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Bear Creek Valley Mercury Sources
Remedial Site Evaluation Sampling and Analysis Plan
Oak Ridge, Tennessee

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Remedial Site Evaluation Sampling and Analysis Plan
Oak Ridge, Tennessee

Date Issued—September 2023

Prepared by the
Water Resources Restoration Program
United Cleanup Oak Ridge LLC

Prepared for the
U.S. Department of Energy
Office of Environmental Management

United Cleanup Oak Ridge LLC
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CONTENTS

FIGURES

TABLES

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ACRONYMS

AWQC	ambient water quality criteria
BCK	Bear Creek kilometer
BCT	Bear Creek transect
BCV	Bear Creek Valley
BRA	baseline risk assessment
BYBY	Boneyard/Burnyard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	contaminant of concern
CSM	conceptual site model
DMIP	Data Management Implementation Plan
DOE	U.S. Department of Energy
DQO	data quality objective
EMDF	Environmental Management Disposal Facility
EPA	U. S. Environmental Protection Agency
FFA	Federal Facility Agreement
HCK	Hinds Creek kilometer
MDL	method detection limit
NT	North Tributary
OREIS	Oak Ridge Environmental Information System
ORR	Oak Ridge Reservation
OU	operable unit
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
RI	remedial investigation
ROD	Record of Decision
RRL	requested reporting limit
RSE	remedial site evaluation
SAP	Sampling and Analysis Plan
SMO	Sample Management Office
TDEC	Tennessee Department of Environment and Conservation
UEFPC	Upper East Fork Poplar Creek
WRRP	Water Resources Restoration Program
Y-12	Y-12 National Security Complex

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1. SAMPLING OBJECTIVES

1.1 OBJECTIVE

The objective of the Bear Creek Valley (BCV) mercury sources remedial site evaluation (RSE) is to evaluate potential sources of mercury and methylmercury within the BCV Watershed *(Record of Decision for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal at the Environmental Management Disposal Facility, Oak Ridge, Tennessee* [DOE/OR/01-2794&D2/R2; Environmental Management Disposal Facility (EMDF) Record of Decision (ROD)]) located in the north-central portion of the Oak Ridge Reservation (ORR) west of the Y-12 National Security Complex (Y-12). Y-12 began operations in the 1940s as part of the Manhattan Project for the purpose of enriching uranium for the first atomic bombs. Since that time, the Y-12 missions have changed, and in the 1950s, new processes for separating lithium used large amounts of mercury. Although process functions were performed adjacent to BCV in the Y-12 Main Plant Area, waste from operations at Y-12 were disposed in pits, trenches, and burial grounds in the 2800-acre BCV Watershed.

Prior remedial investigations (RIs) (e.g., *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* [DOE/OR/01-1455&D2; BCV RI]) and decision documents in BCV cite mercury as a potential contaminant of concern (COC). A source control action performed under the *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1750&D4; BCV Phase I ROD) at the remediated Boneyard/Burnyard (BYBY) (*Phased Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard Remediation Project at the Y 12 National Security Complex, Oak Ridge, Tennessee* [DOE/OR/01-2077&D2]) focused on excavating mercury-contaminated soil along North Tributary (NT)-3. Mercury surface water results in BCV are consistently below Tennessee general ambient water quality criteria (AWQC) (TDEC 2019); however, fish tissue concentrations remain above or near the U.S. Environmental Protection Agency (EPA)-recommended AWQC for mercury (0.3 µg/g in fish). Mercury and methylmercury data for sediment and soil that may contribute to concentrations in fish are limited.

This BCV Mercury Sources RSE Sampling and Analysis Plan (SAP) identifies the locations, media, and sampling methodology that will support the RSE objectives. Impacts of source areas and hydrology on mercury concentrations will be assessed in associated channel sediment, creek bank and floodplain soils, and surface water at multiple sampling transects throughout the length of the stream. Results of this evaluation will be combined with biota data to evaluate potential mercury source areas in BCV to support the RSE and any recommendations made therein.

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2. PROJECT INFORMATION

2.1 INTRODUCTION

This section contains information about BCV and potential sources of mercury in BCV and summarizes existing mercury data in BCV. Information in this section serves to provide a context for the sampling discussed in later sections of this BCV Mercury Sources RSE SAP.

2.2 BACKGROUND

2.2.1 Site Description

The BCV Watershed is located at the western end of Y-12 in the north-central portion of the ORR west of the Upper East Fork Poplar Creek (UEFPC) Watershed (Figure 2.1). BCV contains closed and active waste disposal facilities. The boundary between the BCV and UEFPC Watersheds is defined by a surface water divide between eastward-flowing East Fork Poplar Creek and westward-flowing Bear Creek. The integration point for Bear Creek is at Bear Creek kilometer (BCK) 9.2 where more than 99% of the available water from the eastern portion of BCV passes through this location either as surface water or groundwater. As illustrated in Figure 2.1, the BCV Watershed is subdivided into three zones based on end use. The subareas of BCV to be investigated under this BCV Mercury Sources RSE SAP represent geographic areas located at or downstream from potential U.S. Department of Energy (DOE) on-site source areas. Based on the EMDF ROD, the end use for Zone 1 and Zone 2 will be revised to restricted recreational and controlled industrial, respectively, which will be codified in an upcoming addendum to the BCV Phase I ROD.

2.2.2 Summary of Potential Mercury Source Areas

BCV contains multiple historical waste management and disposal areas that received mercury-contaminated waste streams from Y-12 operations from 1943–1993, in addition to having materials storage areas and construction storage areas (Figure 2.1). There are two RODs for BCV that identify mercury as a COC—the BCV Phase I ROD; and the *Record of Decision for Bear Creek Operable Unit 2 (Spoil Area 1 and SY-200 Yard) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/02-1435&D2; BCV Operable Unit [OU]2 ROD). The BCV Phase I ROD cited mercury as a COC posing environmental hazards due to migration from BYBY. BYBY is a former mercury source area that was remediated using hydraulic controls and excavation of visible waste material; Bear Creek tributary NT-3 runs through BYBY. The BCV RI identified mercury as a COC for human health for the following: BYBY, Oil Landfarm, Hazardous Chemical Disposal Area, S-3 Ponds Site, Sanitary Landfill 1, Bear Creek Road Debris Burial, and Creekside Debris Burial. The BCV RI indicated some elevated soil mercury concentrations exist, generally within an order of magnitude of the background criterion (0.34 mg/kg). The baseline risk assessment (BRA) in the BCV RI stated "the sources of mercury and PCBs to the BCV fish are currently unknown."

The Remedial Investigation Report on Bear Creek Valley Operable Unit 2 (Rust Spoil Area, Spoil Area 1, and SY-200 Yard) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (DOE/OR/01-1273&D2; BCV OU2 RI) identified mercury as a COC for human health for the SY-200 Yard, which was a former equipment storage yard used to store nonradioactive contaminated equipment from the 1950s to 1986. Mercury contamination was discovered during construction in 1990, and a soil cover was placed over the site. While other areas (Spoil Area 1 and the Rust Spoil Area) had mercury as a contaminant of potential concern in the BCV OU2 RI, the BRA did not identify mercury as a COC for these areas. The BCV OU2 RI indicated mercury concentrations were elevated at the SY-200 Yard but were generally within an order of magnitude of background; however, free mercury was seen in some of the borings during the BCV OU2 RI. The BCV OU2 ROD identified the SY-200 Yard as the area with mercury.

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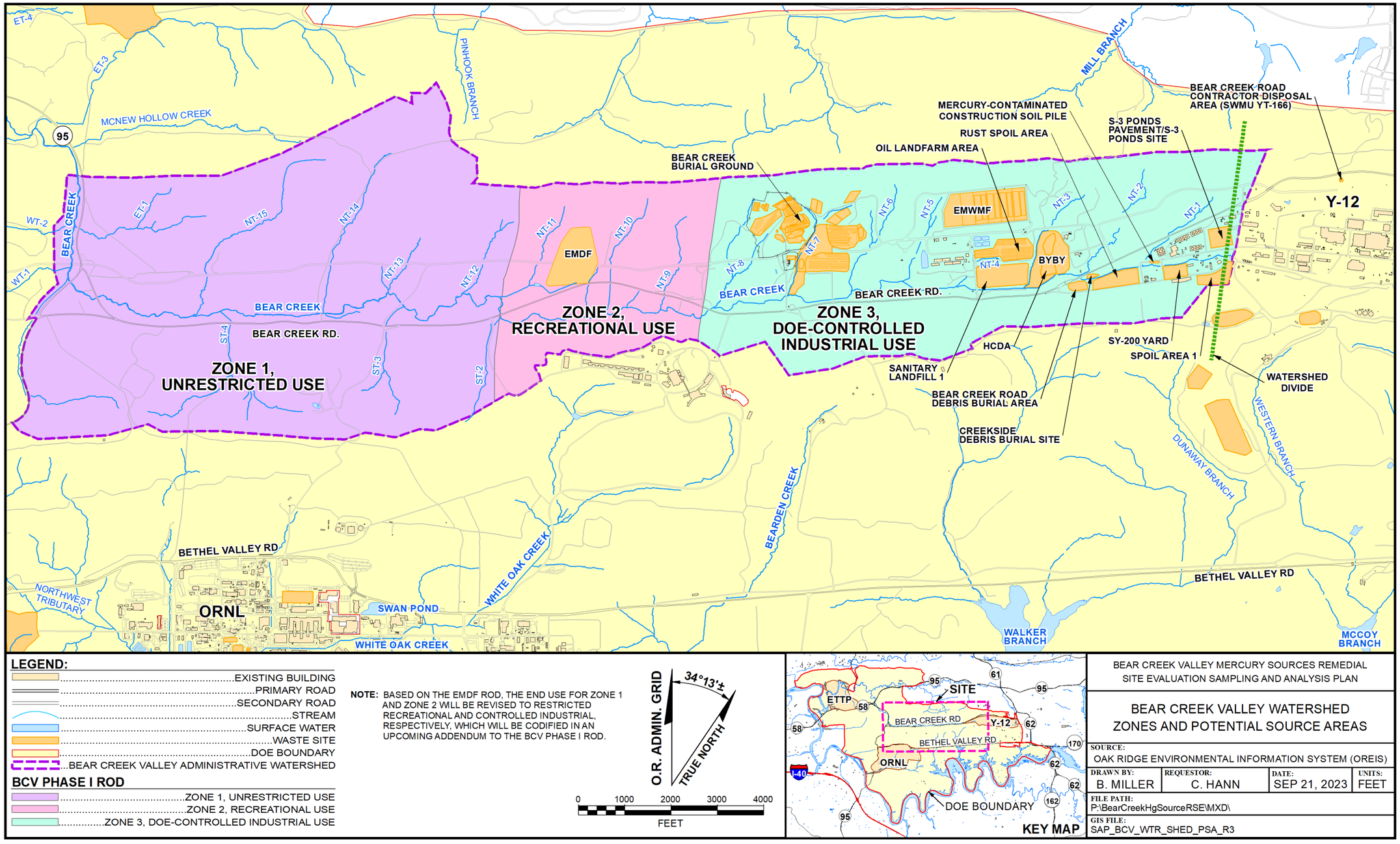

Figure 2.1. BCV Watershed zones and potential source areas.

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2.3 SUMMARY OF EXISTING BEAR CREEK VALLEY MERCURY DATA

Mercury data for sediment, surface water, and biota in BCV are available in the Oak Ridge Environmental Information System (OREIS). However, sediment data are limited, and no methylmercury data are available for BCV sediment in OREIS. Twenty-nine data points for total mercury in BCV sediment are available ranging from 1993–2011: 7 locations in Zone 1, 2 locations in Zone 2, and 20 locations in Zone 3. Concentrations range from non-detect to 6.9 mg/kg total mercury.

As shown in Table 2.1, under the *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2457&D4), surface water and biota sampling have been performed. Results are reported annually in a Remediation Effectiveness Report or every 5 years in a Five-Year Review. Surface water data since 2011 (Figure 2.2) show a steady or declining trend, with mercury below AWQC, with very few exceptions. Mercury concentrations are generally higher upstream and decrease downstream; methylmercury concentrations are more variable upstream to downstream. Mercury concentrations in fish (Figure 2.3) have been generally declining in the last 10 years and are at or below the fish tissue criterion (0.3 µg/g) as of 2022.

Table 2.1. Current surface water and biota sampling in Bear Creek

Medium	Performance standard	Sampling frequency	Parameter	Monitoring location
Surface water	AWQC	Semiannual (Q1 and Q3)	Total mercury and methylmercury	BCK 3.3, BCK 4.55, BCK 9.2, BCK-11.54A, BCK 12.34, NT-3, SS-4, and SS-5
		Semiannual (Q2 and Q4) in year before FYR	Total mercury	BCK 4.55, BCK 9.2, BCK 12.34, NT-3, and NT-8
		Annual in year before FYR	Total mercury	BCK-7.87 and NT-1
		Annual in year before FYR	Methylmercury	NT-5
	Trend monitoring	Quarterly	Bicarbonate, carbonate, chloride, fluoride, and sulfate	NT-1, NT-2, NT-3, SS-4, and SS-5
		Semiannual		NT-7 and NT-8
		Quarterly in year before FYR		NT-5
	Water quality	Semiannual	Total suspended solids and total dissolved solids	NT-7 and NT-8
		Quarterly in year before FYR		BCK 4.55, BCK-7.87, BCK 9.2, BCK 12.34, NT-1, NT-3, NT-5, and NT-8
Biota	Baseline sampling	Semiannual	Mercury and methylmercury	BCK 3.3, BCK 9.9, and HCK 20.6 (whole-body stoneroller minnows and rock bass fillets); BCK 12.4 (whole-body stoneroller minnows)
		Annual in year before FYR	Mercury and methylmercury	BCK 9.9 (whole-body caddisflies)

AWQC = ambient water quality criteria
BCK = Bear Creek kilometer
FYR = Five-Year Review
HCK = Hinds Creek kilometer
NT = North Tributary
Q = quarter
SS = surface spring

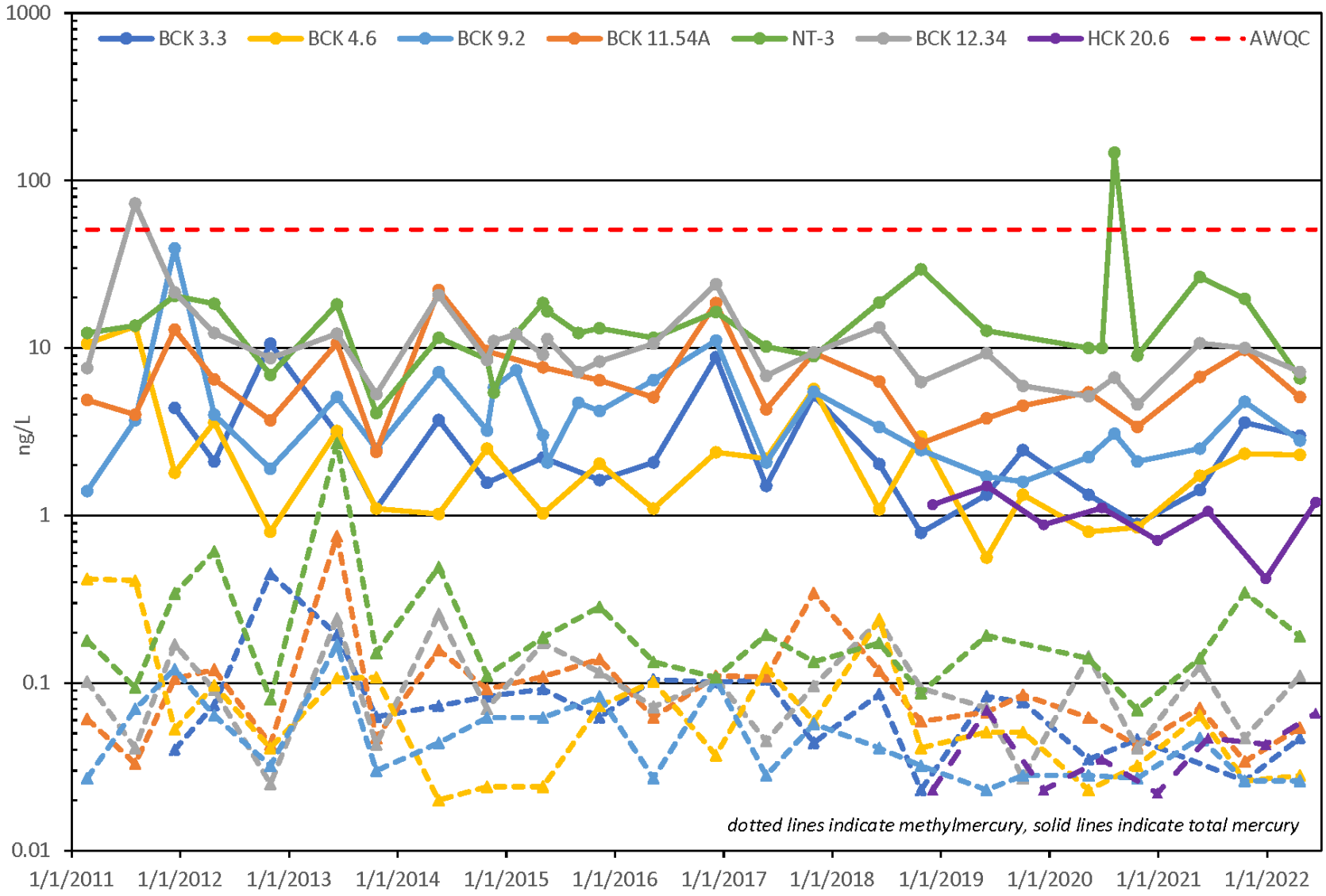

Figure 2.2. Surface water data for mercury and methylmercury in Bear Creek, NT-3, and Hinds Creek, 2011–2022.

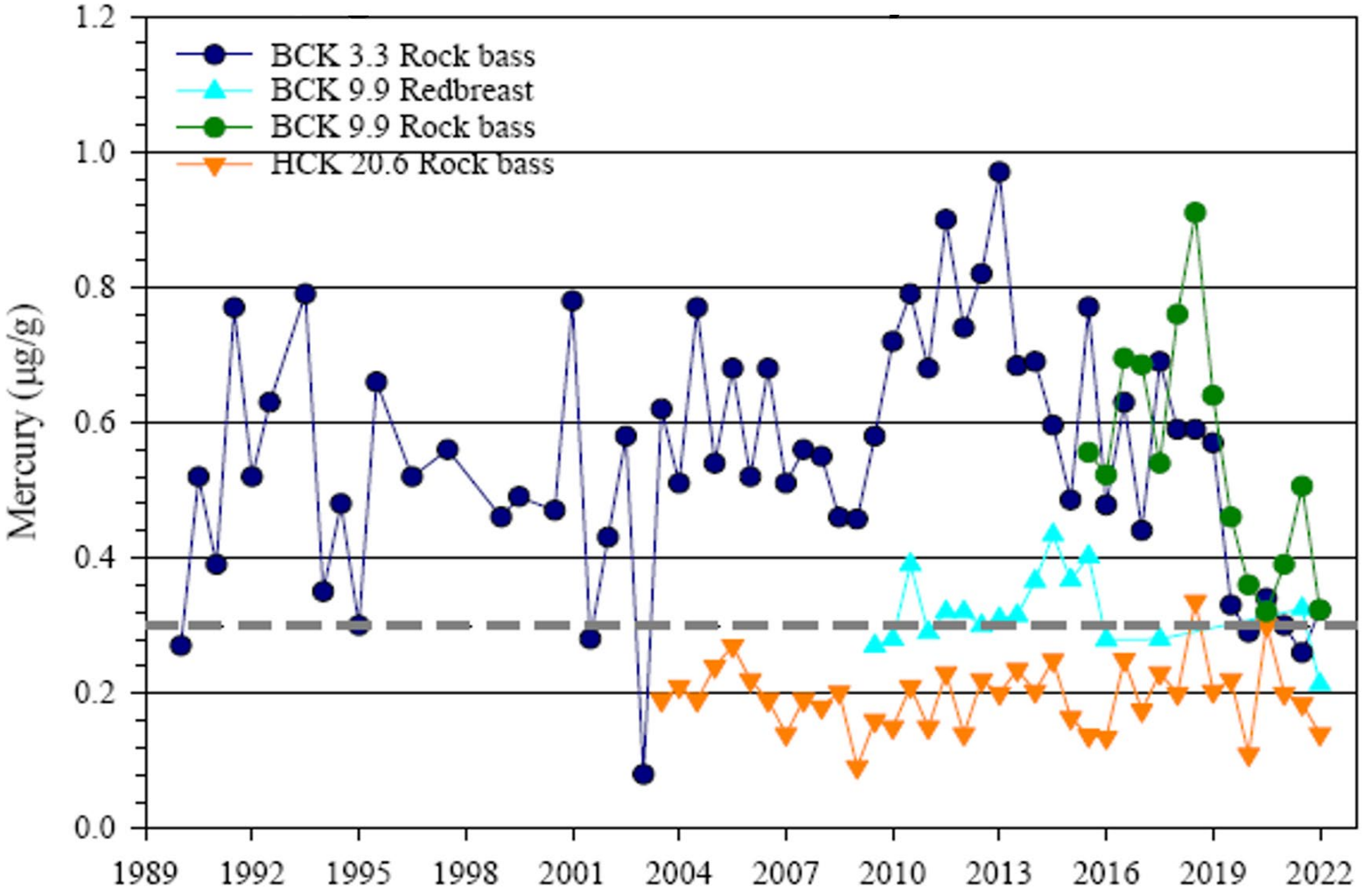

Figure 2.3. Average concentrations of mercury in Bear Creek fish.

Recently, the Oak Ridge National Laboratory conducted special studies of Bear Creek to better understand the biotic and abiotic factors contributing to mercury concentrations in fish in Bear Creek. These field studies focused on gaining an understanding of the processes controlling mercury methylation and bioaccumulation, with beaver dams and periphyton being key areas of interest. Studies included understanding the role of beaver dams in contributing to mercury dynamics in Bear Creek (2017–2018), evaluating the effects of fine-grained sediment deposition (2019), investigating the potential role tributaries to Bear Creek may have on mercury and methylmercury in the main channel (2020–2021), and evaluating periphyton relationships (2021). These special studies were documented in the *Bear Creek Special Studies Report 2021* (ORNL/SPR-2021/2162).

3. DATA QUALITY OBJECTIVES SUMMARY

The Data Quality Objective (DQO) Process provides systematic planning for decision-making and is an important tool for defining the type, quality, and quantity of data needed to make defensible decisions. EPA developed the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA/240/B-06/001) for implementing the DQO Process as part of its Quality System, an Agency-wide program for environmental data. The DQO Process is a seven-step iterative planning approach used to prepare plans for environmental data-collection activities. It provides a systematic approach for defining criteria that a data-collection design should satisfy, including identifying when, where, and how to collect samples or measurements; determining tolerable decision error rates; and specifying the number of samples or measurements that should be collected. DQOs define the purpose of the data-collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs, which are developed in the first six steps, are then used in the seventh and final step of the DQO Process to develop a data-collection design that meets all performance criteria and other design requirements and constraints.

DOE, EPA, and Tennessee Department of Environment and Conservation (TDEC) representatives attended a DQO meeting held on June 29, 2023. Appendix A provides the meeting minutes and a copy of the presentation. The BCV Mercury Sources RSE project DQOs are summarized below.

3.1 DATA QUALITY OBJECTIVE STEP 1: STATE THE PROBLEM

The first step in the DQO Process is to concisely describe the problem to be studied. Review of prior studies and existing information is necessary to gain a sufficient understanding to define the problem (i.e., conceptual site model [CSM]). The problem statement identified during the DQO meeting is:

- There are insufficient data along Bear Creek and its tributaries to determine if there are potential sources of mercury and methylmercury in channel sediment and creek bank and floodplain soils that may be contributing to exceedances of fish tissue criterion in prior years.

3.2 DATA QUALITY OBJECTIVE STEP 2: IDENTIFY GOALS OF THE STUDY

Step 2 of the DQO Process is to identify how data will be used to meet the objectives and what questions the study will attempt to resolve. The goals of the BCV Mercury Sources RSE project are to:

- Determine if there are areas (channel sediment and creek bank and floodplain soils) along Bear Creek and its tributaries that are potential sources of mercury and methylmercury that may affect fish.
- Obtain data from various hydrologic settings (pools, beaver ponds, etc.) that may contribute to mercury methylation and its bioaccumulation in the environment of Bear Creek and a reference location (e.g., Hinds Creek).

3.3 DATA QUALITY OBJECTIVE STEP 3: IDENTIFY INFORMATION INPUTS

This step is to identify the information that needs to be obtained and the measurements that need to be taken to achieve the goals of the study. This information is necessary so that proper data may be collected to resolve the problem statement. The information inputs for the BCV Mercury Sources RSE project are to:

- Review potential sources of mercury and methylmercury in Bear Creek and its tributaries.
- Review existing historical biota, surface water, sediment, and special studies data in Bear Creek, its tributaries, and a reference site (Hinds Creek kilometer [HCK] 20.6).

- Collect additional surface water, channel sediment, creek bank soil, and floodplain soil data along Bear Creek and its tributaries from selected transects.
- Collect additional surface water, channel sediment, creek bank soil, and floodplain soil data from the reference site (HCK 20.6).

3.4 DATA QUALITY OBJECTIVE STEP 4: DEFINE THE STUDY AREA BOUNDARY

The purpose of this step is to clarify the site characteristics that the environmental measurements are intended to represent. In this step, time periods and spatial area to which decisions will apply (i.e., determine when and where data will be collected) are specified. Practical constraints that could interfere with sampling also are identified in this step. The BCV Mercury Sources RSE study area boundaries follow:

- Spatial – Bear Creek, its tributaries, and a reference location and limited surrounding creek bank soil and floodplain soil.
- Vertical – shallow channel sediment, creek bank soil, and floodplain soil (0 to 0.5 ft).
- Temporal – samples to be collected in fall 2023 to meet the RSE milestone of September 2024.

3.5 DATA QUALITY OBJECTIVE STEP 5: DEVELOP THE ANALYTICAL APPROACH

This step is to develop an analytic approach that will guide how the study results are analyzed and conclusions are drawn from the data. The key steps for the analytical approach are to:

- Prepare an initial CSM to include all available information on potential mercury sources and historic sediment and surface water monitoring data from Bear Creek.
- Field-locate transects in potential source areas and pool areas (e.g., upstream of beaver dams) in Bear Creek and the mouths of tributaries (e.g., NT-3) based on the reconnaissance survey. Field-locate a reference site.
- Collect surface water, channel sediment, creek bank soil, and floodplain soil samples at transects to determine mercury and methylmercury concentrations along Bear Creek, its tributaries, and the reference site (HCK 20.6).
- Assess and document physical stream conditions (e.g., channel morphology, substrate) at each transect.
- Analyze samples for mercury, methylmercury, nutrients (e.g., sulfate, total phosphorus, nitrate-nitrite as nitrogen, organic carbon), particle size analysis, and mercury speciation/sequential extraction at select locations.
- Screen mercury surface water data against applicable TDEC AWQC.
- Compare concentrations in channel sediment and creek bank and floodplain soil in and around Bear Creek and its tributaries to the reference site (HCK 20.6) concentrations.

3.6 DATA QUALITY OBJECTIVE STEP 6: SPECIFY THE PERFORMANCE OR ACCEPTANCE CRITERIA

The purpose of this step is to derive the performance or acceptance criteria that the collected data will need to achieve to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels. Sampling uncertainty and associated decision errors are managed by increasing the number of field samples, which is more effective than controlling measurement uncertainty by repeated laboratory analyses. By designing the data-collection process appropriately, the level of uncertainty in the data can be controlled to achieve acceptable results. Thus, errors in decisions

based on environmental data may be managed effectively by complying with the requirements of the *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (UCOR-4049; Water Resources Restoration Program [WRRP] Quality Assurance Project Plan [QAPP]). New data will be obtained under approved WRRP procedures and quality programs and will be archived in OREIS.

3.7 DATA QUALITY OBJECTIVE STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA

The purpose of this step is to identify a field investigation sampling design that meets performance criteria, as specified in the preceding steps of the DQO Process. The output of this step is development of this BCV Mercury Sources RSE SAP. The sampling and analysis approach (Chapters 4 and 5) presents the plan for generating data for the BCV mercury sources RSE that satisfies the DQO and is sufficient to make decisions that achieve RSE requirements.

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4. SAMPLING AND ANALYSIS PLAN – SAMPLE LOCATION SELECTION

The work contained within this BCV Mercury Sources RSE SAP is consistent with a framework of plans, procedures, and protocols under the WRRP that help ensure all data collected are managed in a manner consistent with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requirements. In accordance with this overall objective, the WRRP has developed the WRRP QAPP to identify and implement quality assurance (QA) requirements for use in sample collection, laboratory analysis, and data management of environmental media monitoring activities. The *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee* (UCOR-4160; WRRP Data Management Implementation Plan [DMIP]) serves as the project-level plan for managing all data collected by the WRRP. Together, these plans identify the procedures that are followed in collecting, maintaining custody of, and handling samples, as well as in verifying, validating, and retaining environmental and laboratory data used by the WRRP in preparation of Federal Facility Agreement (FFA) documents.

Sample collection, laboratory analysis, and data management activities performed under this BCV Mercury Sources RSE SAP will follow the requirements of approved, relevant WRRP procedures, as detailed in the WRRP QAPP and WRRP DMIP. Additional requirements governing fieldwork and sample collection, specified in the *Quality Assurance Plan for Environmental Characterization and Monitoring, Oak Ridge, Tennessee* (UCOR-4189), will also apply as appropriate. Per EPA's Uniform Federal Policy, a SAP/QAPP checklist will be submitted under separate cover for EPA approval. The approved checklist will be retained in Appendix F of the WRRP QAPP.

A list of sampling locations along Bear Creek and its tributaries includes transects meeting the requirements of DQO Process Steps 4 and 5 (define the study area boundary and develop the analytical approach) for the collection of channel sediment, creek bank and floodplain soils, and surface water, which was identified in the DQO meeting (Table 4.1 and Figure 4.1). A conceptual diagram of the transect sampling plan is included as Figure 4.2 and is described in Sections 4.1 through 4.4.

4.1 SEDIMENT

Channel sediment samples will be collected at each of the 15 transect monitoring locations as well as at a single reference site (HCK 20.6) following PROC-ES-2302, *Sediment Sampling*. Sediment will be collected to an approximate depth of 0.5 ft and run through a 1-mm sieve until adequate sample volume is achieved.

4.2 SOIL

Both creek bank and floodplain soils will be collected at each of the 15 transect monitoring locations as well as at a single reference site (HCK 20.6) following PROC-ES-2300, *Soil Sampling*. However, collection of these two soil types will vary as follows:

- Creek bank soils will be divided in half into upper and lower sections as follows (Figure 4.2):
  - For the upper section of the creek bank soils, samples will be collected by removing the upper half of the surface soil on each side of the bank. The upper creek bank samples on each side will be composited into a single sample.
  - For the lower section of the creek bank soils, samples will be collected by removing the lower half of the surface soil (above the creek level) on each side of the bank. The lower creek bank samples on each side will be composited into a single sample.
- Floodplain soil will be collected from the upper 0.5 ft on either side of Bear Creek to generate a composite sample representing both sides of the floodplain (Figure 4.2). Loose organic material, such as leaves or brush, will be removed prior to collection.

Table 4.1. List of transect locations in BCV

Sample group	Location
LOWBCV	BCT1 (upstream of BCK 0.6; downstream of beaver dam)
	BCT2 (upstream of BCK 0.6; upstream of beaver dam)
	BCT3 (downstream of BCK 3.3; downstream of beaver dam)
	BCT4 (downstream of BCK 3.3; upstream of beaver dam)
BCV ZONE 1	BCT5 (downstream of BCK 4.55; downstream of beaver dam)
	BCT6 (downstream of BCK 4.55; upstream of beaver dam)
	BCT7 (downstream of BCK 7.87 at the confluence of NT-13/Bear Creek; downstream of westernmost beaver dam)
	BCT8 (downstream of BCK 7.87 at the confluence of NT-13/Bear Creek; upstream of westernmost beaver dam)
	BCT9 (downstream of BCK 7.87; upstream of two beaver dams; southeast of Reeves Road/Haul Road)
BCV ZONE 2	BCT10 (downstream of surface water integration point BCK 9.2; upstream of EMDF)
BCV ZONE 3	BCT11 (upstream of NT-8 at BCK 9.9)
	BCT12 (downstream of BYBY at the confluence of NT-3/Bear Creek)
	BCT13 (upstream of BYBY, EMWMF, and NT-3)
	BCT14 (downstream of SY-200 Yard, Spoil Area 1, and S-3 Ponds Site)
	BCT15 (downstream of S-3 Ponds Site)
Hinds Creek	HCTREF (HCK 20.6 reference site)

BCK = Bear Creek kilometer
BCT = Bear Creek transect
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
HCK = Hinds Creek kilometer
HCTREF = Hinds Creek transect reference site
NT = North Tributary

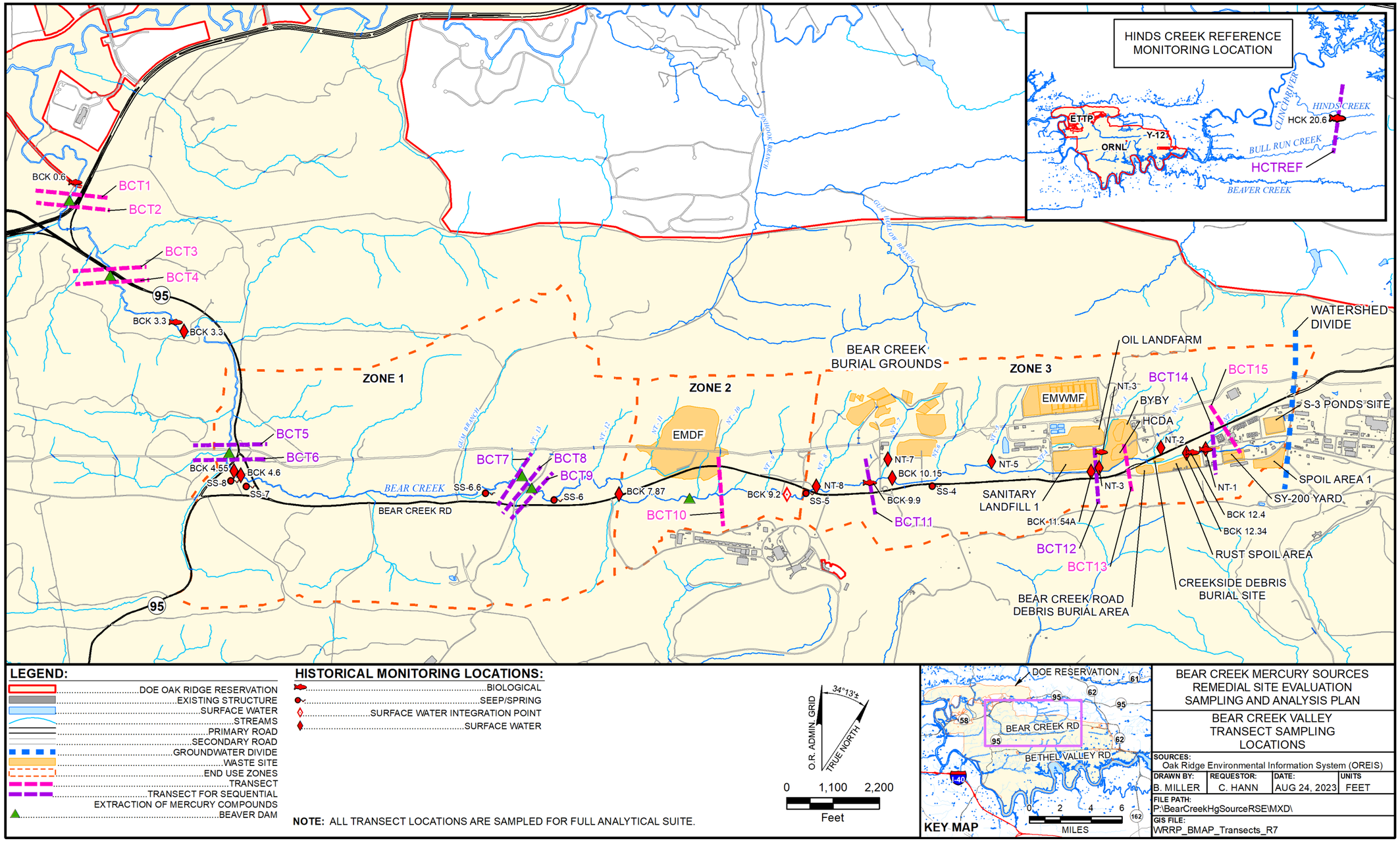

Figure 4.1. BCV transect sampling locations.

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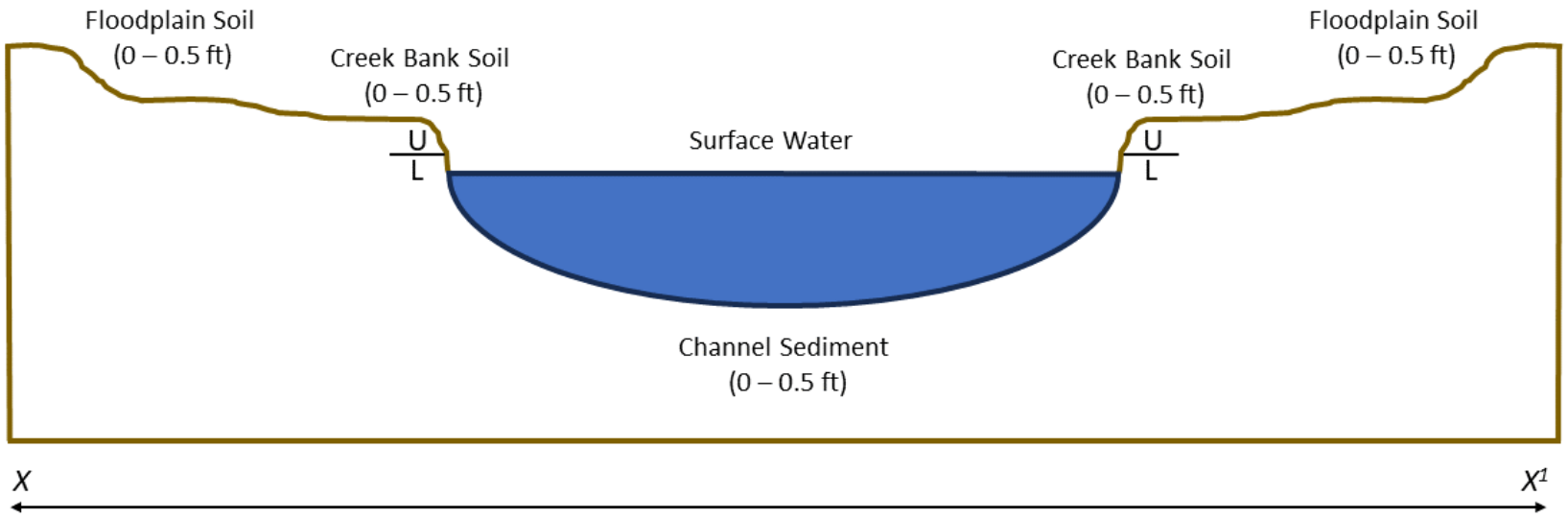

Figure 4.2. BCV RSE transect diagram.

4.3 SURFACE WATER

Surface water samples will be collected at each of the 15 transect monitoring locations as well as at a single reference site (HCK 20.6) following PROC-ES-2203, *Surface Water Sampling – Manual and Automated*.

Because filtered and unfiltered mercury and methylmercury sample volumes are to be collected for analysis, a peristaltic pump will be required for filtration in addition to the grab method. Surface water sampling should be conducted before channel sediment is collected to avoid interference between media.

4.4 SEQUENTIAL EXTRACTION OF MERCURY COMPOUNDS

Eight transect locations, as well as a reference location (HCK 20.6), will be sampled for mercury speciation/sequential extraction analysis. Sufficient mass of solid material from the channel sediment, creek bank soil, and floodplain soil at each selected transect for mercury speciation/sequential extraction will be composited into samples from each of the three representative media types (i.e., three composite samples per transect). Sediment will be collected to an approximate depth of 0.5 ft and passed through a 1-mm sieve until adequate sample volume is achieved. For creek bank soil, one sample will be collected from each side of the bank by removing the upper 0.5 ft of bank soil surface just above the water level and composited. For floodplain soil, samples will be collected from the upper 0.5 ft on each side of the creek to generate a composite sample representing both sides of the floodplain.

Locations for this analysis are shown on Figure 4.1 and include one at the reference site (HCK 20.6); one downstream of the SY-200 Yard, Spoil Area 1, and S-3 Ponds Site (Bear Creek transect [BCT]14); one downstream of BYBY at the confluence of Bear Creek and NT-3 (BCT12); one upstream of NT-8 at BCK 9.9 (BCT11); three downstream of BCK 7.87 at the confluence of Bear Creek and NT-13 in proximity to two prominent beaver dams (BCT7, BCT8, and BCT9); and two downstream of BCK 4.55 in proximity to a beaver dam (BCT5 and BCT6).

4.5 FINAL SELECTION OF SAMPLING LOCATIONS

Table 4.1 presents the transect sample locations for the BCV mercury sources RSE. These locations along Bear Creek were selected based on their location downgradient of and/or in the vicinity of potential source areas, where biota and surface water sampling have historically occurred, and in the vicinity of ponds. Physical stream conditions (e.g., channel morphology, substrate) at each transect were assessed in the selection process.

Actual field locations may be adjusted based on field conditions and sampling viability. Deviations from this BCV Mercury Sources RSE SAP will be documented in the field logbook and in the BCV mercury sources RSE.

5. SAMPLING AND ANALYSIS PLAN – ANALYTICAL PROGRAM

5.1 SUITE OF ANALYTES AND METHODS

The planned suite of analytes and methods of analysis for all samples to be collected during the BCV mercury sources RSE are listed in Appendix B (Tables B.1 through B.3) and summarized in Table 5.1. The suite is based on discussions and input received during the DQO Process; consideration of primary COCs mercury and methylmercury from potential mercury source areas within the BCV Watershed; and the standard suite of analytes and analytical methods used for sediment, soil, and surface water by the WRRP. As such, results for the analyte suite will be consistent with and comparable to the water quality database for the ORR that is maintained in OREIS. As shown in Appendix B, each of the parameter groups for identified analytes corresponds with a table in the latest version of the WRRP QAPP, which has been revised to add the BCVRSE, S-BCVRSE, and HGSEQ parameter groups for this project.

Table 5.1. Summary of field and analytical parameters

Medium	Field parameter	Analytical parameter
Surface water	Temperature	Dissolved and total mercury
	Dissolved oxygen	Dissolved and total methylmercury
	Turbidity	Metals
	pH	Phosphorous (total)
	Specific conductance (conductivity)	Total organic carbon
	Oxidation-reduction potential	Dissolved organic carbon
		Total dissolved solids
		Total suspended solids
		Anions (chloride, fluoride, nitrate-nitrite as nitrogen, sulfate, and sulfide)
Sediment and soil	None	Total mercury
		Total methylmercury
		Metals
		Total organic carbon
		Particle size analysis
		Anions (chloride, fluoride, nitrate, nitrite, sulfate, and sulfide)
		Sequential extraction of mercury compounds

5.2 LABORATORY-DEFINED VALUES AND REQUESTED REPORTING LIMITS

To develop the analytical program, different values were considered for each analyte.

5.2.1 Laboratory-Defined Values

Laboratory-defined values for the BCV mercury sources RSE analytes and analytical methods are listed in Appendix B (Tables B.2 and B.3) and discussed below.

5.2.1.1 MDLs

Method detection limits (MDLs) apply to non-radionuclide analytes and are defined as the minimum concentration of an analyte that can be measured and reported with a 99% confidence that the analyte is present in the sample with a concentration greater than zero. Analyte concentrations at the MDL have a 50% chance of being reported as a non-detect or a false negative, and analyte concentrations near the MDL cannot be quantified with statistical rigor. Values above the MDL but below the practical quantitation limit (PQL) indicate the analyte is likely present in the sample, although at concentrations below those that can be quantified with statistical significance (DOD/DOE 2013).

5.2.1.2 PQLs

PQLs apply to non-radionuclide analytes and are defined as the lowest concentration of an analyte that produces a quantitative result within specified limits of precision and bias. The PQL is typically greater than the MDL. PQLs are dependent on the acceptance limits for precision and bias selected for the requirements of the program. For many projects, the PQL is required to be at or above the lowest concentration of the laboratory standards used in method calibration for an analyte. Measurements falling between the MDL and PQL assure the presence of an analyte with confidence, but their numeric values are estimates and not quantified numbers (DOD/DOE 2013).

5.2.2 Requested Reporting Limits

Requested reporting limits (RRLs), referred to as reporting limits in the *Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (DOD/DOE 2013), are concentration levels for specific constituents within a sample that are specified by the project. The RRLs are defined so that obtained sediment, soil, and surface water data meet all project requirements for reporting quantitative data with known precision and bias for a specific analyte in a specific matrix. For the BCVRSE, S-BCVRSE, and HGSEQ parameter groups, the laboratory is being requested to report detections with respect to the MDLs, which are generally lower than the RRLs. The RRLs, if met, ensure project data can be successfully screened against appropriate criteria and standards. For most WRRP projects, laboratories are requested to report detections of chemical analytes with respect to the MDL.

5.3 ANALYTICAL METHODS

Analytical methods for sediment, soil, and surface water analyses are summarized in Appendix B, Table B.2 (water) and Table B.3 (soil and sediment), and correspond to methods listed by parameter group in the latest version of the WRRP QAPP for each analyte. All analytical methods are EPA standard procedures routinely employed by Oak Ridge Sample Management Office (SMO) contract laboratories.

Discussions during the DQO Process resulted in development of the BCVRSE, S-BCVRSE, and HGSEQ parameter groups (WRRP QAPP) which are unique to the BCV mercury sources RSE. These parameter groups were developed to specify analytes (e.g., mercury, methylmercury, nutrients, particle size analysis, and total organic carbon) and methods for the sequential extraction of mercury in sediment and soil for the BCV mercury sources RSE. For surface water samples collected, AWQC may be used for comparison purposes only, but are not a required screening level.

5.4 FIELD ANALYTICAL SAMPLING AND LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

All relevant QA and quality control procedures and requirements specified in the WRRP QAPP (field collection) and for the SMO (laboratory analyses) are incorporated by reference for compliance. No changes in WRRP and SMO procedures incorporated under the WRRP QAPP are anticipated for the BCV mercury sources RSE.

Appendix B provides the planning tables that will be used for the BCV mercury sources RSE, including locations, sampling methods, frequencies, analyses, and reporting levels. Final selection of locations will be decided as described in Section 4.5 of this BCV Mercury Sources RSE SAP.

5.5 ANALYTICAL MEDIA CONSIDERATIONS

Surface water (Appendix B, Table B.2) will be analyzed for dissolved and total mercury, dissolved and total methylmercury, total phosphorous, dissolved organic carbon, total dissolved solids, total suspended solids, total organic carbon, anions (e.g., chloride, fluoride, nitrate-nitrite as nitrogen, sulfate, and sulfide), and metals. Both filtered and unfiltered surface water samples will be collected for mercury and methylmercury as part of this suite. Field parameters collected at the time of sampling are temperature, dissolved oxygen, turbidity, pH, specific conductivity, and oxidation-reduction potential.

Sediment and soil (Appendix B, Table B.3) will be analyzed for total mercury and methylmercury, particle size analysis, total organic carbon, anions (e.g., chloride, fluoride, nitrate, nitrite, sulfate, and sulfide), and metals. Sediment and soil will also have additional analysis performed for mercury speciation. This analysis will provide data for volatile elemental mercury, water soluble mercury, pH2 soluble mercury, 1N potassium hydroxide extractable mercury, 12N nitric acid soluble mercury, aqua regia soluble mercury residue, and mineral-bound mercury.

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6. SAMPLING AND ANALYSIS PLAN – DATA MANAGEMENT

6.1 DATA VERIFICATION AND VALIDATION

All data will be verified following WRRP QAPP and WRRP DMIP requirements. All mercury and methylmercury data will be validated following the WRRP QAPP and WRRP DMIP. Level 4 data packages will be required for all analyses completed under the BCV Mercury Sources RSE project. Verification and validation will be conducted by United Cleanup Oak Ridge LLC/RSI Entech staff and/or their validation subcontractor.

6.2 DATA STORAGE

All data will be stored in the Project Environmental Measurements System following required procedures and WRRP QAPP requirements and will be archived in OREIS.

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7. PROJECT ORGANIZATION, SCHEDULE, AND REPORTING

7.1 ORGANIZATION

The EMDF ROD outlined the mercury-management approach for Bear Creek that included an RSE. The DOE Environmental Management Program is the responsible organization for implementing the RSE under the CERCLA process, with coordination and approval by EPA and TDEC in accordance with the FFA. The Project Team is comprised of representatives from DOE, EPA, and TDEC. The DOE Environmental Management Program will use the WRRP, a contractor-implemented organization, for support in executing BCV Mercury Sources RSE project monitoring. The WRRP has comprehensive procedures for sampling and provides data for use in making watershed-management decisions related to remedial action effectiveness and contaminant trends on the ORR. WRRP support will include QA, sampling and analysis, and data management resources. Additional details about WRRP organizations, roles, and responsibilities are provided in the WRRP QAPP.

7.2 SCHEDULE

Fieldwork described in this BCV Mercury Sources RSE SAP is planned to be conducted from approximately September through November 2023, but the work schedule may be extended based on the exact start date. Data evaluation and preparation of the BCV Mercury Sources RSE Report will occur between January and September 2024 (FFA Appendix E milestone: September 30, 2024).

7.3 REPORTING

Sampling activities, sampling results, and data evaluation will be summarized in the BCV Mercury Sources RSE Report that has an FFA Appendix E milestone date of September 30, 2024.

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8. REFERENCES

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PROC-ES-2302. *Sediment Sampling*, latest revision, United Cleanup Oak Ridge LLC, Oak Ridge, TN.

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UCOR-4160. *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee*, latest revision, United Cleanup Oak Ridge LLC, Oak Ridge, TN.

UCOR-4189. *Quality Assurance Plan for Environmental Characterization and Monitoring, Oak Ridge, Tennessee*, latest revision, United Cleanup Oak Ridge LLC, Oak Ridge, TN.

APPENDIX A.
DATA QUALITY OBJECTIVE PRESENTATION AND MEETING MINUTES FOR THE BEAR CREEK VALLEY MERCURY SOURCES REMEDIAL SITE EVALUATION

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BEAR CREEK VALLEY (BCV) MERCURY SOURCES REMEDIAL SITE EVALUATION (RSE)
DATA QUALITY OBJECTIVES (DQO) MEETING MINUTES
BCV

DATE: June 29, 2023; 2 p.m.

ATTENDEES:

Sam Scheffler – DOE
Roger Petrie – DOE
Dana Casey – TDEC
Cody Juneau – TDEC
Courtney Thomason – TDEC
Brad Stephenson – TDEC
Randy Young– TDEC
Jana Dawson – EPA (ph)
Eddie Arnold – UCOR, presenter
Sid Garland – UCOR
Diana Turner – UCOR
Bob Bock – UCOR (ph)
Lynn Sims – UCOR
Annette Primrose – UCOR (ph)
Scott Brooks – ORNL-ESD
Natalie Landry – ORNL-ESD
Chris DeRolph – ORNL-ESD (ph)
Terry Mathews – ORNL-ESD
Sally Absher – Leidos (ph)

PURPOSE: The objective of the meeting is to review the history and sources of mercury in Bear Creek and to present DQOs and proposed sampling for the BCV Mercury Sources RSE.

AGENDA (Slide 2):

- Introduction, Safety Topic
- BCV Mercury Sources RSE Milestone
- Site Background
- Previous Investigations
- DQO steps
- Proposed transects and analytes
- RSE schedule

INTRODUCTION, SAFETY TOPIC (Slide 3): Eddie Arnold introduced the participants in the conference room and online and presented a brief safety topic about fireworks in anticipation of the upcoming 4th of July holiday.

BCV Mercury Sources RSE Milestone (Slide 4)

The BCV Mercury Sources RSE Milestone is 9/30/2024 as part of the Federal Facility Agreement (FFA) Appendix E. The RSE is being conducted per an agreement as part of the Environmental Management Disposal Facility (EMDF) Record of Decision (ROD).

NOTE: The remainder of these minutes only includes notes for slides in which there was additional discussion. For slides on which there were no additional questions, comments, or discussions, only the slide title is presented. The final DQO Presentation is attached to these minutes.

Site Background - BCV History (Slide 5)

Oak Ridge Reservation [figure] (Slide 6)

BCV Site Location [figure] (Slide 7)

- Randy Young prompted DOE to explain why the RSE/milestone was in place.
- Roger Petrie explained that Bear Creek is currently listed as impaired and under the anti-degradation rule, no new discharges of mercury from EMDF are allowed; this is not possible, so to

construct the EMDF Treatment Facility, DOE agreed to follow a sequence of events in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to address mercury offsets to get the EMDF ROD signed. The first CERCLA step is the RSE, which DOE has committed to perform. The purpose of the DQO is to present the activities required to complete the RSE.

- Randy Young also clarified for EPA that there was a short discussion while waiting for others to join the call between Randy Young and Roger Petrie about polychlorinated biphenyls (PCBs). DOE stated that PCBs will not be an issue for this facility because DOE expects the PCB inventory to be less than that for EMWMF and for the wastewater treatment to remove all PCBs before discharge to Bear Creek. Therefore, they are not addressed in this approach. Roger Petrie also stated that DOE will develop an offset approach for PCBs if needed. Randy Young asked about potential risks to the cleanup program if landfill operations are impacted by PCB discharge and advised DOE to not take unnecessary risks. Roger Petrie maintained that DOE does not believe it will be an issue and is willing to take the risk in this approach of developing offsets later if necessary. NOTE: During comment resolution on the meeting minutes DOE confirmed that EPA Method 1668 (congener method) will be utilized for comparison of surface water PCB results to the AWQC as applicable.
- Roger Petrie clarified that because the EMDF facility is new, the anti-degradation rule applies, but other existing facilities' discharges are grandfathered in and the anti-degradation rule doesn't apply.

BCV Decision Documents – BCV Mercury Sources [BCV Phase 1 RI and ROD] (Slide 8)

- Randy Young had a question about the second bullet on the slide: has the BCV Phase I RI been looked at enough to know how much of a problem mercury is at Sanitary Landfill 1?
- UCOR clarified that mercury was not a contaminant of concern (COC) for the landfill in the BCV Phase I ROD.

BCV Decision Documents – BCV Mercury Sources [BCV OU2 RI and ROD] (Slide 9)

Potential BCV Mercury Sources [figure] (Slide 10)

BCV Mercury Sources – SY-200 Yard (Slide 11)

- Randy Young asked for clarification on the timing/approval of the cover/cap at the SY-200 Yard
- UCOR and DOE responded that it was part of the BCV OU-2 ROD which was pre-FFA

BCV Mercury Sources – Spoil Area 1 (Slide 12)

BCV Mercury Sources – NT-3 (Slide 13)

BCV Mercury Sources – Others (Slide 14)

- Dana Casey asked what defines minor level of mercury.
- Eddie Arnold responded that it is likely over background, but that they were generally very minor exceedances
- Brad Stephenson asked for further clarification in the case of 58-83 mg/kg, if that was also considered minor
- Eddie Arnold clarified that at the time it was considered minor, as the wording is from the BCV Phase I RI

Previous Investigations – Current Surface Water and Biota Sampling in Bear Creek [fig.] (Slide 15)

Previous Investigations– Current Surface Water and Biota Sampling in Bear Creek [table] (Slide 16)

Previous Investigations – Summary of Historical Surface Water Data (Slide 17)

- Jana Dawson asked for clarification about mercury vs methylmercury, generation vs release.
- Eddie Arnold clarified that the evaluation is from the perspective of the effect on biota.

Previous Investigations – Summary of Historical Biota Data (Slide 18)

- Eddie Arnold invited input from ORNL.
- Terry Mathews mentioned that there had been recent habitat changes that affected mercury methylation but that mercury in fish has been trending downward in the last few years. Additionally, mercury (in fish) at the reference site (where there is no DOE input) has increased; Bear Creek is now around background.
- Randy Young asked if there were any other things that might be addressed regarding habitat in a remedy for mercury or methylmercury.
- Terry Mathews clarified that best management practices and beaver management are being followed – beavers are not necessarily bad for habitat but exacerbate mercury methylation, so beaver management is one of the best things to do. Terry added that mercury methylation is discussed later in the presentation and that the focus is on watershed-scale practices.

Previous Investigations – Summary of Historical Sediment Data [figure] (Slide 19)

Previous Investigations – Summary of Historical Sediment Data (Slide 20)

- Courtney Thomason asked about details regarding historical sediment samples – if they were grab samples, what was the depth, etc.
- Eddie Arnold responded that the few samples were mostly surface grab samples (under 6 inches), with a few deeper samples. Concentrations were low and no methylmercury data was collected except during the ORNL special studies.

Previous Investigations – Summary of Special Studies Data (Slide 21)

Previous Investigations – Summary of Special Studies Data (Slide 22)

- Scott Brooks presented special studies data (slides 22-26) and oriented viewers to figures.
- Although concentrations are elevated at NT-3 and at the borrow area near Highway 95 due to beaver impoundment, mass loading is thought to be low due to the small amount of discharge.

Previous Investigations – Summary of Special Studies Data (Slide 23)

Previous Investigations – Summary of Special Studies Data (Slide 24)

Previous Investigations – Summary of Special Studies Data (Slide 25)

- There are two properties of methylmercury that are important in this case: 1) that it is bioaccumulative 2) that periphyton is known to be a source of methylmercury generation; both factors lead to high levels of methylmercury in periphyton.
- Cody Juneau asked if methylmercury at NT-3 (tributaries) is much higher.
- Scott Brooks clarified that the tributaries are represented by the orange triangles and confirmed that methylmercury is very high at NT-3 relative to other samples, but also cautioned that it is only a single sample and difficult to separate from pond muck. More data are needed to draw conclusions.

Previous Investigations – Summary of Special Studies Data (Slide 26)

- Terry Mathews followed up on Randy Young's previous questions about other actions that may be performed watershed-wide. Studies have indicated that periphyton is a potential contributor of methylmercury to the creek. Chris DeRolph has been using drones to look spatially at periphyton communities and habitat throughout the creek.
- Courtney Thomason asked if microbes have been evaluated separately from periphyton.
- Scott Brooks responded that they have in East Fork but not in BCV.
- Brad Stephenson asked how often surface water is sampled.
- Scott Brooks responded that NT-3 was sampled once or twice; Eddie Arnold responded that WRRP does regular quarterly sampling there.

DQO Steps (Slide 27)

- Eddie Arnold resumed presenting.

DQO Step 1. State the Problem (Slide 28)

DQO Step 2. Identify the Goals of the Study (Slide 29)

- TDEC and Roger Petrie discussed that the goal of the study was to find mercury sources to offset, if possible, not to do an RI, but that data show finding mercury sources to offset may be difficult.
- Discussion continued that mercury concentrations in fish need to be below 0.3 ppt because of the anti-degradation rule. So in addition to the RSE, fish need to be monitored to see if they remain below 0.3 ppt. It's not strictly about mass of mercury produced by EMDF as that will be very small.

DQO Step 3. Identify Information Inputs (Slide 30)

DQO Step 4. Define the Study Area Boundary (Slide 31)

DQO Step 5. Develop the Analytical Approach (Slide 32)

- Cody Juneau asked that mercury speciation be quickly explained.
- Terry Mathews responded that it is sequential extraction – an iterative process with increasingly harsh digestion which results in a percentage of mercury coming off at each step; this determines how tightly bound the mercury is.

DQO Step 6. Specify the Performance or Acceptance Criteria (Slide 33)

DQO Step 7. Develop the Plan for Obtaining Data (Slide 34)

Proposed Transect Locations (Slide 35)

- Eddie Arnold clarified that there is a general idea of locations but transects will be field-located based on access.

Proposed Transect Locations [figure] (Slide 36)

Beaver Dams near BCK 7.0 [figure] (Slide 37)

- Courtney Thomason asked about sediment deposition not associated with beavers.
- Eddie Arnold responded that overbank depositional areas are limited and the upper portion of Bear Creek is often dry.
- Courtney Thomason asked if there will be any effort to locate any non-beaver depositional areas in the lower portion of Bear Creek.
- Eddie Arnold responded that there will be an effort but added that the substrate doesn't lend itself to fine-grained sediment deposition in non-beaver areas.

Transect Sampling (Slide 38)

- Dana Casey asked if there is reason to think that there would be mercury deeper than 6 inches that could connect to the surface water.
- Eddie Arnold agreed that it is a possibility but the groundwater data do not indicate that.
- TDEC, UCOR, DOE, and ORNL participated in a discussion of shallow groundwater and concluded it is out of the scope for the RSE but would be an interesting topic for a separate investigation. NOTE: During comment resolution on the meeting minutes TDEC clarified the recommendation that shallow groundwater sampling should be included in the project scope.
- There was discussion to clarify the goal of this RSE and whether that was to find mercury sources, methylmercury sources, or sources of methylation, and DOE reiterated that this is a source investigation for mercury and methlymercury.

Transect Sampling Diagram (Slide 39)

Analytical Suite (Slide 40)

RSE Schedule (Slide 41)

- Eddie Arnold reviewed the schedule and TDEC asked about what happens afterward/schedule going forward.

- Roger Petrie and TDEC discussed hypothetical future actions, and UCOR mentioned that those discussions are better left until after the results of the RSE.
- Roger Petrie reiterated that this is a very tight schedule but that it can be met. Other valid questions that arose during today's discussion may eventually be addressed but cannot be added to this RSE due to schedule.
- Randy Young agreed but anticipated that TDEC will have several comments. Brad Stephenson also mentioned that TDEC wants EMDF to succeed and this RSE is a big part of getting there and of signing the ROD.

Wrap Up

- There were no additional comments or questions on the BCV RSE DQO presentation.
- TDEC said that they had some data they would share.
- Eddie Arnold mentioned that minutes might be delayed due to the upcoming July 4 holiday.

There were no further questions or comments. The meeting was adjourned at 3:33 pm.

Respectfully submitted

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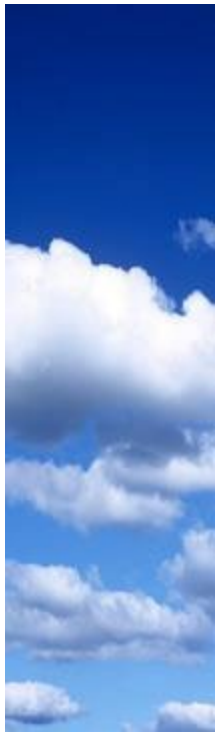
UCOR
United Cleanup Oak Ridge LLC

Bear Creek Valley (BCV) Mercury Sources Remedial Site Evaluation (RSE) Data Quality Objectives (DQOs)

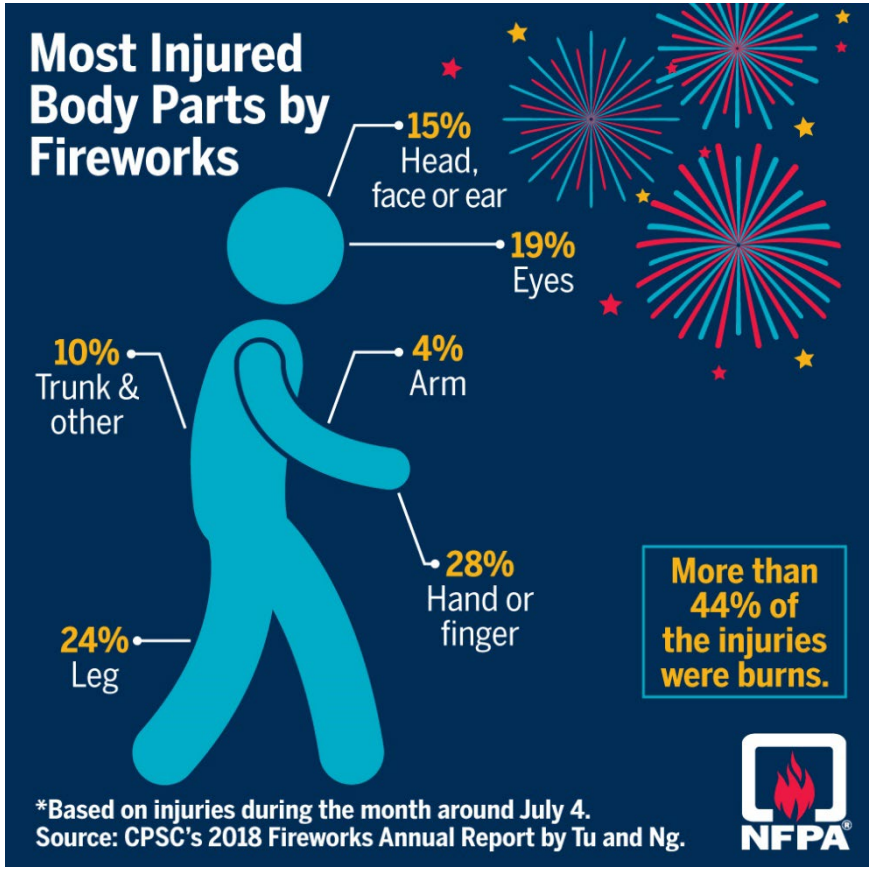




June 29, 2023

Agenda

1. Introductions, Safety Topic
2. BCV Mercury Sources RSE Milestone
3. Site Background
   - BCV History
   - BCV Decision Documents
   - Potential BCV Mercury Sources
4. Previous Investigations
   - Current surface water and biota sampling in Bear Creek
   - Summary of historical data
   - Summary of special studies data
5. DQO steps
6. Proposed transects and analytes
7. RSE Schedule

Safety Topic – Fireworks!!!



A-11

BCV Mercury Sources RSE Milestone

FY 2023 – 2025 Federal Facility Agreement Milestones

Appendix E

Project/Subproject	FY 2023 Milestone	FY 2024 Milestone	FY 2025 Milestone
BCV Mercury Sources		RSE 9/30/24	

A-12

As part of the Environmental Management Disposal Facility Record of Decision (EMDF ROD; DOE/OR/01-2794&D2/R2) it was agreed to conduct a RSE (40 CFR 300.420)

Site Background - BCV History

- BCV contains multiple historical waste management and disposal areas that received mercury contaminated waste streams from Y-12 operations from 1943 to 1993 in addition to having materials storage areas and construction storage areas.
- East of the BCV Watershed is the Upper East Fork Poplar Creek (UEFPC) Watershed including the operational portion of the Y-12 plant. The boundary between the two watersheds is defined by a surface water divide that is between the eastward-flowing EFPC and westward-flowing Bear Creek.
- The Integration Point (IP) for Bear Creek is at BCK 9.2 where more than 99% of the available water from the eastern portion of BCV passes through this location either as surface water or groundwater.
- BCV has two RODs that identify mercury as a constituent of concern (COC): BCV OU2 ROD and BCV Phase I ROD.

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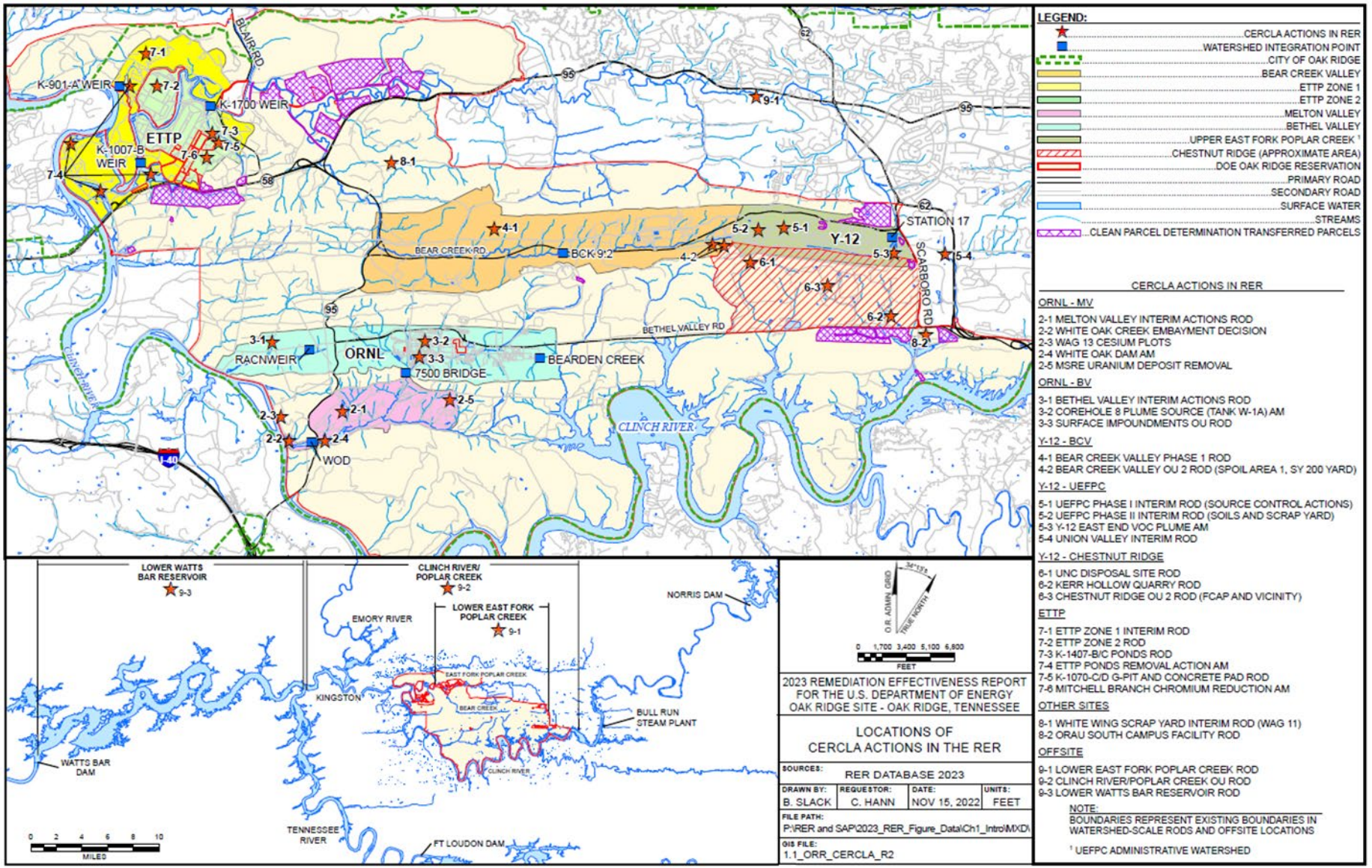
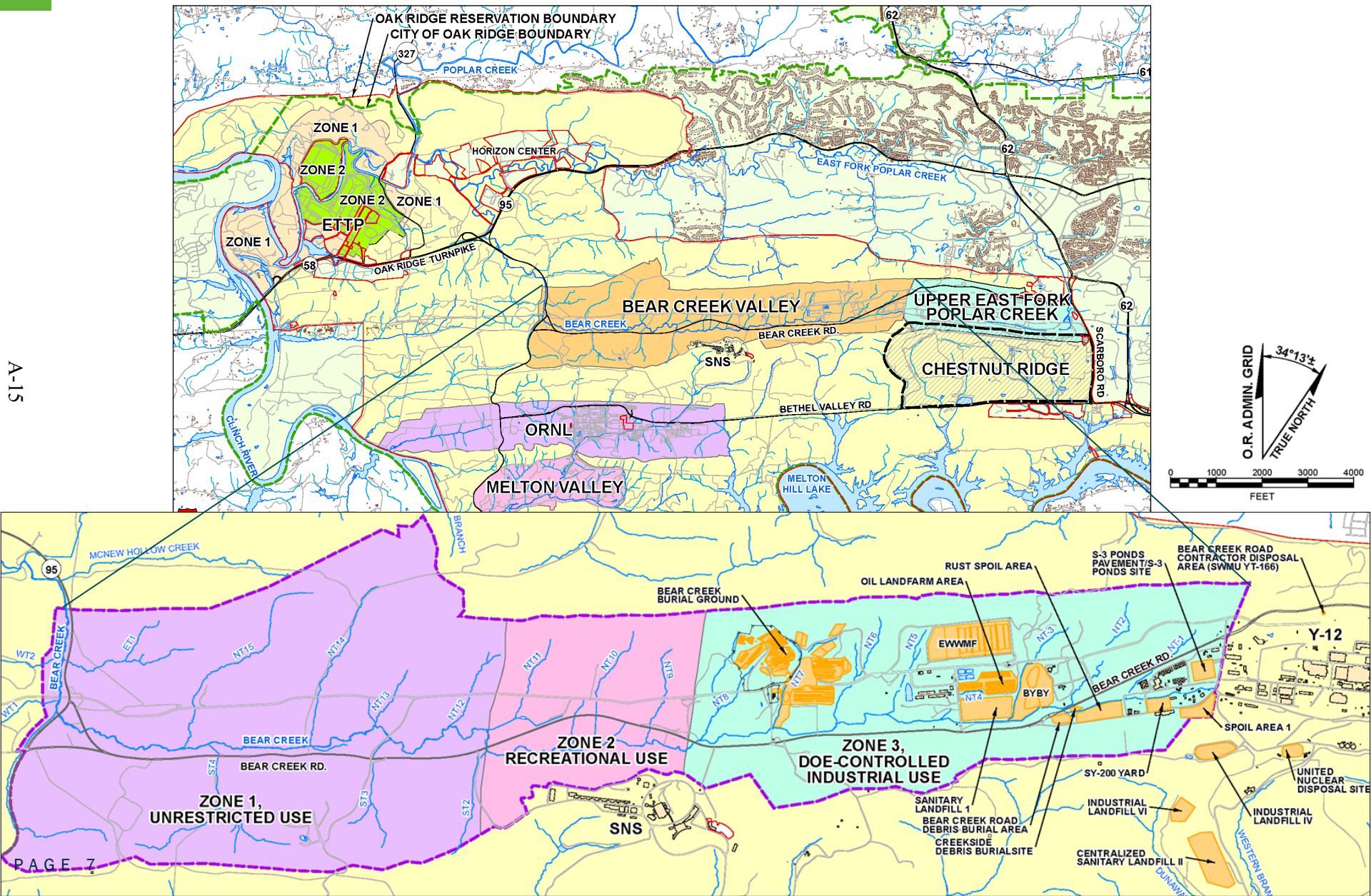
Oak Ridge Reservation



BCV Site Location



BCV Decision Documents – BCV Mercury Sources

BCV Phase I ROD (DOE/OR/01-1750&D4) and BCV Phase I Remedial Investigation (RI) (DOE/OR/01-1455&D2)

- The BCV Phase I ROD cited mercury as a COC posing environmental hazards due to migration from the Boneyard/Burnyard (BYBY). No other mention of mercury in the BCV Phase I ROD.
- The BCV Phase I RI identified mercury as a COC (human health) for BYBY, Oil Landfarm (OLF), Hazardous Chemical Disposal Area (HCDA), S-3 site, Sanitary Landfill 1, Bear Creek Road Debris Burial, and Creekside Debris Burial.
- The BCV Phase I RI indicated there were some elevated soil mercury concentrations, generally within an order of magnitude of background criterion (0.34 mg/kg).
- The Baseline Risk Assessment (BRA) in the BCV Phase I RI stated: *the sources of mercury and PCBs to the BCV fish are currently unknown.*

A-16

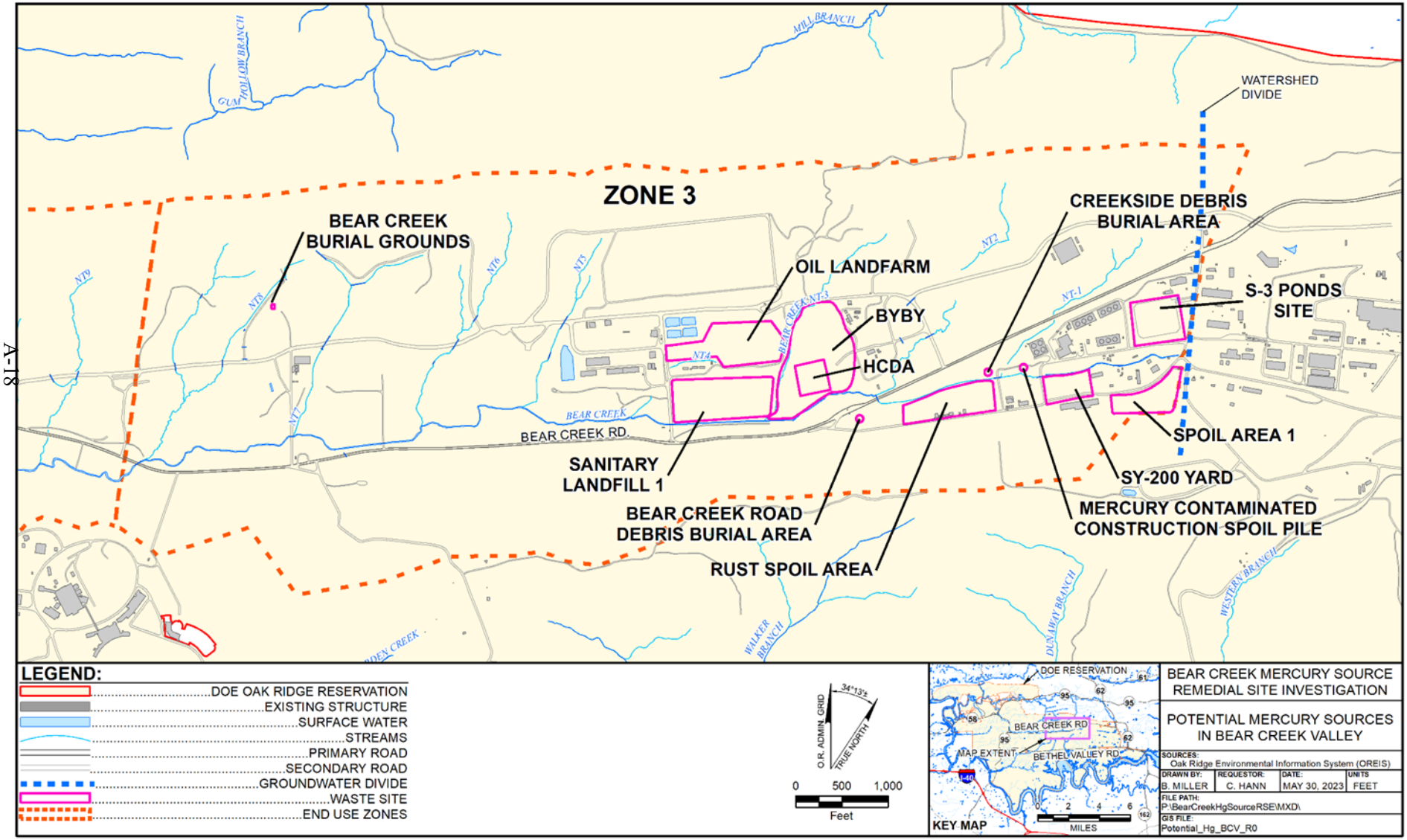
BCV Decision Documents – BCV Mercury Sources

BCV OU2 ROD (DOE/OR/02-1435&D2) and BCV OU2 RI (DOE/OR/01-1273&D2)

- The BCV OU2 ROD identified two areas with mercury, SY-200 and Spoil Area 1. No other mention of mercury in the BCV OU2 ROD.
- The BCV OU2 RI identified mercury as a COC (human health) for SY-200. While Spoil Area 1 and the Rust Spoil Area had mercury as a contaminant of potential concern (COPC), the BRA did not identify mercury as a COC for these areas.
- The BCV OU2 RI indicated that mercury concentrations were elevated at SY-200 but were generally within an order of magnitude of background; however, free mercury was seen in some of the borings during the BCV OU2 RI.

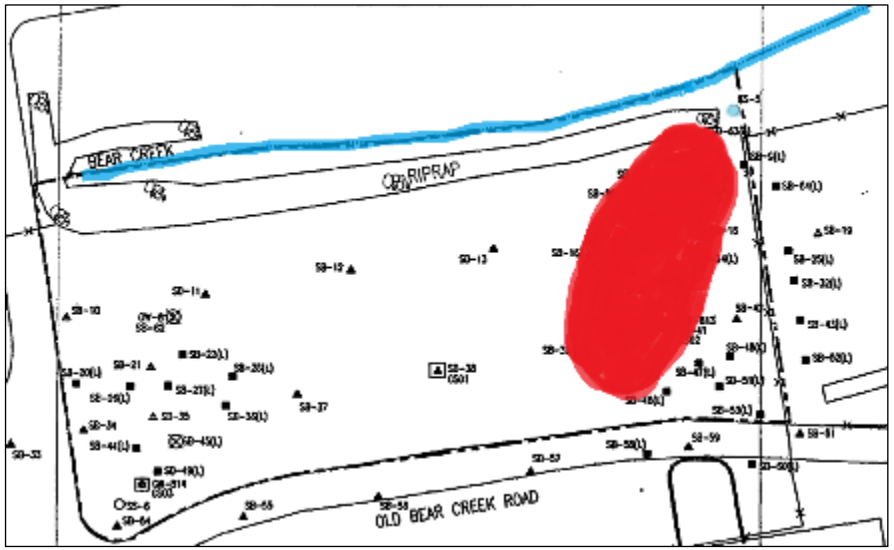
A-17

Potential BCV Mercury Sources



A-18

BCV Mercury Sources – SY-200 Yard



- SY-200 Yard was a former equipment storage yard used to store nonradioactive contaminated equipment, mercury flasks, etc. from the 1950s to 1986
- In 1990, construction of the Environmental Support Facility began at the site. During construction, mercury was detected at high levels (up to 816 mg/kg) in excavated soils and visible mercury was noted
- Construction was paused and a 3 to 5 ft soil cover was placed across the site

- Bear Creek shown in blue
- Red area is high mercury area at SY-200 Yard from human health risk assessment
- Soil borings in the red area had visible mercury

(DOE/OR/01-1273&D2)

BCV Mercury Sources- Spoil Area 1

A-20

- Spoil Area 1 was used for the disposal of what was characterized as uncontaminated construction debris from Y-12, but soil and groundwater studies confirmed the presence of heavy metals and radionuclides
- Mercury exceeded its MCL in a groundwater sample collected from a small intermittent seep near the base of the landfill; no constituents exceeded risk-based levels in surface water samples collected at the site
- Mercury was elevated in soil relative to background; however, mercury was not identified as a COC in soil in the BCV OU2 RI for Spoil Area 1

(DOE/OR/01-1273&D2, DOE/OR/01-2895&D2)

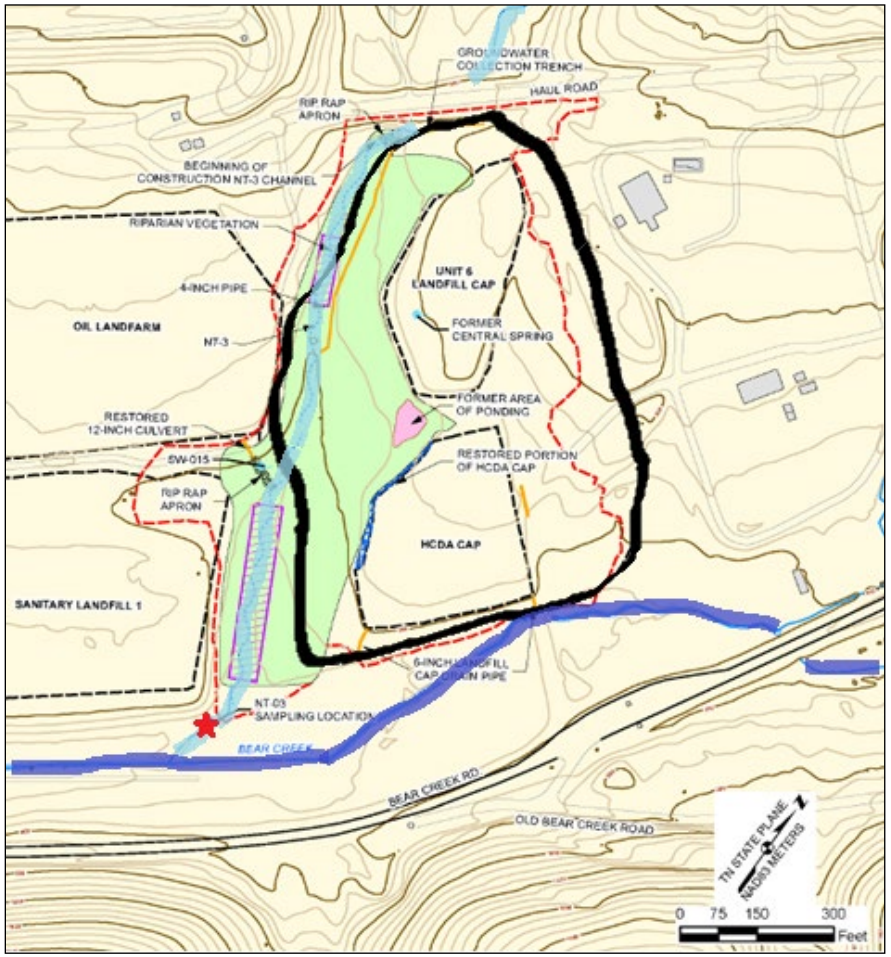
BCV Mercury Sources – NT-3

NT-3 at the Boneyard/Burnyard (BYBY) is a remediated former strong mercury source

- BYBY was a visual cleanup
- Surface water sample in August 2020 had a mercury concentration (147 ng/L) above the AWQC
- It was concluded that it was a statistical outlier based on the available data and attributed to mercury adsorbed to suspended sediment (TDS 17.1 mg)

A-21

(DOE/OR/01-2895&D2/V1)



- Bear Creek shown in dark blue
- NT-3 tributary in light blue
- BYBY outlined in black
- NT-03 sampling point shown as red star

BCV Mercury Sources - Others

S-3 Pond Pathway 3 to NT-1

- Minor mercury contributions from mercury-contaminated fill materials (58-83 mg/kg in soil)

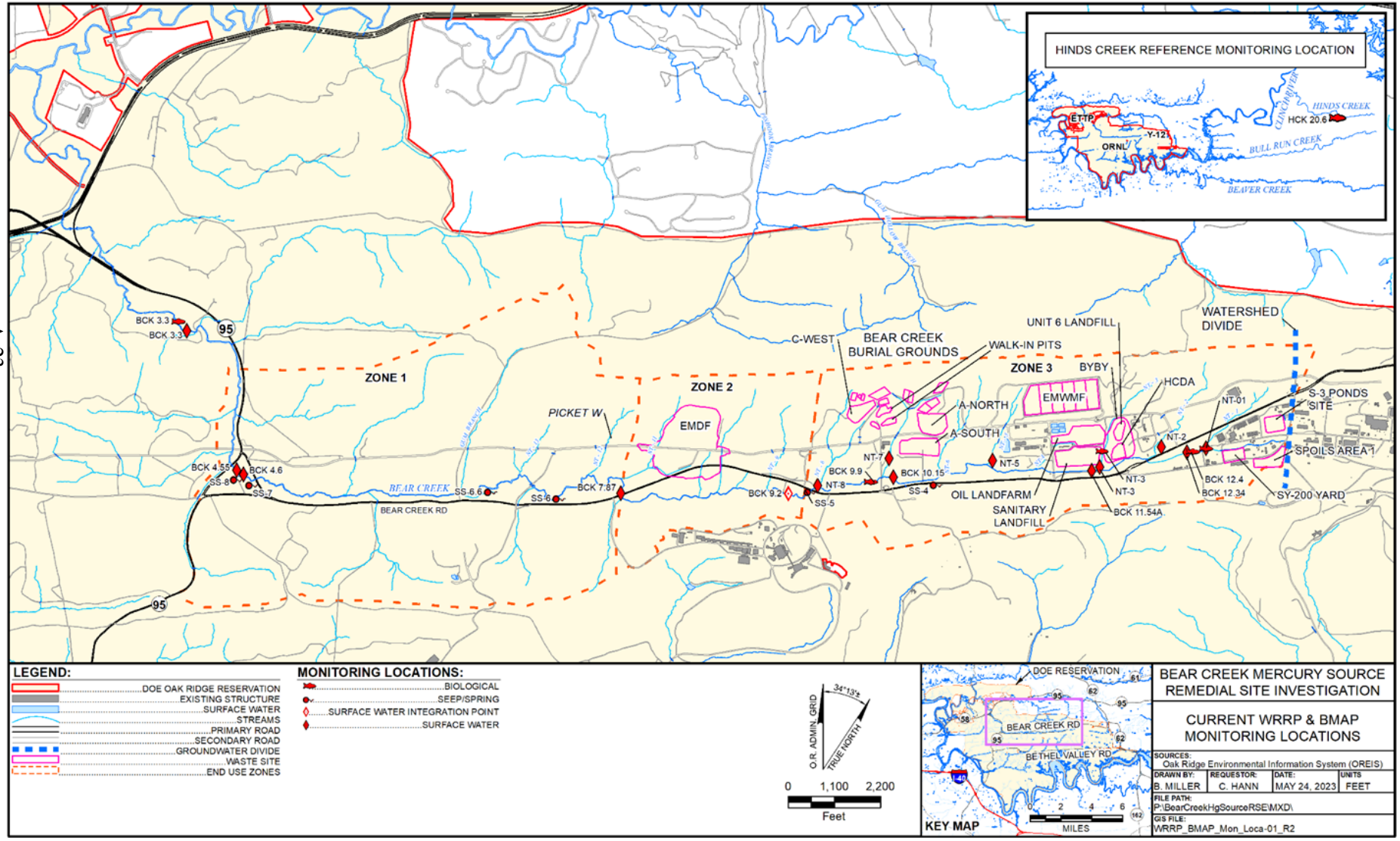
Other sites (BCBG, OLF, HCDA, Sanitary Landfill 1, Bear Creek Road Debris Burial, Creekside Debris Burial, and Rust Spoil Area)

- Minor mercury contributions

(DOE/OR/01-1455/V1&D2)

A-22

Previous Investigations - Current Surface Water and Biota Sampling in Bear Creek

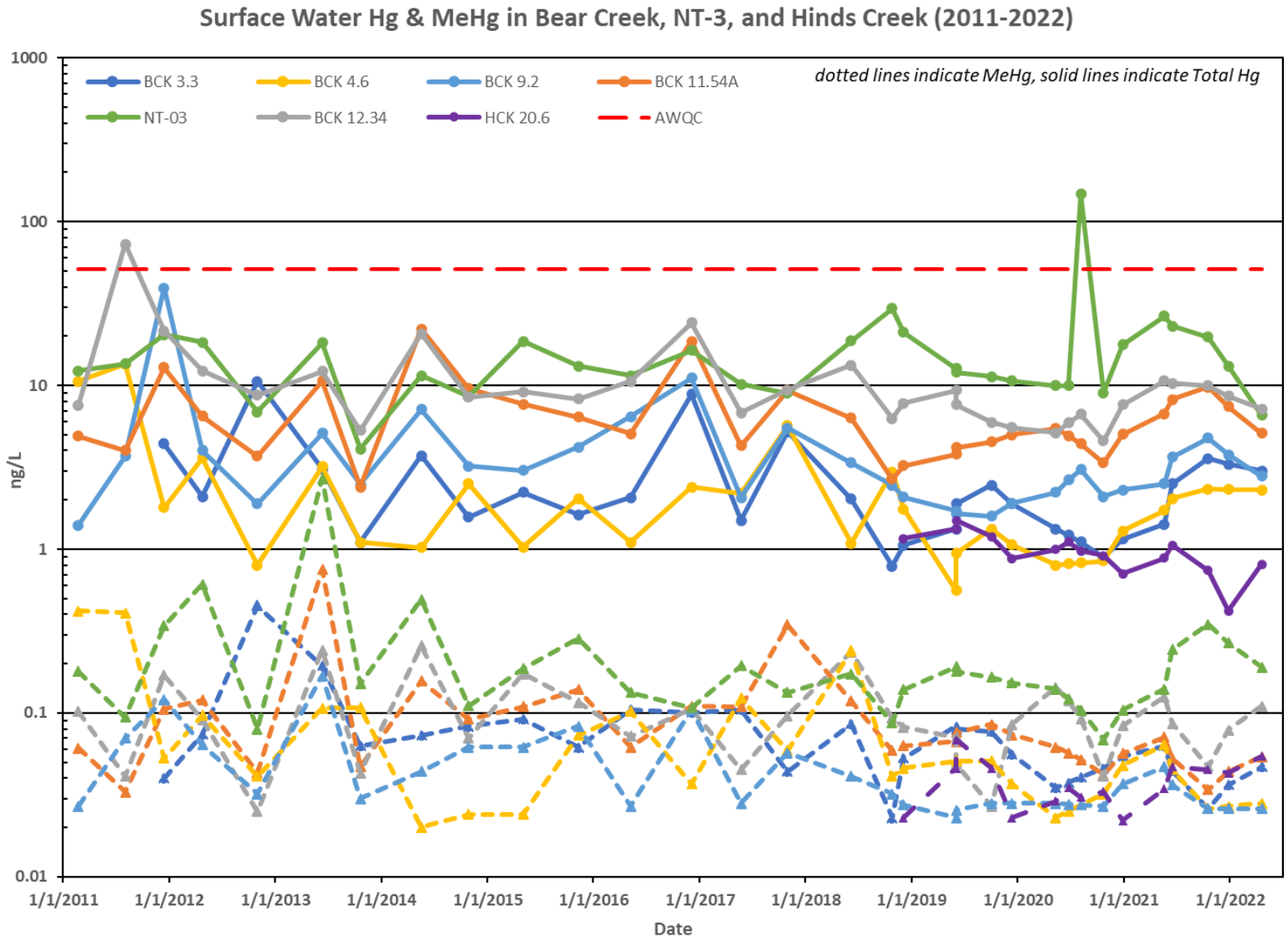


A-23

Previous Investigations - Current Surface Water and Biota Sampling in Bear Creek

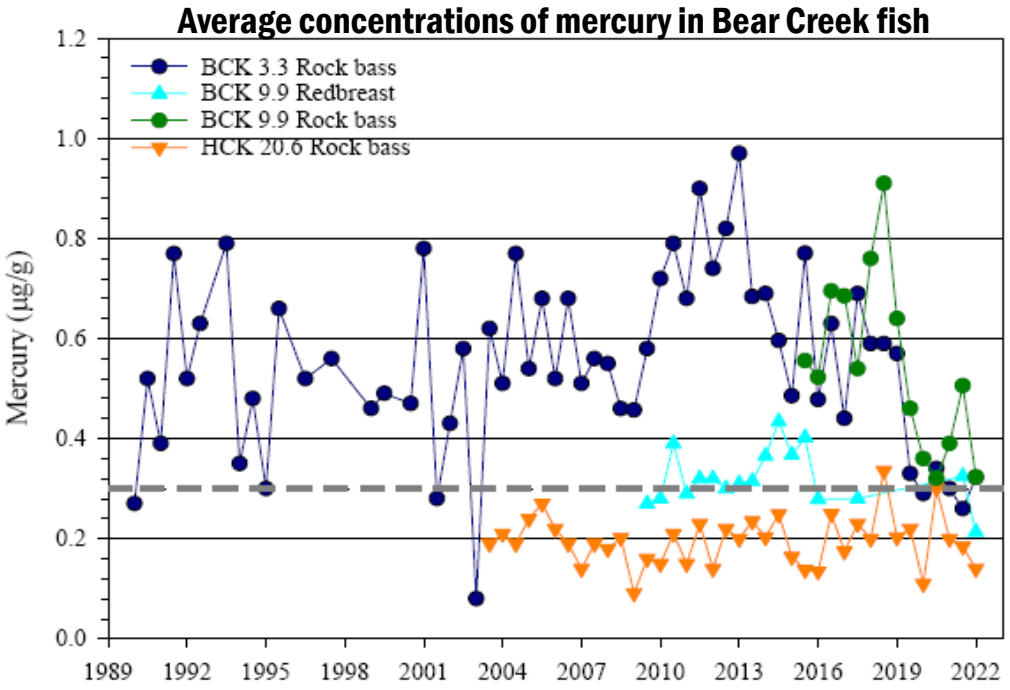
Media	Performance standard	Sampling frequency	Parameters	Monitoring Locations
Surface water	AWQC	Semi-annual (Q1 and Q3)	Total Hg and MeHg	BCK 3.3, BCK 4.55, BCK 9.2, BCK-11.54A, BCK 12.34, NT-03, NT-08, SS-4, and SS-5
		Semi-annual (Q2 and Q4) (year before FYR)	Total Hg	BCK 4.55, BCK 9.2, BCK 12.34, NT-03, and NT-08
		Annual (year before FYR)	Total Hg	BCK-07.87 and NT-01
		Annual (year before FYR)	MeHg	NT-05
	Trend monitoring	Quarterly	Bicarbonate, carbonate, chloride, fluoride, and sulfate	NT-01, NT-02, NT-03, SS-4, and SS-5
		Semi-annual	Bicarbonate, carbonate, chloride, fluoride, and sulfate	NT-07 and NT-08
		Quarterly (year before FYR)	Bicarbonate, carbonate, chloride, fluoride, and sulfate	NT-05
	Water quality	Semi-annual	Total suspended solids and total dissolved solids.	NT-07 and NT-08
		Quarterly (year before FYR)	Total suspended solids and total dissolved solids.	BCK 9.2, BCK-07.87, BCK 4.55, NT-03, BCK-12.34, NT-01, NT-05, and NT-08
Biota	Baseline sampling	Semi-annual	Hg and MeHg	BCK 3.3, BCK 9.9, and HCK 20.6 (whole-body stoneroller minnows and rock bass fillets) BCK 12.4 (whole-body stoneroller minnows)
		Annual (year before FYR)	Hg and MeHg	BCK-9.9 (whole body caddisflies)

Previous Investigations - Summary of Historical Surface Water Data



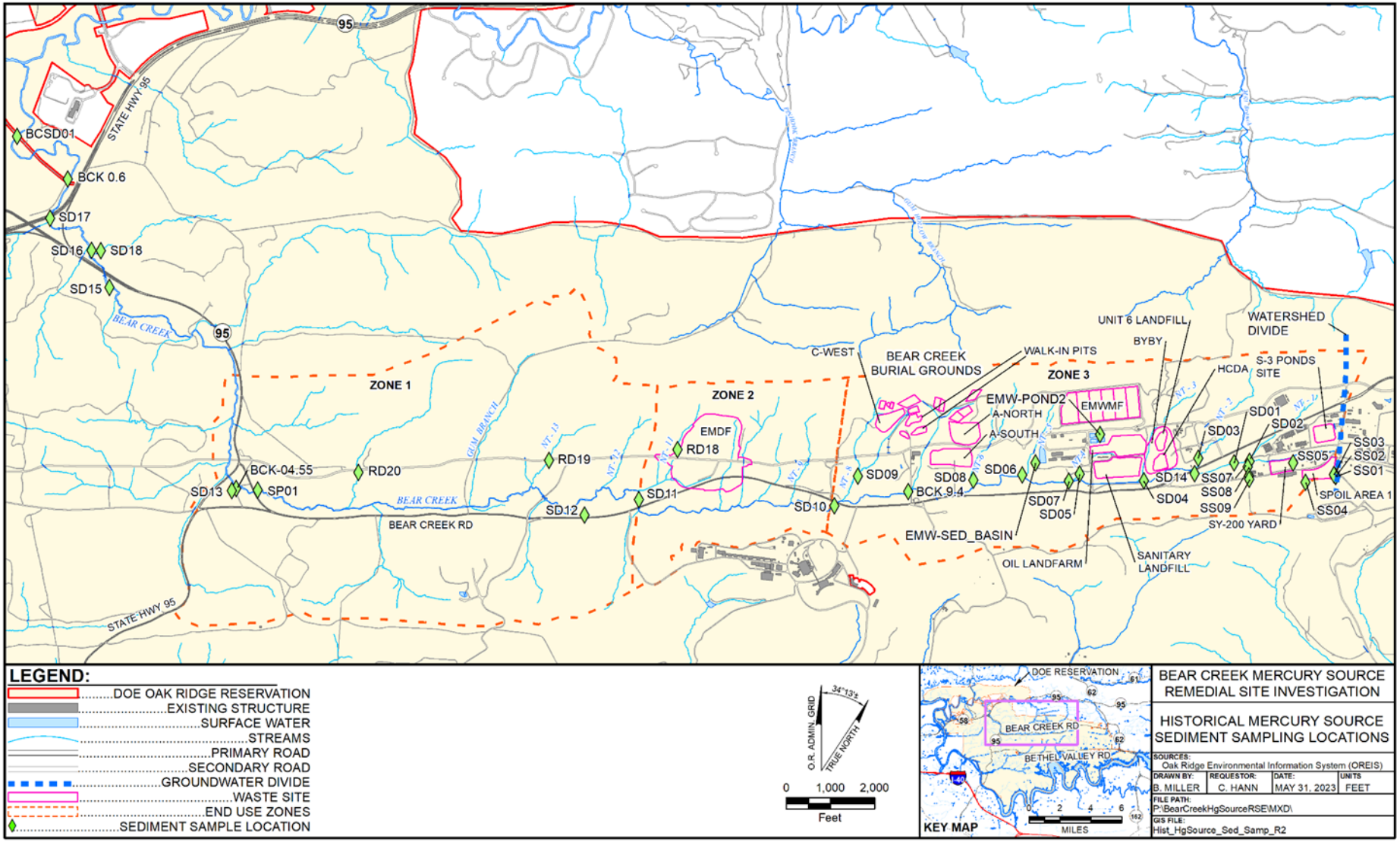
Previous Investigations - Summary of Historical Biota Data

- FY 2022 total mercury concentrations were well below the mercury AWQC (51 ng/L) in surface water
  - BCK 3.3 (3.59 ng/L), BCK 4.6 (2.34 ng/L), BCK 9.2 (4.78 ng/L), BCK 11.54A (9.76 ng/L), BCK 12.34 (10 ng/L), and NT-03 (19.7 ng/L)
  - Fish tissue concentrations in Bear Creek remain near the fish tissue criterion (0.3 µg/g).



Dashed line indicates EPA-recommended AWQC for mercury (0.3 µg/g in fish).

Previous Investigations - Summary of Historical Sediment Data



Previous Investigations - Summary of Historical Sediment Data

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Limited historical sediment data for Bear Creek are available in OREIS (primarily sampled 2011 and earlier)

- Zone 1: 7 locations, 6 in May 1995 and 1 in June 2005
  - Concentrations ranged from 0.14U – 0.97 mg/kg total mercury
- Zone 2: 2 locations sampled in May 1995
  - Concentrations were ND and 0.16 mg/kg total mercury
- Zone 3: 20 locations sampled December 1993 – April 2011
  - Concentrations ranged from 0.0189J – 6.9 mg/kg total mercury

No methylmercury data are available for sediment with the exception of limited special studies data discussed later in this presentation.

Previous Investigations - Summary of Special Studies Data

UCOR
United Cleanup Oak Ridge LLC

Special studies of Bear Creek were conducted between 2017 and 2021 to better understand the biotic and abiotic factors contributing to mercury concentrations in fish in Bear Creek. The focus of these field studies was to gain an understanding of the processes controlling mercury methylation and bioaccumulation with beaver dams and periphyton being key areas of interest. Studies included:

- Understanding the role of beaver dams in contributing to mercury dynamics in Bear Creek (2017-2018)
- Evaluating the effects of fine-grained sediment deposition (2019)
- Investigation of the potential role that tributaries to Bear Creek may have on mercury and methylmercury in the main channel (2020-2021)
- Periphyton relationships (2021)

Previous Investigations - Summary of Special Studies Data

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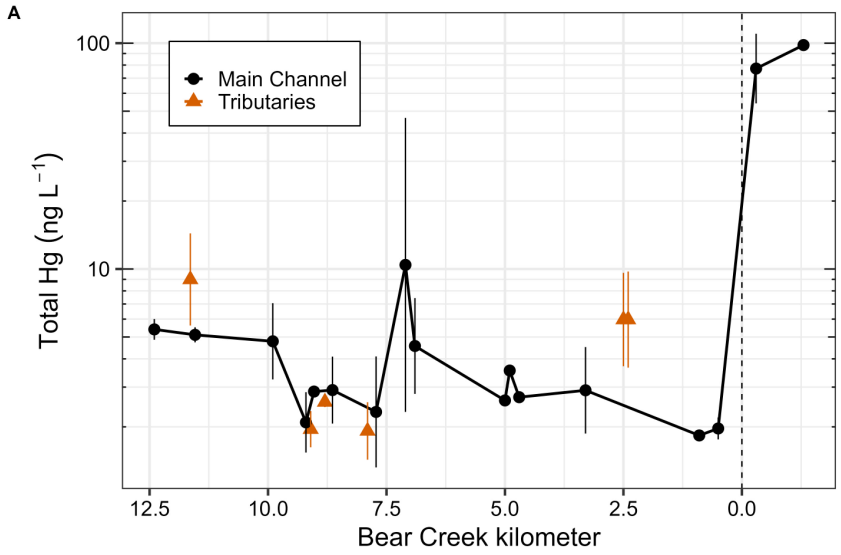
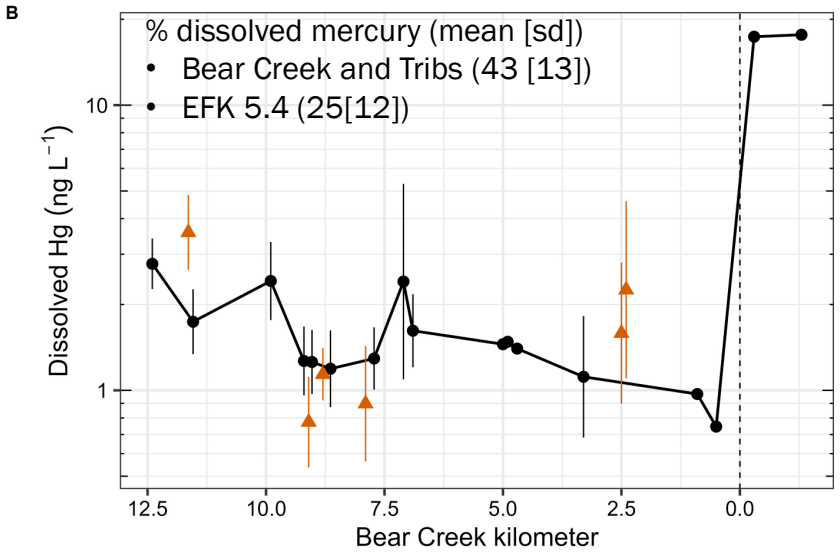
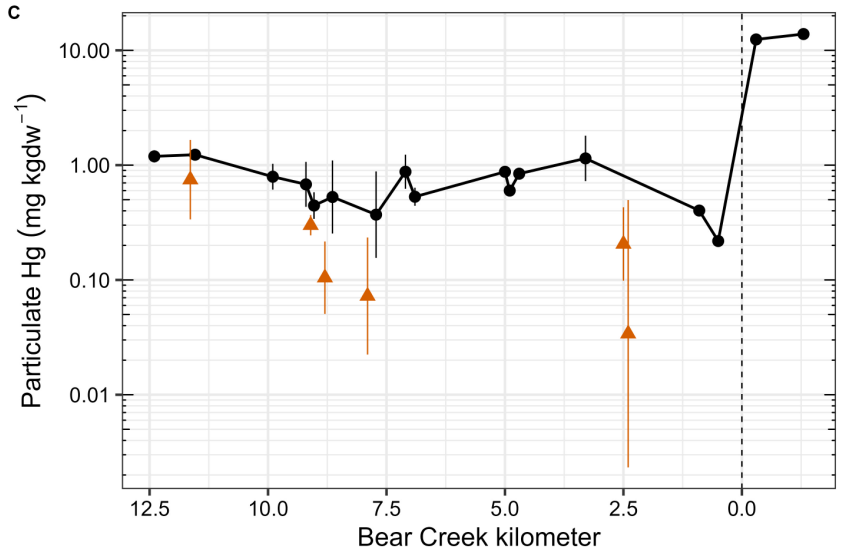
United Cleanup Oak Ridge LLC

Bear Creek Surface Water mercury





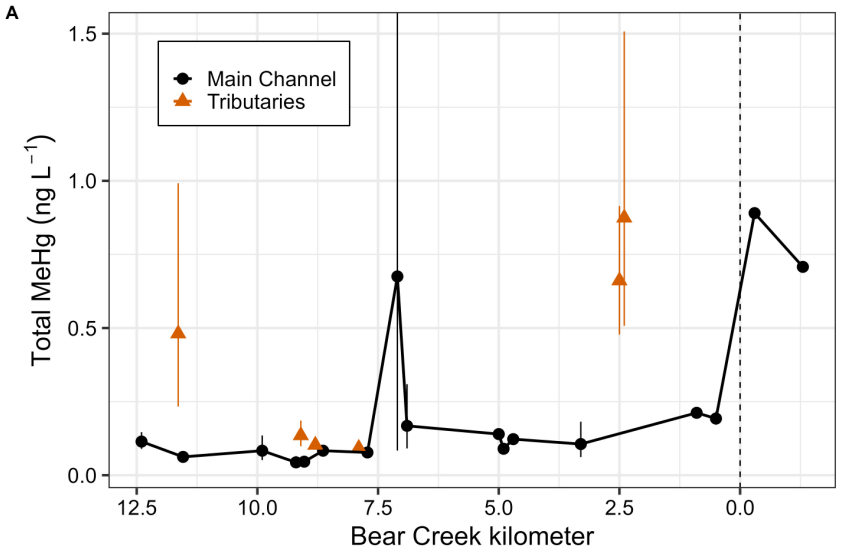


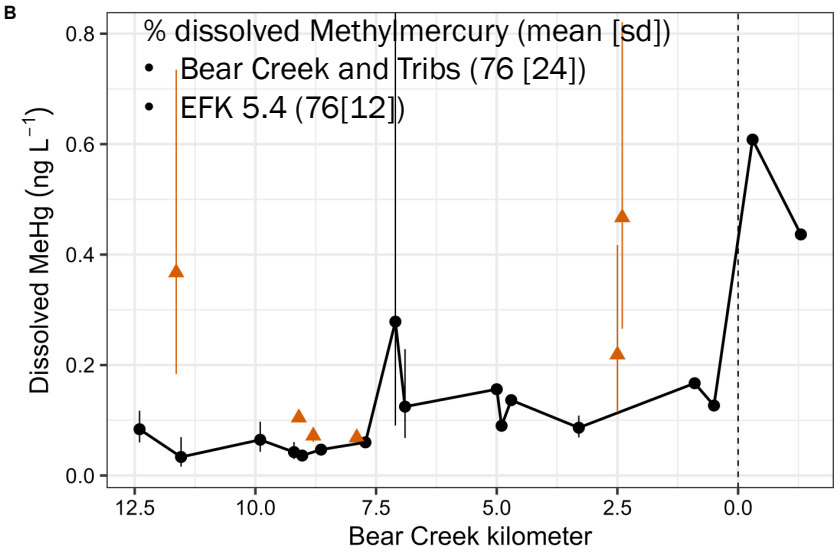
- Total mercury and dissolved mercury concentrations decrease downstream in Bear Creek
- Higher concentrations in NT-03 and beaver pond but mass loading likely small

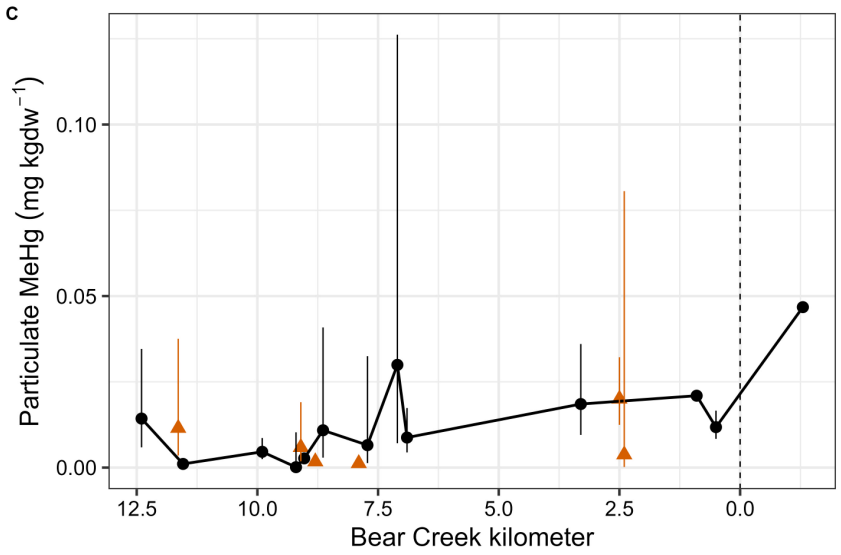
Previous Investigations - Summary of Special Studies Data

UCOR
United Cleanup Oak Ridge LLC

Bear Creek Surface Water methylmercury





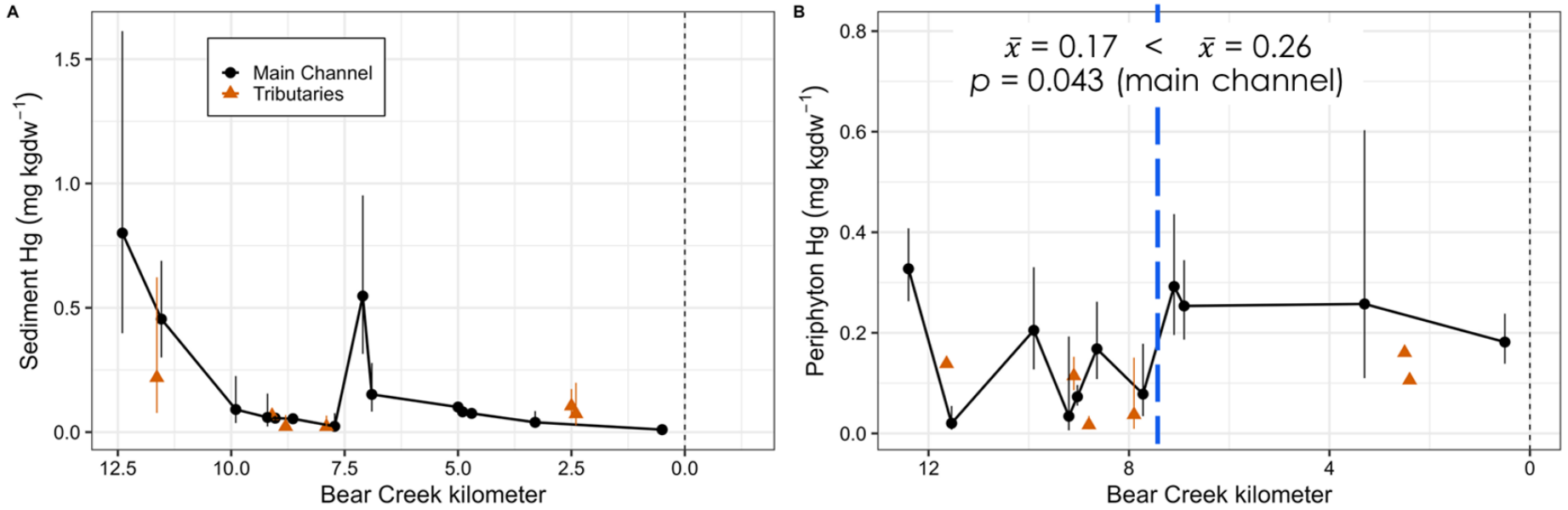


- Total methylmercury, dissolved methylmercury, particulate methylmercury concentrations increase downstream during this study
- Higher concentrations in NT-03 and beaver pond but mass loading likely small
- Effect of beaver dam at BCK 7 evident

Previous Investigations - Summary of Special Studies Data

UCOR
United Cleanup Oak Ridge LLC

Total mercury in sediments (A) and periphyton (B) along Bear Creek



Flow is from left to right on each panel. The vertical dashed line marks the confluence of Bear Creek with EFPC.

- Sediment mercury concentration decreases downstream
- Effect of the former beaver dam at BCK 7 is evident
- Tributary sediments are comparable to Bear Creek
- Total mercury concentrations in periphyton in lower section of Bear Creek is higher than in the upper section
- Total mercury in periphyton is, on average, 1.4 times greater than in co-located sediment

A-32

Previous Investigations - Summary of Special Studies Data

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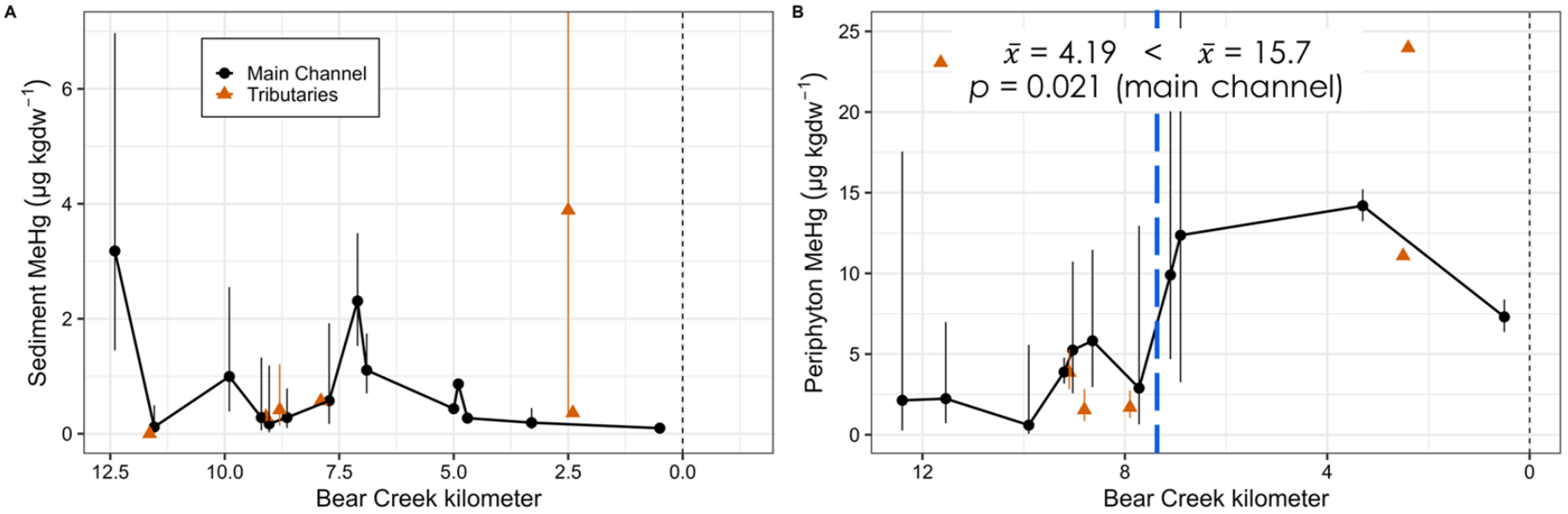
Methylmercury in sediments (A) and periphyton (B) along Bear Creek

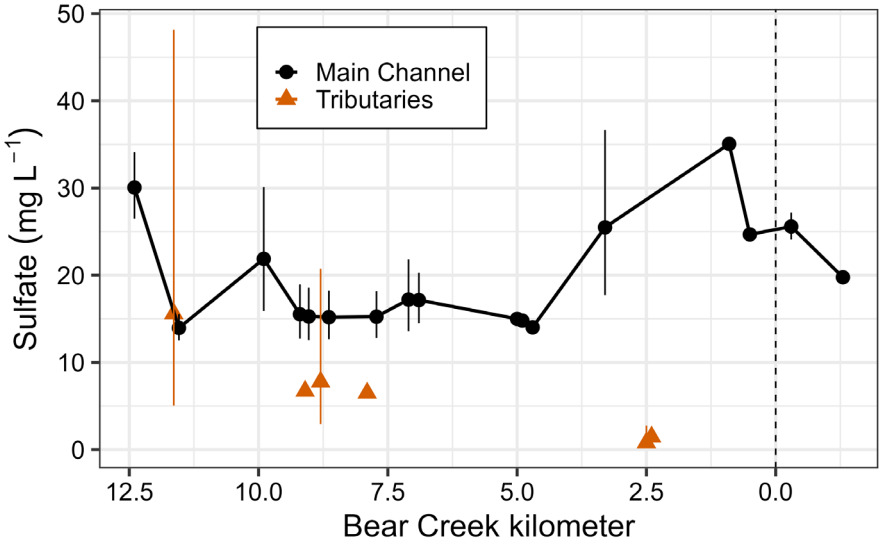


Flow is from left to right on each panel. The vertical dashed line marks the confluence of Bear Creek with EFPC.

- Sediment methylmercury concentration is variable with no strong spatial trend
- Effect of the former beaver dam at BCK 7 is evident
- Methylmercury in periphyton is higher in lower Bear Creek compared to upper
- Periphyton methylmercury in NT-3 and outlet of beaver pond is substantially greater than other locations
- Total methylmercury in periphyton is, on average, 5.6 times greater than in co-located sediment

Previous Investigations - Summary of Special Studies Data

Sulfate concentrations along Bear Creek



- Sulfate concentrations were consistent within the sampled reach but elevated relative to NT-09, NT-10, and NT-11
- The higher sulfate concentrations in lower Bear Creek coincide with relatively higher periphyton methylmercury concentrations in those sample locations

A-34

DQO Steps

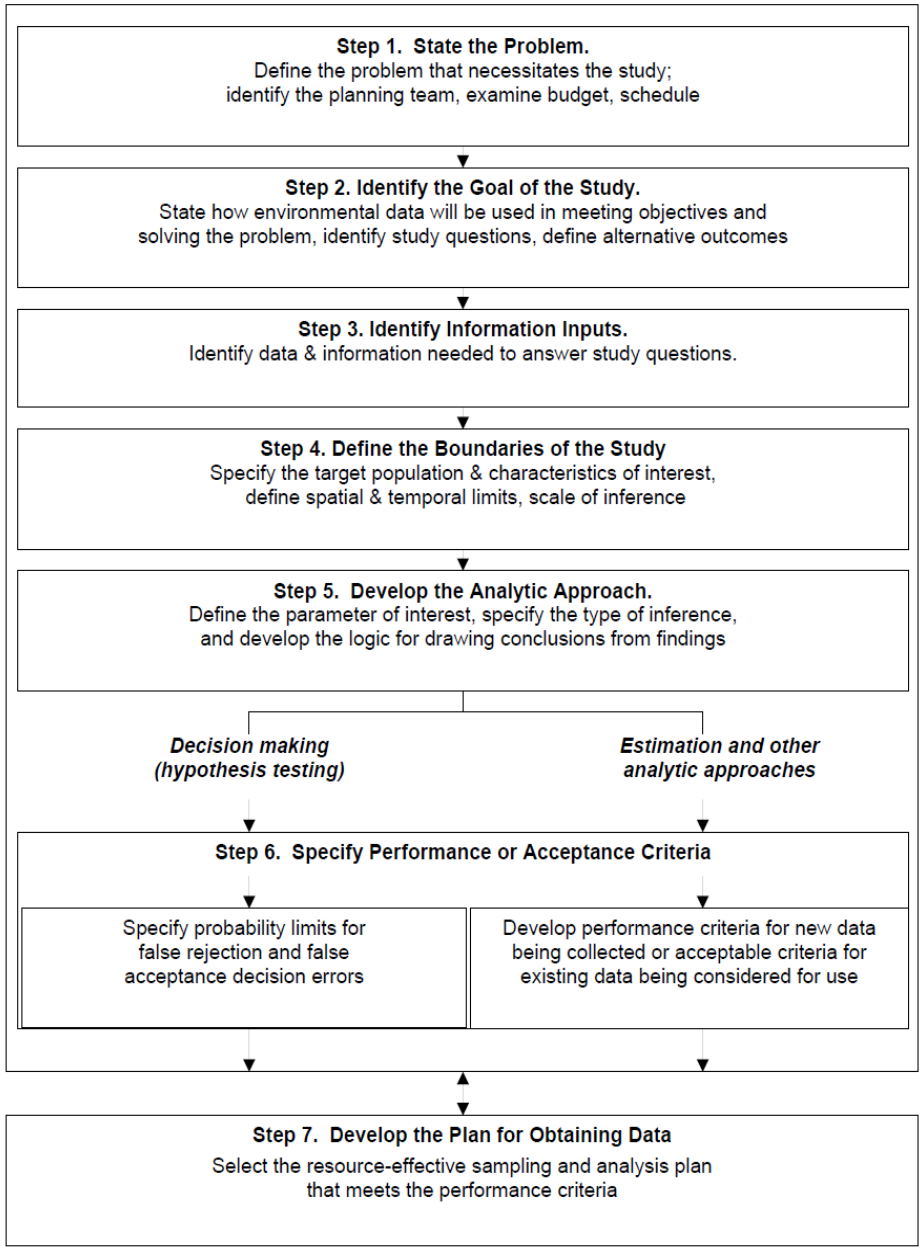
United States Environmental Protection Agency | Office of Environmental Information Washington, DC 20460 | EPA/240/B-06/001 February 2006

EPA

Guidance on Systematic Planning Using the Data Quality Objectives Process

EPA QA/G-4

A-35



DQO Step 1. State the Problem

- There are insufficient data along Bear Creek and its tributaries to determine if there are potential sources of mercury and methylmercury in sediment and floodplain soils that may be contributing to exceedances of fish tissue criterion in prior years

A-36

DQO Step 2. Identify the Goals of the Study

- Determine if there are areas (channel sediment, creek bank, and floodplain soils) along Bear Creek and its tributaries that are potential sources of mercury and methylmercury that may affect fish
- Obtain data from various hydrologic settings (i.e., pools, beaver ponds, etc.) that may contribute to mercury methylation and its bioaccumulation in the environment of Bear Creek and a reference location (e.g., Hinds Creek)

DQO Step 3. Identify Information Inputs

- Review potential sources of mercury and methylmercury in Bear Creek and its tributaries
- Review existing historical biota, surface water, sediment, and special studies data in Bear Creek, its tributaries, and reference site
- Collect additional surface water, channel sediment, creek bank, and floodplain soils data along Bear Creek and its tributaries from selected transects
- Collect additional surface water, channel sediment, creek bank, and floodplain soils data from the reference site

DQO Step 4. Define the Study Area Boundary

- Spatial
  - The study boundary is Bear Creek, its tributaries, and a reference location and limited surrounding creek bank sediment and floodplain soil
- Temporal
  - Collect samples in Fall 2023 to meet the RSE milestone of September 2024

DQO Step 5. Develop the Analytical Approach

- Collect surface water, channel sediment, creek bank, and floodplain soils to determine mercury and methylmercury concentrations along Bear Creek, its tributaries, and the reference site
- Analytical parameters will include mercury, methylmercury, nutrients (e.g., sulfate, phosphate, nitrogen, organic carbon, etc.), particle size analysis (PSA), and mercury speciation at select locations
- Transects will be field-located in potential source areas and pool areas (e.g., upstream of beaver dams) in Bear Creek and the mouths of tributaries (e.g., NT-3) based on a reconnaissance survey

DQO Step 6. Specify the Performance or Acceptance Criteria

- New data will be obtained under UCOR/RSI approved procedures and quality programs and will be archived in OREIS.

A-41

DQO Step 7. Develop the Plan for Obtaining Data

- Compile all available information on potential mercury and methylmercury sources, existing surface water, sediment, and biota data (BMAP)
- Evaluate existing data
- Conduct additional characterization fieldwork:
  - Identify locations to conduct surface water, channel sediment, creek bank, and floodplain soil transect sampling.
  - Identify reference site location for surface water, channel sediment, creek bank, and floodplain soil sampling.

A-42

Proposed Transect Locations

- Proposed transects along Bear Creek are based on the following*:
  - Locations downgradient and in the vicinity of potential source areas
  - Locations where sampling for biota and surface water have historically occurred
  - Locations in the vicinity of beaver ponds

*Exact transect locations are subject to change based on access and other field factors.

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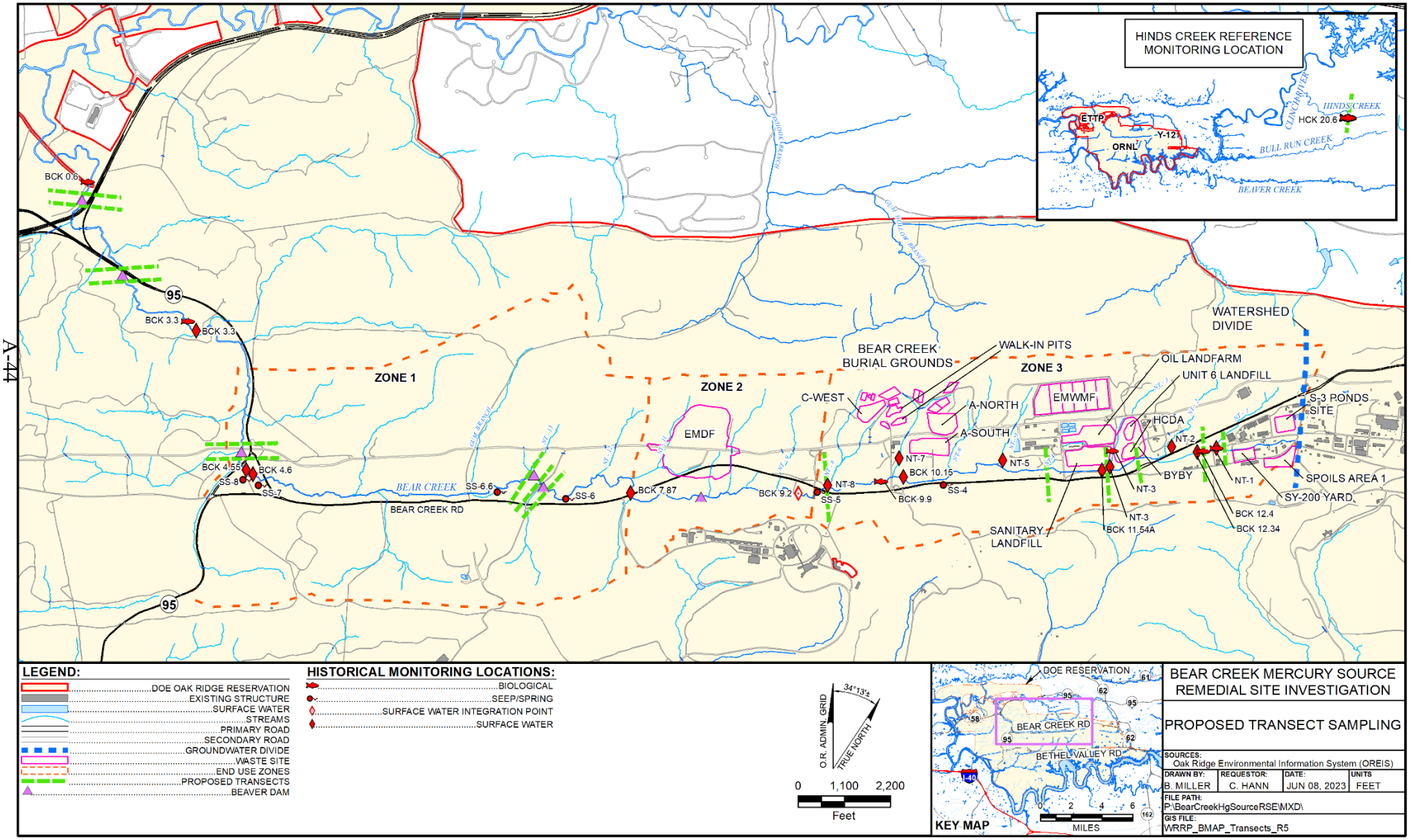
Proposed Transect Locations



A-44

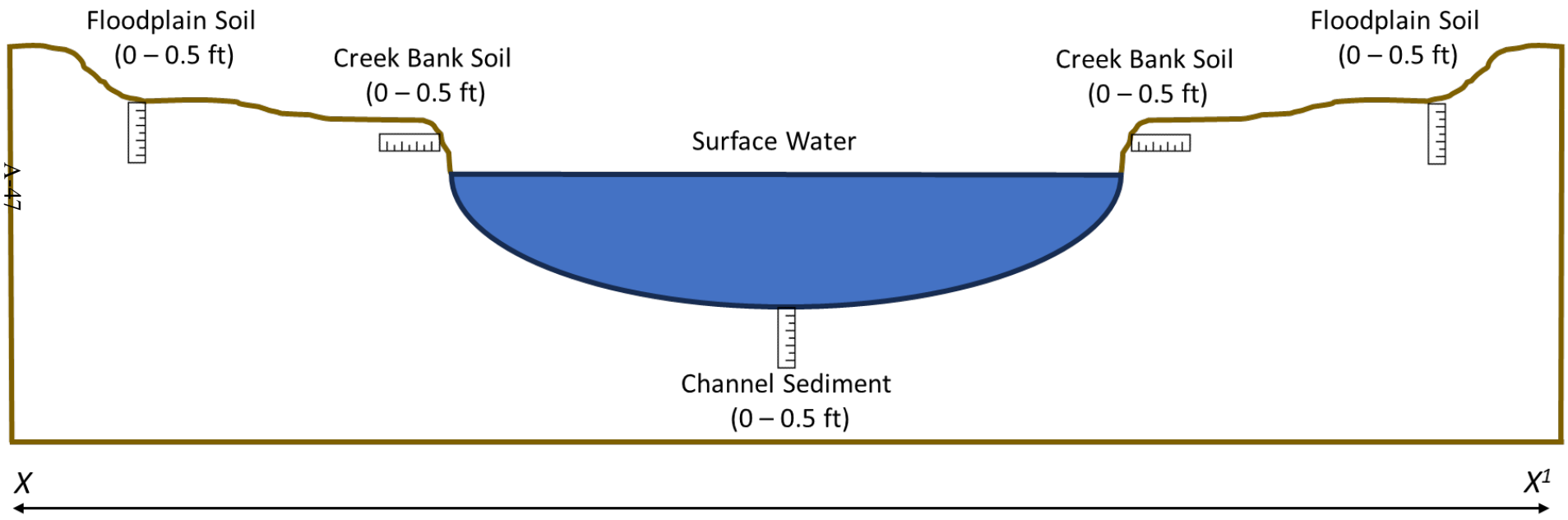
Beaver Dams near BCK 7.0

A-45

Transect Sampling

- **Channel sediment**
  - Collect 1-2 samples of channel sediment (0 – 0.5 ft) at each transect (number of samples at each transect will be based on width of Bear Creek at each location)
- **Creek bank sediment**
  - Collect 2 samples of bank sediment (0 – 0.5 ft) at each transect (one on each bank)
- **Floodplain soil**
  - Collect 2 samples of floodplain soil (0 – 0.5 ft) in the vicinity of Bear Creek (one on each side of Bear Creek)
- **Surface water**
  - Collect 1 surface water sample at each transect

Transect Sampling Diagram



Analytical Suite

- Analyze channel sediment, creek bank, and floodplain soils for mercury, methylmercury, nutrients, PSA, and organic carbon
- Analyze surface water for mercury, methylmercury, nutrients, and organic carbon
- Additional mercury speciation partitioning in select sampling transects based on hydrologic setting

RSE Schedule

Activity	Date(s)
Historical Data Review and DQO Preparation	May/June 2023
DQO Meeting	June 2023
Prepare and Review RSE Sampling and Analysis Plan (SAP; FFA secondary document)	July/August 2023
Submit RSE SAP	August 2023
Perform RSE Sediment and Surface Water Sampling	September - November 2023
Data Evaluation (SED, SW, and 2023 Fish Tissue)	January - March 2024
Prepare and Review RSE D1	April - September 2024
Submit BCV Mercury Sources RSE D1	FFA App E: September 30, 2024

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APPENDIX B.
BEAR CREEK VALLEY MERCURY SOURCES REMEDIAL SITE EVALUATION SAMPLING AND ANALYSIS PLAN TABLES

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Table B.1. Sample groups for the BCV mercury sources RSE

Sample group[a]	Location[b]	Sampling point[b]	Monitoring frequency[c]	Matrix[d]	Sample type[e]	Dup[f]	Analyte/parameter group[g]
LOWBCV	BCT1 (upstream of BCK 0.6; downstream of beaver dam)	BCT1-BSL	Q1	SO	C		S-BCVRSE
		BCT1-BSU		SO	C		S-BCVRSE
		BCT1-CH		SE	C		S-BCVRSE
		BCT1-FP		SO	C		S-BCVRSE
		BCT1-SW		WS	G		BCVRSE(+F)
	BCT2 (upstream of BCK 0.6; upstream of beaver dam)	BCT2-BSL	Q1	SO	C		S-BCVRSE
		BCT2-BSU		SO	C		S-BCVRSE
		BCT2-CH		SE	C		S-BCVRSE
		BCT2-FP		SO	C		S-BCVRSE
		BCT2-SW		WS	G		BCVRSE(+F)
	BCT3 (downstream of BCK 3.3; downstream of beaver dam)	BCT3-BSL	Q1	SO	C		S-BCVRSE
		BCT3-BSU		SO	C		S-BCVRSE
		BCT3-CH		SE	C		S-BCVRSE
		BCT3-FP		SO	C		S-BCVRSE
		BCT3-SW		WS	G		BCVRSE(+F)
	BCT4 (downstream of BCK 3.3; upstream of beaver dam)	BCT4-BSL	Q1	SO	C		S-BCVRSE
		BCT4-BSU		SO	C		S-BCVRSE
		BCT4-CH		SE	C		S-BCVRSE
		BCT4-FP		SO	C		S-BCVRSE
		BCT4-SW		WS	G		BCVRSE(+F)
BCV ZONE 1	BCT5 (downstream of BCK 4.55; downstream of beaver dam)	BCT5-BSL	Q1	SO	C		S-BCVRSE
		BCT5-BSU		SO	C		S-BCVRSE
		BCT5-CH		SE	C		S-BCVRSE, HGSEQ
		BCT5-FP		SO	C		S-BCVRSE, HGSEQ
		BCT5-SW		WS	G		BCVRSE(+F)
		BCT5-BS		SO	C		HGSEQ
	BCT6 (downstream of BCK 4.55; upstream of beaver dam)	BCT6-BSL	Q1	SO	C		S-BCVRSE
		BCT6-BSU		SO	C		S-BCVRSE
		BCT6-CH		SE	C		S-BCVRSE, HGSEQ
		BCT6-FP		SO	C		S-BCVRSE, HGSEQ
		BCT6-SW		WS	G		BCVRSE(+F)
		BCT6-BS		SO	C		HGSEQ

Table B.1. Sample groups for the BCV mercury sources RSE (cont.)

Sample group[a]	Location[b]	Sampling point[b]	Monitoring frequency[c]	Matrix[d]	Sample type[e]	Dup[f]	Analyte/parameter group[g]
BCV ZONE 1	BCT7 (downstream of BCK 7.87 at the confluence of NT-13/Bear Creek; downstream of westernmost beaver dam)	BCT7-BSL	Q1	SO	C		S-BCVRSE
		BCT7-BSU		SO	C		S-BCVRSE
		BCT7-CH		SE	C		S-BCVRSE, HGSEQ
		BCT7-FP		SO	C		S-BCVRSE, HGSEQ
		BCT7-SW		WS	G		BCVRSE(+F)
		BCT7-BS		SO	C		HGSEQ
	BCT8 (downstream of BCK 7.87 at the confluence of NT-13/Bear Creek; upstream of westernmost beaver damn)	BCT8-BSL	Q1	SO	C	X	S-BCVRSE
		BCT8-BSU		SO	C		S-BCVRSE
		BCT8-CH		SE	C		S-BCVRSE, HGSEQ
		BCT8-FP		SO	C		S-BCVRSE, HGSEQ
		BCT8-SW		WS	G		BCVRSE(+F)
		BCT8-BS		SO	C		HGSEQ
	BCT9 (downstream of BCK 7.87; upstream of two beaver dams; southeast of Reeves Road/Haul Road)	BCT9-BSL	Q1	SO	C		S-BCVRSE
		BCT9-BSU		SO	C		S-BCVRSE
		BCT9-CH		SE	C		S-BCVRSE, HGSEQ
		BCT9-FP		SO	C		S-BCVRSE, HGSEQ
		BCT9-SW		WS	G		BCVRSE(+F)
		BCT9-BS		SO	C		HGSEQ
BCV ZONE 2	BCT10 (downstream of surface water integration point BCK 9.2; upstream of EMDF)	BCT10-BSL	Q1	SO	C		S-BCVRSE
		BCT10-BSU		SO	C		S-BCVRSE
		BCT10-CH		SE	C		S-BCVRSE
		BCT10-FP		SO	C		S-BCVRSE
		BCT10-SW		WS	G		BCVRSE(+F)
BCV ZONE 3	BCT11 (upstream of NT-8 at BCK 9.9)	BCT11-BSL	Q1	SO	C		S-BCVRSE
		BCT11-BSU		SO	C		S-BCVRSE
		BCT11-CH		SE	C		S-BCVRSE, HGSEQ
		BCT11-FP		SO	C		S-BCVRSE, HGSEQ
		BCT11-SW		WS	G		BCVRSE(+F)
		BCT11-BS		SO	C		HGSEQ

Table B.1. Sample groups for the BCV mercury sources RSE (cont.)

Sample group[a]	Location[b]	Sampling point[b]	Monitoring frequency[c]	Matrix[d]	Sample type[e]	Dup[f]	Analyte/parameter group[g]
BCV ZONE 3	BCT12 (downstream of BYBY at the confluence of NT-3/Bear Creek)	BCT12-BSL	Q1	SO	C		S-BCVRSE
		BCT12-BSU		SO	C		S-BCVRSE
		BCT12-CH		SE	C		S-BCVRSE, HGSEQ
		BCT12-FP		SO	C		S-BCVRSE, HGSEQ
		BCT12-SW		WS	G		BCVRSE(+F)
		BCT12-BS		SO	C		HGSEQ
	BCT13 (upstream of BYBY, EMWMF, and NT-3)	BCT13-BSL	Q1	SO	C		S-BCVRSE
		BCT13-BSU		SO	C		S-BCVRSE
		BCT13-CH		SE	C		S-BCVRSE
		BCT13-FP		SO	C		S-BCVRSE
		BCT13-SW		WS	G		BCVRSE(+F)
	BCT14 (downstream of SY-200 Yard, Spoil Area 1, and S-3 Ponds Site)	BCT14-BSL	Q1	SO	C	X	S-BCVRSE
		BCT14-BSU		SO	C		S-BCVRSE
		BCT14-CH		SE	C		S-BCVRSE, HGSEQ
		BCT14-FP		SO	C		S-BCVRSE, HGSEQ
		BCT14-SW		WS	G		BCVRSE(+F)
		BCT14-BS		SO	C		HGSEQ
	BCT15 (downstream of S-3 Ponds Site)	BCT15-BSL	Q1	SO	C		S-BCVRSE
		BCT15-BSU		SO	C		S-BCVRSE
		BCT15-CH		SE	C		S-BCVRSE
		BCT15-FP		SO	C		S-BCVRSE
		BCT15-SW		WS	G		BCVRSE(+F)
Hinds Creek	HCTREF (HCK 20.6 reference site)	HCTREF-BSL	Q1	SO	C		S-BCVRSE
		HCTREF-BSU		SO	C		S-BCVRSE
		HCTREF-CH		SE	C		S-BCVRSE, HGSEQ
		HCTREF-FP		SO	C		S-BCVRSE, HGSEQ
		HCTREF-SW		WS	G		BCVRSE(+F)
		HCTREF-BS		SO	C		HGSEQ

Table B.1. Sample groups for the BCV mercury sources RSE (cont.)

[a] Sample group

BCV = Bear Creek Valley Watershed sample group number
LOWBCV = Lower Bear Creek Valley

Samples in each group will be collected during as short a time period as possible, following the schedule provided

[b] Location and sampling point

BCK = Bear Creek kilometer
BCT = Bear Creek transect
BS = creek bank ; soil
BSL = creek bank soil (lower)
BSU = creek bank soil (upper)
BYBY = Boneyard/Burnyard
CH = channel sediment
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
FP = floodplain soil
HCK = Hinds Creek
HCTREF = Hinds Creek transect reference site
NT = northern tributary
SW = surface water
SY = scrap yard

[c] Monitoring frequency

Q = quarter of the fiscal year (e.g., Q1, Q2, Q3, Q4)

[d] Matrix

SE = sediment
SO = soil
WS = surface water

[e] Sample type

G = grab sample
C = composite sample

[f] Duplicate

X = field duplicate sample will be collected

Field duplicate samples will be collected concurrently with the investigative samples and sent to the laboratory responsible for analyses of the investigative sample. Field duplicates will be collected at a frequency of 10% of the samples collected (i.e., 1 to 10 total samples collected equal 1 field duplicate; 1 to 20 total samples collected equal 2 field duplicates) or as specified in the task-specific work control document (e.g., Sampling and Analysis Plans [SAPs]), in accordance with the *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (UCOR-4049; Water Resources Restoration Program [WRRP] Quality Assurance Project Plan [QAPP]). Deviations from this Remedial Site Evaluation (RSE) SAP will be documented in the field logbook and in the BCV Mercury Sources RSE. Changes will be documented, as appropriate in the field, as well as in the Project Environmental Measurements System

[g] Analyte/parameter group

See Tables D.56 through D.58 in the WRRP QAPP for a list of parameter groups and analytes

BCVRSE(+F) = Both a filtered and unfiltered sample are obtained by sampling personnel for the designated metals analysis to be performed by the laboratory. Otherwise, only an unfiltered sample is obtained and analyzed for metals

Table B.2. Analytes, RRLs, and screening levels for water for the BCV mercury sources RSE

WRRP QAPP[a] parameter group	Analyte	CAS number	Analytical method[b]	Units	Laboratory MDL	Laboratory PQL	RRL[c]	Screening levels[d]				
								Surface water				
								DWS	CCC	CMC	W&O	OOC
BCVRSE	**Field parameters**											
	Water temperature	NA	NA	°C	--	--	--	--	--	--	--	--
	Dissolved oxygen	7782-44-7	NA	mg/L	--	--	--	--	--	--	--	--
	Turbidity	NA	NA	NTU	--	--	--	--	--	--	--	--
	pH	NA	NA	pH	--	--	--	--	--	--	--	--
	Specific conductance (conductivity)	NA	NA	µmhos/cm	--	--	--	--	--	--	--	--
	Oxidation-reduction potential	NA	NA	mV	--	--	--	--	--	--	--	--
	Metals											
	Mercury	7439-97-6	EPA-1631	ng/L	0.08	0.5	0.5	2000	770	1400	50	51
	Methylmercury	22967-92-6	EPA-1630	ng/L	0.026	0.08	0.02	--	--	--	--	--
	Aluminum	7429-90-5	SW846-6010 or SW846-6020	mg/L	0.0193	0.05	0.05	--	--	--	--	--
	Antimony	7440-36-0	SW846-6010 or SW846-6020	mg/L	0.001	0.003	0.003	0.006	--	--	0.0056	0.64
	Arsenic	7440-38-2	SW846-6010 or SW846-6020	mg/L	0.005	0.03	0.005	0.01	0.15	0.34	0.01	0.01
	Barium	7440-39-3	SW846-6010 or SW846-6020	mg/L	0.001	0.005	0.005	2	--	--	--	--
	Beryllium	7440-41-7	SW846-6010 or SW846-6020	mg/L	0.0002	0.0005	0.001	0.004	--	--	--	--
	Boron	7440-42-8	SW846-6010 or SW846-6020	mg/L	0.0052	0.015	0.01	--	--	--	--	--
	Cadmium	7440-43-9	SW846-6010 or SW846-6020	mg/L	0.0003	0.001	0.00013	0.005	0.00072	0.0018	--	--
	Calcium	7440-70-2	SW846-6010 or SW846-6020	mg/L	0.05	0.2	0.01	--	--	--	--	--
	Chromium	7440-47-3	SW846-6010 or SW846-6020	mg/L	0.003	0.01	0.005	0.1	0.074	0.57	--	--
	Cobalt	7440-48-4	SW846-6010 or SW846-6020	mg/L	0.0003	0.001	0.005	--	--	--	--	--
	Copper	7440-50-8	SW846-6010 or SW846-6020	mg/L	0.0003	0.002	0.005	--	0.009	0.013	--	--
	Iron	7439-89-6	SW846-6010 or SW846-6020	mg/L	0.033	0.1	0.01	--	--	--	--	--
	Lead	7439-92-1	SW846-6010 or SW846-6020	mg/L	0.0005	0.002	0.002	0.005	0.0025	0.065	--	--
	Lithium	7439-93-2	SW846-6010 or SW846-6020	mg/L	0.003	0.01	0.01	--	--	--	--	--
	Magnesium	7439-95-4	SW846-6010 or SW846-6020	mg/L	0.11	0.3	0.05	--	--	--	--	--
	Manganese	7439-96-5	SW846-6010 or SW846-6020	mg/L	0.001	0.005	0.005	--	--	--	--	--
	Nickel	7439-98-7	SW846-6010 or SW846-6020	mg/L	0.0006	0.002	0.01	0.1	0.052	0.47	0.61	4.6
	Potassium	7440-02-0	SW846-6010 or SW846-6020	mg/L	0.05	0.15	0.025	--	--	--	--	--
	Selenium	7440-09-7	SW846-6010 or SW846-6020	mg/L	0.006	0.03	0.0025	0.05	0.0031	0.02	0.17	4.2
	Silicon	7782-49-2	SW846-6010 or SW846-6020	mg/L	0.025	0.1	0.01	--	--	--	--	--
	Silver	7440-22-4	SW846-6010 or SW846-6020	mg/L	0.0003	0.001	0.0015	--	--	0.0032	--	--
	Sodium	7440-23-5	SW846-6010 or SW846-6020	mg/L	0.1	0.3	0.01	--	--	--	--	--
	Strontium	7440-24-6	SW846-6010 or SW846-6020	mg/L	0.002	0.01	0.005	--	--	--	--	--
	Thallium	7440-28-0	SW846-6010 or SW846-6020	mg/L	0.0006	0.002	0.001	0.002	--	--	0.00024	0.00047
	Uranium	7440-61-1	SW846-6010 or SW846-6020	mg/L	0.000067	0.0002	0.004	--	--	--	--	--
	Vanadium	7440-62-2	SW846-6010 or SW846-6020	mg/L	0.001	0.005	0.01	--	--	--	--	--
	Zinc	7440-66-6	SW846-6010 or SW846-6020	mg/L	0.0033	0.02	0.01	--	0.12	0.12	7.4	26

Table B.2. Analytes, RRLs, and screening levels for water for the BCV mercury sources RSE (cont.)

WRRP QAPP[a] parameter group	Analyte	CAS number	Analytical method[b]	Units	Laboratory MDL	Laboratory PQL	RRL[c]	Screening levels[d]				
								Surface water				
								DWS	CCC	CMC	W&O	OOC
BCVRSE (cont)	**Miscellaneous parameters**											
	Phosphorus (total)	7723-14-0	SW846-6020	mg/L	0.018	0.05	0.05	--	--	--	--	--
	Total organic carbon	E701250	SW846-9060	mg/L	0.33	1	1	--	--	--	--	--
	Dissolved organic carbon	E701250	SW846-9060	mg/L	0.33	1	1	--	--	--	--	--
	Total dissolved solids	E1642222	SM-2540 C	mg/L	3.4	5	10	500	--	--	--	--
	Total suspended solids	E1642818	SM-2540 D	mg/L	1.14	5	5	--	--	--	--	--
	Anions											
	Chloride	16887-00-6	EPA-300.0	mg/L	0.067	0.2	0.01	--	--	--	--	--
	Fluoride	16984-48-8	EPA-300.0	mg/L	0.033	0.1	0.05	--	--	--	--	--
	Sulfate	14808-79-8	EPA-300.0	mg/L	0.133	0.4	0.1	--	--	--	--	--
	Sulfide	18496-25-8	SM-4500-S2 D	mg/L	0.033	0.1	0.1	--	--	--	--	--
	Nitrate-nitrite as nitrogen	E701177	EPA-353.2	mg/L	0.017	0.05	0.1	10	--	--	--	--

[a] UCOR-4049. *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* , latest revision, United Cleanup Oak Ridge LLC, Oak Ridge, TN.

[b] An alternative method or alternate technique may be used to achieve the RRLs.

[c] RRLs are defined so that the data obtained meet program/project requirements for reporting quantitative data. For this parameter group, the laboratory is being requested to report detections with respect to the MDLs, which are generally lower than the RRLs.

[d] Screening levels listed here are for potential comparison purposes only and are not required performance goals.

-- = not available or not applicable

BCV = Bear Creek Valley

CAS = Chemical Abstracts Service

CCC = Tennessee Department of Environment and Conservation fish and aquatic life criterion continuous concentration criteria, Chapter 1200-4-3-.03(3)

CMC = Tennessee Department of Environment and Conservation fish and aquatic life criterion maximum concentration criteria, Chapter 1200-4-3-.03(3)

DWS = Tennessee Department of Environment and Conservation domestic water supply criteria, Chapter 1200-4-3-.03(1).

EPA = U.S. Environmental Protection Agency

MDL = method detection limit

NA = not applicable

NTU = nephelometric turbidity unit

OOC = Tennessee Department of Environment and Conservation recreation organisms only criteria, Chapter 1200-4-3-.03(4)

PQL = practical quantitation limit

QAPP = Quality Assurance Project Plan

RRL = requested reporting limit

RSE = remedial site evaluation

SW846 = EPA test methods for evaluating solid waste, physical/chemical methods

W&O = Tennessee Department of Environment and Conservation recreation water and organisms criteria, Chapter 1200-4-3-.03(4)

WRRP = Water Resources Restoration Program

Table B.3. Analytes, RRLs, and screening levels for sediment and soil for the BCV mercury sources RSE

WRRP QAPP[a] parameter group	Analyte	CAS number	Analytical method[b]	Units	Laboratory MDL	Laboratory PQL	RRL[c]	Screening level
S-BCVRSE	**Metals**							
	Mercury	7439-97-6	SW846-7471	mg/kg	0.009	0.03	0.1	Compare to reference site
	Methylmercury	22967-92-6	EPA-1630 (modified)	ng/g	0.017	0.058	0.017	Compare to reference site
	Aluminum	7429-90-5	SW846-6010 or SW846-6020	mg/kg	6.8	20	1	Compare to reference site
	Antimony	7440-36-0	SW846-6010 or SW846-6020	mg/kg	0.33	2	0.5	Compare to reference site
	Arsenic	7440-38-2	SW846-6010 or SW846-6020	mg/kg	0.338	1	0.5	Compare to reference site
	Barium	7440-39-3	SW846-6010 or SW846-6020	mg/kg	0.1	0.5	0.5	Compare to reference site
	Beryllium	7440-41-7	SW846-6010 or SW846-6020	mg/kg	0.1	0.5	0.1	Compare to reference site
	Boron	7440-42-8	SW846-6010 or SW846-6020	mg/kg	1	5	1	Compare to reference site
	Cadmium	7440-43-9	SW846-6010 or SW846-6020	mg/kg	0.02	0.2	0.1	Compare to reference site
	Calcium	7440-70-2	SW846-6010 or SW846-6020	mg/kg	8	25	5	Compare to reference site
	Chromium	7440-47-3	SW846-6010 or SW846-6020	mg/kg	0.15	1	0.5	Compare to reference site
	Cobalt	7440-48-4	SW846-6010 or SW846-6020	mg/kg	0.15	0.5	0.5	Compare to reference site
	Copper	7440-50-8	SW846-6010 or SW846-6020	mg/kg	0.3	2	0.5	Compare to reference site
	Iron	7439-89-6	SW846-6010 or SW846-6020	mg/kg	8	25	1	Compare to reference site
	Lead	7439-92-1	SW846-6010 or SW846-6020	mg/kg	0.33	2	0.3	Compare to reference site
	Lithium	7439-93-2	SW846-6010 or SW846-6020	mg/kg	0.4	2	1	Compare to reference site
	Magnesium	7439-95-4	SW846-6010 or SW846-6020	mg/kg	8.5	30	5	Compare to reference site
	Manganese	7439-96-5	SW846-6010 or SW846-6020	mg/kg	0.2	1	0.5	Compare to reference site
	Molybdenum	7439-98-7	SW846-6010 or SW846-6020	mg/kg	0.2	1	1	Compare to reference site
	Nickel	7440-02-0	SW846-6010 or SW846-6020	mg/kg	0.15	0.5	1	Compare to reference site
	Potassium	7440-09-7	SW846-6010 or SW846-6020	mg/kg	6.4	25	5	Compare to reference site
	Selenium	7782-49-2	SW846-6010 or SW846-6020	mg/kg	0.36	1	0.5	Compare to reference site
	Silver	7440-22-4	SW846-6010 or SW846-6020	mg/kg	0.1	0.5	0.5	Compare to reference site
	Sodium	7440-23-5	SW846-6010 or SW846-6020	mg/kg	7	25	5	Compare to reference site
	Thallium	7440-28-0	SW846-6010 or SW846-6020	mg/kg	0.14	0.4	0.2	Compare to reference site
	Uranium	7440-61-1	SW846-6010 or SW846-6020	mg/kg	0.0132	0.04	5	Compare to reference site

Table B.3. Analytes, RRLs, and screening levels for sediment and soil for the BCV mercury sources RSE (cont.)

WRRP QAPP[a] parameter group	Analyte	CAS number	Analytical method[b]	Units	Laboratory MDL	Laboratory PQL	RRL[c]	Screening level
	Vanadium	7440-62-2	SW846-6010 or SW846-6020	mg/kg	0.1	0.5	1	Compare to reference site
	Zinc	7440-66-6	SW846-6010 or SW846-6020	mg/kg	0.4	2	0.5	Compare to reference site
S-BCVRSE (cont)	**Miscellaneous parameters**							
	Total organic carbon	E701250	SW846-9060	mg/kg	200	500	1	--
	Particle size analysis	NA	ASTM-D6913	--	--	--	--	--
	Anions							
	Chloride	16887-00-6	SW846-9056	mg/kg	0.72	2	0.72	--
	Fluoride	16984-48-8	SW846-9056	mg/kg	0.34	1	0.34	--
	Nitrate	14797-55-8	SW846-9056	mg/kg	0.33	1	0.33	--
	Nitrite	14797-65-0	SW846-9056	mg/kg	0.33	1	0.33	--
	Sulfate	14808-79-8	SW846-9056	mg/kg	1.33	4	1.33	--
	Sulfide	18496-25-8	SW846-9030/9034	mg/kg	9	25	9	--
HGSEQ	Mercury (F0)	NA	SW846-3200 (modified)	ug/kg	3.6	21	3.6	--
	Mercury (F1)	NA	SW846-3200 (modified)	ug/kg	240	740	240	--
	Mercury (F2)	NA	SW846-3200 (modified)	ug/kg	240	740	240	--
	Mercury (F3)	NA	SW846-3200 (modified)	ug/kg	240	740	240	--
	Mercury (F4)	NA	SW846-3200 (modified)	ug/kg	240	740	240	--
	Mercury (F5)	NA	SW846-3200 (modified)	ug/kg	41	370	41	--
	Mercury (F6)	NA	SW846-3200 (modified)	ug/kg	0.11	1.2	0.11	--

[a] UCOR-4049. *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, latest revision, United Cleanup Oak Ridge LLC, Oak Ridge, TN.

[b] An alternative method or alternate technique may be used to achieve the RRLs.

[c] RRLs are defined so that the data obtained meet program/project requirements for reporting quantitative data. For this parameter group, the laboratory is being requested to report detections with respect to the MDLs, which are generally lower than the RRLs.

-- = not available or not applicable
ASTM = American Standard Test Method
BCV = Bear Creek Valley
CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency
MDL = method detection limit

Table B.3. Analytes, RRLs, and screening levels for sediment and soil for the BCV mercury sources RSE (cont.)

Mercury (F0) = volatile elemental mercury
Mercury (F1) = water soluble mercury
Mercury (F2) = pH2 soluble mercury
Mercury (F3) = 1N potassium hydroxide extractable mercury
Mercury (F4) = 12N nitric acid soluble mercury
Mercury (F5) = aqua regia soluble mercury residue
Mercury (F6) = mineral-bound mercury
NA = not available
PQL = practical quantitation limit
QAPP = Quality Assurance Project Plan
RRL = requested reporting limit
RSE = remedial site evaluation
SW846 = EPA test methods for evaluating solid waste, physical/chemical methods
WRRP = Water Resources Restoration Program

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