336	0.25
Arsenic	20	17	0.004	0.0326	0.08	0.04	0.0533	0.065	0.004	0.0357	0.08
Cadmium	20	20	0.00078	0.0194	0.09	--	--	--	0.00078	0.0194	0.09
Chromium	20	20	0.03	0.258	0.97	--	--	--	0.03	0.258	0.97
Copper	20	20	0.05	2.09	11.9	--	--	--	0.05	2.09	11.9
Lead	20	20	0.02	0.771	2.36	--	--	--	0.02	0.771	2.36
Nickel	20	20	0.02	0.108	0.28	--	--	--	0.02	0.108	0.28
Zinc	20	20	0.36	38.2	168	--	--	--	0.36	38.2	168
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	7	7	0.06	2.25	12.8	--	--	--	0.06	2.25	12.8
pH	7	7	6.15	7.18	8.23	--	--	--	6.15	7.18	8.23
Solids (%)	7	7	28.6	67.1	82.7	--	--	--	28.6	67.1	82.7
Sulfide (AVS; µmol/g)	7	2	0.34	6.47	12.6	0.005	0.011	0.015	0.005	1.86	12.6
Grain size (%)											
Clay	7	7	0	2.12	12.35	--	--	--	0	2.12	12.35
Silt	7	7	0	6.23	25.83	--	--	--	0	6.23	25.83
Very fine sand	7	7	0.15	5.38	22.06	--	--	--	0.15	5.38	22.06
Fine sand	7	7	1.25	16.4	44.62	--	--	--	1.25	16.4	44.62
Medium sand	7	7	1.86	16.5	58.56	--	--	--	1.86	16.5	58.56
Coarse sand	7	7	0.9	23.2	49.52	--	--	--	0.9	23.2	49.52
Very coarse sand	7	7	0.45	20.7	50.41	--	--	--	0.45	20.7	50.41
Fine gravel	7	7	0	8.69	27.52	--	--	--	0	8.69	27.52
Medium gravel	7	7	0	0.921	4.56	--	--	--	0	0.921	4.56

Table 5-3a. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at Start of the Test

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Tributary and Upstream Samples (continued)											
Metals/Metalloids (mg/kg)											
Aluminum	7	7	2480	4850	12000	--	--	--	2480	4850	12000
Antimony	7	4	0.03	0.228	0.31	0.015	0.0183	0.02	0.015	0.138	0.31
Arsenic	7	7	0.81	2.88	8.14	--	--	--	0.81	2.88	8.14
Barium	7	7	21.5	66.4	139	--	--	--	21.5	66.4	139
Beryllium	7	7	0.12	0.32	0.82	--	--	--	0.12	0.32	0.82
Cadmium	7	7	0.08	0.301	0.75	--	--	--	0.08	0.301	0.75
Calcium	7	7	1430	9740	50100	--	--	--	1430	9740	50100
Chromium	7	7	6.11	17.1	43.7	--	--	--	6.11	17.1	43.7
Cobalt	7	7	1.87	5.2	15.2	--	--	--	1.87	5.2	15.2
Copper	7	7	3.56	9.97	27.4	--	--	--	3.56	9.97	27.4
Iron	7	7	5120	11000	20800	--	--	--	5120	11000	20800
Lead	7	7	3.52	11.5	36.6	--	--	--	3.52	11.5	36.6
Magnesium	7	7	1680	3170	7180	--	--	--	1680	3170	7180
Manganese	7	7	115	241	528	--	--	--	115	241	528
Mercury	7	3	0.005	0.0117	0.02	0.005	0.00875	0.01	0.005	0.01	0.02
Nickel	7	7	4.98	14.9	48.2	--	--	--	4.98	14.9	48.2
Potassium	7	7	388	892	2870	--	--	--	388	892	2870
Selenium	7	4	0.09	0.353	0.48	0.09	0.095	0.1	0.09	0.242	0.48
Silver	7	7	0.02	0.0514	0.09	--	--	--	0.02	0.0514	0.09
Sodium	7	7	36.9	76.8	190	--	--	--	36.9	76.8	190
Thallium	7	1	0.3	0.3	0.3	0.015	0.0242	0.045	0.015	0.0636	0.3
Vanadium	7	7	10.2	19.3	34	--	--	--	10.2	19.3	34
Zinc	7	7	21	39.8	77	--	--	--	21	39.8	77
SEM (µmol/g)											
Antimony	7	0	--	--	--	0.00185	0.00318	0.005	0.00185	0.00318	0.005
Arsenic	7	7	0.004	0.00686	0.01	--	--	--	0.004	0.00686	0.01
Cadmium	7	7	0.00033	0.00169	0.00357	--	--	--	0.00033	0.00169	0.00357
Chromium	7	7	0.0068	0.0253	0.09	--	--	--	0.0068	0.0253	0.09
Copper	7	7	0.01	0.0357	0.12	--	--	--	0.01	0.0357	0.12
Lead	7	7	0.01	0.0257	0.09	--	--	--	0.01	0.0257	0.09
Nickel	7	7	0.01	0.0386	0.14	--	--	--	0.01	0.0386	0.14
Zinc	7	7	0.04	0.156	0.38	--	--	--	0.04	0.156	0.38
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	1	1	0.08	0.08	0.08	--	--	--	0.08	0.08	0.08
pH	1	1	8.47	8.47	8.47	--	--	--	8.47	8.47	8.47
Solids (%)	1	1	79.6	79.6	79.6	--	--	--	79.6	79.6	79.6
Sulfide (AVS; µmol/g)	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Grain size (%)											
Clay	1	1	0.79	0.79	0.79	--	--	--	0.79	0.79	0.79
Silt	1	1	3.37	3.37	3.37	--	--	--	3.37	3.37	3.37
Very fine sand	1	1	0.14	0.14	0.14	--	--	--	0.14	0.14	0.14
Fine sand	1	1	19.93	19.9	19.93	--	--	--	19.93	19.9	19.93
Medium sand	1	1	48.3	48.3	48.3	--	--	--	48.3	48.3	48.3
Coarse sand	1	1	25.32	25.3	25.32	--	--	--	25.32	25.3	25.32
Very coarse sand	1	1	0.7	0.7	0.7	--	--	--	0.7	0.7	0.7
Fine gravel	1	1	0	0	0	--	--	--	0	0	0
Medium gravel	1	1	0	0	0	--	--	--	0	0	0
Metals/Metalloids (mg/kg)											
Aluminum	1	1	3420	3420	3420	--	--	--	3420	3420	3420
Antimony	1	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Arsenic	1	1	6.29	6.29	6.29	--	--	--	6.29	6.29	6.29
Barium	1	1	8.19	8.19	8.19	--	--	--	8.19	8.19	8.19
Beryllium	1	1	0.12	0.12	0.12	--	--	--	0.12	0.12	0.12
Cadmium	1	1	0.02	0.02	0.02	--	--	--	0.02	0.02	0.02
Calcium	1	1	3970	3970	3970	--	--	--	3970	3970	3970
Chromium	1	1	25.1	25.1	25.1	--	--	--	25.1	25.1	25.1
Cobalt	1	1	5.79	5.79	5.79	--	--	--	5.79	5.79	5.79
Copper	1	1	4.02	4.02	4.02	--	--	--	4.02	4.02	4.02
Iron	1	1	10900	10900	10900	--	--	--	10900	10900	10900
Lead	1	1	5.71	5.71	5.71	--	--	--	5.71	5.71	5.71
Magnesium	1	1	3200	3200	3200	--	--	--	3200	3200	3200
Manganese	1	1	199	199	199	--	--	--	199	199	199
Mercury	1	1	0.01	0.01	0.01	--	--	--	0.01	0.01	0.01
Nickel	1	1	26.2	26.2	26.2	--	--	--	26.2	26.2	26.2

Table 5-3a. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at Start of the Test

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Negative Control Samples (CTL-SS) (continued)											
Potassium	1	1	646	646	646	--	--	--	646	646	646
Selenium	1	0	--	--	--	0.095	0.095	0.095	0.095	0.095	0.095
Silver	1	1	0.01	0.01	0.01	--	--	--	0.01	0.01	0.01
Sodium	1	1	361	361	361	--	--	--	361	361	361
Thallium	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Vanadium	1	1	19.4	19.4	19.4	--	--	--	19.4	19.4	19.4
Zinc	1	1	19.9	19.9	19.9	--	--	--	19.9	19.9	19.9
SEM (µmol/g)											
Antimony	1	0	--	--	--	0.00235	0.00235	0.00235	0.00235	0.00235	0.00235
Arsenic	1	1	0.003	0.003	0.003	--	--	--	0.003	0.003	0.003
Cadmium	1	0	--	--	--	0.000155	0.000155	0.000155	0.00016	0.00016	0.00016
Chromium	1	1	0.01	0.01	0.01	--	--	--	0.01	0.01	0.01
Copper	1	1	0.01	0.01	0.01	--	--	--	0.01	0.01	0.01
Lead	1	1	0.01	0.01	0.01	--	--	--	0.01	0.01	0.01
Nickel	1	1	0.02	0.02	0.02	--	--	--	0.02	0.02	0.02
Zinc	1	1	0.06	0.06	0.06	--	--	--	0.06	0.06	0.06
Auxiliary Control Samples (CTL-QS)											
Conventional Parameters											
Organic carbon (%)	1	0	--	--	--	0.025	0.025	0.025	0.025	0.025	0.025
pH	1	1	7.56	7.56	7.56	--	--	--	7.56	7.56	7.56
Solids (%)	1	1	76.9	76.9	76.9	--	--	--	76.9	76.9	76.9
Sulfide (AVS; µmol/g)	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Grain size (%)											
Clay	1	1	0	0	0	--	--	--	0	0	0
Silt	1	1	0	0	0	--	--	--	0	0	0
Very fine sand	1	1	0.03	0.03	0.03	--	--	--	0.03	0.03	0.03
Fine sand	1	1	2.39	2.39	2.39	--	--	--	2.39	2.39	2.39
Medium sand	1	1	37.51	37.5	37.51	--	--	--	37.51	37.5	37.51
Coarse sand	1	1	61.26	61.3	61.26	--	--	--	61.26	61.3	61.26
Very coarse sand	1	1	0.07	0.07	0.07	--	--	--	0.07	0.07	0.07
Fine gravel	1	1	0	0	0	--	--	--	0	0	0
Medium gravel	1	1	0	0	0	--	--	--	0	0	0
Metals/Metalloids (mg/kg)											
Aluminum	1	1	7.2	7.2	7.2	--	--	--	7.2	7.2	7.2
Antimony	1	0	--	--	--	0.045	0.045	0.045	0.045	0.045	0.045
Arsenic	1	1	0.18	0.18	0.18	--	--	--	0.18	0.18	0.18
Barium	1	0	--	--	--	0.255	0.255	0.255	0.255	0.255	0.255
Beryllium	1	0	--	--	--	0.015	0.015	0.015	0.015	0.015	0.015
Cadmium	1	0	--	--	--	0.015	0.015	0.015	0.015	0.015	0.015
Calcium	1	0	--	--	--	9.65	9.65	9.65	9.65	9.65	9.65
Chromium	1	1	0.15	0.15	0.15	--	--	--	0.15	0.15	0.15
Cobalt	1	1	0.11	0.11	0.11	--	--	--	0.11	0.11	0.11
Copper	1	1	1.03	1.03	1.03	--	--	--	1.03	1.03	1.03
Iron	1	1	76.5	76.5	76.5	--	--	--	76.5	76.5	76.5
Lead	1	0	--	--	--	0.4	0.4	0.4	0.4	0.4	0.4
Magnesium	1	1	3.79	3.79	3.79	--	--	--	3.79	3.79	3.79
Manganese	1	1	0.19	0.19	0.19	--	--	--	0.19	0.19	0.19
Mercury	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Nickel	1	1	0.49	0.49	0.49	--	--	--	0.49	0.49	0.49
Potassium	1	0	--	--	--	12.75	12.8	12.75	12.75	12.8	12.75
Selenium	1	0	--	--	--	0.19	0.19	0.19	0.19	0.19	0.19
Silver	1	0	--	--	--	0.015	0.015	0.015	0.015	0.015	0.015
Sodium	1	0	--	--	--	4.2	4.2	4.2	4.2	4.2	4.2
Thallium	1	0	--	--	--	0.004	0.004	0.004	0.004	0.004	0.004
Vanadium	1	1	0.05	0.05	0.05	--	--	--	0.05	0.05	0.05
Zinc	1	0	--	--	--	0.25	0.25	0.25	0.25	0.25	0.25

Table 5-3a. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at Start of the Test

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Auxiliary Control Samples (CTL-QS) (continued)											
SEM (µmol/g)											
Antimony	1	0	--	--	--	0.00195	0.00195	0.00195	0.00195	0.00195	0.00195
Arsenic	1	0	--	--	--	0.003	0.003	0.003	0.003	0.003	0.003
Cadmium	1	0	--	--	--	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013
Chromium	1	1	0.0008	0.0008	0.0008	--	--	--	0.0008	0.0008	0.0008
Copper	1	1	0.0011	0.0011	0.0011	--	--	--	0.0011	0.0011	0.0011
Lead	1	1	0.0007	0.0007	0.0007	--	--	--	0.0007	0.0007	0.0007
Nickel	1	1	0.0005	0.0005	0.0005	--	--	--	0.0005	0.0005	0.0005
Zinc	1	0	--	--	--	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-3b. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* on Test Day 21

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Organic carbon (%)	22	22	0.04	0.791	2.26	--	--	--	0.04	0.791	2.26
Solids (%)	22	22	24.5	62.8	80.8	--	--	--	24.5	62.8	80.8
Sulfide (AVS; µmol/g)	22	22	0.06	3.6	11.5	--	--	--	0.06	3.6	11.5
SEM (µmol/g)											
Antimony	22	16	0.0012	0.0498	0.22	0.00285	0.00445	0.01	0.0012	0.0374	0.22
Arsenic	22	20	0.006	0.0298	0.07	0.055	0.055	0.055	0.006	0.0321	0.07
Cadmium	22	22	0.00207	0.0177	0.06	--	--	--	0.00207	0.0177	0.06
Chromium	22	22	0.03	0.292	0.96	--	--	--	0.03	0.292	0.96
Copper	22	22	0.06	2.52	12	--	--	--	0.06	2.52	12
Lead	22	22	0.03	0.758	2.32	--	--	--	0.03	0.758	2.32
Nickel	22	22	0.03	0.112	0.21	--	--	--	0.03	0.112	0.21
Zinc	22	22	0.44	43.7	166	--	--	--	0.44	43.7	166
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	17	17	0.05	1.5	16.4	--	--	--	0.05	1.5	16.4
Solids (%)	17	17	31	72.1	82.8	--	--	--	31	72.1	82.8
Sulfide (AVS; µmol/g)	17	11	0.01	1.18	11.8	0.015	0.0158	0.02	0.01	0.77	11.8
SEM (µmol/g)											
Antimony	17	3	0.0009	0.0024	0.0049	0.00305	0.00411	0.005	0.0009	0.00381	0.005
Arsenic	17	14	0.003	0.008	0.02	0.005	0.00667	0.01	0.003	0.00776	0.02
Cadmium	17	17	0.00035	0.00176	0.00465	--	--	--	0.00035	0.00176	0.00465
Chromium	17	17	0.0071	0.0332	0.14	--	--	--	0.0071	0.0332	0.14
Copper	17	17	0.01	0.0494	0.22	--	--	--	0.01	0.0494	0.22
Lead	17	17	0.01	0.0294	0.12	--	--	--	0.01	0.0294	0.12
Nickel	17	17	0.01	0.0471	0.21	--	--	--	0.01	0.0471	0.21
Zinc	17	17	0.04	0.184	0.53	--	--	--	0.04	0.184	0.53
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	3	3	0.09	0.113	0.13	--	--	--	0.09	0.113	0.13
Solids (%)	3	3	79.4	80.1	81.4	--	--	--	79.4	80.1	81.4
Sulfide (AVS; µmol/g)	3	2	0.01	0.025	0.04	0.015	0.015	0.015	0.01	0.0217	0.04
SEM (µmol/g)											
Antimony	3	0				0.00335	0.0035	0.0036	0.00335	0.0035	0.0036
Arsenic	3	3	0.007	0.00867	0.01	--	--	--	0.007	0.00867	0.01
Cadmium	3	2	0.00023	0.000325	0.00042	0.00024	0.00024	0.00024	0.00023	0.000297	0.00042
Chromium	3	3	0.03	0.03	0.03	--	--	--	0.03	0.03	0.03
Copper	3	3	0.02	0.02	0.02	--	--	--	0.02	0.02	0.02
Lead	3	3	0.02	0.0267	0.03	--	--	--	0.02	0.0267	0.03
Nickel	3	3	0.04	0.0433	0.05	--	--	--	0.04	0.0433	0.05
Zinc	3	3	0.14	0.153	0.16	--	--	--	0.14	0.153	0.16
Auxiliary Control Samples (CTL-QS)											
Conventional Parameters											
Organic carbon (%)	3	0	--	--	--	0.025	0.025	0.025	0.025	0.025	0.025
Solids (%)	3	3	79.5	81.2	82.4	--	--	--	79.5	81.2	82.4
Sulfide (AVS; µmol/g)	3	0	--	--	--	0.005	0.00667	0.01	0.005	0.00667	0.01
SEM (µmol/g)											
Antimony	3	0	--	--	--	0.0018	0.00185	0.0019	0.0018	0.00185	0.0019
Arsenic	3	0	--	--	--	0.003	0.003	0.003	0.003	0.003	0.003
Cadmium	3	0	--	--	--	0.00012	0.000122	0.000125	0.00012	0.000122	0.00013
Chromium	3	1	0.0006	0.0006	0.0006	0.00025	0.000375	0.0005	0.00025	0.00045	0.0006
Copper	3	3	0.0012	0.00137	0.0017	--	--	--	0.0012	0.00137	0.0017
Lead	3	3	0.0007	0.0007	0.0007	--	--	--	0.0007	0.0007	0.0007
Nickel	3	3	0.0004	0.000533	0.0008	--	--	--	0.0004	0.000533	0.0008
Zinc	3	2	0.0027	0.00315	0.0036	0.00125	0.00125	0.00125	0.00125	0.00252	0.0036

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13). Number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-3c. Long-Term Bioassay Sediment Summary Statistics for *Hyalella azteca* on Test Day 21

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Organic carbon (%)	22	22	0.05	0.764	2.25	--	--	--	0.05	0.764	2.25
Solids (%)	22	22	20	62	81.4	--	--	--	20	62	81.4
Sulfide (AVS; µmol/g)	22	22	0.08	4.91	26	--	--	--	0.08	4.91	26
SEM (µmol/g)											
Antimony	22	17	0.0026	0.0496	0.26	0.00355	0.0052	0.01	0.0026	0.0395	0.26
Arsenic	22	18	0.008	0.0282	0.07	0.055	0.0725	0.12	0.008	0.0363	0.12
Cadmium	22	21	0.00216	0.0205	0.09	0.00233	0.00233	0.00233	0.00216	0.0197	0.09
Chromium	22	22	0.02	0.299	1.08	--	--	--	0.02	0.299	1.08
Copper	22	22	0.06	2.58	13	--	--	--	0.06	2.58	13
Lead	22	22	0.03	0.815	2.35	--	--	--	0.03	0.815	2.35
Nickel	22	22	0.03	0.112	0.28	--	--	--	0.03	0.112	0.28
Zinc	22	22	0.42	46	183	--	--	--	0.42	46	183
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	17	17	0.05	1.25	11.5	--	--	--	0.05	1.25	11.5
Solids (%)	17	17	31.2	71.4	82.2	--	--	--	31.2	71.4	82.2
Sulfide (AVS; µmol/g)	17	6	0.01	3.06	17.1	0.015	0.0155	0.02	0.01	1.09	17.1
SEM (µmol/g)											
Antimony	17	0	--	--	--	0.0004	0.00387	0.005	0.0004	0.00387	0.005
Arsenic	17	14	0.004	0.00821	0.02	0.005	0.00667	0.01	0.004	0.00794	0.02
Cadmium	17	17	0.00041	0.00193	0.00444	--	--	--	0.00041	0.00193	0.00444
Chromium	17	17	0.0054	0.0338	0.13	--	--	--	0.0054	0.0338	0.13
Copper	17	17	0.01	0.05	0.21	--	--	--	0.01	0.05	0.21
Lead	17	17	0.01	0.0312	0.12	--	--	--	0.01	0.0312	0.12
Nickel	17	17	0.01	0.0506	0.2	--	--	--	0.01	0.0506	0.2
Zinc	17	17	0.04	0.192	0.5	--	--	--	0.04	0.192	0.5
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	3	3	0.09	0.1	0.12	--	--	--	0.09	0.1	0.12
Solids (%)	3	3	79	79.5	80	--	--	--	79	79.5	80
Sulfide (AVS; µmol/g)	3	1	0.05	0.05	0.05	0.01	0.0125	0.015	0.01	0.025	0.05
SEM (µmol/g)											
Antimony	3	0	--	--	--	0.00185	0.00297	0.0036	0.00185	0.00297	0.0036
Arsenic	3	2	0.008	0.009	0.01	0.003	0.003	0.003	0.003	0.007	0.01
Cadmium	3	2	0.0002	0.00036	0.00052	0.000125	0.000125	0.000125	0.00013	0.000282	0.00052
Chromium	3	3	0.0017	0.0172	0.03	--	--	--	0.0017	0.0172	0.03
Copper	3	3	0.0012	0.0137	0.02	--	--	--	0.0012	0.0137	0.02
Lead	3	3	0.0008	0.0236	0.05	--	--	--	0.0008	0.0236	0.05
Nickel	3	3	0.0009	0.027	0.05	--	--	--	0.0009	0.027	0.05
Zinc	3	2	0.13	0.205	0.28	0.00075	0.00075	0.00075	0.00075	0.137	0.28
Auxiliary Control Samples (CTL-QS)											
Conventional Parameters											
Organic carbon (%)	3	0	--	--	--	0.025	0.025	0.025	0.025	0.025	0.025
Solids (%)	3	3	79.4	81.3	83.9	--	--	--	79.4	81.3	83.9
Sulfide (AVS; µmol/g)	3	0	--	--	--	0.01	0.015	0.02	0.01	0.015	0.02
SEM (µmol/g)											
Antimony	3	0	--	--	--	0.0018	0.00297	0.0037	0.0018	0.00297	0.0037
Arsenic	3	1	0.009	0.009	0.009	0.003	0.004	0.005	0.003	0.00567	0.009
Cadmium	3	1	0.00019	0.00019	0.00019	0.00012	0.000175	0.00023	0.00012	0.00018	0.00023
Chromium	3	1	0.03	0.03	0.03	0.00045	0.00138	0.0023	0.00045	0.0109	0.03
Copper	3	3	0.0012	0.0079	0.02	--	--	--	0.0012	0.0079	0.02
Lead	3	2	0.0008	0.0204	0.04	0.00115	0.00115	0.00115	0.0008	0.014	0.04
Nickel	3	3	0.0003	0.017	0.05	--	--	--	0.0003	0.017	0.05
Zinc	3	2	0.01	0.1	0.19	0.00075	0.00075	0.00075	0.00075	0.0669	0.19

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13). Number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-3d. Long-Term Bioassay Sediment Summary Statistics for *Chironomus dilutus* on Test Day 42

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Organic carbon (%)	22	22	0.07	0.799	2.25	--	--	--	0.07	0.799	2.25
Solids (%)	22	22	28.8	62.8	81.7	--	--	--	28.8	62.8	81.7
Sulfide (AVS; µmol/g)	22	22	0.06	4.1	14	--	--	--	0.06	4.1	14
SEM (µmol/g)											
Antimony	22	10	0.0048	0.0738	0.17	0.0007	0.00766	0.05	0.0007	0.0377	0.17
Arsenic	22	19	0.01	0.0374	0.08	0.055	0.0783	0.12	0.01	0.043	0.12
Cadmium	22	22	0.00213	0.0174	0.06	--	--	--	0.00213	0.0174	0.06
Chromium	22	22	0.02	0.285	0.78	--	--	--	0.02	0.285	0.78
Copper	22	22	0.05	2.61	9.86	--	--	--	0.05	2.61	9.86
Lead	22	22	0.03	0.73	2.35	--	--	--	0.03	0.73	2.35
Nickel	22	22	0.03	0.0986	0.19	--	--	--	0.03	0.0986	0.19
Zinc	22	22	0.44	41.5	139	--	--	--	0.44	41.5	139
Tributary and Upstream Samples											
Conventional Parameters											
Organic carbon (%)	17	17	0.05	1.57	17.6	--	--	--	0.05	1.57	17.6
Solids (%)	17	17	17	71	82.6	--	--	--	17	71	82.6
Sulfide (AVS; µmol/g)	17	14	0.01	3.34	43.2	0.015	0.0167	0.02	0.01	2.75	43.2
SEM (µmol/g)											
Antimony	17	0	--	--	--	0.00215	0.0052	0.015	0.00215	0.0052	0.015
Arsenic	17	11	0.005	0.0101	0.03	0.005	0.00917	0.025	0.005	0.00976	0.03
Cadmium	17	17	0.00042	0.00207	0.00579	--	--	--	0.00042	0.00207	0.00579
Chromium	17	17	0.0056	0.0316	0.14	--	--	--	0.0056	0.0316	0.14
Copper	17	17	0.01	0.0518	0.21	--	--	--	0.01	0.0518	0.21
Lead	17	17	0.0093	0.0317	0.13	--	--	--	0.0093	0.0317	0.13
Nickel	17	17	0.01	0.0512	0.22	--	--	--	0.01	0.0512	0.22
Zinc	17	17	0.04	0.191	0.55	--	--	--	0.04	0.191	0.55
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Organic carbon (%)	3	3	0.09	0.103	0.11	--	--	--	0.09	0.103	0.11
Solids (%)	3	3	77.9	78.8	79.6	--	--	--	77.9	78.8	79.6
Sulfide (AVS; µmol/g)	3	3	0.01	0.02	0.04	--	--	--	0.01	0.02	0.04
SEM (µmol/g)											
Antimony	3	0	--	--	--	0.00355	0.00365	0.00375	0.00355	0.00365	0.00375
Arsenic	3	3	0.008	0.009	0.01	--	--	--	0.008	0.009	0.01
Cadmium	3	2	0.00025	0.00035	0.00045	0.00025	0.00025	0.00025	0.00025	0.000317	0.00045
Chromium	3	3	0.02	0.0267	0.03	--	--	--	0.02	0.0267	0.03
Copper	3	3	0.02	0.02	0.02	--	--	--	0.02	0.02	0.02
Lead	3	3	0.02	0.04	0.07	--	--	--	0.02	0.04	0.07
Nickel	3	3	0.04	0.0433	0.05	--	--	--	0.04	0.0433	0.05
Zinc	3	3	0.13	0.14	0.15	--	--	--	0.13	0.14	0.15
Auxiliary Control Samples (CTL-QS)											
Conventional Parameters											
Organic carbon (%)	3	0	--	--	--	0.025	0.025	0.025	0.025	0.025	0.025
Solids (%)	3	3	79.9	81.3	83.5	--	--	--	79.9	81.3	83.5
Sulfide (AVS; µmol/g)	3	1	0.04	0.04	0.04	0.005	0.01	0.015	0.005	0.02	0.04
SEM (µmol/g)											
Antimony	3	0	--	--	--	0.0018	0.00238	0.00355	0.0018	0.00238	0.00355
Arsenic	3	0	--	--	--	0.003	0.00367	0.005	0.003	0.00367	0.005
Cadmium	3	0	--	--	--	0.00012	0.000158	0.000235	0.00012	0.000158	0.00024
Chromium	3	2	0.0003	0.0006	0.0009	0.00235	0.00235	0.00235	0.0003	0.00118	0.00235
Copper	3	2	0.0014	0.00145	0.0015	0.00235	0.00235	0.00235	0.0014	0.00175	0.00235
Lead	3	2	0.0007	0.0007	0.0007	0.0012	0.0012	0.0012	0.0007	0.000867	0.0012
Nickel	3	2	0.0003	0.00065	0.001	0.0012	0.0012	0.0012	0.0003	0.000833	0.0012
Zinc	3	1	0.0051	0.0051	0.0051	0.00115	0.0012	0.00125	0.00115	0.0025	0.0051

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13). Number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

AVS - acid volatile sulfide

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SEM - simultaneously extracted metals

Table 5-4. Field Porewater Summary Statistics

Analyte	Number of Results[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Alkalinity (mg/L)	81	81	54.8	130	384	--	--	--	54.8	130	384
DOC (mg/L)	84	24	10.2	18.9	57.4	0.815	2.67	4.68	0.815	7.32	57.4
Hardness as $CaCO_3$ (mg/L)	83	83	62.2	127	545	--	--	--	62.2	127	545
pH	82	82	7.17	7.89	9.19	--	--	--	7.17	7.89	9.19
Sulfate (mg/L)	82	82	0.39	9.78	104	--	--	--	0.39	9.78	104
Total chloride (mg/L)	82	3	12.6	20.6	30.1	0.25	1.21	5.15	0.25	1.92	30.1
TOC (mg/L)	84	38	9.82	17.2	47.9	1.13	2.61	4.62	1.13	9.19	47.9
Metals/Metalloids (µg/L)											
Aluminum	91	39	54.6	143	1040	1.05	10.8	25.95	1.05	67.6	1040
Antimony	91	84	0.14	3.74	29.8	0.041	0.0654	0.093	0.041	3.45	29.8
Arsenic	91	91	0.51	8.38	80.4	--	--	--	0.51	8.38	80.4
Barium	91	91	16.8	99.1	417	--	--	--	16.8	99.1	417
Beryllium	91	11	0.009	0.0211	0.07	0.003	0.00435	0.015	0.003	0.00637	0.07
Cadmium	91	63	0.007	0.244	1.21	0.0025	0.00859	0.0245	0.0025	0.171	1.21
Calcium	91	91	17400	39700	157000	--	--	--	17400	39700	157000
Chromium	91	80	0.11	0.312	1.74	0.01	0.0377	0.05	0.01	0.279	1.74
Cobalt	91	80	0.136	0.733	3.25	0.0255	0.0488	0.065	0.0255	0.65	3.25
Copper	91	63	0.75	13	126	0.05	0.145	0.345	0.05	9.04	126
Iron	91	90	35.1	2010	20100	13.35	13.4	13.35	13.35	1980	20100
Lead	91	84	0.066	6.85	101	0.0045	0.014	0.0245	0.0045	6.32	101
Magnesium	91	91	1130	7040	37400	--	--	--	1130	7040	37400
Manganese	91	90	5.06	2110	12800	1.455	1.46	1.455	1.455	2090	12800
Nickel	91	25	2.6	5.66	14.3	0.325	1.08	1.78	0.325	2.34	14.3
Potassium	91	91	655	1940	5430	--	--	--	655	1940	5430
Selenium	91	25	0.3	0.516	1.2	0.15	0.227	0.75	0.15	0.306	1.2
Silver	91	39	0.007	0.133	0.672	0.002	0.00503	0.027	0.002	0.06	0.672
Sodium	91	91	1710	3260	12500	--	--	--	1710	3260	12500
Thallium	91	19	0.03	0.0602	0.172	0.001	0.00625	0.027	0.001	0.0175	0.172
Vanadium	91	80	0.529	4.21	50.9	0.135	0.194	0.25	0.135	3.73	50.9
Zinc	91	1	540	540	540	3.95	40.5	205.5	3.95	45.9	540
Tributary and Upstream Samples											
Conventional Parameters											
Alkalinity (mg/L)	8	8	60.4	186	364	--	--	--	60.4	186	364
DOC (mg/L)	10	0	--	--	--	0.935	1.93	3.1	0.935	1.93	3.1
Hardness as $CaCO_3$ (mg/L)	10	10	34.5	159	292	--	--	--	34.5	159	292
pH	10	10	7.52	7.86	8.42	--	--	--	7.52	7.86	8.42
Sulfate (mg/L)	10	10	1.41	24.5	53.5	--	--	--	1.41	24.5	53.5
Total chloride (mg/L)	10	0	--	--	--	0.18	0.894	2.73	0.18	0.894	2.73
TOC (mg/L)	10	0	--	--	--	1.2	2.55	3.46	1.2	2.55	3.46

Table 5-4. Field Porewater Summary Statistics

Analyte	Number of Results[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Tributary and Upstream Samples (continued)											
Metals/Metalloids (µg/L)											
Aluminum	10	6	59.9	134	265	12.05	14.3	17.6	12.05	86	265
Antimony	10	9	0.163	0.692	2.41	0.083	0.083	0.083	0.083	0.631	2.41
Arsenic	10	10	0.52	1.51	2.83	--	--	--	0.52	1.51	2.83
Barium	10	10	27.1	59.9	114	--	--	--	27.1	59.9	114
Beryllium	10	1	0.014	0.014	0.014	0.003	0.00456	0.0095	0.003	0.0055	0.014
Cadmium	10	8	0.022	0.081	0.148	0.0085	0.0123	0.016	0.0085	0.0673	0.148
Calcium	10	10	17000	46200	77700	--	--	--	17000	46200	77700
Chromium	10	9	0.11	0.364	1	0.04	0.04	0.04	0.04	0.332	1
Cobalt	10	6	0.143	0.183	0.231	0.035	0.0506	0.0625	0.035	0.13	0.231
Copper	10	10	0.88	1.73	5.43	--	--	--	0.88	1.73	5.43
Iron	10	10	21.7	1270	11100	--	--	--	21.7	1270	11100
Lead	10	9	0.128	1.71	5.72	0.0285	0.0285	0.0285	0.0285	1.54	5.72
Magnesium	10	10	3100	11400	30100	--	--	--	3100	11400	30100
Manganese	10	8	4.24	161	859	1.135	1.43	1.725	1.135	129	859
Nickel	10	2	3.86	3.93	3.99	0.465	0.864	1.23	0.465	1.48	3.99
Potassium	10	10	991	2680	4240	--	--	--	991	2680	4240
Selenium	10	5	0.6	1.44	3.1	0.15	0.16	0.2	0.15	0.8	3.1
Silver	10	4	0.005	0.0165	0.034	0.002	0.00533	0.01	0.002	0.0098	0.034
Sodium	10	10	1070	4580	10800	--	--	--	1070	4580	10800
Thallium	10	0	--	--	--	0.001	0.00405	0.017	0.001	0.00405	0.017
Vanadium	10	10	0.77	7.19	16.9	--	--	--	0.77	7.19	16.9
Zinc	10	0	--	--	--	3.9	22.2	55	3.9	22.2	55

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include six tributary locations in the United States and four upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Sample volume was not sufficient to analyze for all parameters in all samples.

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

$CaCO_3$ - calcium carbonate

DOC - dissolved organic carbon

TOC - total orgranic carbon

Table 5-5a. Short-Term Bioassay Porewater Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at the Start of the Test

Analyte	Number of Results[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Alkalinity (mg/L)	59	59	114	219	770	--	--	--	114	219	770
DOC (mg/L)	59	59	1.57	7.8	37.6	--	--	--	1.57	7.8	37.6
Hardness as $CaCO_3$ (mg/L)	59	59	92.1	195	759	--	--	--	92.1	195	759
pH	59	59	7.08	7.84	9.11	--	--	--	7.08	7.84	9.11
Sulfate (mg/L)	59	59	0.45	12.9	63.6	--	--	--	0.45	12.9	63.6
Sulfide (mg/L)	33[c]	26	0.016	0.0653	0.157	0.006	0.006	0.006	0.006	0.0528	0.157
Total chloride (mg/L)	59	59	0.76	2.5	25.2	--	--	--	0.76	2.5	25.2
Metals/Metalloids (µg/L)											
Calcium	59	59	28100	58700	214000	--	--	--	28100	58700	214000
Magnesium	59	59	762	11800	54300	--	--	--	762	11800	54300
Potassium	59	59	882	2790	11700	--	--	--	882	2790	11700
Sodium	59	59	2020	4060	16200	--	--	--	2020	4060	16200
Tributary and Upstream Samples											
Conventional Parameters											
Alkalinity (mg/L)	19	19	63	260	514	--	--	--	63	260	514
DOC (mg/L)	19	19	1.3	7.66	40.3	--	--	--	1.3	7.66	40.3
Hardness as $CaCO_3$ (mg/L)	19	19	98.7	236	476	--	--	--	98.7	236	476
pH	19	19	7.27	7.93	8.27	--	--	--	7.27	7.93	8.27
Sulfate (mg/L)	19	19	0.69	16.2	76.7	--	--	--	0.69	16.2	76.7
Sulfide (mg/L)	16	13	0.013	0.0386	0.09	0.006	0.006	0.006	0.006	0.0325	0.09
Total chloride (mg/L)	19	19	0.43	1.39	6.11	--	--	--	0.43	1.39	6.11
Metals/Metalloids (µg/L)											
Calcium	19	19	27500	68100	142000	--	--	--	27500	68100	142000
Magnesium	19	19	6590	16100	41100	--	--	--	6590	16100	41100
Potassium	19	19	1410	3200	7610	--	--	--	1410	3200	7610
Sodium	19	19	1620	4170	14000	--	--	--	1620	4170	14000
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Alkalinity (mg/L)	7	7	197	226	260	--	--	--	197	226	260
DOC (mg/L)	7	7	4.96	6.76	9.95	--	--	--	4.96	6.76	9.95
Hardness as $CaCO_3$ (mg/L)	7	7	110	137	162	--	--	--	110	137	162
pH	7	7	8.21	8.34	8.44	--	--	--	8.21	8.34	8.44
Sulfate (mg/L)	7	7	118	134	164	--	--	--	118	134	164
Sulfide (mg/L)	7	5	0.014	0.0448	0.111	0.006	0.006	0.006	0.006	0.0337	0.111
Total chloride (mg/L)	7	7	100	144	295	--	--	--	100	144	295
Metals/Metalloids (µg/L)											
Calcium	7	7	16900	21500	26400	--	--	--	16900	21500	26400
Magnesium	7	7	16400	20200	24400	--	--	--	16400	20200	24400
Potassium	7	7	16600	19100	23200	--	--	--	16600	19100	23200
Sodium	7	7	142000	178000	273000	--	--	--	142000	178000	273000
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Conventional Parameters											
Alkalinity (mg/L)	14	14	35	118	287	--	--	--	35	118	287
DOC (mg/L)	14	14	0.95	8.32	17.7	--	--	--	0.95	8.32	17.7
Hardness as $CaCO_3$ (mg/L)	14	14	11.7	72.3	131	--	--	--	11.7	72.3	131
pH	14	14	6.55	7.44	8.4	--	--	--	6.55	7.44	8.4
Sulfate (mg/L)	14	14	0.29	13.7	32.6	--	--	--	0.29	13.7	32.6
Sulfide (mg/L)	8	1	0.083	0.083	0.083	0.006	0.006	0.006	0.006	0.0156	0.083
Total chloride (mg/L)	14	14	2.92	30.8	79.6	--	--	--	2.92	30.8	79.6
Metals/Metalloids (µg/L)											
Calcium	14	14	3000	21300	41200	--	--	--	3000	21300	41200
Magnesium	14	14	1010	4660	9310	--	--	--	1010	4660	9310
Potassium	14	14	772	2910	5400	--	--	--	772	2910	5400
Sodium	14	14	3530	10900	27100	--	--	--	3530	10900	27100

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of porewater results for Site samples from Day 1 of the bioassays is 59 instead of 53 because 2 of the samples (SE-4-B1 and SE-4-B5) were too sandy for the bioassay laboratory to obtain porewater and 2 results are available for 8 samples (SE-2-B2, SE-3-R9, SE-5-B2, SE-6-B1, SE-7-B4, SE-7-B5, SE-8-B1, and SE-REF-5) because they were included in the Batch 5 retest with *H. azteca* (see Section 4.4.1). The number of porewater results for tributary and upstream samples was 19 instead of 16 because 1 of the samples (SE-G-2) was too sandy for the bioassay laboratory to obtain porewater, 2 results are available for one sample (SE-LAL-6) because it was included in different batches for *C. dilutus* and *H. azteca,* and 2 results are available for 3 samples (SE-G-2, SE-LAL-5, and SE-TRIB-3) because they were included in the Batch 5 retest with *H. azteca*.

[b] Calculated with nondetected results at one-half of the detection limit.

[c] Number of results is less than for other analytes because some of the sulfide data were rejected (see Section 4.3.4.3).

-- no value

$CaCO_3$ - calcium carbonate

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

DOC - dissolved organic carbon

Table 5-5b. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 7 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Aluminum	53	32	13.9	29.5	116	3.1	7.63	19.5	3.1	20.9	116
Antimony	53	30	0.13	3	35.2	0.015	0.0422	0.085	0.015	1.72	35.2
Arsenic	53	53	0.38	29	104	--	--	--	0.38	29	104
Barium	53	53	47.2	182	1080	--	--	--	47.2	182	1080
Beryllium	53	0	--	--	--	0.009	0.00901	0.0095	0.009	0.00901	0.0095
Cadmium	53	9	0.075	0.263	0.563	0.0055	0.0116	0.043	0.0055	0.0543	0.563
Chromium	53	37	0.05	0.133	0.33	0.02	0.0388	0.105	0.02	0.105	0.33
Cobalt	53	53	0.063	0.756	4.78	--	--	--	0.063	0.756	4.78
Copper	53	37	0.13	1.36	7.21	0.055	0.179	0.35	0.055	1.01	7.21
Iron	53	53	8.7	5570	40400	--	--	--	8.7	5570	40400
Lead	53	52	0.103	1.05	8.09	0.0495	0.0495	0.0495	0.0495	1.03	8.09
Manganese	53	53	2.25	2620	9260	--	--	--	2.25	2620	9260
Nickel	53	53	0.2	0.767	2.55	--	--	--	0.2	0.767	2.55
Selenium	53	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	53	0	--	--	--	0.0055	0.00558	0.0085	0.0055	0.00558	0.0085
Thallium	53	11	0.026	0.168	0.359	0.002	0.0102	0.0585	0.002	0.0429	0.359
Vanadium	53	49	0.127	0.427	1.2	0.055	0.0564	0.058	0.055	0.399	1.2
Zinc	53	29	3.28	26.2	208	0.445	1.3	3.76	0.445	14.9	208
Tributary and Upstream Samples											
Aluminum	16	6	14.2	22.2	35.1	2.3	4.69	7.75	2.3	11.2	35.1
Antimony	16	5	0.12	0.382	0.66	0.01	0.0423	0.09	0.01	0.148	0.66
Arsenic	16	15	0.47	7.54	31.9	0.055	0.055	0.055	0.055	7.07	31.9
Barium	16	16	29.5	81.6	179	--	--	--	29.5	81.6	179
Beryllium	16	1	0.023	0.023	0.023	0.009	0.00903	0.0095	0.009	0.00991	0.023
Cadmium	16	0	--	--	--	0.0055	0.00788	0.0255	0.0055	0.00788	0.0255
Chromium	16	13	0.05	0.149	0.31	0.025	0.0317	0.045	0.025	0.127	0.31
Cobalt	16	16	0.017	0.503	2.03	--	--	--	0.017	0.503	2.03
Copper	16	8	0.16	0.218	0.29	0.055	0.0956	0.14	0.055	0.157	0.29
Iron	16	15	98.5	2320	11100	1.35	1.35	1.35	1.35	2170	11100
Lead	16	10	0.079	0.171	0.336	0.014	0.0418	0.0665	0.014	0.123	0.336
Manganese	16	16	142	1400	4230	--	--	--	142	1400	4230
Nickel	16	16	0.11	0.953	2.77	--	--	--	0.11	0.953	2.77
Selenium	16	3	1.2	2.03	3.4	0.45	0.45	0.45	0.45	0.747	3.4
Silver	16	0	--	--	--	0.0055	0.00553	0.006	0.0055	0.00553	0.006
Thallium	16	0	--	--	--	0.002	0.003	0.0085	0.002	0.003	0.0085
Vanadium	16	11	0.125	0.465	1.5	0.056	0.056	0.056	0.056	0.337	1.5
Zinc	16	1	4.44	4.44	4.44	0.44	1.18	2.3	0.44	1.38	4.44
Negative Control Samples (CTL-SS)											
Aluminum	6	5	12.6	21	42.6	4.95	4.95	4.95	4.95	18.3	42.6
Antimony	6	6	0.32	0.44	0.51	--	--	--	0.32	0.44	0.51
Arsenic	6	6	4.86	6.2	9.11	--	--	--	4.86	6.2	9.11
Barium	6	5	1.4	1.7	1.9	0.84	0.84	0.84	0.84	1.56	1.9
Beryllium	6	0	--	--	--	0.009	0.009	0.009	0.009	0.009	0.009
Cadmium	6	0	--	--	--	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
Chromium	6	5	0.06	0.08	0.1	0.105	0.105	0.105	0.06	0.0842	0.105
Cobalt	6	6	0.233	0.283	0.324	--	--	--	0.233	0.283	0.324
Copper	6	4	0.51	0.768	1.24	0.205	0.22	0.235	0.205	0.585	1.24
Iron	6	6	22.2	60.3	173	--	--	--	22.2	60.3	173
Lead	6	3	0.074	0.127	0.186	0.046	0.0493	0.054	0.046	0.0882	0.186
Manganese	6	6	191	244	336	--	--	--	191	244	336
Nickel	6	6	0.65	0.792	0.88	--	--	--	0.65	0.792	0.88
Selenium	6	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	6	0	--	--	--	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
Thallium	6	0	--	--	--	0.002	0.00208	0.0025	0.002	0.00208	0.0025
Vanadium	6	6	3.04	4.54	6.12	--	--	--	3.04	4.54	6.12
Zinc	6	0	--	--	--	0.44	0.779	1.05	0.44	0.779	1.05

Table 5-5b. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 7 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Aluminum	12	3	13	45.8	107	3.2	4.83	8.2	3.2	15.1	107
Antimony	12	0	--	--	--	0.015	0.0321	0.085	0.015	0.0321	0.085
Arsenic	12	12	0.17	9.52	25.6	--	--	--	0.17	9.52	25.6
Barium	12	12	2.92	190	547	--	--	--	2.92	190	547
Beryllium	12	7	0.025	0.0311	0.047	0.009	0.009	0.009	0.009	0.0219	0.047
Cadmium	12	0	--	--	--	0.0055	0.00708	0.0125	0.0055	0.00708	0.0125
Chromium	12	6	0.09	0.242	0.37	0.02	0.0442	0.145	0.02	0.143	0.37
Cobalt	12	12	0.172	3.35	8.32	--	--	--	0.172	3.35	8.32
Copper	12	7	0.12	0.36	0.87	0.105	0.148	0.23	0.105	0.272	0.87
Iron	12	9	14.5	22600	51800	1.65	2.25	2.85	1.65	16900	51800
Lead	12	2	0.082	0.148	0.214	0.003	0.0238	0.038	0.003	0.0445	0.214
Manganese	12	12	3.62	4150	11800	--	--	--	3.62	4150	11800
Nickel	12	12	0.65	1.05	1.56	--	--	--	0.65	1.05	1.56
Selenium	12	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	12	0	--	--	--	0.0055	0.00742	0.0285	0.0055	0.00742	0.0285
Thallium	12	0	--	--	--	0.002	0.00617	0.0185	0.002	0.00617	0.0185
Vanadium	12	6	0.938	1.06	1.5	0.0555	0.0566	0.0575	0.0555	0.558	1.5
Zinc	12	2	3.27	4.16	5.04	0.69	1.08	1.52	0.69	1.59	5.04

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-5c. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 7 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Aluminum	53	22	8.9	22.4	72.8	1.85	10.5	32.4	1.85	15.5	72.8
Antimony	53	23	0.16	2.95	16.9	0.014	0.04	0.1285	0.014	1.3	16.9
Arsenic	53	53	0.18	34.3	139	--	--	--	0.18	34.3	139
Barium	53	53	36.9	209	1100	--	--	--	36.9	209	1100
Beryllium	53	1	0.031	0.031	0.031	0.0065	0.00866	0.0095	0.0065	0.00908	0.031
Cadmium	53	18	0.012	0.159	0.725	0.0055	0.0119	0.047	0.0055	0.062	0.725
Chromium	53	25	0.05	0.271	3.36	0.02	0.0498	0.14	0.02	0.154	3.36
Cobalt	53	50	0.03	0.898	4.59	0.0065	0.0245	0.0405	0.0065	0.849	4.59
Copper	53	23	0.13	1.61	5.48	0.055	0.119	0.27	0.055	0.767	5.48
Iron	53	53	5.3	6540	45800	--	--	--	5.3	6540	45800
Lead	53	49	0.079	0.881	5.62	0.027	0.0439	0.0595	0.027	0.818	5.62
Manganese	53	53	2.7	3170	11800	--	--	--	2.7	3170	11800
Nickel	53	44	0.15	0.755	2.63	0.155	0.462	0.66	0.15	0.705	2.63
Selenium	53	0	--	--	--	0.45	0.47	0.58	0.45	0.47	0.58
Silver	53	3	0.008	0.0127	0.018	0.0035	0.00521	0.006	0.0035	0.00563	0.018
Thallium	53	13	0.04	0.168	0.378	0.002	0.00933	0.0585	0.002	0.0482	0.378
Vanadium	53	46	0.148	0.409	1.19	0.035	0.0533	0.0575	0.035	0.362	1.19
Zinc	53	28	2.1	27.3	192	0.45	1.24	3.445	0.45	15	192
Tributary and Upstream Samples											
Aluminum	16	4	12.7	22.6	34.2	1.75	5.19	13.2	1.75	9.53	34.2
Antimony	16	5	0.15	0.384	0.61	0.0125	0.036	0.07	0.0125	0.145	0.61
Arsenic	16	16	0.21	7.36	33.7	--	--	--	0.21	7.36	33.7
Barium	16	16	50.1	95.3	195	--	--	--	50.1	95.3	195
Beryllium	16	1	0.025	0.025	0.025	0.007	0.00873	0.011	0.007	0.00975	0.025
Cadmium	16	5	0.021	0.0628	0.179	0.0055	0.00609	0.009	0.0055	0.0238	0.179
Chromium	16	7	0.07	0.199	0.42	0.02	0.0389	0.065	0.02	0.109	0.42
Cobalt	16	16	0.029	0.568	3.2	--	--	--	0.029	0.568	3.2
Copper	16	4	0.12	0.245	0.43	0.04	0.0958	0.205	0.04	0.133	0.43
Iron	16	15	5.9	3220	14700	1.5	1.5	1.5	1.5	3010	14700
Lead	16	9	0.097	0.178	0.247	0.0115	0.032	0.059	0.0115	0.114	0.247
Manganese	16	16	300	1510	4870	--	--	--	300	1510	4870
Nickel	16	14	0.1	1.17	3.83	1.165	1.18	1.185	0.1	1.17	3.83
Selenium	16	3	1.2	1.83	2.9	0.45	0.485	0.57	0.45	0.738	2.9
Silver	16	1	0.045	0.045	0.045	0.0035	0.0052	0.007	0.0035	0.00769	0.045
Thallium	16	0	--	--	--	0.002	0.00406	0.0165	0.002	0.00406	0.0165
Vanadium	16	15	0.08	0.369	1.73	0.057	0.057	0.057	0.057	0.349	1.73
Zinc	16	3	2.59	3.59	4.54	0.365	1.1	3.095	0.365	1.57	4.54
Negative Control Samples (CTL-SS)											
Aluminum	5	2	16.6	19.1	21.5	5.9	8.22	12.7	5.9	12.6	21.5
Antimony	5	5	0.33	0.42	0.5	--	--	--	0.33	0.42	0.5
Arsenic	5	5	4.86	5.34	6.19	--	--	--	4.86	5.34	6.19
Barium	5	5	1.21	1.77	2.04	--	--	--	1.21	1.77	2.04
Beryllium	5	0	--	--	--	0.009	0.009	0.009	0.009	0.009	0.009
Cadmium	5	0	--	--	--	0.0055	0.006	0.008	0.0055	0.006	0.008
Chromium	5	3	0.06	0.08	0.11	0.04	0.0525	0.065	0.04	0.069	0.11
Cobalt	5	5	0.265	0.294	0.307	--	--	--	0.265	0.294	0.307
Copper	5	4	0.38	0.548	0.65	0.295	0.295	0.295	0.295	0.497	0.65
Iron	5	5	19.9	49.3	66.8	--	--	--	19.9	49.3	66.8
Lead	5	2	0.117	0.169	0.22	0.035	0.0517	0.067	0.035	0.0984	0.22
Manganese	5	5	211	240	290	--	--	--	211	240	290
Nickel	5	5	0.71	0.756	0.82	--	--	--	0.71	0.756	0.82
Selenium	5	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	5	0	--	--	--	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
Thallium	5	0	--	--	--	0.002	0.002	0.002	0.002	0.002	0.002
Vanadium	5	5	2.36	3.78	5.8	--	--	--	2.36	3.78	5.8
Zinc	5	0	--	--	--	0.485	0.947	1.535	0.485	0.947	1.535

Table 5-5c. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 7 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Aluminum	12	3	9.5	19	33	3	4.8	7.3	3	8.34	33
Antimony	12	0	--	--	--	0.015	0.0283	0.055	0.015	0.0283	0.055
Arsenic	12	12	0.18	14.5	48.1	--	--	--	0.18	14.5	48.1
Barium	12	12	3.81	262	713	--	--	--	3.81	262	713
Beryllium	12	6	0.027	0.0337	0.042	0.007	0.00867	0.009	0.007	0.0212	0.042
Cadmium	12	3	0.014	0.0223	0.028	0.0055	0.00794	0.0155	0.0055	0.0115	0.028
Chromium	12	4	0.26	0.295	0.33	0.02	0.0544	0.145	0.02	0.135	0.33
Cobalt	12	12	0.143	4.94	19.1	--	--	--	0.143	4.94	19.1
Copper	12	6	0.11	0.535	0.76	0.055	0.101	0.145	0.055	0.318	0.76
Iron	12	10	0.9	25700	78800	1.4	1.63	1.85	0.9	21400	78800
Lead	12	2	0.086	0.101	0.115	0.0085	0.0266	0.057	0.0085	0.0389	0.115
Manganese	12	12	3.52	5180	19100	--	--	--	3.52	5180	19100
Nickel	12	12	0.64	1.77	5.32	--	--	--	0.64	1.77	5.32
Selenium	12	0	--	--	--	0.45	0.47	0.57	0.45	0.47	0.57
Silver	12	0	--	--	--	0.0035	0.00517	0.0055	0.0035	0.00517	0.0055
Thallium	12	0	--	--	--	0.002	0.00704	0.0125	0.002	0.00704	0.0125
Vanadium	12	6	0.982	1.21	1.45	0.035	0.0525	0.057	0.035	0.633	1.45
Zinc	12	1	6.04	6.04	6.04	0.495	1.26	2.735	0.495	1.66	6.04

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-5d. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 21 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Site Samples											
Aluminum	53	46	3.7	14.2	35.8	1.3	3.56	6.15	1.3	12.8	35.8
Antimony	53	26	0.04	1.66	8.57	0.01	0.0383	0.1	0.01	0.833	8.57
Arsenic	53	53	0.68	38.6	190	--	--	--	0.68	38.6	190
Barium	53	53	89.2	250	1210	--	--	--	89.2	250	1210
Beryllium	53	7	0.02	0.028	0.047	0.009	0.00901	0.0095	0.009	0.0115	0.047
Cadmium	53	14	0.016	0.0875	0.274	0.0055	0.00928	0.0365	0.0055	0.0299	0.274
Chromium	53	36	0.05	0.166	0.4	0.02	0.0338	0.105	0.02	0.124	0.4
Cobalt	53	53	0.111	0.701	2.89	--	--	--	0.111	0.701	2.89
Copper	53	33	0.07	1.16	6.07	0.035	0.129	0.29	0.035	0.771	6.07
Iron	53	53	13.7	7740	43500	--	--	--	13.7	7740	43500
Lead	53	51	0.058	1.21	9.71	0.048	0.051	0.054	0.048	1.16	9.71
Manganese	53	53	2.31	3800	13900	--	--	--	2.31	3800	13900
Nickel	53	50	0.17	0.759	2.48	0.175	0.202	0.25	0.17	0.728	2.48
Selenium	53	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	53	0	--	--	--	0.0045	0.00553	0.0125	0.0045	0.00553	0.0125
Thallium	53	15	0.041	0.174	0.484	0.002	0.00459	0.0195	0.002	0.0524	0.484
Vanadium	53	47	0.13	0.684	1.44	0.0555	0.0568	0.06	0.0555	0.613	1.44
Zinc	53	14	2.2	29.8	95.4	0.2	2.93	12	0.2	10	95.4
Tributary and Upstream Samples											
Aluminum	16	11	4.1	10.7	28.2	2.5	3.32	4.2	2.5	8.42	28.2
Antimony	16	7	0.04	0.224	0.47	0.03	0.045	0.055	0.03	0.123	0.47
Arsenic	16	16	0.61	9.91	46	--	--	--	0.61	9.91	46
Barium	16	16	65.1	126	244	--	--	--	65.1	126	244
Beryllium	16	1	0.03	0.03	0.03	0.009	0.009	0.009	0.009	0.0103	0.03
Cadmium	16	1	0.016	0.016	0.016	0.0055	0.00563	0.0075	0.0055	0.00628	0.016
Chromium	16	10	0.05	0.22	0.52	0.02	0.0383	0.075	0.02	0.152	0.52
Cobalt	16	14	0.025	0.601	2.3	0.0065	0.0268	0.047	0.0065	0.529	2.3
Copper	16	7	0.07	0.133	0.22	0.035	0.0894	0.14	0.035	0.108	0.22
Iron	16	16	138	4250	19900	--	--	--	138	4250	19900
Lead	16	7	0.057	0.163	0.407	0.0145	0.0286	0.04	0.0145	0.0876	0.407
Manganese	16	16	335	2350	8170	--	--	--	335	2350	8170
Nickel	16	16	0.13	1.13	3.15	--	--	--	0.13	1.13	3.15
Selenium	16	3	1.1	1.47	1.9	0.45	0.45	0.45	0.45	0.641	1.9
Silver	16	0	--	--	--	0.0045	0.00531	0.0055	0.0045	0.00531	0.0055
Thallium	16	0	--	--	--	0.002	0.00303	0.012	0.002	0.00303	0.012
Vanadium	16	12	0.134	0.738	3.64	0.0555	0.056	0.057	0.0555	0.568	3.64
Zinc	16	1	4.6	4.6	4.6	0.3	1.44	3.34	0.3	1.63	4.6
Negative Control Samples (CTL-SS)											
Aluminum	6	4	4.2	6.2	7.6	3.25	3.88	4.5	3.25	5.43	7.6
Antimony	6	5	0.22	0.406	0.5	0.075	0.075	0.075	0.075	0.351	0.5
Arsenic	6	6	7.29	9.75	12.2	--	--	--	7.29	9.75	12.2
Barium	6	5	1.48	2.17	2.59	1.385	1.39	1.385	1.385	2.04	2.59
Beryllium	6	0	--	--	--	0.009	0.009	0.009	0.009	0.009	0.009
Cadmium	6	0	--	--	--	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
Chromium	6	4	0.07	0.085	0.11	0.025	0.045	0.065	0.025	0.0717	0.11
Cobalt	6	6	0.342	0.382	0.46	--	--	--	0.342	0.382	0.46
Copper	6	4	0.3	0.483	0.9	0.195	0.198	0.2	0.195	0.388	0.9
Iron	6	6	46.9	124	248	--	--	--	46.9	124	248
Lead	6	4	0.113	0.196	0.28	0.0425	0.0708	0.099	0.0425	0.154	0.28
Manganese	6	6	292	414	532	--	--	--	292	414	532
Nickel	6	6	0.88	1.28	2.51	--	--	--	0.88	1.28	2.51
Selenium	6	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	6	0	--	--	--	0.0045	0.00533	0.0055	0.0045	0.00533	0.0055
Thallium	6	0				0.002	0.00217	0.0025	0.002	0.00217	0.0025
Vanadium	6	6	1.39	1.84	3.29	--	--	--	1.39	1.84	3.29
Zinc	6	0	--	--	--	0.42	1.37	2.835	0.42	1.37	2.835

Table 5-5d. Short-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 21 (µg/L)

Analyte	Number of Samples	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[a]	Mean Nondetected Value[a]	Maximum Nondetected Value[a]	Overall Minimum Value[a]	Overall Mean Value[a]	Overall Maximum Value[a]
Auxiliary Control Samples (CTL-QS and CTL-ERDC)											
Aluminum	12	11	7.4	12	34.2	5.5	5.5	5.5	5.5	11.5	34.2
Antimony	12	4	0.03	0.145	0.23	0.015	0.0419	0.095	0.015	0.0763	0.23
Arsenic	12	12	0.44	20.2	61.2	--	--	--	0.44	20.2	61.2
Barium	12	12	5.97	231	559	--	--	--	5.97	231	559
Beryllium	12	6	0.039	0.053	0.082	0.009	0.009	0.009	0.009	0.031	0.082
Cadmium	12	0	--	--	--	0.0055	0.00567	0.0075	0.0055	0.00567	0.0075
Chromium	12	6	0.36	0.437	0.54	0.025	0.025	0.025	0.025	0.231	0.54
Cobalt	12	12	0.098	4.7	17.4	--	--	--	0.098	4.7	17.4
Copper	12	7	0.1	0.187	0.48	0.085	0.133	0.265	0.085	0.165	0.48
Iron	12	12	43.5	27500	80100	--	--	--	43.5	27500	80100
Lead	12	5	0.069	0.117	0.161	0.0135	0.0256	0.049	0.0135	0.0637	0.161
Manganese	12	12	10.4	6520	18300	--	--	--	10.4	6520	18300
Nickel	12	12	0.33	1.38	4.15	--	--	--	0.33	1.38	4.15
Selenium	12	0	--	--	--	0.45	0.45	0.45	0.45	0.45	0.45
Silver	12	0	--	--	--	0.0045	0.00679	0.023	0.0045	0.00679	0.023
Thallium	12	0	--	--	--	0.002	0.00371	0.013	0.002	0.00371	0.013
Vanadium	12	6	1.76	2.24	3	0.056	0.0568	0.06	0.056	1.15	3
Zinc	12	0	--	--	--	0.485	1.68	3.78	0.485	1.68	3.78

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include 6 tributary locations in the United States and 10 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-6a. Long-Term Bioassay Porewater Summary Statistics for *Chironomus dilutus* and *Hyalella azteca* at the Start of the Test

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Conventional Parameters											
Alkalinity (mg/L)	18	18	120	254	629	--	--	--	120	254	629
DOC (mg/L)	18	18	1.28	7.26	24.5	--	--	--	1.28	7.26	24.5
Hardness as $CaCO_3$ (mg/L)	18	18	43.5	217	600	--	--	--	43.5	217	600
pH	18	18	6.78	7.75	9.17	--	--	--	6.78	7.75	9.17
Sulfate (mg/L)	18	18	0.46	17.1	58.7	--	--	--	0.46	17.1	58.7
Sulfide (mg/L)	17[c]	14	0.01	0.0436	0.13	0.01	0.01	0.01	0.01	0.0376	0.13
Total chloride (mg/L)	18	18	0.73	4.58	24.9	--	--	--	0.73	4.58	24.9
Metals/Metalloids (µg/L)											
Calcium	18	18	12900	64300	183000	--	--	--	12900	64300	183000
Magnesium	18	18	2140	13700	34500	--	--	--	2140	13700	34500
Potassium	18	18	351	3450	12800	--	--	--	351	3450	12800
Sodium	18	18	976	6890	19500	--	--	--	976	6890	19500
Upstream Samples											
Conventional Parameters											
Alkalinity (mg/L)	6	6	73	235	403	--	--	--	73	235	403
DOC (mg/L)	6	6	1.16	3.58	6.95	--	--	--	1.16	3.58	6.95
Hardness as $CaCO_3$ (mg/L)	6	6	103	228	359	--	--	--	103	228	359
pH	6	6	7.16	7.56	7.94	--	--	--	7.16	7.56	7.94
Sulfate (mg/L)	6	6	1.08	18	40.7	--	--	--	1.08	18	40.7
Sulfide (mg/L)	5[c]	2	0.02	0.065	0.11	0.01	0.01	0.01	0.01	0.032	0.11
Total chloride (mg/L)	6	6	0.35	0.557	0.75	--	--	--	0.35	0.557	0.75
Metals/Metalloids (µg/L)											
Calcium	6	6	31200	70200	111000	--	--	--	31200	70200	111000
Magnesium	6	6	6080	12700	20100	--	--	--	6080	12700	20100
Potassium	6	6	1660	2150	3420	--	--	--	1660	2150	3420
Sodium	6	6	1910	2500	4110	--	--	--	1910	2500	4110
Negative Control Samples (CTL-SS)											
Conventional Parameters											
Alkalinity (mg/L)	1	1	288	288	288	--	--	--	288	288	288
DOC (mg/L)	1	1	5.59	5.59	5.59	--	--	--	5.59	5.59	5.59
Hardness as $CaCO_3$ (mg/L)	1	1	276	276	276	--	--	--	276	276	276
pH	1	1	8.18	8.18	8.18	--	--	--	8.18	8.18	8.18
Sulfate (mg/L)	1	1	258	258	258	--	--	--	258	258	258
Sulfide (mg/L)	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Total chloride (mg/L)	1	1	403	403	403	--	--	--	403	403	403
Metals/Metalloids (µg/L)											
Calcium	1	1	41800	41800	41800	--	--	--	41800	41800	41800
Magnesium	1	1	41600	41600	41600	--	--	--	41600	41600	41600
Potassium	1	1	26500	26500	26500	--	--	--	26500	26500	26500
Sodium	1	1	405000	405000	405000	--	--	--	405000	405000	405000
Auxiliary Control Samples (CTL-QS)											
Conventional Parameters											
Alkalinity (mg/L)	1	1	40	40	40	--	--	--	40	40	40
DOC (mg/L)	1	1	5.26	5.26	5.26	--	--	--	5.26	5.26	5.26
Hardness as $CaCO_3$ (mg/L)	1	1	94.3	94.3	94.3	--	--	--	94.3	94.3	94.3
pH	1	1	7.83	7.83	7.83	--	--	--	7.83	7.83	7.83
Sulfate (mg/L)	1	1	25.8	25.8	25.8	--	--	--	25.8	25.8	25.8
Sulfide (mg/L)	1	0	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01
Total chloride (mg/L)	1	1	56.6	56.6	56.6	--	--	--	56.6	56.6	56.6
Metals/Metalloids (µg/L)											
Calcium	1	1	28200	28200	28200	--	--	--	28200	28200	28200
Magnesium	1	1	5800	5800	5800	--	--	--	5800	5800	5800
Potassium	1	1	1540	1540	1540	--	--	--	1540	1540	1540
Sodium	1	1	19900	19900	19900	--	--	--	19900	19900	19900

Notes:

Results for site samples include results for potential reference samples.

Results for upstream samples include 6 upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 18 instead of 20 because porewater could not be collected for 2 locations (4-B1 and 4-B5) at the start of the test because samples consisted primarily of sand. The number of results for tributary and upstream samples is 6 instead of 7 because porewater could not be collected for the tributaroy location (TRIB-3) at the start of the test because sample consisted primarily of sand.

[b] Calculated with nondetected results at one-half of the detection limit.

[c] Number of results is less than for other analytes because some of the sulfide data were rejected (see Section 4.3.6.3).

-- no value

$CaCO_3$ - calcium carbonate

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

DOC - dissolved organic carbon

Table 5-6b. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 7 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Aluminum	22	6	8.3	22.3	56.3	1.2	3.28	4.85	1.2	8.45	56.3
Antimony	22	11	0.52	14.4	90.5	0.015	0.04	0.135	0.015	7.23	90.5
Arsenic	22	22	0.16	30.9	88.7	--	--	--	0.16	30.9	88.7
Barium	22	22	46.6	204	1110	--	--	--	46.6	204	1110
Beryllium	22	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	22	8	0.02	0.28	1.72	0.02	0.02	0.02	0.02	0.115	1.72
Chromium	22	14	0.05	0.0936	0.17	0.22	0.227	0.235	0.05	0.142	0.235
Cobalt	22	22	0.01	0.918	2.32	--	--	--	0.01	0.918	2.32
Copper	22	10	0.48	2.95	6.1	0.04	0.0729	0.14	0.04	1.38	6.1
Iron	22	21	5.2	5930	28500	1.95	1.95	1.95	1.95	5660	28500
Lead	22	19	0.06	0.421	1.71	0.02	0.0367	0.045	0.02	0.368	1.71
Manganese	22	22	10.8	2430	7160	--	--	--	10.8	2430	7160
Nickel	22	22	0.2	0.903	2.33	--	--	--	0.2	0.903	2.33
Selenium	22	0	--	--	--	1.1	1.15	1.15	1.1	1.15	1.15
Silver	22	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	22	8	0.009	0.0786	0.4	0.003	0.0146	0.025	0.003	0.0379	0.4
Vanadium	22	17	0.13	0.368	0.71	0.07	0.195	0.23	0.07	0.328	0.71
Zinc	22	8	7.5	41.6	73.5	0.23	0.845	1.845	0.23	15.6	73.5
Tributary and Upstream Samples											
Aluminum	17	5	7.6	11.8	16.3	1.15	2.63	5.1	1.15	5.34	16.3
Antimony	17	0	--	--	--	0.015	0.0574	0.18	0.015	0.0574	0.18
Arsenic	17	16	0.18	5.33	15.4	0.57	0.57	0.57	0.18	5.05	15.4
Barium	17	17	41.7	87.3	148	--	--	--	41.7	87.3	148
Beryllium	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	17	6	0.01	0.0467	0.14	0.02	0.02	0.02	0.01	0.0294	0.14
Chromium	17	12	0.06	0.153	0.8	0.22	0.227	0.23	0.06	0.174	0.8
Cobalt	17	16	0.01	0.967	3.36	0.02	0.02	0.02	0.01	0.911	3.36
Copper	17	3	0.36	0.553	0.78	0.045	0.105	0.205	0.045	0.184	0.78
Iron	17	13	11.5	2950	10100	0.75	1.63	2.8	0.75	2260	10100
Lead	17	9	0.05	0.143	0.26	0.005	0.0194	0.04	0.005	0.085	0.26
Manganese	17	17	3.54	2340	8890	--	--	--	3.54	2340	8890
Nickel	17	16	0.24	1.55	4.07	0.23	0.23	0.23	0.23	1.47	4.07
Selenium	17	0	--	--	--	1.1	1.15	1.15	1.1	1.15	1.15
Silver	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	17	3	0.006	0.00867	0.01	0.0035	0.0138	0.02	0.0035	0.0129	0.02
Vanadium	17	8	0.14	0.426	0.83	0.22	0.229	0.23	0.14	0.322	0.83
Zinc	17	1	8.93	8.93	8.93	0.19	1.03	2.37	0.19	1.5	8.93
Negative Control Samples (CTL-SS)											
Aluminum	3	0	--	--	--	1.55	2.3	3.55	1.55	2.3	3.55
Antimony	3	1	0.38	0.38	0.38	0.11	0.123	0.135	0.11	0.208	0.38
Arsenic	3	3	8.84	9.39	9.94	--	--	--	8.84	9.39	9.94
Barium	3	3	1.74	2.41	2.87	--	--	--	1.74	2.41	2.87
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	1	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.0167	0.02
Chromium	3	2	0.06	0.075	0.09	0.23	0.23	0.23	0.06	0.127	0.23
Cobalt	3	3	0.3	0.447	0.52	--	--	--	0.3	0.447	0.52
Copper	3	0	--	--	--	0.165	0.183	0.215	0.165	0.183	0.215
Iron	3	3	101	127	149	--	--	--	101	127	149
Lead	3	1	0.07	0.07	0.07	0.035	0.04	0.045	0.035	0.05	0.07
Manganese	3	3	303	457	603	--	--	--	303	457	603
Nickel	3	3	0.93	1.08	1.15	--	--	--	0.93	1.08	1.15
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	3	1.38	1.93	2.66	--	--	--	1.38	1.93	2.66
Zinc	3	0	--	--	--	0.35	0.368	0.38	0.35	0.368	0.38

Table 5-6b. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 7 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Auxiliary Control Samples (CTL-QS)											
Aluminum	3	0	--	--	--	2.15	2.72	3.05	2.15	2.72	3.05
Antimony	3	0	--	--	--	0.07	0.0833	0.095	0.07	0.0833	0.095
Arsenic	3	3	0.16	0.273	0.41	--	--	--	0.16	0.273	0.41
Barium	3	3	5.38	6.31	7.34	--	--	--	5.38	6.31	7.34
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	2	0.03	0.035	0.04	0.02	0.02	0.02	0.02	0.03	0.04
Chromium	3	0	--	--	--	0.225	0.228	0.23	0.225	0.228	0.23
Cobalt	3	3	0.5	0.69	0.92	--	--	--	0.5	0.69	0.92
Copper	3	0	--	--	--	0.105	0.162	0.19	0.105	0.162	0.19
Iron	3	3	25.7	92.3	199	--	--	--	25.7	92.3	199
Lead	3	1	0.05	0.05	0.05	0.01	0.015	0.02	0.01	0.0267	0.05
Manganese	3	3	20.6	29.6	40.2	--	--	--	20.6	29.6	40.2
Nickel	3	3	1.54	1.96	2.61	--	--	--	1.54	1.96	2.61
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	2	0.009	0.0195	0.03	0.01	0.01	0.01	0.009	0.0163	0.03
Vanadium	3	0	--	--	--	0.225	0.228	0.23	0.225	0.228	0.23
Zinc	3	0	--	--	--	1.155	1.74	2.225	1.155	1.74	2.225

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13).
The number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-6c. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 7 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Aluminum	22	6	9.4	16.9	41.2	1.95	2.71	4	1.95	6.59	41.2
Antimony	22	11	0.42	14.6	64.1	0.015	0.0345	0.11	0.015	7.31	64.1
Arsenic	22	22	0.26	31	89	--	--	--	0.26	31	89
Barium	22	22	43.2	208	1030	--	--	--	43.2	208	1030
Beryllium	22	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	22	8	0.03	0.359	2.17	0.005	0.0239	0.045	0.005	0.146	2.17
Chromium	22	11	0.06	0.109	0.24	0.22	0.228	0.23	0.06	0.168	0.24
Cobalt	22	22	0.02	0.948	2.35	--	--	--	0.02	0.948	2.35
Copper	22	9	0.53	3.23	4.7	0.04	0.0769	0.17	0.04	1.37	4.7
Iron	22	19	5.3	6750	28700	1.1	1.42	1.6	1.1	5830	28700
Lead	22	18	0.04	0.448	1.92	0.025	0.0363	0.055	0.025	0.373	1.92
Manganese	22	22	8.16	2680	8460	--	--	--	8.16	2680	8460
Nickel	22	22	0.19	0.935	2.19	--	--	--	0.19	0.935	2.19
Selenium	22	0	--	--	--	1.1	1.14	1.15	1.1	1.14	1.15
Silver	22	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	22	4	0.02	0.13	0.37	0.0035	0.0151	0.025	0.0035	0.036	0.37
Vanadium	22	17	0.13	0.316	0.73	0.22	0.226	0.23	0.13	0.295	0.73
Zinc	22	8	10.6	56	126	0.24	1.1	3.205	0.24	21.1	126
Tributary and Upstream Samples											
Aluminum	17	4	10.2	11.7	14	1.3	2.08	3.6	1.3	4.35	14
Antimony	17	1	0.38	0.38	0.38	0.01	0.0456	0.155	0.01	0.0653	0.38
Arsenic	17	15	0.42	5.27	14.4	0.57	0.57	0.57	0.42	4.72	14.4
Barium	17	17	39.7	93.6	168	--	--	--	39.7	93.6	168
Beryllium	17	0	--	--	--	0.02	0.0203	0.025	0.02	0.0203	0.025
Cadmium	17	5	0.01	0.032	0.06	0.015	0.0283	0.045	0.01	0.0294	0.06
Chromium	17	11	0.06	0.0827	0.11	0.22	0.229	0.235	0.06	0.134	0.235
Cobalt	17	15	0.02	0.981	3.08	0.02	0.02	0.02	0.02	0.868	3.08
Copper	17	3	0.42	0.52	0.61	0.04	0.102	0.21	0.04	0.176	0.61
Iron	17	14	9.2	2880	11200	1.15	1.9	2.45	1.15	2370	11200
Lead	17	9	0.05	0.0989	0.16	0.01	0.0281	0.055	0.01	0.0656	0.16
Manganese	17	17	2.92	2380	8230	--	--	--	2.92	2380	8230
Nickel	17	17	0.11	1.41	3.69	--	--	--	0.11	1.41	3.69
Selenium	17	2	1.2	1.2	1.2	1.1	1.15	1.25	1.1	1.16	1.25
Silver	17	0	--	--	--	0.02	0.0203	0.025	0.02	0.0203	0.025
Thallium	17	3	0.008	0.0127	0.02	0.0035	0.0141	0.025	0.0035	0.0139	0.025
Vanadium	17	8	0.13	0.491	0.94	0.22	0.229	0.235	0.13	0.352	0.94
Zinc	17	4	3.47	4.85	6.05	0.205	0.974	2.495	0.205	1.88	6.05
Negative Control Samples (CTL-SS)											
Aluminum	3	0	--	--	--	1.6	1.92	2.35	1.6	1.92	2.35
Antimony	3	0	--	--	--	0.105	0.118	0.125	0.105	0.118	0.125
Arsenic	3	3	8.03	9.74	10.7	--	--	--	8.03	9.74	10.7
Barium	3	3	1.59	2.28	2.85	--	--	--	1.59	2.28	2.85
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	1	0.02	0.02	0.02	0.02	0.0325	0.045	0.02	0.0283	0.045
Chromium	3	3	0.06	0.07	0.08	--	--	--	0.06	0.07	0.08
Cobalt	3	3	0.27	0.403	0.5	--	--	--	0.27	0.403	0.5
Copper	3	1	0.43	0.43	0.43	0.145	0.165	0.185	0.145	0.253	0.43
Iron	3	3	108	136	179	--	--	--	108	136	179
Lead	3	2	0.08	0.085	0.09	0.045	0.045	0.045	0.045	0.0717	0.09
Manganese	3	3	303	449	554	--	--	--	303	449	554
Nickel	3	3	0.78	0.963	1.11	--	--	--	0.78	0.963	1.11
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	3	1.32	1.55	1.96	--	--	--	1.32	1.55	1.96
Zinc	3	0	--	--	--	0.205	0.347	0.54	0.205	0.347	0.54

Table 5-6c. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 7 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Auxiliary Control Samples (CTL-QS)											
Aluminum	3	1	8.1	8.1	8.1	2.85	3.45	4.05	2.85	5	8.1
Antimony	3	0	--	--	--	0.055	0.0667	0.075	0.055	0.0667	0.075
Arsenic	3	3	0.12	0.187	0.27	--	--	--	0.12	0.187	0.27
Barium	3	3	6.07	6.71	7.39	--	--	--	6.07	6.71	7.39
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	3	0.04	0.0533	0.07	--	--	--	0.04	0.0533	0.07
Chromium	3	0	--	--	--	0.23	0.23	0.23	0.23	0.23	0.23
Cobalt	3	3	0.41	0.593	0.77	--	--	--	0.41	0.593	0.77
Copper	3	1	0.56	0.56	0.56	0.135	0.155	0.175	0.135	0.29	0.56
Iron	3	2	18.4	23.9	29.3	1.45	1.45	1.45	1.45	16.4	29.3
Lead	3	0	--	--	--	0.01	0.015	0.02	0.01	0.015	0.02
Manganese	3	3	13.1	25.5	37.5	--	--	--	13.1	25.5	37.5
Nickel	3	3	1.55	1.73	1.95	--	--	--	1.55	1.73	1.95
Selenium	3	1	1.1	1.1	1.1	1.15	1.15	1.15	1.1	1.13	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	1	0.02	0.02	0.02	0.015	0.0175	0.02	0.015	0.0183	0.02
Vanadium	3	0	--	--	--	0.23	0.23	0.23	0.23	0.23	0.23
Zinc	3	1	5.86	5.86	5.86	1.265	2.18	3.1	1.265	3.41	5.86

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13).
The number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-6d. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 21 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Aluminum	22	14	9.1	18.4	33.3	1.55	3.14	4.05	1.55	12.8	33.3
Antimony	22	10	0.5	2.39	7.01	0.015	0.0654	0.145	0.015	1.12	7.01
Arsenic	22	22	1.29	27.6	109	--	--	--	1.29	27.6	109
Barium	22	22	70.8	208	891	--	--	--	70.8	208	891
Beryllium	22	0	--	--	--	0.015	0.0198	0.02	0.015	0.0198	0.02
Cadmium	22	6	0.01	0.09	0.23	0.005	0.02	0.025	0.005	0.0391	0.23
Chromium	22	14	0.05	0.117	0.28	0.225	0.229	0.235	0.05	0.158	0.28
Cobalt	22	22	0.11	0.725	1.69	--	--	--	0.11	0.725	1.69
Copper	22	16	0.12	1.65	4.86	0.065	0.168	0.42	0.065	1.24	4.86
Iron	22	22	44.6	4230	22700	--	--	--	44.6	4230	22700
Lead	22	22	0.08	0.496	2.4	--	--	--	0.08	0.496	2.4
Manganese	22	22	9.09	2150	5470	--	--	--	9.09	2150	5470
Nickel	22	22	0.37	0.954	2.2	--	--	--	0.37	0.954	2.2
Selenium	22	0	--	--	--	0.95	1.14	1.15	0.95	1.14	1.15
Silver	22	0	--	--	--	0.015	0.0198	0.02	0.015	0.0198	0.02
Thallium	22	8	0.01	0.115	0.52	0.003	0.0158	0.02	0.003	0.0519	0.52
Vanadium	22	20	0.13	0.633	1.46	0.22	0.225	0.23	0.13	0.596	1.46
Zinc	22	7	15.2	31.5	68.2	0.245	1.36	6.7	0.245	10.9	68.2
Tributary and Upstream Samples											
Aluminum	17	7	9.2	14.1	20	1.95	2.85	3.5	1.95	7.47	20
Antimony	17	0	--	--	--	0.015	0.0409	0.1	0.015	0.0409	0.1
Arsenic	17	17	0.46	6.36	13.8	--	--	--	0.46	6.36	13.8
Barium	17	17	44.1	107	221	--	--	--	44.1	107	221
Beryllium	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	17	5	0.01	0.026	0.05	0.01	0.02	0.025	0.01	0.0218	0.05
Chromium	17	14	0.05	0.105	0.16	0.22	0.227	0.23	0.05	0.126	0.23
Cobalt	17	16	0.33	0.725	2.13	0.02	0.02	0.02	0.02	0.684	2.13
Copper	17	12	0.08	0.233	0.6	0.055	0.106	0.175	0.055	0.195	0.6
Iron	17	17	18.5	2120	6820	--	--	--	18.5	2120	6820
Lead	17	13	0.04	0.09	0.18	0.02	0.0225	0.03	0.02	0.0741	0.18
Manganese	17	17	753	2880	9300	--	--	--	753	2880	9300
Nickel	17	17	0.14	1.36	2.52	--	--	--	0.14	1.36	2.52
Selenium	17	0	--	--	--	1.1	1.15	1.15	1.1	1.15	1.15
Silver	17	0	--	--	--	0.005	0.0182	0.02	0.005	0.0182	0.02
Thallium	17	1	0.01	0.01	0.01	0.01	0.0188	0.02	0.01	0.0182	0.02
Vanadium	17	12	0.14	0.631	1.36	0.22	0.228	0.23	0.14	0.512	1.36
Zinc	17	0	--	--	--	0.125	0.501	1.92	0.125	0.501	1.92
Negative Control Samples (CTL-SS)											
Aluminum	3	0	--	--	--	2.65	3.13	3.55	2.65	3.13	3.55
Antimony	3	0	--	--	--	0.055	0.08	0.1	0.055	0.08	0.1
Arsenic	3	3	15.9	17.2	19.6	--	--	--	15.9	17.2	19.6
Barium	3	3	1.26	1.9	2.34	--	--	--	1.26	1.9	2.34
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	0	--	--	--	0.005	0.015	0.02	0.005	0.015	0.02
Chromium	3	3	0.13	0.153	0.19	--	--	--	0.13	0.153	0.19
Cobalt	3	3	0.33	0.42	0.47	--	--	--	0.33	0.42	0.47
Copper	3	2	0.33	0.355	0.38	0.155	0.155	0.155	0.155	0.288	0.38
Iron	3	3	223	321	508	--	--	--	223	321	508
Lead	3	3	0.1	0.22	0.34	--	--	--	0.1	0.22	0.34
Manganese	3	3	386	498	640	--	--	--	386	498	640
Nickel	3	3	1.5	1.71	1.91	--	--	--	1.5	1.71	1.91
Selenium	3	0	--	--	--	1.1	1.13	1.15	1.1	1.13	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	3	1.06	1.57	2.36	--	--	--	1.06	1.57	2.36
Zinc	3	0	--	--	--	0.29	0.342	0.38	0.29	0.342	0.38

Table 5-6d. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 21 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Auxiliary Control Samples (CTL-QS)											
Aluminum	3	3	9.6	10.2	11.4	--	--	--	9.6	10.2	11.4
Antimony	3	1	0.47	0.47	0.47	0.06	0.0825	0.105	0.06	0.212	0.47
Arsenic	3	3	0.49	1.05	1.97	--	--	--	0.49	1.05	1.97
Barium	3	3	8.9	11.2	14.3	--	--	--	8.9	11.2	14.3
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	2	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.0133	0.02
Chromium	3	0	--	--	--	0.22	0.228	0.24	0.22	0.228	0.24
Cobalt	3	3	0.4	0.517	0.64	--	--	--	0.4	0.517	0.64
Copper	3	2	0.13	0.21	0.29	0.185	0.185	0.185	0.13	0.202	0.29
Iron	3	3	465	1680	3640	--	--	--	465	1680	3640
Lead	3	1	0.09	0.09	0.09	0.02	0.025	0.03	0.02	0.0467	0.09
Manganese	3	3	41.4	71	103	--	--	--	41.4	71	103
Nickel	3	3	1.1	1.5	1.79	--	--	--	1.1	1.5	1.79
Selenium	3	0	--	--	--	1.1	1.15	1.2	1.1	1.15	1.2
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	1	0.009	0.009	0.009	0.02	0.02	0.02	0.009	0.0163	0.02
Vanadium	3	0	--	--	--	0.22	0.225	0.235	0.22	0.225	0.235
Zinc	3	0	--	--	--	0.27	1.01	1.535	0.27	1.01	1.535

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13).
The number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).
[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-6e. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 21 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Aluminum	22	9	6.5	17.3	42.4	1.65	2.9	6.8	1.65	8.78	42.4
Antimony	22	9	1.18	9.92	61.3	0.015	0.0642	0.21	0.015	4.1	61.3
Arsenic	22	22	0.58	36	121	--	--	--	0.58	36	121
Barium	22	22	71.6	248	1080	--	--	--	71.6	248	1080
Beryllium	22	0	--	--	--	0.01	0.0195	0.02	0.01	0.0195	0.02
Cadmium	22	5	0.01	0.132	0.32	0.005	0.0215	0.03	0.005	0.0466	0.32
Chromium	22	12	0.05	0.176	0.38	0.035	0.18	0.23	0.035	0.178	0.38
Cobalt	22	22	0.11	0.871	1.8	--	--	--	0.11	0.871	1.8
Copper	22	14	0.1	1.82	5.11	0.035	0.055	0.115	0.035	1.18	5.11
Iron	22	21	34	7260	28600	2.55	2.55	2.55	2.55	6930	28600
Lead	22	17	0.09	0.685	4.8	0.035	0.05	0.065	0.035	0.54	4.8
Manganese	22	22	9.53	3340	9140	--	--	--	9.53	3340	9140
Nickel	22	22	0.21	0.919	2.4	--	--	--	0.21	0.919	2.4
Selenium	22	0	--	--	--	1.1	1.14	1.15	1.1	1.14	1.15
Silver	22	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	22	3	0.09	0.227	0.5	0.003	0.0181	0.025	0.003	0.0465	0.5
Vanadium	22	20	0.11	0.603	1.51	0.225	0.228	0.23	0.11	0.569	1.51
Zinc	22	8	3.54	37	96.5	0.115	1.25	8.6	0.115	14.2	96.5
Tributary and Upstream Samples											
Aluminum	17	4	7	11.3	15.7	1.75	3.35	7.4	1.75	5.21	15.7
Antimony	17	0	--	--	--	0.015	0.0459	0.1	0.015	0.0459	0.1
Arsenic	17	17	0.26	6.39	15.6	--	--	--	0.26	6.39	15.6
Barium	17	17	57.4	124	254	--	--	--	57.4	124	254
Beryllium	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	17	3	0.01	0.0333	0.06	0.02	0.0218	0.025	0.01	0.0238	0.06
Chromium	17	8	0.05	0.104	0.16	0.03	0.152	0.23	0.03	0.129	0.23
Cobalt	17	17	0.03	0.788	2.33	--	--	--	0.03	0.788	2.33
Copper	17	8	0.08	0.3	0.55	0.04	0.0872	0.135	0.04	0.187	0.55
Iron	17	16	30.5	3360	10800	5.25	5.25	5.25	5.25	3170	10800
Lead	17	5	0.09	0.142	0.19	0.01	0.0304	0.055	0.01	0.0632	0.19
Manganese	17	17	489	3390	10400	--	--	--	489	3390	10400
Nickel	17	17	0.1	1.3	2.51	--	--	--	0.1	1.3	2.51
Selenium	17	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	17	0	--	--	--	0.004	0.0173	0.02	0.004	0.0173	0.02
Vanadium	17	12	0.14	0.437	1.07	0.225	0.228	0.23	0.14	0.375	1.07
Zinc	17	0	--	--	--	0.18	0.654	3.1	0.18	0.654	3.1
Negative Control Samples (CTL-SS)											
Aluminum	3	1	9.8	9.8	9.8	3.95	4.35	4.75	3.95	6.17	9.8
Antimony	3	0	--	--	--	0.06	0.0783	0.09	0.06	0.0783	0.09
Arsenic	3	3	12.2	14.7	17.6	--	--	--	12.2	14.7	17.6
Barium	3	3	1.64	2.46	2.97	--	--	--	1.64	2.46	2.97
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	1	0.01	0.01	0.01	0.02	0.0225	0.025	0.01	0.0183	0.025
Chromium	3	2	0.11	0.15	0.19	0.055	0.055	0.055	0.055	0.118	0.19
Cobalt	3	3	0.27	0.35	0.41	--	--	--	0.27	0.35	0.41
Copper	3	1	0.54	0.54	0.54	0.16	0.17	0.18	0.16	0.293	0.54
Iron	3	3	215	319	464	--	--	--	215	319	464
Lead	3	3	0.13	0.263	0.42	--	--	--	0.13	0.263	0.42
Manganese	3	3	413	490	594	--	--	--	413	490	594
Nickel	3	3	1.11	1.42	1.62	--	--	--	1.11	1.42	1.62
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	3	0.96	1.49	2.36	--	--	--	0.96	1.49	2.36
Zinc	3	0	--	--	--	0.175	0.552	0.96	0.175	0.552	0.96

Table 5-6e. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Hyalella azteca* on Test Day 21 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Auxiliary Control Samples (CTL-QS)											
Aluminum	3	1	9	9	9	4.05	4.93	5.8	4.05	6.28	9
Antimony	3	1	0.36	0.36	0.36	0.08	0.095	0.11	0.08	0.183	0.36
Arsenic	3	3	0.21	0.46	0.86	--	--	--	0.21	0.46	0.86
Barium	3	3	10.2	12.2	14.2	--	--	--	10.2	12.2	14.2
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	0	--	--	--	0.015	0.0183	0.02	0.015	0.0183	0.02
Chromium	3	0	--	--	--	0.225	0.23	0.235	0.225	0.23	0.235
Cobalt	3	3	0.46	0.52	0.56	--	--	--	0.46	0.52	0.56
Copper	3	1	0.28	0.28	0.28	0.07	0.125	0.18	0.07	0.177	0.28
Iron	3	3	96.7	852	2060	--	--	--	96.7	852	2060
Lead	3	0	--	--	--	0.015	0.02	0.03	0.015	0.02	0.03
Manganese	3	3	34.2	67.9	97	--	--	--	34.2	67.9	97
Nickel	3	3	1.1	1.12	1.14	--	--	--	1.1	1.12	1.14
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.003	0.011	0.02	0.003	0.011	0.02
Vanadium	3	0	--	--	--	0.225	0.227	0.23	0.225	0.227	0.23
Zinc	3	0	--	--	--	0.34	0.42	0.555	0.34	0.42	0.555

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13).
The number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-6f. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 42 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Site Samples											
Aluminum	22	15	10.2	22.8	49.3	1.8	3.14	4.5	1.8	16.5	49.3
Antimony	22	11	0.26	2.66	8.86	0.015	0.05	0.225	0.015	1.36	8.86
Arsenic	22	22	1.79	30.6	120	--	--	--	1.79	30.6	120
Barium	22	22	78.6	182	683	--	--	--	78.6	182	683
Beryllium	22	2	0.02	0.02	0.02	0.02	0.021	0.03	0.02	0.0209	0.03
Cadmium	22	10	0.01	0.041	0.15	0.015	0.0221	0.035	0.01	0.0307	0.15
Chromium	22	16	0.05	0.169	0.35	0.22	0.23	0.235	0.05	0.186	0.35
Cobalt	22	21	0.17	0.582	1.75	0.055	0.055	0.055	0.055	0.558	1.75
Copper	22	16	0.08	1.44	5.45	0.045	0.114	0.315	0.045	1.08	5.45
Iron	22	22	245	4690	15600	--	--	--	245	4690	15600
Lead	22	18	0.07	0.594	1.76	0.03	0.0688	0.1	0.03	0.498	1.76
Manganese	22	22	12	2160	6650	--	--	--	12	2160	6650
Nickel	22	22	0.29	0.952	2.14	--	--	--	0.29	0.952	2.14
Selenium	22	0	--	--	--	0.95	1.19	1.75	0.95	1.19	1.75
Silver	22	0	--	--	--	0.015	0.0207	0.03	0.015	0.0207	0.03
Thallium	22	3	0.1	0.203	0.4	0.004	0.0178	0.03	0.004	0.0431	0.4
Vanadium	22	22	0.18	1.08	3	--	--	--	0.18	1.08	3
Zinc	22	5	18	36.4	52.3	0.29	1.54	4.67	0.29	9.47	52.3
Tributary and Upstream Samples											
Aluminum	17	8	6.4	16.4	45.8	2.15	3.46	5.15	2.15	9.53	45.8
Antimony	17	0	--	--	--	0.015	0.04	0.06	0.015	0.04	0.06
Arsenic	17	17	0.44	6.5	12.6	--	--	--	0.44	6.5	12.6
Barium	17	17	35.4	93.2	184	--	--	--	35.4	93.2	184
Beryllium	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	17	2	0.03	0.035	0.04	0.02	0.0213	0.025	0.02	0.0229	0.04
Chromium	17	13	0.06	0.151	0.31	0.23	0.233	0.235	0.06	0.17	0.31
Cobalt	17	16	0.17	0.454	1.25	0.02	0.02	0.02	0.02	0.429	1.25
Copper	17	10	0.09	0.204	0.57	0.04	0.0914	0.125	0.04	0.158	0.57
Iron	17	17	113	1840	4690	--	--	--	113	1840	4690
Lead	17	7	0.05	0.0871	0.14	0.015	0.032	0.08	0.015	0.0547	0.14
Manganese	17	17	683	2400	6930	--	--	--	683	2400	6930
Nickel	17	17	0.12	1.1	2.89	--	--	--	0.12	1.1	2.89
Selenium	17	1	1.1	1.1	1.1	1.15	1.16	1.2	1.1	1.16	1.2
Silver	17	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	17	1	0.009	0.009	0.009	0.005	0.0172	0.02	0.005	0.0167	0.02
Vanadium	17	16	0.15	0.833	2.31	0.235	0.235	0.235	0.15	0.797	2.31
Zinc	17	0	--	--	--	0.145	0.347	0.79	0.145	0.347	0.79
Negative Control Samples (CTL-SS)											
Aluminum	3	1	8.8	8.8	8.8	3.65	4.03	4.4	3.65	5.62	8.8
Antimony	3	1	0.31	0.31	0.31	0.1	0.118	0.135	0.1	0.182	0.31
Arsenic	3	3	19.2	21.3	22.7	--	--	--	19.2	21.3	22.7
Barium	3	3	1.07	1.24	1.45	--	--	--	1.07	1.24	1.45
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	1	0.01	0.01	0.01	0.02	0.0225	0.025	0.01	0.0183	0.025
Chromium	3	3	0.17	0.223	0.27	--	--	--	0.17	0.223	0.27
Cobalt	3	3	0.23	0.283	0.34	--	--	--	0.23	0.283	0.34
Copper	3	2	0.34	0.35	0.36	0.265	0.265	0.265	0.265	0.322	0.36
Iron	3	3	274	358	416	--	--	--	274	358	416
Lead	3	2	0.23	0.25	0.27	0.09	0.09	0.09	0.09	0.197	0.27
Manganese	3	3	323	372	423	--	--	--	323	372	423
Nickel	3	3	1.39	1.82	2.06	--	--	--	1.39	1.82	2.06
Selenium	3	0	--	--	--	1.15	1.15	1.15	1.15	1.15	1.15
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	3	2.34	2.97	4.03	--	--	--	2.34	2.97	4.03
Zinc	3	0	--	--	--	0.195	0.367	0.635	0.195	0.367	0.635

Table 5-6f. Long-Term Bioassay Porewater Summary Metal/Metalloid Statistics for *Chironomus dilutus* on Test Day 42 (µg/L)

Analyte	Number of Samples[a]	Number of Detected Values	Minimum Detected Value	Mean Detected Value	Maximum Detected Value	Minimum Nondetected Value[b]	Mean Nondetected Value[b]	Maximum Nondetected Value[b]	Overall Minimum Value[b]	Overall Mean Value[b]	Overall Maximum Value[b]
Auxiliary Control Samples (CTL-QS)											
Aluminum	3	2	14	14.2	14.3	5.4	5.4	5.4	5.4	11.2	14.3
Antimony	3	2	0.25	0.26	0.27	0.115	0.115	0.115	0.115	0.212	0.27
Arsenic	3	3	1.39	1.87	2.21	--	--	--	1.39	1.87	2.21
Barium	3	3	9.41	13	16	--	--	--	9.41	13	16
Beryllium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium	3	0	--	--	--	0.02	0.0217	0.025	0.02	0.0217	0.025
Chromium	3	0	--	--	--	0.23	0.233	0.235	0.23	0.233	0.235
Cobalt	3	3	0.07	0.18	0.25	--	--	--	0.07	0.18	0.25
Copper	3	1	0.14	0.14	0.14	0.12	0.128	0.135	0.12	0.132	0.14
Iron	3	3	1920	2580	3250	--	--	--	1920	2580	3250
Lead	3	1	0.05	0.05	0.05	0.005	0.0225	0.04	0.005	0.0317	0.05
Manganese	3	3	41	73.6	103	--	--	--	41	73.6	103
Nickel	3	3	0.42	0.7	1.01	--	--	--	0.42	0.7	1.01
Selenium	3	0	--	--	--	1.15	1.17	1.2	1.15	1.17	1.2
Silver	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	3	0	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium	3	1	0.14	0.14	0.14	0.225	0.228	0.23	0.14	0.198	0.23
Zinc	3	0	--	--	--	0.22	0.377	0.46	0.22	0.377	0.46

Notes:

Results for site samples include results for potential reference samples.

Results for tributary and upstream samples include one tributary location in the United States and six upstream locations in Canada.

Averaged results have three significant figures applied.

[a] The number of results for site samples is 22 instead of 20 because one location, REF-10b, was included in all three batches (see Table 2-13).
The number of results for tributary and upstream samples is 17 instead of 7 because five locations were included in all three batches (see Table 2-13).

[b] Calculated with nondetected results at one-half of the detection limit.

-- no value

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-7a. Comparison of Actual MDLs with ACGs for Nondetected Metals in Field Sediment Samples (mg/kg)

Analyte	ACG	Minimum Actual MDL[a]	Maximum Actual MDL[a]	Number of ACG Exceedances/ Total Nondetected Results
Cadmium	0.99	0.015	0.015	0 / 2
Copper	31.6	0.7	0.7	0 / 1
Lead	35.8	1.1	7.9	0 / 3
Mercury	0.18	0.002	0.002	0 / 10

Notes:

[a] Laboratory MDLs for sediment were not provided in the QAPP (Exponent et al. 2013).

ACG - analytical concentration goal

MDL - method detection limit

Table 5-7b. Comparison of Actual MDLs with ACGs for Nondetected Metals in Long-Term Bioassay Sediment Samples (mg/kg)

Analyte	ACG	Minimum Actual MDL[a]	Maximum Actual MDL[a]	Number of ACG Exceedances/ Total Nondetected Results
Cadmium	0.99	0.013	0.013	0 / 1
Lead	35.8	0.8	0.8	0 / 1
Mercury	0.18	0.002	0.003	0 / 5
Zinc	121	0.5	0.5	0 / 1

Notes:

[a] Laboratory MDLs for sediment were not provided in the QAPP (Exponent et al. 2013).

ACG - analytical concentration goal

MDL - method detection limit

Table 5-7c. Comparison of Actual MDLs with ACGs for Nondetected Metals in Field Porewater Samples

Analyte	ACG	QAPP MDL	Minimum Actual MDL	Maximum Actual MDL	Number of 1X ACG Exceedances/ Total Nondetected Results
Aluminum	87	0.3	2.1	51.9	0 / 56
Cadmium	0.19	0.005	0.005	0.049	0 / 30
Chromium	53	0.04	0.02	0.1	0 / 12
Copper	6.4	0.02	0.1	0.69	0 / 28
Iron	1000	3	26.7	26.7	0 / 1
Lead	1.6	0.005	0.009	0.057	0 / 8
Nickel	37	0.03	0.65	3.56	0 / 74
Selenium	5	0.3	0.3	1.5	0 / 71
Silver	1.6	0.004	0.004	0.054	0 / 58
Zinc	74	0.2	7.8	411	38 / 100

Notes:
ACG - analytical concentration goal
MDL - method detection limit

Table 5-7d. Comparison of Actual MDLs with ACGs for Nondetected Metals in Short-Term Bioassay Porewater Samples (µg/L)

Analyte	ACG	QAPP MDL	Minimum Actual MDL	Maximum Actual MDL	Number of ACG Exceedances/ Total Nondetected Results
Aluminum	87	0.3	2.6	64.8	0 / 112
Arsenic	150	0.1	0.11	0.11	0 / 1
Cadmium	0.19	0.005	0.011	0.094	0 / 211
Chromium	53	0.04	0.04	0.29	0 / 105
Copper	6.4	0.02	0.07	0.7	0 / 116
Iron	1000	3	2.7	5.7	0 / 7
Lead	1.6	0.005	0.006	0.198	0 / 65
Nickel	37	0.03	0.31	2.37	0 / 15
Selenium	5	0.3	0.9	1.16	0 / 252
Silver	1.6	0.004	0.007	0.057	0 / 257
Zinc	74	0.2	0.4	24	0 / 182

Notes:

ACG - analytical concentration goal

MDL - method detection limit

Table 5-7e. Comparison of Actual MDLs with ACGs for Nondetected Metals in Long-Term Bioassay Porewater Samples (µg/L)

Analyte	ACG	QAPP MDL	Minimum Actual MDL	Maximum Actual MDL	Number of ACG Exceedances/ Total Nondetected Results
Aluminum	87	0.3	2.3	14.8	0 / 138
Arsenic	150	0.1	0.11	0.11	0 / 3
Cadmium	0.19	0.005	0.01	0.06	0 / 156
Chromium	53	0.04	0.04	0.21	0 / 87
Copper	6.4	0.02	0.07	0.84	0 / 113
Iron	1000	3	1.5	10.5	0 / 14
Lead	1.6	0.005	0.013	0.203	0 / 74
Nickel	37	0.03	0.09	0.09	0 / 1
Selenium	5	0.3	0.8	1.4	0 / 221
Silver	1.6	0.004	0.009	0.017	0 / 225
Zinc	74	0.2	0.2	17.2	0 / 183

Notes:

ACG - analytical concentration goal

MDL - method detection limit

Table 5-8. Summary of Field Duplicate RPDs for Field Sediment Samples

Analyte	Number of Samples	Number of RPDs > 35%	Maximum RPD
Site Samples			
Conventional Parameters			
Organic carbon	12	1	56.1
pH	12	0	22.1
Solids	12	0	11.1
Sulfide	12	7	147
Grain size			
Clay	12	2	81.1
Silt	12	4	75
Very fine sand	12	2	72.6
Fine sand	12	1	82.5
Medium sand	12	1	50.6
Coarse sand	12	1	57.6
Very coarse sand	12	3	59.3
Fine gravel	12	5	200
Medium gravel	12	1	200
Metals/Metalloids			
Aluminum	12	0	18.3
Antimony	12	0	20.4
Arsenic	12	0	21.3
Barium	12	0	21.1
Beryllium	12	1	134
Cadmium	12	1	39.8
Calcium	12	0	19.9
Chromium	12	0	21.8
Cobalt	12	0	18.4
Copper	12	0	18.2
Iron	12	0	23.3
Lead	12	0	19.5
Magnesium	12	0	18.8
Manganese	12	0	21.8
Mercury	12	4	129
Nickel	12	0	21.9
Potassium	12	0	20.5
Selenium	12	0	19.4
Silver	12	0	34.1
Sodium	12	0	14.9
Thallium	12	1	38.1
Vanadium	12	0	17.7
Zinc	12	0	19.4
SEM			
Antimony	12	2	88.6
Arsenic	12	3	85.7
Cadmium	12	5	107
Chromium	12	4	79.9
Copper	12	5	95.4
Lead	12	5	84.3
Nickel	12	3	72.9
Zinc	12	5	84.6

Table 5-8. Summary of Field Duplicate RPDs for Field Sediment Samples

Analyte	Number of Samples	Number of RPDs > 35%	Maximum RPD
Tributary and Upstream Samples			
Conventional Parameters			
Organic carbon	2	0	28.8
pH	2	0	2.69
Solids	2	0	4.91
Sulfide	2	0	18.2
Grain size			
Clay	2	0	22.2
Silt	2	0	11.8
Very fine sand	2	2	46
Fine sand	2	0	31.8
Medium sand	2	0	29
Coarse sand	2	0	14.7
Very coarse sand	2	0	6
Fine gravel	2	0	15.6
Medium gravel	2	0	0
Metals/Metalloids			
Aluminum	2	0	27.9
Antimony	2	2	130
Arsenic	2	0	10
Barium	2	1	143
Beryllium	2	0	9.71
Cadmium	2	0	24.8
Calcium	2	1	42.9
Chromium	2	0	0.445
Cobalt	2	0	7.95
Copper	2	0	13.3
Iron	2	0	29.3
Lead	2	0	16.7
Magnesium	2	0	24.8
Manganese	2	1	148
Mercury	2	0	0
Nickel	2	0	13.7
Potassium	2	0	28.2
Selenium	2	0	0
Silver	2	0	11.1
Sodium	2	0	24
Thallium	2	0	19.6
Vanadium	2	0	34.7
Zinc	2	0	22.5
SEM			
Antimony	2	0	33.3
Arsenic	2	1	40
Cadmium	2	1	86.7
Chromium	2	1	42.1
Copper	2	0	11.5
Lead	2	0	10.5
Nickel	2	0	16.7
Zinc	2	0	17.6

Notes:

Highlighted cells identify relative percent differences (RPDs) greater than the control limit.

SEM - simultaneously extracted metals

Table 5-9a. Results for the Short-Term *Chironomus dilutus* Bioassays

Sample ID	Survival (%) Mean	Survival (%) SD	Weight[a] (mg AFDW/individual) Mean	Weight[a] (mg AFDW/individual) SD	Biomass[b] (mg AFDW/individual) Mean	Biomass[b] (mg AFDW/individual) SD
Batch 1 (Initiated 1/22/2014)						
Site Locations						
1-R1	94	5.2	1.30	0.206	1.21	0.184
3-R2	95	7.6	1.85	0.210	1.74	0.106
4-B6	90	7.6	1.34	0.188	1.20	0.176
5-B1	78	21	1.71	0.303	1.29	0.252
6-B6	75	18	1.70	0.279	1.24	0.162
6-R3	80	7.6	1.55	0.0981	1.23	0.0918
8-B3	84	15	1.49	0.203	1.23	0.148
8-B4	79	14	1.51	0.145	1.18	0.105
REF-6[c]	93	7.1	1.72	0.0987	1.59	0.115
Tributary and Upstream Locations						
TRIB-4	89	9.9	1.81	0.177	1.58	0.103
G-1	94	11	1.49	0.139	1.40	0.162
Negative Control (CTL-SS)						
CTL-SS-B1	95	7.6	1.65	0.199	1.56	0.095
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B1	96	7.4	1.38	0.0642	1.33	0.122
CRL-ERDC-B1	95	7.6	1.49	0.162	1.41	0.148
Batch 2 (Initiated 1/23/2014)						
Site Locations						
2-R1	99	3.5	1.64	0.232	1.61	0.200
4-B2	99	3.5	1.51	0.0957	1.49	0.104
4-B4	96	5.2	1.20	0.139	1.16	0.135
5-B3	44	13	2.50	0.440	1.05	0.192
6-B5	59	23	2.06	0.649	1.09	0.267
REF-4[c]	85	14	1.40	0.145	1.18	0.138
REF-8[c]	75	17	1.56	0.250	1.14	0.093
Tributary and Upstream Locations						
LAL-1	64	14	1.87	0.316	1.18	0.231
LAL-2	95	5.4	1.74	0.0748	1.65	0.0905
LAL-3	93	7.1	1.66	0.141	1.53	0.107
LAL-6	99	3.5	1.60	0.0986	1.58	0.0849
Negative Control (CTL-SS)						
CTL-SS-B2	94	7.4	1.52	0.127	1.42	0.108
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B2	98	4.6	1.46	0.113	1.42	0.117
CRL-ERDC-B2	94	5.2	1.62	0.144	1.52	0.144
Batch 3 (Initiated 1/24/2014)						
Site Locations						
2-R3	94	7.4	1.61	0.220	1.50	0.170
3-R1	100	0.0	1.09	0.150	1.09	0.150
3-R8	84	14	0.753	0.149	0.642	0.189
5-B4	36	22	2.00	0.435	0.670	0.310
6-B4	35	17	1.86	0.848	0.722	0.316
7-B2	46	21	1.88	0.449	0.793	0.264
REF-1[c]	61	15	1.94	0.224	1.16	0.188
REF-10b[c]	95	5.4	1.18	0.196	1.12	0.185
REF-3[c]	60	19	1.86	0.448	1.05	0.130
REF-7[c]	69	16	1.67	0.374	1.10	0.133

Table 5-9a. Results for the Short-Term *Chironomus dilutus* Bioassays

Sample ID	Survival (%) Mean	Survival (%) SD	Weight[a] (mg AFDW/individual) Mean	Weight[a] (mg AFDW/individual) SD	Biomass[b] (mg AFDW/individual) Mean	Biomass[b] (mg AFDW/individual) SD
Batch 3 (Initiated 1/24/2014) (continued)						
Tributary and Upstream Locations						
TRIB-3	101[d]	14	1.56	0.112	1.50	0.130
LAL-4	99	3.5	1.45	0.0280	1.43	0.0645
Negative Control (CTL-SS)						
CTL-SS-B3	98	4.6	1.06	0.108	1.03	0.121
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B3	98	4.6	1.29	0.0512	1.26	0.0595
CTL-ERDC-B3	99	3.5	1.26	0.0528	1.24	0.0518
Batch 4 (Initiated 1/29/2014)						
Site Locations						
1-B5	94	5.2	1.76	0.152	1.65	0.123
2-B1	96	5.2	1.45	0.101	1.39	0.0755
3-B3	93	12	1.33	0.115	1.22	0.106
3-R7	88	13	1.70	0.155	1.48	0.193
5-B5	78	12	1.68	0.239	1.28	0.0801
5-B6	80	13	1.55	0.211	1.21	0.0850
7-B3	89	8.4	1.35	0.107	1.20	0.0823
7-B6	64	16	1.59	0.318	0.975	0.115
REF-2[c]	80	13	1.56	0.207	1.23	0.142
Tributary and Upstream Locations						
TRIB-2	95	7.6	1.72	0.336	1.62	0.339
TRIB-5	98	4.6	1.49	0.0961	1.45	0.0718
G-4	95	7.6	1.19	0.155	1.12	0.136
Negative Control (CTL-SS)						
CTL-SS-B4	99	3.5	1.41	0.0828	1.39	0.0761
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B4	95	11	1.23	0.171	1.16	0.0537
CTL-ERDC-B4	66	20	1.87	0.362	1.18	0.191
Batch 5 (Initiated 1/30/2014)						
Site Locations						
2-B2	93	4.6	1.41	0.107	1.30	0.0813
3-R9	95	11	1.84	0.227	1.72	0.0664
4-B1	90	13	1.36	0.273	1.20	0.0623
5-B2	86	13	1.50	0.126	1.28	0.119
6-B1	79	14	1.20	0.142	0.937	0.159
7-B4	61	6.4	1.94	0.219	1.18	0.125
7-B5	89	9.9	1.47	0.164	1.30	0.115
8-B1	74	9.2	1.48	0.204	1.08	0.0835
REF-5[c]	93	7.1	1.36	0.0589	1.26	0.0796
Tributary and Upstream Locations						
TRIB-1	89	14	1.33	0.170	1.16	0.102
G-2	86	7.4	1.37	0.0897	1.18	0.132
LAL-5	78	18	1.75	0.386	1.30	0.214
Negative Control (CTL-SS)						
CTL-SS-B5	89	3.5	1.50	0.119	1.33	0.113
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B5	96	5.2	1.06	0.049	1.02	0.0395
CTL-ERDC-B5	84	18	1.66	0.317	1.34	0.105

Table 5-9a. Results for the Short-Term *Chironomus dilutus* Bioassays

Sample ID	Survival (%)		Weight[a] (mg AFDW/individual)		Biomass[b] (mg AFDW/individual)	
	Mean	SD	Mean	SD	Mean	SD
Batch 6 (Initiated 1/31/2014)						
Site Locations						
1B-R2	83	15	0.970	0.170	0.790	0.154
1-R2	94	9.2	1.16	0.0990	1.08	0.0883
4-B3	73	7.1	1.42	0.213	1.03	0.186
4-B5	91	9.9	1.19	0.113	1.08	0.117
6-B2	83	7.1	0.703	0.163	0.575	0.109
7-B1	66	15	1.47	0.249	0.954	0.167
8-B2	96	11	0.849	0.116	0.813	0.105
8-B5	86	12	1.28	0.169	1.09	0.107
8-B6	80	15	1.34	0.215	1.05	0.101
Tributary and Upstream Locations						
TRIB-6	85	11	0.866	0.119	0.737	0.143
G-3	99	3.5	0.863	0.111	0.852	0.112
Negative Control (CTL-SS)						
CTL-SS-B6	88	8.9	1.41	0.0876	1.23	0.137
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B6	100	0.0	1.14	0.123	1.14	0.123
CTL-ERDC-B6	71	19	1.51	0.299	1.03	0.120

Notes:

[a] Weight is the total weight (measured as AFDW) divided by the number of survivors.

[b] Biomass is the total weight (measured as AFDW) for each replicate divided by the initial number of organisms introduced into the test chamber; *C. dilutus* biomass is calculated by dividing the total AFDW by the number of individuals at the start of the test less the number of organisms that pupated or emerged during the testing period.

[c] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

[d] Mean survival is greater than 100 percent due to an excess of organisms added at test initiation. Survival is the number of survivors divided by the intended number of organisms seeded at test initiation (i.e., 10 organisms per replicate).

AFDW - ash free dry weight

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SD - standard deviation

Table 5-9b. Results for the Short-Term *Hyalella azteca* Bioassays

Sample ID	Survival (%)		Weight[a] (mg/individual)		Biomass[b] (mg/individual)	
	Mean	SD	Mean	SD	Mean	SD
Batch 1 (Initiated 1/22/2014)						
Site Locations						
1-R1	100	0.0	0.633	0.230	0.633	0.230
3-R2	73	13	0.766	0.157	0.550	0.135
4-B6	98	4.6	0.758	0.0504	0.738	0.0422
5-B1	93	12	0.709	0.0403	0.647	0.0804
6-B6	96	5.2	0.782	0.0492	0.752	0.0548
6-R3	96	5.2	0.740	0.0580	0.711	0.0532
8-B3	95	7.6	0.643	0.0712	0.609	0.0627
8-B4	95	7.6	0.697	0.0522	0.662	0.0673
REF-6[c]	94	7.4	0.765	0.0929	0.721	0.123
Tributary and Upstream Locations						
TRIB-4	96	5.2	0.676	0.242	0.652	0.233
G-1	84	35	0.602	0.267	0.574	0.254
Negative Control (CTL-SS)						
CTL-SS-B1	100	0.0	0.765	0.0561	0.765	0.0561
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B1	94	14	0.554	0.0962	0.528	0.139
CTL-ERDC-B1	31	21	0.542	0.187	0.164	0.126
Batch 2 (Initiated 1/23/2014)						
Site Locations						
2-R1	99	3.5	0.719	0.0574	0.711	0.0662
4-B2	96	7.4	0.738	0.0698	0.713	0.0993
4-B4	94	12	0.641	0.0461	0.596	0.0988
5-B3	96	5.2	0.744	0.0528	0.715	0.0423
6-B5	96	5.2	0.772	0.0442	0.743	0.0516
REF-4[c]	93	7.1	0.733	0.110	0.682	0.130
REF-8[c]	96	5.2	0.695	0.105	0.668	0.0962
Tributary and Upstream Locations						
LAL-1	98	4.6	0.666	0.202	0.647	0.194
LAL-2	99	3.5	0.799	0.0757	0.790	0.0894
LAL-3	98	4.6	0.805	0.155	0.789	0.173
Negative Control (CTL-SS)						
CTL-SS-B2	98	4.6	0.741	0.0717	0.725	0.097
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B2	98	7.1	0.603	0.0776	0.585	0.0619
CTL-ERDC-B2	96	5.2	0.706	0.0647	0.678	0.0553
Batch 3 (Initiated 1/24/2014)						
Site Locations						
2-R3	98	4.6	0.824	0.0562	0.803	0.049
3-R1	95	5.4	0.787	0.0583	0.749	0.0822
3-R8	94	7.4	0.529	0.0371	0.496	0.0488
5-B4	100	0.0	0.767	0.0797	0.767	0.0797
6-B4	98	7.1	0.766	0.0968	0.752	0.133
7-B2	98	4.6	0.792	0.0579	0.771	0.0422
REF-1[c]	100	0.0	0.830	0.0723	0.830	0.0723
REF-10b[c]	100	0.0	0.749	0.0349	0.749	0.0349
REF-3[c]	99	3.5	0.731	0.0688	0.722	0.0756
REF-7[c]	99	3.5	0.804	0.0270	0.794	0.0371

Table 5-9b. Results for the Short-Term *Hyalella azteca* Bioassays

Sample ID	Survival (%)		Weight[a] (mg/individual)		Biomass[b] (mg/individual)	
	Mean	SD	Mean	SD	Mean	SD
Batch 3 (Initiated 1/24/2014) (continued)						
Tributary and Upstream Locations						
TRIB-3	100	0.0	0.726	0.0868	0.726	0.0868
LAL-4	90	14	0.348	0.109	0.317	0.124
Negative Control (CTL-SS)						
CTL-SS-B3	93	7.1	0.628	0.184	0.585	0.192
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B3	99	3.5	0.570	0.0794	0.562	0.0736
CTL-ERDC-B3	96	7.4	0.748	0.0582	0.718	0.0655
Batch 4 (Initiated 1/29/2014)						
Site Locations						
1-B5	95	11	0.825	0.0325	0.784	0.0944
2-B1	96	7.4	0.662	0.0833	0.636	0.0819
3-B3	66	25	0.514	0.0813	0.337	0.130
3-R7	98	4.6	0.448	0.188	0.441	0.195
5-B5	94	11	0.781	0.0886	0.739	0.146
5-B6	95	9.3	0.881	0.0509	0.835	0.0683
7-B3	98	4.6	0.853	0.0571	0.830	0.0395
7-B6	99	3.5	0.759	0.0800	0.749	0.0785
REF-2[c]	96	7.4	0.699	0.0721	0.672	0.0797
Tributary and Upstream Locations						
TRIB-2	90	19	0.698	0.256	0.630	0.248
TRIB-5	100	0.0	0.796	0.283	0.796	0.283
G-4	79	20	0.112	0.0501	0.094	0.0617
Negative Control (CTL-SS)						
CTL-SS-B4	84	12	0.603	0.0555	0.507	0.0912
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B4	96	5.2	0.622	0.0706	0.598	0.0661
CTL-ERDC-B4	90	9.26	0.595	0.0585	0.539	0.103
Batch 5 Re (Initiated 3/27/2014) [d]						
Site Locations						
2-B2	103[e]	7.1	0.416	0.0844	0.416	0.0844
3-R9	96	7.4	0.356	0.0676	0.341	0.0612
4-B1	88	14	0.277	0.0618	0.245	0.0748
5-B2	94	11	0.320	0.0871	0.300	0.0909
6-B1	91	11	0.320	0.103	0.289	0.0940
7-B4	98	8.9	0.414	0.0944	0.402	0.108
7-B5	79	16	0.258	0.0581	0.202	0.0587
8-B1	96	5.2	0.363	0.0579	0.350	0.0606
REF-5[c]	95	11	0.309	0.131	0.292	0.118
Tributary and Upstream Locations						
TRIB-1	99	3.5	0.557	0.0697	0.551	0.0786
G-2	88	18	0.324	0.0435	0.287	0.0827
LAL-5	91	17	0.265	0.0528	0.237	0.0670
Negative Control (CTL-SS)						
CTL-SS-B5-RE	96	7.4	0.376	0.103	0.367	0.1100
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B5-RE	93	8.9	0.401	0.0683	0.375	0.0940
CTL-ERDC-B5-RE	88	8.86	0.287	0.0534	0.251	0.0544

Table 5-9b. Results for the Short-Term *Hyalella azteca* Bioassays

Sample ID	Survival (%)		Weight[a] (mg/individual)		Biomass[b] (mg/individual)	
	Mean	SD	Mean	SD	Mean	SD
Batch 6 (Initiated 1/31/2014)						
Site Locations						
1B-R2	95	11	0.743	0.054	0.708	0.107
1-R2	75	18	0.522	0.043	0.392	0.0971
4-B3	88	12	0.638	0.0706	0.560	0.111
4-B5	90	17	0.623	0.110	0.575	0.165
6-B2	91	17	0.711	0.0922	0.640	0.114
7-B1	99	3.5	0.747	0.0961	0.737	0.0941
8-B2	91	14	0.685	0.0419	0.625	0.100
8-B5	96	5.2	0.743	0.0731	0.713	0.0589
8-B6	94	7.4	0.566	0.0762	0.532	0.0877
Tributary and Upstream Locations						
TRIB-6	98	7.1	0.808	0.0819	0.788	0.104
G-3	98	7.1	0.482	0.188	0.472	0.196
LAL-6	96	5.2	0.763	0.0707	0.736	0.0924
Negative Control (CTL-SS)						
CTL-SS-B6	96	7.4	0.658	0.101	0.629	0.0837
Auxiliary Controls (CTL-QS and CTL-ERDC)						
CTL-QS-B6	94	7.4	0.363	0.149	0.342	0.148
CTL-ERDC-B6	96.3	5.18	0.747	0.0621	0.718	0.06

Notes:

[a] Weight is the total weight divided by the number of survivors.

[b] Biomass is the total weight divided by the initial number of organisms introduced into the test chamber.

[c] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

[d] PER negative control results for the original *H. azteca* Batch 5 initiated on January 30, 2014, did not meet test acceptability criteria. The data presented are for the retest that was initiated on March 27, 2014. The original Batch 5 results are provided in the bioassay laboratory report in Appendix E of this data summary report.

[e] Mean survival is greater than 100 percent due to an excess of organisms added at test initiation. Survival is the number of survivors divided by the intended number of organisms seeded at test initiation (i.e., 10 organisms per replicate).

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SD - standard deviation

Table 5-10. Pupation in the Short-Term *Chironomus dilutus* Bioassay

Sample ID	Number of Live Organisms			Total Pupation (%)
	Larvae	Pupae	Adult	
Batch 1 (Initiated 1/22/2014)				
Site Locations				
1-R1	74	1	0	1.3
3-R2	74	2	0	2.5
4-B6	69	3	0	3.8
5-B1	62	0	0	0
6-B6	58	2	0	2.5
6-R3	64	0	0	0
8-B3	67	0	0	0
8-B4	63	0	0	0
REF-6[a]	74	0	0	0
Tributary and Upstream Locations				
TRIB-4	69	2	0	2.5
G-1	75	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B1	76	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B1	77	0	0	0
CRL-ERDC-B1	76	0	0	0
Batch 2 (Initiated 1/23/2014)				
Site Locations				
2-R1	79	0	0	0
4-B2	79	0	0	0
4-B4	77	0	0	0
5-B3	35	0	0	0
6-B5	47	0	0	0
REF-4[a]	68	0	0	0
REF-8[a]	60	0	0	0
Tributary and Upstream Locations				
LAL-1	51	0	0	0
LAL-2	76	0	0	0
LAL-3	74	0	0	0
LAL-6	79	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B2	75	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B2	78	0	0	0
CRL-ERDC-B2	75	0	0	0
Batch 3 (Initiated 1/24/2014)				
Site Locations				
2-R3	75	0	0	0
3-R1	80	0	0	0
3-R8	67	0	0	0
5-B4	29	0	0	0
6-B4	28	0	0	0
7-B2	37	0	0	0
REF-1[a]	49	0	0	0
REF-10b[a]	76	0	0	0
REF-3[a]	48	0	0	0
REF-7[a]	55	0	0	0

Table 5-10. Pupation in the Short-Term *Chironomus dilutus* Bioassay

Sample ID	Number of Live Organisms			Total Pupation (%)
	Larvae	Pupae	Adult	
Batch 3 (Initiated 1/24/2014) (continued)				
Tributary and Upstream Locations				
TRIB-3	81	0	0	0
LAL-4	79	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B3	78	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B3	78	0	0	0
CTL-ERDC-B3	79	0	0	0
Batch 4 (Initiated 1/29/2014)				
Site Locations				
1-B5	75	0	0	0
2-B1	76	1	0	1.3
3-B3	74	0	0	0
3-R7	70	0	0	0
5-B5	62	0	0	0
5-B6	64	0	0	0
7-B3	71	0	0	0
7-B6	51	0	0	0
REF-2[a]	63	1	0	1.3
Tributary and Upstream Locations				
TRIB-2	72	4	0	5.0
TRIB-5	78	0	0	0
G-4	76	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B4	79	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B4	76	0	0	0
CTL-ERDC-B4	53	0	0	0
Batch 5 (Initiated 1/30/2014)				
Site Locations				
2-B2	74	0	0	0
3-R9	76	0	0	0
4-B1	72	0	0	0
5-B2	69	0	0	0
6-B1	63	0	0	0
7-B4	49	0	0	0
7-B5	71	0	0	0
8-B1	59	0	0	0
REF-5[a]	74	0	0	0
Tributary and Upstream Locations				
TRIB-1	71	0	0	0
G-2	69	0	0	0
LAL-5	62	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B5	71	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B5	77	0	0	0
CTL-ERDC-B5	67	0	0	0

Table 5-10. Pupation in the Short-Term *Chironomus dilutus* Bioassay

Sample ID	Number of Live Organisms			Total Pupation (%)
	Larvae	Pupae	Adult	
Batch 6 (Initiated 1/31/2014)				
Site Locations				
1B-R2	66	0	0	0
1-R2	75	0	0	0
4-B3	58	0	0	0
4-B5	73	0	0	0
6-B2	66	0	0	0
7-B1	53	0	0	0
8-B2	77	0	0	0
8-B5	69	0	0	0
8-B6	64	0	0	0
Tributary and Upstream Locations				
TRIB-6	68	0	0	0
G-3	79	0	0	0
Negative Control (CTL-SS)				
CTL-SS-B6	70	0	0	0
Auxiliary Controls (CTL-QS and CTL-ERDC)				
CTL-QS-B6	80	0	0	0
CTL-ERDC-B6	57	0	0	0

Notes:

[a] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-11a. Results for the Long-Term *Chironomus dilutus* Bioassays

Sample ID	Survival (%) Day 16		Weight[a] (mg AFDW/individual) Day 16		Biomass[b] (mg AFDW/individual) Day 16		Emergence[c] (%)		Eggs/Egg Mass		Eggs/Female		Hatchability[d] (%)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Batch 1 (Initiated 2/13/2015)														
Site Locations														
1-B5	79	14	1.57	0.432	1.19	0.367	57	16	1190	560	872	553	75	22
1B-R2	65	17	1.69	0.505	1.04	0.147	57	15	1130	688	604	368	92	3.6
1-R2	86	13	1.87	0.136	1.60	0.302	73	17	1060	456	553	497	86	19
4-B6	90	8.2	1.97	0.202	1.74	0.127	82	14	1310	354	871	316	94	5.3
6-B2	81	19	1.12	0.196	0.884	0.133	52	30	1260	451	1070	256	71	19
7-B5	69	32	1.99	0.576	1.23	0.272	27	8.5	1200	548	1030	455	87	26
8-B3	75	14	1.71	0.271	1.25	0.102	56	14	1440	527	1210	579	88	12
REF-10b[e]	88	8.5	1.59	0.197	1.38	0.180	61	12	1550	726	1090	712	86	18
Tributary and Upstream Locations														
TRIB-3	77	7.7	1.26	0.163	0.972	0.147	56	23	1380	415	1060	464	96	4.5
G-1	100	0.0	1.21	0.120	1.21	0.120	72	15	1080	344	648	413	91	7.9
G-3	100	6.8	1.24	0.139	1.22	0.134	80	12	1180	234	707	357	78	22
LAL-3	56	14	2.14	0.485	1.13	0.0463	43	17	1230	326	646	350	91	14
LAL-5	65	22	2.3	0.512	1.40	0.266	47	25	1350	153	823	110	74	16
Negative Control (CTL-SS)														
CTL-SS-B1	94	8.1	1.55	0.135	1.45	0.0874	61	20	1050	395	534	284	88	14
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B1	98	4.0	1.77	0.236	1.69	0.190	76	10	1060	158	574	303	75	36
Batch 2 (Initiated 2/25/2015)														
Site Locations														
2-B1	92	7.0	1.7	0.435	1.54	0.373	64	17	1240	346	860	137	86	14
2-R1	94	8.1	1.45	0.149	1.33	0.116	79	13	1500	508	624	98.8	73	40
3-R7	94	8.1	1.67	0.172	1.56	0.140	73	8.6	1430	370	907	355	87	6.7
4-B1	94	4.0	1.48	0.112	1.38	0.0536	67	10	1470	336	933	549	87	5.8
5-B2	96	14	1.13	0.203	1.05	0.0798	75	15	1550	383	698	382	94	5.2
8-B2	88	14	1.89	0.370	1.62	0.204	68	19	1310	608	643	344	88	16
REF-10b[e]	98	4.0	1.44	0.180	1.40	0.218	73	11	1470	275	1060	471	89	5.3
Tributary and Upstream Locations														
TRIB-3	96	8.5	1.36	0.262	1.30	0.224	68	10	1360	314	803	440	74	26
G-1	98	8.0	1.32	0.100	1.26	0.152	74	15	1480	285	1110	425	93	5.9
G-3	94	4.0	1.62	0.178	1.50	0.168	70	17	1000	361	753	387	86	10
LAL-2	92	9.8	1.64	0.342	1.48	0.182	70	14	1460	330	731	233	82	17
LAL-3	98	4.0	1.8	0.115	1.76	0.0865	75	14	1140	344	879	360	80	25
LAL-5	94	8.1	1.94	0.265	1.83	0.377	58	10	1510	461	875	283	82	10
Negative Control (CTL-SS)														
CTL-SS-B2	96	4.6	1.56	0.0959	1.50	0.165	57	11	1150	232	741	440	87	9.6
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B2	94	8.1	1.63	0.230	1.51	0.0831	82	16	1010	649	520	403	94	2.9
Batch 3 (Initiated 3/5/2015)														
Site Locations														
3-B3	75	15	1.20	0.406	0.925	0.441	70	18	1530	240	913	459	70	31
3-R8	63	11	0.880	0.280	0.539	0.133	56	10	1400	396	994	392	86	9.9
4-B5	90	8.2	1.45	0.129	1.29	0.0651	72	8.7	1330	328	612	187	95	3.3
5-B4	79	4.6	1.72	0.171	1.36	0.108	37	17	1440	347	1100	447	82	9.3
6-B5	92	26	1.19	0.267	0.983	0.0988	45	13	1460	251	1240	454	65	37
7-B2	75	18	1.38	0.155	1.02	0.195	54	13	1550	537	1150	354	64	38
REF-10b[e]	100	0.0	1.56	0.0784	1.56	0.0784	51	25	1500	466	669	281	86	10

Table 5-11a. Results for the Long-Term *Chironomus dilutus* Bioassays

Sample ID	Survival (%) Day 16 Mean	Survival (%) Day 16 SD	Weight[a] (mg AFDW/individual) Day 16 Mean	Weight[a] Day 16 SD	Biomass[b] (mg AFDW/individual) Day 16 Mean	Biomass[b] Day 16 SD	Emergence[c] (%) Mean	Emergence[c] (%) SD	Eggs/Egg Mass Mean	Eggs/Egg Mass SD	Eggs/Female Mean	Eggs/Female SD	Hatchability[d] (%) Mean	Hatchability[d] (%) SD
Batch 3 (Initiated 3/5/2015) (continued)														
Tributary and Upstream Locations														
TRIB-3	94	8.1	1.52	0.0699	1.43	0.130	79	16	1330	229	888	467	93	5.5
G-1	100	0.0	1.25	0.157	1.25	0.157	89	7.3	1180	185	1090	225	96	1.8
G-2	79	11	1.39	0.240	1.08	0.0950	75	15	1350	358	1070	471	93	3.8
G-3	94	4.0	1.09	0.0722	1.03	0.0969	78	11	1500	501	932	657	90	11
LAL-3	69	10	1.54	0.228	1.04	0.0398	54	19	1520	574	911	573	89	11
LAL-5	54	8.0	1.63	0.202	0.890	0.202	51	12	1830	462	1300	610	95	2.7
Negative Control (CTL-SS)														
CTL-SS-B3	100	6.8	1.61	0.142	1.57	0.0801	71	15	1790	388	1300	430	91	9.5
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B3	86	19	1.05	0.129	0.904	0.253	63	15	1320	646	861	470	74	22

Notes:

[a] Weight is the total weight (measured as AFDW) divided by the number of survivors.

[b] Biomass is the total weight (measured as AFDW) for each replicate divided by the initial number of organisms introduced into the test chamber; *C. dilutus* biomass is calculated by dividing the total AFDW by the number of individuals at the start of the test less the number of organisms that pupated or emerged during the testing period.

[c] Emergence is the number of pupae emerged during the test to complete adulthood divided by the number of larvae loaded at test initiation.

[d] Hatchability is the total number of fertilized eggs that hatch divided by the total number of eggs.

[e] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

AFDW - ash free dry weight

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SD - standard deviation

Table 5-11b. Results for the Long-Term *Hyalella azteca* Bioassays

	Survival (%)				Weight[a] (mg/individual)				Biomass[b] (mg/individual)				Number of Offspring/Female	
	Day 28		Day 42		Day 28		Day 42		Day 28		Day 42		Day 42	
Sample ID	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Batch 1 (Initiated 2/13/2015)														
Site Locations														
1-B5	120[c]	54	95	7.6	0.578	0.106	0.956	0.0663	0.544	0.0761	0.907	0.0823	15	3.2
1B-R2	88	13	85	15	0.503	0.0500	0.839	0.0947	0.455	0.0787	0.710	0.125	4.8	1.4
1-R2	73	23	68	16	0.259	0.0908	0.498	0.121	0.184	0.137	0.335	0.119	1.0	1.2
4-B6	99	2.9	100	0.0	0.525	0.127	0.786	0.119	0.510	0.120	0.786	0.119	11	3.4
6-B2	98	4.5	98	4.6	0.556	0.0439	0.868	0.0774	0.541	0.0264	0.846	0.0798	11	3.0
7-B5	94	7.9	94	7.4	0.528	0.0723	0.832	0.0653	0.485	0.0503	0.783	0.113	10	3.4
8-B3	91	12	88	14	0.551	0.0279	0.783	0.122	0.496	0.0473	0.691	0.167	10	2.9
REF-10b[d]	100	8.2	98	4.6	0.549	0.0603	0.804	0.128	0.536	0.0737	0.784	0.129	13	4.7
Tributary and Upstream Locations														
TRIB-3	83	39	86	35	0.253	0.294	0.583	0.305	0.253	0.294	0.578	0.308	4.5	3.4
G-1	98	3.9	98	4.6	0.505	0.0373	0.721	0.135	0.505	0.0373	0.699	0.108	9.7	4.8
G-3	94	12	78	36	0.472	0.0572	0.380	0.212	0.472	0.0572	0.343	0.217	4.1	4.6
LAL-3	98	5.8	98	7.1	0.551	0.161	0.805	0.122	0.532	0.190	0.787	0.146	13	6.7
LAL-5	98	3.9	95	5.4	0.522	0.027	0.741	0.126	0.522	0.027	0.704	0.122	8.8	2.3
Negative Control (CTL-SS)														
CTL-SS-B1	98	6.2	95	11	0.433	0.0969	0.644	0.113	0.433	0.0969	0.611	0.128	5.0	3.7
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B1	98	6.2	95	7.6	0.244	0.0292	0.496	0.0319	0.244	0.0292	0.472	0.0523	3.0	1.3
Batch No.2 (Initiated 2/24/2015)														
Site Locations														
2-B1	99	2.9	100	0.0	0.537	0.142	0.789	0.0898	0.529	0.158	0.789	0.0898	13	3.5
2-R1	100	0.0	99	3.5	0.535	0.0550	0.826	0.0761	0.535	0.055	0.814	0.067	6.1	2.5
3-R7	98	4.5	93	8.9	0.484	0.0192	0.748	0.073	0.461	0.0444	0.691	0.0818	5.9	3.5
4-B1	95	5.2	94	7.4	0.488	0.0612	0.733	0.118	0.466	0.0786	0.686	0.113	4.9	2.8
5-B2	93	8.7	90	9.3	0.464	0.0612	0.710	0.131	0.451	0.0512	0.640	0.143	8.3	3.7
8-B2	98	6.2	98	7.1	0.474	0.133	0.784	0.0927	0.461	0.129	0.768	0.127	6.3	3.2
REF-10b[d]	99	2.9	95	9.3	0.529	0.0601	0.861	0.130	0.529	0.0601	0.811	0.105	11	2.8
Tributary and Upstream Locations														
TRIB-3	90	29	99	3.5	0.284	0.227	0.806	0.0627	0.279	0.230	0.796	0.0669	7.6	0.8
G-1	95	6.7	95	7.6	0.509	0.0663	0.657	0.0885	0.470	0.072	0.622	0.0874	9.1	3.2
G-3	100	0.0	96	5.2	0.518	0.0337	0.688	0.0886	0.518	0.0337	0.662	0.0877	7.4	3.2
LAL-2	88	19	75	21	0.415	0.225	0.445	0.343	0.321	0.233	0.367	0.331	3.5	5.4
LAL-3	100	0.0	98	4.6	0.507	0.0853	0.751	0.166	0.507	0.0853	0.739	0.188	9.4	3.0
LAL-5	98	3.9	94	11	0.561	0.0647	0.779	0.135	0.545	0.0541	0.738	0.167	11	4.7
Negative Control (CTL-SS)														
CTL-SS-B2	97	6.5	94	9.2	0.542	0.0744	0.699	0.104	0.529	0.0763	0.655	0.121	8.2	6.0
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B2	97	4.9	98	4.6	0.304	0.120	0.626	0.045	0.286	0.109	0.611	0.0563	3.9	1.8
Batch No.3 (Initiated 3/5/2015)														
Site Locations														
3-B3	98	3.9	96	5.2	0.663	0.0644	0.989	0.0514	0.645	0.0386	0.951	0.0506	14	3.8
3-R8	53	16	53	17	0.172	0.0456	0.552	0.183	0.0783	0.014	0.293	0.152	1.6	1.9
4-B5	74	27	79	31	0.407	0.0955	0.862	0.140	0.256	0.0628	0.660	0.280	5.6	3.1
5-B4	98	3.9	95	7.6	0.506	0.0782	0.771	0.118	0.506	0.0782	0.735	0.130	9.4	3.9
6-B5	96	5.2	93	7.1	0.531	0.0526	0.861	0.095	0.531	0.0526	0.793	0.0632	8.5	3.3
7-B2	99	2.9	96	5.2	0.574	0.0800	0.861	0.0819	0.574	0.0800	0.828	0.0801	12	5.1
REF-10b[d]	100	0.0	94	14	0.511	0.130	0.712	0.272	0.511	0.130	0.695	0.291	8.1	4.3

Table 5-11b. Results for the Long-Term *Hyalella azteca* Bioassays

Sample ID	Survival (%)				Weight[a] (mg/individual)				Biomass[b] (mg/individual)				Number of Offspring/Female	
	Day 28		Day 42		Day 28		Day 42		Day 28		Day 42		Day 42	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Batch No.3 (Initiated 3/5/2015) (continued)														
Tributary and Upstream Locations														
TRIB-3	87	31	74	43	0.525	0.0503	0.454	0.373	0.525	0.0503	0.441	0.389	4.2	6.0
G-1	99	2.9	99	3.5	0.487	0.0667	0.759	0.0975	0.476	0.0787	0.749	0.0974	7.8	1.9
G-2	100	0.0	100	0.0	0.554	0.0806	0.833	0.105	0.554	0.0806	0.833	0.105	11	4.0
G-3	98	5.8	94	18	0.414	0.0829	0.576	0.294	0.414	0.0829	0.572	0.303	5.9	4.2
LAL-3	98	6.2	95	7.6	0.606	0.0489	0.924	0.0300	0.606	0.0489	0.877	0.0707	13	4.5
LAL-5	98	3.9	96	5.2	0.576	0.0466	0.849	0.106	0.562	0.0574	0.821	0.135	9.1	4.0
Negative Control (CTL-SS)														
CTL-SS-B3	100	0.0	95	7.6	0.519	0.0276	0.66	0.107	0.519	0.0276	0.623	0.0799	8.8	3.4
Auxiliary Control (CTL-QS and CTL-ERDC)														
CTL-QS-B3	98	3.9	96	5.2	0.231	0.0908	0.576	0.157	0.231	0.0908	0.556	0.158	2.5	1.7

Notes:

[a] Weight is the total weight divided by the number of survivors.

[b] Biomass is the total weight divided by the initial number of organisms introduced into the test chamber.

[c] Mean survival is greater than 100 percent due to an excess of organisms added at test initiation. Survival is the number of survivors divided by the intended number of organisms seeded at test initiation (i.e., 10 organisms per replicate).

[d] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

SD - standard deviation

Table 5-12. Pupation and Emergence at Day 16 of the Long-Term *Chironomus dilutus* Bioassay

Sample ID	Total Number of Live Organisms at Day 16[a] Larvae	Pupae	Adult	Total Pupation at Day 16 (%)	Total Emergence at Day 16 (%)
Batch 1 (Initiated 2/13/2015)					
Site Locations					
1-B5	31	6	1	12.5	2.1
1B-R2	31	0	0	0	0
1-R2	40	1	0	2.1	0
4-B6	40	3	0	6.3	0
6-B2	39	0	0	0	0
7-B5	33	0	0	0	0
8-B3	36	0	0	0	0
REF-10b[b]	40	2	0	4.2	0
Tributary and Upstream Locations					
TRIB-3	37	0	0	0	0
G-1	48	0	0	0	0
G-3	48	0	0	0	0
LAL-3	25	2	0	4.2	0
LAL-5	31	0	0	0	0
Negative Control (CTL-SS)					
CTL-SS-B1	45	0	0	0	0
Auxiliary Control (CTL-QS and CTL-ERDC)					
CTL-QS-B1	36	6	5	12.5	10.4
Batch 2 (Initiated 2/25/2015)					
Site Locations					
2-B1	38	5	1	10.4	2.1
2-R1	39	6	0	12.5	0
3-R7	45	0	0	0	0
4-B1	45	0	0	0	0
5-B2	46	0	0	0	0
8-B2	42	0	0	0	0
REF-10b[b]	43	4	0	8.3	0
Tributary and Upstream Locations					
TRIB-3	46	0	0	0	0
G-1	47	0	0	0	0
G-3	39	4	2	8.3	4.2
LAL-2	44	0	0	0	0
LAL-3	46	1	0	2.1	0
LAL-5	45	0	0	0	0
Negative Control (CTL-SS)					
CTL-SS-B2	45	1	0	2.1	0
Auxiliary Control (CTL-QS and CTL-ERDC)					
CTL-QS-B2	44	1	0	2.1	0
Batch 3 (Initiated 3/5/2015)					
Site Locations					
3-B3	36	0	0	0	0
3-R8	30	0	0	0	0
4-B5	43	0	0	0	0
5-B4	38	0	0	0	0
6-B5	44	0	0	0	0
7-B2	36	0	0	0	0
REF-10b[b]	48	0	0	0	0
Tributary and Upstream Locations					
TRIB-3	44	1	0	2.1	0
G-1	48	0	0	0	0
G-2	38	0	0	0	0
G-3	45	0	0	0	0
LAL-3	33	0	0	0	0
LAL-5	26	0	0	0	0
Negative Control (CTL-SS)					
CTL-SS-B3	47	1	0	2.0	0
Auxiliary Control (CTL-QS and CTL-ERDC)					
CTL-QS-B3	41	0	0	0	0

Notes:

[a] Total pupation and emergence at Day 16 are presented for the 4 replicates that were selected per sample for evaluation of *C. dilutus* survival, weight, and biomass at Day 16; pupation and emergence for the remaining 8 replicates are captured in the end of test emergence data.

[b] Identified in the QAPP (Exponent et al. 2013) as a potential internal reference location.

CTL-ERDC - ERDC auxiliary control sediment

CTL-QS - quartz sand auxiliary control

CTL-SS - PER negative control sediment

Table 5-13. Slag Content of Sediment Samples (%)[a]

Sample ID	River Mile	Zn/V Ratio[b]	Slag 1	Slag 2	Slag 3	Total Slag[c]	Altered Slag
Site Locations							
SE-1-R5	745	354	25.4	0.119	0.0000	25.5	0.0326
SE-1-R5[d]	745	354	31.0	0.0927	0.0000	31.1	0.038
SE-1-R1	745	303	16.6	0.132	0.0000	16.8	0.205
SE-1-R2	743	398	32.9	0.166	0.0000	33	0.0862
SE-1-B5	738	161	26.3	0.734	0.0000	27	1.23
SE-1-R8	738	225	13.6	0.0000	0.0000	13.6	0.101
SE-1B-R3	735	305	48.0	0.895	0.0000	48.9	0.192
SE-1B-C3	735	186	10.5	0.381	0.0000	10.9	0.156
SE-1B-C1	735	346	29.0	0.0000	0.0000	29	0.498
SE-2-B1	733	28.1	0.234	0.0848	0.0000	0.319	0.0057
SE-2-R1	733	299	22.8	0.0883	0.0000	22.9	0.43
SE-2-B2	733	242	12.2	0.0524	0.0000	12.3	0.0735
SE-2-R3	732	85.4	2.93	0.0716	0.0000	3	0.207
SE-2B-C4	729	389	70.8	0.544	0.0000	71.3	0.609
SE-2B-R1	728	324	23.5	0.179	0.0000	23.6	0.052
SE-2B-C3	727	178	5.44	0.0000	0.0000	5.4	0.574
SE-3-B1	726	420	48.2	0.0512	0.449	48.7	0.0243
SE-3-B2	725	576	71.7	0.689	0.00328	72.4	0.0238
SE-3-C1	724	202	20.1	6.38	0.0000	26.4	0.732
SE-3-B4	724	388	59.8	0.54	0.0000	60.4	0.108
SE-3-B4[d]	724	388	66.5	0.155	0.0000	66.7	0.0628
SE-3-R7	723	430	43.9	0.117	0.0000	44	0.061
SE-3-R7[d]	723	430	62.2	0.51	0.0000	62.7	0.0573
SE-3-R7[d]	723	430	52.2	0.712	0.0000	52.9	0.0818
SE-3-R8	722	494	75.3	0.724	0.0000	76	0.0312
SE-3-R9	722	89.5	3.58	0.0113	0.0000	3.6	0.498
SE-3-C4	722	385	48.9	1.55	0.0000	50.5	0.387
SE-3-R10	721	398	46.1	0.587	0.0000	46.6	0.435
SE-3B-C3	716	463	66.3	0.00000	0.0000	66.3	0.037
SE-4-R1	711	297	45.5	1.5	0.0000	47	0.0646
SE-4-B1	711	393	51.6	0.888	0.0000	52.5	0.179
SE-4-B6	709	418	60.0	0.201	0.0000	60.2	0.145
SE-4-B6[e]	709	418	59.6	0.202	0.0000	59.8	0.193
SE-4-B6[d]	709	418	60.9	0.475	0.0000	61.4	0.561
SE-4-B2	709	420	59.5	0.285	0.0000	59.8	1.23
SE-4-B4	707	302	33.7	1.65	0.0923	35.4	0.551
SE-4-B5	705	382	34.8	2.32	0.0000	37.1	0.229
SE-4-C4	705	22	0.234	0.0000	0.0000	0.234	0.018
SE-4B-C3	692	14.2	0.024	0.0000	0.0000	0.024	0.051
SE-REF-3	689	18.9	0.001	0.0000	0.0000	0.0005	0.0032
SE-5-B2	678	18.7	0.003	0.0000	0.0000	0.003	0.0006
SE-5B-C1	673	8.41	0.013	0.0000	0.0000	0.013	0.0000
SE-6-B4	664	18	0.000	0.0000	0.0000	0.0000	0.0000
SE-6B-C4	652	5.57	0.000	0.0000	0.0000	0.0000	0.0005
SE-7-B1	645	6.97	0.000	0.0000	0.0000	0.0000	0.0011
SE-8-B3	604	17.5	0.000	0.0000	0.0000	0.0000	0.0000
SE-8B-C2	599	12.6	0.000	0.0000	0.0000	0.0000	0.0042
Upstream Location							
SE-LAL-5	NA	2.33	0.000	0.0000	0.0000	0.0000	0.0001

Notes:

[a] Slag content as determined by computer controlled scanning electron microscopy; quality control results using alternative image analysis procedure are discussed in Section 5.6 of this report, and presented in detail in Appendix F of this data summary report.

[b] Final zinc-to-vanadium (Zn/V) ratios are slightly different than the prelimnary Zn/V ratios used to select locations for backscattered scanning electron microscopy analysis.

[c] Total slag is the sum of Slag 1, Slag 2, and Slag 3.

[d] Replicate analysis of re-mounted sample.

[e] Duplicate analysis of same sample mount.

NA - not applicable

Table 5-14. Particle Size of Samples Evaluated for Slag Content

Sample ID	River Mile	Size Class (percent)		
		>4 mm[a]	2-4 mm[b]	<2 mm[b]
Site Locations				
SE-1-R5	745	0.08	0.78	99.22
SE-1-R1	745	0.00	0.00	100.00
SE-1-R2	743	0.00	0.00	100.00
SE-1-B5	738	0.00	1.68	98.32
SE-1-R8	738	0.00	0.00	100.00
SE-1B-R3	735	0.76	22.26	77.74
SE-1B-C3	735	0.02	0.00	100.00
SE-1B-C1	735	0.00	0.00	100.00
SE-2-B1	733	0.25	0.00	100.00
SE-2-R1	733	0.62	1.75	98.25
SE-2-B2	733	0.00	0.00	100.00
SE-2-R3	732	0.00	0.00	100.00
SE-2B-C4	729	0.27	5.95	94.05
SE-2B-R1	728	0.00	4.17	95.83
SE-2B-C3	727	2.27	0.00	100.00
SE-3-B1	726	0.00	1.73	98.27
SE-3-B2	725	1.45	1.76	98.24
SE-3-C1	724	0.00	6.33	93.67
SE-3-B4	724	0.00	1.88	98.12
SE-3-R7	723	0.00	0.36	99.64
SE-3-R8	722	0.00	2.02	97.98
SE-3-R9	722	0.00	0.00	100.00
SE-3-C4	722	0.00	0.00	100.00
SE-3-R10	721	1.32	0.00	100.00
SE-3B-C3	716	0.02	0.60	99.40
SE-4-R1	711	4.58	5.91	94.09
SE-4-B1	711	0.05	0.92	99.08
SE-4-B6	709	0.07	0.23	99.77
SE-4-B2	709	0.17	0.00	100.00
SE-4-B4	707	0.00	0.00	100.00
SE-4-B5	705	0.10	0.00	100.00
SE-4-C4	705	0.00	0.00	100.00
SE-4B-C3	692	0.54	2.33	97.67
SE-REF-3	689	0.14	0.00	100.00
SE-5-B2	678	0.00	0.00	100.00
SE-5B-C1	673	0.00	0.00	100.00
SE-6-B4	664	0.00	0.00	100.00
SE-6B-C4	652	0.00	0.00	100.00
SE-7-B1	645	0.00	0.00	100.00
SE-8-B3	604	0.00	0.00	100.00
SE-8B-C2	599	0.11	0.00	100.00
Upstream Location				
SE-LAL-5	NA	0.00	0.30	99.70

Notes:

[a] Expressed as a percent of the total sample.

[b] Expressed as a percent of the portion of sample less than 4 mm.

NA - not applicable

Table 5-15. Percent Distribution by Size Class for Particles Identified as Slag 1

Sample ID	River Mile	Size Class (µm) for Slag 1 Particles: 15 to 22	22 to 31	31 to 44	44 to 62	62 to 88	88 to 125	125 to 177	177 to 250	250 to 350	350 to 500	500 to 710	710 to 1000	1000 to 1410	1410 to 2000	2000 to 2830	2830 to 4000	>4000	Total % Slag 1[a]
Site Locations																			
SE-1-R5	745	0.0	0.0	0.1	0.2	0.6	0.8	1.4	5.3	14.7	42.7	25.4	8.6	0.0	0.0	0.0	0.0	0.0	25.4
SE-1-R5[b]	745	0.0	0.1	0.1	0.4	0.6	0.7	1.2	6.2	17.7	33.4	33.8	5.7	0.0	0.0	0.0	0.0	0.0	31.0
SE-1-R1	745	0.1	0.1	0.3	0.7	1.3	1.7	8.0	16.8	33.9	33.4	3.7	0.0	0.0	0.0	0.0	0.0	0.0	16.6
SE-1-R2	743	0.1	0.0	0.1	0.4	0.6	1.0	1.9	9.2	22.6	49.6	14.5	0.0	0.0	0.0	0.0	0.0	0.0	32.9
SE-1-B5	738	0.0	0.1	0.3	0.6	1.1	1.2	3.9	10.9	25.1	30.6	26.2	0.0	0.0	0.0	0.0	0.0	0.0	26.3
SE-1-R8	738	0.0	0.1	0.2	0.8	1.3	2.4	7.1	25.4	35.6	27.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6
SE-1B-R3	735	0.0	0.0	0.1	0.2	0.3	0.3	0.4	0.9	4.2	29.2	49.0	15.3	0.0	0.0	0.0	0.0	0.0	48.0
SE-1B-C3	735	0.2	0.2	0.5	0.9	2.4	3.9	14.7	29.4	29.4	16.4	2.1	0.0	0.0	0.0	0.0	0.0	0.0	10.5
SE-1B-C1	735	0.0	0.1	0.2	0.3	0.5	1.3	3.4	7.1	21.6	44.1	21.2	0.0	0.0	0.0	0.0	0.0	0.0	29.0
SE-2-B1	733	0.0	0.0	0.7	1.6	2.8	10.5	21.0	17.8	0.0	45.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.234
SE-2-R1	733	1.6	2.9	3.8	3.8	7.2	6.6	20.3	31.8	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8
SE-2-B2	733	0.0	0.1	0.3	0.5	0.9	1.8	5.6	14.3	42.3	30.1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2
SE-2-R3	732	0.2	0.5	1.3	4.9	11.5	20.1	34.7	24.5	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.93
SE-2B-C4	729	0.0	0.0	0.1	0.1	0.3	0.2	0.3	1.2	3.2	21.1	46.2	26.1	1.2	0.0	0.0	0.0	0.0	70.8
SE-2B-R1	728	0.0	0.1	0.1	0.5	0.6	0.6	0.9	5.1	12.5	29.3	30.7	15.8	3.7	0.0	0.0	0.0	0.0	23.5
SE-2B-C3	727	0.4	1.0	2.8	5.2	7.9	18.3	26.7	33.4	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.44
SE-3-B1	726	0.0	0.0	0.1	0.4	0.8	0.5	1.6	5.0	13.3	33.4	32.0	12.7	0.0	0.0	0.0	0.0	0.0	48.2
SE-3-B2	725	0.0	0.0	0.0	0.0	0.2	0.5	0.3	0.7	2.8	12.9	37.4	33.5	10.4	1.2	0.0	0.0	0.0	71.7
SE-3-C1	724	0.0	0.0	0.2	0.2	0.5	0.2	1.5	1.9	5.4	14.1	38.3	31.7	5.9	0.0	0.0	0.0	0.0	20.1
SE-3-B4	724	0.0	0.1	0.1	0.2	0.5	0.5	1.0	2.4	8.2	19.5	40.3	23.3	3.8	0.0	0.0	0.0	0.0	59.8
SE-3-B4[b]	724	0.1	0.1	0.2	0.3	0.7	0.3	0.6	1.6	8.5	26.7	34.6	23.5	2.7	0.0	0.0	0.0	0.0	66.5
SE-3-R7	723	0.0	0.0	0.2	0.3	0.5	0.5	0.7	2.6	10.9	23.9	38.9	17.7	3.8	0.0	0.0	0.0	0.0	43.9
SE-3-R7[b]	723	0.0	0.1	0.2	0.3	0.5	0.5	1.1	5.2	18.0	28.8	29.7	15.5	0.0	0.0	0.0	0.0	0.0	62.2
SE-3-R7[b]	723	0.0	0.1	0.2	0.3	0.5	0.4	0.7	2.8	9.2	31.0	33.3	16.8	4.8	0.0	0.0	0.0	0.0	52.2
SE-3-R8	722	0.1	0.1	0.1	0.1	0.2	0.1	0.4	0.7	1.9	13.1	38.7	35.3	8.1	1.0	0.0	0.0	0.0	75.3
SE-3-R9	722	0.2	0.2	1.2	1.4	4.9	5.4	19.3	16.6	47.3	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.58
SE-3-C4	722	0.0	0.0	0.1	0.2	0.3	0.4	1.1	1.6	6.6	35.2	42.3	12.2	0.0	0.0	0.0	0.0	0.0	48.9
SE-3-R10	721	0.0	0.1	0.2	0.4	1.0	1.5	3.5	10.0	27.5	36.3	17.3	2.0	0.0	0.0	0.0	0.0	0.0	46.1
SE-3B-C3	716	0.0	0.1	0.2	0.3	0.4	0.5	0.9	3.1	7.2	28.2	34.9	22.7	1.4	0.0	0.0	0.0	0.0	66.3
SE-4-R1	711	0.0	0.0	0.1	0.2	0.4	0.4	1.0	2.3	8.0	28.0	37.2	19.7	2.5	0.0	0.0	0.0	0.0	45.5
SE-4-B1	711	0.0	0.1	0.1	0.2	0.4	0.3	0.6	2.3	7.7	28.2	42.1	14.8	3.2	0.0	0.0	0.0	0.0	51.6
SE-4-B6	709	0.0	0.0	0.1	0.2	0.6	0.6	1.1	3.9	16.0	41.4	30.0	4.5	1.5	0.0	0.0	0.0	0.0	60.0
SE-4-B6[c]	709	0.0	0.1	0.1	0.3	0.5	0.6	1.2	3.8	15.4	39.8	29.2	7.6	1.5	0.0	0.0	0.0	0.0	59.6
SE-4-B6[b]	709	3.9	2.6	4.8	1.3	7.6	0.0	0.0	0.0	0.0	32.8	45.7	0.0	0.0	0.0	0.0	0.0	0.0	60.9
SE-4-B2	709	0.0	0.1	0.1	0.2	0.5	0.3	0.8	3.3	14.8	37.4	36.7	4.2	1.6	0.0	0.0	0.0	0.0	59.5
SE-4-B4	707	0.0	0.1	0.1	0.2	0.5	0.7	2.0	6.1	19.8	43.7	23.9	2.8	0.0	0.0	0.0	0.0	0.0	33.7
SE-4-B5	705	0.0	0.0	0.1	0.2	0.2	0.2	0.6	1.1	3.7	41.0	42.2	10.5	0.0	0.0	0.0	0.0	0.0	34.8
SE-4-C4	705	0.8	4.8	15.0	21.7	50.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.234
SE-4B-C3	692	14.5	28.9	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.024
SE-REF-3	689	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001
SE-5-B2	678	40.6	59.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.003
SE-5B-C1	673	0.0	14.3	19.2	0.0	66.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.013
SE-6-B4	664	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000
SE-6B-C4	652	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000
SE-7-B1	645	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000
SE-8-B3	604	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000
SE-8B-C2	599	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000

Table 5-15. Percent Distribution by Size Class for Particles Identified as Slag 1

Sample ID	River Mile	Size Class (µm) for Slag 1 Particles: 15 to 22	22 to 31	31 to 44	44 to 62	62 to 88	88 to 125	125 to 177	177 to 250	250 to 350	350 to 500	500 to 710	710 to 1000	1000 to 1410	1410 to 2000	2000 to 2830	2830 to 4000	>4000	Total % Slag 1[a]
Upstream Location																			
SE-LAL-5	NA	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	NA[d]	0.000
Minimum		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum		40.6	59.4	50	21.7	66.5	20.1	34.7	33.4	47.3	49.6	49	35.3	10.4	1.2	0	0	0	75.3
Mean		1.5	2.8	2.5	1.2	4.3	2.3	4.6	7.6	12.9	24.1	22.8	9.1	1.4	0.1	0.0	0.0	0.0	30.8

Notes:

Note that these data are based on apparent particle sizes that were estimated by computerized methods that detect particle periphery in the plane of the polished section during electron microscopy analysis. There are uncertainties associated with these estimates because the actual particle size can only be measured where the analyzed polished section of the sample bisects a particle's exact maximum circumference, which is unknown to the investigator.

[a] Content of Slag 1 relative to total sample material, as presented in Table 5-13.

[b] Replicate analysis of remounted sample

[c] Duplicate analysis of same sample mount

[d] Not applicable because no particles were identified as Slag 1.

NA - not applicable

APPENDIX A

FIELD ACTIVITY REPORT

Upper Columbia River

Field Activity Report for the Phase 2 Sediment Study September 5 – October 24, 2013

Prepared for:

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February 2014, revised April 2017

URS Project No. 36310189
AECOM Project No. 60535657

URS

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ACRONYMS

CCT	Confederated Tribes of the Colville Reservation
COPC	contaminants of potential concern
DI	distilled deionized
DOC	dissolved organic carbon
D-TAL	dissolved target analyte list metals
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
ER	equipment rinsate
GPS	global positioning system
Gravity	Gravity Environmental, LLC
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high density polyethylene
Hg	mercury
IDW	investigation derived wastes
LAL	Lower Arrow Lake
LRNRA	Lake Roosevelt National Recreation Area
NPS	National Park Service, U.S. Department of the Interior
PW	porewater
QAPP	Quality Assurance Project Plan
Ref	Reference
RI/FS	remedial investigation/feasibility study
RM	river mile
STI	Spokane Tribe of Indians
SOPs	standard operating procedures
TAI	Teck American Incorporated
TOC	total organic carbon
Trib	tributary
T-TAL	total target analyte list metals
UCR	Upper Columbia River

USGS	United States Geological Survey, U.S. Department of the Interior
UTM	Universal Transverse Mercator, North American Datum 1983 (NAD 83)
WQP	water quality parameters

1 INTRODUCTION

1.1 PROJECT BACKGROUND

This document presents a summary report for the 2013 Phase 2 field sediment sampling conducted by URS Corporation (URS) during the period September 5, 2013, through October 24, 2013. Field activities were performed in accordance with the *Final Quality Assurance Project Plan for the Phase 2 Sediment Study*,; dated March 2013 and amended September 2013 (Exponent et al., 2013). This work was conducted as part of the Upper Columbia River (UCR) (herein the 'Site') Remedial Investigation and Feasibility Study (RI/FS) on behalf of Teck American Incorporated (TAI). The objective of the RI/FS is to investigate the nature and extent of unacceptable risk at the Site to human health and the environment; and to develop and evaluate potential remedial alternatives for the Site. The primary objective of the Phase 2 sediment study is to evaluate if there are unacceptable risks to benthic invertebrates (herein "benthos") associated with exposure to metals and other chemicals in Site sediments.

The Quality Assurance Project Plan (QAPP), as approved by the United States Environmental protection Agency (EPA), described the organization, data quality objectives (DQOs), study design, analytical procedures, and quality assurance and quality control (QA/QC) procedures upon which the Phase 2 sediment study was based. Sediment toxicity to benthos will be evaluated using field-collected sediments from representative locations throughout the Site (Exponent et al., 2013).

This report presents the final sample locations, the sample collection procedures and methodologies, QAPP modifications and deviations, and tabulation of the field data collected during the sediment sampling program.

Activities described herein were conducted under the direct oversight of EPA or their authorized representatives and in strict accordance with the QAPP; Special Use Permit number PWR LARO TCAI-007 issued by the United States Department of the Interior; National Park Service; and Research Permit 2013-09 approved by the Colville Business Council (acting for and on behalf of the Colville Confederated Tribes) in special session meeting on September 5, 2013. Sampling in Canada was performed in accordance with an approval letter from Natural Resources Canada dated July 4, 2013. These permits and approval are attached as Appendix A.

1.2 SITE DESCRIPTION

The Site extends from Grand Coulee Dam at river mile (RM) 596 to the US-Canada border at RM 745. Map 1 shows an overview of the sediment sampling locations within the Site. Maps 2 through 6 show sediment sampling locations for Tiles 1 through 5 respectively, as defined in the QAPP. Map 7 shows the sediment sampling locations in Canada.

During the Phase 2 sediment field sampling program samples were collected as follows:

- 110 sediment samples from primary or reserve locations distributed along the Site

- 10 sediment samples from anticipated internal reference locations within the Site between RM 601 and RM 699
- Attempts were made to collect sediment at 47 additional Site locations which produced no usable sediment based on criteria specified in the QAPP.
- 14 field duplicate sediment samples (10 percent) spaced intermittently during the field sampling effort
- 30 split-sediment samples were provided to EPA for QA/QC purposes; 10 for bioassay analyses and 20 for chemistry analyses

In addition to the above-listed samples, 6 sediment samples were collected from reference locations located in adjacent tributaries between RM 685 and RM 726; 10 sediment samples were collected from upstream reference locations in Canada with permission from the Government of Canada; 101 porewater samples were collected from the 136 sediment sampling locations in the US and Canada. Finally, 240 equipment rinsate samples and one porewater sampling equipment method blank sample were collected to evaluate equipment decontamination procedures. A summary of project-specific sampling is presented in Section 3 of this report.

Consistent with permit requirements from both the Confederated Tribes of the Colville Reservation (CCT) and the National Park Service (NPS), additional sediment was collected and transferred under chain-of-custody to CCT and NPS representatives. Given that these samples are not related to the RI/FS they will no longer be discussed herein.

1.3 SAMPLING OVERVIEW

The sampling program consisted of collecting below-water sediment and corresponding porewater samples from locations specified by the EPA-approved QAPP. Sediment was collected using a decontaminated Van Veen power grab sampler (herein ‘grab sampler’). Samples were obtained from the top 6 inches of the recovered sediment. Porewater samples were collected from the same 6-inch sediment horizon within the grab sampler; or from the sediment after being placed into a dedicated Lexan® tub.

Sediment samples were collected from a circular area with a 150-foot radius centered on locations identified in the QAPP unless otherwise specified in this report (see Section 4 for deviations and changes to the QAPP). As many as nine grab sample attempts were specified in the QAPP to collect sufficient sediment for a sample. Tributary samples were collected using hand-operated sampling equipment from areas where fine-grained sediment was visually observed. Sampling locations and stations where sampling was unsuccessful based on QAPP specified criteria (e.g., coarse-grained sediments) are illustrated on Map 1. Location identifiers and river mile information for sampling stations within the Site are presented on Maps 2 through 6. Sampling locations in Canada are shown on Map 7.

The sampling program started on September 5, 2013, and was completed on October 24, 2013. Table 1 presents the initially planned baseline sampling schedule as compared with the actual sampling schedule. As illustrated within Table 1, sampling was completed 2 days ahead of the planned completion date.

1.4 PROJECT STAFFING

URS provided a nine-person field crew consisting of two, three-person, on-water sampling teams and one, three-person shore support crew. Each on-water sampling team was led by a licensed geologist or engineer, and was staffed with one professional archaeologist meeting the Secretary of Interior's Professional Qualification Standards as outlined in 36 Code of Regulations (CFR) Part 61. The field crew was responsible for completing, monitoring, and documenting the sampling process, physical descriptions of samples and conditions, and general observations.

Cultural resources monitoring direction was provided by cultural resource monitors from the CCT, NPS, or Spokane Tribe of Indians (STI). TAI contracted with URS to provide professional archaeologists assist with sample collection and to compile notes and author a separate Cultural Resources Monitoring Report. To avoid vandalism and restrict information about the location of archaeological sites, the Cultural Resources Monitoring Report is classified confidential pursuant to Section 304 of the National Historic Preservation Act, Section 9(a) of the Archaeological Resources Protection Act, and Washington State laws RCW 27.53.070 and RCW 42.56.300.

Gravity Environmental LLC (Gravity) provided two sampling boats from which all on-water sampling activities were completed. In addition, Gravity provided two additional vessels for safety and support for the sampling crews. Columbia Navigation, Inc. was contracted through Gravity to provide additional safety and logistical support. Columbia Navigation, Inc. provided one additional support boat.

1.5 CULTURAL RESOURCES

In accordance with the protocols outlined in Cultural Resources Coordination Plan of the EPA-approved QAPP, cultural resources monitors were present with each sampling team on the sampling vessels throughout the duration of the field program. The NPS provided cultural resources personnel when sediment sampling occurred on lands/waters managed by the NPS within the jurisdiction of the Lake Roosevelt National Recreation Area (LRNRA). Boat assignments for the various cultural resource monitors were discussed with representatives from EPA, CCT, NPS, STI, and URS prior to field activities and during the daily morning meetings.

All sediment was visually examined as it was released from the grab sampler and again when the sediment was manually transferred from the Lexan® tub to dedicated 5-gallon high-density polyethylene (HDPE) containers (buckets). Consistent with the cultural resources coordination plan, a confidential report presenting results of archaeological monitoring activities and findings has been submitted to EPA under separate cover.

1.6 TECHNICAL OVERSIGHT AND OBSERVERS

Technical oversight for the project was provided by the EPA or their designated subcontractor (CH2M Hill) throughout the duration of the project. Technical oversight personnel were present with each sampling team for the entire operational day. Technical oversight observers were provided the opportunity to ask questions of the URS field coordinator, on-water sampling leads, and cultural resource monitors; and to participate in open dialogue regarding the sampling procedures relative to the EPA-approved QAPP. A daily safety meeting attendance record documenting the onsite project related personnel is provided in Appendix B. The following is a list of the on-boat technical oversight observers:

EPA Technical Oversight Personnel (September 5 through October 24, 2013)

Observer	**Organization**
Dr. Laura Buelow	EPA
Matt Wilkening	EPA
Monica Tonel	EPA
Burt Shephard	EPA
Andrea Latier	EPA
Marc Stifelman	EPA
Marylyn Gauthier	CH2M Hill
Cameron Irvine	CH2M Hill
Nicole Badon	CH2M Hill
Mark Endo	CH2M Hill
Mario Lopez	CH2M Hill

The NPS, U.S. Fish and Wildlife (USFW), U.S. Geological Survey (USGS), and Washington Department of Ecology (Ecology) also observed sampling activities conducted within LRNRA. These observers accepted custody of NPS/CCT split samples collected at bioassay sampling locations within the LRNRA jurisdiction.

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Tuesday, September 03, 2013			Mobe to Canada	Mobe to Spokane	Field Preparation with Canada Crew
Wednesday, September 04, 2013			Field Preparation	Mobe to Canada	
Thursday, September 05, 2013	Trail, BC	CCT as Guest of Canadian Government	G-1	G-1	
			G-2	G-2	
Friday, September 06, 2013	Trail, BC	CCT as Guest of Canadian Government	G-3	G-3	
			G-4	G-4	
Saturday, September 07, 2013	Scotty's Marina	CCT as Guest of Canadian Government	LAL-4	LAL-4	
			LAL-5	LAL-5	
			LAL-6	LAL-6	
Sunday, September 08, 2013	Scotty's Marina	CCT as Guest of Canadian Government	LAL-1	LAL-1	
			LAL-2	LAL-2	
				LAL-3	
Monday, September 09, 2013	Scotty's Marina		LAL-3	Off Day	
Tuesday, September 10, 2013			Planned Mobe Day	Mobe Day	Field Management Team Met with Teck in Spokane while Remaining Crew Mobes to Two Rivers
Wednesday, September 11, 2013					Field Preparation with Full Crew
Thursday, September 12, 2013	Two Rivers	CCT and STI	7B-C2	7B-C2	
			7-C4	7-C4	
			7B-C3	7B-C3	
			7-C3	7-C3	
Friday, September 13, 2013	Two Rivers	CCT and STI	7-B2	7-B1	
			7-B5	7-B5	
			7-B3	7-B3	
			7-B4	7-B4	
			7-B6	7-B6	
				Ref-7	
Saturday, September 14, 2013	Two Rivers	CCT and STI	6B-C2	6B-C2	
			Ref-6	Ref-6	
			7-B1		
			Ref-7		
Sunday, September 15, 2013					
Monday, September 16, 2013	Two Rivers	CCT and NPS	6B-C3	6B-C3	
			6B-C4	6B-C4	
			7-C1	7-C1	
			7-C2	7-C2	
				7-B2	
				7B-C1	
				7B-C4	
				Ref-8	

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Tuesday, September 17, 2013	Two Rivers		7B-C1	Mobe Day	
			7B-C4		
			Ref-8		
Wednesday, September 18, 2013	Spring Canyon	CCT and NPS	Planned Mobe Day	8B-C1	
				8B-C3	
				8B-C4	
				8B-C2	
				8-C3	
				Ref-10	
				Ref-10B	
Thursday, September 19, 2013	Spring Canyon	CCT and NPS	8B-C1	8B-C1	
			8B-C3	8-B3	
			8B-C4	8-B4	
			8B-C2	8-C4	
			8-C3	8-B2	
			Ref-10	Ref-9	
				Ref-9B	
Friday, September 20, 2013	Spring Canyon	CCT and NPS	8-B3	8-B5	
			8-B4	8-B6	
			8-C4	8-B1	
			8-B2	8-C2	
			Ref-9		
Saturday, September 21, 2013	Spring Canyon	CCT	8-B5	8-C1	
			8-B6		
			8-C1		
			8-B1		
			8-C2		
Sunday, September 22, 2013					
Monday, September 23, 2013	Spring Canyon		Planned Catch-up-Day / Off Day	Mobe Day	
Tuesday, September 24, 2013		STI and NPS	Planned Mobe Day	6B-C1	
				6-C4	
				6-B5	
				6-B6	
				6-C3	
Wednesday, September 25, 2013	Gifford	STI and NPS	6B-C1	6-B2	
			6-C4	6-C1	
			6-B5	6-C2	
			6-B6	6-B1	
			6-C3	6-B3	
				6-R3	

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Thursday, September 26, 2013	Gifford	STI and NPS	6-B2	6-B4	
			6-C1	5B-C2	
			6-C2	5B-C3	
			6-B1	5B-C4	
			6-B3	Trib-1	
Friday, September 27, 2013	Gifford	STI and NPS	6-B4	5-B4	
			5B-C1	5B-C1	
			5B-C2	5-B5	
			5B-C3	5-B6	
			5B-C4	5-C4	
				Ref-5	
				Ref-5B	
Saturday, September 28, 2013	Gifford	STI and NPS	5-B5	5-C3	
			5-B6	5-B1	
			5-C4	5-B2	
			Ref-5		
Sunday, September 29, 2013					
Monday, September 30, 2013	Gifford	STI and NPS	5-B4	5-B3	
			5-C3	5-C1	
			5-B1	5-C2	
			5-B2	Ref-4	
Tuesday, October 01, 2013	Gifford	STI and NPS	5-B3	4B-C4	Federal Government Shuts Down
			5-C1	Ref-2	
			5-C2	Ref-3	
			Ref-4	Trib-3	
Wednesday, October 02, 2013	Gifford		Trib-1	Off Day	
			Trib-3		
			4B-C4		
Thursday, October 03, 2013	Gifford		Planned Catch-up-Day / Off Day	Mobe Day	
Friday, October 04, 2013		CCT and NPS	Planned Mobe Day	Ref-1	
				4-C4	
				4-C5	
				4B-C1	
				4B-C2	
				4B-C3	
Saturday, October 05, 2013	Kettle Falls	CCT and NPS	4B-C2	4-B2	
			4B-C3	4-B3	
			Ref-1	4-B4	
			Ref-2	4-B5	
			Ref-3	4-C3	
				4-C6	

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Sunday, October 06, 2013					
Monday, October 07, 2013	Kettle Falls	CCT and NPS	Trib-2	Trib-2	
			4-B5	4-B1	
			4B-C1	4-C1	
			4-C4	4-C2	
			4-C5		
			4-C6		
Tuesday, October 08, 2013	Kettle Falls	CCT and NPS	4-B2	3B-C1	
			4-B4	3B-C2	
			4-B3	3B-C3	
			4-C2	3B-C4	
			4-C3	4-B6	
				3-C4	
				4-R5	
Wednesday, October 09, 2013	Kettle Falls	CCT and NPS	4-B1	Trib-4	Sampling Vessel 'Tahoma' Breaks Down
			4-B6	Trib-5	
			4-C1		
			3B-C3		
			3B-C4		
Thursday, October 10, 2013	Kettle Falls	CCT	Trib-4	Trib-6	One Sampling Crew Working
			Trib-5		Boat Crews Conducting Maintenance
			3-C4		
			3B-C1		
			3B-C2		
Friday, October 11, 2013	Kettle Falls		Planned Catch-up-Day / Off Day	Off Day	
Saturday, October 12, 2013			Planned Mobe Day	Off Day	
Sunday, October 13, 2013				Mobe Day	
Monday, October 14, 2013	China Bend	CCT and NPS	3-B5	3-B4	
			3-C3	3-B5	
			3-B4	3-R2	
			3-B6	3-R5	
				3B-R1	
				3B-R2	

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Tuesday, October 15, 2013	China Bend	CCT and NPS	3-C2	3-B6	
			3-B2	3-C1	
			3-B3	3-C2	
			3-C1	3-C3	
				3-R3	
				3-R6	
				3-R7	
				3-R10	
				2-R9	
				2-R10	
Wednesday, October 16, 2013	China Bend	CCT and NPS	3-B1	3-B1	
			2B-C3	3-B2	
			2B-C2	3-B3	
			2B-C1	2B-C3	
				2B-R3	
				2B-R4	
Thursday, October 17, 2013	China Bend	CCT and NPS	2B-C4	3-R1	Federal Government Resumes Business
			2-B6	2-B4	
			2-B5	2B-C1	
			2-B4	2B-C2	
				2-R2	
				2-R4	
				2-R7	
				2B-R1	
Friday, October 18, 2013	China Bend	CCT	2-C3	1-B5	Sampling Crews out of Lake Roosevelt National Recreational Area
			2-C4	2-C2	
			2-B3	2-C3	
			2-C2	2-C4	
			Trib-6	2-R3	
				2-R5	
				2-R6	
				1-R10	
Saturday, October 19, 2013		CCT	Planned Off Day	2-C1	One Sampling Crew Working
				1-R3	
				1-R6	
Sunday, October 20, 2013					

Table 1-1. Planned Versus Actual Field Sampling Schedule, Fall 2013
Upper Columbia River Phase 2 Sediment Study

Date	Boat Launch	Cultural Oversight	Proposed Sampling Location	Actual Sampling Location	Notes
Monday, October 21, 2013	Northport	CCT	2-C1	1-B1	
			1B-C4	1-B3	
			2-B2	1-B6	
			2-B1	1-C1	
				1-C4	
				1-R1	
				1-R2	
				1-R4	
				1-R7	
				1-R8	
Tuesday, October 22, 2013	Northport	CCT	1B-C2	1-B2	
			1B-C1	1-C1	
			1B-C3	1-C2	
			1-B4	1B-C1	
				1B-C2	
				1B-C3	
				1-R5	
				1-R9	
				1B-R1	
				1B-R2	
Wednesday, October 23, 2013	Northport	CCT	1-B5	2-B1	
			1-C1	2-B2	
			1-B6	2-B3	
			1-C3	1-B4	
				1B-C4	
				2-R1	
				1B-R3	
				1B-R4	
Thursday, October 24, 2013	Northport	CCT and NPS	1-B3	2B-C4	Three Cultural Resource Observers Present; one NPS observer and two CCT observers as requested by the CCT.
			1-C2	4-R1	
			1-B2	2B-R2	
				3-R8	
				3-R9	
Friday, October 25, 2013	Northport		1-B1	Demobe Crews	Sample Acid Rinse Water Stored in Kettle Falls for Disposal Purposes
			1-C4		
Saturday, October 26, 2013	Northport		Catch-up-Day / Off Day		Deliver Final Group of Samples to Laboratory
Sunday, October 27, 2013			Demobe Crews		

Notes:
CCT - Confederated Tribes of the Colville Reservation
NPS - National Park Service
STI - Spokane Tribe of Indians

2 PHASE 2 SEDIMENT SAMPLING METHODOLOGY

Sampling activities were performed in accordance with the Standard Operating Procedures (SOPs) listed in the Field Sampling Plan (Appendix A of the EPA-approved QAPP), unless otherwise detailed herein (see Section 4 for deviations and changes). SOPs provide guidance and instructions on items, such as boat positioning, field documentation, below-water grab sampling procedures, tributary sampling procedures, porewater sampling procedures, sample labeling and management, equipment decontamination, and chain-of-custody protocols.

2.1 SCOPE OF WORK

The scope of work for the Phase 2 sediment sampling program included:

- Coordinating and scheduling the field sampling program with TAI, subcontractors, technical observers, cultural observers, and representatives from the various federal, state, and local agencies and participating parties.
- Obtaining and decontaminating approximately 400 5-gallon buckets, sampling equipment, materials, and supplies, monitoring equipment such as cameras, hand-held global positioning system (GPS) units, and decontamination supplies pursuant to the QAPP.
- Preparing a project-specific Health and Safety Plan for URS and subcontractors to supplement the general Site health and Safety Plan (SHSP).
- Obtaining and/or preparing field documentation, such as field sample logs, chain-of-custodies, field record notebooks, and related location and station coordinate references.
- Mobilizing equipment, boats and sampling teams.
- Conducting a daily review of sample procedures, boat operations, and health and safety protocols during morning meetings prior to field activities.
- Collecting daily attendance records and health and safety signature acceptance from all onsite participants (includes oversight personnel and observers) (Appendix B) with the exception of NPS staff who operated under their own safety program,
- Conducting station sampling and recording pertinent field data as outlined in the EPA-approved QAPP.
- Transferring of samples to ALS Environmental laboratory (ALS) in Kelso, Washington, using chain-of-custody protocols outlined in the EPA-approved QAPP.

2.2 SAMPLING METHODOLOGY

This section describes the general methods used for sampling and sample handling at each of the 172 locations visited during the Phase 2 field sampling program.

2.2.1 SAMPLE LABELING

Sampling identification and labeling was derived from SOP-2. Sample identification includes project name, and a distinct sample number, date and time of sample collection, sampler initials, analyses requested, and the presence of any sample preservatives.

Each sample was assigned a unique identifier as follows:

- Sediment samples were identified with the prefix 'SE-,' followed by the station identification (ID) number in Table A1 of the Field Sampling Plan in the QAPP. An example of a sediment sample identification number for station 8-C2 is 'SE-8-C2.'
- Duplicate sediment samples were identified and sequentially labeled as MUD0001, MUD0002… MUD0016.
- Porewater samples were identified with the prefix 'PW-,' followed by the station ID number. An example of a porewater sample identification number for station ID 8-C1 is 'PW-8-C1.'
- Equipment rinsate samples were identified with the prefix 'ER-,' followed by the station ID number of last station sampled by that sample crew that day, followed by the boat code 'TI' (Tieton) or 'TA,' (Tahoma), followed by a number 1 through 5 based on the number of equipment pieces used that day. An example of an equipment rinsate identification number is 'ER-8-B3-TI-1' corresponding to a rinsate sample collected for one piece of sampling equipment used on the Tieton that day. The location ID '8-B3' identifies the last location sampled by that crew that day.

The unique sample identifier was used to provide a specific reference to the individual samples. This identifier was recorded on the appropriate field sampling form and chain of custody. One sampling form was completed for each grab sample attempted. Completed field sampling forms were electronically scanned and are included as Appendix C. Complete chain-of-custody forms are included as Appendix D.

Field duplicate sediment samples were identified with a unique identification number to prevent the analytical laboratory from associating duplicate samples with respective primary samples. The association was recorded on the appropriate sampling form (see Appendix C), but not provided to the laboratory.

2.2.2 DECONTAMINATION

Decontamination of field sampling equipment ensures sample integrity and minimizes cross-contamination during sample handling. Decontamination methods followed those outlined in SOP-4. The following decontamination procedures were used for field equipment, including the grab samplers (provided by Gravity), Lexan® collection tubs, 5-mm sediment sieves, stainless steel sediment mixer paddles, and sample scoops.

All sediment sampling equipment were decontaminated prior to daily sample collection and after sampling at each of the stations. Decontamination procedures included:

- Rinse of the equipment with site water to remove visible sediment debris
- Spraying with a dilute Liquinox™ solution followed by scrubbing using a plastic brush with rigid bristles on the inside and outside surfaces
- Second rinse with site water to remove washing solution
- The sampling equipment was then rinsed with a dilute acid solution (5 percent nitric acid)
- Final rinse using laboratory grade deionized (DI) water

All porewater sample collection equipment (e.g., suction devices, tubing) and 5-gallon buckets were decontaminated by ALS prior to shipment to the field team for use. The 5-gallon buckets were wrapped and sealed in plastic wrap prior to transport to the field. Once cleaned by ALS, porewater sampling equipment were assembled into complete kits and placed in re-sealable plastic bags for storage until needed. The kits were shipped to the field crew sealed and ready for use.

2.2.3 SAMPLING COLLECTION METHODS AND PROTOCOLS

Sampling methods and protocols used were defined in SOP-1, SOP-3, SOP-3A, and SOP-5 through SOP-7 of the Field Sampling Plan (Appendix A of the QAPP).

Boat Positioning at Sample Stations. Accurate station positioning is required to help ensure quality and consistency in collecting samples and in data interpretation and analysis. The sampling boats were maneuvered to the best of the captain’s ability to the designated sample station as provided in Table A1of the EPA-approved QAPP. The first boat position in which a sediment grab sample was attempted was the designated coordinate in Table A1 of the EPA approved QAPP or an alternate location within the 150-foot radius circle if the field team leader, in consultation with EPA oversight personnel, determined through best professional judgment that the alternative location would likely be more successful. Primary variables affecting the ability of the sampling boat to achieve and hold the designated station coordinates included velocity of the river, wind velocity, and accuracy of the digital global positioning system (GPS) equipment which can vary given position on the Earth and solar interferences. Nobeltec™ marine navigation software and a digital GPS antenna connected to a Panasonic Toughbook™ laptop was employed by the sampling boat captains to manage the boat positioning. GPS antennas were located on the top of the sampling boat’s cabin. Corrections were programed into the positioning software to adjust for the distance from the antenna to the sampling boom that deployed the grab samplers.

The Gravity boat captain maintained position within the perimeter of the 150-foot radius station under power when slack water, eddy, or slow river currents allowed for safe maneuvering.

The boats containing both EPA oversight personnel and NPS observers remained motorized during sample collection and then moored to the sampling boats or moved within a safe observational distance to directly observe and discuss sampling activities. Once a representative sediment sample was collected from a location all boats associates with that particular sampling activity proceeded to shore for sample processing. All decisions regarding safety and boat maneuvering were made by the respective boat captains in consultation with the URS boat lead and, when appropriate, EPA-approved observers.

Up to nine grab attempts from within the 150-foot approved sampling radius of a sample location were performed to obtain a representative sample. If a representative sample was not obtained after nine attempts, the Field Team Leader consulted with EPA oversight personnel to determine whether additional grabs at this sample station would be attempted or if moving to a reserve location was necessary.

Sediment sampling was not attempted at four locations (2-B5, 2-B6, 1-R10, and1-B2) because of unsafe conditions based on best professional judgment of the boat captain (e.g., high river flow rates). These decisions were discussed with EPA oversight personnel prior to moving to a designated reserve station. Table 2-1 shows the sequence that reserve stations were utilized during the project and the associated primary station.

On-Water Sample Collection. The boat captain maneuvered the boat to a given station and then signaled the crew to lower the grab sampler. Two types of grab samplers were available: pneumatically activated grab samplers and mechanically activated grab samplers. Typically sampling crews used the pneumatically activated grab samplers, however the mechanical samplers were used for sampling at extreme depth where pressures could damage the pneumatic grab samplers (i.e., >260 feet below water surface).

Grab samplers were lowered to the river bottom at an approximate rate of 30 centimeters per second (cm/sec) [1-foot per second (ft/sec)]. Upon contact with the river bottom, the pneumatically activated grab sampler was triggered to close and collect the sediment sample. In situations where a mechanically activated grab sampler was used, when the sampler reached the bottom, the line holding the sampler went slack releasing the mechanism that locks the sampler open. After resting on the bottom approximately 5 seconds, the sampler retrieval processes was commenced. As the line became taught the sampler closed collecting the sediment sample.

Grab samplers were then raised to the surface at an approximate rate of approximately 30 cm/sec (about 1 ft/sec), maneuvered over the deck using the boom, and placed into a cradle specifically designed to safely hold the loaded sampler. At this point the pH of the sediment was measured using a hand-held field pH meter that was calibrated daily. Copies of all pH meter calibration forms are included in Appendix C. Once the grab sampler was secured and the pH measured, the collected sediment was inspected for acceptability following the criteria specified in SOP-3.

Once inspected for acceptability, the bulk sediment sample was placed into a decontaminated transparent Lexan® tub to facilitate cultural resource observations. Onboard cultural resource monitors examined the sediment to determine if cultural resources were present. At no time during the course of sampling activities did cultural resource observers identify the need to abandon a designated sampling location.

Grab samples not meeting the acceptability criteria detailed within SOP-4 were labeled 'rejected' and temporarily placed in a decontaminated, transparent Lexan® tub. Sampling steps were repeated until an 'accepted' sample was obtained or until a minimum of nine attempts per sampling station did not provide an 'accepted' sample. The field team leader, in consultation with EPA oversight personnel, used their experience and professional judgment applying the acceptance criteria to identify accepted and rejected samples.

Overlying water present in the Lexan® tub was removed by slowly siphoning it off or by scooping the water out using hand-held plastic scoops. Care was taken to ensure that fine-grained suspended sediment was not removed during this process.

Locating Tributary Sample Stations. A 3-step process was used to locate tributary sample stations. First, the sampling team located the planned sample station using Map A8 in the field sampling plan of the EPA-approved QAPP, and confirmed the sample coordinates using a handheld GPS unit. Second, the team conducted a visual survey of the tributary in the vicinity of the planned sample station to determine if conditions were amenable to collection of fine-grained sediment (≤ 2mm). A minimum area of fine-grained sediment of 2 square feet, and a sediment depth of 6 inches was needed to provide sufficient volume of material for sampling purposes. If conditions were not amenable (e.g., the dominant substrate size is gravel and cobble, or the current prevents safely accessing the location), the Field Team Leader and onsite EPA representative, in consultation with the onsite cultural resource monitor, moved the sampling location to an area within the reference tributary that contained sufficient volume of fine-grained sediment. Third, once an amendable location was identified the field team obtained location coordinates with the GPS unit. For situations where sufficient sample volume was not found at a single location and conditions required the team to sample along a reach of the stream, coordinate locations of the upstream sampling extent and downstream sampling extent were recorded with the GPS unit.

Tributary Sample Collection. Sediment sampling from locations in tributaries was conducted following procedures described in SOP-3A of the EPA-approved QAPP. Once a viable sediment sampling location was identified, the sampling team collected sediment using a petite Ponar grab sampler and/or a stainless steel shovel depending on conditions in the tributary. The recovered sediment was passed through a 5mm stainless steel sieve and placed directly into a Lexan® tub and the process repeated until the necessary volume of sediment was collected. This provided the cultural resource monitors an opportunity to examine the sediment as it was collected to determine if cultural resources were present. At no time during the course of sampling activities did cultural resource observers identify the need to abandon a designated tributary sampling location.

As with the on-water sampling, the overlying water present in the Lexan® tub was removed by slowly siphoning it off or by scooping the water out using hand-held plastic scoops. Care was taken to ensure that fine-grained suspended sediment was not removed during this process. The sediment pH was then measured using a hand-held field pH meter that was calibrated daily. Copies of the pH meter calibration forms are included in Appendix C.

Porewater Sampling. Porewater samples were collected by drawing water directly from the sediment samples via suction through airstones. In general, a cylindrically shaped ceramic airstone (10 to 15 cm long and 1.5 cm in diameter) was used to collect porewater for metals analyses; while silica airstones were used to collect porewater for routine analyses (e.g., major cations anions). Where possible, a laboratory pre-cleaned syringe was used to draw porewater through the airstones. This proved to be problematic at several locations and peristaltic pumps were employed to apply the additional suction needed to obtain sufficient sample volume. Porewater samples were not collected at several locations where the sediment was sandy, allowing the porewater to drain from the sediment before it could be placed into the Lexan® tub. A summary of porewater sampling procedure for each successful sample is summarized in Table 2-2.

Sediment Sample Preparation. After obtaining verbal confirmation from onsite cultural monitors that no cultural resources were present and that sample processing could occur, sediment samples were homogenized within the Lexan® tub until the texture and color of the sediment appeared to be uniform. Sediment containing large proportions of material >2mm in grain size were passed through a 5mm sieve by shaking or pressing the sediment through the sieve. Homogenized sediment was transferred from the Lexan® tub to the prescribed sample containers using decontaminated plastic or stainless steel scoops.

Laboratory-provided sample jars were filled and placed in iced coolers for subsequent shipment to the analytical laboratory. The 5-gallon buckets were filled approximately 2/3 to 3/4 full, with the sample surface covered with Site water. The lids for the 5-gallon buckets were self-sealing, water and air-tight, and tamper-resistant. The lids are designed to only allow access through cutting the lip edge at several places with a knife or cutters, removing a tab encircling the lid’s circumference, and pulling upward.

Each sample container was labeled with information including: sample number, date, time, sampler name, requested analyses, and preservatives if applicable. Labels were placed on both the top and side of the 5-gallon buckets.

Rejected sediment samples were placed back into the river at the approximate point of collection, as approved by the EPA and, in the case of samples collected within the NPS cultural resource jurisdiction, the NPS. Initially condition #27 of the NPS permit mandated that all sediment removed from the river within the NPS-managed areas was to be removed from the Site and managed as investigation derived waste (IDW). This proved to create such a large volume of IDW that managing it on the sampling boats quickly became a safety concern. On September 20, 2013, the NPS informed TAI that this condition (#27) of the permit was no longer required and from day forward, rejected sediment and associated Site water could be returned at the point of location near the river bottom.

Sample Documentation. Visual observations were recorded on a grab-specific Sediment/Porewater Sampling Form. Each form was labeled with the station identifier, the coordinates of the grab sample location, and the drop number. Samples collected for analyses were also identified on these forms.

Information recorded by the URS field team for each sample included: sample name and identification information (sample date and time, sample station identification and location coordinates); water depth measured by on-board fathometers; grab sampler penetration depth; sample acceptance criteria; sediment pH information; sediment characteristics such as color, odor, grain size characteristics (visual/manual method); and presence or absence of visible organic matter, cultural resources, or black silica glass (i.e., having the appearance of granulated slag); as well as other observed distinguishing features.

Photographs were taken of the grab samples and the surrounding area as specified in the EPA-Approved QAPP. Photographs from a particular sampling location were identified within the photographic record using a white board showing the sample station number. Photographs taken during sampling activities are included in Appendix E.

Field notes, observations, and activities were documented using environmental field notebooks. Notebooks were kept by each sampling team lead, the field coordinator, and the logistics coordinator. Field notebooks were electronically scanned at the end of field sampling activities and are made available in Appendix F.

Daily chain-of-custody forms were prepared for the collected sediment, porewater and equipment rinsate samples by the sampling team and signed by the URS lead sampler. These accompanied the samples during transit to the analytical laboratory. As previously mentioned, copies of all chain-of-custody forms generated during this sediment study are included as Appendix D.

2.2.4 SAMPLE HANDLING AND CHAIN-OF-CUSTODY PROTOCOL.

At the close of the day’s sampling efforts, sample containers were transported to shore and transferred to the boat dock where they were passed to the URS on-shore crew. At this time the shore crew and sampling team reviewed the information on the chain-of-custodies and sample labels to ensure a match. Sample containers were placed into a refrigerated truck for temporary storage. The refrigerated truck door was then closed and sealed with a keyed lock. The keys to this lock remained in the possession of the shore crew. The shore crew then packaged the chemistry-only sediment samples, porewater samples and equipment rinsate samples for overnight shipment to ALS. The 5-gallon buckets were kept in the refrigerated truck at approximately 4 degrees C. URS personnel subsequently drove the truck containing the 5-gallon buckets to ALS.

2.2.5 MANAGEMENT OF INVESTIGATION DERIVED WASTE

Residual sediment remaining after sampling at a station was completed was removed from the sampling equipment and managed separately. Where allowed, the residual sediment and site water was returned to the system. However, in the case of samples collected within the NPS jurisdiction, the NPS permit mandated that all sediment removed from the river within the NPS-managed areas was to be removed from the Site and managed as investigation derived waste (IDW). This material was placed in 5-gallon buckets and transported to shore for offsite storage in the refrigerated truck with the bioassay samples. The residual sediment remained in the truck until sufficient volume of material was collected to warrant transport under chain of custody to ALS, where the material was stored until disposal could be arranged. This condition (#27) of the NPS permit was amended on September 20, 2013 after which all residual sediment and site water were returned to the system at or near its point of origin (see Appendix A).

Decontamination fluids were collected into a plastic tub placed below the sampling equipment being cleaned and managed as IDW. The liquid IDW was transferred to sealed 5-gallon buckets on the research vessels and then transferred to the shore at the end of the day for waste management and disposal. The liquid IDW was transported to the Columbia Navigation equipment yard in Kettle Falls for storage until final disposal was arranged. The liquid IDW containers were labeled with information describing the contents, dates, and URS contact information. At the end of field sampling program, the liquid IDW was sampled for waste characterization purposes prior to disposal by a licensed waste handling company.

2.3 HEALTH AND SAFETY

All observers, with the exception of NPS staff who operated under their own safety program, read and signed the project-specific SHSP, prepared by URS for the UCR Phase 2 Sediment Study. The URS project-specific SHSP expanded upon the Upper Columbia River General Site Health and Safety Plan prepared for TAI by Exponent. URS and subcontractor field personnel employed on this project met the requirements of Occupational Safety and Health Act (OSHA) Code of Federal Regulations (CFR) 1910.120. Daily health and safety “tailgate” meetings were conducted during implementation of field activities. Appendix B presents health and safety agreement forms signed daily by the URS field crews and subcontractors, EPA oversight and cultural resource monitoring personnel. There were no OSHA reportable injuries during the entire Phase 2 sediment sampling program.

Table 2-1. Reserve Station Sampling
Upper Columbia River Phase 2 Sediment Study

River Mile	Primary Station	Reserve Stations																	Sample Collection Status
598	8B-C4	8B-R2	8-R7	7B-R1	7B-R2	8-R2	8-R6	8-R9	8-R10	-	-	-	-	-	-	-	-	-	Successful
599	8B-C3	8B-R3	8B-R4	8-R1	8-R3	8-R4	8-R5	8-R8		-	-	-	-	-	-	-	-	-	Successful
600	8B-C2	8B-R2	8-R7	7B-R1	7B-R2	8-R2	8-R6	8-R9	8-R10	-	-	-	-	-	-	-	-	-	Successful
601	Ref-10	Ref-10b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
602	8B-C1	8B-R1	8-R6	8R-9	8R-10	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
603	8-C3	5-R2	5-R4	8-R3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
604	8-C4	8-R8	8-R1	8-R5	8-R3	8-R4	7-R8	7B-R3	-	-	-	-	-	-	-	-	-	-	Successful
604	Ref-9	Ref-9b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
605	8-B2	8-R6	8-R9	8-R10	8-R2	8B-R1	7-R4	7-R5	7-R6	7-R7	7-R10	8-R1	8R-3	8-R4	8-R5	8-R7	-	-	Successful
605	8-B3	8-R8	8-R1	8-R5	8-R3	8-R4	8B-R3	8B-R4	7-R8	8-R2	8-R6	8-R9	8-R10	-	-	-	-	-	Successful
605	8-B4	8-R6	8-R9	8-R10	8-R2	8B-R1	7-R4	7-R5	7-R6	7-R7	7-R10	8-R1	8R-3	8-R4	8-R5	8-R7	-	-	Successful
605	8-C2	8-R7	7B-R2	7B-R1	7-R1	7-R2	-	-	-	-	-	-	-	-	-	-	-	-	Successful
606	8-B1	8-R2	8-R10	8-R6	8-R9	8B-R1	7-R4	7-R5	7-R6	7-R7	7-R10	8-R1	8R-3	8-R4	8-R5	8-R7	-	-	Successful
607	8-B6	8-R8	8-R1	8-R5	8-R3	8-R4	8B-R3	8B-R4	7-R8	8-R2	8-R6	8-R9	8-R10	-	-	-	-	-	Successful
608	8-B5	8-R6	8-R9	8-R10	8-R2	8B-R1	7-R4	7-R5	7-R6	7-R7	7-R10	8-R1	8R-3	8-R4	8-R5	8-R7	-	-	Successful
609	8-C1	8-R7	7B-R2	7B-R1	7-R1	7-R2	-	-	-	-	-	-	-	-	-	-	-	-	Successful
626	7B-C3	7B-R3	8B-R1	8R-2	8R-3	8R-4	-	-	-	-	-	-	-	-	-	-	-	-	Successful
632	7B-C2	7B-R4	7-R4	7-R5	7-R6	7-R7	7-R10	-	-	-	-	-	-	-	-	-	-	-	Successful
632	Ref-8	Ref-8b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
634	7B-C4	7B-R3	8B-R1	8R-2	8R-3	8R-4	-	-	-	-	-	-	-	-	-	-	-	-	Successful
637	7B-C1	7B-R4	7-R4	7-R5	7-R6	7-R7	7-R10	-	-	-	-	-	-	-	-	-	-	-	Successful
640	7-C3	7-R8	6-R2	6;R8	8-R3	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
641	7-C4	7-R8	6-R2	6;R8	8-R3	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
643	7-B4	7-R1	7-R2	7-R3	7-R9	7-C2	6B-R2	7B-R1	7B-R2	-	-	-	-	-	-	-	-	-	Successful
643	7-B5	7-R8	6-R8	8-R1	8-R3	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
643	7-B6	7-R4	7-R5	7-R10	7-R6	7-R7	7B-R4	6-R3	6-R6	6-R7	6-R10	-	-	-	-	-	-	-	Successful
645	7-B3	7-R4	7-R5	7-R10	7-R6	7-R7	7B-R4	6-R3	6-R6	6-R7	6-R10	-	-	-	-	-	-	-	Successful
646	7-B1	7-R1	7-R2	7-R3	7-R9	7-C1	7B-R1	7B-R2	6B-R1	6B-R3	6B-R4	-	-	-	-	-	-	-	Successful
646	7-B2	7-R6	7-R7	7-R4	7-R5	7-R10	6-R1	6-R3	6-R6	6-R7	6-R10	7B-R4	-	-	-	-	-	-	Successful
646	Ref-7	Ref-7b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
648	7-C1	7-R1	7-R2	7-R3	7-R9	7B-R1	7B-R2	6-R4	6-R5	-	-	-	-	-	-	-	-	-	Successful
649	7-C2	7-R1	7-R2	7-R3	7-R9	7B-R1	7B-R2	6-R4	6-R5	-	-	-	-	-	-	-	-	-	Successful
652	6B-C4	6-R1	6-R3	6-R6	6-R7	6-R10	-	-	-	-	-	-	-	-	-	-	-	-	Successful
652	Ref-6	Ref-6b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
657	6B-C3	6B-R1	6B-R3	6B-R4	6B-R2	7-R1	7-R2	6-R4	6-R5	6-R9	-	-	-	-	-	-	-	-	Successful
659	6B-C2	6B-R1	6B-R3	6B-R4	6B-R2	7-R1	7-R2	6-R4	6-R5	6-R9	-	-	-	-	-	-	-	-	Successful
663	6B-C1	6-R3	6-R6	6-R7	6-R10	6-R1	-	-	-	-	-	-	-	-	-	-	-	-	Successful
664	6-B5	6-R3	6-R6	6-R7	6-R10	6-R1	5B-R1	7-R4	7-R5	7-R10	5B-R2	5B-R3	5B-R4	-	-	-	-	-	Successful
664	6-B6	6-R3	6-R6	6-R7	6-R10	6-R1	5B-R1	7-R4	7-R5	7-R10	5B-R2	5B-R3	5B-R4	-	-	-	-	-	Successful
664	6-C3	6-R4	6-R5	6-R9	6B-R1	6B-R2	6B-R3	6B-R4	-	-	-	-	-	-	-	-	-	-	Successful
664	6-C4	6-R8	6-R2	5-R7	7-R8	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
665	6-B1	6-R3	6-R6	6-R7	6-R10	6-R1	5B-R1	7-R4	7-R5	7-R10	5B-R2	5B-R3	5B-R4	-	-	-	-	-	Successful
665	6-B2	6-R8	6-R2	5-R7	7-R8	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
665	6-B4	6-R4	6-R5	6-R9	6-C1	6-C3	6B-R1	6B-R2	6B-R3	6B-R4	-	-	-	-	-	-	-	-	Successful
666	6-B3	6-R3	6-R6	6-R7	6-R10	6-R1	5B-R1	7-R4	7-R5	7-R10	5B-R2	5B-R3	5B-R4	-	-	-	-	-	Successful
666	6-C1	6-R4	6-R5	6-R9	6B-R1	6B-R2	6B-R3	6B-R4	-	-	-	-	-	-	-	-	-	-	Successful
666	6-C2	6-R8	6-R2	5-R7	7-R8	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
668	5B-C4	5B-R2	5B-R3	5B-R4	5B-R1	6-R1	6-R3	6-R6	6-R7	6-R10	5-R3	5-R10	-	-	-	-	-	-	Successful
671	5B-C2	5B-R2	5B-R3	5B-R4	5B-R1	6-R1	6-R3	6-R6	6-R7	6-R10	5-R3	5-R10	-	-	-	-	-	-	Successful
671	5B-C3	5-R8	6-R5	6-R9	6-C1	6-C3	3-R3	-	-	-	-	-	-	-	-	-	-	-	Successful
674	5B-C1	5B-R2	5B-R3	5B-R4	5B-R1	6-R1	6-R3	6-R6	6-R7	6-R10	5-R3	5-R10	-	-	-	-	-	-	Successful

Table 2-1. Reserve Station Sampling
Upper Columbia River Phase 2 Sediment Study

River Mile	Primary Station	Reserve Stations																	Sample Collection Status
675	5-C4	5-R5	5-R6	5-R7	5-R9	5-R1	4-R9	4-R11	-	-	-	-	-	-	-	-	-	-	Successful
676	5-B5	5-R3	5-R10	5-C2	5B-R1	5-R1	5-R5	5-R6	5-R7	5-R8	5-R9	-	-	-	-	-	-	-	Successful
676	5-B6	5-R3	5-R10	5-C2	5B-R2	5B-R3	5B-R4	4-R6	5-R1	5-R5	5-R6	5-R7	5-R9	5-R8	-	-	-	-	Successful
676	Ref-5	Ref-5b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
677	5-B4	5-R5	5-R6	5-R7	5-R9	5-R1	4-R1	4-R9	-	-	-	-	-	-	-	-	-	-	Successful
677	5-C3	5-R5	5-R6	5-R7	5-R9	5-R1	4-R9	4-R11	-	-	-	-	-	-	-	-	-	-	Successful
678	5-B1	5-R8	4B-R1	6-R4	6-R5	6-R9	-	-	-	-	-	-	-	-	-	-	-	-	Successful
678	5-B2	5-R5	5-R6	5-R7	5-R9	5-R1	4-R1	4-R9	-	-	-	-	-	-	-	-	-	-	Successful
678	5-B3	5-R5	5-R6	5-R7	5-R9	5-R1	4-R1	4-R9	-	-	-	-	-	-	-	-	-	-	Successful
678	5-C2	5-R3	5-R10	5B-R2	5B-R3	5B-R4	4-R6	5-R1	5-R5	5-R6	5-R7	5-R9	5-R8	-	-	-	-	-	Successful
679	Ref-4	Ref-4b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
680	5-C1	5-R5	5-R6	5-R7	5-R9	5-R1	4-R9	4-R11	-	-	-	-	-	-	-	-	-	-	Successful
688	4B-C4	4B-R4	4B-R2	4B-R3	4R-5	4R-9	4R-11	-	-	-	-	-	-	-	-	-	-	-	Successful
689	Ref-3	Ref-3b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
692	4B-C3	4B-R2	4B-R3	4B-R4	4R-11	4R-5	4R-9	-	-	-	-	-	-	-	-	-	-	-	Successful
696	Ref-2	Ref-2b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
698	4B-C2	4B-R2	4B-R3	4B-R4	4R-11	4R-5	4R-9	-	-	-	-	-	-	-	-	-	-	-	Successful
699	Ref-1	Ref-1b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
701	4B-C1	4B-R1	5-R8	3-R3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
703	4-C6	4-R6	3-R1	3-R7	3-R8	3-R9	4-R1	4-R3	4-R4	4-R5	-	-	-	-	-	-	-	-	Successful
704	4-C5	4-R5	4-R9	4-R11	4-R3	4-R4	4-R10	4-R12	4-R1	3-R10	5-R9	5-R5	-	-	-	-	-	-	Successful
705	4-B5	3-R5	2-R9	2-R10	4-R7	4-C4	4-R1	4-R11	4-R3	4-R4	4-R5	4-R9	4-R10	4-R12	-	-	-	-	Successful
705	4-C4	4-R7	3-R2	3-R6	3-R4	3-R5	3-R10	4-R1	4-R3	4-R4	4R-5	-	-	-	-	-	-	-	Successful
706	4-B4	4-R1	4-R3	4-R4	4-R5	4-R9	4-R11	4-R10	4-R12	5-R5	5-R6	-	-	-	-	-	-	-	Successful
706	4-C3	4-R4	4-R3	4-R1	4-R9	4-R5	4-R10	4-R12	4-R11	5-R5	5-R6	-	-	-	-	-	-	-	Successful
707	4-B3	4-R7	4-C4	3-R2	3-R6	2-R1	2B-R2	1B-R1	1B-R2	1B-R3	1B-R4	-	-	-	-	-	-	-	Successful
707	4-C2	4-R12	4-R10	4-R5	4-R9	4-R11	4-R4	4-R3	4-R1	5-R1	5-R7	3-R10	-	-	-	-	-	-	Successful
708	4-B2	4-R7	4-C4	3-R2	3-R6	2-R1	2B-R2	1B-R1	1B-R2	1B-R3	1B-R4	-	-	-	-	-	-	-	Successful
709	4-R2 (4-B6)	4-R6	3-R7	3-R8	3-R9	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
710	4-B1	3-R4	4-R7	4-C4	2-R1	2B-R2	3-R2	3-R6	-	-	-	-	-	-	-	-	-	-	Successful
710	4-C1	4-R5	4-R9	4-R11	4-R3	4-R4	4-R10	4-R12	4-R1	5-R5	5-R6	-	-	-	-	-	-	-	Successful
714	3B-C4	3B-R1	3B-R2	3B-R3	3B-R4	3-R1	-	-	-	-	-	-	-	-	-	-	-	-	Successful
715	3B-C3	3B-R1	3B-R2	3B-R3	3B-R4	3-R1	-	-	-	-	-	-	-	-	-	-	-	-	Successful
719	3B-C2	3B-R1	3B-R2	3B-R3	3B-R4	3-R1	-	-	-	-	-	-	-	-	-	-	-	-	Successful
720	3B-C1	3B-R1	3B-R2	3B-R3	3B-R4	3-R1	-	-	-	-	-	-	-	-	-	-	-	-	Successful
721	3-C4	3-R3	2B-R3	2B-R4	4-R1	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
722	3-B6	3-R7	3-R8	3-R9	3-R1	3-C1	2B-R1	4-R6	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	-	-	-	-	Successful
723	3-B4[a]	3-R5	2-R9	2-R10	3-R6[a]	3-R2	3-R10[a]	-	-	-	-	-	-	-	-	-	-	-	Partially Successful
723	3-B5	3-R2	3-R6	2-R1	2B-R2	4-R7	3-R4	3-R5	-	-	-	-	-	-	-	-	-	-	Successful
723	3-C3	3-R3	2B-R3	2B-R4	4-R1	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
724	3-B2[a]	3-R5	2-R9	2-R10	3-R6	3-R2	3-R10	-	-	-	-	-	-	-	-	-	-	-	Partially Successful
724	3-B3	3-R4	3-R2	3-R6	2-R1	2B-R2	1B-R1	1B-R2	1B-R3	1B-R4	4-R7	-	-	-	-	-	-	-	Successful
724	3-C1	3-R7	3-R8	3-R9	3-R1	2B-R1	4-R6	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	-	-	-	-	-	Successful
724	3-C2	3-R3	2B-R3	2B-R4	4-R1	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
725	3-B1[a]	3-R1	3-R7	3-R8	3-R9	3-C1	2-R3	2B-R1	4-R6	2-R2	2-R4	2-R5	2-R6	2-R7	2-R8	-	-	-	Successful
726	2B-C3	2B-R3	2B-R4	1-R3	1-R4	3-R3	-	-	-	-	-	-	-	-	-	-	-	-	Successful
727	2B-C1	2B-R1	2-R2	2-R4	2-R5	2-R6	2-R7	-	-	-	-	-	-	-	-	-	-	-	Unsuccessful
727	2B-C2	2B-R1	2-R2	2-R4	2-R5	2-R6	2-R7	-	-	-	-	-	-	-	-	-	-	-	Successful
728	2B-C4	2B-R1	2-R2	2-R4	2-R5	2-R6	2-R7	-	-	-	-	-	-	-	-	-	-	-	Successful
729	2-B5	2-R10	2-R9	1-R10	1-R5	1-R1	1-R2	3-R5	2-R1	2B-R2	-	-	-	-	-	-	-	-	Successful
729	2-B6	2-R10	2-R9	1-R10	1-R5	1-R1	1-R2	3-R5	2-R1	2B-R2[a]	-	-	-	-	-	-	-	-	Partially Successful

Table 2-1. Reserve Station Sampling
Upper Columbia River Phase 2 Sediment Study

River Mile	Primary Station	Reserve Stations																	Sample Collection Status
730	2-B4[a]	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	2-C1	2-C3	2-C2	1-R6	3-R1	3-R7	3-R8	3-R9	-	-	-	Successful
730	2-C3	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	2B-R1	2B-R3	2B-R4	1-R6	-	-	-	-	-	-	-	Unsuccessful
730	2-C4	2B-R3	2B-R4	1-R3	1-R4	3-R3	-	-	-	-	-	-	-	-	-	-	-	-	Unsuccessful
731	2-B3	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	2-C1	2-C3	2-C2	1-R6	3-R1	3-R7	3-R8[a]	3-R9	-	-	-	Successful
731	2-C1	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	2B-R1	2B-R3	2B-R4	1-R6	-	-	-	-	-	-	-	Successful
731	2-C2	2-R3	2-R2	2-R4	2-R5	2-R6	2-R7	2B-R1	2B-R3	2B-R4	1-R6	-	-	-	-	-	-	-	Unsuccessful
732	2-B2	2-R2	2-R4	2-R5	2-R6	2-R7	2-R3	2-R3	2-C3	2-C2	1-R6	3-R1	3-R7	3-R8	3-R9	-	-	-	Successful
733	1B-C4	1B-R1	1B-R2	1B-R3	1B-R4	1-R9	2-R1	2B-R2	3-R1	3-R6	1-R1	1-R2	1-R5	1-R10	1-R7	1-R8	-	-	Unsuccessful
733	2-B1	2-R1	2B-R2	1B-R1	1B-R2	1B-R3	1B-R4	3-R2	3-R6	4-R7	2-R9	2-R10	-	-	-	-	-	-	Successful
734	1B-C1	1-R7	1-R8	3-R4	1B-R1	1B-R2	1B-R3	1B-R4	-	-	-	-	-	-	-	-	-	-	Successful
734	1B-C2	1B-R1	1B-R2	1B-R3	1B-R4	1-R9	2-R1	2B-R2	3-R1	3-R6	1-R1	1-R2	1-R5	1-R10	1-R7	1-R8	-	-	Unsuccessful
735	1B-C3	1B-R1	1B-R2	1B-R3	1B-R4	1-R9	2-R1	2B-R2	3-R1	3-R6	1-R1	1-R2	1-R5	1-R10	1-R7	1-R8	-	-	Successful
737	1-B4	1-R9	1-C2	1B-R1	1B-R2	1B-R3	1B-R4	2-R1	2B-R2	1-R1	1-R2	1-R5	1-R7	1-R8	1-R10	-	-	-	Unsuccessful
737	1-B5	1-R7	1-R8	1B-C1	1-C3	3-R4	1-R9	-	-	-	-	-	-	-	-	-	-	-	Successful
738	1-B6	1-R10	1-R2	1-R1	1-R5	1-C1	1-R9	2-R9	2-R10	-	-	-	-	-	-	-	-	-	Successful
738	1-C1	1-R1	1-R5	1-R2	1-R10	2-R9	2-R10	1-R9	1B-R1	1B-R2	1B-R3	1B-R4	-	-	-	-	-	-	Successful
739	1-C2	1-R9	1B-C2	1B-C3	1B-C4	2-R1	2B-R2	1B-R1	1B-R2	1B-R3	1B-R4	3-R10	1-R1	1-R2	1-R5	1-R7	1-R8	1-R10	Successful
739	1-C3	1-R7	1-R8	1B-C1	3-R4	1-R9	-	-	-	-	-	-	-	-	-	-	-	-	Successful
740	1-B3	3-R10	1-R3	1-R6	2-R2	2-R4	2-R7	-	-	-	-	-	-	-	-	-	-	-	Unsuccessful
742	1-B2	1-R9	1-C2	1B-R1	1B-R2	1B-R3	1B-R4	2-R1	2B-R2	1-R1	1-R2	1-R5	1-R7	1-R8	1-R10	-	-	-	Successful
743	1-C4	1-R3	1-R4	3-R3	1-R6	2-R2	2-R3	2-R4	2-R5	2-R6	2-R7	-	-	-	-	-	-	-	Unsuccessful
744	1-B1	1-R1	1-R5	1-R2	1-R10	1-C1	1-R9	2-R9	2-R10	-	-	-	-	-	-	-	-	-	Successful
-	Trib-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	Trib-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	Trib-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	Trib-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	Trib-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	Trib-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	G-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	G-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	G-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	G-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful
-	LAL-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Successful

Notes:

Unsuccessful sampling attempt

Successful sampling attempt

Partial sample collected

No sample attempted due to unsafe conditions

Location previously utilized

a Rejected grabs from eight sampling locations (2-B4, 2B-R2, 3-B1, 3-B2, 3-B4, 3-R10, 3-R6, and 3-R8) did not meet sample acceptability criteria, but in accordance with the QAPP, these samples were analyzed because the material collected would enable at least some evaluation of the area.

Table 2-2. Select Porewater Sampling Procedures Summary
Upper Columbia River Phase 2 Sediment Study

Date	Sample ID	Collection Method[1]		Collection Container (Van Veen or Lexan Tub)
		Airstone used to Collect Sample	Airstone used to Collect Dissolved Metals	
9/5/2013	PW-G-1	Sand[2]	Sand[2]	Lexan Tub
9/6/2013	PW-G-4	Ceramic	Ceramic	Van Veen
9/7/2013	PW-LAL-4	Sand[2]	Sand[2]	Not Reported
9/7/2013	PW-LAL-6	Both	Uncertain	Van Veen
9/12/2013	PW-7B-C2	Both	Both	Van Veen
9/13/2013	PW-Ref-7	Sand[3]	Sand[3]	Van Veen[3]
9/14/2013	PW-Ref-6	Sand[2]	Sand[2]	Lexan Tub
9/18/2013	PW-8B-C1	Sand[2]	Sand[2]	Lexan Tub
9/18/2013	PW-8B-C2	Not Reported	Not Reported	Lexan Tub
9/18/2013	PW-8B-C3	Sand[2]	Sand[2]	Lexan Tub
9/18/2013	PW-8B-C4	Sand	Sand	Lexan Tub
9/18/2013	PW-8-C3	Both	Uncertain	Lexan Tub
9/18/2013	PW-REF-10b	Sand	Sand	Lexan Tub
9/19/2013	PW-8-B2	Both	Uncertain	Lexan Tub[3]
9/19/2013	PW-8-B3	Both	Uncertain	Lexan Tub
9/19/2013	PW-8-B4	Both	Uncertain	Lexan Tub
9/19/2013	PW-8-C4	Both	Uncertain	Lexan Tub
9/19/2013	Began using a peristaltic pump to collect porewater samples as a standard practice			
9/20/2013	PW-8-B5	Both	Uncertain	Lexan Tub
9/20/2013	PW-8-B6	Both	Uncertain	Lexan Tub
9/20/2013	PW-8-B1	Ceramic	Ceramic	Lexan Tub
9/20/2013	PW-8-C2	Both[2]	Uncertain	Lexan Tub
9/21/2013	PW-8-C1	Ceramic	Ceramic	Lexan Tub
9/24/2013	PW-6B-C1	Ceramic[3]	Ceramic[3]	Lexan Tub
9/24/2013	PW-6-B6	Both[3]	Ceramic[3]	Lexan Tub
9/24/2013	PW-6-C4	Both	Ceramic	Lexan Tub
9/24/2013	PW-6-B5	Ceramic[3]	Ceramic[3]	Lexan Tub
9/24/2013	PW-6-C3	Both	Ceramic	Lexan Tub
9/25/2013	PW-6-B1	Both	Ceramic	Lexan Tub
9/25/2013	PW-6-R3	Both	Ceramic	Lexan Tub
9/25/2013	PW-6-B2	Both[3]	Ceramic[3]	Lexan Tub
9/25/2013	PW-6-C1	Both[3]	Ceramic[3]	Lexan Tub
9/25/2013	PW-6-C2	Both[3]	Ceramic[3]	Lexan Tub
9/26/2013	PW-6-B4	Both	Ceramic	Lexan Tub
9/26/2013	PW-5B-C4	Both	Ceramic	Lexan Tub
9/26/2013	PW-5B-C2	Both	Ceramic	Lexan Tub
9/26/2013	PW-5B-C3	Both	Ceramic	Lexan Tub
9/26/2013	PW-TRIB-1	Ceramic	Ceramic	In situ
9/27/2013	PW-5-B4	Both[3]	Ceramic[3]	Lexan Tub

Date	Sample ID	Collection Method[1]		Collection Container (Van Veen or Lexan Tub)
		Airstone used to Collect Sample	Airstone used to Collect Dissolved Metals	
9/27/2013	PW-5-B5	Both	Ceramic	Lexan Tub
9/27/2013	PW-5-B6	Both[3]	Ceramic[3]	Lexan Tub
9/27/2013	PW-5B-C1	Both	Ceramic	Lexan Tub
9/27/2013	PW-5-C4	Both	Ceramic	Lexan Tub
9/27/2013	PW-REF-5	Both	Ceramic	Lexan Tub
9/28/2013	PW-5-B1	Both	Ceramic	Lexan Tub
9/28/2013	PW-5-B2	Both[3]	Ceramic[3]	Lexan Tub
9/28/2013	PW-5-C3	Both[3]	Ceramic[3]	Lexan Tub
9/30/2013	PW-5-C2	Both	Ceramic	Lexan Tub
9/30/2013	PW-5-C1	Both[3]	Ceramic[3]	Lexan Tub
9/30/2013	PW-5-B3	Both[3]	Ceramic[3]	Lexan Tub
9/30/2013	PW-REF-4	Both	Ceramic	Lexan Tub
10/1/2013	PW-REF-3	Both	Ceramic	Lexan Tub
10/1/2013	PW-4B-C4	Both	Ceramic	Lexan Tub
10/1/2013	PW-TRIB-3	Sand	Sand	In situ
10/1/2013	PW-REF-2	Both[3]	Ceramic[3]	Lexan Tub
10/4/2013	PW-4B-C1	Both	Ceramic	Lexan Tub
10/4/2013	PW-REF-1	Ceramic[3]	Ceramic[3]	Lexan Tub
10/4/2013	PW-4B-C3	Both	Ceramic	Lexan Tub
10/4/2013	PW-4B-C2	Both	Ceramic	Lexan Tub
10/4/2013	PW-4-C5	Both	Ceramic	Lexan Tub
10/4/2013	PW-4-C4	Both	Ceramic	Lexan Tub
10/5/2013	PW-4-C6	Both	Ceramic	Lexan Tub
10/5/2013	PW-4-B3	Both	Ceramic	Lexan Tub
10/5/2013	PW-4-C3	Both	Ceramic	Lexan Tub
10/5/2013	PW-4-B2	Both	Ceramic	Lexan Tub
10/5/2013	PW-4-B4	Both	Ceramic	Lexan Tub
10/7/2013	PW-4-B1	Sand[2]	Sand[2]	Lexan Tub
10/7/2013	PW-Trib-2	Both	Ceramic	Lexan Tub
10/7/2013	PW-4-C2	Both	Ceramic	Lexan Tub
10/7/2013	Because of the time needed to collect porewater samples EPA project manager suggest a change in the process. Shake the Lexan tub to allow sediment and porewater to separate then collect porewater sample from the top of the sediment.			
10/9/2013	PW-Trib-4	Both	Ceramic	Lexan Tub
10/9/2013	PW-Trib-5	Both	Ceramic	Lexan Tub
10/10/2013	PW-Trib-6	Both	Ceramic	Lexan Tub
10/8/2013	PW-4-R5	Both	Ceramic	Lexan Tub
10/8/2013	PW-3B-C3	Both	Ceramic	Lexan Tub
10/8/2013	PW-4-B6	Both	Ceramic	Lexan Tub
10/8/2013	PW-3B-C4	Both	Ceramic	Lexan Tub
10/8/2013	PW-3B-C2	Both	Ceramic	Lexan Tub
10/8/2013	PW-3-C4	Both	Ceramic	Lexan Tub
10/14/2013	PW-3-R2	Both	Ceramic	Lexan Tub

Date	Sample ID	Collection Method[1]		Collection Container (Van Veen or Lexan Tub)
		Airstone used to Collect Sample	Airstone used to Collect Dissolved Metals	
10/15/2013	PW-3-R7	Both	Ceramic	Lexan Tub
10/16/2013	PW-3-B3	Both	Ceramic	Lexan Tub
10/17/2013	PW-3-R1	Both	Ceramic	Lexan Tub
10/18/2013	PW-2-R3	Both	Ceramic	Lexan Tub
10/19/2013	PW-2-C1	Both	Ceramic	Lexan Tub
10/21/2013	PW-1-R1	Both	Ceramic	Lexan Tub
10/21/2013	PW-1-R2	Both	Ceramic	Lexan Tub
10/16/2013	PW-2B-C3	Both	Ceramic	Lexan Tub
10/17/2013	PW-2B-R1	Both	Ceramic	Lexan Tub
10/21/2013	PW-1-R8	Ceramic	Ceramic	Lexan Tub
10/18/2013	PW-1-B5	Both	Ceramic	Lexan Tub
10/22/2013	PW-1B-C3	Ceramic	Ceramic	Lexan Tub
10/22/2013	PW-1-R5	Both	Ceramic	Lexan Tub
10/22/2013	PW-1B-R2	Both	Ceramic	Lexan Tub
10/22/2013	PW-1B-C1	Both	Ceramic	Lexan Tub
10/23/2013	PW-2-R1	Both	Ceramic	Lexan Tub
10/23/2013	PW-2-B1	Both	Ceramic	Lexan Tub
10/23/2013	PW-2-B2	Both	Ceramic	Lexan Tub
10/23/2013	PW-1B-R3	Sand[4]	Sand[4]	Lexan Tub
10/24/2013	PW-3-R8	Both	Ceramic	Lexan Tub
10/24/2013	PW-3-R9	Both	Ceramic	Lexan Tub
10/24/2013	PW-2B-C4	Both	Ceramic	Lexan Tub
10/24/2013	PW-4-R1	Ceramic	Ceramic	Lexan Tub

Notes:

1. Collection Method was determined based on review of URS field notes, sample collection forms, pictures and previous conversations with URS field leads. EPA oversight field notes were also reviewed to suplement URS field notes.

2. Ceramic airstone clogged. Sample was successfully collected using the sand airstone.

3. URS field notes, sample collection forms, pictures and previous conversations with field leads do not indicate the type of airstone used or whether the sample was collected from the Lexan tub or Van Veen. Presented information comes from EPA oversight field notes.

4. URS Field Notes indicate "no porewater with ceramic stone, switched to sand stone."

Definitions:

Not Reported - information was not reported or provided in URS or EPA field notes.

Uncertain - information was not recorded in field notes or provided by field leads.

3 SAMPLE COLLECTION

This section summarizes the field data collected during the Phase 2 sediment sampling program. As part of the Phase 2 sediment sampling program, grab samplers were deployed at 832 discreet locations at 168 primary and reserve sampling stations within the Site. An additional 56 grab sampler attempts were made to collect 10 external reference samples in Canada. A detailed list of these grab sample locations, including the station identification, map coordinates, and associated river mile, are included as Appendix G.

Flowing river conditions in the narrower riverine sections of the Site from river mile 720, just below China Bend and the US-Canada border (RM 745), created challenging boat maneuvering and sampling conditions. These conditions required careful maneuvering by the boat captains to maintain positioning of the sampling vessels. Coarse river bottom composition in several areas also created conditions that made sediment sampling difficult to unattainable in this portion of the Site. As a result the sampling crews attempted sediment collection at numerous reserve stations within this portion of the Site (see Maps 2 and 3).

3.1 ENVIRONMENTAL SAMPLES

Several conditions prevented the collection of 'acceptable' sediment samples and required the rejection of samples based on criteria specified in SOP-3. Samples with visual evidence of extensive winnowing and washing within the grab sampler were rejected. Coarse materials such as gravels, cobbles, and boulders limited or prevented sample collection by deflecting the grab sampler or preventing closure of the grab sampler.

The field sampling team collected 120 of the 124 proposed acceptable Site sediment samples as identified by EPA-approved QAPP; a 97 percent success rate. These consisted of the following:

- 53 Site samples were collected for bioassay and chemistry analyses (four less than the planned number).
- 67 Site samples were collected for chemistry-only analyses (one more than the planned number).

The field sampling team collected 100 percent of the planned external-reference sediment samples; 6 tributary locations and 10 Canadian locations. These samples were collected for both bioassay and chemistry analyses. In addition, 14 field duplicate sediment samples were collected for chemistry-only analyses; 10 percent of the total number of samples planned for the project.

At many locations, the force required to extract porewater from the fine-grained sediments through the airstones quickly exceeded the suction of the hand-operated syringe sampling devices. The use of peristaltic pumps was necessary in these instances, although the use of the peristaltic pump was not universally successful. A total of 101 porewater samples were collected from the 136 locations where sediment samples were collected. See Table 2-2 for additional details.

Table 3-1 identifies locations where the sediment samples were collected for both bioassay and chemistry analyses. Table 3-2 identifies locations where sediment samples were collected for chemistry-only analyses.

3.2 EQUIPMENT RINSATE SAMPLES

Site equipment rinsate samples were collected at a frequency of one sample per piece of sampling equipment used, per sampling crew per day. This resulted in the collection of 240 equipment rinsate samples. Table 3-3 presents a summary of these samples by date collected and identifies which sampling equipment the sample represents and the associated sediment samples collected using that equipment on the given day. Scanned copies of the Daily Rinsate Sample Collection forms are attached as Appendix H.

Table 3-1. Environmental Samples Collected at Bioassay Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Identification	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
Map Tile 1 - Canadian Border to China Bend						
1-B1	744	10/21/2013	No Sample Collected	No Sample Collected		
1-R1	744	10/21/2013	SE-1-R1	PW-1-R1	TBD[1]	Reserve for Station 1-B1
1-B2	742	10/22/2013	No Sample Collected	No Sample Collected		Station rejected due to safety and equipment concerns caused by swift current
1B-R1	735	10/22/2013	No Sample Collected	No Sample Collected		Reserve for Station 1-B2
1B-R2	734	10/22/2013	SE-1B-R2	PW-1B-R2	TBD[1]	Reserve for Station 1-B2
1-B3	740	10/21/2013	No Sample Collected	No Sample Collected		
1-B4	737	10/23/2013	No Sample Collected	No Sample Collected		
1-B5	737	10/18/2013	SE-1-B5	PW-1-B5	TBD[1]	
1-B6	738	10/21/2013	No Sample Collected	No Sample Collected		
1-R2	742	10/21/2013	SE-1-R2	PW-1-R2	TBD[1]	Reserve for Station 1-B6
2-B1	733	10/23/2013	SE-2-B1	PW-2-B1	TBD[1]	
2-B2	732	10/23/2013	SE-2-B2	PW-2-B2	TBD[1]	
2-B3	731	10/23/2013	No Sample Collected	No Sample Collected		
2-B4	730	10/17/2013	Partial Sample Collected	No Sample Collected		See Table 3-2
2-R2	732	10/17/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-B4
2-R4	731	10/17/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-B4
2-R6	731	10/18/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-B4
2-R3	732	10/18/2013	SE-2-R3	PW-2-R3	TBD[1]	Reserve for Station 2-B4
2-B5	729	10/17/2013	No Sample Collected	No Sample Collected		Station rejected due to safety and equipment concerns caused by swift current
2-R1	732	10/23/2013	SE-2-R1	PW-2-R1	TBD[1]	Reserve for Station 2-B5
2-B6	729	10/17/2013	No Sample Collected	No Sample Collected		Station rejected due to safety and equipment concerns caused by swift current
1-R10	737	10/18/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-B6 - Station rejected due to safety and equipment concerns caused by swift current
2B-R2	728	10/24/2013	Partial Sample Collected	No Sample Collected		Reserve for Station 2-B6. See Table 3-2
3-B1	725	10/16/2013	Partial Sample Collected	No Sample Collected		See Table 3-2
3-R1	726	10/17/2013	SE-3-R1	PW-3-R1		Reserve for Station 3-B1
3-B2	724	10/16/2013	Partial Sample Collected	PW-2-B2		See Table 3-2
3-B3	724	10/16/2013	SE-3-B3	PW-3-B3	NPS	
3-B4	723	10/14/2013	Partial Sample Collected	No Sample Collected		See Table 3-2
3-R5	723	10/14/2013	No Sample Collected	No Sample Collected		Reserve for Station 3-B4
2-R9	729	10/15/2013	No Sample Collected	No Sample Collected		Reserve for Station 3-B4
2-R10	729	10/15/2013	No Sample Collected	No Sample Collected		Reserve for Station 3-B4 - Location rejected after sampler became stuck on first grab
3-R6	723	10/15/2013	Partial Sample Collected	No Sample Collected		Reserve for Station 3-B4
3-B5	723	10/14/2013	No Sample Collected	No Sample Collected		
3-R2	725	10/14/2013	SE-3-R2	PW-3-R2	NPS	Reserve for Station 3-B5
Trib-5	726	10/9/2013	SE-Trib-5	PW-Trib-5		
Trib-6	732	10/10/2013	SE-Trib-6	PW-Trib-6	TBD[1]	

Table 3-1. Environmental Samples Collected at Bioassay Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Identification	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
Map Tile 2 - Kettle Falls Reach						
3-B6	722	10/15/2013	No Sample Collected	No Sample Collected		
3-R7	722	10/15/2013	SE-3-R7	No Sample Collected	NPS	Reserve for Station 3-B6
3-R8	722	10/24/2013	SE-3-R8	PW-3-R8	NPS	Reserve for Station 2-B3 - Rejected Sediment Sampled
3-R9	721	10/24/2013	SE-3-R9	PW-3-R9	NPS	Reserve for Station 2-B3
3-R10	721	10/15/2013	Partial Sample Collected	No Sample Collected		Reserve for Station 3-B4. See Table 3-2
4-B1	710	10/7/2013	SE-4-B1	PW-4-B1	NPS	
4-B2	708	10/5/2013	SE-4-B2	PW-4-B2	NPS	
4-B3	707	10/5/2013	SE-4-B3	PW-4-B3	NPS	
4-B4	706	10/5/2013	SE-4-B4	PW-4-B4	NPS	
4-B5	705	10/5/2013	SE-4-B5	No Sample Collected	NPS	
4-B6	709	10/8/2013	SE-4-B6	PW-4-B6	NPS	
REF-1	699	10/4/2013	SE-REF-1	PW-REF-1	NPS	
REF-2	696	10/1/2013	SE-REF-2	PW-REF-2	NPS	
Trib-2	705	10/7/2013	SE-Trib-2	PW-Trib-2	NPS	
Trib-4	721	10/9/2013	SE-Trib-4	PW-Trib-4	NPS	
Map Tile 3 - Inchelium - Gifford Reach						
5-B1	678	9/28/2013	SE-5-B1	PW-5-B1	NPS	
5-B2	678	9/28/2013	SE-5-B2	PW-5-B2	NPS	
5-B3	678	9/30/2013	SE-5-B3	PW-5-B3	CCT	
5-B4	677	9/27/2013	SE-5-B4	PW-5-B4	NPS	
5-B5	676	9/27/2013	SE-5-B5	PW-5-B5	NPS	
5-B6	676	9/27/2013	SE-5-B6	PW-5-B6	NPS	
6-B1	665	9/25/2013	SE-6-B1	PW-6-B1	CCT	
6-B2	665	9/25/2013	SE-6-B2	PW-6-B2	CCT	
6-B3	666	9/25/2013	No Sample Collected	No Sample Collected		
6-R3	666	9/25/2013	SE-6-R3	PW-6-R3	NPS	Reserve for Station 6-B3
6-B4	665	9/26/2013	SE-6-B4	PW-6-B4	CCT	
6-B5	664	9/24/2013	SE-6-B5	PW-6-B5	NPS	
6-B6	664	9/24/2013	SE-6-B6	PW-6-B6	NPS	
Ref-3	689	10/1/2013	SE-REF-3	PW-REF-3	NPS	
Ref-4	679	9/30/2013	SE-REF-4	PW-REF-4	CCT	
Ref-5	676	9/27/2013	SE-REF-5	PW-REF-5		
Ref-5b	678	9/27/2013	No Sample Collected	No Sample Collected		Reserve for Station Ref-5. Insufficient sediment to collect samples after 10 grabs.
Trib-1	686	9/26/2013	SE-TRIB-1	PW-Trib-1	NPS	
Trib-3	685	10/1/2013	SE-TRIB-3	PW-Trib-3	NPS	
Map Tile 4 - Two Rivers Area						
7-B1	646	9/13/2013	SE-7-B1	No Sample Collected	CCT	Airstone clogged, No porewater could be obtained.
7-B2	646	9/13/2013	SE-7-B2	No Sample Collected	CCT	Airstone clogged, No porewater could be obtained.

Table 3-1. Environmental Samples Collected at Bioassay Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Identification	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
7-B3	645	9/13/2013	SE-7-B3	No Sample Collected	CCT	No porewater recovery.
7-B4	643	9/13/2013	SE-7-B4	No Sample Collected	CCT	2 grabs composited for sed sample, airstone plugged
7-B5	643	9/13/2013	SE-7-B5	No Sample Collected	CCT	Airstone clogged, No porewater could be obtained.
7-B6	643	9/13/2013	SE-7-B6	No Sample Collected	CCT	Airstone clogged, No porewater could be obtained.
Ref-6	652	9/14/2013	SE-Ref-6	PW-Ref-6	CCT	
Ref-7	646	9/13/2013	SE-Ref-7	PW-Ref-7	CCT	
Ref-8	632	9/16/2013	SE-REF-8	No Sample Collected	NPS	No porewater could be obtained.
Map Tile 5 - Spring Canyon Area						
8-B1	606	9/20/2013	SE-8-B1	PW-8-B1	NPS	
8-B2	605	9/19/2013	SE-8-B2	PW-8-B2	NPS	
8-B3	605	9/19/2013	SE-8-B3	PW-8-B3	NPS	
8-B4	605	9/19/2013	SE-8-B4	PW-8-B4	CCT	
8-B5	608	9/20/2013	SE-8-B5	PW-8-B5	NPS	
8-B6	607	9/20/2013	SE-8-B6	PW-8-B6	NPS	
REF-9	604	9/19/2013	SE-REF-9	No Sample Collected	CCT	Not sufficient sediment for bioassay analyses. No porewater could be obtained.
REF-9b	607	9/19/2013	No Sample Collected	No Sample Collected		Reserve for Station Ref-9. Rocky point - made 3 attempts and collected only rocks. No evidence of any sediment.
REF-10	601	9/18/2013	No Sample Collected	No Sample Collected		
REF-10b	601	9/18/2013	SE-REF-10b	PW-REF-10b	CCT	Reserve for Station Ref-10
Map Tile 6 - Canadian Locations						
G-1	NA	9/5/2013	SE-G-1	PW-G-1	EPA	
G-2	NA	9/5/2013	SE-G-2	No Sample Collected		No porewater sample collected because water drained from van veen before sampler could be inserted
G-3	NA	9/6/2013	SE-G-3	No Sample Collected		No porewater sample collected because water drained from van veen before sampler could be inserted. The sample was scooped from the van veen to allow the collection of the 0 to 6-inch target horizon in the sediment
G-4	NA	9/6/2013	SE-G-4	PW-G-4		The sample was scooped from the van veen to allow the collection of the 0 to 6-inch target horizon in the sediment.
LAL-1	NA	9/8/2013	SE-LAL-1	No Sample Collected	EPA	Insufficient porewater to collect a companion sample
LAL-2	NA	9/8/2013	SE-LAL-2	No Sample Collected		Sample contained 90% organic matter but remaining cast produced no additional material
LAL-3	NA	9/8/2013	SE-LAL-3			
LAL-4	NA	9/7/2013	SE-LAL-4	PW-LAL-4		No porewater passed through ceramic airstone switched to blue stone for sample collection
LAL-5	NA	9/7/2013	SE-LAL-5	No Sample Collected	EPA	Airstones (both types) clogged, no porewater was collected

Table 3-1. Environmental Samples Collected at Bioassay Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Identification	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
LAL-6	NA	9/7/2013	SE-LAL-6	PW-LAL-6		

TBD[1] These locations are designated as potential EPA split sample locations. Additional sediment volume was collected at each of these locations for that purpose.

Notes:

CCT -	Conferated Tribes of the Colville Reservation
EPA -	U.S. Environmental Protection Agency
LAL -	Lower Arrow Lake
NA -	not applicable
NPS -	National Park Service
PW -	Porewater
Ref -	Reference
SE -	Sediment
TBD -	to be determined
Trib -	Tributary

Table 3-2. Environmental Samples Collected at Chemistry Only Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Id.	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
Map Tile 1 - Canadian Border to China Bend						
1-C1	738	10/22/2013	SE-1-C1	No Sample Collected		Rejected sediment sample not analyzed
1-R5	744	10/22/2013	SE-1-R5	PW-1-R5	EPA	Reserve for Station 1-C1
1-C2	739	10/22/2013	No Sample Collected	No Sample Collected		Station rejected without attempting any grabs due to swift current and shallow depth
1-R9	737	10/22/2013	No Sample Collected	No Sample Collected		Reserve for Station 1-C2
1B-R3	735	10/23/2013	SE-1B-R3	PW-1B-R3		Reserve for Station 1-C2
			MUD0016	No Sample Collected		Duplicate sample for SE-1B-R3
1-C3	739	10/21/2013	No Sample Collected	No Sample Collected		
1-R7	739	10/21/2013	No Sample Collected	No Sample Collected		Reserve for Station 1-C3
1-R8	737	10/21/2013	SE-1-R8	PW-1-R8	EPA	Reserve for Station 1-C3
1-C4	743	10/21/2013	No Sample Collected	No Sample Collected		
1-R4	743	10/21/2013	No Sample Collected	No Sample Collected		Reserve for Station 1-C4
1-R2	742	10/21/2013	MUD0014	No Sample Collected		Chemistry Duplicate Sample for Bioassay Sample SE-1-R2. See Table 3-1
1B-C1	734	10/22/2013	SE-1B-C1	PW-1B-C1		Very shallow water at this location so sample collected using petite ponar sampler
1B-C2	734	10/22/2013	No Sample Collected	No Sample Collected		
1B-C3	735	10/22/2013	SE-1B-C3	PW-1B-C3		
1B-C4	733	10/23/2013	No Sample Collected	No Sample Collected		
1B-R4	735	10/23/2013	No Sample Collected	No Sample Collected		Reserve for Station 1B-C4
1B-R2	734	10/22/2013	SE-1B-R2	No Sample Collected	EPA	Very shallow water at this location so sample collected using petite ponar sampler. Chemistry Split from a Bioassay Sample. Reserve for Station 1-B2
2-B2	732	10/23/2013	SE-2-B2	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
2-B4	730	10/17/2013	SE-2-B4	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
2B-C1	727	10/17/2013	No Sample Collected	No Sample Collected		
2-R5	731	10/18/2013	No Sample Collected	No Sample Collected		Reserve for Station 2B-C1
2-R7	730	10/17/2013	No Sample Collected	No Sample Collected		Reserve for Station 2B-C1
2B-C2	727	10/17/2013	No Sample Collected	No Sample Collected		
2B-R1	728	10/17/2013	SE-2B-R1	PW-2B-R1		Reserve for Station 2B-C2

Table 3-2. Environmental Samples Collected at Chemistry Only Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Id.	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
2B-C3	726	10/16/2013	SE-2B-C3	PW-2B-C3		
2B-C4	728	10/24/2013	SE-2B-C4	PW-2B-C4		
2B-R2	728	10/24/2013	SE-2B-R2	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. Reserve for Bioassay Station 2B-6. See Table 3-1
2-C1	731	10/19/2013	SE-2-C1	PW-2-C1		
			MUD0013	No Sample Collected		Duplicate sample for SE-2-C1
2-C2	731	10/18/2013	No Sample Collected	No Sample Collected		
2-C3	730	10/18/2013	No Sample Collected	No Sample Collected		
1-R6	741	10/19/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-C3
2-C4	730	10/18/2013	No Sample Collected	No Sample Collected		
1-R3	744	10/18/2013	No Sample Collected	No Sample Collected		Reserve for Station 2-C4
2-R1	732	10/23/2013	MUD0015	No Sample Collected		Chemistry Duplicate Sample for Bioassay Sample SE-2-R1. See Table 3-1
3-B1	725	10/16/2013	SE-3-B1	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
3-B2	724	10/16/2013	SE-3-B2	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
3-B3	724	10/16/2013	SE-3-B3	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
3-B4	723	10/14/2013	SE-3-B4	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
3-C1	724	10/15/2013	SE-3-C1	No Sample Collected		
3-C2	724	10/15/2013	No Sample Collected	No Sample Collected		
2B-R3	727	10/16/2013	No Sample Collected	No Sample Collected		Reserve for Station 3-C2
2B-R4	726	10/16/2013	No Sample Collected	No Sample Collected		Reserve for Station 3-C2
3-C3	723	10/15/2013	No Sample Collected	No Sample Collected		
3-R3	725	10/15/2013	SE-3-R3	No Sample Collected		Reserve for Station 3-C3
			MUD0011	No Sample Collected		Duplicate sample for SE-3-R3
3-R6	723	10/15/2013	SE-3-R6	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
Map Tile 2 - Kettle Falls Reach						
4-R1	711	10/24/2013	SE-4-R1	PW-4-R1		Reserve for Station 3-C2
3-R10	721	10/15/2013	SE-3-R10	No Sample Collected		Partial Bioassay Sample Submitted for Chemistry Analyses. See Table 3-1
3B-C1	720	10/8/2013	No Sample Collected	No Sample Collected		

Table 3-2. Environmental Samples Collected at Chemistry Only Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Id.	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
3B-R1	720	10/14/2013	No Sample Collected	No Sample Collected		Reserve for Station 3B-C1
3B-R2	718	10/14/2013	SE-3B-R2	No Sample Collected		Reserve for Station 3B-C1
3B-C2	719	10/8/2013	SE-3B-C2	PW-3B-C2		
3B-C3	715	10/8/2013	SE-3B-C3	PW-3B-C3		
3B-C4	714	10/8/2013	SE-3B-C4	PW-3B-C4		
3-C4	721	10/8/2013	SE-3-C4	PW-3-C4	EPA	Porewater collected with ceramic air stone for filtered dissolved analysis. Blue air stone used for other parameters.
4-B3	707	10/5/2013	SE-4-B3	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
4-B6	709	10/8/2013	MUD0010	No Sample Collected		Duplicate sample for SE-4-B6 (Chemistry only analyses)
4-C1	710	10/7/2013	No Sample Collected	No Sample Collected		
4-R5	707	10/8/2013	SE-4-R5	PW-4-R5		Reserve for Station 4-C1
4-C2	707	10/7/2013	SE-4-C2	PW-4-C2		
4-C3	706	10/5/2013	SE-4-C3	PW-4-C3		
4-C4	705	10/4/2013	SE-4-C4	PW-4-C4		
4-C5	704	10/4/2013	SE-4-C5	PW-4-C5		
4-C6	703	10/5/2013	SE-4-C6	PW-4-C6	EPA	
4B-C1	701	10/4/2013	SE-4B-C1	PW-4B-C1		
			MUD0009	No Sample Collected		Duplicate sample for SE-4B-C1
4B-C2	698	10/4/2013	SE-4B-C2	PW-4B-C2		
			MUD0002	No Sample Collected		Duplicate sample for SE-4B-C2
4B-C3	692	10/4/2013	SE-4B-C3	PW-4B-C3		
Map Tile 3 - Inchelium - Gifford Reach						
4B-C4	688	10/1/2013	SE-4B-C4	PW-4B-C4		
5-B2	678	9/28/2013	SE-5-B2	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
5-B5	676	9/27/2013	SE-5-B5	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
5-B6	676	9/27/2013	SE-5-B6	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
5-C1	680	9/30/2013	SE-5-C1	PW-5-C1		
5-C2	678	9/30/2013	SE-5-C2	PW-5-C2		
5-C3	677	9/28/2013	SE-5-C3	PW-5-C3	EPA	
5-C4	675	9/27/2013	SE-5-C4	PW-5-C4		
			MUD0007	Chemistry Only		Duplicate sample for SE-5-C4
5B-C1	674	9/27/2013	SE-5B-C1	PW-5B-C1		
5B-C2	671	9/26/2013	SE-5B-C2	PW-5B-C2		
5B-C3	671	9/26/2013	SE-5B-C3	PW-5B-C3	EPA	

Table 3-2. Environmental Samples Collected at Chemistry Only Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Id.	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
5B-C4	668	9/26/2013	SE-5B-C4	PW-5B-C4		
6-C1	666	9/25/2013	SE-6-C1	PW-6-C1		
6-C2	666	9/25/2013	SE-6-C2	PW-6-C2		
			MUD0006	No Sample Collected		Duplicate sample for SE-6-C2
6-C3	664	9/24/2013	SE-6-C3	PW-6-C3		
6-C4	664	9/24/2013	SE-6-C4	PW-6-C4		
6B-C1	663	9/24/2013	SE-6B-C1	PW-6B-C1		
6-R3	666	9/25/2013	SE-6-R3	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample. Reserve for Station 6-B3
Ref-4	679	9/30/2013	SE-REF-4	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
Trib-1	686	9/26/2013	MUD0008	No Sample Collected		
Trib-3	685	10/1/2013	SE-TRIB-3	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
Map Tile 4 - Two Rivers Area						
6B-C2	659	9/13/2013	SE-6B-C2	No Sample Collected	EPA	Airstone clogged, No porewater could be obtained.
6B-C3	657	9/16/2013	SE-6B-C3	No Sample Collected		Airstone clogged, No porewater could be obtained.
6B-C4	652	9/16/2013	SE-6B-C4	No Sample Collected		Airstone clogged, No porewater could be obtained.
7-B5	643	9/13/2013	SE-7-B5	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
7-C1	648	9/16/2013	SE-7-C1	No Sample Collected		No porewater could be obtained
7-C2	649	9/16/2013	SE-7-C2	No Sample Collected		No porewater could be obtained.
7-C3	640	9/12/2013	SE-7-C3	No Sample Collected		< 1ml porewater was obtained
7-C4	641	9/12/2013	SE-7-C4	No Sample Collected		No porewater could be obtained
7B-C1	637	9/16/2013	SE-7B-C1	No Sample Collected		Airstone clogged, No porewater could be obtained.
7B-C2	632	9/12/2013	SE-7B-C2	PW-7B-C2		Partial porewater sample (2-5 ml) collected
7B-C3	626	9/12/2013	SE-7B-C3	No Sample Collected		No porewater could be obtained
7B-C4	634	9/16/2013	SE-7B-C4	No Sample Collected		Airstone clogged, No porewater could be obtained.
Ref-8	632	9/16/2013	SE-REF-8	No Sample Collected	EPA	Chemistry Split from a Bioassay Sample
Map Tile 5 - Spring Canyon Area						
8-C1	609	9/21/2013	SE-8-C1	PW-8-C1		
			MUD0005	No Sample Collected		Duplicate sample for SE-8-C1
8-C2	605	9/20/2013	SE-8-C2	PW-8-C2		
8-C3	603	9/18/2013	SE-8-C3	PW-8-C3		
8-C4	604	9/19/2013	SE-8-C4	PW-8-C4	EPA	
8B-C1	602	9/18/2013	SE-8B-C1	PW-8B-C1		

Table 3-2. Environmental Samples Collected at Chemistry Only Sampling Locations
Upper Columbia River Phase 2 Sediment Study

Station Id.	River Mile	Sample Date	Sediment Sample	Pore Water Sample	Sediment Split Samples	Comments
8B-C2	600	9/18/2013	SE-8B-C2	PW-8B-C2		
			MUD0003	No Sample Collected		Duplicate sample for SE-8B-C2
8B-C3	599	9/18/2013	SE-8B-C3	PW-8B-C3		
8B-C4	598	9/18/2013	SE-8B-C4	PW-8B-C4		
Map Tile 6 - Canadian Locations						
LAL-3	NA	9/8/2013	MUD0001			Chemistry Duplicate Sample for Bioassay Sample LAL-3. See Table 3-1

Notes:

EPA - U.S. Environmental Protection Agency
LAL - Lower Arrow Lake
PW - Porewater
Ref - Reference
SE - sediment
Trib - Tributary

Table 3-3. Equipment Rinsate Samples
Upper Columbia River Phase 2 Sediment Study

Date	Sampling Crew	Sample Number	Associated Equipment	Associated Sediment Samples
9/5/2013	Tieton	ER-G-2-TI	Scoop	SE-G-1, SE-G-2
9/6/2013	Tieton	ER-G-4-TI	Grab sampler	SE-G-3, SE-G-4
9/7/2013	Tieton	ER-LAL-6-TI	Lexan Tub	SE-LAL-4, SE-LAL-5, SE-LAL-6
9/8/2013	Tieton	ER-LAL-3-TI	Screen	SE-LAL-3, MUD0001
9/12/2013	Tahoma	ER-7-C3-TA-1	Grab sampler	SE-7B-C3, SE-7-C3
9/12/2013	Tahoma	ER-7-C3-TA-2	Scoop	SE-7B-C3, SE-7-C3
9/12/2013	Tahoma	ER-7-C3-TA-3	Lexan tub	SE-7B-C3, SE-7-C3
9/12/2013	Tieton	ER-7-C4-TI-1	Grab sampler	SE-7B-C2, SE-7-C4
9/12/2013	Tieton	ER-7-C4-TI-2	Scoop	SE-7B-C2, SE-7-C4
9/12/2013	Tieton	ER-7-C4-TI-3	Lexan tub	SE-7B-C2, SE-7-C4
9/12/2013	Tieton	ER-7-C4-TI-4	Mixer	SE-7B-C2, SE-7-C4
9/13/2013	Tahoma	ER-Ref-7-TA-1	Grab sampler	SE-7-B3, SE-Ref-7
9/13/2013	Tahoma	ER-Ref-7-TA-2	Scoop	SE-7-B3, SE-Ref-7
9/13/2013	Tahoma	ER-Ref-7-TA-3	Lexan tub	SE-7-B3, SE-Ref-7
9/13/2013	Tahoma	ER-Ref-7-TA-4	Screen	SE-7-B3, SE-Ref-7
9/13/2013	Tahoma	ER-Ref-7-TA-5	Mixer	SE-7-B3, SE-Ref-7
9/13/2013	Tieton	ER-7-B1-TI-1	Grab sampler	SE-7-B1, SE-7-B2, SE-7-B4, SE-7-B5, SE-7-B6
9/13/2013	Tieton	ER-7-B1-TI-2	Scoop	SE-7-B1, SE-7-B2, SE-7-B4, SE-7-B5, SE-7-B6
9/13/2013	Tieton	ER-7-B1-TI-3	Lexan tub	SE-7-B1, SE-7-B2, SE-7-B4, SE-7-B5, SE-7-B6
9/13/2013	Tieton	ER-7-B1-TI-4	Mixer	SE-7-B1, SE-7-B2, SE-7-B4, SE-7-B5, SE-7-B6
9/14/2013	Tieton	ER-Ref-6-TI-1	Grab sampler	SE-Ref-6, SE-6B-C2
9/14/2013	Tieton	ER-Ref-6-TI-2	Scoop	SE-Ref-6, SE-6B-C2
9/14/2013	Tieton	ER-Ref-6-TI-3	Lexan tub	SE-Ref-6, SE-6B-C2
9/14/2013	Tieton	ER-Ref-6-TI-4	Mixer	SE-Ref-6, SE-6B-C2
9/14/2013	Tieton	ER-Ref-6-TI-5	Screen	SE-Ref-6, SE-6B-C2
9/16/2013	Tieton	ER-7B-C1-TI-1	Grab sampler	SE-6B-C3, SE-6B-C4, SE-7B-C4, SE-7B-C1
9/16/2013	Tieton	ER-7B-C1-TI-2	Scoop	SE-6B-C3, SE-6B-C4, SE-7B-C4, SE-7B-C1
9/16/2013	Tieton	ER-7B-C1-TI-3	Lexan tub	SE-6B-C3, SE-6B-C4, SE-7B-C4, SE-7B-C1
9/16/2013	Tieton	ER-7B-C1-TI-4	Mixer	SE-6B-C3, SE-6B-C4, SE-7B-C4, SE-7B-C1
9/16/2013	Tahoma	ER-REF-8-TA-1	Grab sampler	SE-7-C1, SE-7-C2, SE-REF-8
9/16/2013	Tahoma	ER-REF-8-TA-2	Scoop	7-C1, 7-C2, REF-8
9/16/2013	Tahoma	ER-REF-8-TA-3	Lexan tub	7-C1, 7-C2, REF-8
9/16/2013	Tahoma	ER-REF-8-TA-4	Mixer	7-C1, 7-C2, REF-8
9/18/2013	Tieton	ER-8-C3-TI-1	Grab sampler	SE-8-C3, SE-8B-C1, SE-8B-C3, SE-8B-C4
9/18/2013	Tieton	ER-8-C3-TI-2	Scoop	SE-8-C3, SE-8B-C1, SE-8B-C3, SE-8B-C4
9/18/2013	Tieton	ER-8-C3-TI-3	Lexan tub	SE-8-C3, SE-8B-C1, SE-8B-C3, SE-8B-C4
9/18/2013	Tieton	ER-8-C3-TI-4	Mixer	SE-8-C3, SE-8B-C1, SE-8B-C3, SE-8B-C4
9/18/2013	Tahoma	ER-REF-10b-TA-1	Grab sampler	SE-8B-C2, SE-REF-10b, MUD0003
9/18/2013	Tahoma	ER-REF-10b-TA-2	Scoop	SE-8B-C2, SE-REF-10b, MUD0003
9/18/2013	Tahoma	ER-REF-10b-TA-3	Lexan tub	SE-8B-C2, SE-REF-10b, MUD0003
9/18/2013	Tahoma	ER-REF-10b-TA-4	Mixer	SE-8B-C2, SE-REF-10b, MUD0003
9/19/2013	Tieton	ER-8-B3-TI-1	Grab sampler	SE-8-B3, SE-8-C4, SE-8-B4
9/19/2013	Tieton	ER-8-B3-TI-2	Scoop	SE-8-B3, SE-8-C4, SE-8-B4
9/19/2013	Tieton	ER-8-B3-TI-3	Lexan tub	SE-8-B3, SE-8-C4, SE-8-B4
9/19/2013	Tieton	ER-8-B3-TI-4	Mixer	SE-8-B3, SE-8-C4, SE-8-B4
9/19/2013	Tahoma	ER-REF-9-TA-1	Grab sampler	SE-8-B2, SE-REF-9
9/19/2013	Tahoma	ER-REF-9-TA-2	Scoop	SE-8-B2, SE-REF-9
9/19/2013	Tahoma	ER-REF-9-TA-3	Screen	SE-8-B2, SE-REF-9
9/19/2013	Tahoma	ER-REF-9-TA-4	Lexan Tub	SE-8-B2, SE-REF-9
9/19/2013	Tahoma	ER-REF-9-TA-5	Mixer	SE-8-B2, SE-REF-9
9/20/2013	Tieton	ER-8-B5-TI-1	Grab sampler	SE-8-B5, SE-8-B6
9/20/2013	Tieton	ER-8-B5-TI-2	Scoop	SE-8-B5, SE-8-B6
9/20/2013	Tieton	ER-8-B5-TI-3	Lexan tub	SE-8-B5, SE-8-B6
9/20/2013	Tieton	ER-8-B5-TI-4	Mixer	SE-8-B5, SE-8-B6
9/20/2013	Tieton	ER-8-B5-TI-5	Screen	SE-8-B5, SE-8-B6
9/20/2013	Tahoma	ER-8-B1-TA-1	Grab sampler	SE-8-C2
9/20/2013	Tahoma	ER-8-B1-TA-2	Scoop	SE-8-C2, SE-8-B1
9/20/2013	Tahoma	ER-8-B1-TA-3	Lexan tub	SE-8-C2, SE-8-B1
9/20/2013	Tahoma	ER-8-B1-TA-4	Mixer	SE-8-C2, SE-8-B1

Table 3-3. Equipment Rinsate Samples
Upper Columbia River Phase 2 Sediment Study

Date	Sampling Crew	Sample Number	Associated Equipment	Associated Sediment Samples
9/20/2013	Tahoma	ER-8-B1-TA-5	Grab sampler	SE-8-B1
9/21/2013	Tieton	ER-8-C1-TI-1	Grab sampler	SE-8-C1, MUD0005
9/21/2013	Tieton	ER-8-C1-TI-2	Scoop	SE-8-C1, MUD0005
9/21/2013	Tieton	ER-8-C1-TI-3	Lexan tub	SE-8-C1, MUD0005
9/21/2013	Tieton	ER-8-C1-TI-4	Mixer	SE-8-C1, MUD0005
9/24/2013	Tieton	ER-6-B6-TI-1	Grab sampler	SE-6-B6, SE-6B-C1, SE-6-C4
9/24/2013	Tieton	ER-6-B6-TI-2	Scoop	SE-6-B6, SE-6B-C1, SE-6-C4
9/24/2013	Tieton	ER-6-B6-TI-3	Lexan tub	SE-6-B6, SE-6B-C1, SE-6-C4
9/24/2013	Tieton	ER-6-B6-TI-4	Mixer	SE-6-B6, SE-6B-C1, SE-6-C4
9/24/2013	Tahoma	ER-6-C3-TA-1	Grab sampler	SE-6-B5, SE-6-C3
9/24/2013	Tahoma	ER-6-C3-TA-2	Scoop	SE-6-B5, SE-6-C3
9/24/2013	Tahoma	ER-6-C3-TA-3	Lexan tub	SE-6-B5, SE-6-C3
9/24/2013	Tahoma	ER-6-C3-TA-4	Lexan tub	SE-6-B5, SE-6-C3
9/24/2013	Tahoma	ER-6-C3-TA-5	Mixer	SE-6-B5, SE-6-C3
9/25/2013	Tahoma	ER-6-R3-TA-1	Grab sampler	SE-6-B1, SE-6-R3
9/25/2013	Tahoma	ER-6-R3-TA-2	Scoop	SE-6-B1, SE-6-R3
9/25/2013	Tahoma	ER-6-R3-TA-3	Lexan tub	SE-6-B1, SE-6-R3
9/25/2013	Tahoma	ER-6-R3-TA-4	Mixer	SE-6-B1, SE-6-R3
9/25/2013	Tieton	ER-6-C2-TI-1	Grab sampler	SE-6-C1, SE-6-B2, SE-6-C2, MUD0006
9/25/2013	Tieton	ER-6-C2-TI-2	Scoop	SE-6-C1, SE-6-B2, SE-6-C2, MUD0006
9/25/2013	Tieton	ER-6-C2-TI-3	Lexan tub	SE-6-C1, SE-6-B2, SE-6-C2, MUD0006
9/25/2013	Tieton	ER-6-C2-TI-4	Mixer	SE-6-C1, SE-6-B2, SE-6-C2, MUD0006
9/26/2013	Tieton	ER-5B-C3-TI-1	Grab sampler	SE-6-B4, SE-5B-C2, SE-5B-C3, SE-5B-C4
9/26/2013	Tieton	ER-5B-C3-TI-2	Scoop	SE-6-B4, SE-5B-C2, SE-5B-C3, SE-5B-C4
9/26/2013	Tieton	ER-5B-C3-TI-3	Lexan tub	SE-6-B4, SE-5B-C2, SE-5B-C3, SE-5B-C4
9/26/2013	Tieton	ER-5B-C3-TI-4	Mixer	SE-6-B4, SE-5B-C2, SE-5B-C3, SE-5B-C4
9/26/2013	N/A	ER-TRIB-1-1	Grab sampler	SE-TRIB-1, MUD-0008
9/26/2013	N/A	ER-TRIB-1-2	Scoop	SE-TRIB-1, MUD-0008
9/26/2013	N/A	ER-TRIB-1-3	Screen	SE-TRIB-1, MUD-0008
9/26/2013	N/A	ER-TRIB-1-4	Lexan tub	SE-TRIB-1, MUD-0008
9/26/2013	N/A	ER-TRIB-1-5	Mixer	SE-TRIB-1, MUD-0008
9/27/2013	Tieton	ER-5-B4-TI-1	Grab sampler	SE-5B-C1, SE-5-B5, SE-5-B6, SE-5-B4
9/27/2013	Tieton	ER-5-B4-TI-2	Scoop	SE-5B-C1, SE-5-B5, SE-5-B6, SE-5-B4
9/27/2013	Tieton	ER-5-B4-TI-3	Lexan tub	SE-5B-C1, SE-5-B5, SE-5-B6, SE-5-B4
9/27/2013	Tieton	ER-5-B4-TI-4	Mixer	SE-5B-C1, SE-5-B5, SE-5-B6, SE-5-B4
9/27/2013	Tahoma	ER-REF-5B-TA-1	Grab sampler	SE-5-C4, SE-REF-5, MUD0007
9/27/2013	Tahoma	ER-REF-5B-TA-2	Lexan tub	SE-5-C4, SE-REF-5, MUD0007
9/27/2013	Tahoma	ER-REF-5B-TA-3	Scoop	SE-5-C4, SE-REF-5, MUD0007
9/27/2013	Tahoma	ER-REF-5B-TA-4	Mixer	SE-5-C4, SE-REF-5, MUD0007
9/27/2013	Tahoma	ER-REF-5B-TA-5	Screen	SE-5-C4, SE-REF-5, MUD0007
9/28/2013	Tahoma	ER-5-B1-TA-1	Grab sampler	SE-5-B1
9/28/2013	Tahoma	ER-5-B1-TA-2	Scoop	SE-5-B1
9/28/2013	Tahoma	ER-5-B1-TA-3	Lexan tub	SE-5-B1
9/28/2013	Tahoma	ER-5-B1-TA-4	Mixer	SE-5-B1
9/28/2013	Tieton	ER-5-B2-TI-1	Grab sampler	SE-5-B2, SE-5-C3
9/28/2013	Tieton	ER-5-B2-TI-2	Scoop	SE-5-B2, SE-5-C3
9/28/2013	Tieton	ER-5-B2-TI-3	Lexan tub	SE-5-B2, SE-5-C3
9/28/2013	Tieton	ER-5-B2-TI-4	Mixer	SE-5-B2, SE-5-C3
9/30/2013	Tieton	ER-5-B3-TI-1	Grab sampler	SE-5-C1, SE-5-B3
9/30/2013	Tieton	ER-5-B3-TI-2	Scoop	SE-5-C1, SE-5-B3
9/30/2013	Tieton	ER-5-B3-TI-3	Lexan tub	SE-5-C1, SE-5-B3
9/30/2013	Tieton	ER-5-B3-TI-4	Mixer	SE-5-C1, SE-5-B3
9/30/2013	Tahoma	ER-REF-4-TA-1	Grab sampler	SE-5-C2, SE-REF-4
9/30/2013	Tahoma	ER-REF-4-TA-2	Lexan tub	SE-5-C2, SE-REF-4
9/30/2013	Tahoma	ER-REF-4-TA-3	Scoop	SE-5-C2, SE-REF-4
9/30/2013	Tahoma	ER-REF-4-TA-4	Mixer	SE-5-C2, SE-REF-4
10/1/2013	Tahoma	ER-REF-3-TA-1	Grab sampler	SE-4B-C4, SE-REF-3
10/1/2013	Tahoma	ER-REF-3-TA-2	Lexan tub	SE-4B-C4, SE-REF-3
10/1/2013	Tahoma	ER-REF-3-TA-3	Scoop	SE-4B-C4, SE-REF-3

Table 3-3. Equipment Rinsate Samples
Upper Columbia River Phase 2 Sediment Study

Date	Sampling Crew	Sample Number	Associated Equipment	Associated Sediment Samples
10/1/2013	Tahoma	ER-REF-3-TA-4	Mixer	SE-4B-C4, SE-REF-3
10/1/2013	Tieton	ER-REF-2-TI-1	Grab sampler	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-2	Scoop	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-3	Lexan tub	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-4	Mixer	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-5	Screen	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-6	Shovel	SE-REF-2, SE-TRIB-3
10/1/2013	Tieton	ER-REF-2-TI-7	Ponar sampler	SE-REF-2, SE-TRIB-3
10/4/2013	Tieton	ER-4B-C1-TI-1	Grab sampler	SE-4B-C3, SE-4B-C1, SE-REF-1, MUD0009
10/4/2013	Tieton	ER-4B-C1-TI-2	Scoop	SE-4B-C3, SE-4B-C1, SE-REF-1, MUD0009
10/4/2013	Tieton	ER-4B-C1-TI-3	Lexan tub	SE-4B-C3, SE-4B-C1, SE-REF-1, MUD0009
10/4/2013	Tieton	ER-4B-C1-TI-4	Mixer	SE-4B-C3, SE-4B-C1, SE-REF-1, MUD0009
10/4/2013	Tahoma	ER-4-C5-TA-1	Grab sampler	SE-4B-C2, SE-4-C4, SE-4-C5, MUD0002
10/4/2013	Tahoma	ER-4-C5-TA-2	Scoop	SE-4B-C2, SE-4-C4, SE-4-C5, MUD0002
10/4/2013	Tahoma	ER-4-C5-TA-3	Lexan tub	SE-4B-C2, SE-4-C4, SE-4-C5, MUD0002
10/4/2013	Tahoma	ER-4-C5-TA-4	Mixer	SE-4B-C2, SE-4-C4, SE-4-C5, MUD0002
10/5/2013	Tahoma	ER-4-C3-TA-1	Grab sampler	SE-4-C6, SE-4-B3, SE-4-C3
10/5/2013	Tahoma	ER-4-C3-TA-2	Scoop	SE-4-C6, SE-4-B3, SE-4-C3
10/5/2013	Tahoma	ER-4-C3-TA-3	Lexan tub	SE-4-C6, SE-4-B3, SE-4-C3
10/5/2013	Tahoma	ER-4-C3-TA-4	Mixer	SE-4-C6, SE-4-B3, SE-4-C3
10/5/2013	Tieton	ER-4-B4-TI-1	Grab sampler	SE-4-B5, SE-4-B2, SE-4-B4
10/5/2013	Tieton	ER-4-B4-TI-2	Scoop	SE-4-B5, SE-4-B2, SE-4-B4
10/5/2013	Tieton	ER-4-B4-TI-3	Lexan tub	SE-4-B5, SE-4-B2, SE-4-B4
10/5/2013	Tieton	ER-4-B4-TI-4	Mixer	SE-4-B5, SE-4-B2, SE-4-B4
10/7/2013	Tieton	ER-4-B1-TI-1	Grab sampler	SE-4-B1, SE-Trib-2
10/7/2013	Tieton	ER-4-B1-TI-2	Scoop	SE-4-B1, SE-Trib-2
10/7/2013	Tieton	ER-4-B1-TI-3	Lexan tub	SE-4-B1, SE-Trib-2
10/7/2013	Tieton	ER-4-B1-TI-4	Screen	SE-4-B1, SE-Trib-2
10/7/2013	Tieton	ER-4-B1-TI-5	Ponar sampler	SE-4-B1, SE-Trib-2
10/7/2013	Tahoma	ER-4-C1-TA-1	Grab sampler	SE-4-C1, SE-4-C2
10/7/2013	Tahoma	ER-4-C1-TA-2	Scoop	SE-4-C1, SE-4-C2
10/7/2013	Tahoma	ER-4-C1-TA-3	Mixer	SE-4-C1, SE-4-C2
10/7/2013	Tahoma	ER-4-C1-TA-4	Lexan tub	SE-4-C1, SE-4-C2
10/7/2013	Tahoma	ER-4-C1-TA-5	Screen	SE-4-C1, SE-4-C2
10/8/2013	Tahoma	ER-3B-C2-TA-1	Grab sampler	SE-4-R5, SE-3B-C4, SE-3B-C2
10/8/2013	Tahoma	ER-3B-C2-TA-2	Scoop	SE-4-R5, SE-3B-C4, SE-3B-C2
10/8/2013	Tahoma	ER-3B-C2-TA-3	Mixer	SE-4-R5, SE-3B-C4, SE-3B-C2
10/8/2013	Tahoma	ER-3B-C2-TA-4	Lexan tub	SE-4-R5, SE-3B-C4, SE-3B-C2
10/8/2013	Tahoma	ER-3B-C2-TA-5	Screen	SE-4-R5, SE-3B-C4, SE-3B-C2
10/8/2013	Tieton	ER-3-C4-TI-1	Grab sampler	SE-4-B6, SE-3B-C3, SE-3-C4, MUD0010
10/8/2013	Tieton	ER-3-C4-TI-2	Scoop	SE-4-B6, SE-3B-C3, SE-3-C4, MUD0010
10/8/2013	Tieton	ER-3-C4-TI-3	Lexan tub	SE-4-B6, SE-3B-C3, SE-3-C4, MUD0010
10/9/2013	Tieton	ER-Trib-4-TI-1	Scoop	SE-Trib-4
10/9/2013	Tieton	ER-Trib-4-TI-2	Screen	SE-Trib-4
10/9/2013	Tieton	ER-Trib-4-TI-3	Lexan tub	SE-Trib-4
10/9/2013	Tahoma	ER-Trib-5-TA-1	Shovel	SE-Trib-5
10/9/2013	Tahoma	ER-Trib-5-TA-2	Scoop	SE-Trib-5
10/9/2013	Tahoma	ER-Trib-5-TA-3	Lexan tub	SE-Trib-5
10/9/2013	Tahoma	ER-Trib-5-TA-4	Screen	SE-Trib-5
10/10/2013	Tahoma	ER-Trib-6-TI-1	Shovel	SE-Trib-6
10/10/2013	Tahoma	ER-Trib-6-TI-2	Screen	SE-Trib-6
10/10/2013	Tahoma	ER-Trib-6-TI-3	Lexan tub	SE-Trib-6
10/10/2013	Tahoma	ER-Trib-6-TI-4	Scoop	SE-Trib-6
10/14/2013	Mazama	ER-3B-R2-MA-1	Grab sampler	SE-3B-R1, SE-3B-R2
10/14/2013	Mazama	ER-3B-R2-MA-2	Scoop	SE-3B-R1, SE-3B-R2
10/14/2013	Mazama	ER-3B-R2-MA-3	Lexan tub	SE-3B-R1, SE-3B-R2
10/14/2013	Mazama	ER-3B-R2-MA-4	Screen	SE-3B-R1, SE-3B-R2
10/14/2013	Tieton	ER-3-B4-TI-1	Grab sampler	SE-3-R2, SE-3-B4
10/14/2013	Tieton	ER-3-B4-TI-2	Scoop	SE-3-R2, SE-3-B4

Table 3-3. Equipment Rinsate Samples
Upper Columbia River Phase 2 Sediment Study

Date	Sampling Crew	Sample Number	Associated Equipment	Associated Sediment Samples
10/14/2013	Tieton	ER-3-B4-TI-3	Lexan tub	SE-3-R2, SE-3-B4
10/14/2013	Tieton	ER-3-B4-TI-4	Mixer	SE-3-R2, SE-3-B4
10/15/2013	Tieton	ER-3-R7-TI-1	Grab sampler	SE-3-R7
10/15/2013	Tieton	ER-3-R7-TI-2	Scoop	SE-3-R7
10/15/2013	Tieton	ER-3-R7-TI-3	Lexan tub	SE-3-R7
10/15/2013	Mazama	ER-3-C1-MA-1	Grab sampler	SE-3-R3, SE-3-C1, MUD0011
10/15/2013	Mazama	ER-3-C1-MA-2	Scoop	SE-3-R3, SE-3-C1, MUD0011
10/15/2013	Mazama	ER-3-C1-MA-3	Lexan tub	SE-3-R3, SE-3-C1, MUD0011
10/16/2013	Mazama	ER-2B-C3-MA-1	Grab sampler	SE-2B-C3
10/16/2013	Mazama	ER-2B-C3-MA-2	Scoop	SE-2B-C3
10/16/2013	Mazama	ER-2B-C3-MA-3	Lexan tub	SE-2B-C3
10/16/2013	Tieton	ER-3-B1-TI-1	Grab sampler	SE-3-B3, SE-3-B2, SE-3-B1
10/16/2013	Tieton	ER-3-B1-TI-2	Scoop	SE-3-B3, SE-3-B2, SE-3-B1
10/16/2013	Tieton	ER-3-B1-TI-3	Lexan tub	SE-3-B3, SE-3-B2, SE-3-B1
10/16/2013	Tieton	ER-3-B1-TI-4	Mixer	SE-3-B3, SE-3-B2, SE-3-B1
10/17/2013	Mazama	ER-2-R7-MA-1	Grab sampler	SE-2B-R1
10/17/2013	Mazama	ER-2-R7-MA-2	Scoop	SE-2B-R1
10/17/2013	Mazama	ER-2-R7-MA-3	Screen	SE-2B-R1
10/17/2013	Mazama	ER-2-R7-MA-4	Lexan tub	SE-2B-R1
10/17/2013	Tieton	ER-2-B4-TI-1	Grab sampler	SE-2-B4, SE-3-R1
10/17/2013	Tieton	ER-2-B4-TI-2	Scoop	SE-2-B4, SE-3-R1
10/17/2013	Tieton	ER-2-B4-TI-3	Lexan tub	SE-2-B4, SE-3-R1
10/17/2013	Tieton	ER-2-B4-TI-4	Mixer	SE-2-B4, SE-3-R1
10/17/2013	Tieton	ER-2-B4-TI-5	Screen	SE-2-B4, SE-3-R1
10/18/2013	Mazama	ER-2-C2-MA-1	Grab sampler	No Samples Collected this Day
10/18/2013	Tieton	ER-1-B5-TI-1	Grab sampler	SE-2-R3, 1-B5
10/18/2013	Tieton	ER-1-B5-TI-2	Scoop	SE-2-R3, 1-B5
10/18/2013	Tieton	ER-1-B5-TI-3	Lexan tub	SE-2-R3, 1-B5
10/18/2013	Tieton	ER-1-B5-TI-4	Mixer	SE-2-R3, 1-B5
10/18/2013	Tieton	ER-1-B5-TI-5	Screen	SE-2-R3, 1-B5
10/19/2013	Mazama	ER-1-R3-MA-1	Grab sampler	SE-2-C1, MUD0013
10/19/2013	Mazama	ER-1-R3-MA-2	Scoop	SE-2-C1, MUD0013
10/19/2013	Mazama	ER-1-R3-MA-3	Lexan tub	SE-2-C1, MUD0013
10/19/2013	Mazama	ER-1-R3-MA-4	Mixer	SE-2-C1, MUD0013
10/21/2013	Mazama	ER-1-R8-MA-1	Grab sampler	SE-1-R8
10/21/2013	Mazama	ER-1-R8-MA-2	Scoop	SE-1-R8
10/21/2013	Mazama	ER-1-R8-MA-3	Lexan tub	SE-1-R8
10/21/2013	Tieton	ER-1-R2-TI-1	Grab sampler	SE-1-R1, SE-1-R2, MUD0014
10/21/2013	Tieton	ER-1-R2-TI-2	Scoop	SE-1-R1, SE-1-R2, MUD0014
10/21/2013	Tieton	ER-1-R2-TI-3	Lexan tub	SE-1-R1, SE-1-R2, MUD0014
10/22/2013	Mazama	ER-1-R5-MA-1	Grab sampler	SE-1B-C3, SE-1-C1, SE-1-R5
10/22/2013	Mazama	ER-1-R5-MA-2	Scoop	SE-1B-C3, SE-1-C1, SE-1-R5
10/22/2013	Mazama	ER-1-R5-MA-3	Lexan tub	SE-1B-C3, SE-1-C1, SE-1-R5
10/22/2013	Tieton	ER-1B-C1-T1-1	Ponar sampler	SE-1B-C1, SE-1B-R2, SE-1B-R1
10/22/2013	Tieton	ER-1B-C1-T1-2	Scoop	SE-1B-C1, SE-1B-R2, SE-1B-R1
10/22/2013	Tieton	ER-1B-C1-T1-3	Lexan tub	SE-1B-C1, SE-1B-R2, SE-1B-R1
10/22/2013	Tieton	ER-1B-C1-T1-4	Mixer	SE-1B-C1, SE-1B-R2, SE-1B-R1
10/22/2013	Tieton	ER-1B-C1-T1-5	Screen	SE-1B-C1, SE-1B-R2, SE-1B-R1
10/23/2013	Mazama	ER-2-B3-MA-1	Grab sampler	SE-1B-R3, MUD0016
10/23/2013	Mazama	ER-2-B3-MA-2	Scoop	SE-1B-R3, MUD0016
10/23/2013	Mazama	ER-2-B3-MA-3	Lexan tub	SE-1B-R3, MUD0016
10/23/2013	Mazama	ER-2-B3-MA-4	Screen	SE-1B-R3, MUD0016
10/23/2013	Tieton	ER-2-B2-TI-1	Grab sampler	SE-2-B2, SE-2-R1, SE-2-B1, MUD0015
10/23/2013	Tieton	ER-2-B2-TI-2	Scoop	SE-2-B2, SE-2-R1, SE-2-B1, MUD0015
10/23/2013	Tieton	ER-2-B2-TI-3	Lexan tub	SE-2-B2, SE-2-R1, SE-2-B1, MUD0015
10/24/2013	Tieton	ER-3-R9-TI-1	Grab sampler	SE-3-R9, SE-2B-R2, SE-3-R8
10/24/2013	Tieton	ER-3-R9-TI-2	Scoop	SE-3-R9, SE-2B-R2, SE-3-R8
10/24/2013	Tieton	ER-3-R9-TI-3	Lexan tub	SE-3-R9, SE-2B-R2, SE-3-R8
10/24/2013	Tieton	ER-3-R9-TI-4	Mixer	SE-3-R9, SE-2B-R2, SE-3-R8

Table 3-3. Equipment Rinsate Samples
Upper Columbia River Phase 2 Sediment Study

Date	Sampling Crew	Sample Number	Associated Equipment	Associated Sediment Samples
10/24/2013	Tieton	ER-3-R9-TI-5	Screen	SE-3-R9, SE-2B-R2, SE-3-R8
10/24/2013	Mazama	ER-4-R1-MA-1	Grab sampler	SE-2B-C4, SE-4-R1
10/24/2013	Mazama	ER-4-R1-MA-2	Scoop	SE-2B-C4, SE-4-R1
10/24/2013	Mazama	ER-4-R1-MA-3	Lexan Tub	SE-2B-C4, SE-4-R1

Notes:

ER - Equipment Rinsate
LAL - Lower Arrow Lake
Ref - Reference
SE - Sediment
MA - Mazama
TA - Tahoma
TI - Tieton
Trib - Tributary

4 QAPP CHANGES AND DEVIATIONS

The field team strictly followed the EPA-approved QAPP and its associated SOPs. However, situations arose during field sampling activities that required modifications to the EPA-approved QAPP. All modifications were discussed with EPA or their designee and ultimately agreed to by all parties. For purposes of the 2013 field sampling program, there were two types of modifications: changes and deviations.

> **Changes** were modifications to the QAPP that were identified prior to actual sample collection. The change process included preparation of a change order form and associated documentation to support the change request. The form was initiated by URS field staff, reviewed by the URS field supervisor and URS project manager, and then signed by representatives of TAI and EPA.
>
> **Deviations** are modifications from the EPA-approved QAPP that were generally identified during daily field sampling activities. The field staff and EPA-oversight personnel discussed deviations at the time they were recognized and agreed that the proposed modification were appropriate before implementing it.

This section summarizes these changes and deviations.

4.1 QAPP CHANGES

Three approved change requests (numbers 1, 2 and 4) were processed during field sampling activities. Change request #3, was intended to address acceptance of undisturbed portions of the sample after removal of those portions near the edge of the sampler that experienced winnowing. This was handled as deviation (see Section 4.2). Copies of executed change requests and supporting documentation are included in Appendix I but can be summarized as follows:

1. **Change 1:** On August 28, 2013, URS submitted a change request to relocate sample locations LAL-4, LAL-5, and LAL-6. The change in sample locations was based on the recommendations of a professional archaeologist in Canada and was approved by EPA on September 3, 2013.
2. **Change 2:** On September 9, 2013, URS submitted a change request to prepare a new standard operating procedure (SOP-3A) to be followed during tributary sampling. During review of the EPA-approved QAPP in preparation for field sampling activities URS noted that no SOP specific to tributary sampling was available. The change was approved by EPA on September 23, 2013.
3. **Change 3:** Not Used.
4. **Change 4:** On November 12, 2013, URS submitted a change request to prepare a new standard operating procedure (SOP-10) to be followed for collecting EPA-chemistry only split samples from sediment samples located at ALS Environmental laboratory in Kelso, Washington. This was necessary because no SOP specific to collecting EPA-split samples at ALS was provided in the EPA-approved QAPP. The change was approved on 12 November 2013.

None of the above-listed changes are expected to adversely affect data quality.

4.2 DEVIATIONS

The field team followed the SOPs described in the field sampling plan (Appendix A of the EPA-approved QAPP). During field activities deviations to the SOPs were documented. Table 4-1 summarizes these deviations and URS's assessment of their impact on the data quality objectives, if any. As indicated in Table 4-1, the changes and deviations are not expected to adversely affect the data quality objectives as outlined in the EPA-approved QAPP.

Table 4-1. Identified Deviations from the QAPP
Upper Columbia River Phase 2 Sediment Study

Date	Situation	Deviation	Impact to Data Quality
5-Sep-13	Upon arrival at the Trail boat launch the field sampling team encountered one CCT observer and two EPA observers. The CCT cultural oversight observer and both EPA observers wanted to be on the sampling boat.	Allowed two observers on the safety boat instead of one as agreed prior to commencement of work. Established an observer rotation between sampling boat and safety boat to accommodate each observer.	None
5-Sep-13	Dr. Laura Buelow of the EPA indicated that, in addition to the split sample volume requirements outlined within the March 2013 QAPP, EPA is requiring that split-sample volume requirements be 3-5 gallons.	TAI instructed URS to comply with this request.	None
5-Sep-13	Fine substrates adversely affected the extraction of porewater in the field. The ceramic air stones performed poorly during the test, so alternate air stones with larger pore spaces were obtained as a contingency.	During porewater sampling, sample collection was first attempted using the ceramic air stones. If this failed to collect a sample the alternate air stones were used.	None
8-Sep-13	Discovered that the water depth at planned sample locations LAL-1, LAL-2, and LAL-3 is over 500 feet. This exceeds the depth capacity of the sampling equipment (approximately 350 feet).	After discussing the situation with the EPA oversight personnel and cultural observers, it was agreed to move these sample locations to an area near the eastern shore of Lower Arrow Lake where the sampling equipment could reach the bottom.	None. Three accepted sediment samples were collected.
8-Sep-13	Sampling crew reported that at locations where sediment is sandy pore water drains from the sample to quickly to obtain a pore water sample from within the grab sampler.	After discussing the situation with the EPA oversight personnel is was decided to place the sample into the Lexan® tub and then collect the porewater sample from the tub.	None
18-Sep-13	The sampling crew encountered a situation where the collected sediment filled the grab sampler such that the material just touched the lids of the grab sampler but does not cause the lids of the grab sampler to be lifted.	This deviates from the sample acceptance criteria stated in the QAPP but the URS sampling crew and the EPA oversight person agreed that the sample was acceptable.	None
27-Sep-13	During sediment sampling at location Trib-1 the grab sampler retained a high percentage of water relative to the sediment volume. The sampling crew could not distinguish porewater from overlying surface water within the Lexan® tub.	The decision was made to collect porewater insitu by inserting the ceramic air stone into the sediments at the margin of the stream and extracting pore water using a peristaltic pump. The pH was measured in both extracted porewater and surface water in the stream. The pH readings were 6.7 for the extracted pore water and 7.2 for the surface water indicating that the pore water is distinctly different than the surface water in the stream.	None
2-Oct-13	URS was notified by ALS that the temperature blank associated with bulk sediments samples delivered on 29 September 2013 recorded a temperature of 8.3 degrees C.	This temperature blank is outside the prescribed temperature ranges of 4 degrees C (+/- 2 degrees C).	The analytical results for these bioassay samples should be flagged by the data validator. No significant impact to data quality is anticipated.
7-Oct-13	Dr. Laura Buelow was concerned that the time spent collecting porewater samples was cutting into time allocated for sediment collection. She recommended modifying the process as described.	1) Remove the overlying water from sediment collected in the Lexan® tub. 2) Shake the Lexan® tub to allow the sediment and porewater to separate. 3) Sample the porewater from the top of the sediment without inserting the air stone into the sediment.	None

Table 4-1. Identified Deviations from the QAPP
Upper Columbia River Phase 2 Sediment Study

Date	Situation	Deviation	Impact to Data Quality
16-Oct-13	After one attempt with the grab sampler at Station 2-R10 (reserve for Primary Station 3-B4) the grab sampler became snagged on the bottom. Retrieval of the sampler required careful maneuvering with the boat in conjunction with timed operation of the hydraulics. Subsequent attempts at this location could result in the loss of the grab sampler, or create an urgent situation consisting of a snagged sampler attached to the bow of the boat in a fast moving river current.	Rejected reserve sampling station 2-R10 after one attempt at sample collection. Additional reserve sampling stations for primary station 3-B4 were still available and sampling crew moved to the next reserve station in the sequence. Two partial sediment samples were collected at reserve stations for primary station 3-B4.	None
18-Oct-13	Review of bathymetry data and river conditions at locations 2-B5 and 2-B6 raised concerns by the boat captain that attempted sampling at these locations could cause the potential loss of the grab sampler. These locations are similar to location 2-R10 where the grab sampler became snagged on the bottom on 16 October 2013.	Rejected primary stations 2-B5 and 2-B6. Additional reserve sampling stations for primary stations 2-B5 and 2-B6 were still available and sampling crew moved to the next reserve stations in the sequence. A full sediment sample was collected at reserve station 2-R1 for primary station 2-B5. A partial sediment sample was collected at reserve station 2B-R2 for primary station 2-B6.	None
18-Oct-13	After one attempt with the grab sampler at Station 1-R10 (reserve for Primary Station 2-B6) it was determined that the strong current caused the sampler to be dragged along the bottom preventing sample collection.	Rejected reserve sampling station 1-R10 after one attempt at sample collection. Additional reserve sampling stations for primary station 2-B6 are still available and sampling crew moved to the next reserve station in the sequence. A partial sediment sample was collected at reserve station 2B-R2 for primary station 2-B6.	None
21-Oct-13	Visual observation of the river bottom at location 1-B6 indicated a cobble-lined bottom. The river current at this location was also very swift.	Rejected primary sampling station 1-B6 without attempting sample collection. Reserve sampling stations for primary station 1-B6 were still available and sampling crew moved to the next reserve station in the sequence. A full sediment sample was collected at reserve station 1-R2 for primary station 1-B6.	None
23-Oct-13	A swift current and a river bottom consisting of cobbles and a large submerged boulder presented a boat safety issue at Primary Station 1-C2.	Rejected primary sampling station 1-C2 without attempting sample collection. Reserve sampling stations for primary station 1-C2 were still available and sampling crew moved to the next reserve station in the sequence. A full sediment sample was collected at reserve station 1B-R3 for primary station 1-C2.	None

5 LIMITATIONS

This report has been prepared for the exclusive use of TAI to provide a summary of the 2013 Phase 2 Sediment Study field work performed by URS and its subcontractors during the period September 5, 2013 to October 24, 2013. No other party may rely on the product of our services unless we agree in advance of such reliance in writing. URS makes no warrantee or guarantee regarding the accuracy or completeness of information provided or compiled by others.

This report is intended exclusively for the purposes outlined herein and the project and Site indicated. It should be recognized that this work was not intended to be a definitive investigation of the Site and the conclusions provided are not necessarily inclusive of all the possible conditions.

URS' objective is to perform our work exercising the customary standard of care, in accordance with the standard for professional services for a national consulting firm at the time these services are provided. No expressed or implied representation or warranty is included or intended in our reports except that our work was performed, within the limits prescribed by our client, in accordance with the customary and professional standard of care described herein.

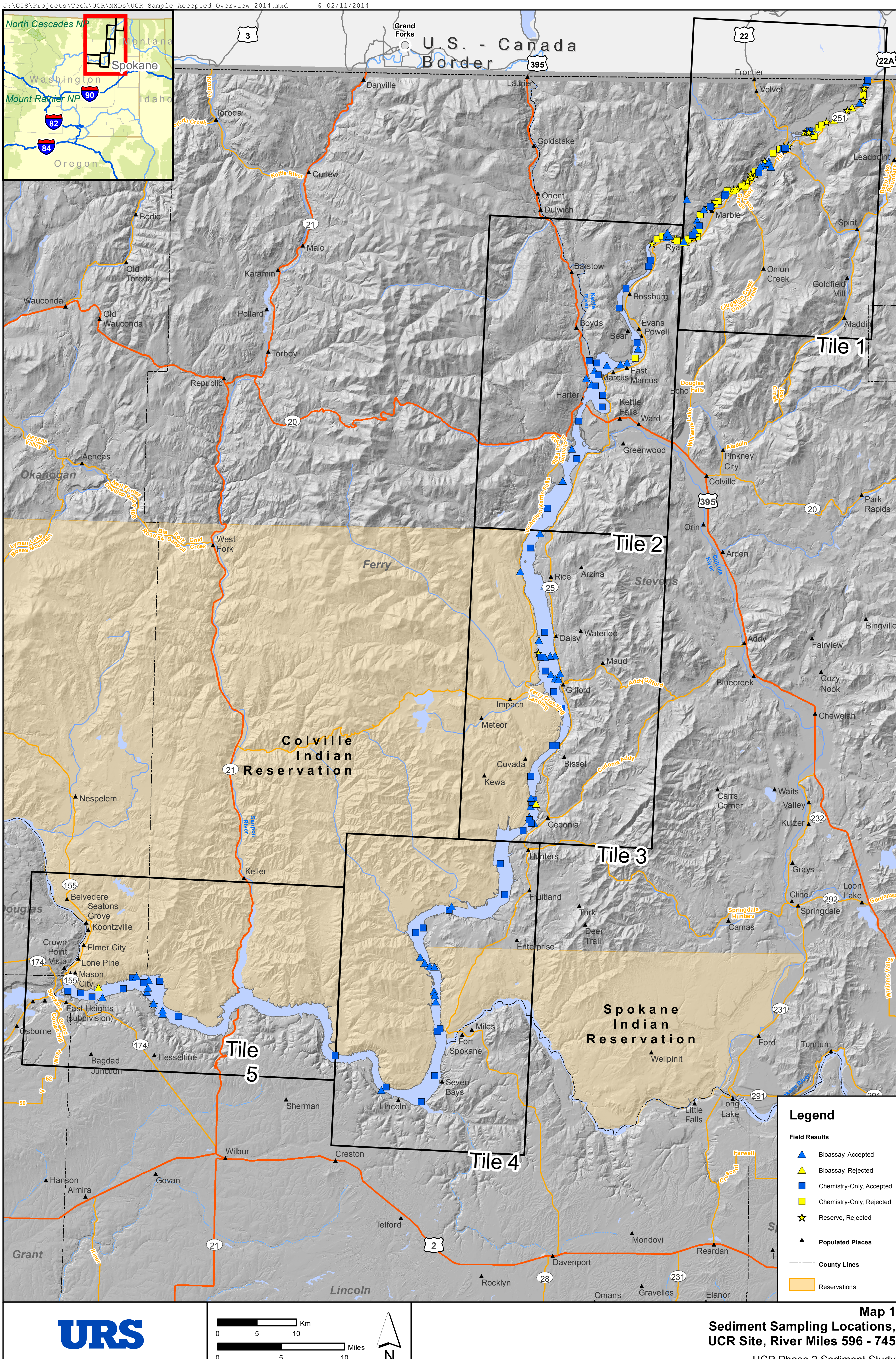
6 REFERENCES

Exponent Inc. and HDR HydrolQual, Inc., in Association and Consultation with Parametrix, Cardwell Consulting LLC. and Integral Consulting, Inc. 2013. *Final Quality Assurance Project Plan for the Phase 2 Sediment Study*. *Upper Columbia River*. . March 2013, Amended September 2013.

URS Corporation (URS). 2013. *Final Site Health and Safety Plan*. 2013 Sediment Study, Upper Colombia River RI/FS. August 20, 2013.

MAPS

J:\GIS\Projects\Teck\UCR\MXDs\UCR_Sample_Accepted_Overview_2014.mxd @ 02/11/2014



URS

Map 1
Sediment Sampling Locations, UCR Site, River Miles 596 - 745

UCR Phase 2 Sediment Study

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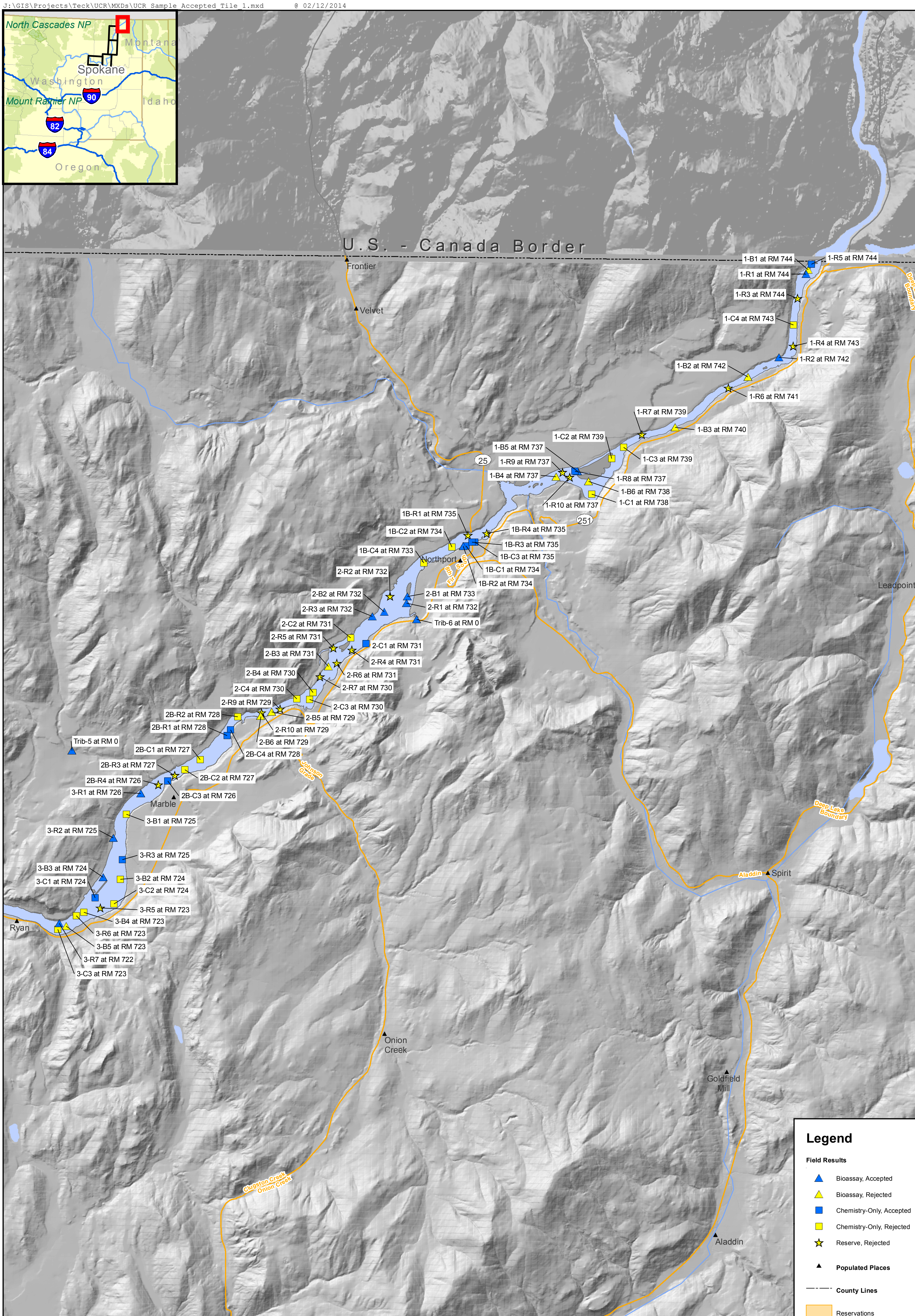

URS

Km
0 1.25 2.5
Miles
0 1.25 2.5
N

Map 2
Tile 1 - Sediment Sampling Locations,
U.S. - Canada Border to China Bend, River Miles 745 - 723
UCR Phase 2 Sediment Study

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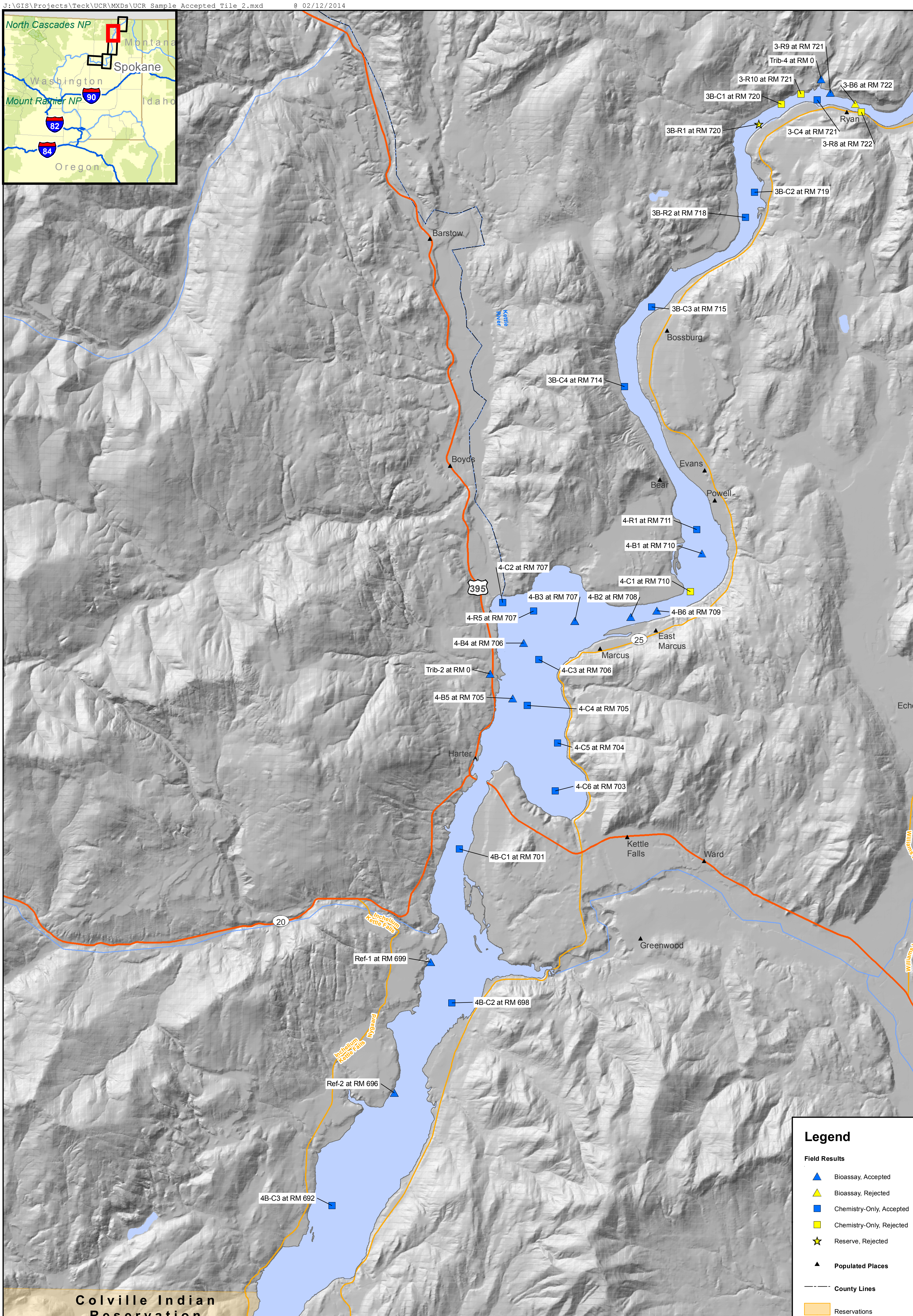

URS

Map 3

Tile 2 - Sediment Sampling Locations, China Bend to Inchelium, River Miles 723 - 691

UCR Phase 2 Sediment Study

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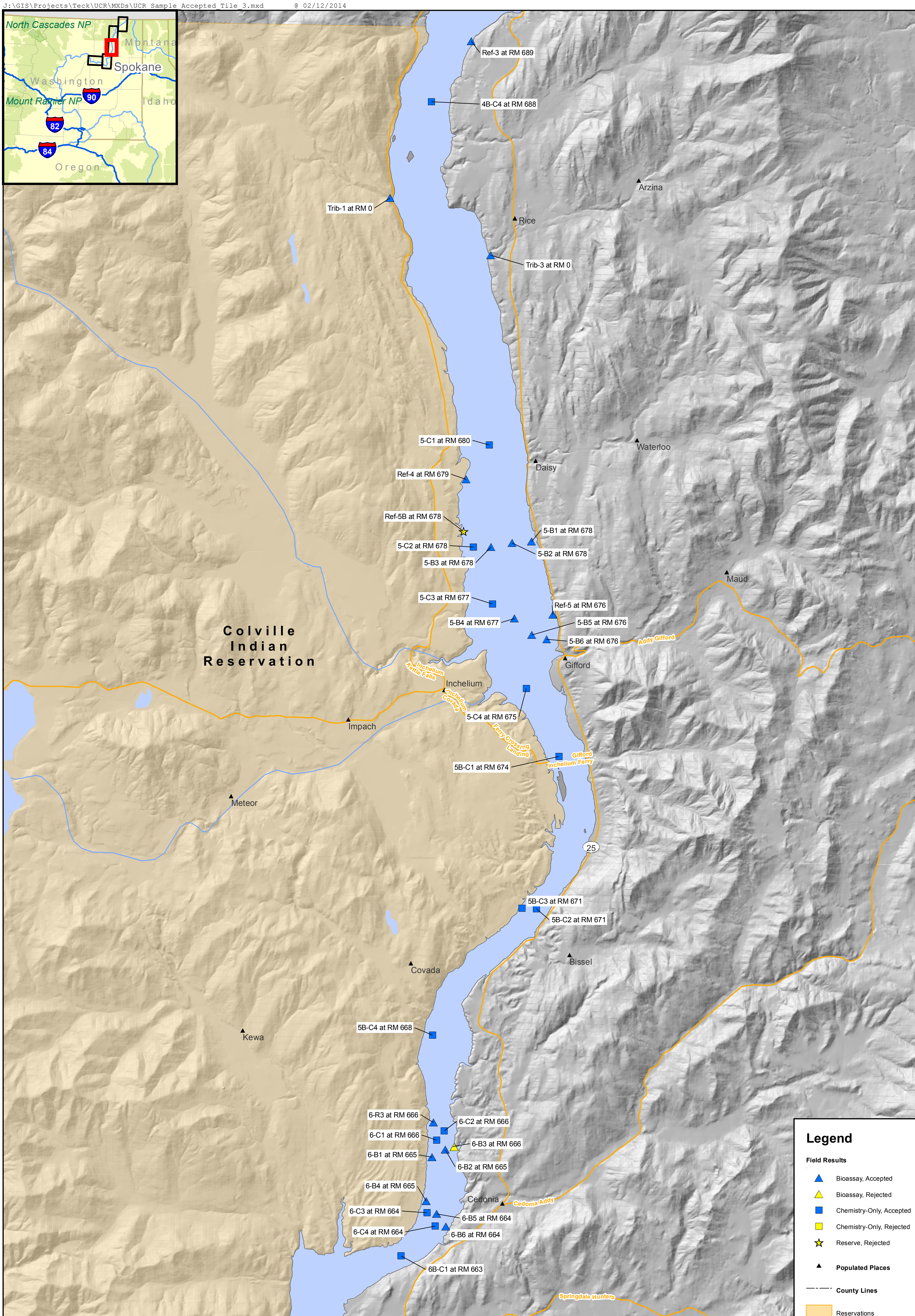

URS

Km
0 1.25 2.5
Miles
0 1.25 2.5

N

Map 4
Tile 3 - Sediment Sampling Locations,
Inchelium to Gifford Reach, River Miles 691 - 661
UCR Phase 2 Sediment Study

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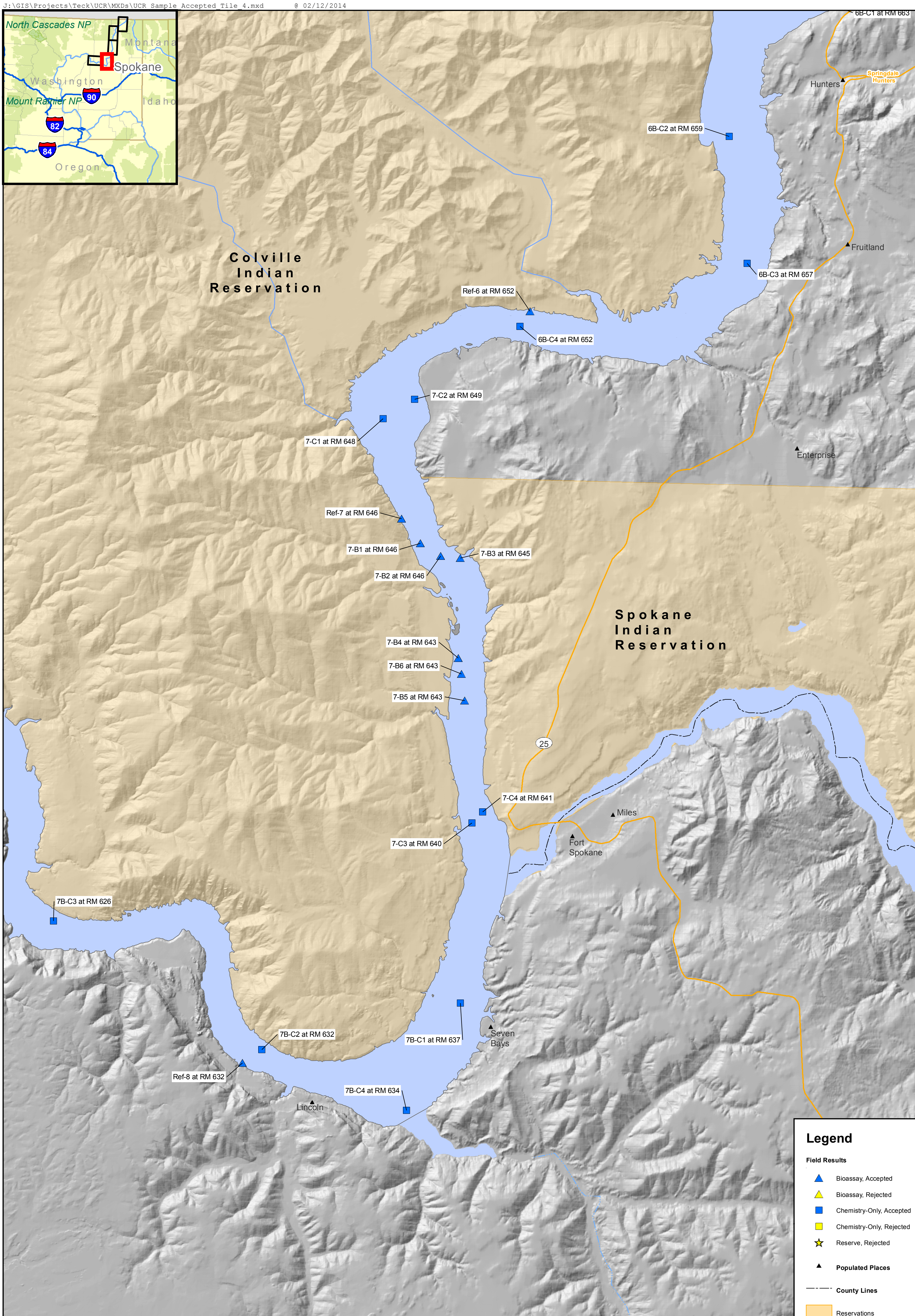

URS

Km
0 1.25 2.5

Miles
0 1.25 2.5

N

Map 5
Tile 4 - Sediment Sampling Locations,
Two Rivers Area, River Miles 661 - 626
UCR Phase 2 Sediment Study

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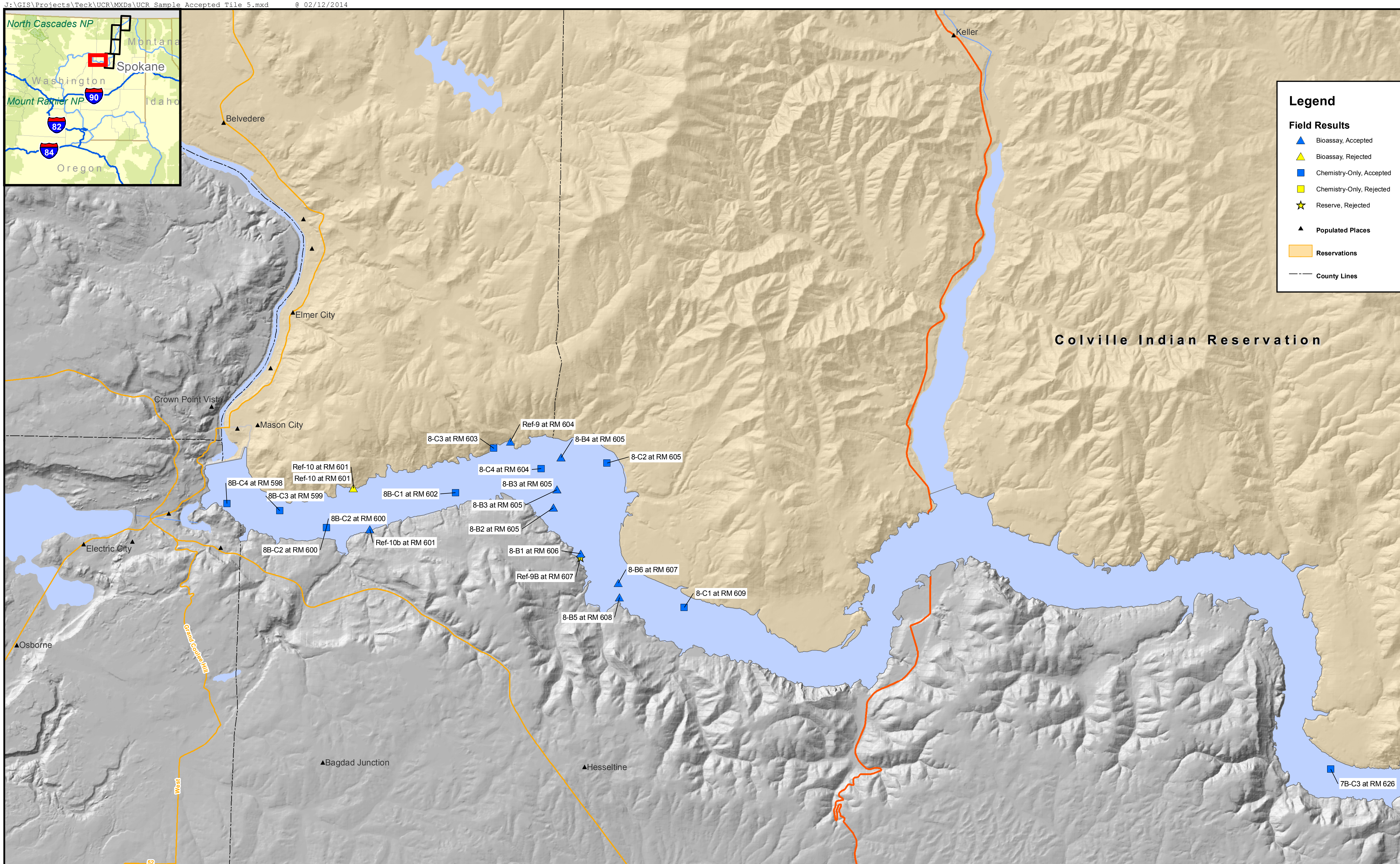


URS

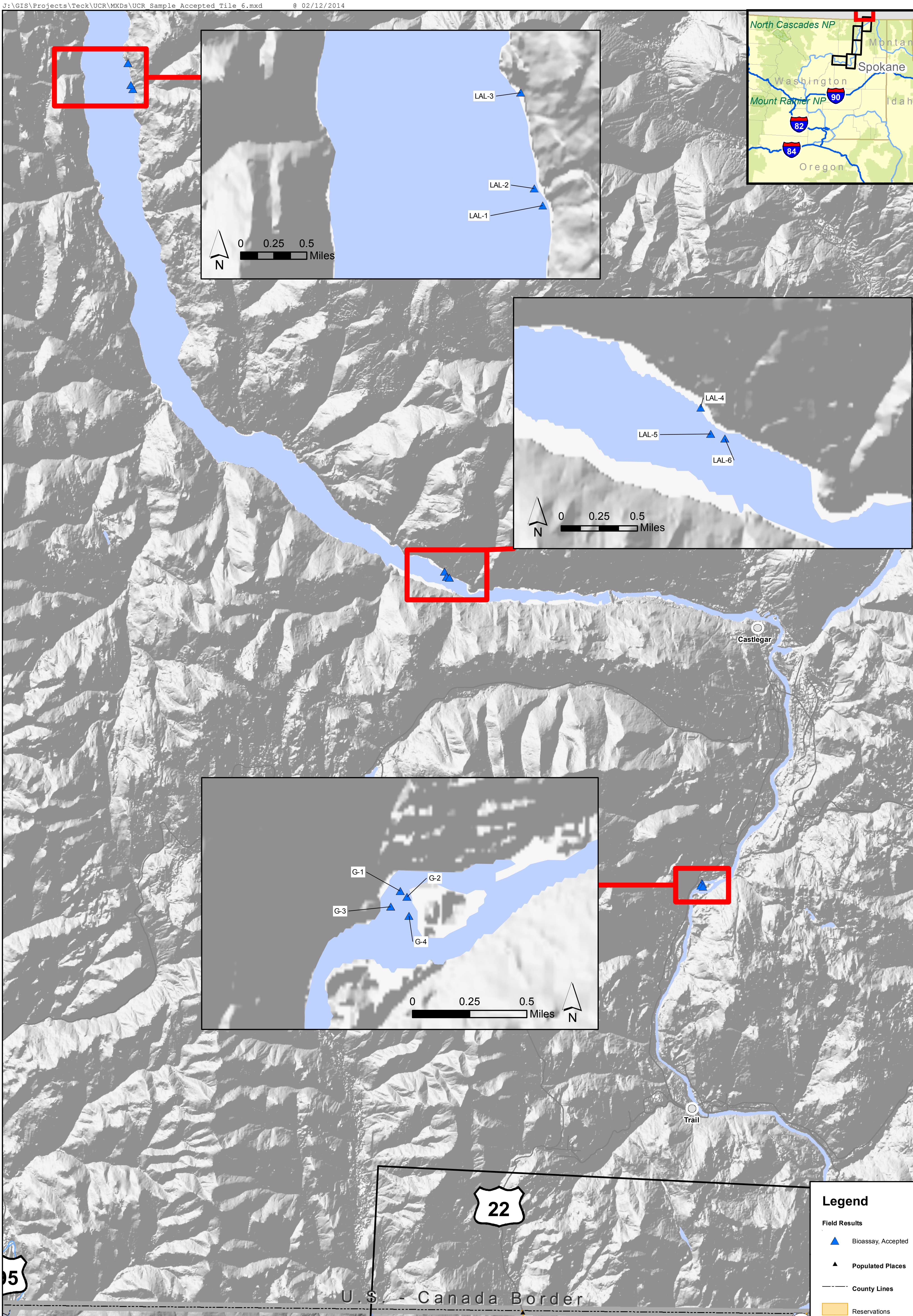
Km 0 1.25 2.5

Miles 0 1.25 2.5

N

Map 6
Tile 5 - Sediment Sampling Locations,
Spring Canyon Area, River Miles 626 - 596
UCR Phase 2 Seidment Study

J:\GIS\Projects\Teck\UCR\MXDs\UCR_Sample_Accepted_Tile_6.mxd @ 02/12/2014



URS

Km 0 2 4

Miles 0 2 4

N

Map 7
Tile 6 - Sediment Sampling Locations, Canada
UCR Phase 2 Sediment Study

APPENDIX A

PERMITS AND LETTER

Natural Resources Canada | Ressources naturelles Canada

CANMET Mining and Mineral Sciences Laboratories | Laboratoires des mines et des sciences minérales de CANMET

555 Booth Street
Ottawa, Canada K1A 0G1 | 555, rue Booth
Ottawa, Canada K1A 0G1

RECEIVED
JUL 15 2013

Ottawa, July 4th, 2013

Marko Adzic, P.E.
Manager, Environmental Engineering
Teck Cominco American Incorporated
Suite 300 – 501 North Riverpoint Boulevard
Spokane, WA 99202

Subject: 2013 sediment sampling for the Phase 2 sediment study

Mr Adzic,

This is to confirm that permission is granted to collect sediment samples in Canada as part of the Upper Columbia River Remedial Investigation and Feasibility Study (UCR RI/FS). It is clear that the sampling is directly related to the UCR RI/FS and is scientifically relevant. We concluded that the proposed sampling does not require a permit. Environment Canada and Foreign Affairs Canada have been advised of the sediment sampling work plan and are in agreement.

Please note, however, that we request that the consultant keeps us informed as to any changes in the scheduling or location of sampling in Canada.

Best regards

Carrie Rickwood
Mine Closure and Ecosystem Risk Management Program
CANMET Mining
Natural Resources Cnaada
555 Booth St, Ottawa
ON, K1A 0G1

cc. Beverly McNaughton (Environment Canada, Pacific Region), Steve Cobham (Environment Canada, NCR), Stephen Gluck (Foreign Affairs Canada) Laura Buelow and Matt Wilkening (US EPA)

Canada

United States Department of the Interior

NATIONAL PARK SERVICE
Lake Roosevelt National Recreation Area
1008 Crest Drive
Coulee Dam, WA 99116

IN REPLY REFER TO:

A9015 (LARO)

RECEIVED
JUL 18 2013

July 16, 2013

Mr. Marko Adzic
Teck American Incorporated
501 North Riverpoint Blvd, Suite 300
Spokane WA 99202

Dear Mr. Adzic

The National Park Service, Lake Roosevelt National Recreation Area has received your application for a Special Use Permit (SUP) pertaining to the 2013 Sediment Sampling Activities as part of the Upper Columbia River Remedial Investigation and Feasibility Study.

Enclosed are two copies of the SUP along with the stipulated conditions. Please sign both copies of the permit as the Permitee, and return one copy in the enclosed envelope. Also, please indicate how many research vehicle identification placards your field crews will need.

If you have any questions regarding the conditions of this permit, please feel free to contact Keith Holliday at (509) 633-3860 ext 161.

Sincerely,

Dan A. Foster
Superintendent

CC: David Godlewski, Teck American Inc.
Kris McCaig, Teck American Inc.
Laura Buelow, U. S. EPA

Form 10-114
Rev. DEC. 99

UNITED STATES DEPARTMENT OF THE INTERIOR
National Park Service

Special Use Permit

Name of Use: **Sample Collection for Sediment Study**

Date Permit Reviewed: July 17, 2013
Expires: November 29, 2013
Permit #PWR LARO TCAI-007
Region Park Type No. #

Long Term _

Short Term X

Name of Area: **Lake Roosevelt National Recreation Area**

Name or Permittee: Teck America Inc.
Phone: (509) 623-4585

Service Address: **501 N Riverpoint Blvd., Suite 300**
Spokane, WA 99202

Teck America is hereby authorized during the period from (16 day 9 Month 2013), through (29 Day 11 Month 2013), to use the following described land or facilities in the permit conditions:

Those areas within Lake Roosevelt National Recreation Area described within the *Final Quality Assurance Project Plan for the Phase 2 Sediment Study* dated March 2013 **and as approved by the U.S. Environmental Protection Agency in consultation with the Cultural Resource Coordination Group.**

For the purpose(s) of: **Collecting Sediment Samples** [Research (2500)]
Contact: **Keith Holliday** Phone: **(509) 633-3860 Ext. 161**

Authorizing legislation or other authority (RE - DO-53): 16 U.S.C. §§1a-1; 42 U.S.C. §§9601 *et seq.*

NEPA Compliance: CATEGORICALLY EXCLUDED ___ EA/FONSI __ EIS X OTHER APPROVED PLANS

DO-12 CE 3.3 (P)

PERFORMANCE BOND: Required X Not Required ____ **Amount $500,000**

LIABILITY INSURANCE: Required X Not Required ____ Amount **$1,000,000**

ISSUANCE of this permit is subject to the conditions on the reverse hereof and appended pages and when appropriate to the payment to the U.S. Dept. of the Interior, National Park Service.

The undersigned hereby accepts this permit subject to the terms, conditions, covenants, obligations, and reservations, expressed or implied herein.

Permittee:

Signature	Print Name and Title	Date

Authorizing Official:

[signature]	Dan A. Foster	July 16, 2013
Signature	Park Superintendent	Date

CONDITIONS OF THIS PERMIT

1. The Permittee shall exercise this privilege subject to the supervision of the Park Superintendent and shall comply with all applicable laws, regulations, codes, standards and policies, including but not limited to 29 CFR 1910 and 16 U.S.C. Section 1 *et seq*.

   Based on previously cited and/or documented violations at Lake Roosevelt National Recreation Area (LARO), the following firm and/or individual is not granted access and shall not perform any field activities under this Permit.

   Mr. Greg Diefenbach, Consulting Geologist

2. The Permittee shall pay the United States for any damage resulting from the activities contemplated by this Permit, which would not reasonably be inherent in the use that the Permittee is authorized to make of the Site. For purposes of this Permit, the Site is that portion of the Upper Columbia River (UCR) Site as defined within the June 2, 2006 Settlement Agreement between the U.S. Environmental Protection Agency (EPA) and Teck Cominco that lies within the boundaries of LARO.

3. No Member of or Delegate to Congress, or Resident Commissioner shall be admitted to any share or part of this Permit or to any benefit that may arise there from, but this provision shall not be construed to extend to this grant if made with a corporation for its general benefit.

4. During the performance of this Permit, the Permittee agrees that it will not discriminate against any person because of race, color, religion, sex, or national origin. The Permittee will take affirmative action to ensure that applicants are employed without regard to their race, color, religion, sex, or national origin.

5. ANTI-DEFICIENCY ACT. No provision of this Permit shall be interpreted as or constitute a commitment or requirement that the United States obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. §§1341-1344 and 1511-1519, or any other applicable provision of law.

6. This Permit may not be transferred or assigned to parties not described within the permit application without the prior written consent of the Park Superintendent.

7. The National Park Service (NPS) reserves the right to stop any work being performed on the Site pursuant to this Permit should NPS determine that such work has or will negatively impact any NPS resources, which would not reasonably be inherent in the use that the Permittee is entitled to make of the Site pursuant to this Permit.

8. The Permittee is prohibited from giving false information; to do so will be considered a breach of conditions and be grounds for revocation [Re: 36 CFR 2.32(a)(4)].

9. This Permit is granted upon the express condition that the United States, its agents and employees, shall be free from all liabilities and claims for damages and/or suits for or by any reason, arising from or related to activities conducted pursuant to this Permit, including any releases of Waste Materials (as defined in Paragraph 35 of this Permit), injury, or death to any person or property of the Permittee, its contractors, subcontractors, agents or employees, or third parties, from any cause or causes whatsoever while in or upon the Site or any part thereof during the term of this Permit or occasioned by any use of the Site or any activity carried on by the Permittee or its contractors or subcontractors in connection herewith, and the Permittee hereby covenants and agrees to indemnify, defend, save and hold harmless the United States, its agents and employees, from all liabilities, charges, expenses and costs on account of or by reason of any such injuries, deaths, liabilities, claims, suits or losses however occurring, or damages arising from any acts related to this Permit.

10. The required performance bond guarantees the Permittee's compliance with permit conditions and reimbursement to the Park for damage to resources and/or facilities as a result of the Permittee's activities. The Permittee shall place a bond with a commercial Bonding Agent prior to initiating work under this Permit. A listing of bonding companies authorized to issue bonds to the United States may be found in Treasury Circular 570. The agent will hold the bond until informed by NPS of the successful completion of all terms of the Permit. The performance bond will not be released until all costs have been recovered and any damages repaired.

11. This Permit is issued only for the use of the portion of the Site within LARO identified in the EPA approved *Final Quality Assurance Project Plan for the Phase 2 Sediment Study* dated March 2013 (QAPP), and only for the dates and times specified.

12. At no time will Permittee's activities at the Site interfere with a visitor's enjoyment of the Park, except as necessary to conduct the activities contemplated by this Permit. Visitor access to all park facilities, exhibits, resources, etc. will be maintained at all times and the Permittee will not block or obstruct any park walkway, dock, boat launch, trail, or road, except to the extent necessary to conduct the activities authorized by this Permit.

13. The Permittee will comply with any and all instructions from official representatives of the NPS (e.g., Rangers, Point(s) of Contact, and Cultural Resource Representatives), including but not limited to orders to cease and desist work.

14. This Permit does not authorize any use, activity, or purpose other than those expressly described herein.

15. NPS reserves the right to immediately rescind this Permit at any time should any of the Permit conditions be violated, or should the activity in any way interfere with any program of the Park, except as expressly authorized by this Permit, or at the discretion of the Park Superintendent.

16. If the Permittee fails to comply with the requirements of the Permit or uses the Permit for

an unauthorized use, activity, or purpose, the Permittee shall pay the Department $25,000 for each failure to comply or unauthorized use, activity or purpose, unless excused by the Park Superintendent.

17. The issuance of this Permit will grant the Permittee access to the Site to conduct only those activities necessary to perform the work in the EPA approved QAPP and described in the Permit conditions. To the extent practicable, all work performed subject to this Permit shall comply with the EPA guidance, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*, EPA 542-R-08-002 (April 2008).

18. Future access to NPS property or any modifications to this Permit will require a written amendment issued by the NPS.

19. The Permittee shall coordinate the performance of work with the appropriate representative of the NPS. The primary local NPS point of contact for all aspects of this Permit will be Keith Holliday (Office: 509/633-3860 Ext. 161, Cell: 509/631-0306, and Email: keith_holliday@nps.gov). The alternate point of contact is Jon Edwards (Office: 509/754-7811, Cell: 509-631-0103, and Email: jon_edwards@nps.gov). In the event of emergency, accident, injury or death, call 911. For any other environmental accidents, spill or release, NPS law enforcement must be contacted via the local county Sherriff's office, Stevens County (509/684-2555) or Lincoln County (509/725-3501). Additionally, Keith Holliday must be contacted within one-hour of any incident.

20. REGULATORY REQUIREMENTS: All Site work will be conducted and implemented in accordance with all federal, state, and local laws, regulations and requirements as directed by the NPS, and will be consistent with the NPS mission (*see, e.g.*, 16 U.S.C. Section 1 *et seq.*) and Permit conditions.

21. The Permittee is responsible for complying with any federal, state, or local requirement(s) to obtain any licenses and/or permits for the activities conducted pursuant to this Permit, and for obtaining any utility clearances required before the permitted work is commenced.

22. All work and investigations on NPS property requires a minimum 48-hour advance notice (business days, Monday-Friday except federal holidays) to the NPS points of contact identified above. The Permittee will provide before activities commence the NPS a written list of names with email addresses, phone and fax numbers of its points of contact, including the Permittee's contractors and subcontractors for activities conducted on the Site pursuant to this Permit.

23. The Permittee and its representatives, agents, contractors, and subcontractors must be apprised of, be familiar with, and comply with the contents of this Permit. A copy of this Permit will be available and producible upon request to the Permittee and/or its contractors and subcontractors during all phases of the permitted work.

24. Any and/or all sample collection activities on NPS property, or those activities that are or may be impacting NPS property and resources shall be monitored by a NPS cultural resource representative. When samples are to be collected from a boat, the NPS cultural resource representative shall be on the boat(s) at the time samples are collected from NPS property. The daily work hours for NPS cultural resource representatives are 7:00 am to 5:00 pm PDT. Travel and meetings (e.g., safety) necessary for the activities allowed by this Permit will occur during work hours. Also, included in work hours are at least two 15-minute breaks and an hour lunch. NPS cultural resource representatives weekly work days are Monday through Saturday, but not Sunday.

25. This Permit does not grant any property rights, easements, right-of-ways, or any other interest in real property, including ownership of samples collected.

26. For all sediment samples collected on NPS property and selected for sediment toxicity testing (i.e., bioassay samples, as identified in Table A1 of Appendix 1 [Field Sampling Plan] of the EPA approved QAPP) or those activities that are or may be impacting NPS property and resources, the Permittee shall provide a split sample to the NPS or its designee. The Permittee shall provide the NPS or its designee with a split sample that contains at least 3 gallons but not more than 5 gallons of sediment collected from each sampling location and selected for analysis. In cases where the split sample to be provided to NPS or its designee would contain less than 3 gallons, the Permittee shall hold the entire sediment sample collected and move to the reserve sampling location(s) identified in the EPA approved QAPP and make an effort acceptable to the NPS or its designee to collect sufficient volume of sediment for a sample, including a split sample. In those cases where an acceptable effort has been made at the primary and reserve sampling locations but an insufficient volume of sediment has been collected to split the sample, the NPS or its designee may waive the split sample requirement for that particular sediment sample.

    When sufficient volume has been collected, the split sample shall be provided to the NPS or its designee immediately (i.e., within two hours or when special situations arise as previously agreed upon) after the Permittee has completed sample processing in the field (i.e., sieving, homogenizing, etc.) in accordance with the EPA approved QAPP. The Permittee shall complete a chain-of-custody form to document the transfer of split sample(s) to the NPS or its designee. If the NPS or its designee is not available to accept or approve of the transfer of split sample(s), the Permittee shall store the split sample(s) at 4 degrees Celsius until custody is transferred and documented.

    Section B.2 of the EPA approved QAPP requires the Permittee to provide splits of sediment samples to EPA to support its QA/QC program. The splits referred to in this Permit are separate, distinct and in addition to the splits required by EPA. Hence, provision of split samples to EPA in no way relieves the Permittee of the obligation to provide the NPS or its designee the split samples required by this permit.

    It is recognized that the Permittee may be required to provide split sediment samples to multiple jurisdictions within LARO as a condition of the permits issued by the NPS and other entities. It is not the intent of the NPS to require the Permittee to provide more than one split sample of any sediment sample collected from the stations identified in the EPA approved QAPP and located within LARO. In situations where potentially overlapping jurisdictions appear to be requiring multiple split samples of a sediment sample collected and selected for bioassay testing within the boundaries of LARO, the Permittee shall coordinate with the NPS or its designee to ensure custody of a split sample is transferred to an acceptable entity in order for the NPS or its designee to waive the split sample requirement for that particular sediment sample. Non-compliance with any portion of this condition is grounds for the NPS to order the Permittee to cease and desist its operations, and for Permit revocation.

27. Permittee shall dispose of sediment samples collected but not selected for analysis or sediment collected in excess of the 12 gallon sample volume required in the EPA approved QAPP (Table B3-1) and the 3 to 5 gallon NPS required split sample as Investigation Derived Waste (IDW) prior to expiration of the Permit, unless amended. Permittee shall submit to the NPS point of contact a copy of the complete chain of custody form, manifest, and receipt of disposal for each sample collected within 10-days of permit expiration.

28. The Permittee and its contractors and subcontractors are responsible for the proper handling and off-Site disposal of all generated wastes, including but not limited to samples, in accordance with state and federal regulations. This includes all IDW, which will be handled in accordance with all legal requirements and will be containerized, characterized for disposal purposes only, and properly disposed of at an off-Site facility at the Permittee's expense. All IDW shall be placed in appropriate containers and removed from NPS property at the end of each work day. IDW shall not be staged or stored for more than 24 hours on NPS property. IDW shall not be disposed on NPS property. IDW shall not be used for any other purposes and/or characterized/analyzed, except as needed for disposal.

29. Appropriate Occupational Safety and Health Administration personal protective equipment must be used by field crews and other on-Site personnel.

30. A copy of all data (*e.g.*, sample results, laboratory results, coordinates, wildlife inventories), documentation (*e.g.*, manifests, field notes, maps, photographs, monitoring results), and reports prepared relating to work performed pursuant to this Permit will be submitted to the NPS points of contact when submitted to the EPA.

31. The Permittee assumes liability for all activities, releases, incidents and events caused by or associated with any permitted activity, including any and all releases of Waste Materials into the environment resulting from permitted activities. The Permittee assumes responsibility for costs, repairs, and/or restoration to any areas damaged by such releases and/or discharges, whether those areas are within the permitted area or not.

32. In the event of a spill or other release or threatened release of a Waste Material into the environment that constitutes an emergency situation or may present an immediate threat

to public health or welfare or the environment, the Permittee shall immediately take all appropriate action to prevent, abate, or minimize such release or threat of release, and shall immediately make proper notification in accordance with all applicable legal and regulatory requirements. Notification of any release of a Waste Material shall be made to the Washington Emergency Management Division at 1-800-258-5990 and NPS law enforcement at (509) 754-7813. Notice also shall be made to the NPS points of contact identified in Paragraph 19 above. Contingency measures will be implemented as noted in the following paragraph, and the Permittee shall be responsible for cleanup of all spills or other releases.

33. Contingency measures:

    a. Permittee and its contractors will immediately stop operations;

    b. All crew members will don appropriate personal protective equipment and take appropriate steps to abate and remediate the release; and

    c. Authorized activities will be suspended until conditions are determined to be stable according to NPS' determination.

34. Nothing in the preceding paragraphs shall be deemed to limit any authority of the United States, (a) to take all appropriate action to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Materials on, at, or from the Site, or (b) to direct or order such action, or seek an order from the requisite Court, to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Materials on, at, or from the Site.

35. "Waste Material" shall mean, for purposes of this Permit, (a) any "hazardous substance" under CERCLA Section 101(14), 42 U.S.C. § 9601(14); (b) any "pollutant or contaminant" under CERCLA Section 101(33), 42 U.S.C. § 9601(33); (c) any "solid waste" under RCRA Section 1004(27); (d) any hazardous waste under RCRA Section 1004(5), 42 U.S.C. § 6903(5); (e) any petroleum product or waste, including crude oil or any fraction thereof or waste; and (f) natural gas, liquefied natural gas, or synthetic gas or any mixtures thereof.

36. The Permittee shall ensure its liability insurance remains in full force during the entirety of the period covered by this Permit. The Permittee agrees to be fully responsible for the management, performance, use and safety of the Site under this Permit and hereby accepts responsibility and assumes liability for any and all claims arising from the intentional, reckless or negligent actions or omissions of its representatives, employees, agents, contractors or subcontractors directly or indirectly connected with the work performed, or the maintenance or use of the Site, to the extent permitted by law. The Permittee shall, and shall require all of its contractors and subcontractors to:

    a. Procure a general liability insurance policy from responsible companies for $1,000,000 (one million dollars), or the minimum required by law, if any, whichever amount is greater. The United States of America shall be named as an additional insured on all policies. The Permit number will be included on said policy. All such policies shall specify that the insured shall have no right of subrogation against the United States for payments of any premiums or deductibles thereunder, and such insurance policies shall be obtained by, be for the account of, and be at the insured's sole risk. A copy of the Certificate of Insurance evidencing proper insurance coverage and referencing the Permit number shall be returned to NPS with the executed Permit to the Park Superintendent. No work shall be allowed to proceed under this Permit until the copy of said Certificate of Insurance is provided to the Park Superintendent.

b. Pay the United States the full value for all damages to the lands or other property of the United States caused by the Permittee or by the Permittee's employees, agents, contractors, subcontractors, or employees of the contractors or subcontractors.

c. Indemnify, save and hold harmless and defend the United States against all fines, claims, damages, losses, judgments, and expenses to the extent permitted by law rising out of, or from any omission or activity in connection with activities conducted under this Permit.

37. The Permittee and its contractors and subcontractors shall take adequate measures as directed and approved by NPS to prevent, minimize, and mitigate damage to Park resources during all activities conducted pursuant to this Permit. The Permittee shall restore any injury to NPS property resulting from activities conducted pursuant to this Permit in accordance with NPS, other federal and state requirements, and at the direction of NPS.

38. No IDW or waste materials shall be allowed to enter natural or manmade water or sewer systems in or on NPS property by either direct or indirect action of the Permittee. Any waste material entering onto NPS property shall be removed and the affected property cleaned, stabilized, or restored the day that this condition is discovered, at the direction, and to the satisfaction, of NPS. The Permittee shall take all necessary measures to prevent air, noise, and water pollution by any material and/or equipment used during this permitted activity.

39. Construction equipment, materials, and all other supplies shall be staged in such a way as to allow for the safe use of the area by park visitors, to the extent possible.

40. The Permittee is responsible for the safety of all Site visitors and shall provide the necessary direction, barricades, detours, and other safety measures to ensure visitor safety. All access restrictions to the work area will be coordinated with the NPS points of contact listed above.

41. Other than the immediate work area and the clearly defined safety zone, all sidewalks, walkways, roadways, docks, boat launches, and trails must remain unobstructed to allow for the reasonable use of these areas by pedestrians, vehicles, and other park users.

42. Any injuries to any persons from the activities authorized under this Permit shall be reported immediately to the NPS points of contact. At least one operable cell phone is required to be with each field crew at all times.

43. The United States shall have no liability for any claims or causes of action in any forum regarding any activities conducted pursuant to this Permit, including but not limited to liability for claims or causes of action for property damage, bodily injury, or death caused by Permittee's use of NPS property in connection with this Permit.

44. The Permittee agrees to comply with and be bound by the terms of this Permit and to undertake all actions set forth in this Permit. In any action by the NPS to enforce the terms of this Permit, the Permittee consents to and agrees not to contest the authority or jurisdiction of NPS to issue or enforce this Permit, and agrees not to contest the validity of the Permit or its terms.

45. All promotional and informational material related to Site activities, including signage, relating to activities undertaken pursuant to this Permit shall be reviewed and approved by the Park Superintendent prior to its release or use.

46. Good order and proper decorum shall be maintained by those persons conducting and participating in Site activities and public safety and general welfare will not be endangered.

UPON THE ACCEPTANCE OF THE CONDITIONS CONTAINED IN THIS PERMIT, INDICATED BY THE APPROVAL OF THE PERMITTEE IN THE SPACE PROVIDED ON THIS PERMIT, AND THE RETURN OF A PROPERLY EXECUTED ORIGINAL TO THIS OFFICE WITHIN NOT MORE THAN 30 DAYS OF ISSUANCE, THIS PERMIT BECOMES VALID FOR THE ACTIVITIES DESCRIBED.

RETURN ONE SIGNED ORIGINAL TO:

Attention: Superintendent
Dan Foster
1008 Crest Drive
Coulee Dam, WA
99116

Form 10-114
Rev. DEC. 99

UNITED STATES DEPARTMENT OF THE INTERIOR
National Park Service

Special Use Permit

Name of Use: **Sample Collection for Sediment Study**

Date Permit Reviewed: July 17, 2013
Expires: November 29, 2013
Permit #PWR LARO TCAI-007
Region Park Type No. #

Long Term _

Short Term X

Name of Area: **Lake Roosevelt National Recreation Area**

Name or Permittee: Teck America Inc.
Phone: (509) 623-4585

Service Address: **501 N Riverpoint Blvd., Suite 300**
Spokane, WA 99202

Teck America is hereby authorized during the period from (16 day 9 Month 2013), through (29 Day 11 Month 2013), to use the following described land or facilities in the permit conditions:

Those areas within Lake Roosevelt National Recreation Area described within the *Final Quality Assurance Project Plan for the Phase 2 Sediment Study* dated March 2013 **and as approved by the U.S. Environmental Protection Agency in consultation with the Cultural Resource Coordination Group.**

For the purpose(s) of: **Collecting Sediment Samples** [Research (2500)]
Contact: **Keith Holliday** Phone: **(509) 633-3860 Ext. 161**

Authorizing legislation or other authority (RE - DO-53): 16 U.S.C. §§1a-1; 42 U.S.C. §§9601 *et seq*.

NEPA Compliance: CATEGORICALLY EXCLUDED ___ EA/FONSI __ EIS X OTHER APPROVED PLANS

DO-12 CE 3.3 (P)

PERFORMANCE BOND: Required X Not Required ____ **Amount $500,000**

LIABILITY INSURANCE: Required X Not Required ____ Amount **$1,000,000**

ISSUANCE of this permit is subject to the conditions on the reverse hereof and appended pages and when appropriate to the payment to the U.S. Dept. of the Interior, National Park Service.

The undersigned hereby accepts this permit subject to the terms, conditions, covenants, obligations, and reservations, expressed or implied herein.

Permittee:

Signature	Print Name and Title	Date

Authorizing Official:

[signature]	Dan A. Foster	July 16, 2013
Signature	Park Superintendent	Date

CONDITIONS OF THIS PERMIT

1. The Permittee shall exercise this privilege subject to the supervision of the Park Superintendent and shall comply with all applicable laws, regulations, codes, standards and policies, including but not limited to 29 CFR 1910 and 16 U.S.C. Section 1 *et seq*.

   Based on previously cited and/or documented violations at Lake Roosevelt National Recreation Area (LARO), the following firm and/or individual is not granted access and shall not perform any field activities under this Permit.

   Mr. Greg Diefenbach, Consulting Geologist

2. The Permittee shall pay the United States for any damage resulting from the activities contemplated by this Permit, which would not reasonably be inherent in the use that the Permittee is authorized to make of the Site. For purposes of this Permit, the Site is that portion of the Upper Columbia River (UCR) Site as defined within the June 2, 2006 Settlement Agreement between the U.S. Environmental Protection Agency (EPA) and Teck Cominco that lies within the boundaries of LARO.

3. No Member of or Delegate to Congress, or Resident Commissioner shall be admitted to any share or part of this Permit or to any benefit that may arise there from, but this provision shall not be construed to extend to this grant if made with a corporation for its general benefit.

4. During the performance of this Permit, the Permittee agrees that it will not discriminate against any person because of race, color, religion, sex, or national origin. The Permittee will take affirmative action to ensure that applicants are employed without regard to their race, color, religion, sex, or national origin.

5. ANTI-DEFICIENCY ACT. No provision of this Permit shall be interpreted as or constitute a commitment or requirement that the United States obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. §§1341-1344 and 1511-1519, or any other applicable provision of law.

6. This Permit may not be transferred or assigned to parties not described within the permit application without the prior written consent of the Park Superintendent.

7. The National Park Service (NPS) reserves the right to stop any work being performed on the Site pursuant to this Permit should NPS determine that such work has or will negatively impact any NPS resources, which would not reasonably be inherent in the use that the Permittee is entitled to make of the Site pursuant to this Permit.

8. The Permittee is prohibited from giving false information; to do so will be considered a breach of conditions and be grounds for revocation [Re: 36 CFR 2.32(a)(4)].

9. This Permit is granted upon the express condition that the United States, its agents and employees, shall be free from all liabilities and claims for damages and/or suits for or by any reason, arising from or related to activities conducted pursuant to this Permit, including any releases of Waste Materials (as defined in Paragraph 35 of this Permit), injury, or death to any person or property of the Permittee, its contractors, subcontractors, agents or employees, or third parties, from any cause or causes whatsoever while in or upon the Site or any part thereof during the term of this Permit or occasioned by any use of the Site or any activity carried on by the Permittee or its contractors or subcontractors in connection herewith, and the Permittee hereby covenants and agrees to indemnify, defend, save and hold harmless the United States, its agents and employees, from all liabilities, charges, expenses and costs on account of or by reason of any such injuries, deaths, liabilities, claims, suits or losses however occurring, or damages arising from any acts related to this Permit.

10. The required performance bond guarantees the Permittee's compliance with permit conditions and reimbursement to the Park for damage to resources and/or facilities as a result of the Permittee's activities. The Permittee shall place a bond with a commercial Bonding Agent prior to initiating work under this Permit. A listing of bonding companies authorized to issue bonds to the United States may be found in Treasury Circular 570. The agent will hold the bond until informed by NPS of the successful completion of all terms of the Permit. The performance bond will not be released until all costs have been recovered and any damages repaired.

11. This Permit is issued only for the use of the portion of the Site within LARO identified in the EPA approved *Final Quality Assurance Project Plan for the Phase 2 Sediment Study* dated March 2013 (QAPP), and only for the dates and times specified.

12. At no time will Permittee's activities at the Site interfere with a visitor's enjoyment of the Park, except as necessary to conduct the activities contemplated by this Permit. Visitor access to all park facilities, exhibits, resources, etc. will be maintained at all times and the Permittee will not block or obstruct any park walkway, dock, boat launch, trail, or road, except to the extent necessary to conduct the activities authorized by this Permit.

13. The Permittee will comply with any and all instructions from official representatives of the NPS (e.g., Rangers, Point(s) of Contact, and Cultural Resource Representatives), including but not limited to orders to cease and desist work.

14. This Permit does not authorize any use, activity, or purpose other than those expressly described herein.

15. NPS reserves the right to immediately rescind this Permit at any time should any of the Permit conditions be violated, or should the activity in any way interfere with any program of the Park, except as expressly authorized by this Permit, or at the discretion of the Park Superintendent.

16. If the Permittee fails to comply with the requirements of the Permit or uses the Permit for

an unauthorized use, activity, or purpose, the Permittee shall pay the Department $25,000 for each failure to comply or unauthorized use, activity or purpose, unless excused by the Park Superintendent.

17. The issuance of this Permit will grant the Permittee access to the Site to conduct only those activities necessary to perform the work in the EPA approved QAPP and described in the Permit conditions. To the extent practicable, all work performed subject to this Permit shall comply with the EPA guidance, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*, EPA 542-R-08-002 (April 2008).

18. Future access to NPS property or any modifications to this Permit will require a written amendment issued by the NPS.

19. The Permittee shall coordinate the performance of work with the appropriate representative of the NPS. The primary local NPS point of contact for all aspects of this Permit will be Keith Holliday (Office: 509/633-3860 Ext. 161, Cell: 509/631-0306, and Email: keith_holliday@nps.gov). The alternate point of contact is Jon Edwards (Office: 509/754-7811, Cell: 509-631-0103, and Email: jon_edwards@nps.gov). In the event of emergency, accident, injury or death, call 911. For any other environmental accidents, spill or release, NPS law enforcement must be contacted via the local county Sherriff's office, Stevens County (509/684-2555) or Lincoln County (509/725-3501). Additionally, Keith Holliday must be contacted within one-hour of any incident.

20. REGULATORY REQUIREMENTS: All Site work will be conducted and implemented in accordance with all federal, state, and local laws, regulations and requirements as directed by the NPS, and will be consistent with the NPS mission (*see, e.g.*, 16 U.S.C. Section 1 *et seq.*) and Permit conditions.

21. The Permittee is responsible for complying with any federal, state, or local requirement(s) to obtain any licenses and/or permits for the activities conducted pursuant to this Permit, and for obtaining any utility clearances required before the permitted work is commenced.

22. All work and investigations on NPS property requires a minimum 48-hour advance notice (business days, Monday-Friday except federal holidays) to the NPS points of contact identified above. The Permittee will provide before activities commence the NPS a written list of names with email addresses, phone and fax numbers of its points of contact, including the Permittee's contractors and subcontractors for activities conducted on the Site pursuant to this Permit.

23. The Permittee and its representatives, agents, contractors, and subcontractors must be apprised of, be familiar with, and comply with the contents of this Permit. A copy of this Permit will be available and producible upon request to the Permittee and/or its contractors and subcontractors during all phases of the permitted work.

24. Any and/or all sample collection activities on NPS property, or those activities that are or may be impacting NPS property and resources shall be monitored by a NPS cultural resource representative. When samples are to be collected from a boat, the NPS cultural resource representative shall be on the boat(s) at the time samples are collected from NPS property. The daily work hours for NPS cultural resource representatives are 7:00 am to 5:00 pm PDT. Travel and meetings (e.g., safety) necessary for the activities allowed by this Permit will occur during work hours. Also, included in work hours are at least two 15-minute breaks and an hour lunch. NPS cultural resource representatives weekly work days are Monday through Saturday, but not Sunday.

25. This Permit does not grant any property rights, easements, right-of-ways, or any other interest in real property, including ownership of samples collected.

26. For all sediment samples collected on NPS property and selected for sediment toxicity testing (i.e., bioassay samples, as identified in Table A1 of Appendix 1 [Field Sampling Plan] of the EPA approved QAPP) or those activities that are or may be impacting NPS property and resources, the Permittee shall provide a split sample to the NPS or its designee. The Permittee shall provide the NPS or its designee with a split sample that contains at least 3 gallons but not more than 5 gallons of sediment collected from each sampling location and selected for analysis. In cases where the split sample to be provided to NPS or its designee would contain less than 3 gallons, the Permittee shall hold the entire sediment sample collected and move to the reserve sampling location(s) identified in the EPA approved QAPP and make an effort acceptable to the NPS or its designee to collect sufficient volume of sediment for a sample, including a split sample. In those cases where an acceptable effort has been made at the primary and reserve sampling locations but an insufficient volume of sediment has been collected to split the sample, the NPS or its designee may waive the split sample requirement for that particular sediment sample.

    When sufficient volume has been collected, the split sample shall be provided to the NPS or its designee immediately (i.e., within two hours or when special situations arise as previously agreed upon) after the Permittee has completed sample processing in the field (i.e., sieving, homogenizing, etc.) in accordance with the EPA approved QAPP. The Permittee shall complete a chain-of-custody form to document the transfer of split sample(s) to the NPS or its designee. If the NPS or its designee is not available to accept or approve of the transfer of split sample(s), the Permittee shall store the split sample(s) at 4 degrees Celsius until custody is transferred and documented.

    Section B.2 of the EPA approved QAPP requires the Permittee to provide splits of sediment samples to EPA to support its QA/QC program. The splits referred to in this Permit are separate, distinct and in addition to the splits required by EPA. Hence, provision of split samples to EPA in no way relieves the Permittee of the obligation to provide the NPS or its designee the split samples required by this permit.

    It is recognized that the Permittee may be required to provide split sediment samples to multiple jurisdictions within LARO as a condition of the permits issued by the NPS and other entities. It is not the intent of the NPS to require the Permittee to provide more than one split sample of any sediment sample collected from the stations identified in the EPA approved QAPP and located within LARO. In situations where potentially overlapping jurisdictions appear to be requiring multiple split samples of a sediment sample collected and selected for bioassay testing within the boundaries of LARO, the Permittee shall coordinate with the NPS or its designee to ensure custody of a split sample is transferred to an acceptable entity in order for the NPS or its designee to waive the split sample requirement for that particular sediment sample. Non-compliance with any portion of this condition is grounds for the NPS to order the Permittee to cease and desist its operations, and for Permit revocation.

27. Permittee shall dispose of sediment samples collected but not selected for analysis or sediment collected in excess of the 12 gallon sample volume required in the EPA approved QAPP (Table B3-1) and the 3 to 5 gallon NPS required split sample as Investigation Derived Waste (IDW) prior to expiration of the Permit, unless amended. Permittee shall submit to the NPS point of contact a copy of the complete chain of custody form, manifest, and receipt of disposal for each sample collected within 10-days of permit expiration.

28. The Permittee and its contractors and subcontractors are responsible for the proper handling and off-Site disposal of all generated wastes, including but not limited to samples, in accordance with state and federal regulations. This includes all IDW, which will be handled in accordance with all legal requirements and will be containerized, characterized for disposal purposes only, and properly disposed of at an off-Site facility at the Permittee's expense. All IDW shall be placed in appropriate containers and removed from NPS property at the end of each work day. IDW shall not be staged or stored for more than 24 hours on NPS property. IDW shall not be disposed on NPS property. IDW shall not be used for any other purposes and/or characterized/analyzed, except as needed for disposal.

29. Appropriate Occupational Safety and Health Administration personal protective equipment must be used by field crews and other on-Site personnel.

30. A copy of all data (*e.g.*, sample results, laboratory results, coordinates, wildlife inventories), documentation (*e.g.*, manifests, field notes, maps, photographs, monitoring results), and reports prepared relating to work performed pursuant to this Permit will be submitted to the NPS points of contact when submitted to the EPA.

31. The Permittee assumes liability for all activities, releases, incidents and events caused by or associated with any permitted activity, including any and all releases of Waste Materials into the environment resulting from permitted activities. The Permittee assumes responsibility for costs, repairs, and/or restoration to any areas damaged by such releases and/or discharges, whether those areas are within the permitted area or not.

32. In the event of a spill or other release or threatened release of a Waste Material into the environment that constitutes an emergency situation or may present an immediate threat

to public health or welfare or the environment, the Permittee shall immediately take all appropriate action to prevent, abate, or minimize such release or threat of release, and shall immediately make proper notification in accordance with all applicable legal and regulatory requirements. Notification of any release of a Waste Material shall be made to the Washington Emergency Management Division at 1-800-258-5990 and NPS law enforcement at (509) 754-7813. Notice also shall be made to the NPS points of contact identified in Paragraph 19 above. Contingency measures will be implemented as noted in the following paragraph, and the Permittee shall be responsible for cleanup of all spills or other releases.

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    a. Permittee and its contractors will immediately stop operations;

    b. All crew members will don appropriate personal protective equipment and take appropriate steps to abate and remediate the release; and

    c. Authorized activities will be suspended until conditions are determined to be stable according to NPS' determination.

34. Nothing in the preceding paragraphs shall be deemed to limit any authority of the United States, (a) to take all appropriate action to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Materials on, at, or from the Site, or (b) to direct or order such action, or seek an order from the requisite Court, to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Materials on, at, or from the Site.

35. "Waste Material" shall mean, for purposes of this Permit, (a) any "hazardous substance" under CERCLA Section 101(14), 42 U.S.C. § 9601(14); (b) any "pollutant or contaminant" under CERCLA Section 101(33), 42 U.S.C. § 9601(33); (c) any "solid waste" under RCRA Section 1004(27); (d) any hazardous waste under RCRA Section 1004(5), 42 U.S.C. § 6903(5); (e) any petroleum product or waste, including crude oil or any fraction thereof or waste; and (f) natural gas, liquefied natural gas, or synthetic gas or any mixtures thereof.

36. The Permittee shall ensure its liability insurance remains in full force during the entirety of the period covered by this Permit. The Permittee agrees to be fully responsible for the management, performance, use and safety of the Site under this Permit and hereby accepts responsibility and assumes liability for any and all claims arising from the intentional, reckless or negligent actions or omissions of its representatives, employees, agents, contractors or subcontractors directly or indirectly connected with the work performed, or the maintenance or use of the Site, to the extent permitted by law. The Permittee shall, and shall require all of its contractors and subcontractors to:

    a. Procure a general liability insurance policy from responsible companies for $1,000,000 (one million dollars), or the minimum required by law, if any, whichever amount is greater. The United States of America shall be named as an additional insured on all policies. The Permit number will be included on said policy. All such policies shall specify that the insured shall have no right of subrogation against the United States for payments of any premiums or deductibles thereunder, and such insurance policies shall be obtained by, be for the account of, and be at the insured's sole risk. A copy of the Certificate of Insurance evidencing proper insurance coverage and referencing the Permit number shall be returned to NPS with the executed Permit to the Park Superintendent. No work shall be allowed to proceed under this Permit until the copy of said Certificate of Insurance is provided to the Park Superintendent.

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UPON THE ACCEPTANCE OF THE CONDITIONS CONTAINED IN THIS PERMIT, INDICATED BY THE APPROVAL OF THE PERMITTEE IN THE SPACE PROVIDED ON THIS PERMIT, AND THE RETURN OF A PROPERLY EXECUTED ORIGINAL TO THIS OFFICE WITHIN NOT MORE THAN 30 DAYS OF ISSUANCE, THIS PERMIT BECOMES VALID FOR THE ACTIVITIES DESCRIBED.

RETURN ONE SIGNED ORIGINAL TO:

Attention: Superintendent
Dan Foster
1008 Crest Drive
Coulee Dam, WA
99116

Teck American Incorporated
501 N Riverpoint Blvd., Suite 300
Spokane, WA 99202
PO Box 3087
Spokane, WA 99220-3087

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Teck

August 26, 2013

File No.: 01-773180-000

Dr. Laura C. Buelow
Project Manager, Hanford/INL Project Office
U.S. Environmental Protection Agency, Region 10
309 Bradley Boulevard, Suite 115
Richland, WA 99352

Mr. Keith Holliday, Environmental Protection Specialist
U.S. Department of the Interior, National Park Service
Lake Roosevelt National Recreation Area
1368 Kettle Park Road
Kettle Falls, WA 99141

VIA ELECTRONIC MAIL ONLY

Subject: Upper Columbia River Remedial Investigation Feasibility Study (UCR RI/FS)
U.S. Department of the Interior, National Park Service
Special Use Permit #PWR LARO TCAI-007 Conditions Clarification

Dear Dr. Buelow and Mr. Holliday:

Further to our recent discussions and as requested, Teck American Incorporated (TAI) is pleased to submit for your review and information a list of items to which clarification on the above-referenced permit and subsequent correspondence as received by the U.S. Environmental Protection Agency (EPA), and the U.S. Department of the Interior, National Park Service (DOI, NPS) are needed.

Consistent with our August 23, 2013 discussions, TAI wholly agrees that conducting Phase 2 sediment sampling activities must be carried out consistent with the EPA-approved quality assurance project plan (QAPP). Accordingly, TAI was surprised and disappointed that NPS Special Use Permit (SUP) #PWR LARO TCAI-007 includes a condition that TAI provide split samples to DOI, NPS, a demand considered during QAPP development but ultimately excluded from the final EPA-approved QAPP. We understand that a SUP is needed to complete RI/FS work within the Lake Roosevelt National Recreational Area (LARO), and that conditions set-forth within the SUP are independent of the RI/FS. TAI is committed to completing the RI/FS and the Phase 2 sediment sampling program consistent with the EPA-approved QAPP. However, language within a number of conditions associated with the above-referenced SUP appears to be inconsistent with the EPA-approved QAPP. As a result, TAI requests clarification of the following permit conditions.

1. ***Condition 26: DOI, NPS Split Samples***

    a. Based on DOI, NPS' August 12, 2013 correspondence, it is TAI's understanding that NPS is seeking split sediment samples from "bioassay" sampling stations as identified within Table A1 in Appendix A (Field Sampling Plan [FSP]) of the EPA-approved QAPP. Language within Permit #PWR LARO TCAI-007 further specifies that for "those activities that are or may be impacting NPS property and resources, the Permittee shall provide a split sample to the NPS or its designee." It is unclear to TAI what is the intent of the aforementioned language, and what if any, activities would require such additional split samples to be made available to the NPS or its designee. Please clarify and confirm that only split samples from "bioassay" sampling stations are being required.

    b. Consistent with the EPA-approved QAPP, sampling success rate and the requirement to collect additional sample is based solely on the ability to address data quality objectives, refer to January 18, 2013 dispute resolution (i.e., Specific Comment No. 30). Language within Permit #PWR LARO TCAI-007 states however, that "In cases where the split sample to be provided to NPS or its designee would contain less than 3 gallons, the Permittee shall hold the entire sediment sample collected and move to the reserve sampling location(s) identified in the EPA approved QAPP and make an effort acceptable to the NPS or its designee to collect sufficient volume of sediment for a sample, including a split sample." This permit language potentially conflicts with the EPA-approved QAPP for reasons discussed below.

       First, a scenario may arise in which TAI successfully collects a sufficient volume of sediment to complete all analyses required under the EPA-approved QAPP, but is unsuccessful in collecting sufficient volume to satisfy the split sample permit condition (i.e., at least 3 gallons but not more than 5 gallons of additional sediment). Under this scenario and consistent with the EPA-approved QAPP, TAI would not collect additional sediment sample volume. Under the EPA-approved QAPP, sampling success at a station is not gauged by the absolute volume of sediment and/or porewater collected. Instead, the EPA-approved QAPP specifies that the potential lack of sediment volume will not be cause to reject or dismiss the sampling location; but rather, that the retained sediment volume is to be evaluated against analytical priorities. At EPA's insistence TAI agreed that at designated bioassay sampling stations, field sampling personnel will attempt to collect the minimum sediment volume of 12 gallons to complete all planned analyses (i.e., chemistry, short- and long-term bioassays, and Toxicity Identification Evaluations). However, the potential failure to attain the desired 12 gallons of sediment will not be cause to reject or dismiss the sediment sampling location. Language in the NPS permit which requires that TAI conduct additional sampling to satisfy the SUP condition is inconsistent with the EPA-approved QAPP. We respect EPA's August 16, 2013 letter asking TAI to resolve issues with the permit conditions in time for sampling this season – an objective no one supports more fully than TAI. However, TAI remains uncertain whether EPA now requires that the decisional criterion used to define sampling success within the EPA-approved QAPP is secondary to NPS' split sample objective.

Consistent with TAI's August 12, 2013 correspondence to the NPS, we reiterate that TAI will provide NPS or its designee sediment collected from bioassay sampling stations on NPS managed lands[1] which exceeds the amount needed for RI/FS purposes. However, the volume requirement outlined within the permit has the potential to undermine the EPA-approved QAPP and the RI/FS process (e.g., dispute resolution). Furthermore DOI's initial request for split samples as communicated via RI/FS comments was less than 2 gallons (i.e., "Each DOI field split sample will contain not less than 7.5 liters (10.5 liters if available) and will be collected as splits of homogenized sediments.") TAI believes that the originally requested volume of $\leq$ 2 gallons is manageable; and would not adversely affect the RI/FS while still satisfying NPS' needs. It should also be noted that given the size of the sampling equipment for this study, should additional efforts be used to fulfill NPS' current split sample requirements (3-5 gallons), such actions would substantial amplify substrate disturbance.

Second, the EPA–approved QAPP provides that after nine failed attempts to collect a sediment sample from NPS managed lands (e.g., 6-B3, refer to Table A1 of the FSP), the field team leader and EPA agree to move to the designated reserve station. However, the prioritized and designated reserve station (i.e., 6-R2), is not on NPS managed lands. It should be noted that there are at least 10 bioassay sampling stations (i.e., ~33 percent) in which this is the case. Under such a scenario, TAI would complete activities consistent with the EPA-approved QAPP, but by default be in non-compliance with the existing NPS permit condition. TAI is committed to performing the work consistent with the EPA-

[1] To that end, TAI would appreciate receiving copies of the NPS chain-of-custody forms prior to sampling on NPS managed lands or confirmation that such forms will be made available at the time samples are relinquished to NPS or its designee.

approved QAPP and requests clarification of how such scenarios would be addressed.

2. ***Condition 27: Investigation Derived Waste***

   a. Based on NPS' August 12, 2013 correspondence, there appears to be an inconsistency in the definition of investigation derived waste (IDW) from Condition 27 of Permit #PWR LARO TCAI-007. The August 12th correspondence identifies "excess sediment and/or porewater collected during this field work" as IDW; while the permit only specifies sediment. Clarification on this matter would be greatly appreciated.

   b. Condition 27 specifies that the "Permittee shall dispose of sediment samples collected but not selected for analysis or sediment collected in excess of the 12 gallon sample volume required in the EPA approved QAPP (Table B3-1) and the 3 to 5 gallon NPS required split sample as Investigation Derived Waste (IDW) prior to the expiration of the Permit, unless amended. Permittee shall submit to the NPS point of contact a copy of the complete chain of custody form, manifest, and receipt of disposal for each sample collected within 10-days of permit expiration." This permit language potentially conflicts with the EPA-approved QAPP and requires clarification.

      Specifically, the EPA-approved QAPP specifies that large rocks, debris, excess sediments (e.g., greater than 2 millimeters), and excess porewater (or otherwise materials not acceptable for analysis) be returned to the site upon completing sampling activities at the specified sampling location. The permit language and subsequent NPS correspondence (August 12, 2013) are inconsistent with the EPA-approved QAPP. TAI requests that this condition be clarified.

In addition to the above-listed SUP conditions that appear to be inconsistent with the EPA-approved QAPP, TAI requests clarification on additional inconsistencies of the permit relative to RI/FS field planning activities and the July 23, 2008 Access Agreement.

3. ***Duration of Permit***

   Presently, SUP #PWR LARO TCAI-007 identifies an effective period of September 16, 2013 through November 29, 2013. The Cultural Resources Working Group (CRWG) has communicated to TAI that NPS cultural resource monitors are not available prior to the 16th of September 2013. As a result, TAI, under EPA oversight and in coordination with the CRWG, has structured sediment sampling activities to occur on lands managed by the NPS within LARO on or after September 16, 2013. However, consistent with the EPA-approved QAPP and coordination efforts with EPA and the CRWG, sediment sampling activities within boundaries of the LARO are anticipated to occur prior to the 16th of September[2].

Therefore and as outlined within TAI's May 23, 2013 SUP application, we request that the SUP and associated research vehicle placards be made effective prior to the 16th of September to facilitate the timely completion of Phase 2 sediment sampling within boundaries of LARO; or clarification that sampling activities within LARO may commence prior to the 16th of September 2013.

Furthermore, the duration of the permit is inconsistent with the terms and conditions of the July 23, 2008 Access Agreement. Consistent with Paragraph 1, Section 4, TAI understands that "*... Activities will be permitted for the length of one-year from the date of issuance (Term), with the potential to extend or modify at the end of one-year based on internal review or upon the written request of TCAI.*" As a result, TAI requests clarification as to why the duration of the permit is inconsistent with the terms and conditions of the July 23, 2008 Access Agreement.

While we are disappointed that the NPS initially declined our invitation to discuss these issues in person, we wish to re-extend that invitation. In light of the fast-approaching sampling season and TAI's desire to proceed as soon as possible with the planned RI/FS sediment sampling, your prompt response would be greatly appreciated. Thank you in advance for your prompt attention and cooperation on this matter. Please feel free to contact me or Kris McCaig should you have any questions or require any additional information.

Sincerely,
Teck American Incorporated

Marko E. Adzic, P.E.
Manager, Environmental Engineering

cc: Kris R. McCaig, Teck American Incorporated, Spokane, WA
David W. Godlewski, Teck American Incorporated, Spokane, WA

[2] A detailed field sampling schedule for Phase 2 sediment sampling activities was agreed upon and reflects discussions with the CRWG on July 30, 2013 at Fort Spokane.

APPENDIX B

MORNING SAFETY BRIEFING ATTENDANCE FORMS

11.4 SAFETY AND HEALTH PLAN AGREEMENT

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	URS	9/12/13
[signature]	GRAVITY	9/12/13
[signature]	URS	9/12/13
[signature]	CH2MHILL	9/12/13
[signature]	USEPA	9/12/13
[signature]	Gravity	9/12/2013
[signature]	Gravity	9/12/13
[signature]	Gravity	9/12/13

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Employee signature	Company	Date
[signature]	Gravity	9/12/13
[signature]	URS	9/12/13
[signature]	URS	9/12/13
[signature]	URS	9/12/13
[signature]	Gravity	9/12/13
[signature]	GRAVITY	9/12/13
[signature]	URS	9/12/13
[signature]	Gravity	9/12/13
[signature]	CCT	9/12/13
[signature]	GRAVITY 401	9-12-13

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Employee signature	Company	Date
	Gravity	9/12/13
	VRS	9/12/13
	URS	9/12/13
	S.T.O.I.	9/12/13
	U/S	9/12/13

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Employee signature	Company	Date
[signature]	URS	9/13/13
[signature]	CCT	9/13/13
[signature]	Gravity	9/13/13
[signature]	URS	9/13/13
[signature]	URS	9/13/13
[signature]	URS	9/13/13
[signature]	gravity	9/13/13
[signature]	Gravity	9-13-2013

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Employee signature	Company	Date
[signature]	GRAVITY	9.13.13
[signature]	S.T.O.I.	9-13-13
[signature]	GRAVITY	09/13/13
[signature]	GRAVITY	9-13-13
[signature]	Gravity	9/13/13
[signature]	Gravity	9/13/13
[signature]	EPA	9/13/2013
[signature]	Gravity	9/13/13
[signature]	CNI	9/13/13
[signature]	CNI	9/13/13
[signature]	CH2M HILL	9/13/13
[signature]	URS	9/13/13

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Employee signature	Company	Date
[illegible]	URS	9/13/12
[illegible]	URS	9/13/13
[illegible]	URS	9/13/13
[illegible]	URS	9/13/13
[illegible]	Gravity	9/13/13

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Employee signature	Company	Date
	URS	9/14/13
	CCT	9/14/13
	URS	9/14/13
	EPA	9/14/2013
	CWI	9/14/2013
	CNI	9/14/13
	Gravity	9/14/13
	URS	9/14/13

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Employee signature	Company	Date
[illegible]	URS	9/14/2013
[illegible]	URS	9·14·13
[illegible]	Gravity	9/14/13
[illegible]	GRAVITY	9-14-13
[illegible]	GRAVITY	9/14/13
[illegible]	GRAVITY	9/14/13
[illegible]	Gravity	9/14/13

Employee signature — Company — Date

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Employee signature	Company	Date
[signature]	URS	9/16/13
[signature]	Gravity	9/16/13
[signature]	GRAVITY	9-16-13
[signature]	CH2M HILL	9/16/13
[signature]	EPA	9/16/2013
[signature]	Gravity	9-16-13
[signature]	CWI	9/16/13
[signature]	Gravity	9/16/13
[signature]	GRAVITY	9/16/13

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Employee signature	Company	Date
[illegible]	URS	9-16-13
Rob Jimenez	CNI	9/16/13
[illegible]	Gravity	9/16/13
[illegible]	URS	9/16/2013
[illegible]	URS	9/16/13
[illegible]	URS	16 Sept 2013
[illegible]	URS	16 Sept 13
[illegible]	Gravity	9/16/13

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Employee signature	Company	Date
	Gravity	9/16/13
	GRAVITY	09/16/13
	Gravity	09/16/13
	Gravity	9/16/13
	URS	9/16/13
	Spokane TRIBe	9/14/13
	URS	9/16/13
		091613

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Employee signature	Company	Date
[signature]	URS	9/18/13
[signature]	NPS	9/18/13
[signature]	URS	9-18-13
[signature]	URS	9/18/13
[signature]	CCT	9/18/13
[signature]	URS	9.18.13
[signature]	CNI	9/18/13
[signature]	CNI	9/18/13

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Employee signature	Company	Date
	URS	09.18.13
	URS	9/18/13
	Gravity	9/18/13
	EPA	9/18/2013
	Gravity	9/18/13
	URS	9/18/13
Dale Bean	Gravity	9/18/13
	EPA	9/18/13

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Employee signature	Company	Date
[illegible]	Gravity	9/18/13
[illegible]	Gravity	9/18/13
[illegible]	Gravity	9-18-13
[illegible]	GRAVITY	9/18/13
[illegible]	Gravity	9/18/13
[illegible]	Gravity	9/18/13
[illegible]	GRAVITY	9-18-13
[illegible]	URS	9/18/13

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Employee signature	Company	Date
William Kidder	URS	18 Sept 2013
Charles D. Joseph	CCT F3W	9/18/13
[signature]	GRAVITY	9/18/13
[signature]	NPS	9/18/13
[signature]	USFWS	9/18/2013
[signature]	BLM	9/18/2013
[signature]	USGS	9-18-13

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Employee signature	Company	Date
David R. Hose	URS	9/19/13
John Whatterman	CWI	9/19/13
[illegible]	NPS	9/19/13
Rod Jimeney	CWI	7/19/13
[illegible]	GRAVITY	7-19-13
[illegible]	Gravity	9/19/13
M. [illegible]	CH2MHILL	9/19/13
Matt Wilkening	EPA	9/19/13

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Employee signature	Company	Date
[signature]	CCT	9/19/13
[signature]	URS	9/14/13
[signature]	USFWS	9/19/2013
Charles B. Joseph	CCT F&W	9/19/13
Elizabeth Earp	BLM	9/19/13
[signature]	NPS	9/19/2013
[signature]	Gravity	9/19/13
William Kidder	URS	19 Sept 2013

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Employee signature	Company	Date
[signature]	URS	9-19-13
[signature]	URS	9-19-13
[signature]	URS	09/19/13
[signature]	Gravity	9/19/13
[signature]	Gravity	9-19-13
[signature]	Gravity	9/19/13
[signature]	Gravity	9/19/13
[signature]	Gravity	9-19-13

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Employee signature	Company	Date
[signature]	URS	19 Sept-13
[signature]	URS	9/19/13
[signature]	URS	9/19/13
[signature]	GRAVITY	9/19/13
[signature]	Gravity	9/19/13
[signature]	GRAVITY	9/19/13

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Employee signature	Company	Date
[signature]	URS	9/20/13
[signature]	Gravity	9/20/13
[signature]	GRAVITY	9-20-13
[signature]	Gravity	9/20/13
[signature]	Gravity	9/20/13
[signature]	URS	9/20/13
[signature]	GRAVITY	9/20/13
[signature]	URS	9/20/13

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Employee signature	Company	Date
	URS	9/20/2013
	CCT	9/20/13
	CNI	9/20/13
	NPS	9/20/13
	CCT FS LW	9/20/2013
	CNI	9/20/13
	Gravity	9.20.13
	URS	9/20/13

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Employee signature	Company	Date
	URS	9.20.13
	URS	9/20/13
	EPA	9/20/13
	EPA	9/20/13
	URS	20 Sept 2013
	Gravity	9-20-13
	Gravity	9/20/13
	GRAVITY	9/20/13

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Employee signature	Company	Date
[signature]	URS	092013
[signature]	Gravity	9/20/13
[signature]	USFWS	9/20/2013

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Employee signature	Company	Date
[signature]	URS	9/21/13
[signature]	GRAVITY	9/21/13
[signature]	9/21/URS	9/21/13
[signature]	CNI	9/21/13
[signature]	CNI	9/21/13
[signature]	Gravity	9-21-13
[signature]	Gravity	9/21/13
[signature]	URS	9.21.13

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Employee signature	Company	Date
	URS	21 Sept 2013
	URS	21 Sept. 13
	CCT	9-21-13
	CH2MHill	09/21/13
	URS	9/21/13
	Gravity	9/21/13
	GRAVITY	9-21-13
	Gravity	9-21-13

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Employee signature	Company	Date
	URS	9/24/13
	Gravity	9/24/13
	Gravity	9-24-13
Dale Bean	Gravity	9/24/13
	Gravity	9/24-13
	GRAVITY	9/24/13
	URS	9/24/13
	Gravity	9.24.13

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Employee signature	Company	Date
[illegible]	Gravity	9/24/13
[illegible]	GRAVITY	9-24-13
[illegible]	URS	9-24-13
[illegible]	URS	9/24/13
Alfred Herbert	Spokane Trib	8/24/13
[illegible]	URS Corp	24 SEPT 2013
[illegible]	URS	9/24/13
Arthur Kiddle	URS	24 Sept 2013

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Employee signature	Company	Date
[illegible]	EPA R10	9/24/13
[illegible]	Gravity	9/24/13
[illegible]	CH2M HILL	9/24/13
[illegible]	URS	9/24/13
[illegible]	URS	9/24/13

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Employee signature	Company	Date
David R. Hose	URS	9/25/13
[signature]	GRAVITY	9/25/13
[signature]	GRAVITY	9-25-13
Dale Bean	Gravity	9-25-13
[signature]	URS	9-25-13
Mike [signature]	Gravity	9.25.13
William Ridde	URS	25 Sept 2013
[signature]	URS	25 SEPT 2013

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Employee signature	Company	Date
Alfred Hubert	Spokane Tribe	9-25-13
[illegible]	Gravity	9-25-13
[illegible]	Gravity	9-25-13
[illegible]	CNI	9/25/13
[illegible]	Gravity	9/25/13
[illegible]	CWI	9/25/13
[illegible]	GRAVITY	9/25/13
[illegible]	CH2M HILL	9/25/13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	URS	9/25/13
[signature]	URS	9-25-13
[signature]	URS	9-25-13
[signature]	URS	9-25-13
[signature]	Gravity	9/25/13
[signature]	Gravity	9/25/13
[signature]	URS	9/25/13
[signature]	EPA	9/25/13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	URS	9/26/13
[signature]	URS	9/26/13
[signature]	URS	9/26/13
[signature]	URS	9/26/13
[signature]	URS	9-26-13
[signature]	Gravity	9/26/13
Alfred Hubert	SPOKANE TRIBE	9/26/13
Laura McCullough	NPS	9/26/2013

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	URS	26 Sept 2013
[signature]	CWI	9/26/13
[signature]	CNI	9/26/13
[signature]	Gravity	9.26.13
[signature]	Gravity	9/26/13
[signature]	GRAVITY	9-26-13
[signature]	GRAVITY	9/26/13
[signature]	CH2M HILL	9/26/13

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Employee signature	Company	Date
[signature]	EPA	9/24/13
[signature]	URS	9/26/13

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Employee signature	Company	Date
	URS	9/27/13
	URS	9-27-13
	Gravity	9-27-13
	CNI	9/27/13
	CNI	9/27/13
	URS	9/27/13
	URS	27 Sept 2013
	EPA	9/27/13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[illegible]	Gravity	9/27/13
[illegible]	CH2M HILL	9/27/13
[illegible]	Gravity	9-27-13
[illegible]	GRAVITY	9.27.13
Dale Beach	Gravity	9/27/13
John Rapp	URS	9/27/13
Alfred Huber	SPOKANE TRIBE	9/27/13
Laura McCullough	NPS	9/27/2013

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Employee signature	Company	Date
[signature]	URS	092713
[signature]	Gravity	9/27/13
Gina Franco	URS	9/27/13
[signature]	Gravity	9/27/13
[signature]	Gravity	9.27.13
[signature] Bielmann	URS	9.27-13
[signature]	GRAVITY	9-27-13
[signature]	URS	27 SEPT. 13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	URS	9/27/13
[signature]	Gravity	9/27/13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[illegible]	URS	9/28/13
[illegible]	URS	9/28/13
[illegible]	URS	23 Sept 2013
[illegible]	URS	9-28-13
[illegible]	URS	9-28-13
[illegible]	EPA	9/28/13
[illegible]	CH2M HILL	9/28/13
Alfred Hubert	SPOKANE TRIBE	9/28/13

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Employee signature	Company	Date
[signature]	Gravity	9-28-13
[signature]	Gravity	9/28/13
[signature]	Gravity	9/28/13
[signature]	Gravity	9.28.13
[signature]	Gravity	9/28/13
[signature]	GRAVITY	9/28/13
[signature]	CNI	9/28/13
[signature]	GRAVITY	9-28-13

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Employee signature	Company	Date
	GRAVITY	9/28/13
	CWI	9/28/13
	Gravity	9/28/13
	NPS	9/28/13
	GRAVITY	9-28-13
	URS	28 Sept. 2013
	URS	9/28/13
	URS	9/28/13

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Employee signature	Company	Date
[signature]	URS	092813

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[illegible signature]	URS	9/30/13
Dale Bean	Gravity	9/30/13
[illegible signature]	Gravity	9/30/13
[illegible signature]	Gravity	9.30.13
[illegible signature]	URS	30 SEPT 2013
[illegible signature]	URS	9-30-13
[illegible signature]	URS	9/30/13
[illegible signature]	Gravity	9-30-13
Monica Tonel	USEPA	9/30/2013

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Employee signature	Company	Date
[signature]	SPOKANE TRIBE	9/30/13
[signature]	NPS	9/30/2013
[signature]	URS	9-30-13
[signature]	URS	9-30-13
[signature]	URS	9-30-13
[signature]	CNI	9/30/13
[signature]	CWI	9/30/13
[signature]	GRAVITY	9-30-2013

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Employee signature	Company	Date
	GRAVITY	9/30/13
	GRAVITY	9/30/13
	Gravity	9/30/13
	GRAVITY	9-30-13
	Gravity	9-30-13
	CH2M HILL	9/30/13
	URS	9/30/13
	URS	9/30/13

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Employee signature	Company	Date
	URS	10/01/13
	Gravity	10/1/13
	URS	1 OCT 2013
	Gravity	1 oct 13
	GRAVITY	10/01/13
	Gravity	10/01/13
	URS	10-1-13
	URS	10-1-13

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Employee signature	Company	Date
[signature]	URS	10/1/13
[signature]	URS	10/1/13
[signature]	URS	10-1-13
[signature]	URS	10-1-13
[signature]	URS	10-1-13
[signature]	NPS	10.1.13
[signature]	USEPA	10/1/13
[signature]	CH2M HILL	10/1/13

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Employee signature	Company	Date
Alfred Hubert	SPOKANE TRIBE	10-1-13
Rob Jiminez	CNI	10/1/13
[illegible]	GRAVITY	10-1-13
[illegible]	GRAVITY	10-1-13
[illegible]	GRAVITY	10-1-13
J. Weatherman	CNI	10/1/13
Dale Bean	Gravity	10/1/13
[illegible]	Gravity	10.1.13

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Employee signature	Company	Date
	GRAVITY	10/1/13

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Employee signature	Company	Date
[signature]	URS	10/4/13
[signature]	URS	10-4-13
[signature]	URS	10/4/13
[signature]	URS	10/4/13
[signature]	URS	10/4/13
[signature]	URS	10-4-13
[signature]	NPS	10-4-13
[signature]	USEPA	10/4/2013

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Employee signature	Company	Date
[signature]	CH2M HILL	10/4/13
[signature]	CCT	10/4/13
[signature]	URS	10-4-13
[signature]	URS	10-4-13
[signature]	GRAVITY	10-4-13
[signature]	Gravity	10/4/13
[signature]	Gravity	10.4.13
[signature]	Gravity	10/4/13

By their signature, the following site workers or visitors certify this plan has been read or otherwise communicated. They have had an opportunity to ask any questions and have been provided with satisfactory responses. They further certify that they completely understand this plan and will follow its procedures for the protection of health and safety of all persons entering this site.

Employee signature	Company	Date
[signature]	Gravity	10/4/13
[signature]	GRAVITY	10/4/13
[signature]	Gravity	10-4-13
[signature]	Gravity	10/4/13
[signature]	GRAVITY	10-4-13
[signature]	CWI	10-4-13
[signature]	CWI	10/4/13
[signature]	URS	10-4-13

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Employee signature	Company	Date
	GRAVITY	10/05/13
	Gravity	10/5/13
	GRAVITY	10-5-13
	URS	10-5-13
	URS	10-5-13
	CWI	10-5-13
	URS	10/5/13
	URS	10/5/13

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Employee signature	Company	Date
	URS	10/5/13
	[illegible]	10/5/13
	URS	10/5/13
	URS	10/5/13
	URS	10·5·13
	NPS	10.5.13
	USEPA	10/5/2013
	CCT	10/5/13

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Employee signature	Company	Date
	CH2M HILL	10/5/13
	Gravity	10.5.13
	Gravity	10/5/13
	Gravity	10/5/13
	Gravity	10-5-2013
	CNI	10/5/13
	Gravity	10/5/13
	GRAVITY	10-5-13

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Employee signature	Company	Date
	URS	10/7/13
	GRAVITY	10/7/13
	URS	7 Oct 2013
	URS	7 Oct 2013
	CWI	10/7/13
	Gravity	10/7/13
	CWI	10-7-13
	CCT	10-7-13

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Employee signature	Company	Date
[signature]	CH2M HILL	10/7/13
[signature]	EPA	10/7/13
[signature]	Gravity	10/7/13
[signature]	GRAVITY	10-7-13
[signature]	GRAVITY	10-7-13
[signature]	Gravity	10/7/13
[signature]	GRAVITY	10/7/13
[signature]	GRAVITY	10-7-13

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Employee signature	Company	Date
[signature]	URS	10/7/13
[signature]	URS	10/7/13
[signature]	GRAVITY	10/7/13
[signature]	URS	10/7/13
[signature]	Gravity	10/7/13
[signature]	URS	10/7/13
[signature]	URS	10-7-13
[signature]	URS	10-7-13

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Employee signature	Company	Date
[signature]	URS	10/8/13
[signature]	GRAVITY	10/8/13
[signature]	CCT	10/8/13
[signature]	NPS	10.8.13
[signature]	GRAVITY	10-8-13
Dale Bean	Gravity	10/8/13
[signature]	GRAVITY	10-8-13
[signature]	CNI	10/8/13

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Employee signature	Company	Date
[signature]	GRAVITY	10 8 13
[signature]	CWI	10-8-13
[signature]	Gravity	10-8-13
[signature]	URS	10/8/13
[signature]	URS	10/8/13
[signature]	GRAVITY	10/8/13
[signature]	URS	10-8-13
[signature]	URS	10/8/13

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Employee signature	Company	Date
[signature]	URS	10/8/13
[signature]	CH2M HILL	10/8/13
[signature]	EPA	10/8/13
[signature]	Gravity	10/8/13
[signature]	GRAVITY	10/8/13
[signature]	Gravity	10/8/13
[signature]	URS	10/5/13
[signature]	URS	10/8/13

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Employee signature	Company	Date
William Kidder	URS	8 Oct 2013
Grant T. McCullagh	URS	8 Oct 13

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Employee signature	Company	Date
[signature]	URS	10/9/13
[signature]	URS	10-9-13
[signature]	URS	10-9-13
[signature]	URS	10-9-13
[signature]	CNI	10/9/13
[signature]	URS	9 Oct 2013
[signature]	Gravity	10/9/13
[signature]	Gravity	10-9-13

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Employee signature	Company	Date
[signature]	CWF	10-9-13
[signature]	Gravity	10-9-13
[signature]	Gravity	10-9-13
[signature]	EPA	10-9-13
[signature]	GRAVITY	10-9-13
[signature]	Gravity	10-9-13
[signature]	GRAVITY	10/9/13
[signature]	NPS	10-9-13

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Employee signature	Company	Date
	CCT	10-9-13
	CH2M HILL	10/9/13
	URS	10/9/13
	GRAVITY	10/9/13
	Gravity	10/9/13
	URS	10/9/13
	URS	10/9/13
	URS	10/9/13
	GRAVITY	10/9/13

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Employee signature	Company	Date
	URS	10/10/13
	URS	10 Oct 2013
	CCT	10/10/13
	EPA	10/10/13
	URS	10/10/13
	URS	10/10/13
	GRAVITY	10/10/13
	GRAVITY	10/10/13
	URS	10-10-13

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Employee signature	Company	Date
[signature]	URS	10/14/13
[signature]	CNI	10-14-13
[signature]	Gravity	10-14-13
[signature]	Gravity	10/14/13
[signature]	URS	10/14/13
[signature]	URS	10/14/13
[signature]	CNI	10/14/13
[signature]	USEPA	10/14/2013

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Employee signature	Company	Date
Mark [illegible]	CH2M Hill	10/14/2013
Ray DePuydt	NPS	10.14.2013
William Kidder	URS	14 Oct 2013
Elyssa [illegible]	URS	10/14/13
[illegible]	URS	10/14/13
Michael [illegible]	URS	10/14/2013
[illegible]	CCT	10/14/13
[illegible]	URS	10-14-13

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Employee signature	Company	Date
	URS	10/14/13
	GRAVITY	10-14-13
	GRAVITY	10-14-13
	GRAVITY	10-14-13
	GRAVITY	10/14/13
	Gravity	10/14/13
	GRAVITY	10/14/13
	Gravity	10/14/13

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Employee signature	Company	Date
	Grauitz	10/14/13

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Employee signature	Company	Date
David R. Hose	URS	10/15/13
William T Kidder	URS	15 Oct 2013
[illegible]	GRAVITY	10/15/13
Dale Bean	Gravity	10/15/13
[illegible]	Gravity	10/15/13
[illegible]	GRAVITY	10/15/13
[illegible]	Gravity	10-15-13
Dan Smith	Gravity	10-15-13

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Employee signature	Company	Date
[signature]	URS	10/15/13
[signature]	GRAVITY	10/15/13
[signature]	URS	10/15/13
[signature]	GRAVITY	10-15-13
[signature]	GRAVITY	10-15-13
[signature]	NPS	10.15.13
[signature]	USEPA	10/15/2013
[signature]	CH2M HILL	10/15/2013

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Employee signature	Company	Date
[signature]	Granite	10/15/13
[signature]	URS	10/15/13
[signature]	URS	10/15/13
[signature]	CNI	10/15/13
[signature]	URS	10/15/13
[signature]	URS	10/15/13
[signature]	ACT	10/15/13
[signature]	URS	10-15-13

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Employee signature	Company	Date
	URS	10/16/13
	URS	10/16/13
	CNI	10/16/13
	URS	10/16/13
	Gravity	10/16/13
	GRAVITY	10-16-2013
	URS	10/16/2013
	GRAVITY	10/16/2013

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Employee signature	Company	Date
[signature]	Gravity	10/16/2013
[signature]	Gravity	10-16-13
Dale Bean	Gravity	10/16/13
Dan Smith	Gravity	10-16-13
[signature]	URS	10/16/13
J Weatherman	CWI	10-16-13
Alyssa Dixon	URS	10/16/13
[signature]	Gravity	10/16/13

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Employee signature	Company	Date
	URS	10/16/2013
	CCT	10/16/13
	URS	10/16/13
	GRAVITY	10/16/13
	URS	16 Oct 2013
	NPS	16 Oct 2013
	USEPA	10/16/2013
	GRAVITY	10-16-13

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Employee signature	Company	Date
Mark Enk	CH2M HILL	10.16.2013

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Employee signature	Company	Date
	URS	10/17/13
	GRAVITY	10-17-13
	Gravity	10-17-13
Matt Collins	GRAVITY	10-17-13
	Gravity	10-17-13
	URS	10/17/13
	CCT	10/17/13
	CH2M HILL	10/17/2013

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Employee signature	Company	Date
[illegible]	USEPA	10/17/2013
[illegible]	NPS	10/17/2013
[illegible]	GRAVITY	10/17/13
[illegible]	CNI	10/17/13
[illegible]	GRAVITY	10-17-2013
Dan Smith	Gravity	11-17-2013
[illegible]	URS	10/17/13
[illegible]	URS	10/17/13

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Employee signature	Company	Date
[illegible]	Gravity	10/17/13
Scott Nielsen	Columbia Navigation	10/17/13
Dale Bean	Gravity	10/17/13
[illegible]	GRAVITY	10/17/13
[illegible]	URS	10/17/13
Michelle [illegible]	URS	10/17/13
Alyssa Dixon	URS	10/17/13
[illegible]	URS	10/17/13

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Employee signature	Company	Date
David R. Hose	URS	10/18/13
[illegible]	GRAVITY	10/18/13
Eric Weatherman	CNI	10/18/13
[illegible]	Gravity	10/18/13
[illegible]	GRAVITY	10-18-13
[illegible]	URS	10/18/13
[illegible]	URS	10/18/13
Dan Smith	Gravity	10/18/13

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Employee signature	Company	Date
Matt Collins	GRAVITY	10/18/13
Monica Tonel	USEPA	10/18/2013
Michelle Stegner	URS	10/18/2013
Mark E[illegible]	CH2M HILL	10/18/2013
[illegible]	CCT	10/18/13
[illegible]	CCT	10-18-13 Fri.
Scott Mi[illegible]	Columbia Navigation	10-18-13
Dale Bean	Gravity	10/18/13

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Employee signature	Company	Date
Alyssa Dixon	URS	10/18/13
[illegible]	URS	10/18/13
[illegible]	URS	13 Oct 2013
[illegible]	URS	10/18/13
[illegible]	URS	10/18/13
[illegible]	GRAVITY	10-18-13
[illegible]	GRAVITY	10-18/13
[illegible]	Gravity	10/18/13

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Employee signature	Company	Date
[signature]	GRAVITY	10-18-13

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Employee signature	Company	Date
[signature]	URS	10/19/13
Elyssa Dixon	URS	10/19/13
[signature]	CCT	10/19/13
[signature]	URS	19 Oct 2013
Michelle Stegner	URS	10/19/2013
[signature]	URS	10/19/13
[signature]	URS	10/19/13
Monica Tonel	USEPA	10/19/2013

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Employee signature	Company	Date
	GRAVITY	10/19/13
	Gravity	10-19-13
	Gravity	10-19-13
	Gravity	10-19-13
	GRAVITY	10-19-13
	GRAVITY	10/19/13
	CNI	10/19/13

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Employee signature	Company	Date
David R. Horn	URS	10/21/13
[illegible]	URS	10-21-13
[illegible]	URS	10-21-13
William Kidder	URS	21 Oct 2013
Alyssa Dixon	URS	10/21/13
[illegible]	CCT	10/21/13
Michelle Stegner	URS	10/21/13
[illegible]	Grant	10/21/13

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Employee signature	Company	Date
	Gravity	10/21/13
	Gravity	10-21-13
	Gravity	10/21/13
	GRAVITY	10/21/13
	GRAVITY	10/21/13
	GRAVITY	10-21-13
	Gravity	10-21-13
	GRAVITY	10/21/13

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Employee signature	Company	Date
[illegible]	Gravity	10/21/13
[illegible]	URS	10/21/13
[illegible]	URS	10/21/13
[illegible]	URS	10/21/13
[illegible]	CCT	10-21-13
[illegible]	CNI	10/21/13
[illegible]	Gravity	10/21/13
[illegible]	CH2M Hill	10/21/13

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Monica Tonel	USEPA	10/21/2013
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date

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Employee signature	Company	Date
[illegible]	URS	10/22/13
[illegible]	URS	10.22.13
Monica Tonel	USEPA	10/22/2013
[illegible]	CCT	10/22/2013
[illegible]	Gravity	10/22/2013
Dale Bean	Gravity	10/22/13
J Weatherman	CWI	10-22-13
[illegible]	URS	10/22/13

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Employee signature	Company	Date
	URS	10-22-13
	URS	10/22/13
	GRAVITY	10/22/13
	Gravity	10/22/13
	CH2M	10/22/13
	CH2MHill	10/22/13
	URS	22 Oct 2013
	GRAVITY	10-22-13

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Employee signature	Company	Date
Dr. [signature]	Gravity	10-22-13
[signature]	Gravity	10/22/13
[signature]	GRAVITY	10/22/13
Gabe Winter	Gravity	10-22-13
[signature]	Gravity	10/22/13
Michelle Stegner	URS	10/22/2013
[signature]	CCT	10-22-13 Tue
Joe Withan	CCC	10-22-13

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Employee signature	Company	Date
[signature]	CNI	10/22/13
[signature]	URS	10/22/13
[signature]	URS	10/22/13

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Employee signature	Company	Date
David R. Horn	URS	10/23/13
Elyssa Dixon	URS	10/23/13
[illegible]	URS	10/23/13
[illegible]	CH2M HILL	10/23/13
M. [illegible]	CH2M Hill	10/23/13
William T Kidd	URS	23 Oct 2013
[illegible]	URS	10/23/13
David C. [illegible]	CCT	10-23-13 Wed.

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Employee signature	Company	Date
[signature]	Gravity	10-23-13
[signature]	GRAVITY	10-23-13
[signature]	Gravity	10-23-13
[signature]	Gravity	10-23-13
[signature]	GRAVITY	10/23/13
[signature]	GRAVITY	10-23-13
[signature]	Gravity	10-23-13
[signature]	Gravity	10/23/13

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Employee signature	Company	Date
[signature]	GRAVITY	10/23/13
[signature]	CNI	10/23/13
[signature]	URS	10/23/13
[signature]	URS	10.23.13
[signature]	Gravity	10/22/13
[signature]	CCT	10/22-13
[signature]	URS	10-23-13
[signature]	URS	10/23/2013

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Employee signature	Company	Date
Monica Tonel	USEPA	10/23/2013

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Employee signature	Company	Date
	URS	10/~~23~~ 24/13
	URS	10/24/13
	CH2MHill ~~URS~~	10/24/13
	CH2MHill	10/24/2013
	Gravity	10/24/13
	CWI	10-24-13
	GRAVITY	10-24-13
	Gravity	10/24/13

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Employee signature	Company	Date
	GRAVITY	10/24/13
	GRAVITY	10/24/13
	Gravity	10/24/13
	URS	10.24.13
	Gravity	10/24/13
	CNI	10/24/13
	CCT	10-24-13 Th.
	CCT	10-24-13

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Employee signature	Company	Date
Al Fletcher	URS	24 Oct. 13
[signature]	NPS	10/24/2013
Michelle Stegner	URS	10/24/2013
Alyssa Dixon	URS	10/24/13
[signature]	URS	10-24-13
William Kidd	URS	24 Oct 2013
DR. GREG POSEY	GRAVITY	10-24-13
[signature]	GRAVITY	10/24/13

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Employee signature	Company	Date
	Gravity	10/24/13
	URS	10/24/13