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VIA ELECTRONIC FILING

March 19, 2024

DEBBIE-ANNE A. REESE
ACTING SECRETARY
FEDERAL ENERGY REGULATORY COMMISSION
888 FIRST STREET NE
WASHINGTON, D.C. 20426

Re: Final *Newhalem Penstock Engineering Evaluation/Cost Analysis,* Newhalem Creek Hydroelectric Project (P-2705-037)

Dear Acting Secretary Reese,

Seattle City Light (City Light) is filing the final *Newhalem Penstock Engineering Evaluation/Cost Analysis* ("EE/CA") and related National Park Service ("NPS") Action Memorandum under P-2705-037, the proposed surrender and decommissioning of the Newhalem Creek Hydroelectric Project ("Project").

The EE/CA, dated July 2023, was prepared by City Light in relation to penstock repair work conducted in 2017, prior to the decision to decommission and surrender the license. The EE/CA recommended the No Action alternative because contaminant concentrations that remained in the soil after the 2017 removal action do not pose unacceptable risk to people or ecological receptors, and additional removal of soil is not required. The EE/CA and Administrative Record supporting the EE/CA was made available for public comment for thirty (30) days starting on January 10, 2023. On September 25, 2023, the NPS issued an Action Memorandum recommending the No Action Alternative because risks to public health or welfare or the environment were addressed by the previous removal action. The EE/CA was approved by the North Cascades National Park Complex and ratified by the NPS Environmental Compliance and Cleanup Division Chief on February 21, 2024. Signatures are found on page 3 of the EE/CA.

This filing is being provided to finalize the record because the EE/CA was described and discussed in two previous filings under Docket P-2705-037:

- City Light's response to the Federal Energy Regulatory Commission's ("FERC") Scoping Document 1 filed on September 28, 2022 (see page 3); and
- City Light's response to FERC's Additional Information Request ("AIR") filed on December 12, 2022, particularly Section 9: Soil Sampling. City Light's response to the AIR included an attached, draft-final EE/CA dated August 2022.

If you have any questions, please feel free to contact me at (206) 684-3117. City Light looks forward to continued engagement with FERC and other parties to surrender the license and decommission the Project facilities.

Sincerely,

Shelly Adams
Decommissioning Project Manager
Seattle City Light

Attachments

Cc: Diana Shannon, FERC
Mark Ivy, FERC

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Prepared for

City of Seattle – City Light Department
P.O. Box 34023
Seattle, WA 98124-4023

For submittal to the National Park Service

July 2023

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LIMITATIONS

This report has been prepared for the exclusive use of Seattle City Light, their authorized agents, and regulatory agencies. It has been prepared following the described methods and information available at the time of the work. No other party should use this report for any purpose other than that originally intended, unless Floyd|Snider agrees in advance to such reliance in writing. The information contained herein should not be utilized for any purpose or project except the one originally intended. Under no circumstances shall this document be altered, updated, or revised without written authorization of Floyd|Snider.

The interpretations and conclusions contained in this report are based in part on site characterization data collected by others and provided by Seattle City Light. Floyd|Snider cannot assure the accuracy of this information.

Signatories

Submitted By:		
CST Federal Government Lead on Behalf of the CST	ROBERT BURROWS Digitally signed by ROBERT BURROWS Date: 2023.10.17 17:21:30 -07'00'	
	Signature	Date
Routed Through:		
Park Superintendent	DONALD STRIKER Digitally signed by DONALD STRIKER Date: 2023.10.31 19:08:25 -07'00'	
	Signature	Date
Regional Environmental Point-of-Contact	GARY RILEY Digitally signed by GARY RILEY Date: 2023.11.02 10:52:08 -07'00'	
	Signature	Date
Regional Director	RANDOLPH LAVASSEUR Digitally signed by RANDOLPH LAVASSEUR Date: 2023.11.15 14:31:13 -08'00'	
	Signature	Date
Ratified By:		
WASO Environmental Compliance and Cleanup Division Chief	SHAWN MULLIGAN Digitally signed by SHAWN MULLIGAN Date: 2024.02.21 12:07:38 -07'00'	
	Signature	Date

Executive Summary

This Executive Summary provides stand-alone documentation of the information contained in the Engineering Evaluation/Cost Analysis Report (EE/CA) so that the content and findings of the EE/CA can be understood without having to read the entirety of the document. It contains a summary of the site description including investigation results and an updated conceptual site model (CSM) based on the investigation results. A summary of the risk assessment and of applicable or relevant and appropriate requirements (ARARs) is also included along with a discussion of the No Action alternative proposed for the site.

ES 1. INTRODUCTION AND PURPOSE

The Seattle City Light (City Light) Newhalem Penstock Site (Site) is located within the Ross Lake National Recreation Area, in North Cascades National Park, also known as the North Cascades National Park Service Complex (NOCA), in the state of Washington and is owned by the United States and managed by the National Park Service (NPS). The Site is being investigated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). NPS is the lead agency under CERCLA and is authorized to respond as the lead agency to a release or threatened release of hazardous substances, or a release or threatened release of any pollutant or contaminant that may present an imminent and substantial danger to public health or the environment, on NPS-managed land.

Preparation of this EE/CA fulfills the CERCLA requirement of Section 300.415(b)(4)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan or NCP, to conduct investigations and other studies to characterize the nature and extent of a release or threat of release, determine if response is necessary to protect public health or welfare or the environment, and evaluate response alternatives. Based on preliminary investigations at the Site, NPS determined that Site conditions warranted additional response to evaluate the release or threatened release of hazardous substances and that a non-time-critical removal action may be appropriate at the Site.

This document has been prepared in accordance with an EE/CA Approval Memorandum for the Site, signed on December 19, 2017, by Martha Lee, Acting Regional Director, NPS Pacific West Region, which directs City Light to prepare an EE/CA for the Site. This EE/CA is intended to comply with NPS EE/CA guidance (NPS 2019a); CERCLA Section 104(b) and the NCP, 40 CFR Section 300.415(b)(4)(i); the U.S. Environmental Protection Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA 1993a); and the U.S. Department of the Interior Environmental Compliance Memorandum 10-1 (USDOI 2018).

The purpose of the EE/CA is to document the release, nature, and extent of hazardous substances at the Site; evaluate potential risks to human and ecological receptors; and provide a framework for evaluating potential removal action alternatives. The EE/CA identifies removal action objectives (RAOs) and analyzes the effectiveness, implementability, and cost of the removal action alternative used to satisfy the RAOs.

ES 2. SITE DESCRIPTION, INVESTIGATION RESULTS, AND CONCEPTUAL SITE MODEL

The Site is located within Ross Lake National Recreation Area, in NOCA. The Site is in a lowland region of NOCA, on the south side of the Skagit River, directly across the river from Newhalem in Whatcom County, Washington. The Site is approximately 1.5 acres and consists of an exposed penstock that is approximately 904 feet in length and rests aboveground on cast-in-place concrete supports.

The penstock is part of the Newhalem Creek Hydroelectric Facility project, operated by City Light under a Federal Energy Regulatory Commission (FERC) license. The penstock was originally constructed by City Light in the 1920s as part of the power plant used during construction of the Gorge Dam and conveys water to the Newhalem Powerhouse for power generation. In January 2022, City Light filed a license surrender application with the Federal Energy Regulatory Commission (FERC) to decommission the Newhalem Creek Hydroelectric Project. The details of the decommissioning process are under consideration. Decommissioning the project will not change the current land use aside from operation of the penstock.

Historical records indicate the penstock was painted several times throughout its history and may have been coated with lead paint. Before the penstock was repainted, the historical paint coatings were tested at the Site in 2009 using an x-ray fluorescence (XRF) spectrometer, a field instrument that measures metals concentrations of in situ media. Detectable lead concentrations were documented with the XRF spectrometer in approximately half of the samples collected (RGA 2009). The penstock was then repainted to encapsulate the historical paint coatings.

Historically, the aboveground portion of the penstock rested on 56 creosote-treated wood frame supports, or saddles, with bases of wood, concrete, or stone. Several of these saddles were damaged in the August 2015 wildfire (the Goodell Fire), and temporary supports were installed at four saddle locations as an emergency project to prevent the penstock from being damaged by buckling.

To comply with FERC dam safety guidelines, City Light began preparation for a support saddle replacement project, which included soil sampling in the immediate vicinity of the penstock. This work was completed in 2014 (Hart Crowser 2014) to investigate potential soil contamination associated with the structure. Prior to performing the saddle replacement work, City Light conducted additional sampling in 2015 (Floyd|Snider 2016) to further evaluate the extent of soil contamination and determine proper handling of soil to be removed by the saddle replacement work. Samples were also collected in 2016 from the wood saddles to determine the specific type of preservatives in the wood.

Results of the soil sampling indicated that soil in the vicinity of the penstock contained elevated concentrations of metals greater than project screening levels (SLs). Samples collected from the wood saddles indicated the use of coal-tar creosote preservative, and soil sampling also indicated the presence of polycyclic aromatic hydrocarbons (PAHs) at concentrations exceeding project SLs in soils within approximately 3 inches of the wood saddles. In 2016 and 2017, in response to these findings and as part of the penstock saddle replacement project, a total of 171 tons of contaminated soil were removed from the Site. The soil removal was completed as a Time-Critical Removal Action (TCRA) under the NPS Action Memorandum (NPS 2016a) and Administrative Settlement Agreement and Order on Consent (ASAOC; NPS 2019b). All subsequent Site investigations and removal actions related to the TCRA were performed under the 2016 Action Memorandum and ASAOC.

Following completion of the TCRA, NPS determined that Site conditions warranted additional response to evaluate the release or threatened release of hazardous substances and that a non-time-critical removal action may be appropriate at the Site as specified in 40 CFR Section 300.415(b). This determination was formalized in an EE/CA Approval Memorandum, signed on December 19, 2017, by Martha Lee, Acting Regional Director, NPS Pacific West Region, and included in the Administrative Record for the Site.

In 2018, additional investigation was performed to delineate the remaining lateral and vertical extent of metals and PAH contamination in the soil in the vicinity of the penstock and collect data for the EE/CA.

The CSM summarizes the current understanding of how chemical contaminants have been released to the environment, have migrated, and may result in exposure to human and ecological receptors. The presumed mechanism for metals contamination to soil is degradation of the historical paint coatings over time (i.e., flaking and chipping). PAH contamination in soil is presumed to result from creosote-treated wood used to construct the historical penstock support saddles that were removed in 2017. The CSM considers several migration pathways including transport via ephemeral and intermittent streams, groundwater, and air and pathways for chemical exposure to human and ecological receptors via ingestion, dermal contact, and inhalation.

ES 3. RISK ASSESSMENT SUMMARY

A Site-specific baseline human health risk assessment (HHRA) and an ecological risk assessment, including both a screening-level ecological risk assessment (SLERA) and baseline ecological risk assessment (BERA), were completed for chemicals determined to be contaminants of potential concern (COPCs).

Human Health

The baseline HHRA was prepared according to USEPA guidance on conducting HHRAs at CERCLA sites (USEPA 1989). COPCs were identified using a tiered process based on frequency of detection and a comparison of site soil data to SLs, referred to as COPC Selection SLs. The Human Health COPC Selection SLs are the minimum of the USEPA Regional Screening Levels (RSLs; target cancer risk [TR] = 10^{-6}, target hazard quotient [HQ] = 0.1) and Model Toxics Control Act (MTCA) Method A SLs, or the MTCA Method B SL if a MTCA Method A SL was not available. COPCs identified in the HHRA include two metals (arsenic and lead), bis(2-chloroethyl)ether, five PAH compounds, and a calculated carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalent (TEQ).

The populations that could contact Site-related contaminants include site workers and site visitors (e.g., hikers and tribal members). Two adult site worker scenarios were developed, one to represent NPS or City Light employees conducting routine maintenance or inspection activities around the penstock and the second to represent construction workers that may engage in ground-disturbing activities at or near the penstock. A site visitor scenario was evaluated for both adults and children. In addition, a hypothetical residential exposure scenario was evaluated.

Soil is the only environmental medium that people accessing the Site could reasonably be expected to encounter on an ongoing basis. For most people, soil exposures are likely to be primarily surficial in nature (i.e., 0 to 0.5 feet below ground surface [bgs]). For construction workers, soil exposures could occur to the maximum depth studied (3.25 feet bgs), depending upon the type of future construction activity. The intermittent and ephemeral streams are dry during portions of the year and in many areas become vegetated and accumulate organic material such that their beds become more characteristic of soil than sediment. Exposure to stream sediment was, therefore, presumed to be minor due to the low residence times of these streams and was not evaluated separately from exposure to soil.

Surface water features at the Site include an ephemeral stream and an intermittent stream. Because the impacts to surface water from soil are expected to be minimal due to the small size of the Site and low residence time of surface water in the streams, and minimal exposure due to the small size of the streams and lack of Site recreational opportunities, risks to people from potentially encountering contaminants in this water are expected to be much lower than risks from soil exposure. Therefore, this exposure medium and the associated exposure pathways were not evaluated quantitatively.

Contaminants in soil may migrate to shallow groundwater, which may re-emerge as surface water or could potentially migrate to the Skagit River. Like surface water, impacts to groundwater re-emerging as surface water are expected to be minimal and human contact is expected to be limited; therefore, this pathway was not quantified in the risk assessment. There is one potable well in the area, located approximately 0.25 miles upriver, on the opposite (north) side of the Skagit River from the Site, which the town of Newhalem uses for its domestic water supply. Based on topography and predominant hydrologic conditions, it is not possible for Site contaminants to migrate to the well used for drinking water; therefore, this pathway was determined to be incomplete.

Risk characterization is conducted to quantify the significance of chemicals in the environment in terms of their potential to cause adverse health effects. NPS generally considers cancer risks exceeding 10^{-6} or non-cancer risks exceeding a hazard index (HI) of 1 to be unacceptable. For exposures to soil, there were no exposure scenarios for any receptor populations that resulted in non-cancer hazards greater than acceptable levels. Additionally, none of the cancer risks for the visitor or worker scenarios exceeded 1×10^{-6}. Cancer risks for the hypothetical adult and child resident scenarios were 1×10^{-5} and 3×10^{-5}, respectively. Residential use is not an expected future site use; however, at the request of NPS, the results for the hypothetical residential scenario were presented for information purposes and were not used in the designation of COPCs as contaminants of concern (COCs).

Based on these results, none of the COPCs were designated as COCs for protection of human health. These results indicate Site soil does not pose unacceptable risk to people under current and expected future site use.

Ecological Risk

An ecological risk assessment (both a SLERA and a BERA) includes the following components: problem formulation, exposure and effects assessment, and risk characterization (including an uncertainty analysis). The objective of the SLERA is to identify and document conditions that may warrant further evaluation (i.e., potential unacceptable risk) and to identify contaminants of potential ecological concern (COPECs). In the BERA, risk estimates from the SLERA were further refined by using a more appropriate estimate of exposure (the exposure point concentration [EPC]) and comparing species-specific estimated exposure doses to toxicity reference values for select receptors of concern.

Surface water features at the Site include only ephemeral and intermittent streams; a fish barrier near the terminus of the powerhouse tail race prevents access to these streams by fish from the Skagit River. Although amphibians are present at the Site and may be exposed to sediments in the intermittent and ephemeral stream channels, exposure of amphibians is comparatively minor due to the small size of the stream channels and the seasonal nature of the streams. Therefore, the ecological risk assessment focused on plants, soil invertebrates, birds, and mammals.

The primary medium of concern for ecological receptors is soil, both surface (0 to 0.5 feet bgs) and subsurface (greater than 0.5 feet bgs). The primary exposure pathway for birds and mammals is incidental ingestion of soil in or on food items while feeding or digging, and the primary exposure pathway for terrestrial plants and soil invertebrates is direct contact with soil. Birds and mammals may also experience direct contact (i.e., dermal exposure) to soil and surface water, may ingest surface water, and may inhale airborne dust. However, these exposure pathways are usually considered to be minor compared to exposures from ingestion (USEPA 2005) and were not evaluated in this ecological risk assessment.

In the SLERA, COPECs were identified using a tiered process based on detection frequency and a comparison of site data to ecological screening values (ESVs), referred to as the SLERA COPEC Selection ESVs. The ESVs used for each chemical was the minimum SLERA COPEC Selection ESV among the plant, invertebrate, bird, and mammal ESVs included in *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes* (NPS 2018). COPECs identified in the SLERA included metals (arsenic, cadmium, chromium, copper, lead, mercury, and zinc), three PAHs and total high molecular weight PAHs, and bis(2-ethylhexyl)phthalate. The COPECs were then evaluated in a refined SLERA. HQs were calculated by dividing the maximum concentration for each COPEC by the Refined ESVs. COPECs with HQs greater than 1, indicating the potential to cause harmful effects, were further evaluated in a BERA.

In the BERA, risk estimates from the SLERA were further refined by using a more appropriate estimate of exposure (the EPC) and comparing species-specific estimated exposure doses to toxicity reference values (TRVs) for receptors of concern. The detailed BERA conducted for this Site also incorporated Site-specific bioaccumulation factors. In the BERA, none of the geometric mean HQs were greater than 1 for birds or mammals and the plant and invertebrate HQs were less than or equal to 1.

Based on the results from the BERA, none of the COPECs were designated as contaminants of ecological concern (CECs). These results indicate Site soil does not pose unacceptable risk to ecological receptors.

ES 4. IDENTIFICATION AND ANALYSIS OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The identification of ARARs is a prerequisite to evaluating and selecting a cleanup action (USEPA 1992b). “Under circumstances where the non-time-critical removal action is expected to be the first and final action at the site, the selected removal action must satisfy all adopted ARARs” (USDOI 2018). If a “no action” alternative is selected following the evaluation of alternatives, ARARs must still be met by this alternative. Other factors to be considered (TBC) are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal or state governments.

There are four basic criteria that define ARARs (NPS 2015c; USEPA 1988). ARARs are (1) substantive rather than administrative, (2) applicable or relevant and appropriate, (3) promulgated, and (4) categorized as either chemical-, location-, or action-specific. ARARs and TBC factors identified for the Site are listed as follows.

- **Chemical-specific ARARs** address specific hazardous substances and are typically health- or risk-based numerical values that cleanups must achieve.
- **Location-specific ARARs** must be achieved because of the specific location of the release and the related response action (e.g., requirements that address the conduct of activities in sensitive areas such as national parks, floodplains, wetlands, and locations where endangered species or significant cultural resources are present). Location-specific ARARs often focus on protecting resources in a specific area. Therefore, NPS-specific ARARs generally fall within this category.
- **Action-specific ARARs** are typically technology or activity-based requirements or limitations on actions conducted to respond to the release of specific hazardous substances. Action-specific ARARs generally prescribe how a selected alternative must be implemented rather than what alternative may be selected.

NPS has identified ARARs and TBCs for the Site. Other agencies, including Ecology, were given the opportunity to provide input about ARARs and TBCs for the Site.

ES 5. REMOVAL ACTION OBJECTIVES AND PRELIMINARY REMOVAL GOALS

RAOs define what the removal action is intended to accomplish. The RAOs for this EE/CA are as follows:

- Prevent unacceptable risks to people and ecological receptors from exposure to Site contaminants in soil.
- Maintain the full enjoyment and utilization of park resources consistent with NPS mandates and policies.
- Attain all federal and state ARARs and consider TBCs.

The EE/CA risk assessment indicates that, following the TCRA, there is no remaining unacceptable risk to people or ecological receptors at the Site. Based on these results, and consequent compliance with ARARs, the RAOs for the Site have been met and no further actions are necessary for the Site. Because there is no remaining unacceptable risk to people or ecological receptors at the Site, and COCs and CECs were not identified, preliminary removal goals and Removal Action Goals were not developed for this Site.

The overarching objective of the TCRA was also to protect against unacceptable risks to people and ecological receptors posed by the Site. A summary of the TCRA activities in light of this objective is provided.

A total of 171 tons of contaminated soil were removed from the Site in 2016 and 2017 as part of the penstock saddle replacement project and TCRA. The TCRA was conducted in response to the findings from Site assessment activities that indicated that soil concentrations of lead, arsenic, and PAHs beneath and in close proximity to the penstock exceeded MTCA cleanup levels for unrestricted land use. In the NPS Action Memorandum dated August 22, 2016, NPS approved and authorized the removal and disposal of contaminated soil excavated as part of the replacement of deteriorated wooden saddles along the penstock (NPS 2016a).

During the saddle replacement work, contaminated soil was excavated, resulting in the removal of approximately 40% of the soil beneath the penstock between the powerhouse and the adit. The results of the risk assessment indicate the TCRA removal work was successful in reducing risk to people and ecological receptors to acceptable levels.

ES 6. IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Following the TCRA and based on the results of the risk assessment, the Site currently poses no unacceptable risk to people or ecological receptors and RAOs have been met; therefore, an additional removal action is not required. Consistent with the NCP and CERCLA guidance, a No Action alternative is the only alternative retained. Under the No Action alternative, no additional removal of soil or maintenance would be performed.

City Light currently monitors conditions at the Site. Vegetation and invasive species are monitored twice per year to ensure the area disturbed by the August 2015 wildfire (the Goodell

Fire) and TCRA activities is being revegetated by native plants, and City Light staff periodically check the powerhouse tailrace for accumulation of rocks and sediment from Newhalem Creek to confirm that they have not accumulated to levels that would overtop the fish barrier located at the outlet of the tailrace.

ES 7. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The No Action alternative was analyzed using the following evaluation criteria: effectiveness, implementability, and cost (Table ES 7.1). The effectiveness of the alternative was evaluated by the alternative's protectiveness of human health and the environment; attainment of ARARs; reduction of toxicity, mobility, or volume through treatment; long-term effectiveness and permanence; and short-term effectiveness. The implementability criterion addresses the technical feasibility of implementing the response (including availability of services and materials), the administrative feasibility, and state and community acceptance. The cost criterion addresses the total cost of implementing the response.

The results of the risk assessment presented in Section 3.0 indicate that, following the TCRA, there is no unacceptable risk to people or ecological receptors at the Site. Therefore, continuation of current environmental conditions under the No Action alternative is protective of human health and the environment, complies with ARARs, and is protective of short- and long-term public health and the community. Because no additional activities would be required, the No Action alternative is technically feasible and no permits would be required. There are no costs associated with the No Action alternative.

Table ES 7.1
Comparison of Alternatives

Alternative	Effectiveness: Protective of Human Health?	Effectiveness: Protective of the Environment?	Effectiveness: Complies with ARARs?	Effectiveness: Reduces Toxicity, Mobility, or Volume	Effectiveness Duration: Short Term	Effectiveness Duration: Long Term	Implementability: Technical Feasibility	Implementability: Administrative Feasibility	Implementability: State Acceptance	Implementability: Community Acceptance	Cost
1- No action	*Yes*	*Yes*	*Yes*	*Not applicable*	*Good*	*Good*	*Good*	*Good*	*Pending*	*Pending*	*$0*

ES 8. RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the results of the risk assessment, and the comparative analysis evaluation criteria, the No Action alternative is recommended. The No Action alternative would effectively protect human health and the environment over the short- and long-term, would be in compliance with ARARs, and would be implementable at no cost.

Because no additional removal activities are needed, there is no associated interruption or limitation to the use of the Site by workers or recreational users. The No Action alternative would also protect and preserve the NOCA natural resources, conditions, and values over the long term and would enable park managers to manage the park in such a manner as to achieve the purposes for which the park was established (NPS 2015b).

City Light currently monitors conditions at the Site. Regrowth of native vegetation and invasive species are monitored twice per year at the Site, and non-native and invasive plants are removed manually. City Light also periodically checks the powerhouse tailrace for accumulation of rocks and sediment from Newhalem Creek, the source of the flow through the penstock to the tailrace, to confirm that they have not accumulated to levels that would overtop the fish barrier located at the outlet of the tailrace. To supplement the current monitoring activities, NPS has requested that City Light include monitoring for signs of erosion and migration of sediment to the tailrace. City Light will coordinate with NPS to prepare a Monitoring Plan to document the monitoring activities and the monitoring schedule. Monitoring activities are expected to continue for 5 years, or as defined in the Monitoring Plan.

This EE/CA and the Administrative Record supporting this EE/CA will be made available for public comment for 30 days. After the public comment period, the EE/CA will be finalized and entered into the Administrative Record and an Action Memorandum will be issued by NPS. The Action Memorandum, as the decision document, will summarize the need for additional action (if any), identify the selected alternative, provide the rationale for the selected alternative, and address significant comments received from the public, including those received from other jurisdictions (e.g., states, tribes, USEPA).

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List of Abbreviations

Abbreviation	Definition
ADD	Average daily dose
ALM	Adult Lead Methodology
ARAR	Applicable or relevant and appropriate requirement
ASAOC	Administrative Settlement Agreement and Order on Consent
BERA	Baseline ecological risk assessment
bgs	Below ground surface
CDI	Chronic daily intake
CEC	Contaminant of ecological concern

Abbreviation	**Definition**
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CIP	Community involvement plan
City Light	Seattle City Light
COC	Contaminant of concern
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSCSL	Confirmed and Suspected Contaminated Site List
CSF	Cancer slope factor
CSL	Cleanup Screening Level
CSM	Conceptual site model
Eco-SSL	Ecological Soil Screening Level
EE/CA	Engineering Evaluation/Cost Analysis
EPC	Exposure point concentration
ESA	Endangered Species Act
ESV	Ecological screening value
°F	Degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
FOD	Frequency of detection
FOE	Frequency of exceedance
geomean	Geometric mean
Hart Crowser	Hart Crowser, Inc.
Herrera	Herrera Environmental Consultants
HHRA	Human health risk assessment
HI	Hazard index
HMW	High molecular weight
HQ	Hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic

Abbreviation	Definition
IUR	Inhalation unit risk
K_{oc}	Organic carbon to water partition coefficient
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restriction
LOAEL	Lowest observed adverse effects level
MDL	Method detection limit
µg/dL	Micrograms of lead per deciliter of blood
µg/m^3	Micrograms per cubic meter
mg/kg	Milligrams per kilogram
mg/kg body weight-day	Milligrams per kilogram of body weight per day
mg/kg-day	Milligrams per kilogram per day
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
MP	Management Policy
MTCA	Model Toxics Control Act
NCCN	North Coast and Cascades Network
NCP	National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan
NOAEL	No observed adverse effect level
NOCA	North Cascades National Park, also known as the North Cascades National Park Service Complex
NPS	National Park Service
Organic Act	National Park Service Organic Act of 1916
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PEL	Permissible exposure limit
PRG	Preliminary removal goal
PRSC	Post-removal site control
RAO	Remedial action objective
RBA	Relative bioavailability

Abbreviation	Definition
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RfD	Reference dose
RG	Removal Goal
RL	Reporting limit
RME	Reasonable maximum exposure
RSL	Regional Screening Level
SCO	Sediment Cleanup Objective
Site	Newhalem Penstock Site
SL	Screening level
SLERA	Screening-level ecological risk assessment
SMS	Sediment Management Standards
SPLP	Synthetic precipitation leaching procedure
SVOC	Semivolatile organic compound
TBC	To be considered
TCLP	Toxicity characteristic leaching procedure
TCRA	Time-critical removal action
TEF	Toxic equivalent factor
TEQ	Toxic equivalent
TR	Target cancer risk
TRV	Toxicity reference value
UCL	Upper confidence limit
USC	United States Code
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound
WHO	World Health Organization
XRF	X-ray fluorescence

1.0 Introduction

The purpose of Section 1.0 is to describe the National Park Service (NPS) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority and the purpose of the Engineering Evaluation/Cost Analysis (EE/CA).

This EE/CA has been prepared to evaluate the nature and extent of contamination at the Seattle City Light (City Light) Newhalem Penstock Site (Site), assess potential human health and ecological risk, and, if needed, evaluate removal alternatives and provide the basis for recommending a non-time-critical removal action for the Site. The Site is approximately 1.5 acres and is located in the State of Washington within the Ross Lake National Recreation Area, across the Skagit River from the town of Newhalem in Whatcom County (Figure 1.1). The Site consists of an operating power plant used during construction of the Gorge Dam and a penstock that runs downhill, south to north, in a forest clearing. The 30- to 33-inch-diameter penstock ends approximately 600 feet south of the southern bank of the Skagit River (Figure 1.2). The penstock is 1,122 feet long, of which approximately 904 feet are aboveground and the remaining 218 feet are within a bedrock tunnel. The aboveground portion of the penstock is located on a steep and somewhat rocky slope above the Newhalem Powerhouse and is supported by concrete pedestals.

1.1 NATIONAL PARK SERVICE CERCLA AUTHORITY

The NPS is authorized under CERCLA, 42 United States Code (USC) Section 9601 et seq., to respond as the lead agency to a release or threatened release of hazardous substances, or a release or threatened release of any pollutant or contaminant that may present an imminent and substantial danger to public health or the environment, on NPS-managed land. Section 104(b) of CERCLA, 42 USC Section 9604(b), authorizes NPS to conduct investigations and other studies to characterize the nature and extent of a release or threat of release, determine if response is necessary to protect public health or welfare or the environment, and evaluate response alternatives. Section 104(a) of CERCLA, 42 USC Section 9604(a), authorizes NPS to select and implement a response action when NPS determines a response is necessary.

CERCLA's implementing regulations, codified in the National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, establishes the framework for responding to such releases and threatened releases. The NCP authorizes and describes two processes for responding to releases: (1) a removal action process and (2) a remedial action process (refer to NCP Sections 300.400 through 300.440). Based on preliminary investigations at the Site, NPS determined that Site conditions warranted additional response to evaluate the release or threatened release of hazardous substances and that a non-time-critical removal action may be appropriate at the Site as specified in 40 CFR Section 300.415(b). This determination was formalized in an EE/CA Approval Memorandum, signed on December 19, 2017, by Martha Lee, Acting Regional Director, NPS Pacific West Region, and included in the Administrative Record for the Site.

This EE/CA was prepared in accordance with NPS EE/CA guidance (NPS 2019a); CERCLA Section 104(b) and the NCP, 40 CFR Section 300.415(b)(4)(i); the U.S. Environmental Protection Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA 1993a); and the U.S. Department of the Interior (USDOI) Environmental Compliance Memorandum 10-1 (USDOI 2018).

1.2 EE/CA PURPOSE AND ORGANIZATIONAL STRUCTURE

This EE/CA is organized by the following topical headings, which also represent the overall objectives of the EE/CA:

- Characterize the nature and extent of contamination at the Site (Sections 2.0 and 3.0).
- Conduct human health and ecological risk assessments (Section 3.0).
- Identify applicable or relevant and appropriate requirements (ARARs; Section 4.0).
- Summarize time-critical removal action (TCRA) activities and TCRA compliance with applicable requirements (Section 5.0).
- Identify and analyze the potential removal action alternatives (Section 6.0).
- Evaluate the alternative against the effectiveness, implementability, and cost evaluation criteria (Section 7.0).
- Recommend an alternative and describe the reason for selection (Section 8.0).

1.2.1 Impact of NPS-Specific Regulations and Policies on EE/CA Development

NPS has several requirements and policies that must be satisfied when undertaking a response to the release of hazardous substances, or pollutants or contaminants, on NPS-managed land (NPS 2015a), including the NPS Organic Act of 1916 (Organic Act; 54 USC Sections 100101 et seq.; 36 CFR Chapter 1, Part 1), which requires that NPS manage parks to conserve the scenery, natural and historic objects, and wildlife and provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations. In accordance with this mandate, NPS strives to clean up contaminated sites with long-term, comprehensive solutions that do not rely on post-removal site controls (PRSCs) to the maximum extent practicable.

This EE/CA will be the basis for selecting what is intended to be a final, permanent response action to address human health risk, ecological risk, and ARARs at the Site. Consequently, in accordance with NPS policy, this EE/CA includes a baseline human health risk assessment (HHRA) and a screening-level ecological risk assessment (SLERA). Because the SLERA indicated further evaluation was required, a baseline ecological risk assessment (BERA) is also included in this EE/CA.

1.2.2 Park-Specific Considerations during EE/CA Development

The Site is located within Ross Lake National Recreation Area within the North Cascades National Park, also known as the North Cascades National Park Service Complex (NOCA), a more than

500,000-acre area located within the Cascade Mountains (Figure 1.1). The Ross Lake National Recreation Area is the most accessible part of NOCA and is managed under a General Management Plan (NPS 2012). This region was historically settled by Native American tribes, is home to a diverse ecological community, and is also historically significant to the hydroelectric infrastructure of the region. Primary park-specific considerations that will factor into the EE/CA development and determination of removal actions include the following:

- Potential for cultural resources and significance of the area to tribal communities
- Historical significance of the Penstock system as part of the Skagit River Hydroelectric Project and the ongoing operation of the Penstock system for power generation
- Location of the Site in relation to the Skagit River, which is designated under the Wild and Scenic Rivers Act and home to spawning populations of all six salmon species native to the Pacific
- Protection of water quality in the Skagit River watershed, which provides drinking water to a significant portion of the population of Washington
- Diversity of native wildlife and plants present in the NOCA
- Use of the area for recreation including hiking and camping in close proximity to the Site
- Ongoing use of the NOCA as a wilderness area, preserving the region for future generations

These factors, considered with the NPS-specific policies described above, will be used in this EE/CA to assess remediation options that satisfy the non-impairment ARAR of the Organic Act (54 USC Sections 100101 et seq.; 36 CFR Chapter 1, Part 1).

2.0 Site Description, Investigation Results, and Conceptual Site Model

The purpose of Section 2.0 is to provide information on the extent of contamination and the physical characteristics of the Site and to present the conceptual site model (CSM) so that the location and fate and transport of contamination is understood.

This section includes a summary of site features, operational history, historical sources and releases of contaminants, the specific hazardous substances released at the Site, and other factors that influence contaminant migration such as hydrogeology, hydrology, climate, extent of contaminants in Site media, and contaminant transport pathways and behavior. All of these elements contribute to the development of the CSM, which is presented in Section 2.11.

2.1 SITE DESCRIPTION

The Site is located within Ross Lake National Recreation Area, in NOCA. The Site is in a lowland region of NOCA, on the south side of the Skagit River, directly across the river from Newhalem, Whatcom County, Washington. The Site is approximately 600 feet south from the south bank of the Skagit River at a latitude and longitude of 48°40'8.74"N and 121°14'59.02"W, respectively. Figure 1.1 shows the regional location of the Site. Figure 2.1 shows the topography of the surrounding area, the Penstock system, the Newhalem Creek Campground, and nearby recreational trails. Photographs of the Site are presented in Appendices A.1 and A.2.

The Site is approximately 1.5 acres and consists of the exposed penstock that is approximately 904 feet in length and rests aboveground on cast-in-place concrete supports. The aboveground portion of the penstock is located on a steep and somewhat rocky slope. Exposed bedrock is present along the southern half of the aboveground portion of the penstock. The penstock continues upslope another 218 feet within a bedrock tunnel/adit and leads to the diversion intake along Newhalem Creek. Along the northern half of the penstock, approximately 4 feet of alluvium overlays the bedrock.

Vegetation at the Site is representative of a typical low elevation North Cascades ecoregion forest, with a mix of Douglas fir, western red cedar, and western hemlock, as well as some alder and maple. In forested areas, undergrowth includes shrubs, such as salal and salmonberry, and ferns. There is an approximately 5- to 15-foot margin on either side of the penstock that has been historically clear of trees to facilitate operations and maintenance and minimize damage to the penstock from hazard trees and falling limbs. Undergrowth is less densely established in this margin. Although saddle replacement activities disturbed much of the margin surrounding the penstock between 2016 and 2017, the area has been naturally revegetated by grasses, shrubs, and ferns. The northern half of the Site is more densely vegetated than the southern, upslope half of the Site, which is predominantly exposed bedrock.

The upper portion of the penstock generally crosses the slope obliquely; therefore, during precipitation events, runoff from the bedrock and talus slope above the penstock drains under the penstock and away from it obliquely toward the northwest. A small ephemeral stream carrying this runoff drains back toward the lower portion of the penstock and crosses under it, joining an intermittent stream that runs parallel to the penstock on the eastern side of the structure toward the powerhouse. Intermittent stream outflow enters the powerhouse tailrace, a channel that carries the water conveyed through the penstock and powerhouse away from the powerhouse and, after passing over a fish barrier, into the Skagit River. The path of the intermittent stream from where it flows away from the penstock to where the tailrace meets the fish barrier is approximately 500 feet in length. The fish barrier is located approximately 250 feet north of the powerhouse, and the Skagit River is approximately 390 feet north of the powerhouse, as illustrated on Figure 1.2. City Light periodically conducts inspections to make sure that sediment does not accumulate to levels that would release to the Skagit River. The Skagit River supports all six native species of salmon, including Puget Sound chinook salmon, which is federally listed as threatened, as well as Puget Sound steelhead and bull trout, which are also federally listed as threatened. Fish cannot enter the tailrace from the Skagit River due to the fish barrier and, therefore, also cannot enter the intermittent stream (Photograph 9 in Appendix A.2). In August 2015, wildfires burned much of the area surrounding the penstock, including several of the wooden penstock saddle supports, reducing native vegetation and likely increasing runoff and the potential for erosion in the immediate vicinity of the penstock (Photograph 1 in Appendix A.2).

A trail maintained by City Light as a flood escape route that is primarily used by City Light for operations and maintenance activities ascends the slope east of the penstock to the adit where the penstock enters the tunnel at its highest location. This trail begins just east of the powerhouse and meanders upward, with some sections approaching within approximately 20 feet of penstock. Near the base of the slope, a relatively flat trail system paralleling the Skagit River connects this trail to a footbridge crossing the river into Newhalem (approximately 0.25 miles east of the Site; Figure 1.2). This trail, known as the Trail of the Cedars, is popular and frequently used by visitors. Although connected to the Trail of the Cedars and open to the public, the trail leading to the upper sections of the penstock is used mainly by City Light for operations and maintenance, and likely due to its steepness does not attract many visitors.

NOCA encompasses more than 500,000 acres of scenic wild lands and supports a diversity of plants and wildlife. According to the 2015 Natural Resource Condition Assessment, up to 1,381 vascular plant species, 70 native mammal species, 222 bird species (23 regularly occurring), and 11 species of amphibians may reside during some or all of the year in NOCA (NPS 2015b). Six mammal species (gray wolf, grizzly bear, Canada lynx, wolverine, fisher, and western gray squirrel) found in NOCA are federally or state listed as threatened or endangered. Three bird species (sandhill cranes, marbled murrelets, and the northern spotted owl) found in NOCA are federally or state listed as threatened or endangered. However, sandhill cranes and marbled murrelets have not been detected recently within the park by the North Coast and Cascades Network (NCCN) Landbird Monitoring program. The northern spotted owl has been detected "outside of point counts" (NPS 2015b).

At the Site, NPS staff have observed 18 mammal species, including three species of concern (Canada lynx, fisher, and gray wolf), and 17 bird species, including four species of concern (harlequin duck, bald eagle, peregrine falcon, and pileated woodpecker; Kraft 2021). Mammal and bird species observed at the Site are summarized in the following table. No active murrelet or spotted owl nests have been observed at the Site in the past several years.

Summary of Mammals and Birds Observed at the Site

Mammals Observed at the Site	Species of Concern	Birds Observed at the Site	Species of Concern
American marten	No	American dipper	No
American mink	No	American robin	No
Black bear	No	Bald eagle	Yes
Bobcat	No	Barred owl	No
Canada lynx	Yes	Common merganser	No
Columbian black-tailed deer	No	Dark-eyed junco	No
Cougar	No	Harlequin duck	Yes
Coyote	No	Pacific wren	No
Deer mouse	No	Peregrine falcon	Yes
Douglas squirrel	No	Pileated woodpecker	Yes
Elk	No	Red-breasted sapsucker	No
Fisher	Yes	Ruffed grouse	No
Gray wolf	Yes	Spotted sandpiper	No
Montane shrew	No	Spotted Towhee	No
Raccoon	No	Steller’s jay	No
River otter	No	Swainson’s thrush	No
Townsend’s chipmunk	No	Varied thrush	No
Trowbridge’s shrew	No		

2.2 OPERATIONAL HISTORY

The Newhalem Penstock is part of the Newhalem Creek Hydroelectric Facility project, operated by City Light under a Federal Energy Regulatory Commission (FERC) license. The project includes a powerhouse, penstock, bedrock power tunnel, and creek diversion structure. The penstock was constructed by City Light in the 1920s as part of the power plant used during construction of the Gorge Dam and conveys water to the Newhalem Powerhouse for power generation. The penstock and powerhouse are not currently operating. Historically, the aboveground portion of the penstock rested on 56 creosote-treated wood frame supports, or saddles, with bases of wood, concrete, or stone. Several of these saddles were damaged in the August 2015 wildfire (the Goodell Fire), and temporary supports were installed at four saddle locations as an emergency project to prevent the penstock from being damaged by buckling. City Light removed and replaced the saddles with cast-in-place concrete pedestals in 2016–2017. Two original concrete supports located south of Thrust

Block II (supports number 7 and 8, Figure 2.2) and two treated wood frame supports located adjacent to the tunnel/adit (supports number 55 and 56, Figure 2.2) were not replaced. As part of the penstock saddle replacement project, a total of 171 tons of contaminated soil was removed from the Site. The soil removal was completed as a TCRA under the NPS Action Memorandum (NPS 2016a) and Administrative Settlement Agreement and Order on Consent (ASAOC; NPS 2019b).

The Newhalem Penstock has been maintained by City Light since its construction in the 1920s. Historically, sandblasting was common practice for coating removal and maintenance of structures of this type; however, no physical evidence or visual indications of sandblast grit have been observed at the Site, and no historical records have been located indicating this activity was conducted. The penstock has been repainted since the use of lead-based paint, with the latest coating occurring after the 2009 RGA Environmental, Inc., investigation, based on the different paint color descriptions in reports completed in 2009 by RGA Environmental, Inc., and in 2014 by Hart Crowser, Inc. (Hart Crowser; RGA 2009 and Hart Crowser 2014). Analytical data from the structures and the soil surrounding the original wood supports indicate that they may have been preserved with creosote, which may have leached polycyclic aromatic hydrocarbons (PAHs) into nearby soil.

In January 2022, City Light filed a license surrender application with the Federal Energy Regulatory Commission (FERC) to decommission the Newhalem Creek Hydroelectric Project. The details of the decommissioning process are under consideration. Decommissioning the project will not change the current land use aside from operation of the penstock.

2.3 HISTORICALLY AND CULTURALLY SIGNIFICANT FEATURES

Native American activities throughout the North Cascades can be inferred through artifacts associated with settlements, trade routes, and historical accounts through contact with Euro-American settlers. There are documented archeological sites within the area surrounding the Site. Therefore, City Light completed a Section 106 consultation process for sampling activities at the Site, and archaeological monitoring was conducted during sampling, soil removal, and saddle replacement activities. Stakeholders for the Site include the federally recognized Upper Skagit Indian Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Indian Tribe.

The penstock was constructed by City Light in the 1920s as part of the power plant used to supply power during construction of the Gorge Dam and is listed on the National Register of Historic Places.

2.4 WASTE CHARACTERISTICS

Results of soil sampling at the Site indicated that soil in the vicinity of the penstock contained elevated concentrations of metals greater than project screening levels (SLs). The release of metals to the environment is assumed to have occurred as penstock paint coatings have aged and degraded, resulting in flaking and chipping of the coatings. It is also possible for metals to be released to the environment through sandblasting. Historically, sandblasting was a common practice for coating removal and maintenance of structures of this type; however, there is no indication in maintenance records that this practice was conducted at this Site and there is no physical evidence or visual indications of sandblast grit observed at the Site. Given this, it is assumed that chipping and flaking of undercoating paint is the primary source of contaminant release. Paint coatings from the era of the penstock construction contained metals, including lead, which decreased the amount of time that paint took to dry, and mercury, which was added as a biocide. The primary metals associated with paints are lead, arsenic, cadmium, copper, chromium, and zinc.

In addition to metals, PAHs have been detected in investigations at the Site. The presence of PAHs is a result of use of treated wood for the former penstock support structures. Analytical data from the structures and the soil surrounding the original wood supports indicate that they were preserved with creosote, which then leached PAHs into immediately adjacent soil. All but four of the wood support saddles and soil surrounding the former saddles were removed from the Site as part of the TCRA conducted in 2017. The TCRA is summarized in Section 2.9. Contaminated media containing PAH and metals are considered non-hazardous waste and do not require management as a State Dangerous Waste or Federal Hazardous Waste.

2.5 GEOLOGY AND HYDROGEOLOGY

The Site is located within NOCA, whose geology consists of a crystalline core composed of a diverse assortment of glacially sculpted sedimentary, metamorphic, and plutonic rocks. The exposed crystalline core domain within this region was formed in the roots of ancient volcanic arcs.

2.5.1 Regional and Local Geology

The town of Newhalem is situated at the mouth of the Skagit River Gorge and sits along the Skagit River’s floodplain. The topography of the surrounding area (including the Site) has been shaped by the advance and retreat of the Cordilleran Ice Sheet, with the most recent advance occurring during the Fraser Glaciation between 25,000 and 13,000 years ago. The voluminous meltwater of many advances and retreats cut the gorge and exposed the Skagit Gneiss Complex, the main rock unit of the crystalline core, that consists of light-colored orthogneiss and darker-colored banded gneiss (USGS 2009).

The Site surface mainly consists of Quaternary alluvium deposits and bedrock composed of orthogneiss (USGS 2009). Bedrock is exposed at the surface in the upper half of the aboveground penstock alignment and is buried by at least 4 feet of alluvium in areas of the lower half of the alignment.

The exposed bedrock in the upper portion of the penstock above Thrust Block IV (Figure 2.2) slopes to the northwest at an approximate angle of 36.5 degrees or a gradient of 0.74. In some areas along the penstock, there is less than 3 inches of soil covering the bedrock. Between Thrust Blocks III and IV, the surface grades from exposed bedrock to a mixed talus/soil slope, and the slope angle decreases to approximately 19 and 10.5 degrees on the east side and west side of the penstock, respectively. Between Thrust Blocks II and III, the surface grades to a relatively flat bench with a slight slope of 5 degrees to the northeast. Soil along the penstock between Thrust Blocks II and III generally consists of dark brown silty sand or sandy silt; however, soil along the ephemeral stream pathway adjacent to Saddles 16 through 19 consists of coarse sand and fine subangular gravel down to 2 feet below ground surface (bgs) with bedrock greater than 4 feet bgs. Between Thrust Blocks I and II, the gradient slopes to the north at an angle of 33 degrees and the soil consists of dark brown silty sand or sandy silt. The powerhouse, tailrace, fish ladder, and Trail of the Cedars are located in the Skagit River floodplain, which is a prominent geologic feature within the area. The powerhouse is located at the southern boundary of the floodplain, as shown on Figure 2.1.

2.5.2 Hydrogeology

An intermittent stream runs adjacent to the east side of penstock, flowing down the slope to the powerhouse, and then to the tailrace, which discharges into the Skagit River after passing over a fish barrier. In addition to the intermittent stream, a small ephemeral stream carries surface runoff from the upper portion of the Site, traversing underneath the penstock in one location, and connects into the intermittent stream (refer to Figure 2.1). Shallow groundwater at the Site was not encountered during sampling activities; during the saddle replacement activities, shallow subsurface water was observed seeping into the saddle excavations between Saddles 21 and 25 during the months of November and December (Herrera 2018). Therefore, shallow groundwater at the Site is likely seasonally intermittent, unsubstantial, and perched upon or within fractures in the shallow bedrock, from which it may return to surface water flow as evident by the intermittent and ephemeral streams.

The Site is located within the overall Skagit Drainage Basin and adjacent to the lower Newhalem Watershed. The penstock carries water from Newhalem Creek to the powerhouse; however, the Site drainage is separated from the Newhalem Creek drainage by a subtle topographic rise. The topographic rise is evident when looking at the drainage direction of the small ephemeral stream, which drains surface water to the northeast, away from Newhalem Creek, and toward the lower portion of the penstock (Figure 2.1).

The powerhouse is located on the historical Skagit River floodplain but is approximately 35 feet above the current river level. The Skagit River has a drainage area of 1,175 square miles and a mean daily discharge of approximately 4,508 cubic feet per second (cfs) over the course of a year, with an annual maximum of up to 12,000 cfs at U.S. Geological Survey gauge No. 12178000 at Newhalem, Washington (USGS 2021). Newhalem Creek has a drainage area of 26.9 square miles and a mean daily discharge of approximately 125 cfs, with a historical maximum of 504 cfs (USGS 2021).

The Skagit River and Newhalem Creek are the Site's nearest wetlands in the U.S. Fish & Wildlife Service's National Wetlands Inventory database (USFWS 2021). They are classified as an upper perennial, riverine system with an unconsolidated bottom and water covering the substrate through the year in all years. The Skagit River is located 600 feet north of the Site, and Newhalem Creek is located approximately 1,500 feet to the west of the Site.

2.5.2.1 Groundwater Use

There is one potable water well in the area, located approximately 0.25 miles upriver, on the opposite (north) side of the Skagit River from the Site, which the town of Newhalem uses for its domestic water supply. The well is a 16-inch-diameter well with a screened interval between 130.2 and 157.3 feet bgs and is completed at a depth of 157.3 feet bgs.

There are no other potable or domestic wells within a 0.25-mile radius of the Site. The second nearest potable water well is over 5 miles downriver from the Site and on the opposite side of the Skagit River.

2.6 SITE SURFACE WATER

Surface runoff in the upper portion of the penstock (between Saddle 29 and Thrust Block VI) follows the topographic relief and flows downslope to the northwest away from the penstock and eventually back to the penstock, via the ephemeral stream. During wetter months, the surface runoff aggregates in the ephemeral and intermittent streams previously mentioned and shown on Figure 2.1. Nearly all of site surface runoff flows to the intermittent stream, which flows to the north, joining the tailrace from the powerhouse, and eventually discharges into the Skagit River after passing over a fish barrier. The vertical fish barrier wall was constructed by City Light in the 1990s to restrict fish from entering and swimming up the tailrace toward the powerhouse. The fish barrier is a vertical concrete wall, approximately 2 to 3 feet tall. In addition to blocking fish passage, the tailrace acts as a sediment catch prior to the tailrace discharging to the Skagit River. Since its installation in the 1990s, sediment behind the fish barrier wall has not been removed. Field observations suggest that, to date, sediment has not accumulated to a level at which it would pass the barrier wall and migrate to the Skagit River.

Contaminant transport or impact to the Site from the Skagit River during river flood events is not possible due to Site topography. The powerhouse is approximately 35 feet higher in elevation than the average water level of the Skagit River, whereas Newhalem on the opposite side of the river is approximately 20 feet higher in elevation than the river level (Figure 2.1). In the event of a flood, the river would overtop the north bank, flooding the town of Newhalem before overtopping the southern bank and reaching the elevation of the powerhouse (the lowest portion of the Site). Figure 2.1 shows the topography of the Skagit River and surrounding area.

In addition to the intermittent and ephemeral streams, a seep was observed at Saddle 36 during the October 2018 investigation. The seep is likely shallow subsurface flow that surfaces at Saddle 36 from trickles of overland flow observed at Saddles 38, 40, and 41 that has percolated into the talus and bedrock fractures (Photographs 10, 11, and 12 in Appendix A.2). Erosion caused by surface water runoff is likely minimal at the Site. The upper portion of the Site consists of exposed bedrock with little to no soil, and erosion is minimal between Thrust Blocks II and III, where topography is relatively flat. Any soil transported from the penstock vicinity would be deposited in the ephemeral and intermittent stream channels. Soil or sediment migrating down the intermittent stream channel toward the Skagit River, would likely be contained at the culvert structures before the stream joins the tailrace, and then finally by the tailrace fish barrier wall, substantially reducing the potential for transport to the Skagit River. Additional information on contaminant concentrations in sediment and potential surface water transport of soil and sediment downstream is presented Sections 2.9.4.2 and 2.11.2, respectively.

Newhalem Creek, the other surface water feature in the area, enters the Skagit River approximately 0.25 miles west of the powerhouse. Surface runoff from the penstock vicinity does not flow west to Newhalem Creek, and there is a topographic divide between the Site and Newhalem Creek (Figure 2.1). Visitor attractions, such as Ladder Creek Falls, Gorge Lake, Diablo Lake, Thunder Arm, and Ross Lake, are all located upriver from the Site along the Skagit River.

2.7 LOCAL CLIMATE

Situated approximately 500 feet above mean sea level on the western slope of the Cascade Mountains, the local climate in the Newhalem area consists of long cold periods with short days in the winter season. Summers are short and mild with long days. Based on National Weather Service data for the city of Newhalem, compiled between 1991-2020, the temperature ranges from an average minimum temperature of 32 degrees Fahrenheit (°F) in January to an average maximum temperature of 79 °F in August. The average temperature for the year is 50 °F. Annual average rainfall is 80 inches. The rainy season is generally between October and April, with most of the rain occurring in November, with an average of 14 inches. There is an annual average of 180 days of precipitation. Snowfall can occur between late September and late May, with an average annual total snowfall of 27 inches and the most snowfall occurring in January, with an average of 9.4 inches. The regional wind direction is predominantly to the southeast and southwest and is affected by westerlies. However, the Site experiences a localized microclimate created by the varied topography, forest cover, vegetation, elevation, and slope, which produces downward drafts toward the river.

2.8 SENSITIVE ENVIRONMENTS

Sensitive environments are defined as terrestrial or aquatic resources, fragile natural settings, and other areas of unique or highly valued environmental and cultural features (NPS 2019a). The Site is considered a sensitive environment because it is located within Ross Lake National Recreation Area, in NOCA. The Site is representative of a typical low elevation North Cascades ecoregion forest, with a mix of Douglas fir, western red cedar, and western hemlock, as well as some alder and maple. In forested areas, undergrowth includes shrubs, such as salal and salmonberry, and ferns. There is an approximately 5- to 15-foot margin on either side of the penstock that has been historically clear of trees to facilitate operations and maintenance and minimize damage to the penstock from hazard trees and falling limbs. Undergrowth is less densely established in this margin. Although saddle replacement activities disturbed much of the margin surrounding the penstock between 2016 and 2017, the area has been naturally revegetated by grasses, shrubs, and ferns. The northern half of the Site is more densely vegetated than the southern, upslope half of the Site, which is predominantly exposed bedrock. As detailed in Section 2.1, NPS staff have observed 18 mammal species at the Site, including three species of concern (Canada lynx, fisher, and gray wolf), and 17 bird species, including four species of concern (harlequin duck, bald eagle, peregrine falcon, and pileated woodpecker; Kraft 2021). Predominant terrestrial species at the Site are expected to be consistent with those most predominant in the region and include birds, mammals, and amphibians, such as barred owl, cougar, robin, chickadee, shrew, squirrel, raccoon, western toad, northern red-legged frog, Pacific chorus frog, northwestern salamander, Pacific giant salamander, and western redback salamander (Kraft 2021).

Aquatic resources at the Site include an intermittent and ephemeral stream (Figure 2.1). Nearly all of the Site surface runoff flows to the intermittent stream, which flows to the north, joining the tailrace from the powerhouse, and eventually discharges into the Skagit River after passing over a fish barrier. The Skagit River supports all six native species of salmon, including Puget Sound chinook salmon, which is federally listed as threatened, as well as Puget Sound steelhead and bull trout, which are also federally listed as threatened. Migration of soil and sediment from the Site is limited as described in Section 2.11.2; therefore, although the Skagit River is downgradient from the Site, it is not expected to be affected by the Site.

Newhalem Creek is located close to the Site, approximately 0.25 miles to the west; however, it is in a drainage separated by a topographic divide from the Site; therefore, it is very unlikely to be affected by contaminants from the Site. Therefore, the only sensitive environments with potential to be impacted by the Site are terrestrial resources in the vicinity of the penstock, the intermittent and ephemeral streams adjacent to the penstock, and potential cultural features in the Site vicinity.

2.9 PREVIOUS INVESTIGATIONS AND RESPONSE ACTIONS

The penstock, constructed in the 1920s as part of the power plant used during construction of the Gorge Dam, conveys water to the Newhalem Powerhouse for power generation for the residents of the Newhalem community. Historical records indicate the penstock was painted several times throughout its history and may have been coated with lead paint.

The undercoat paint was initially tested at the Site in 2009 using an x-ray fluorescence (XRF) meter, a field instrument that measures metals concentrations of in situ media. Detectable lead concentrations were documented with the XRF spectrometer in approximately half of the samples collected (RGA 2009). To comply with FERC dam safety guidelines, City Light began preparation for a support saddle replacement project that was ultimately completed in 2016–2017 as part of an approved TCRA (NPS 2016a). In preparation for this work, in 2014, City Light conducted soil sampling in the immediate vicinity of the penstock to investigate potential soil contamination associated with the structure (Hart Crowser 2014). Prior to performing the saddle replacement work, in 2015, City Light conducted additional sampling to further evaluate the extent of soil contamination and determine proper handling of soil to be removed by the saddle replacement work (Floyd|Snider 2016). Samples were also collected in 2016 from the wood saddles to determine the specific type of preservatives in the wood. Soil sample results from this investigation were evaluated relative to the Model Toxics Control Act (MTCA) cleanup levels for human health for unrestricted use. Results of the soil sampling indicated that soil in the vicinity of the penstock contained concentrations of lead and arsenic greater than the MTCA cleanup levels. Wood samples indicated the use of coal-tar creosote preservative. Soil sampling also indicated the presence of PAHs in soils within approximately 3 inches of the wood saddles. In response to these findings, on September 1, 2016, NPS approved through an Action Memorandum a TCRA at the Site (NPS 2016a), authorizing the removal and disposal of contaminated soil excavated to complete the scope of work associated with the replacement of deteriorated wooden saddles along the penstock. The TCRA was completed in September 2017 and included removal and disposal of 171 tons of contaminated soil. In 2018, after the saddle replacement activities were complete, an environmental investigation was performed to delineate the remaining lateral and vertical extent of metals and PAH contamination in the soil in the vicinity of the penstock. The investigation was focused on determining the nature and extent of contaminants remaining at the Site. The results from these investigations are summarized in Section 2.9.4.

2.9.1 Nature and Extent of Contaminants Controlled or Treated through Previous Cleanup Actions

Historically, the aboveground portion of the penstock rested on wood frame supports, or saddles, with bases of wood, concrete, or stone. Between November 9, 2016, and May 5, 2017, as part of a City Light public works project, 52 of the 56 creosote-treated wooden saddles along the exposed portion of the penstock were removed and replaced with cast-in-place concrete supports. The wood frame supports, bases, and surrounding soils were removed from the Site and transported off-site for disposal. Removal of contaminated soil was incidental to the work required to complete the saddle replacement work. At about this time, the Site was designated under CERCLA, and as detailed in a TCRA Action Memorandum (NPS 2016a), the contaminated soil removal was authorized by NPS as a TCRA in accordance with CERCLA. During the saddle replacement work, a total of 171 tons of contaminated soil was excavated and disposed of to provide a focused soil remediation. Rectangular excavations were completed around each of the 52 replaced saddle supports, extending approximately 3 feet in each direction past the saddle supports (Photograph 4 in Appendix A.2). Excavation depths ranged from 1 to 3 feet bgs, depending on the depth of the existing support and the design depth of the replacement concrete support. The footprints of each saddle support excavation are shown on Figure 2.2, as the hatched line around each replaced saddle support. Approximately 3 cubic yards, or approximately 70 cubic feet, of soil was removed from around each saddle support. Soil removed was transported off-site for disposal at an appropriate Waste Management facility (Herrera 2018).

Based on the spacing of saddle supports along the penstock alignment and the footprints of the saddle excavations, approximately 40% of the soil beneath the penstock was removed by the TCRA removal work. During the saddle replacement project, stormwater runoff in several locations, as well as water flowing toward the penstock alignment in the ephemeral stream, was rerouted by polyvinyl chloride pipes to avoid contacting excavation areas.

2.9.2 Treatability of Compounds

Contaminants confirmed to be present at the Site include heavy metals and PAHs. These contaminants are common, and treatment technologies are available for both contaminant types. Metals compounds are most commonly treated through stabilization or immobilization techniques, and PAH contaminants may be treated through degradation technologies as well as stabilization or immobilization techniques. During the 2016–2017 TCRA, treatability techniques were not considered, because the saddle replacement work was required for FERC compliance and in situ treatment was not an option. As part of the TCRA, a total of 171 tons of contaminated soil was removed from the Site.

2.9.3 Equipment/Utilities/Installations at the Site

There are no utilities at the Site outside of the powerhouse, except for several electric lines that travel up the slope alongside the penstock, secured to the saddles. These lines supply power from the powerhouse via the adit and tunnel to the diversion intake along Newhalem Creek. Power supply to the powerhouse and electricity generated at the powerhouse are transferred through aboveground powerlines located between the powerhouse and the Skagit River. No overhead lines exist upslope of the powerhouse. No equipment is typically stored on the Site outside of the powerhouse. There is no potable water or sewer connection at the powerhouse.

2.9.4 Site Contaminants

This section summarizes the environmental investigations that have been conducted at the Site between 2014 and 2018, and the detected analytical results from those investigations of the contaminants of potential concern (COPCs) and contaminants of potential ecological concern (COPECs) in Site and background soil and sediment. COPCs were identified using a tiered process based on frequency of detection and a comparison of Site data to SLs, referred to as the COPC Selection SLs, as described in Section 3.1. COPECs were identified using a tiered process based on detection frequency and a comparison of Site data to ecological screening values (ESVs), referred to as the SLERA COPEC Selection ESVs, as described in Section 3.2.2.

2.9.4.1 Summary of Investigations

Data collected at the Site to date have been compiled to generate the dataset available for use in this EE/CA and are the basis for the EE/CA risk assessments, presented in Section 3.0. The soil chemistry data from the investigations described in this section are also summarized in a data report memorandum appended to this EE/CA (Appendix B) and are compared to project SLs in Tables C.2a through C.2c and C.4a through C.4c in Appendix C. The project SLs are described in Section 3.0. XRF data from in situ soil measurements are provided in Table 2 of Appendix B. Synthetic precipitation leaching procedure (SPLP) data are presented in Table 3 of Appendix B.

Historical sampling data from soil that was removed during saddle replacement activities in 2016 and 2017 are not included in the dataset used for evaluations in this EE/CA. Data collected prior to the saddle work but representing soil remaining in situ were evaluated and determined to be useable for the EE/CA. Figure 2.2 shows the locations of all samples used in this EE/CA. Sampling at Transects 1 through 13 was conducted in 2014 and 2015 prior to saddle replacement activities, and sampling at Transects 14 through 27 was conducted in 2018, post-saddle-replacement activities.

Data included in the EE/CA were collected during the investigations summarized in the following sections.

Hart Crowser 2014

Due to results of the 2009 penstock coatings investigation, soils near the penstock were tested for the presence of heavy metals in 2014 by Hart Crowser on behalf of City Light (Hart Crowser 2014). During the 2014 site investigation, Hart Crowser collected soil samples and XRF measurements along six transects, Transects 1 through 6 (Figure 2.2). Results indicated that lead and arsenic concentrations in soil were greater than MTCA Method A criteria for unrestricted residential land uses. Elevated concentrations of the other common sandblast grit metals were not observed, and visual signs of sandblast grit were not identified at the Site during the 2014 investigation. Given this, it is assumed that the contamination observed in soil was associated with chipping or flaking of lead paint caused by general weathering or maintenance activities and is not associated with the presence or use of sandblast grit. Additionally, PAHs were detected in soil samples at concentrations greater than MTCA Method B criteria for unrestricted residential land uses. Hart Crowser concluded that the former wood saddle supports were preserved with creosote and the source of the PAHs (Hart Crowser 2014). These wood saddles were tested during TCRA activities in 2017, and sampling confirmed the presence of PAHs in the removed wood saddle support structures. Four soil samples were analyzed by toxicity characteristic leaching procedures (TCLP) for disposal purposes. TCLP results indicated that soil removed during the saddle replacement activities classified as non-hazardous waste (Table 1 in Appendix B).

Two background samples were collected by Hart Crowser in 2014 and analyzed for arsenic, chromium, copper, lead, and zinc. These samples were not included in the background soil dataset of this EE/CA because one of the samples was located relatively close to the penstock in proximity to Site samples and the rationale for the sample locations could not be confirmed.

City Light 2015

In November 2015, in association with another project in the area (Ladder Creek Tank), City Light collected five background samples in the vicinity of the Site, outside the penstock clearing, and analyzed them for Resource Conservation and Recovery Act (RCRA) 8 metals (Appendix D), PAHs, and semivolatile organic compounds (SVOCs). Three of these samples (SCL-LC-BG3, SCL-LC-BG4, and SCL-LC-BG5; refer to Figure 2.3) are included in the background soil dataset of this EE/CA; two samples (SCL-LC-BG1 and SCL-LC-BG2) were not included due to their distance from the Site. The three samples included in the background soil dataset had detected concentrations of barium, cadmium, chromium, lead, and mercury. Arsenic, selenium, and silver were not detected. PAHs and SVOCs were also detected in the three background samples.

Floyd|Snider 2015

In 2015, Floyd|Snider conducted a limited environmental investigation to provide additional information regarding the lateral extent of metals contamination at the Site to further inform saddle replacement construction planning (Floyd|Snider 2016). The 2015 investigation included field observations, XRF measurements along seven transects (Transects 7 through 13), and chemical analysis of soil samples (Figure 2.2). Consistent with the results of the 2014 investigation, elevated concentrations of lead and arsenic were identified in surface soil beneath the penstock. In addition, elevated concentrations of antimony, manganese, molybdenum, and nickel were detected in XRF measurements. Of these XRF detections, antimony was detected only once in 69 samples, which was considered to be anomalous. Nickel was detected in less than 10% of samples, manganese was detected in 95% of samples, and molybdenum was detected in 80% of samples. Barium was never detected using the XRF spectrometer in soil during the 2015 investigation of soil in the vicinity of the penstock. Background concentrations of lead and arsenic at three locations outside the penstock clearing (at least 500 feet away) were less than the XRF spectrometer detection limits (Floyd|Snider 2016).

City Light 2016

On August 25, 2016, City Light analyzed a paint chip sample from the historical penstock undercoating for RCRA 8 metals and performed TCLP analysis, for material handling and disposal purposes. Arsenic, barium, chromium, and lead were detected in the paint; however, TCLP results were non-detect for all metals except barium.

Herrera 2016–2017

During the saddle replacement and TCRA activities, Herrera provided oversight and an environmental monitor was present periodically at the Site on behalf of City Light. The environmental monitor collected soil samples at the base of several saddle excavations to determine the relative chemical condition of soil in the excavations just prior to construction of the concrete saddle. Results of this monitoring were consistent with previous testing conducted at the Site, with elevated concentrations of PAHs and metals in the soil immediately adjacent to the wood saddles and beneath the penstock. Documentation of this monitoring and results of analytical testing conducted during saddle replacement work are presented in the Environmental Monitoring Report prepared by Herrera (Herrera 2018).

Floyd|Snider 2018

In 2018, after the saddle replacement activities, Floyd|Snider conducted an environmental investigation to delineate the lateral and vertical extent of metals and PAH contamination remaining at the Site. A detailed summary of the 2018 investigation is included in the data report memorandum in Appendix B. The investigation activities included a site inspection and documentation of field observations, recording XRF measurements along 14 transects (Transects 14 through 27), and collecting soil samples for comparison of XRF measurements to laboratory data (Figure 2.2). XRF monitoring and soil sampling were conducted to evaluate the extent of soil contamination, conditions within sediment (within the footprints of the intermittent and ephemeral streams), and background conditions. Sampling included 16 background locations (Figure 2.3). Based on the XRF results, select soil samples were submitted for laboratory analysis for select metals, PAHs, and SPLP testing.

Transects were spaced at approximately 50-foot intervals along the Penstock system and extended laterally a minimum of 15 feet (to the degree accessible) from either side of the penstock. For each transect, surface and subsurface (6 inches bgs and deeper) XRF measurements were recorded directly beneath the penstock and at 5-foot intervals progressing outward from the penstock centerline, on either side of the penstock. Select soil samples were submitted for laboratory analysis from locations that would assist with horizontal bounding of the extent of contamination. Additionally, samples were submitted for laboratory analysis from the locations with the greatest detected XRF sample results, to determine the upper range of contaminant concentrations present at the Site. SPLP analysis was also conducted on these samples to provide a conservative representation of the leachability potential from contaminated soil.

Twelve sediment samples were collected within the ephemeral and intermittent stream channels. Because these stream channels are not continuously saturated, the samples were included in the Site soil dataset. Ten of the sediment samples were collected within the ephemeral stream channel—a moist micro-channel or depression that collects surface water runoff from both the upper portion of the penstock and other nearby upslope areas during rain events. This surface water pathway is oriented from southwest to northeast and flows toward the penstock, intersecting it in the vicinity of Saddle 32 (Figure 2.2).

Two sediment samples, NHP-SED-1 and NHP-SED-2, were collected downstream of the ephemeral stream, from the intermittent stream channel. NHP-SED-1 was collected north of the pathway footbridge that crosses the stream channel, and NHP-SED-2 was collected further downstream near the powerhouse. XRF measurements (Table 2 in Appendix B) were recorded for both samples, and sample NHP-SED-1 was submitted for laboratory analysis (Figure 2.2; Tables C.2a and C.4a in Appendix C).

These data and other aspects of the 2018 investigation are discussed in the data report memorandum in Appendix B.

2.9.4.2 Analytical Data Summary

The soil and sediment data from the investigations described in Section 2.9.4.1 are the basis of the EE/CA dataset, referred to as the EE/CA soil dataset throughout the remainder of this document, and the risk assessments presented in Section 3.0. A detailed summary of the detected analytical results of the COPCs and COPECs in Site and background soil and sediment samples is presented in this section. Twelve sediment samples were included in the EE/CA soil dataset and are also summarized separately in this section. The COPCs are discussed in Section 3.1.1 and include two metals (arsenic and lead), bis(2-chloroethyl)ether, five PAH compounds, and a calculated carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalent (TEQ). The COPECs are discussed in Section 3.2 and include seven metals (arsenic, cadmium, chromium, copper, lead, mercury, and zinc), bis(2-ethylhexyl)phthalate, three PAH compounds, and calculated total high molecular weight (HMW) PAHs. PAHs were evaluated as totals in the risk assessments; therefore, a summary of the concentrations of cPAH TEQ and total HMW PAHs, but not the individual compounds, is provided in this section.

Tables 2.1 and 2.2 present the frequency of detection (FOD) and frequency of exceedance (FOE) for analytical Site samples and background samples, respectively. Additionally, although COPCs and COPECs were not selected based on the XRF data, FOD and FOE tables were also prepared for the XRF data (Tables 2.3 and 2.4). Figure 2.4 shows the concentrations and vertical and lateral extent of lead in soil at the Site, which has the greatest number of detections, is one of the most widespread metals, and is representative of the nature and extent of the COPCs, particularly metals. In addition, total cPAH TEQ concentrations are shown on Figure 2.5. All of the samples that exceeded total HMW PAH SLERA COPEC Selection ESVs also exceeded the COPC Selection SL for cPAH TEQ; therefore, the vertical and lateral extent of cPAH TEQ concentrations at the Site are generally representative of the lateral and vertical extent of total HMW PAH contamination.

Metals in the EE/CA Soil Dataset

- **Arsenic:** A total of 54 Site samples and 13 background samples were analyzed for arsenic. Arsenic was detected in 54% of Site samples and 38% of background soil samples. Arsenic concentrations ranged from 4.5 to 94 milligrams per kilogram (mg/kg) in Site samples and from 9.6 to 18 mg/kg in background samples (Tables 2.1 and 2.2). All of the detected concentrations in Site and background samples analyzed by the laboratory exceeded the COPC Selection SL of 0.68 mg/kg and the SLERA COPEC Selection ESV of 0.25 mg/kg. All non-detect results were also greater than the COPC Selection SL and SLERA COPEC Selection ESV. A total of 392 XRF measurements of arsenic were recorded in Site samples, with 244 detections greater than the XRF detection limit. XRF detections for arsenic ranged from 5.5 to 787 mg/kg in Site samples and from 6 to 15 mg/kg in background samples (Tables 2.3 and 2.4). In general, XRF and laboratory data indicate that arsenic concentrations are the greatest below and immediately adjacent to the penstock within the top 1 foot of soil. The greatest laboratory arsenic concentration, 94 mg/kg, was detected at Transect 15, location T15-5E, at a depth of 0.5 feet bgs with a corresponding XRF reading of 139 mg/kg. However, XRF and laboratory data show decreasing concentrations with depth and laterally away from the penstock (Figure 1 of Appendix B; Tables C.2a and C.4a). The lateral extent of elevated arsenic concentrations is generally broader in the lower half of the penstock where the slope is not as steep and where bedrock is not present.
- **Cadmium:** Based on the historical source of contamination at the Site, cadmium was not expected to be a COPC. However, in 2014, Hart Crowser submitted four soil samples with the greatest lead concentrations to be analyzed for cadmium to evaluate potential disposal requirements. These four samples and three background samples were analyzed for cadmium. Cadmium was detected in all samples. Cadmium

concentrations ranged from 0.23 to 0.82 mg/kg in Site samples and from 0.29 to 0.46 mg/kg in background samples (Tables 2.1 and 2.2). None of the samples exceeded the COPC Selection SL of 2 mg/kg. Concentrations in three of the four Site samples and all three background samples exceeded the SLERA COPEC Selection ESV of 0.27 mg/kg. Cadmium was measured by XRF in 279 Site soil and background samples; there were no detections exceeding the XRF detection limit.

- **Chromium:** A total of 14 Site samples (collected in 2014) and three background samples were analyzed for total chromium. Chromium was detected in all samples. Chromium concentrations ranged from 12 to 40 mg/kg in Site samples and from 30 to 37 mg/kg in background samples (Tables 2.1 and 2.2). Because Site samples did not show elevated chromium concentrations compared to the background samples, chromium was not analyzed in more recent laboratory samples. None of the samples exceeded the COPC Selection SL of 2,000 mg/kg. All Site samples and all three background samples exceeded the SLERA COPEC Selection ESV of 0.34 mg/kg, which is based on the more toxic chromium(VI), not total chromium. A total of 392 XRF measurements of chromium were recorded in Site samples, with 42 detections greater than the XRF detection limit. XRF detections for chromium ranged from 11 to 152 mg/kg in Site samples (Table 2.3). Chromium was not detected by XRF at concentrations greater than the XRF's detection limit in any of the background samples (Table 2.4).

- **Copper:** A total of 14 Site samples were analyzed for copper; none of the background samples were analyzed for copper. Copper was detected in all Site samples with concentrations ranging from 14 to 47 mg/kg (Table 2.1). None of the samples exceeded the COPC Selection SL of 310 mg/kg. All Site samples, except one, exceeded the SLERA COPEC Selection ESV of 14 mg/kg. A total of 392 XRF measurements of copper were recorded in Site samples, with 75 detections greater than the XRF detection limit. XRF detections for copper ranged from 8 to 1,556 mg/kg in Site samples (Table 2.3). Copper was not detected by XRF at concentrations greater than the XRF's detection limit in any of the background samples (Table 2.4).

- **Lead:** A total of 56 Site samples and 13 background samples were analyzed for lead. Lead was detected in 98% of the Site samples and 92% of the background samples. Lead concentrations ranged from 6.9 to 2,000 mg/kg in Site samples and from 6.9 to 27 mg/kg in background samples (Tables 2.1 and 2.2). All of the Site samples, but none of the background samples, exceeded the COPC Selection SL of 250 mg/kg (Table C.2a). All Site and background samples exceeded the SLERA COPEC Selection ESV of 0.94 mg/kg. The non-detect results in Site and background soil samples also exceeded the ESV. A total of 392 XRF measurements of lead were recorded in Site samples, with 382 detections greater than the XRF detection limit. XRF detections for lead ranged from 9 to 5,485 mg/kg in Site samples and from 10 to 21 mg/kg in background samples (Tables 2.3 and 2.4). The greatest laboratory concentration for lead, 2,000 mg/kg, was detected along Transect 6 at location T6-E-5ft within the top 6 inches, which also had an XRF reading of 1,837 mg/kg. However, Figure 2.4 shows that concentrations decrease laterally to the east and west of the penstock along Transect 6. In general, XRF and laboratory data indicate that lead concentrations are the greatest below and immediately adjacent to the penstock within the top 1 foot of soil. Concentrations decrease with depth and laterally away from the penstock (Figure 2.4). The lateral extent of elevated lead concentrations is generally similar across the entire penstock but is slightly broader in the upper half of the penstock, along Transect 6, where the terrain is steep and very little soil is encountered over exposed bedrock.

- **Mercury:** Similar to cadmium, mercury was not anticipated to be a COPC based on the historical source of contamination at the Site. However, in 2014, Hart Crowser submitted four soil samples with the greatest lead concentrations to be analyzed for mercury to evaluate potential disposal requirements. These four samples and three background samples were analyzed for mercury. Mercury was detected in all Site samples with concentrations ranging from 0.031 to 0.35 mg/kg (Table 2.1). Mercury was not detected in the background samples (Table 2.2). None of the samples exceeded the COPC Selection SL of 1.1 mg/kg. All Site samples and the non-detect results in background samples exceeded the COPEC Selection ESV of 0.013 mg/kg.
- **Zinc:** A total of 34 Site samples and 10 background samples were analyzed for zinc. Zinc was detected in all samples with concentrations ranging from 39 to 980 mg/kg in Site samples and from 17 to 100 mg/kg in background samples (Tables 2.1 and 2.2). None of the samples exceeded the COPC Selection SL of 2,300 mg/kg. All Site samples and all background samples exceeded the SLERA COPEC Selection ESV of 6.62 mg/kg. A total of 392 XRF measurements of zinc were recorded in Site samples, with 387 detections greater than the XRF detection limit. XRF detections for zinc ranged from less than the XRF detection limit to 2,802 mg/kg in Site samples and from 24 to 104 mg/kg in background samples (Tables 2.3 and 2.4). Zinc concentrations are the greatest below and immediately adjacent to the penstock within the top 1 foot of soil. Similar to the other metals, XRF results indicate that zinc concentrations decrease with depth and laterally away from the penstock (Figure 3 and Table 2 of Appendix B). The greatest laboratory zinc concentration, 980 mg/kg, was detected in Transect 15 in location T15-5E at a depth of 0.5 feet bgs, which had a corresponding XRF reading of 639 mg/kg. The lateral extent of elevated zinc concentrations is generally broader in the lower half of the penstock, particularly along Transect 14.

PAHs in the EE/CA Soil Dataset

A total of 17 Site samples and three background samples were analyzed for PAHs.

- At least one cPAH compound was detected in 94% of the Site samples and 33% of the background samples. Total cPAH TEQ concentrations (calculated with non-detect results set to zero) ranged from 0.0024 to 2.3 mg/kg in Site samples and from non-detect to 0.0014 mg/kg in the background sample (Tables 2.1 and 2.2). Nine of the Site samples exceeded the COPC Selection SL of 0.10 mg/kg. None of the background samples exceeded the SL. There are no SLERA COPEC Selection ESVs for total cPAH TEQ.

Soil analytical data collected during the 2018 post-saddle investigation show cPAH TEQ exceedances along Transect 24 beneath the penstock and in soil samples collected 5 and 10 feet west of the penstock; however, concentrations decreased to less than the SL of 0.10 mg/kg at 15 feet west of the penstock and 5 feet east of the penstock. Bedrock was encountered within the top 3 inches along Transect 24 (Figure 2.5).

- At least one HMW PAH compound was detected in all samples. Total HMW PAH concentrations (calculated with non-detect results set to zero) ranged from 0.011 to 21 mg/kg in Site samples and from 0.017 to 0.046 mg/kg in background samples. Eight of the Site samples exceeded the SLERA COPEC Selection ESV of 1.1 mg/kg. None of the background samples exceeded the ESV. There are no COPC Selection SLs for total HMW PAHs.

SVOCs in the EE/CA Soil Dataset

- Bis(2-chloroethyl)ether was analyzed in nine Site samples and three background samples. Bis(2-chloroethyl)ether was detected in only one Site sample at a concentration of 0.26 mg/kg and was not detected in the background samples. The one detected result exceeded the COPC Selection SL of 0.23 mg/kg. No SLERA COPEC Selection ESVs are available.
- Bis(2-ethylhexyl)phthalate was analyzed in nine Site samples and three background samples. Bis(2-ethylhexyl)phthalate was detected in 56% of the Site samples and was not detected in the background samples. Concentrations ranged from 0.048 to 0.27 mg/kg in Site samples. None of the samples exceeded the COPC Selection SL of 39 mg/kg, and five of the Site sample results exceeded the SLERA COPEC Selection ESV of 0.020 mg/kg.

SPLP Results from Maximum Concentration Soil Samples

SPLP analysis was conducted on the four Site samples that contained the greatest metals concentrations detected at the Site. The SPLP results are presented in Table 3 of Appendix B, and the results for detected concentrations of arsenic, lead, and zinc are summarized as follows:

- Arsenic was detected in two of the four SPLP samples with concentrations ranging from 0.0035 to 0.0059 milligrams per liter (mg/L).
- Lead was detected in three of the four SPLP samples with concentrations ranging from 0.021 to 0.030 mg/L.
- Zinc was not detected in any of the SPLP samples.

Metals in Sediment

Sediment results were included in the Site soil dataset described in Section 2.9.4.1. The XRF measurements are presented in Table 2 of Appendix B, and the chemistry results are summarized in Tables C.2a and C.4a. XRF measurements and analytical results are summarized in this section.

Additionally, in consideration of potential impacts to benthic invertebrates that may be present at the Site and are present in the Skagit River, the XRF and analytical results were also compared to the Sediment Management Standards (SMS) Freshwater Sediment Cleanup Objectives (SCOs) and Cleanup Screening Levels (CSLs) Chemical Criteria (WAC-173-204-563). The SMS criteria apply to freshwater sediments for toxicity to the benthic community. Chemical concentrations at or less than the SCOs correspond to sediment quality that results in no adverse effects to the benthic community, and chemical concentrations at or less than the CSLs correspond to sediment quality that results in minor adverse effects to the benthic community.

- Ten XRF measurements were collected in the sediment deposited within the ephemeral stream channel.
    - Arsenic was detected in 3 of the 10 XRF samples, and measurements ranged from 8.0 to 72 mg/kg. One of the arsenic XRF measurements (SED #139) exceeded the arsenic SCO of 14 mg/kg but not the CSL of 120 mg/kg. Of the sediment samples, sample SED #139 is located the farthest upstream and is the closest to the penstock.
    - Lead was detected in all 10 XRF samples, and measurements ranged from 13 to 1,016 mg/kg. One of the lead XRF measurements (also from SED #139) exceeded the SCO of 360 mg/kg but not the CSL of 1,300 mg/kg.
    - Zinc was detected in all 10 XRF samples, and measurements ranged from 44 to 75 mg/kg. None of the sample measurements exceeded the SCO or CSL for zinc of 3,200 and 4,200 mg/kg, respectively.
    - Other Site COPCs and COPECs (cadmium, chromium, and copper) showed non-detect XRF measurements, and mercury readings were not recorded.
- XRF measurements were collected in the sediment deposited within the intermittent stream, downstream of the ephemeral stream channel.
    - Arsenic was not detected in any of the XRF samples.
    - Lead was detected in both XRF samples with measurements of 24 and 42 mg/kg. The lowest measurement (24 mg/kg) was from the most downstream sediment sample (NHP-SED-2). Neither of the lead measurements exceeded the SCO or CSL.
    - Zinc was detected in both XRF samples with measurements of 45 and 54 mg/kg. Neither of the zinc measurements exceeded the SCO or CSL.
    - Other Site COPCs and COPECs (cadmium, chromium, and copper) were not detected by XRF. XRF measurements for mercury were not recorded.
- Metals were analyzed from the sediment sample deposited within the intermittent stream (NHP-SED-1).
    - Arsenic was not detected.
    - Lead was detected at a concentration of 15 mg/kg and did not exceed the SCO or CSL.
    - Zinc was detected at a concentration of 39 mg/kg and did not exceed the SCO or CSL.

Based on these results, which indicate metals COPCs and COPECs are not migrating downstream at concentrations that would cause adverse effects to the benthic community, risks to aquatic receptors—including benthic invertebrates, fish (not present at the Site), amphibians, and reptiles—were not further quantified in the risk assessment. Risks from pathways that were quantified in the risk assessment (Section 3.0) are expected to be much greater than risks from pathways that were not quantified.

2.9.4.3 XRF Data Use in the EE/CA

XRF data were used primarily as a screening tool to inform soil sample collection for chemical analysis and to support the characterization of the nature and extent of contaminated soil at the Site. XRF data were not used to identify COPCs or COPECs and were not used in the SLERA; however, if there was a strong correlation between the chemistry data and the XRF data, XRF data were included in the estimation of exposure point concentrations (EPCs) described in Sections 3.1.2.5 and 3.2.3.1. The XRF and chemistry data correlation analysis is described as follows.

XRF data were included in EPCs if there was a strong correlation (r-squared greater than 0.7) between the chemistry data and the XRF data. The r-squared value was determined based on the best fit line of the chemistry data and the corresponding XRF result. Only detected data were used for the correlation analysis. XRF and chemistry data result pairs were excluded from the correlation evaluation if the ratio of the pair was greater than 5:1 or 1:5, indicating potentially anomalous XRF results. XRF results identified as outliers based on Rosner's Outlier Test, conducted on all detected XRF results using ProUCL version 5.1 (USEPA 2015), were also excluded from the correlation analysis. ProUCL output for Rosner's Outlier Tests and scatterplots showing the best fit lines and r-squared values are included in Appendix D.

The r-squared values for the best fit lines of the paired XRF and chemistry results for arsenic, lead, and zinc were 0.95, 0.84, and 0.86 respectively. The r-squared values for the best fit lines of the paired XRF and chemistry results for chromium and copper were 0.51 and 0.0089, respectively. Based on these results, adjusted XRF data for arsenic, lead, and zinc were included in the EPC calculations. Detected XRF data for these chemicals were adjusted using the equation of the best fit line. Non-detect XRF results were reported at the instrument detection limit and were not adjusted. Adjusted data with negative values were conservatively replaced with the original XRF result. The chemistry data, original XRF data, and adjusted XRF data for COPC and COPEC metals are included in Appendix D.

2.9.4.4 Data Usability

A data usability assessment was completed for the data included in this EE/CA. Overall, analytical data were acceptable for use as determined through the data validation process. Based on the results of the XRF data evaluation described in Section 2.9.4.3, adjusted XRF data for arsenic, lead, and zinc were included in the EPC calculations. Analytical data and XRF data from sample locations that were excavated during saddle replacement activities in 2016 and 2017 were not included in the EE/CA soil dataset.

Site data were also evaluated for representativeness prior to making a data usability determination. Laboratory-analyzed and XRF sample locations are shown for selected contaminants in Figures 1 through 5 of the data report memorandum in Appendix B. Metals XRF and chemistry samples were collected along the length of the penstock, and out to 40 feet to the west and east of the centerline of the penstock, providing good spatial coverage of the Site. Most metals samples were collected within the 0- to 1-foot surface interval, but samples have also been collected down to 3.25 feet bgs to support the vertical delineation of contamination. The vertical and lateral extent of lead and cPAH TEQ concentrations are shown on Figures 2.4 and 2.5. Figures 2.6 and 2.7 show the approximate locations of Transects 4, 22, and 23 on a Site photograph and include charts showing the concentrations of lead and chromium at each of the sample locations along the transects. The charts show that lead and chromium concentrations decrease as distance from the penstock centerline increases.

Summary statistics for analytical data and XRF measurements for the Site and background soil datasets are presented in Tables 2.1 to 2.4. These tables also present the SLERA COPEC Selection ESVs for plants and invertebrates and for birds and mammals, and the COPC Selection SLs. Percent exceedance of the minimum ESV or SL is summarized for detected and non-detect results. Non-detect results are reported at the laboratory reporting limit (RL) or the method detection limit (MDL) when available. For the analytical Site soil dataset, out of 88 chemicals with SLERA COPEC Selection ESVs or COPC Selection SLs, eight chemicals had non-detect results that were greater than the minimum ESV or SL. Four of those chemicals (arsenic, lead, molybdenum, and bis(2-ethylhexyl)phthalate) also had detected results. The FOD for these chemicals was 54%, 98%, 39%, and 56%, respectively (Table 2.1). Arsenic, lead, and bis(2-ethylhexyl)phthalate were identified as COPCs or COPECs and were evaluated in the risk assessments; molybdenum was not identified as a COPC or COPEC. The remaining four chemicals with non-detect results that were greater than the minimum ESV or SL, 2,4-dimethylphenol, benzidine, di-*n*-butyl phthalate, and *N*-nitrosodimethylamine, were not detected in any samples. Although only the RLs were originally reported in the laboratory reports, the MDLs were requested from the laboratory for those chemicals and were compared to the minimum ESV or SL. The MDLs were also greater than the minimum ESV or SL, indicating that the data quality objective for the RLs and MDLs (the RL and/or MDL should be less than the minimum ESV or SL) for these chemicals was not met. Because the MDLs were greater than the minimum ESV and SL for these four chemicals, and to maintain consistency in the Site soil dataset, the non-detect results were maintained at the RL.

For arsenic, lead, and zinc, EPCs were calculated using the adjusted XRF results and included between 386 to 411 results, capturing the range of concentrations occurring at the Site. The FOD for XRF measurements for these chemicals was 62%, 97%, and 99%. The XRF detection limits were greater than the minimum SLERA COPEC Selection ESVs or COPC Selection SLs. Fourteen results were available for chromium and copper, and four results were available for cadmium and mercury. Although the number of results for cadmium and mercury in the Site soil dataset was comparatively low, sample analysis for these chemicals was triggered based on high concentrations of lead. Because lead paint was the primary historical source of contamination at the Site the results for cadmium and mercury are conservative (biased high) and are appropriate for use in the risk assessment.

To evaluate PAHs and SVOCs, samples were collected near the former wood saddles and are representative of the highest concentrations present at the Site. Seventeen PAH samples and nine SVOC samples were collected and were determined to be acceptable for use in the risk assessment. The PAH and SVOC data provide a conservative evaluation of risk, because the data were collected from the areas with the highest potential concentrations on-Site. In summary, the Site data were determined to be valid and representative of Site conditions and, therefore, appropriate for use in the EE/CA.

Background data were also evaluated for representativeness prior to making a data usability determination. Summary statistics for XRF and analytical data for the background soil dataset are presented in Tables 2.2 and 2.4. Samples collected in the vicinity of the Site and outside the influence of impacts from the penstock were considered representative of background conditions and were included in the background soil dataset. Background data are summarized in Section 2.9.4.2 and are also discussed in Section 2.9.6.

2.9.5 Chemical and Physical Properties of Selected Site Contaminants

2.9.5.1 Arsenic

Arsenic is a metalloid and is commonly treated as a metal. Arsenic forms various complexes depending on the prevailing soil and groundwater geochemistry. Arsenic comes from both natural and anthropogenic sources. Under most conditions, arsenic tends to adsorb to soil, forming relatively insoluble and immobile complexes with iron, aluminum, and magnesium oxides. Arsenic can also change mineral forms due to weather, generally becoming more stable and less available for solubilization and uptake over time. The factors most strongly influencing arsenic mobility in water include reduction–oxidation potential, pH, metal sulfide and sulfide ion concentrations, iron concentrations, temperature, salinity, distribution and composition of the biota, season, and the nature and concentration of natural organic matter. For example, arsenic is naturally sequestered in subsurface environments with significant peat content.

2.9.5.2 Lead

Lead is a naturally occurring metal; however, where lead concentrations are elevated, the source is generally anthropogenic. Lead compounds were historically used as a pigment in paints, which is the most likely source of lead at the Site. Lead exists in various forms and tends to be relatively immobile. Common forms of lead are strongly sorbed to organic matter in soil and are generally considered immobile in soil; little lead is transported through runoff to surface water or leaching to groundwater. The solubility of lead in water is a function of pH, hardness, salinity, and the presence of humic material.

2.9.5.3 Polycyclic Aromatic Hydrocarbons

The transport and fate of PAHs in the environment are largely determined by physical and chemical properties such as their Henry's law constant and organic carbon to water partition coefficient (K_{oc}). These properties are approximately correlated to their molecular weights. PAHs have moderate to strong soil sorption capacity and low water solubility, with higher molecular weight PAHs having greater sorption capacity and lower water solubility. Therefore, they are fairly immobile in soil and do not readily leach to groundwater or solubilize in surface water. PAHs may be degraded in soil; the principal process for degradation of PAHs in soil is microbial metabolism. Degradation rates are affected by the degree of contamination, environmental factors, the soil organic content, the soil structure and particle size, characteristics of the microbial population, the presence of contaminants toxic to microorganisms, and the physical and chemical properties of the PAHs (ATSDR 1995).

2.9.6 Background and Reference Concentrations

2.9.6.1 Background Studies

Metals occur naturally in the bedrock and soil in Washington due to the geologic processes that formed these layers. These metals concentrations are considered natural background. Additionally, some persistent contaminants such as PAHs can be found in soil and sediment throughout Washington. These concentrations are also considered natural background.

The background soil dataset consists of 19 samples, 3 soil samples collected by Hart Crowser in 2015 as part of the TCRA and 16 soil samples collected by Floyd|Snider in 2018. All background soil samples were collected from the 0- to 6-inch-bgs depth interval. A summary of naturally occurring Site-specific background concentrations in Site samples is provided in Appendix C (Tables C.2a through C.2c and C.4a through C.4c). Background sample locations are shown on Figure 2.3, and background concentrations of select contaminants are shown on Figures 1 through 5 of Appendix B. A detailed summary of the detected analytical results of the COPCs and COPECs in background soil samples is presented in Section 2.9.4.2.

The background samples collected in 2015 were collected as part of the Ladder Creek Tank Site work. They were collected from burned areas with soil characteristics that were like those observed at the Site to assess the impact of the 2015 Goodell Fire on PAH concentrations in soil. Metals were measured in all three samples using an XRF spectrometer, and the samples were also submitted for chemical analysis of PAHs, SVOCs, volatile organic compounds (VOCs), and metals.

The 2018 samples were also collected in background areas with soil characteristics that were like those observed at the Site. Metals were measured in all 16 samples using an XRF spectrometer. Ten of the samples were also submitted for chemical analysis of arsenic, lead, and zinc.

2.9.6.2 Summary of Relevant Background Values

Site background data and Washington natural background concentrations (Ecology 1994) were considered in two elements of the risk assessments (refer to Sections 3.1.2.7 and 3.2.3.3). Background values were not used to develop preliminary removal goals (PRGs).

2.9.7 Physical Site Characteristics Affecting Contaminant Migration

The primary physical characteristics at the Site as described in the previous sections with the potential to affect contamination migration are the following:

- **Geology:** the presence of exposed and shallow bedrock and bedrock talus
- **Hydrology:** seasonal runoff in the ephemeral and intermittent streams
- **Hydrogeology:** the presence of shallow groundwater
- **Topography:** the steep grades in portions of the Site affecting both the migration of contaminants and the ability of receptors to access the Site

2.9.8 Site-Specific Contaminant Transport

The primary contaminant transport mechanisms at the Site as described in the previous sections are the following:

- Historical flaking and chipping of penstock coatings into soil and rock surrounding the penstock
- Historical leaching of PAHs from treated wood support structures (removed in 2017)
- Erosion of surface soil from the penstock vicinity via steep slope erosion or surface water transport in the ephemeral and intermittent streams

2.10 CURRENT/FUTURE LAND USES

The Site and surrounding lands are located within Ross Lake National Recreation Area, in NOCA, and the Site is owned by the NPS. Current land use at the Site includes the operation of the penstock by City Light under a FERC license; recreational use by the public; and usual and accustomed activities, including hunting and gathering by the Upper Skagit Indian Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Indian Tribe. In January 2022, City Light filed a license surrender application with the Federal Energy Regulatory Commission (FERC) to decommission the Newhalem Creek Hydroelectric Project. The details of the decommissioning process are under consideration. Decommissioning the project will not change the current land use aside from operation of the penstock.

Recreational activities in the vicinity of the Site include hiking and camping. Visitors, City Light staff, and NPS staff can use the trail system (Trail of the Cedars, the linking trail to the Lower Newhalem Creek Trail, and the flood escape route trail) in the vicinity of and adjacent to the penstock. Although connected to the Trail of the Cedars and open to the public, the flood escape route trail leading to the upper sections of the penstock is used mainly by City Light for operations and maintenance and is referenced as the operations and maintenance trail in this EE/CA.

The NPS Newhalem Creek Campground is located approximately 0.25 miles west of the Site (Figure 1.2). The campground has three loops with individual, group, and family sites, which can hold up to 30 people. Campers can drive to the powerhouse on an unpaved road or can walk using the road or linking trails.

The Site property is expected to remain under the ownership of the United States federal government and will be managed by NPS in perpetuity. The property ownership, management, and land use for the area, and more specifically in the vicinity of the penstock and powerhouse, are not expected to change.

2.11 CONCEPTUAL SITE MODEL

The CSM is used to organize and communicate information about the Site and summarize how and where contaminants may move in the environment. Figure 2.8 depicts the CSM, which graphically represents the current understanding of the Site, including conditions at the Site that affect how chemical contaminants have been released and are transported in the environment. The risks posed to human health and the environment from the Site conditions shown in the graphical CSM are then evaluated by looking at the populations with the potential to encounter the contamination and the different routes through which this exposure may occur. Figures 2.9 and 2.10 are pathway–receptor diagrams showing sources of contamination, exposure media, exposure pathways, and populations of concern for humans (Figure 2.9) and ecological receptors (Figure 2.10). Additional detail on the features of the CSM, including sources of contamination, transport in the environment, receptors of concern, and exposure pathways are provided in the following sections.

2.11.1 Sources of Contamination

Site investigations have shown that soils across the Site have been impacted by metals, which are thought to have originated from the flaking and chipping of lead-based paint that historically coated the penstock. Flaking and chipping of paint likely occurred during maintenance activities and because of general weathering, prior to recoating of the penstock with its current, more robust coating. Lead-based paints were banned in 1978, and the penstock has been repainted multiple times since then.

Although there are no other current sources of metals at the Site, lead and arsenic were documented in paint chip samples from the historical (pre-1978) green paint that underlies more recent paint coatings (RGA 2009). The current exterior penstock coating is in very good condition and is considered a good encapsulant, containing the historical coating layers beneath it. Disturbance of the outer layer leading to the flaking and chipping of historical underlayers may be a current, although minor, source of ongoing contamination and would be associated with maintenance events or disturbance to the coating from events like downed trees contacting the penstock.

PAHs were observed in the soil surrounding the penstock's former wood support structures in previous investigations conducted between 2014 and 2018. Analytical data from the structures and the soil surrounding the original wood supports indicate the wood was preserved with creosote, which leached PAHs into immediately adjacent soil (Hart Crowser 2014). However, soil surrounding 52 of the original penstock supports was removed from the Site during the TCRA in conjunction with the saddle replacement project, as described in Section 2.9. The wood supports were replaced with cast-in-place concrete pedestals, removing the source of PAHs.

Although there are no other current anthropogenic sources of PAHs, residues from the 2015 Goodell Fire that burned much of the area surrounding the Site, including several of the referenced wooden penstock saddle supports, are a potential source of PAHs that may still reside in burned wood and other organic materials on the ground surface throughout the burned forest area surrounding the Site; however, data do not indicate the wildfire resulted in an area-wide PAH impact.

2.11.2 Transport in the Environment

- **Surface Water Transport.** Contaminants may be carried in surface water runoff from areas with contaminated soil to downgradient soil and sediment. An intermittent stream runs adjacent to and on the east side of the penstock, flowing down the slope toward the powerhouse. A small ephemeral stream west of the penstock that includes runoff from the hillside upslope of the penstock approaches and then runs adjacent to (and in one location, beneath) the penstock. During precipitation events, this ephemeral stream connects into the intermittent stream on the eastern side of the penstock. The intermittent stream flows for most of the year, except during the dry season in the summer. The XRF results from the ephemeral and intermittent stream channels indicate that sediment within the streambed proximal to the penstock appears to have been impacted by the penstock and its structural components; however, if this sediment were to migrate down the intermittent channel to the Skagit River floodplain, some or most of the sediment would likely be contained at the culvert structures before the stream joins the tailrace, and then finally by the tailrace fish barrier wall, substantially reducing the potential for transport to the Skagit River. Although soil or sediment from the Site may be entrained in intermittent stream flow that reaches the tailrace, the rocks and sediments accumulated in the tailrace are primarily those occasionally entrained in high Newhalem Creek flows at the diversion above the Site and discharged to the tailrace via the penstock and powerhouse. The contribution of sediment to the tailrace from the intermittent stream is likely minor compared to that of Newhalem Creek. Sediment in the tailrace is not known to have overtopped the fish barrier to date. City Light conducts inspections to maintain this condition. If suspended sediments did not settle out at the fish barrier, they could be discharged to the Skagit River. If this were to occur, Site COPCs/COPECs could be present at detectable concentrations in these sediments; however, analytical results (NHP-SED-1) and XRF measurements (NHP-SED-2) indicate that such concentrations would be less than the SMS SCO and CSL and thus protective of the benthic community.

  The 2015 Goodell Fire left portions of the Site scorched of vegetation and likely increased erosion and the potential for contaminant migration. However, this condition lasted only a few months until area vegetation naturally recruited and was re-established in abundance.

- **Groundwater Transport.** Contaminants in soil and sediment could potentially leach to shallow groundwater, which could then re-emerge as surface water, or migrate as groundwater downgradient to the Skagit River. However, based on the small size of the Site relative to the surrounding groundwater contribution area, the likely high rate of attenuation of contaminants that would occur during migration underground through soil and rock, and the minuscule fraction of water discharge from this area would represent in the total flow of the Skagit River, it is unlikely that Site contaminants would result in detectable concentrations or unacceptable risks to aquatic receptors within the Skagit River. There is one potable well in the area, located approximately 0.25 miles upriver, on the opposite (north) side of the Skagit River from the Site, which the town of Newhalem uses for its domestic water supply. Based on topography and predominant hydrologic conditions, it is extremely unlikely that Site contaminants could migrate to the well.
- **Air Transport.** Contaminants in soil and sediment may be spread by wind; however, this pathway was not considered relevant for this Site because the forested hillsides, heavy undergrowth vegetation, and existing duff layer present throughout most areas of the Site protect against material transport by wind. As mentioned previously, impacts from the 2015 Goodell Fire may have temporarily increased the potential for contaminant migration; however, this condition lasted only a few months until area vegetation naturally recruited and was re-established in abundance.

2.11.3 Receptors of Concern

2.11.3.1 Human Receptors

The people that could contact Site-related contaminants include site workers (City Light, NPS, or construction workers) and site visitors (including tribal members). Figure 2.9 presents potential exposure pathways for human receptors. Site visitor scenarios were evaluated for both adults and children. In addition, a residential exposure scenario was evaluated for the purpose of comparison with other NPS sites. A description of human receptors (potentially exposed populations) is provided in Section 3.1.2.1.

2.11.3.2 Ecological Receptors

Species with the potential to contact Site contamination, with risks from pathways that were quantified in the ecological risk assessment, include plants, soil invertebrates, birds, mammals, amphibians, and reptiles (Figure 2.10).

Fish are not present at the Site; therefore, aquatic receptors were not evaluated in this EE/CA. Risks to amphibians were not quantified in the risk assessment.

2.11.4 Exposure Pathways

Exposure pathways were evaluated and determined to be complete and quantified in the risk assessment; complete and not quantified in the risk assessments; or incomplete. The determination for each exposure pathway is shown in Figures 2.9 and 2.10 and summarized in this section. Additional detail is provided in Sections 3.1.2 and 3.2.1.

For site workers and site visitors, the following exposure pathways to soil are complete and quantified in the HHRA:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of dust derived from surface soil

For ecological receptors, the following exposure pathways to soil are complete and were quantified in the Ecological Risk Assessment:

- Terrestrial plants: direct contact of the roots with soil
- Soil invertebrates: direct contact with and ingestion of soils
- Birds and mammals: ingestion of contaminants in or on food items and incidental ingestion of soil while feeding or digging

Birds and mammals may also experience direct contact (i.e., dermal exposure) to soil and may inhale airborne dust. However, these exposure pathways are usually considered to be minor compared to exposures from ingestion (USEPA 2005).

The exposure pathway for terrestrial ecological receptors through ingestion and direct contact with surface water was determined to be complete but was not quantified in the risk assessment. Risks to receptors from potentially encountering contaminants in stream water are expected to be much lower than risks from soil exposure because exposure is limited (the ephemeral stream runs only during rain events, and the intermittent stream does not run in the summer and has limited volume of surface water during the late spring and early fall) and impacts to surface water from contaminated soil are expected to be low due to the low residence time of surface water in the streams. Aquatic receptors were not evaluated in this EE/CA, because fish are not present at the Site, and benthic invertebrates, if present, are expected to be a minor component of the invertebrate community relative to the terrestrial invertebrates.

When the ephemeral and intermittent streams are flowing, soil that is present in those streambeds may provide limited sediment habitat for a small number of benthic invertebrates that are adapted to transient environmental conditions. For portions of the year, however, the streambeds are dry. During such time periods, the soil in these streambeds provides habitat for terrestrial invertebrates. In addition, people encountering the dry streambed could be exposed to soil in the same manner by which they are exposed to soil in other parts of the Site. Because these streambeds dry out, exposure to these areas by people and ecological receptors was assessed via soil exposure pathways, rather than sediment exposure pathways.

Contaminants in soil may migrate to shallow groundwater. Terrestrial plants and invertebrates and burrowing mammals could potentially be exposed to shallow groundwater; therefore, this pathway was determined to be complete but was not quantified in the risk assessment.

In summary, for humans, soil is the only environmental medium that populations are expected to encounter on an ongoing basis. Similarly, for ecological receptors, exposure to contaminants via soil and ingestion of prey (e.g., earthworms) are the only complete exposure pathways expected to occur on an ongoing basis. Risks from these pathways are expected to be much greater than risks from pathways that were complete but not quantified, and as such, the risk assessments conducted in Section 3.0 focus on this primary medium and exposure pathway.

3.0 Risk Assessment

The purpose of Section 3.0 is to describe the potential risks to human health and ecological receptors posed by contamination at the Site.

Risk assessments provide an estimation of the potential threat to human health and the environment posed by Site contaminants. The results of the risk assessment are used to determine if potential risks are unacceptable and, if so, to establish risk-based Preliminary Removal Goals (PRGs) that must be satisfied when selecting final removal goals (RGs), unless there are extenuating circumstances, such as background values that are greater than the PRGs. EE/CA guidance (USEPA 1993a) discusses the use of streamlined risk evaluations for an EE/CA when used for interim response actions. However, when the EE/CA is the basis for selecting a final response action, streamlined risk evaluations are not sufficient. Instead, an HHRA and a SLERA are developed for the Site (USDOI 2018). A BERA may be required if the SLERA identifies the need to refine the ecological risk assessment with Site-specific or receptor-specific information. In accordance with risk assessment guidance, a baseline risk assessment is to evaluate potential adverse effects caused by hazardous releases from a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action).

A Site-specific HHRA and an ecological risk assessment, including both a SLERA and BERA, were completed for the Site. The methods and results for the HHRA and the ecological risk assessment are presented in Sections 3.1 and 3.2, respectively.

3.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

The baseline HHRA was prepared according to USEPA guidance on conducting HHRAs at CERCLA sites (USEPA 1989). The EE/CA soil dataset (site investigation soil and sediment data) used for the risk assessment was collected from 2014 to 2018. These data are summarized in Section 2.9.4.

The HHRA includes the following components:

- Hazard identification
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Uncertainty assessment

3.1.1 Hazard Identification

COPCs were identified using a tiered process based on FOD and a comparison of site soil data to COPC Selection SLs. The Human Health COPC Selection SLs are the minimum of the USEPA Regional Screening Levels (RSLs; target cancer risk [TR] = 10^{-6}, target hazard quotient [HQ] = 0.1) and MTCA Method A SLs, or the MTCA Method B SL if a MTCA Method A SL was not available.

These SLs are based on assumptions derived from a residential exposure scenario. These conservative SLs ensure that potential contaminants are not prematurely rejected and are carried through the risk assessment and ARAR analysis specific to the Site.

The process for identifying COPCs is summarized as follows:

- Compare the EE/CA soil data to the COPC Selection SLs.
- Eliminate analytes that were not detected at the Site and have no history of Site use.
- Retain as COPCs analytes with maximum results that are greater than the respective SLs.

The COPCs are summarized in Table 3.1 and include two metals (arsenic and lead), bis(2-chloroethyl)ether, five PAH compounds, and a calculated cPAH TEQ. FOD and minimum and maximum values for all analytes are summarized in Tables 2.1 through 2.4. The COPC selection screening tables are presented in Tables C.2a through C.2c in Appendix C. Because the five PAH compounds are all considered to have carcinogenic potential and were included in the cPAH TEQ calculation, excess cancer risks were not quantified for each individual cPAH compound that was identified as a COPC. The cPAH TEQ adequately represents these compounds for cancer risk assessment. The individual PAHs were evaluated for non-cancer effects. Chemicals not selected as COPCs are summarized in Table C.3 in Appendix C. Chemicals not selected as COPCs because of the lack of screening values are discussed in the uncertainty assessment (Section 3.1.5.2).

3.1.2 Exposure Assessment

This section describes how people may come in contact with Site-related contaminants. It includes the exposure populations, pathways, parameters, and the equations used to quantify the exposure. The exposure populations and pathways are also depicted and discussed in the human health pathway receptor diagram in Figure 2.9.

3.1.2.1 Potentially Exposed Populations

The Newhalem Penstock, which was constructed in the 1920s, conveys water to the Newhalem Powerhouse for power generation. The current land use of the Site is expected to continue. The people who could contact Site-related contaminants include site workers and site visitors (e.g., hikers and tribal members). In addition to site worker and site visitor exposure scenarios, a residential exposure scenario was evaluated. Although residential land use is not considered a feasible future land use scenario at the Site, the residential scenario was included at the request of NPS for consistency with the NPS EE/CA process and for the purpose of comparison with other NPS sites. Risks calculated for this hypothetical residential scenario were not used to inform the development of PRGs.

Two different site worker scenarios were developed. The first site worker scenario represents NPS or City Light employees conducting routine maintenance or inspection activities around the penstock. These workers would typically access the penstock area from the City Light operations and maintenance trail to the east of the penstock (Figure 1.2). Under this scenario, workers would cause limited disturbance to the penstock or surrounding structures. The second site worker scenario represents construction workers who may engage in ground-disturbing activities at or near the penstock. This scenario assumes full-time (250 work days/year) activity for a two-year duration, which could occur for a significant construction project such as removal of the penstock and the supporting saddles. No specific construction activities have been identified at this time, so this scenario represents a conservative (higher exposure frequency) potential future use condition, especially relative to the more typical penstock worker scenario of 20 days per year for 10 years. Both the site worker and construction worker scenarios were evaluated for adults only.

Site visitor scenarios were evaluated for both adults and children. The most likely type of activity that could be associated with exposure to Site contaminants is hiking. Hikers can access the powerhouse at the northern edge of the Site via the Trail of the Cedars, a 1.0-mile-long nature trail loop that runs adjacent to the Skagit River, or the Linking Trail, which runs from the Newhalem Creek Campground to the Trail of the Cedars at the powerhouse. From the powerhouse, hikers can access the City Light operations and maintenance trail. This trail is approximately 0.2 miles long and passes close to the penstock in two areas. There are no picnic tables, benches, or other visitor facilities in the area, and time spent at the Site by visitors is expected to be short in duration (less than 1 hour). Visitors can also access the powerhouse via the unpaved road that runs from the Newhalem Creek Campground to the powerhouse (Figure 1.2). Although tribal use has not been documented in the area, tribal members may access the area for usual and accustomed activities, including hunting and gathering. These activities are not expected to be significant in the area, because the plant and animal species typical to these practices are not present at the Site.

3.1.2.2 Exposure Pathways

As discussed in Section 2.11, soil is the only environmental medium that the populations described in Section 3.1.2.1 could reasonably be expected to encounter on an ongoing basis. Because the ephemeral and intermittent streams are dry during portions of the year, and in many areas become vegetated and accumulate organic material, their beds become more characteristic of soil than sediment. During such time periods, people encountering the dry streambed could be exposed to soil in the same manner by which they are exposed to soil in other parts of the Site. Because these streambeds dry out, exposure to these areas by people was assessed via soil exposure pathways, rather than sediment exposure pathways.

The following exposure pathways to soil are complete and were, therefore, evaluated quantitatively for each scenario in the HHRA:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of dust derived from surface soil

An ephemeral stream carrying runoff from the hillside upslope of the penstock runs adjacent to (and in one location beneath) the penstock, then joins the intermittent stream carrying runoff from the eastern side of the penstock that flows down the slope toward the powerhouse, and joining the tailrace. The path of the intermittent stream from where it flows away from the penstock to where it meets the fish barrier downslope from the powerhouse is approximately 500 feet in length. The lower portion of the penstock is accessed via a branch of the City Light operations and maintenance trail that crosses the intermittent stream over a wooden foot bridge (Photograph 8 in Appendix A.2). The ephemeral stream runs only during rain events, and the intermittent stream does not run in the summer and has limited volume of surface water during the late spring and early fall. Because the impacts to surface water from soil are expected to be minimal due to the small size of the Site and low residence time of surface water in the streams, and minimal exposure due to the size of the streams and lack of recreational opportunities, risks to people from potentially encountering contaminants in this water are expected to be much lower than risks from soil exposure. Therefore, this exposure medium and the associated exposure pathways were not evaluated quantitatively.

Contaminants in soil may migrate to shallow groundwater. Groundwater may be contacted by people during ground-disturbing activities or excavation activities; however, these activities are expected to occur infrequently and risks to people from potentially encountering contaminants in groundwater are expected to be much lower than risks from soil exposure. Therefore, this exposure medium and the associated exposure pathways were not quantified in the risk assessment. There is one potable well in the area, located approximately 0.25 miles upriver, on the opposite (north) side of the Skagit River from the Site, which the town of Newhalem uses for its domestic water supply. Based on the Site topography, it is not possible for contaminants in soil to migrate to groundwater used for drinking water; therefore, this pathway was determined to be incomplete. Site topography is shown on Figure 2.1.

3.1.2.3 Exposure Area

Exposure areas are defined based on the receptor, exposure medium, and the type and frequency of activities (USEPA 1989). The exposure area for this HHRA is equivalent to the geographical area over which soil was collected in the various environmental investigations, as summarized in Section 2.9. Areas characterized as background were excluded from the exposure area, although background results were evaluated as part of the risk assessment (refer to Sections 3.1.2.7 and 3.2.3.3). Twelve samples were collected from the dry ephemeral and intermittent streambeds. For the HHRA, these samples were also considered to be soil samples and were included in the dataset because the ephemeral stream runs only during rain events, and the intermittent stream does not run in the summer and has limited volume of surface water during the late spring and early fall.

Given the relatively small size of the Site (approximately 1.5 acres), a single decision unit equivalent to the entire Site was established for the HHRA. Human use patterns are not likely to differ among various locations along the penstock. This decision to include a single decision unit is also supported by the fact that elevated COPC concentrations are not limited to isolated areas, but are dispersed along the entire length of the penstock. Within this decision unit, it was assumed that a person could be randomly exposed to contaminated soil for the assumed exposure duration and at the assumed frequency, as discussed in Section 3.1.2.4.

Soil chemistry data have been collected from discrete samples at the Site from the ground surface down to 3.25 feet bgs, although the majority of the samples were collected within the upper 1 foot. Data for the HHRA exposure scenarios included all soil depth intervals, with the exception of the visitor scenario. The soil dataset for the visitor scenario was limited to surface soil within the top 6 inches. Two samples (NHP-T16-C and NHP-T19-C) that included soil from the surface down to 1 foot bgs were also included in the soil dataset for the visitor scenario. For the City Light and NPS worker scenario, construction worker scenario, and the potential future use residential scenario, all Site soil data were included because this scenario could include ground-disturbing activities such as digging.

3.1.2.4 Exposure Parameters

Exposure parameters are related to human behaviors that define the rates, time, frequency, and duration of exposure. It is expected that there will be differences in exposure between different individuals within a given receptor population due to differences in the exposure parameters. There may be a wide range of average daily exposures between different individuals of an exposed population. In this HHRA, attention is focused on exposures near the upper end of the range (e.g., 95th percentile), which is referred to as the reasonable maximum exposure (RME). Only RME values were developed for each scenario because remediation decisions for the Site will be based on RME estimates of exposure and risk. Standard default values for RME exposure parameters (USEPA 2014) were used in the HHRA. When standard default values were not available, RME exposure parameters were determined based on other sources (e.g., USEPA 2008 and 2011) and best professional judgment. The exposure factors and intake parameters used in the HHRA are provided in Table 3.2. The exposure frequency and duration are also summarized in the following table.

Exposure Frequency and Duration

Scenario	Exposure Frequency (days/year)	Exposure Duration (years)
Visitor (adult)	20	20
Visitor (child)	20	14
City Light worker	20	20
Construction worker	250	2
Hypothetical resident (adult)	365	33
Hypothetical resident (child)	365	16

3.1.2.5 Exposure Point Concentrations

Because risk assessments are based on chronic health effects, the most appropriate expression for the EPC is the long-term average concentration within the exposure area. Guidance states that "because of the uncertainty associated with estimating the true average concentration [of a contaminant] at a site, the 95 percent upper confidence limit (95% UCL) of the arithmetic mean should be used" as the EPC (USEPA 1992a). The EPCs were calculated using USEPA's ProUCL version 5.1 (USEPA 2015). The EPC was selected from the 95% UCL results based on ProUCL's recommendations. If ProUCL recommended more than one UCL, the UCL was selected from these recommendations based on best professional judgment. For COPCs without a sufficient number of detected values, as determined by the ProUCL software, the maximum detected concentration was used as the EPC. The EPCs for each COPC and exposure scenario are provided in Table 3.3. The ProUCL output is provided in Appendix E.

Adjusted XRF data were included in the EPC calculations for lead, arsenic, and zinc (refer to Section 2.9.4.3).

3.1.2.6 Dose Calculations for Non-Lead COPCs

The amount of a chemical ingested, inhaled, or absorbed through the skin is referred to as "intake" or "dose." The average daily dose (ADD) is the dose rate averaged over a pathway-specific period of exposure expressed as a daily dose on a per unit body weight basis. The exposure parameters were used to calculate the ADD for incidental ingestion and dermal intake, and an estimated chemical concentration in air for the dust inhalation pathway. The following equations were used for each exposure scenario:

Incidental soil ingestion

$$ADD = \frac{(EPC \times IRS \times RBA \times FI \times EF \times ED \times CF_1)}{(BW \times\ AT)}$$

Eq. 1

Dermal contact with soil

$$ADD = \frac{(EPC \times DAF \times SA \times AF \times EF \times ED \times CF_1)}{(BW \times AT)}$$

Eq. 2

Dust inhalation—cancer risk

$$C_{air\_c} = \frac{EPC}{PEF}\ x\ CF_2\ x\ \frac{\left(\frac{ET}{24}\right) x\ EF\ x\ ED}{AT}$$

Eq. 3

Dust inhalation—non-cancer HQ

$$C_{air\_nc} = \frac{EPC}{PEF}\ x\ \frac{\left(\frac{ET}{24}\right) x\ EF\ x\ ED}{AT}$$

Eq. 4

Where:

ADD = average daily dose, mg/kg per day (mg/kg-day),
EPC = exposure point concentration, mg/kg,
IRS = ingestion rate soil, milligrams per day,
RBA = relative bioavailability, unitless,
FI = fractional intake from contaminated source, unitless,
EF = exposure frequency, days per year,
ED = exposure duration, years,
CF_1 = conversion factor 1, kilograms per milligram,
BW = body weight, kilograms,
AT = averaging time, days,
DAF = dermal absorption factor, unitless,
SA = skin surface area exposed, square centimeters,
AF = adherence factor, milligrams per square centimeters per day,
C_{air_c} = concentration in air for cancer risk assessment, micrograms per cubic meter (µg/m^3),
PEF = particulate emission factor, cubic meters per kilogram,
CF_2 = conversion factor 2, micrograms per milligram,
ET = exposure time, hours per day, and
C_{air_nc} = concentration in air for non-cancer assessment, milligrams per cubic meter (mg/m^3).

3.1.2.7 Lead-Specific Assessment

Exposure to lead was evaluated using a different approach than for the other COPCs. First, lead is widespread in the environment and exposure can occur by many different pathways. Thus, lead exposure assessment generally includes all exposure pathways rather than just those that are Site-related exposures. Second, it has been demonstrated that there is no safe level of exposure to lead and that children are especially sensitive and subject to lifelong adverse effects. Third, studies of lead exposures and resultant health effects in humans are traditionally described in terms of blood lead concentration. The concentration of lead in the blood is expressed in units of micrograms per deciliter (µg/dL).

Lead exposures are typically assessed using an uptake-biokinetic model that predicts blood lead concentration from a specified exposure rather than simply calculating an estimated chronic daily intake (CDI). The USEPA has developed an Integrated Exposure Uptake Biokinetic (IEUBK) model for predicting the likely range of blood lead concentrations in a residential population of young children (age 0 to 84 months) exposed to a specified set of environmental lead concentrations (USEPA 1994). When adults are exposed to lead, the subpopulation of chief concern is those who are pregnant or may become pregnant. The Adult Lead Methodology (ALM) is used for assessing risks to adults and older children from exposures to lead (USEPA 2003).

Exposure parameter inputs to the IEUBK model and ALM are central tendency, not RME estimates. In addition, the EPC for lead in a medium at an exposure area is equal to the arithmetic mean of the measured values for that medium (USEPA 1994, 2003). To remain consistent with the approach for the non-lead COPCs, the 95% UCL was used for both the IEUBK model and ALM.

The IEUBK model assumes continuous exposure in its default configuration. USEPA has developed guidance to assess intermittent or variable exposure at sites where lead is a concern (USEPA 2003). The exposure frequencies developed for the Site-specific exposure scenarios described in previous sections were used, in keeping with the method proposed in USEPA guidance.

The basic premise of the adjustments to the default configuration for the IEUBK model to account for intermittent exposure is to create a weighted average lead concentration. The weighting reflects a typical exposure to lead that is equivalent to background and a much less frequent exposure to higher lead concentrations associated with the Site. The following equation was used to calculate a weighted lead concentration for the child visitor scenario.

$$Weighted\ Pb\ Conc = (C_{site} \times EF_{site}) + (C_{background} \times EF_{background}) \qquad \textit{Eq. 5}$$

Where:

C_{site} = soil EPC for lead at Site, mg/kg,
EF_{site} = exposure frequency for child visitor at Site, as fraction of year, unitless,
$C_{background}$ = background lead concentration, mg/kg, and
$EF_{background}$ = exposure frequency for child visitor outside Site, as fraction of year, unitless.

A background lead concentration of 17.1 mg/kg was used in Equation 5, which is the 90th percentile of statewide soil lead concentrations from the Ecology study (Ecology 1994). In the IEUBK model, a background value for lead that represents the individual's ambient environment completely independent of the Site (in this case, their home environment) is needed. The statewide background value is appropriate for this purpose because it was assumed that the visitor in this exposure scenario did not reside in the immediate vicinity of the Site. The remainder of the IEUBK model (IEUBKwin32, version 1.1, build 11) was set for default values.

For the hypothetical child resident scenario, the soil lead concentration used in the IEUBK model was equal to the lead EPC. Given the continuous exposure assumption for that scenario, no weighting of lead soil concentration was conducted.

The most recent version of the ALM calculation worksheet (version date 6/14/2017) was used to assess the probability that fetal blood lead concentrations for those who are pregnant could exceed a target blood lead concentration of concern of 5 µg/dL. Soil lead concentrations were set equal to the applicable lead EPCs, and soil ingestion rates and exposure frequencies for each of the four adult scenarios (i.e., site worker, construction worker, adult visitor, and adult residential) were used.

IEUBK and ALM results are discussed in Section 3.1.4.2.

3.1.3 Toxicity Assessment

The objective of a toxicity assessment is to describe the adverse health effects caused by a chemical and identify how these adverse effects relate to exposure concentration. In addition, the toxic effects of a chemical frequently depend on the route of exposure (oral or inhalation) and the duration of exposure (subchronic, chronic, or lifetime).

There are typically major differences in the time course of action and the shape of the dose-response curve for cancer and non-cancer effects. Therefore, the toxicity assessment separates the non-cancer effects of chemicals from the cancer effects.

The potential for non-cancer effects was estimated by comparing a calculated exposure to a reference dose (RfD) for oral exposures or a reference concentration (RfC) for inhalation exposures for each individual chemical. The RfD and RfC represent a daily exposure that is designed to be protective of human health, even for sensitive individuals or subpopulations, over a lifetime of exposure.

For a given chemical, the dose or concentration that elicits no adverse effect when evaluating the most sensitive response in the most sensitive species is referred to as the no observed adverse effect level (NOAEL). The NOAEL was used to establish non-cancer toxicity values. The RfD and RfC represent a daily exposure level that is not expected to cause adverse non-cancer health effects.

Cancer effects were evaluated based on the assumption that any level of exposure to a carcinogenic compound can cause an effect. The USEPA extrapolated from observed laboratory animal data using a mathematical model known as the linear multi-stage model. This model plots a line back toward the origin, adjusting the background cancer rate in the control (unexposed) animal populations. For oral exposures, the cancer slope factor (CSF) is the 95% upper bound on the slope of the dose-response curve in the low dose region and has dimensions of risk of cancer per unit dose. For inhalation exposures, cancer risk is characterized by an inhalation unit risk (IUR) value, which represents the upper-bound excess lifetime cancer risk estimated to result from continuous lifetime exposure to a chemical at a concentration of 1 $\mu g/m^3$ in air.

Chemicals are classified as known, probable, or possible human carcinogens based on a USEPA weight-of-evidence scheme in which chemicals are systematically evaluated for their ability to cause cancer in humans or laboratory animals with the following descriptors: (1) carcinogenic to humans, (2) likely to be carcinogenic to humans, (3) suggestive evidence of carcinogenic potential, (4) inadequate information to assess carcinogenic potential, and (5) not likely to be carcinogenic to humans.

The USEPA RSLs tables (USEPA 2020) provide the latest toxicity values and physical and chemical properties for individual chemicals. The RfDs, RfCs, CSFs, and IURs identified for each COPC are provided in Table 3.4.

As indicated in Section 3.1.1, the toxicity of the cPAH compounds was represented by a cPAH TEQ value. The toxic equivalent factors (TEFs) used to calculate the TEQ are shown in Table 3.5. These TEFs are identical to those presented in Table 708-2 of MTCA.

3.1.4 Risk Characterization

3.1.4.1 Non-Lead COPCs

Risk characterization is the process of quantifying the significance of chemicals in the environment in terms of their potential to cause adverse health effects. The quantitative estimates are expressed in terms of a probability statement for the potential excess lifetime cancer risk and an HQ for the likelihood of adverse non-cancer health effects. Excess lifetime cancer risk refers to Site-related risks greater than what a person experiences from exposures outside the Site. This phrase is shortened to “cancer risk” hereafter. When there are multiple COPCs that cause non-cancer effects, the cumulative hazard index (HI) is calculated as the sum of HQs that have similar toxic effects.

The NCP describes a potentially acceptable range of cancer risk between 1×10^{-4} and 1×10^{-6} and expresses a preference for establishing the acceptable target cancer risk at or near the more protective end of this range. Similarly, non-cancer health effects generally should not exceed an HI of 1. NPS generally considers cancer risks exceeding 1×10^{-6} or non-cancer risks exceeding an HI of 1 to be unacceptable, absent compelling site-specific factors that preclude achieving these levels of protection. Selection of a target risk level of 1×10^{-5} may be justified based on considerations of background concentrations for contaminants of concern (COCs) that occur naturally. However, 1×10^{-4} is considered a threshold for emergency response and not adequately protective as a target risk level for final response actions within units of the NPS.

The following equations are used for estimating cancer risks and non-cancer hazards:

$$Cancer\ risk\ (oral) = ADD \times CSF_{oral} \qquad Eq.\ 6$$

$$Cancer\ risk\ (inhalation) = C_{air\_c} \times IUR \qquad Eq.\ 7$$

$$Hazard\ quotient\ (oral) = \frac{ADD}{RfD} \qquad Eq.\ 8$$

$$Hazard\ quotient\ (inhalation) = \frac{C_{air\_nc}}{RfC} \qquad Eq.\ 9$$

Where:

ADD = average daily dose, mg/kg-day,
CSF_{oral} = cancer slope factor for oral exposure, 1 per mg/kg-day,
C_{air_c} = concentration in air for cancer risk assessment, µg/m^3,
IUR = inhalation unit risk, 1 per µg/m^3,
RfD = reference dose, mg/kg-day,
C_{air_nc} = concentration in air for non-cancer assessment, mg/m^3, and
RfC = reference concentration, mg/m^3.

Table 3.6 presents the risk results for each scenario and indicates which scenarios have potential cancer risks greater than 1×10^{-6} or non-cancer HIs greater than 1.

None of the cancer risks for the visitor or worker scenarios exceeded 1×10^{-6}, although the cancer risk for the child visitor scenario was exactly 1×10^{-6}, primarily because of arsenic. Cancer risks for the hypothetical adult and child resident scenarios were 1×10^{-5} and 3×10^{-5}, respectively, again primarily because of arsenic. Cancer risks from the soil ingestion pathway were far greater than cancer risks from either the dermal or inhalation pathways.

HQs for all scenarios were much less than 1 (Table 3.6). The greatest HQs were for the hypothetical child resident scenario. The HQ for this scenario across all exposure pathways was 0.25 for arsenic and 0.018 for benzo(a)pyrene. Because the target organs for these two COPCs are different, it is not appropriate to sum the arsenic and benzo(a)pyrene HQs to yield an HI.

Based on the cancer risk and HQ results discussed in this section, none of the non-lead COPCs were designated as COCs for protection of human health. The results for the hypothetical residential scenario were presented for information purposes only and were not used in the designation of non-lead COPCs as COCs.

3.1.4.2 Lead

As discussed in Section 3.1.2.7, lead models were run for the child visitor and child residential scenarios (IEUBK) and the four adult scenarios (ALM). The output for the IEUBK model is the assumed blood lead concentration by year from birth to age 7 (Table 3.7). Results for the child visitor scenario are presented from ages 2 to 7 because it was assumed that children younger than 2 would not be directly exposed to Site soils in this scenario. The output for the ALM is the probability that fetal blood lead concentrations for those who are pregnant could exceed a target blood lead concentration of 5 µg/dL (Table 3.8). The 5 µg/dL reference value, which is also used in the IEUBK model, was established by the Centers for Disease Control and Prevention as a benchmark to identify children who have been exposed to lead and may require follow-up case management.

Predicted blood lead concentrations for the child visitor scenario range from 0.900 to 1.30 µg/dL, less than the 5 µg/dL reference value (Table 3.7). For the hypothetical child resident scenario, the blood lead concentrations ranged from 2.70 to 5.10 µg/dL. Only the blood lead concentrations for the ages 1 to 2 interval exceeded the 5 µg/dL reference value.

The ALM results indicated a very low (0.02%) probability that the fetal blood lead concentration would exceed the 5 µg/dL reference value for the site worker and adult visitor scenarios. Because the construction worker scenario included a much higher exposure frequency (250 days/year) compared to the site worker and adult visitor scenarios, the probability that the fetal blood lead concentration would exceed the reference value was also higher (2.4%). For the hypothetical adult resident, the model predicted a 5.6% probability that the fetal blood lead concentration would exceed 5 µg/dL (Table 3.8).

Based on the IEUBK and ALM results, lead was not designated as a COC at the Site. The lead modeling results for the hypothetical residential scenario were presented for information purposes only and were not used in the designation of lead as a COC.

3.1.4.3 Summary

Based on the results from the HHRA, none of the COPCs were designated as COCs.

3.1.5 Uncertainty Assessment

A summary of the uncertainties inherent to each component of the HHRA process and how they may affect the quantitative risk estimates and conclusions of the risk analysis is provided here. There are uncertainties at each level of the risk assessment, including the exposure assessment, toxicity assessment, and risk characterization. Specific uncertainties at each level are discussed in the following sections.

3.1.5.1 Exposure

Exposure Point Concentrations

The EPC for this HHRA was the 95% UCL. When data are plentiful and inter-sample variability is not large, the 95% UCL may be only slightly higher than the mean of the data. However, when data are sparse or are highly variable, the 95% UCL may be much higher than the mean of available data. In this case, the EPCs for the chemicals with the highest risk estimates (arsenic and lead) were based on hundreds of samples. Consequently, these samples, and the associated EPCs, are likely to provide a good representation of the concentrations of contaminants at the Site.

In the case of exposures from dust released into air from soil, no measured data were available; therefore, airborne concentrations were estimated using soil-to-air transfer factors (i.e., particulate emission factor for airborne dust). In general, such predicted concentration values have high uncertainty compared to measured values; thus, the actual concentrations of COPCs in air are uncertain, and true values might be either greater or less than the estimated values. However, because the Site is located within a mountain zone that is generally moist relative to drier sites, the estimated risks for inhalation of dust are so much less than the risks from incidental soil ingestion (Table 3.6); the predicted concentration value uncertainty is unlikely to have a meaningful impact on risk-based decision-making at the Site.

Exposure Parameters

The exposure parameters used in this HHRA are not known with certainty and must be estimated from limited data or knowledge. Many of the exposure parameters, particularly exposure frequency and duration, are based on input from NPS personnel and professional judgment and are intended to be overestimates. For example, the construction worker scenario assumed exposures to surface and subsurface soil would occur for 250 days per year for 2 years (refer to Table 3.2). Given the relatively small area of the Site and the maintenance history, and considering that no construction activities are planned for the Site, these assumptions are likely overestimated.

The RME scenarios are based on "reasonable" upper percentile values for each parameter, often at the 90th percentile or greater when quantitative data are available (USEPA 1989). When multiple upper percentile values are combined into the calculation of the ADD, the result may be implausibly high with respect to the potentially exposed population. Nonetheless, when the resulting risk calculations are less than a threshold of concern, as they are for this Site, such overestimates can provide additional confidence for decision-makers that human health is protected.

Chemical Absorption

The risk from an ingested chemical depends on how much of the ingested chemical is absorbed from the gastrointestinal tract into the body. This issue is especially important for metals in soil because some of the metals may exist in poorly absorbable forms. Failure to account for this may result in a substantial overestimation of exposure and risk. In this assessment, the relative bioavailability (RBA) for the organic COPCs was assumed to be 1.0 (100%). This assumption is likely to overestimate the true exposure, with the magnitude of the error depending on the true RBA value. For inorganic arsenic and lead, the USEPA default RBA values were assumed (i.e., 0.6 [60%]) for both chemicals (USEPA 2007a, 2012). These results do not reflect the Site-specific bioavailability characteristics of Site soils. Because risk estimates are already less than concentrations of concern for all COPCs, these uncertainties are unlikely to affect the conclusions of the risk assessment.

3.1.5.2 Toxicity

Uncertainty Factors

The uncertainty associated with the toxicity values used in this assessment varies by COPC. There are multiple sources of uncertainty, including extrapolations related to: (1) animal studies to humans, (2) high to low dose, and (3) continuous to intermittent exposure. In deriving toxicity values, USEPA applied uncertainty factors to these and other sources of uncertainty.

Consequently, it is more likely that the uncertainty will result in an overestimation rather than an underestimation of risk.

Chemicals without Toxicity Factors

Toxicity factors are not available for 13 chemicals measured at the Site (refer to Table C.3 in Appendix C). Although it is possible that the total risk from exposure to Site-related chemicals is underestimated because of the absence of these chemicals in the risk assessment calculations, the magnitude of this underestimation is likely to be low. To support this conclusion, an analysis of available toxicity information was conducted for those chemicals without screening values. The results of that analysis are discussed in the following sections and are presented in Table 3.9.

Polycyclic Aromatic Hydrocarbons

There are no screening values for three PAHs that were detected at the Site (acenaphthylene, benzo(g,h,i)perylene, and phenanthrene). The World Health Organization (WHO) compiled relative carcinogenic potency estimates for multiple PAHs that are thought to have carcinogenic potential, including the three discussed here (WHO 1998). The potencies are relative to benzo(a)pyrene, for which an SL of 0.1 mg/kg was used for this risk assessment (Table C2.b). The maximum relative potency values from WHO (1998) ranged from 0.001 to 0.022 for these three PAHs. By applying the maximum relative potency values to the 0.1 mg/kg screening value for benzo(a)pyrene, surrogate screening values were calculated. As shown in Table 3.9, the maximum detected concentrations for each of these three PAHs were much less than the surrogate screening values, indicating a very low level of concern for these compounds.

Other Semivolatile Organic Compounds

Ten other SVOCs that were measured at the Site do not have screening values (Table 3.9). Only one of these compounds (carbazole) was detected. The other compounds were all non-detect with a maximum reporting limit of 0.056 mg/kg. Surrogate screening values were estimated for most of the compounds. The maximum reporting limit was less than these surrogate screening values (Table 3.9). Toxicity data were insufficient to calculate surrogate screening values for 4-bromophenyl phenyl ether and 4-chlorophenyl phenyl ether.

USEPA’s Integrated Risk Information System database includes an assessment of the carcinogenicity of 4-bromophenyl phenyl ether, but USEPA did not derive a quantitative estimate of carcinogenic risk. Two animal studies were summarized. Doses as high as 579 mg/kg-day given to mice did not induce any evidence of carcinogenicity. This exposure rate is several orders of magnitude greater than any exposure that might reasonably occur at the Site. Consequently, the risk from exposure to this compound, and the similar compound 4-chlorophenol phenyl ether, is considered very low.

3.1.5.3 Risk Characterization

Because risk estimates for a chemical are a result of combining uncertain estimates of exposure and toxicity (refer to Sections 3.1.5.1 and 3.1.5.2), risk estimates for each chemical are more uncertain than either the exposure estimate or the toxicity estimate alone. Additional uncertainty arises from the issue of how to combine risk estimates across different chemicals. In some cases, effects caused by one chemical may have no influence on the effects of other chemicals. In other cases, the effects of one chemical may interact with effects of other chemicals, causing responses that are approximately additive, greater than additive (synergistic), or less than additive (antagonistic). USEPA generally assumes effects are additive for chemicals with non-carcinogenic effects on the same target tissue and for all carcinogens. Documented cases of synergistic interactions between chemicals are relatively uncommon. Therefore, the additive assumption is likely to be reasonable for most chemicals.

3.2 ECOLOGICAL RISK ASSESSMENT

The SLERA includes the first two steps in the ecological risk assessment process. The objective of the SLERA is to identify and document conditions that may warrant further evaluation (i.e., potential unacceptable risk) and to identify COPECs. The goal is to eliminate insignificant hazards while identifying contaminants whose concentrations are sufficiently high to potentially pose unacceptable risks to ecological receptors. For a SLERA, it is important to minimize the chances of concluding that there is no risk when in fact risk exists. Thus, selected exposure and toxicity values and assumptions are consistently biased toward overestimating risk. This ensures that sites that might pose an ecological risk are studied further; that is, a SLERA is deliberately designed to be protective in nature, not predictive of effects.

The SLERA includes the identification of COPECs based on a comparison of maximum concentrations to lowest ecological SLs. It is important to note the results of the COPEC selection are neither designed nor intended "to provide definitive estimates of actual risk or generate cleanup goals and, in general, are not based upon site-specific assumptions" (USEPA 2001). If any potentially significant exposure pathways are indicated from the SLERA, then these pathways are further evaluated in a more refined BERA, which employs Site-specific modifications but conservative exposure and effect assessment methods to determine potential risks.

An ecological risk assessment (both a SLERA and a BERA) includes the following components:

- Problem formulation
- Exposure and effects assessment
- Risk characterization (including an uncertainty analysis)

The EE/CA soil dataset (site investigation soil and sediment data) used for the ecological risk assessment is the same dataset used for the baseline HHRA. These data are summarized in Section 2.9.4.

3.2.1 Problem Formulation

NOCA encompasses more than 500,000 acres of scenic wild lands and supports a diversity of plants and wildlife. The Site is approximately 1.5 acres and consists of the exposed penstock that is approximately 904 feet in length and rests aboveground on cast-in-place concrete supports. Vegetation at the Site is representative of a typical low elevation North Cascades ecoregion forest, with a mix of Douglas fir, western red cedar, and western hemlock, as well as some alder and maple. In forested areas, undergrowth includes shrubs, such as salal and salmonberry, and ferns. There is an approximately 5- to 15-foot margin on either side of the penstock that has been historically clear of trees to facilitate operations and maintenance and minimize damage to the penstock from hazard trees and falling limbs. Undergrowth is less densely established in this margin. Although saddle replacement activities disturbed much of the margin surrounding the penstock between 2016 and 2017, the area has been naturally revegetated by grasses, shrubs, and ferns. The northern half of the Site is more densely vegetated than the southern, upslope half of the Site, which is predominantly exposed bedrock.

An ephemeral stream carrying runoff from the hillside upslope of the penstock runs adjacent to (and in one location beneath) the penstock, before joining an intermittent stream that flows down the eastern side of the penstock toward the powerhouse, during the winter, early spring, and late fall. The intermittent stream enters a tailrace and, after passing over a fish barrier, discharges into the Skagit River (Figure 1.2). Fish cannot enter the tailrace from the Skagit River due to the fish barrier and, therefore, also cannot enter the intermittent stream. In August 2015, wildfires burned much of the area surrounding the penstock; however, the Site has naturally revegetated (Photographs 1 and 2 in Appendix A.2). When the ephemeral and intermittent streams are flowing, soil that is present in those streambeds may provide limited sediment habitat for a small number of benthic invertebrates that are adapted to transient environmental conditions. For portions of the year, however, the streambeds are dry. During such time periods, the soil in these streambeds provides habitat for terrestrial invertebrates. Because these streambeds dry out, exposure to these areas by ecological receptors was assessed via soil exposure pathways, rather than sediment exposure pathways.

Amphibians including frog tadpoles, northwestern salamander larvae, and all life stages of Pacific giant salamander are present at the Site and may be exposed to contamination in sediment of the intermittent and ephemeral streambeds. Because of the small area and seasonal nature of the streambeds, exposure of amphibians is minor; therefore, the risk assessment conducted in Section 3.2 focuses on soil invertebrates, plants, birds, and mammals. Risks to receptors that were quantified in the risk assessment are expected to be much greater than risks to receptors that were not quantified.

Contamination has been detected in soil and sediment within the bed of the ephemeral and intermittent streams. Section 2.11 summarizes the sources of this contamination and the potential transport pathways through which it came to be present in Site soils. Complete exposure pathways quantified in the ecological risk assessment by which plants or animals may contact this soil and sediment are listed as follows and also depicted in Figures 2.8 and 2.10:

- Terrestrial plants: direct contact of the roots with contaminants in soil
- Soil invertebrates: direct contact with (and ingestion of) contaminated soils
- Birds and mammals: ingestion of contaminants in or on food items and incidental ingestion of soil while feeding or digging

Birds and mammals may also experience direct contact (i.e., dermal exposure) to soil and surface water, ingest surface water, and may inhale airborne dust. However, these exposure pathways are usually considered to be minor compared to exposures from ingestion (USEPA 2005) and were not evaluated in this ecological risk assessment.

Because it is not feasible to evaluate the potential exposure and effects to every species that may be present, surrogate species were selected to represent the taxonomic groups listed above. Terrestrial plants were evaluated as a group because the available toxicity information for plant species that may be found at NOCA is sparse. Soil invertebrates were represented in this ecological risk assessment by earthworms. For mammals, the short-tailed shrew was selected to represent other burrowing mammals potentially found at NOCA that may feed on invertebrates, such as the water shrew, vagrant shrew, or Pacific mole. For birds, the American robin was selected to represent other NOCA bird species that may feed on invertebrates, including the Pacific wren, varied thrush, and dark-eyed junco. Both the American robin and short-tailed shrew are commonly used in ecological risk assessments to represent birds and mammals, respectively.

During the problem formulation, the goals, breadth, and focus of the ecological risk assessment are established through the selection and description of site-specific assessment and measurement endpoints. Measurement endpoints are quantifiable environmental or ecological characteristics that can be measured, interpreted, and related to the valued ecological components chosen as the assessment endpoints (USEPA 1997). The selected assessment and measurement endpoints for each ecological receptor are listed in Table 3.10.

3.2.2 Screening-Level Ecological Risk Assessment

3.2.2.1 Identification of COPECs

In the SLERA, COPECs were identified using a tiered process based on detection frequency and a comparison of the EE/CA soil data (site investigation soil and sediment data) to ESVs. The ESVs used for each chemical was the minimum SLERA COPEC Selection ESV among the plant, invertebrate, bird, and mammal ESVs included in *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes* (NPS 2018).

The process for identifying COPECs is summarized as follows:

- Compare the EE/CA soil data to the SLERA COPEC Selection ESVs.
- Eliminate analytes that were not detected at the Site and have no history of Site use.
- Retain as COPECs analytes with maximum results that are greater than the respective SLERA COPEC Selection ESVs.

The COPECs are summarized in Table 3.11. FOD and minimum and maximum values are summarized in Table C.1 in Appendix C. The COPEC selection screening tables are presented in Tables C.4a through C.4c in Appendix C. Chemicals not selected as COPECs because of the lack of screening values are discussed in the uncertainty assessment (Section 3.2.4.2).

3.2.2.2 SLERA Results

Consistent with NPS protocol, once chemicals have been identified as COPECs, they may be further evaluated in a refined SLERA. HQs were calculated by dividing the maximum concentration for each COPEC by the Refined ESVs as presented in Table 5 of the *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes* (NPS 2018).

HQ = Maximum Concentration of COPEC / Refined ESV *Eq. 10*

In the SLERA, the maximum concentration for each COPEC in the environmental medium was compared to the Refined ESV for each receptor group. The SLERA is designed to minimize chances of eliminating a COPEC from further consideration when it may pose an actual ecological risk. Thus, the resulting risk calculation is expected to be an overestimate of actual risk and should not be used to derive response action cleanup levels (USEPA 1997). If the HQ is less than or equal to 1.0, harmful effects are not likely and the exposure pathway can be eliminated from further evaluation. If the HQ is greater than 1.0, that contaminant and the associated exposure pathway will be further evaluated in a BERA.

Tables 3.12 and 3.13 present the SLERA HQs for each receptor. Table 3.14 presents a summary of the COPEC/receptor scenario combinations that have HQs greater than 1.0.

3.2.3 Baseline Ecological Risk Assessment

In the BERA, risk estimates from the SLERA were further refined by using a more appropriate estimate of exposure (the EPC) and comparing species-specific estimated exposure doses to toxicity reference values for select receptors of concern. The detailed BERA conducted for this Site also incorporated Site-specific bioaccumulation factors and toxicity reference values (TRVs), as described in the following sections.

Risks to plants and invertebrates were based on a comparison of the EPCs to concentrations associated with toxic effects. Risks to American robin and short-tailed shrew were based on exposure models described in Section 3.2.3.1. Doses were estimated and compared to the toxicity values described in Section 3.2.3.2.

3.2.3.1 Exposure Assessment

Exposure Area

Exposure areas are defined based on the receptor, home range, and area use. The exposure area is the geographical area in which a receptor is randomly exposed to the contaminated medium for the assumed exposure duration. For receptors that do not move (plants) or move over very small distances (soil invertebrates), the exposure area for an individual organism is roughly equivalent to the single soil sampling location. However, it is standard practice to evaluate such organisms in an ecological risk assessment in the context of a population. The exposure area for a population of plants and invertebrates cannot be defined without explicitly defining the areal extent of the population, which is much larger than the Site. In practice, the exposure area is thus set to the area of the Site. In other words, a single decision unit is appropriate for plants and invertebrates.

The exposure of mobile birds and mammals to Site contaminants is integrated over multiple soil sampling locations. For these receptors, home ranges and area use factors can be explicitly defined for individuals to determine the appropriate exposure area for the risk assessment. The foraging area for the American robin has been reported to range from 0.4 to 2 acres (USEPA 1993c); the Site is approximately 1.5 acres. In the North Cascades, American robins are uncommon in some of the colder months of the year (Seattle Audubon Society 2021), suggesting that an area use factor less than 1 could be appropriate. However, because the Site is within the range of the documenting foraging area, the exposure area for American robins was assumed to be equal to the area of the Site, and the area use factor was set to 1. The mean home range of shrews has been reported to be 1 acre (USEPA 1993c). Because this value is reasonably close to the area of the Site, the exposure area for shrew was also set equal to the area of the Site. In summary, a single decision unit was used for all the receptors in the BERA.

Exposure Parameters

Exposure doses for American robin and short-tailed shrew were estimated with the same exposure model used to develop USEPA's Ecological Soil Screening Level (Eco-SSL) values (USEPA 2005). This model assumes that animals are exposed through their diet and incidental soil ingestion. The following general equation was used for both birds and mammals:

$$Dose = FIR \times (Soil \times P_s \times B) \qquad \textit{Eq. 11}$$

Where:

Dose = estimated dose, milligrams per kilogram of body weight per day (mg/kg body weight-day),
FIR = food ingestion rate, kilograms of food (dry weight) per kilogram of body weight (wet weight) per day,
P_s = soil ingestion rate as proportion of food ingestion rate, unitless, and
B = concentration in prey, mg/kg dry weight.

Values for *FIR* and P_s, and the references for those values, are presented in Table 3.15.

The diet for the American robin was assumed to be 40% earthworms, 50% arthropods, and 10% plants (Beyer and Sample 2017). The diet of the short-tailed shrew was assumed to be 20% earthworms, 65% other invertebrates, and 15% small mammals (Moore et al. 2016). Equations developed by Sample and Arenal (2017) and Sample et al. (1998a, 1998b) to estimate the chemical concentrations in each of these dietary items based on the chemical concentration in soil were used in the BERA. These equations are provided in Table 3.16.

Bioaccumulation Testing

The relationship between chemical concentrations in soil and chemical concentrations in earthworms has been studied extensively, the results of which are the regression equations provided in Table 3.16. However, for a given chemical concentration in soil, the chemical concentration in earthworms may range over an order in magnitude in the dataset used to derive the regression equations (Sample et al. 1998a). Given this wide variability, an earthworm bioaccumulation test was conducted for the BERA to collect Site-specific data on earthworm accumulation of trace elements from soil collected at the Site. The results from the bioaccumulation test provided values for the parameter *B* (concentration in prey) in Equation 11. The test also provided data on earthworm survival that was used to supplement the analysis of potential toxic effects to earthworms from exposure to Site soil.

Archived soil from the 2018 field investigation was used for the bioaccumulation test. Eurofins TestAmerica in Corvallis, Oregon, conducted the test with the oligochaete *Eisenia fetida* following ASTM International Guide E-1676-12. Prior to beginning the test, the soil was tested for several trace elements of interest, including arsenic, chromium, lead, mercury, and zinc. The concentrations in soil and the concentrations in the worms after a 28-day exposure are reported in Table 3.17. That table also includes the predicted concentrations in earthworms using the regression equations in Table 3.16. The laboratory reports for the bioaccumulation test, including the analytical results for the associated soil and tissue analyses, are included in Appendix F.

Exposure Point Concentrations

EPCs were calculated using the same approach as for the HHRA (refer to Section 3.1.2.5), using the full vertical extent of the soil chemistry data (to 3.25 feet bgs). It was assumed that plant roots and earthworms could be present anywhere within that soil horizon and that birds and mammals that consume earthworms could also be indirectly exposed to the full vertical extent of the soil that was sampled.

Because the chromium results for the soils at the Site are for total chromium and the chromium TRVs used for both plants and invertebrates are based on studies with chromium(VI), which is known to have toxicity 100-fold greater than chromium(III), the EPC for chromium for plants and invertebrates was adjusted to represent an estimated concentration of chromium(VI) at the Site. In coordination with NPS, the EPC was adjusted assuming that 5% of the total chromium concentration present is chromium(VI). This assumption is appropriate and likely overestimates the concentration of chromium(VI) given that the predominant form of chromium is chromium(III); there is no known history of Site use of materials containing chromium(VI); and even at sites with a history of chromite ore (hexavalent form) processing, chromium(VI) may be only 5% of the total chromium concentration (Broadway et al. 2010).

EPCs for plants, soil invertebrates, birds, and mammals are summarized in Table 3.18. Adjusted XRF data were included in the EPC calculations for lead, arsenic, and zinc (refer to Section 2.9.4.3).

3.2.3.2 Toxicity Assessment

In the SLERA, risk estimates were based on the lowest ESV across multiple NPS-approved toxicity value sources. However, in the BERA, risk estimates were estimated using dose-based TRVs. TRVs for both NOAEL and lowest observed adverse effects level (LOAEL) were used in the BERA. Where multiple NOAEL TRVs were available, the geometric mean (geomean) NOAEL value was used. For some COPECs, the geomean NOAEL was higher than the TRV used to set the Eco-SSL, which was based on the highest bounded NOAEL that was lower than the lowest bounded LOAEL. In such instances, the higher NOAEL TRV based on a geomean was used because it is consistent with guidance for developing PRGs from ecological risk assessments (LANL 2018).

The following hierarchy was used to select wildlife TRVs:

- Eco-SSL (USEPA 2005). NOAEL dose-based TRVs for birds and wildlife were preferentially selected from this source because they are derived from toxicity data drawn from multiple studies across multiple species and because these values have undergone extensive peer review. Dose-based LOAEL TRVs for birds and mammals have also been derived from the same underlying Eco-SSL toxicity datasets, using a similar derivation methodology (TechLaw 2008).
- LANL ECORISK Database. Los Alamos National Laboratory (LANL) developed and maintains a database of SLs and toxicity data (LANL 2017). Release 4.1 of this database was used for both NOAEL and LOAEL TRVs when Eco-SSL values were unavailable.
- Primary Literature. When TRVs were not available in either of the previous sources, they were obtained from the primary literature.

NOAELs and LOAELs for plants and invertebrates were also identified, but these are expressed in units of mg/kg, rather than as a dose as for the wildlife TRVs. The plant and invertebrate TRVs were taken from the LANL ECORISK database.

The toxicity values used to calculate HQs for each receptor are provided in Tables 3.19 (plants and invertebrates) and 3.20 (birds and mammals).

3.2.3.3 Risk Characterization

There are several different evaluation methods, or lines of evidence, available for determining the impact of site releases on ecological receptors (e.g., HQ estimates, toxicity tests, and habitat and community evaluations). Each of these lines of evidence has inherent advantages and limitations. For this reason, conclusions based on only one line of evidence may be misleading. Therefore, the best approach for reaching reliable conclusions about potential ecological risks is to combine the findings across all evaluation methods for which data are available, taking the relative strengths and weaknesses of each method into account. If the methods all yield similar conclusions, confidence in the conclusion is increased. If the methods all yield different conclusions, then a careful review must be performed to identify the basis of the discrepancy (if possible) and decide which method provides the most reliable information.

The initial line of evidence for the BERA is HQs. Additional lines of evidence for the BERA pertain to background concentrations, plant community health, and earthworm toxicity test results. Each line of evidence is discussed separately in the following sections.

Hazard Quotients

HQs were calculated according to the following equations:

For plants and invertebrates:

$$HQ = \frac{EPC}{TRV} \qquad \textit{Eq. 12}$$

Where:

EPC = exposure point concentration, mg/kg, and
TRV = toxicity reference values, mg/kg (Table 3.19).

For birds and mammals:

$$HQ = \frac{Dose}{TRV} \qquad \textit{Eq. 13}$$

Where:

Dose = modeled dose calculated according to Equation 11, mg/kg body weight-day, and
TRV = toxicity reference values, mg/kg body weight-day (Table 3.20).

The HQs are presented in Tables 3.21 (plants and invertebrates) and 3.22 (birds and mammals). Those tables include HQs based on both NOAELs and LOAELs, when both are available. The threshold for adverse effects lies between the NOAEL and LOAEL TRVs. The threshold TRV was estimated as the geomean of the NOAEL and LOAEL TRVs (Tables 3.19 and 3.20). The threshold TRVs were used to calculate a geomean HQ, as shown on Tables 3.21 and 3.22.

HQs for chemicals included in the earthworm bioaccumulation testing were calculated in two different ways. The first method used the published regression estimates presented in Table 3.16. The second method used the results of the bioaccumulation tests for the worm portion of the bird and mammal diets. Because the chemical concentrations in the soil that was tested were lower than the EPCs, the chemical concentrations in worms were linearly extrapolated upward using the ratio of the EPC to the tested soil concentration.

None of the geomean HQs were greater than 1 for plants or invertebrates. The NOAEL HQ for lead for plants was 3, but the LOAEL HQ was 0.4 and the geomean HQ was 1. The NOAEL HQ for both arsenic and zinc for invertebrates was 2, however the LOAEL HQs were 0.3 and 0.2, respectively, and the geomean HQs were 0.7 and 0.5. The NOAEL HQ for chromium(VI) for both plants and invertebrates was 4; however, the LOAEL HQ was 0.4 and the geomean HQ was 1. Because none of the geomean HQs were greater than 1, none of the COPECs were designated as contaminants of ecological concern (CECs) for plants or invertebrates. Although the EPC for chromium(VI) is uncertain (refer to Section 3.2.3.1), because the value is estimated, additional lines of evidence for chromium are discussed in Section 3.2.4.

None of the geomean HQs were greater than 1 for birds or mammals. The NOAEL HQs for lead were 2 for American robin, but the geomean HQs were 0.8 and 0.9 using the regression estimate and bioaccumulation test results, respectively. Based on these results, none of the COPECs were designated as CECs for birds or mammals.

Summary

Based on the results from the BERA, none of the COPECs were designated as CECs.

3.2.4 Uncertainty Assessment

A summary of the uncertainties inherent to each component of the ecological risk assessment process and how they may affect the quantitative risk estimates and conclusions of the risk analysis is provided here. There are uncertainties at each level of the risk assessment, including the exposure assessment, toxicity assessment, and risk characterization. Specific uncertainties at each level are discussed separately in the following sections.

3.2.4.1 Exposure

Exposure Pathways Not Evaluated

For birds and mammals, this BERA quantitatively evaluated exposure to chemicals through the direct ingestion of soil and prey items. Exposure pathways that were not selected include drinking water, absorption through dermal contact with soil or water, and inhalation. Omission of these pathways will tend to lead to an underestimation of total risk to the exposed receptors. However, these other exposure pathways are likely to be minor compared to the ingestion pathway that was evaluated because drinking water for ecological receptors is not perennially present at the Site; metals are not readily absorbed through the skin; and most metals, particularly lead, are not volatile. Therefore, the magnitude of the underestimation is unlikely to be a cause for concern.

Wildlife Exposure Parameters

The ingestion rates for food and soil used to estimate exposure of wildlife at the Site are derived from literature reports. These published ingestion rates are based on representative species (for example, ingestion rates for robins were used to represent birds at the Site), and therefore, the actual ingestion rates of the animals at this Site may be higher or lower. This BERA assumed a single dietary composition for each species, although the actual dietary composition likely varies daily and seasonally. These uncertainties could either under- or overestimate the actual exposures of wildlife to chemicals in soil and diet.

Exposure estimates were derived assuming that the biological absorption of all COPECs in site soils was 100%. However, for some metals, it is likely that the bioavailability from soil is less than 100%. Therefore, this assumption is likely to overestimate risks from incidental ingestion of soil.

The BERA assumed that wildlife exposures were continuous and receptor home ranges were located entirely within the Site. This assumption is probably appropriate for American robin and short-tailed shrew, which have home ranges on the order of 1 acre (USEPA 1993c), compared to the approximately 1.5-acre Site. Therefore, the uncertainty of this assumption is relatively low.

Concentrations in Tissues of Dietary Items

With the exception of the earthworm bioaccumulation data for arsenic, lead, mercury, and zinc, measured data on concentrations in dietary items are not available for the Site. Dietary tissue concentrations were estimated using uptake equations from the literature. These equations are derived from a variety of field and laboratory studies that may not account for site-specific factors that may influence accumulation into biota. Therefore, predictions of wildlife risk based on estimated tissue concentrations are considered uncertain.

The earthworm bioaccumulation test was conducted to obtain Site-specific data on the potential of earthworms to accumulate trace elements from soil collected at the Site. The concentrations of trace elements in the soil were lower than the EPCs for which HQs were estimated. Consequently, the measured tissue concentrations were adjusted upward using the ratio of the EPC to the measured concentration in test soil. This extrapolation assumed a linear relationship between soil and tissue concentrations. The appropriateness of this assumption is uncertain. The bioaccumulation potential of some chemicals declines at higher concentrations. However, the ratios of EPC to tested soil concentration were a factor of 3 or less. Consequently, the potential bias introduced by this assumption is likely to be relatively low, particularly in light of the fact that earthworms represent only a fraction of the assumed diet of the robin and shrew.

3.2.4.2 Toxicity

Receptors Evaluated

Risks to wildlife were assessed for American robin and short-tailed shrew, which were intended to represent feeding guilds likely to be present at the Site. These species may not represent the full range of sensitivities of other similar species that are present at the Site. Because toxicity data are unavailable for most of these other species, the uncertainty associated with this decision is unknown.

Toxicity Values for Plants and Invertebrates

The toxicity benchmarks used in HQ calculations for terrestrial plants and invertebrates are typically based on laboratory studies. These studies usually do not account for occurrence of metals in mineral forms in soil that are largely insoluble and do not contribute as much toxicity as soluble forms, nor do they account for other site-specific factors that influence the toxicity of metals in soils. Therefore, confidence in the risk estimates for terrestrial plants and soil invertebrates is low, and risks are likely to be overestimated.

Chromium Toxicity

This section presents other lines of evidence to provide additional context for the chromium(VI) HQs for plants and invertebrates, including toxicity values, background concentrations, plant community health, and earthworm toxicity test results. These lines of evidence support not designating chromium as a CEC.

Toxicity Values

Although the chromium results at the Site are for total chromium, the chromium TRVs used for both plants and invertebrates were from the LANL Ecorisk database, based on studies with chromium(VI), which is known to have toxicity 100-fold greater than chromium(III) (Saha et al. 2011). The two most stable valences of chromium are trivalent (chromium(III)) and hexavalent (chromium(VI)). Other than at sites with industrial operations that generate chromium(VI), of which there have been none at the Site, the predominant form of chromium is the less toxic trivalent form (Saha et al. 2011). Even at sites with a history of chromite ore (hexavalent form) processing, chromium(VI) may be only 5% of the total chromium concentration (Broadway et al. 2010). Based on the greater toxicity of chromium(VI) compared to total chromium, and the understanding that materials containing chromium(VI) have not been used or processed at the Site, the use of TRVs for chromium(VI) greatly overestimates the risk to plants and invertebrates from exposure to chromium. The ratio of chromium(VI) to total chromium at the Site is not known. However, based on the Site history and other biological and geochemical processes occurring at the Site, which tend to result in the conversion of chromium(VI) to chromium(III) (Shahid et al. 2017), that ratio is likely to be very small. This information supports the comparison of the plant and invertebrate chromium TRVs to the chromium(VI) EPC, which was estimated assuming 5% of the total chromium measured at the Site is chromium(VI).

Background Concentrations

The Site-specific background average chromium concentration is 32.7 mg/kg (n = 3), which is greater than the bird and mammal EPC used in the BERA (25.8 mg/kg). The chromium EPC is also less than the median (30.3 mg/kg) and 90th percentile (48.2 mg/kg) concentrations for background soils in Puget Sound (Ecology 1994). Because Site chromium concentrations are less than background concentrations, and because the geomean HQs for plants and invertebrates for chromium(VI) were not greater than 1, chromium(VI) was not designated as a CEC.

Earthworm Toxicity Test Results

The earthworm bioaccumulation test also evaluated the survival and growth (biomass) of the worms over the 28-day test. These results are another line of evidence for the invertebrate (earthworm) assessment endpoint. The survival and growth of the earthworms tested in 100% Site soil was not significantly different ($p > 0.1$) than the survival and growth of earthworms in the control group. These results are consistent with the observed geomean HQ for chromium(VI) of 1, indicating there is no unacceptable risk to invertebrates from chromium(VI) in soil. These results support the decision to not designate chromium(VI) as a CEC for the invertebrate assessment endpoint.

Plant Community Health

As discussed in previous sections, although the NOAEL HQ for plants for chromium(VI) was 4, the geomean HQ for plants for chromium(VI) was 1. In general, site-specific assessments using field data are preferred over predictive HQs based on literature values. Although a formal assessment of plant community health was not conducted for the BERA, there is abundant photographic evidence that was collected after saddle replacement activities in 2018 that indicate the plant community immediately adjacent to the penstock is healthy. The photograph shown in Figure 2.7 is a representative example of an apparently healthy plant community surrounding the penstock. The photograph in this figure also depicts the location of soil sampling at Transect 4. The chromium concentrations (measured as total chromium) from samples in this transect are shown Figure 2.7. There are multiple chromium concentrations from these transects that are at the higher end of the range of chromium concentrations at the Site; however, plant communities appear to be thriving there. These observations are consistent with the observed geomean HQ for plants for chromium(VI) of 1.

Toxicity Values for Wildlife

Dose-based TRVs do not account for site-specific environmental attributes that may influence uptake and toxicity. As noted for the plant and invertebrate toxicity values, the studies from which these wildlife TRVs are derived often utilize soluble forms of the chemicals, which tend to more bioavailable than forms found in the natural environment. Consequently, the calculated HQ values are more likely to overestimate actual risk.

Absence of Toxicity Data

Toxicity data are not available for six detected chemicals that were evaluated for ecological risk at the Site. As discussed in Section 3.1.5.2, this may result in an underestimation in actual risk. However, the magnitude of any underestimation is likely to be low. To support this conclusion, an analysis of available toxicity information was conducted for those chemicals without screening values. The results of that analysis are discussed in the following sections and are presented in Table 3.23.

Polycyclic Aromatic Hydrocarbons

There are no screening values for two PAHs that were detected at the Site and evaluated for ecological risk (1-methylnaphthalene and benzofluoranthenes (j+k)). Screening values are available for 2-methylnaphthalene and benzo(b)fluoranthene, which are PAHs that have very similar structures to 1-methylnaphthalene and benzofluoranthenes (j+k), respectively. The screening values for these two PAHs are more than 1,000 times greater than the maximum detected concentrations for 1-methylnaphthalene and benzofluoranthenes (j+k) (Table 3.23), which indicates a very low level of concern for these compounds.

Other Semivolatile Organic Compounds

Four other detected SVOCs that were measured at the Site do not have ecological screening values (Table 3.23). Surrogate screening values were derived for each of these SVOCs using the available toxicity literature. All of the surrogate screening values were at least 500 times greater than the maximum detected concentration for these chemicals. Therefore, it is very unlikely that these chemicals pose a significant ecological risk at the Site.

3.2.4.3 Risk Characterization

Chemical Interactions

Most toxicity benchmark values are derived from studies of a single chemical. However, exposures to ecological receptors usually involve multiple chemicals, which may react together in unpredictable fashion. Generally, data are not adequate to permit any quantitative adjustment in toxicity values or risk calculations based on inter-chemical interactions. At this Site, HQ values for each chemical were not added across different COPECs. If any of the COPECs at the Site act by a similar mode of action, total risks could be higher than estimated.

Estimation of Population-Level Impacts

Assessment endpoints for this BERA are based on the sustainability of exposed populations. Risks to some individuals in a population can occur and still allow for a healthy and stable population. However, estimating the impact of those effects on the population is generally difficult and uncertain. Given the relatively small area of the Site and the relatively low risks that were predicted, it is highly unlikely that adverse effects at the population level have occurred or are occurring.

3.3 DEVELOPMENT OF RISK-BASED PRELIMINARY REMOVAL GOALS

Risk-based PRGs establish the concentrations of contaminants for each exposure medium that will not present unacceptable risk to human health or ecological receptors based on site-specific conditions.

3.3.1 Selection of Human Health Risk-Based Preliminary Removal Goals

Generally, PRGs are developed only for those chemicals that are identified as COCs in the risk assessment. Non-lead COCs are defined as those chemicals for which the estimated cancer risks or HQs are greater than 10^{-6} or 1, respectively. Lead is defined as a COC if the IEUBK and ALM results are greater than the 5 µg/dL reference value. Because none of the estimated cancer risks or HQs exceeded 10^{-6} or 1, respectively, for the visitor or worker scenarios, and the IEUBK and ALM results were less than 5 µg/dL for the visitor and worker scenarios, development of risk-based PRGs for the protection of human health is not required for the Site.

3.3.2 Selection of Ecological Risk-Based Preliminary Removal Goals

Generally, PRGs are developed only for those chemicals that are identified as CECs in the risk assessment. CECs are defined as those chemicals for which the estimated HQ is greater than 1. Although HQs for chromium exceeded 1 for plants and invertebrates, other lines of evidence were used to reach the conclusion that chromium is not a CEC. The BERA also concluded that none of the other COPECs were CECs. Therefore, development of PRGs for the protection of ecological health is not required for the Site.

4.0 Identification and Analysis of Applicable or Relevant and Appropriate Requirements

The purpose of Section 4.0 is to identify ARARs for the Site. ARARs include standards, requirements, criteria, and limitations under federal, or more stringent state, environmental law (Section 121(d)(2)(A) of CERCLA, 42 USC 9621). For an ARAR to be adopted at an NPS CERCLA site, NPS must determine that the requirement is either "applicable" to conditions at the site or, if not applicable, that it is both "relevant" and "appropriate" based on site conditions. A requirement is applicable if compliance with it is legally required. A requirement is relevant and appropriate if NPS determines, based on its discretion, that the requirement is well suited to addressing site conditions. NPS consulted with Ecology to ensure that Washington ARARs were considered.

The identification of ARARs is a prerequisite to evaluating and selecting a cleanup action (USEPA 1992b). "Under circumstances where a non-time-critical removal action is expected to be the first and final action at the site, the selected removal action must satisfy all adopted ARARs" (USDOI 2018). If a "no action" alternative is selected following the evaluation of alternatives, ARARs must still be met by this alternative.

Other factors to be considered (TBC) are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal or state governments. TBC factors are not enforceable and a response action is not required, but TBC factors may be appropriate in shaping or guiding the development or implementation of a response action in certain circumstances, for example, where ARARs do not provide sufficient direction.

There are four basic criteria that define ARARs (NPS 2015c; USEPA 1988). ARARs are (1) substantive rather than administrative, (2) applicable or relevant and appropriate, (3) promulgated, and (4) categorized as one of the following:

- **Chemical-specific ARARs** address specific hazardous substances and are typically health- or risk-based numerical values that cleanups must achieve.
- **Location-specific ARARs** must be achieved because of the specific location of the release and the related response action (e.g., requirements that address the conduct of activities in sensitive areas such as national parks, floodplains, wetlands, and locations where endangered species or significant cultural resources are present). Location-specific ARARs often focus on protecting resources in a specific area. Therefore, NPS-specific ARARs generally fall within this category.
- **Action-specific ARARs** are typically technology or activity-based requirements or limitations on actions conducted to respond to the release of specific hazardous substances. Action-specific ARARs generally prescribe *how* a selected alternative must be implemented rather than what alternative may be selected.

Pursuant to its delegated CERCLA lead agency authority, NPS has identified ARARs and TBC factors for this EE/CA. The results of the ARARs analysis, including state ARARs, are summarized in Tables 4.1, 4.2, and 4.3.

4.1 CHEMICAL-SPECIFIC ARARS

Table 4.1
Chemical-Specific ARARs: Newhalem Penstock

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal				
Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs)	29 CFR 1910.1000	Provides permissible limits for workers exposed to chemicals through air or skin absorption.	Applicable except where Washington standards are more stringent.	Applicable to the extent there are airborne contaminants that are readily absorbed through the skin and are listed in Tables Z-1, Z-2, or Z-3 of the cited source. Determination of risk to workers exposed to chemicals through the air or skin is at least as stringent as PELs. No risk to people through air or skin absorption was identified in the risk characterization.
RSLs for Chemical Contaminants at Superfund Sites based on USEPA Guidance	USEPA 2020	Used to screen chemicals in soil, air, and drinking water at CERCLA sites.	TBC except where Washington standards are more stringent.	The USEPA RSLs for residential soil were considered in the selection of SLs to identify COPCs, except where Washington standards were more stringent. The most stringent criteria applicable to the media was selected for use in the risk assessment. Additionally, the USEPA RSL tables provide the toxicity values and physical and chemical properties for individual chemicals used in the risk assessment.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
Federal Ambient Water Quality Criteria	Clean Water Act 33 USC Section 1314, 40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and humans.	Not applicable or relevant and appropriate.	Site surface water is not perennially present.
National Primary Drinking Water Standards, Maximum Contaminant Levels (MCLs)	Safe Drinking Water Act 42 USC §§ 300f et seq., 40 CFR Part 141	Human health-based drinking water standards, MCLs for public water systems.	Not applicable or relevant and appropriate.	Groundwater at the Site is not used as a drinking water supply.
National Primary Drinking Water Standards, Secondary MCLs	Safe Drinking Water Act 42 USC §§ 300f et seq., 40 CFR Part 143	Establishes aesthetic drinking water standards (secondary MCLs) for public water systems.	Not applicable or relevant and appropriate.	Groundwater at the Site is not used as a drinking water supply.
National Toxics Rule	40 CFR Part 131	Establishes water quality standards for protection of human health and aquatic organisms for states with water quality standards that are inconsistent with Clean Water Act requirements.	Not applicable or relevant and appropriate to Washington.	Site surface water is not perennially present and Washington standards are protective of Washington's designated uses for its water.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
NPS ESVs	NPS 2018	ESVs are used in SLERAs to identify contaminants that may warrant further examination in a BERA.	TBC.	The ESVs used for each chemical was the minimum SLERA COPEC Selection ESV among the plant, invertebrate, bird, and mammal ESVs included in *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes* (refer to Section 3.2.2.1; NPS 2018).
State				
Washington PELs	Chapter 296-841-20025 WAC	Provides permissible limits for workers exposed to chemicals through air.	Applicable.	Applicable to the extent there are airborne contaminants that are readily absorbed through the skin and are listed in Table 3 of the cited source. Determination of risk to workers exposed to chemicals through the air or skin is at least as stringent as Washington State PELs. No risk to people through air or skin absorption was identified in the risk characterization.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
State (cont.)				
MTCA - Methods for defining background concentrations	Chapter 173-340-709 WAC	A cleanup level that is less than natural background should be adjusted up to the natural background concentration. If the background adjustment results in a higher cleanup level than what Ecology recognizes as natural background, it would be considered insufficiently protective under MTCA.	TBC.	Site background concentrations were considered for comparison to Washington natural background concentrations (refer to Section 3.1.2.7 and 3.2.4.2; Ecology 1994). Background values were not used to develop PRGs.
MTCA - Ground water cleanup standards	Chapter 173-340-720 WAC	Used for setting groundwater cleanup levels and for calculating soil leaching cleanup levels to protect groundwater.	Not applicable or relevant and appropriate.	Groundwater at the Site is not used as a drinking water supply.
MTCA - Surface water cleanup standards	Chapter 173-340-730 WAC	Used for setting surface water cleanup levels and for calculating soil leaching cleanup levels to protect surface water via soil leaching to groundwater followed by transport to surface water.	Not applicable or relevant and appropriate.	Site surface water is not perennially present.
MTCA - Unrestricted land use soil cleanup standards	Chapter 173-340-740 WAC	Used for setting soil cleanup levels to protect the following pathways: • Direct human contact • Leaching to groundwater • Leaching to groundwater followed by transport to surface water and sediment • Soil vapor intrusion to indoor air	Applicable.	MTCA Method A and B unrestricted land use soil cleanup standards were used in the selection of SLs to identify COPCs (refer to Section 3.1).

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
State (cont.)				
MTCA - Deriving soil concentrations for ground water protection	Chapter 173-340-747 WAC	Used for setting soil leaching cleanup levels to protect groundwater, surface water, and sediment.	Not applicable or relevant and appropriate.	Groundwater at the Site is not used as a drinking water supply.
MTCA - Terrestrial ecological evaluation (TEE) procedures	Chapter 173-340-7490 to -7494 WAC	Used to determine if the existence of hazardous substances at a site could harm terrestrial plants or animals, and to establish soil cleanup levels to protect terrestrial ecological receptors.	Applicable, except where more stringent standards apply.	Consistent with NPS protocol, a more stringent and complete ecological risk assessment, including a SLERA and a BERA, was conducted for the Site; therefore, use of the TEE procedures was not necessary.
Natural Background Soil Metals Concentrations	Ecology 1994	Defines region-specific natural background concentrations for metals in surficial soils throughout the state.	TBC.	Washington natural background concentrations (Ecology 1994) were considered in two elements of the risk assessments (refer to Sections 3.1.2.7 and 3.2.4.2). Background values were not used to develop PRGs.
SMS – Sediment cleanup standards	Chapter 173-204 WAC	Provides the basic process for establishing sediment cleanup standards.	Not applicable or relevant and appropriate.	When the ephemeral and intermittent streams are flowing, soil that is present in those streambeds may provide limited sediment habitat for a small number of benthic invertebrates that are adapted to transient environmental conditions. However, for part of the year, the streambeds are dry and provide terrestrial habitat. Therefore, exposure in these areas was assessed for people and ecological receptors via soil exposure pathways, rather than sediment exposure pathways.

4.2 LOCATION-SPECIFIC ARARS

Table 4.2
Location-Specific ARARs: Newhalem Penstock

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal				
Bald Eagle Protection Act	16 USC §§ 668 et seq	Requires consultation with the U.S. Fish and Wildlife Service (USFWS) during remedial design and remedial construction to ensure that any cleanup does not adversely affect bald or golden eagles.	Applicable.	Bald eagle habitat is present on or near the Site.
Endangered Species Act (ESA)	16 USC § § 1531-1544	Outlines procedures for federal agencies to follow if actions may jeopardize ESA-listed species. Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat.	Applicable.	ESA-listed species are present on or near the Site.
National Historic Preservation Act (Section 106)	16 USC § 470; 36 CFR Part 800; 40 CFR 6.301(b)	Requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any property with historic, architectural, archeological, or cultural value that is included in or eligible for inclusion in the National Register of Historic Places.	Applicable.	There are documented prehistoric and historic cultural resources within the area surrounding the Site (DAHP 2017). The Site is also located with the Skagit River & Newhalem Creek Hydroelectric Projects property, which is listed in the National Register of Historic Places.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
NPS mandate to ensure the non-impairment of national park resources for the enjoyment of future generations and the non-degradation of national park values and purposes	NPS Organic Act of 1916 54 USC Section 1001 01, et seq. General Authorities Act, as amended, 16 USC Section 1a-1	The Organic Act requires NPS to manage national parks in such manner as to protect a park's fundamental purpose, resources, and values in order to leave them unimpaired for the enjoyment of future generations.	Applicable.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.
National Park Area Nuisance Regulation	36 CFR § 5.13	Prohibits the creation or maintenance of a nuisance upon the federally owned lands of a park area or upon any private lands within a park area under the exclusive legislative jurisdiction of the United States.	Applicable.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.
North Cascades National Park Enabling Legislation	Public Law 90-544: Enabling Legislation (1968)	Requires preservation of the North Cascades National Park for the benefit, use, and inspiration of present and future generations, and provision for public outdoor recreation use and enjoyment, and for the conservation of park values contributing to public enjoyment of the park.	Applicable.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.

Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate, or TBC?**	**Comment**
Federal (cont.)				
2006 NPS Management Policies (MPs)	NPS 2006	The 2006 MPs articulate NPS policies concerning management of all resources and values in the National Park System, including natural and cultural resources, restoration of natural systems, wildlife and biota, and wilderness areas. The following sections have been deemed applicable: 4.1.3, 4.1.5, 4.4.2.3, 4.6.3, 4.6.6, 4.7.1, 4.8.2.4, 5.1.3, and 5.3.5 (if cultural resources are encountered).	TBC.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.
General Management Plan for the North Cascades National Park Complex	NPS 1988	The plan provides a decision-making framework for NPS managers to protect the park's resources and ensure quality visitor experiences.	TBC.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.
Ross Lake National Recreation Area General Management Plan	NPS 2012	The plan describes actions to manage Ross Lake National Recreational Area as a gateway to wilderness by providing enhanced visitor opportunities and ensuring the long-term stewardship of the surrounding North Cascades ecosystem and wilderness.	TBC.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
Foundation Document North Cascades National Park Service Complex	NPS 2017a	The foundation document provides basic guidance for planning and management, including special mandates and administrative commitments, and an assessment of planning and data needs.	TBC.	The Site is located on NPS-managed land and NPS is authorized under CERCLA as the lead agency for completing this EE/CA.
Archaeological Resources Protection Act	16 USC § 470	Specifies actions that must be taken to preserve archaeological resources if they are identified.	Applicable.	Required if historic, archaeological, or cultural resources are identified at the Site. Prehistoric and historic cultural resources have been documented at the Site and within the area surrounding the Site (DAHP 2017).
Archeological and Historic Preservation Act	16 USC § 469; 40 CFR 6.301(c)	Requires preservation of historic sites, buildings, and objects of national significance.	Applicable.	Required if historic, archaeological, or culture resources are identified at the Site. Prehistoric and historic cultural resources have been documented at the Site and within the area surrounding the Site (DAHP 2017). Additionally, the Site is located within the Skagit River & Newhalem Creek Hydroelectric Projects property, which is listed in the National Register of Historic Places.
Native American Graves Protection and Reparation Act	25 USC § 3001 et seq.	Establishes protective requirements to be followed when graves or Native American burial sites are encountered.	Applicable.	Required if there is an inadvertent discovery of graves or Native American burial sites are encountered or if tribal consultation identifies such sites.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
The American Indian Religious Freedom Act	42 USC § 1996	Requires federal agencies to protect the right of Native American tribes to practice their traditional religions.	Applicable.	The action must not preclude the rights, express or implicit, of any Native American tribe that exists under treaties, Executive orders, and laws of the United States.

4.3 ACTION-SPECIFIC ARARS

Table 4.3
Action-Specific ARARs: Newhalem Penstock

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal				
Clean Water Act Stormwater Requirements—National Pollution Discharge Elimination System (Section 402)	33 USC Section 1342; 40 CFR Part 122	Regulates the discharge of stormwater to surface waters from industrial and construction sites. Requires implementation of best management practices, including run-on and run-off controls, and sedimentation basins.	Applicable.	Applicable to all actions that require clearing, grading, or excavation that results in the disturbance of 1 or more acres and discharges stormwater to surface waters of the state.
Subtitle D—Managing Municipal and Solid Waste	42 USC § 6901, 40 CFR Parts 257 and 258	Establishes guidelines for the management of non-hazardous solid waste.	Applicable.	Applicable to all actions with non-hazardous waste included as part of the Removal Action scope.

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate, or TBC?	Comment
Federal (cont.)				
Fugitive Dust Emissions	40 CFR Section 50.6	Established standards for particulate matter emissions during construction.	Applicable.	Applicable to all actions that require ground disturbance.
Clean Air Act	42 USC § 7401 et seq., 40 CFR Part 50	Establishes limits for air emissions.	Applicable.	Applicable to all actions that require construction, where construction will result in emissions release.
Invasive Species	Executive Order 13112	Requires federal agencies to prevent the introduction of invasive species.	TBC.	TBC for all actions that require seeding and/or revegetation.
State				
Solids Waste Handling Standards	RCW 70.95, WAC Chapter 173-350	Establishes standards for the proper handling and disposal of solid waste and requirements for the design, construction, operation, and closure of solid waste handling facilities.	Applicable or relevant and appropriate.	Applicable or relevant and appropriate to all actions with solid waste disposal included as part of the Removal Action scope. The Site is not a solid waste handling facility.
Maximum Environmental Noise Levels	RCW 70.107, WAC Chapter 173-60	Washington's maximum permissible noise levels.	Applicable.	Applicable to all actions that require construction activities.

5.0 Removal Action Objectives and Removal Goals

The purpose of Section 5.0 is to present the remedial action objectives (RAOs) and scope for the non-time-critical removal action (e.g., remove contaminated soils that pose unacceptable risk to human health and the environment). The RAOs should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited.

RAOs define what the removal action is intended to accomplish. Specific RAOs are presented in Section 5.1. Other aspects of the RAOs are described therein and in Section 5.2.1.

5.1 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The RAOs for this EE/CA are as follows:

- Prevent unacceptable risks to people and ecological receptors from exposure to Site contaminants in soil.
- Maintain the full enjoyment and utilization of park resources consistent with NPS mandates.
- Attain all federal and state ARARs and consider TBCs.

5.1.1 Determination of Removal Action Scope

The overarching objective of this EE/CA is to protect against unacceptable risks to people and ecological receptors posed by the Site. The EE/CA risk assessment presented in Section 3.0 indicates that following the TCRA implemented in 2016–2017, there is no remaining unacceptable risk to people or ecological receptors at the Site. Based on these results, and the consequent compliance of current Site conditions with ARARs, the RAOs for the Site have been met and no further actions are necessary for the Site.

5.2 RISK MANAGEMENT: REMOVAL GOALS SELECTION

In accordance with USEPA and NPS guidance (Section 1.1), RGs are selected by comparing the PRGs and selecting the most stringent. Additionally, to ensure cleanup will be technically feasible and cost effective, the PRGs are also compared to background for naturally occurring COCs and CECs, as well as reference locations for anthropogenic COCs and CECs, in all media at the Site.

PRGs are developed only for those chemicals that are identified as COCs or CECs in the risk assessment. Based on the results from the HHRA, none of the COPCs were designated as COCs (refer to Section 3.1.4). Similarly, based on the results from the BERA, none of the COPECs were designated as CECs (refer to Section 3.2.3). Therefore, development of PRGs for the protection human health or of ecological health is not required for the Site.

5.2.1 Background and Reference Concentrations

To ensure cleanup will be technically feasible and cost effective and to reduce the potential for recontamination of clean areas from surrounding sources, the PRGs, if developed, would be compared to background values for naturally occurring constituents in all media at the Site and may be compared to reference values for environmentally ubiquitous anthropogenic constituents.

Because none of the COPCs or COPECs were designated as COCs or CECs in the risk assessments, the development of PRGs is not required for the Site.

5.2.2 Removal Goal Selection

In accordance with USEPA and NPS guidance (Section 1.1), selection of RGs would include a comparison of human health risk-based PRGs, ecological risk-based PRGs, ARAR-based PRGs, and representative background and reference concentrations, and when multiple PRGs exist, the lower (i.e., more protective) value would be chosen as the RG. If the background concentration of the contaminant was greater, the background concentration would be selected as the RG. However, because there is no remaining unacceptable risk to people or ecological receptors at the Site, and none of the COPCs or COPECs were designated as COCs or CECs in the risk assessments, the development of PRGs and RGs is not required for the Site, and no RGs were selected.

5.3 DESCRIPTION OF THE COMPLETED TCRA

The overarching objective of the TCRA was also to protect against unacceptable risks to people and ecological receptors posed by the Site. A summary of the TCRA activities in light of this objective is provided.

A total of 171 tons of contaminated soil were removed from the Site in 2016 and 2017 as part of the penstock saddle replacement project and TCRA. The TCRA was conducted in response to the findings from Site assessment activities that indicated that soil concentrations of lead, arsenic, and PAHs beneath and in close proximity to the penstock exceeded MTCA cleanup levels for unrestricted land use. In the Action Memorandum dated August 22, 2016, NPS approved and authorized the removal and disposal of contaminated soil excavated as part of the replacement of deteriorated wooden saddles along the penstock (NPS 2016a). All subsequent Site investigations and removal actions related to the TCRA were performed under the 2016 NPS Action Memorandum and ASAOC (NPS 2016a and 2019b). Additionally, all TCRA activities were completed within the time frame and other conditions of a Special Use Permit approved by NPS for the saddle replacement project (NPS 2016b).

Between November 9, 2016, and May 5, 2017, 52 of the 56 creosote-treated wooden saddles along the exposed portion of the penstock were removed and replaced with cast-in-place concrete supports. During the saddle replacement work, a total of 171 tons of contaminated soil was excavated. The soil excavation work is described in detail in Section 2.9.1. The excavated soil was transported off-site for disposal at an appropriate Waste Management facility (Herrera 2018). During the TCRA activities, monitoring was performed by an environmental consultant to ensure that all work was being conducted in compliance with applicable regulatory requirements as well as conditions outlined in the Special Use Permit (NPS 2016b).

Based on the spacing of saddle supports along the penstock alignment and the footprints of the saddle excavations, approximately one-half to two-thirds of the soil beneath the penstock between the powerhouse and the adit was removed by the TCRA removal work. Consequently, assuming all soil beneath the penstock alignment was contaminated, approximately one-third to one-half of the contaminated soil remained after the TCRA. Although the contaminated soil remained in place, the results of the risk assessment indicate the TCRA removal work was successful in reducing risk to people and ecological receptors to acceptable levels (Section 3.0).

5.4 TCRA COMPLIANCE WITH APPLICABLE REQUIREMENTS

Conditions at the Site met the NCP Section 300.415(b) criteria for conducting TCRAs, and NPS determined that the TCRA activities were necessary and appropriate (NPS 2016b). TCRA activities were accordingly performed under oversight and guidance from NPS and completed in compliance with the best management practices, standards, requirements, and other criteria included in the NPS 2016 Action Memorandum and Special Use Permit (NPS 2016a and 2016b). The TCRA protected against unacceptable risks to people and ecological receptors posed by the Site.

6.0 Identification of Removal Action Alternatives

The purpose of this section is to present removal action alternatives proposed to achieve the RAOs identified in Section 5.0. The selected removal action must meet the RAOs and comply with ARARs. The location of the Site within a unit of the National Park System must be considered when evaluating removal alternatives. Following the TCRA conducted in 2016–2017, and based on the results of the risk assessment in Section 3.0, the Site currently poses no unacceptable risk to people or ecological receptors; therefore, as discussed in Section 5.0, the Site in its current condition meets RAOs and an additional removal action is not required. Therefore, consistent with the NCP and CERCLA guidance, a No Action alternative was considered and is retained.

This section describes the No Action alternative and its effectiveness.

6.1 NO ACTION/NO FURTHER ACTION

Under the No Action alternative, no additional removal of soil or maintenance would be performed. The contaminated soil that remains at the Site following the TCRA would be left in place; however, Site soil does not pose unacceptable risk to people or ecological receptors. All other Site conditions would be left unchanged.

City Light currently monitors conditions at the Site. Vegetation and invasive species are monitored twice per year to ensure the area disturbed by the 2015 Goodell Fire and TCRA activities is being revegetated by native plants, and City Light staff periodically check the powerhouse tailrace for accumulation of rocks and sediment from Newhalem Creek to confirm that they have not accumulated to levels that would overtop the fish barrier located at the outlet of the tailrace. Rocks and sediments accumulated in the tailrace are primarily those occasionally entrained in high Newhalem Creek flows at the diversion above the Site and discharged to the tailrace via the penstock and powerhouse. As discussed in Section 2.11.2, sediment from the Site may also be entrained in intermittent stream flow that reaches the tailrace; however, the contribution of sediment to the tailrace from the intermittent stream is likely minor compared to that of Newhalem Creek. Additional information regarding monitoring is provided in Section 8.2.

6.2 EFFECTIVENESS IN MEETING REMOVAL ACTION OBJECTIVES AND REMOVAL GOALS

As stated in Section 5.0, the RAOs for the Site are to prevent unacceptable risks to people and ecological receptors from exposure to Site contaminants in soil, maintain the full enjoyment and utilization of park resources consistent with NPS mandates, and attain all other federal and state ARARs. The No Action alternative meets all the RAOs for the Site. The results of the risk assessment indicate that after the TCRA, there is no unacceptable risk to people or ecological receptors remaining at the Site; therefore, additional removal activities are unnecessary. Additionally, the No Action alternative avoids disturbing the existing habitat at the Site—which through the natural process of revegetation has largely recovered from vegetation loss that occurred during the 2015 Goodell Fire and 2016 and 2017 TCRA activities—and avoids limiting recreational opportunities such as hiking. The No Action is also in compliance with the ARARs.

7.0 Analysis of the No Action Alternative

The purpose of Section 7.0 is to provide a comparative analysis of the No Action alternative identified in Section 6.0 against each of the evaluation criteria. Pursuant to the NCP, the No Action alternative was analyzed using the following evaluation criteria: effectiveness, implementability, and cost. The effectiveness criterion addresses the alternative's protectiveness of human health and the environment; attainment of ARARs; reduction of toxicity, mobility, or volume; short-term effectiveness; and long-term effectiveness and permanence. The implementability criterion addresses the technical feasibility of implementing the response (including availability of services and materials), the administrative feasibility, and state and community acceptance. The cost criterion addresses the total cost of implementing the response.

7.1 EFFECTIVENESS

This section evaluates the alternative's ability to meet the RAOs as identified in Section 5.0; in particular, its ability to achieve the criteria of protectiveness of human health and the environment and to attain ARARs. Other factors that affect the overall protectiveness of a removal action include preference for treatment to reduce contaminant toxicity, mobility, or volume for principal threats; short-term effectiveness; and long-term effectiveness/permanence. Details regarding the effectiveness evaluation criteria are presented in the following subsections.

7.1.1 Overall Protection of Human Health and the Environment

The results of the risk assessment presented in Section 3.0 indicate there is no unacceptable risk to people or ecological receptors at the Site. These results indicate the TCRA conducted in 2016 and 2017 was successful in eliminating unacceptable risks. Therefore, continuation of current environmental conditions under the No Action alternative would achieve the RAO to prevent unacceptable risks to people and ecological receptors from exposure to Site contaminants in soil.

7.1.2 Compliance with ARARs

An analysis of how the No Action alternative would comply with each of the ARARs is summarized in this section. Under the No Action Alternative, the Site would be retained in its post-TCRA condition. The TCRA was completed in compliance with the standards, requirements, and other criteria included in the NPS 2016 Action Memorandum (NPS 2016a) and Special Use Permit (NPS 2016b). Because no cleanup action is taken, no chemical- or action-specific ARARs or TBCs are triggered. In addition, because no additional removal activities would be needed, there would be no associated effects on use of the Site by workers or recreational users. The No Action alternative would also protect and preserve the NOCA natural resources, conditions, and values over the long term and would enable park managers to manage the park in such a manner as to achieve the purposes for which the park was established (NPS 2015b).

Compliance with Chemical-Specific ARARs:

- OSHA PELs: Because this alternative would involve no cleanup action, workers will not be conducting remedial activities, and therefore, worker exposure standards would not be triggered.
- Washington PELs: Because this alternative would involve no cleanup action, workers will not be conducting remedial activities, and therefore, worker exposure standards would not be triggered.
- MTCA unrestricted land use soil cleanup standards: The risk assessment presented in Section 3.0, which takes these standards into account, indicates that there is no remaining unacceptable risk to people or ecological receptors at the Site. Because there is no remaining unacceptable risk to receptors at the Site, and because this alternative would involve no cleanup action, cleanup standards would not be needed.

Compliance with Location-Specific ARARs:

- Bald Eagle Protection Act: The EE/CA risk assessment determined that current Site conditions do not adversely affect birds (refer to Section 3.2). Through the No Action alternative, bald or golden eagle habitat would not be adversely affected by remedial construction.
- Endangered Species Act (ESA): The EE/CA risk assessment determined that current Site conditions do not adversely affect terrestrial receptors (refer to Section 3.2). Through the No Action alternative, critical habitat would not be adversely affected by remedial construction.
- National Historic Preservation Act (Section 106): Through the No Action alternative, remedial construction would not occur; therefore, archaeological and historical resources would not be impacted.
- NPS mandate to ensure the non-impairment of national park resources for the enjoyment of future generations and the non-degradation of national park values and purposes: The EE/CA risk assessment determined that current Site conditions do not pose unacceptable risk to people (refer to Section 3.1), and under the No Action alternative, no remedial construction activities would occur. Therefore, resources at the Site would not be impaired, nor would the fundamental purpose, resources, and values of national park resources be adversely affected.
- National Park Area Nuisance Regulation: The EE/CA risk assessment determined that current Site conditions do not pose unacceptable risk to people (refer to Section 3.1), and under the No Action alternative, no remedial construction activities would occur. Therefore, the No Action alternative would not create or maintenance a nuisance upon the Site.
- North Cascades National Park Enabling Legislation: The EE/CA risk assessment determined that current Site conditions do not pose unacceptable risk to people (refer to Section 3.1), and under the No Action alternative, no remedial construction

activities would occur. Therefore, resources at the Site would not be impaired, and the benefit, use, and inspiration of present and future generations and conservation of park values contributing to public enjoyment of the park would not be adversely affected.

- Archaeological Resources Protection Act: Through the No Action alternative, remedial construction would not occur; therefore, archaeological resources will be protected.
- Archeological and Historic Preservation Act: Through the No Action alternative, remedial construction would not occur; therefore, historic, archaeological, and cultural resources will be preserved.
- Native American Graves Protection and Reparation Act: Through the No Action alternative, remedial construction would not occur; therefore, if graves or Native American burial sites are present, they will be protected.
- The American Indian Religious Freedom Act: Through the No Action alternative, remedial construction would not occur; therefore, there will be no associated effects on use of the Site by Native American Tribes. Current and future Site use includes usual and accustomed activities by the Upper Skagit Indian Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Indian Tribe.

Compliance with Action-Specific ARARs:

- Clean Water Act Stormwater Requirements—National Pollution Discharge Elimination System (Section 402): Because this alternative would involve no cleanup action, requirements from this ARAR related to discharges of stormwater from to surface waters of the state from areas where clearing, grading, or excavation is taking place would not be triggered.
- Subtitle D—Managing Municipal and Solid Waste: Because this alternative would involve no cleanup action, requirements from this ARAR for managing non-hazardous solid waste would not be triggered.
- Fugitive Dust Emissions: Because this alternative would involve no cleanup action, standards for particulate emissions during construction would not be triggered.
- Clean Air Act: Because this alternative would involve no cleanup action, limits for air emissions during construction would not be triggered.
- Solids Waste Handling Standards: Because this alternative would involve no cleanup action, standards for the proper handling and disposal of solid waste would not be triggered. This Site is not a waste handling facility; therefore, requirements for the design, construction, operation, and closure of solid waste handling facilities are not applicable or relevant and appropriate.
- Maximum Environmental Noise Levels: Because this alternative would involve no cleanup action, maximum permissible noise levels for construction activities would not be triggered.

7.1.3 Reduction of Toxicity, Mobility, or Volume through Treatment

The results of the risk assessment indicate that there is no remaining unacceptable risk to people or ecological receptors at the Site. These results indicate the TCRA removal of 171 tons of contaminated soil was successful in eliminating unacceptable risk to human health, the environment, and ecological receptors and permanently and significantly reducing the toxicity and volume of contaminated soils at the Site. Additionally, metals COPCs and COPECs are considered generally immobile. As discussed in Section 2.9.4 and 2.11.2, metals COPCs and COPECs are unlikely to migrate downstream and very unlikely to do so at concentrations that would cause adverse effects to the benthic community in either the intermittent stream, tailrace, or off-site in the Skagit River. Consistent with the No Action alternative, no additional activities would be needed to reduce toxicity.

7.1.4 Short-Term Effectiveness

The results of the risk assessment indicate there is no unacceptable risk to people or ecological receptors at the Site; therefore, the No Action alternative would be protective of short-term public health and the community. Additionally, under the No Action alternative, there would be no impacts to park visitors, park personnel, or the surrounding community that would result from implementation of the alternative.

7.1.5 Long-Term Effectiveness and Permanence

The results of the risk assessment indicate that there is no unacceptable risk to people or ecological receptors at the Site; therefore, the No Action alternative would be protective of long-term public health and the community. Additionally, under the No Action alternative, there would be no long-term impacts to park visitors, park personnel, or the surrounding community that would result from implementation of the alternative. There would be no long-term operation or maintenance requirements associated with the No Action alternative for NPS in the future.

7.2 IMPLEMENTABILITY

This section provides an evaluation of the technical and administrative feasibility of implementing the No Action alternative.

7.2.1 Technical Feasibility

The No Action alternative would be technically feasible because no additional actions or activities would be required. Additionally, because there would be no actions required, no services or materials would be required.

7.2.2 Administrative Feasibility

Under CERCLA, federal, state, and local permits are not required for on-site CERCLA response actions; however, the substantive requirements of all permits that would otherwise be required must be met (40 CFR Section 300.400(e)). Because there would be no actions required under the No Action alternative, permits would not be required, and state and local requirements would not apply.

7.2.3 State (Support Agency) Acceptance

State support agency acceptance is not required (Alberts 2022). Prior to being designated under CERCLA by NPS and the August 2016 TCRA Action Memorandum, the Site was listed on Ecology's Confirmed and Suspected Contaminated Site List (CSCSL) as Site ID 10891. An Early Notice Letter was sent to City Light by Ecology on July 10, 2015, following an Initial Investigation Field Report developed by Ecology based on the 2014 Hart Crowser data submitted by City Light. Because the Site became designated under CERCLA by NPS, City Light has not coordinated with Ecology since receipt of the Early Notice Letter.

NPS will provide Ecology with the draft final EE/CA during the public review period and address comments at that time. It is anticipated that Ecology will remove the Site from the CSCSL.

7.2.4 Community Acceptance

A Community Involvement Plan (CIP) has been prepared and included in the Administrative Record in accordance with CERCLA and the NCP, 40 CFR Part 300 (NPS 2017b). The NPS CIP serves as a guide for the NPS to engage and inform community members, environmental groups, government officials, the media, and other interested parties in the environmental investigation and cleanup activities at a site. Consistent with the CIP and EE/CA guidance, once drafted, this EE/CA will be made available for a 30-day public comment period, after which it will be finalized. Assessment of community acceptance will include an evaluation of and response to any significant questions received during the public comment period regarding the No Action alternative presented in this EE/CA.

7.3 COST

Under the No Action alternative, no additional activities or maintenance would be required; therefore, there would be no costs associated with this alternative.

7.4 SUMMARY OF THE ALTERNATIVE COMPARATIVE ANALYSIS

Table 7.1 summarizes the results of the evaluation of the effectiveness, implementability, and cost criteria for the No Action alternative.

Table 7.1
Comparison of Alternatives

Alternative	Effectiveness: Protective of Human Health?	Effectiveness: Protective of the Environment?	Effectiveness: Complies with ARARs?	Effectiveness: Reduces Toxicity, Mobility, or Volume	Effectiveness Duration: Short Term	Effectiveness Duration: Long Term	Implementability: Technical Feasibility	Implementability: Administrative Feasibility	Implementability: State Acceptance	Implementability: Community Acceptance	Cost
1- No action	*Yes*	*Yes*	*Yes*	*Not applicable*	*Good*	*Good*	*Good*	*Good*	*Pending*	*Pending*	*$0*

8.0 Recommended Alternative and Implementation

The purpose of Section 8.0 is to describe the recommended alternative and the reason for the selection. Taking into consideration the results of the risk assessment and the evaluation criteria presented in this EE/CA, the recommended alternative for the Site is the No Action alternative.

8.1 RECOMMENDED ALTERNATIVE

The recommended alternative for the Site is the No Action alternative. Under the No Action alternative, no additional removal activities or maintenance at the Site would be proposed, and there would be no costs associated with implementation.

The No Action alternative is selected as the recommended alternative based on the results of the comparative analysis completed in Section 7.0, showing that the alternative would effectively protect human health and the environment over the short- and long-term, would be in compliance with ARARs, satisfies all Site RAOs, and would be implementable at no cost.

The results of the risk assessment presented in Section 3.0 indicate that there is no unacceptable risk to people or ecological receptors at the Site. These results indicate the TCRA conducted in 2016 and 2017, which removed 171 tons of contaminated soil, was successful in eliminating unacceptable risk to people and ecological receptors.

Because no additional removal activities are needed, there is no associated interruption or limitation to the use of the Site by workers or recreational users. The No Action alternative would also protect and preserve the NOCA natural resources, conditions, and values over the long term and would enable park managers to manage the park in such a manner as to achieve the purposes for which the park was established (NPS 2015b).

8.2 MONITORING

City Light currently monitors conditions at the Site. Regrowth of native vegetation and invasive species are monitored twice per year at the Site, and non-native and invasive plants are removed manually. This monitoring was initiated after the 2015 Goodell Fire and subsequent saddle replacement and soil removal activities completed under the TCRA to ensure the area disturbed by the fire and TCRA activities is being revegetated by native plants.

As stated in Section 6.1, City Light also periodically checks the powerhouse tailrace for accumulation of rocks and sediment from Newhalem Creek, the source of the flow through the penstock to the tailrace, to check that they have not accumulated to levels that would overtop the fish barrier located at the outlet of the tailrace. Rocks and sediments accumulated in the tailrace are primarily those occasionally entrained in high Newhalem Creek flows at the diversion above the Site and discharged to the tailrace via the penstock and powerhouse. As discussed in Section 2.11.2, soil or sediment from the Site may also be entrained in intermittent stream flow that reaches the tailrace; however, the contribution of sediment to the tailrace from the intermittent stream is likely minor compared to that of Newhalem Creek.

Under conditions where soil and/or sediment erode from the Site, it would likely be limited to the intermittent stream pathway to the tailrace and be contained there behind the fish barrier. In the event that suspended sediments are discharged to the Skagit River from the tailrace, the EE/CA results indicate that Site COPCs/COPECs that may be present at detectable concentrations in these sediments would not pose a risk to the benthic community (refer to Section 2.11.2).

To supplement the current monitoring activities, NPS has requested that City Light include monitoring for signs of erosion and migration of sediment to the tailrace. City Light will coordinate with NPS to prepare a Monitoring Plan to document the monitoring activities described in this section and the monitoring schedule. Monitoring activities are expected to continue for 5 years, or as defined in the Monitoring Plan.

8.3 IMPLEMENTATION AND SCHEDULE

The draft EE/CA and the Administrative Record supporting this EE/CA will be made available for public comment for 30 days. Following receipt and evaluation of public comments, the EE/CA will be finalized and an Action Memorandum will be issued by NPS. The Action Memorandum, as the decision document selecting a Non-Time-Critical Removal Action, will summarize the need for additional action (if any), will identify the selected alternative, provide the rationale for the selected alternative, and address significant comments received from the public, including those received from other jurisdictions (e.g., states, tribes, USEPA).

9.0 References

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Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Tables

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Metals															
Arsenic	7440-38-2	Yes	54	29	54%	4.5	94	NHP-T15-5E	NHP-T15-5E-0.5	10/12/2018	0.5 ft	6.8	0.25	0.68	0.25
Cadmium	7440-43-9	Yes	4	4	100%	0.23	0.82	T6-E-11ft	T6-E-11ft	7/11/2014	0-6 in	4	0.27	2	0.27
Chromium	7440-47-3	Yes	14	14	100%	12	40	T4-C	T4-C	7/11/2014	0-6 in	0.34	23	2,000	0.34
Copper	7440-50-8	Yes	14	14	100%	14	47	T6-E-11ft	T6-E-11ft	7/11/2014	0-6 in	50	14	310	14
Lead	7439-92-1	Yes	56	55	98%	6.9	2,000	T6-E-5ft	T6-E-5ft	7/11/2014	0-6 in	50	0.94	250	0.94
Manganese	7439-96-5	No	18	18	100%	320	2,200	NHP-T22-10E	NHP-T22-10E-0	10/12/2018	0 ft	220	322	--	220
Mercury	7439-97-6	Yes	4	4	100%	0.031	0.35	T6-E-11ft	T6-E-11ft	7/11/2014	0-6 in	0.05	0.013	1.1	0.013
Molybdenum	7439-96-5	No	18	7	39%	0.62	110	NHP-T15-5E	NHP-T15-5E-0.5	10/12/2018	0.5 ft	2	0.52	--	0.52
Nickel	7440-02-0	No	6	6	100%	17	29	NHP-T22-5W	NHP-T22-5W-0	10/12/2018	0 ft	38	10	--	10
Zinc	7440-66-6	Yes	34	34	100%	39	980	NHP-T15-5E	NHP-T15-5E-0.5	10/12/2018	0.5 ft	6.62	12	2300	6.62
Polycyclic Aromatic Hydrocarbons (PAHs)															
1-Methylnaphthalene	90-12-0	No	17	7	41%	0.019	0.17	SDL15	SDL15-B-2.0ft	6/5/2017	2 ft	--	--	18	18
2-Methylnaphthalene	91-57-6	No	17	8	47%	0.0089	0.23	SDL15	SDL15-B-2.0ft	6/5/2017	2 ft	--	16	24	16
Acenaphthene	83-32-9	Yes	17	8	47%	0.034	0.85	SDL15	SDL15-B-2.0ft	6/5/2017	2 ft	0.25	130	360	0.25
Acenaphthylene	208-96-8	No	17	8	47%	0.034	0.24	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	120	--	120
Anthracene	120-12-7	No	17	13	76%	0.0089	6.5	NHP-T24-5W	NHP-T24-5W-0-0.2	10/12/2018	0-0.2 ft	6.8	210	1,800	6.8
Benzo(a)anthracene	56-55-3	Yes	17	15	88%	0.015	2.9	NHP-T24-10W	NHP-T24-10W-0-0.3	10/12/2018	0-0.3 ft	18	0.73	1.1	0.73
Benzo(a)pyrene	50-32-8	Yes	17	14	82%	0.015	1.5	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	1.98	0.1	0.1
Benzo(b)fluoranthene	205-99-2	Yes	17	16	94%	0.012	2.9	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	18	44	1.1	1.1
Benzo(g,h,i)perylene	191-24-2	No	17	14	82%	0.0078	0.63	SDL15	SDL15-B-2.0ft	6/5/2017	2 ft	--	25	--	25
Benzo(k)fluoranthene	207-08-9	Yes	17	14	82%	0.0095	0.96	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	--	0.42	0.42
Chrysene	218-01-9	Yes	17	16	94%	0.014	4.2	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	3.1	110	3.1
Dibenzo(a,h)anthracene	53-70-3	Yes	17	8	47%	0.038	0.21	NHP-T24-10W SDL15	NHP-T24-10W-0-0.3 SDL15-B-2.0ft	10/12/2018 6/5/2017	0-0.3 ft 2 ft	--	14	0.11	0.11
Fluoranthene	206-44-0	No	17	17	100%	0.012	7.1	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	10	22	240	10
Fluorene	86-73-7	No	17	9	53%	0.009	1	SDL52	SDL52-B-2.0ft	6/26/2017	2 ft	3.7	250	240	3.7
Indeno(1,2,3-c,d)pyrene	193-39-5	No	17	14	82%	0.0096	0.7	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	71	1.1	1.1
Naphthalene	91-20-3	No	17	10	59%	0.011	0.15	NHP-T24-5W	NHP-T24-5W-0-0.2	10/12/2018	0-0.2 ft	1	3.4	3.8	1
Phenanthrene	85-01-8	No	17	16	94%	0.0099	4.9	SDL52	SDL52-B-2.0ft	6/26/2017	2 ft	5.5	11	--	5.5
Pyrene	129-00-0	No	17	17	100%	0.011	7.3	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	10	23	180	10
Total cPAH TEQ (U=0)	cPAH TEQ	Yes	17	16	94%	0.0024	2.3	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	--	--	0.1	0.1
Total HMW PAHs (U=0)	HPAH (U=0)	Yes	17	17	100%	0.011	21	NHP-T24-C	NHP-T24-C-0-0.1	10/12/2018	0-0.1 ft	18	1.1	--	1.1
Total LMW PAHs (U=0)	LPAH (U=0)	No	17	17	100%	0.022	14	NHP-T24-5W	NHP-T24-5W-0-0.2	10/12/2018	0-0.2 ft	29	100	--	29
Semivolatile Organic Compounds															
1,2,4-Trichlorobenzene	120-82-1	No	9	None	NA	NA	NA	NA	NA	NA	--	1.2	0.27	5.8	0.27
1,2-Dichlorobenzene	95-50-1	No	9	None	NA	NA	NA	NA	NA	NA	--	20	0.92	180	0.92
1,2-Diphenylhydrazine	122-66-7	No	9	1	11%	0.63	0.63	SDL35	SDL35-B-2.0ft	5/11/2017	2 ft	--	--	0.68	0.68
1,3-Dichlorobenzene	541-73-1	No	9	None	NA	NA	NA	NA	NA	NA	--	20	0.74	--	0.74
1,4-Dichlorobenzene	106-46-7	No	9	None	NA	NA	NA	NA	NA	NA	--	1.2	0.89	2.6	0.89
2,3,4,6-Tetrachlorophenol	58-90-2	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	190	190
2,3,5,6-Tetrachlorophenol	935-95-5	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
2,3-Dichloroaniline	608-27-5	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Semivolatile Organic Compounds (cont.)															
2,4,5-Trichlorophenol	95-95-4	No	9	None	NA	NA	NA	NA	NA	NA	--	4	--	630	4
2,4,6-Trichlorophenol	88-06-2	No	9	None	NA	NA	NA	NA	NA	NA	--	10	--	6.3	6.3
2,4-Dichlorophenol	120-83-2	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	19	19
2,4-Dimethylphenol	105-67-9	No	9	None	NA	NA	NA	NA	NA	NA	--	0.01	--	130	0.01
2,4-Dinitrophenol	51-28-5	No	9	None	NA	NA	NA	NA	NA	NA	--	20	--	13	13
2,4-Dinitrotoluene	121-14-2	No	9	None	NA	NA	NA	NA	NA	NA	--	6	14	1.7	1.7
2,6-Dinitrotoluene	606-20-2	No	9	None	NA	NA	NA	NA	NA	NA	--	30	4	0.36	0.36
2-Chloronaphthalene	91-58-7	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	480	480
2-Chlorophenol	95-57-8	No	9	None	NA	NA	NA	NA	NA	NA	--	--	0.39	39	0.39
2-Methylphenol	95-48-7	No	9	None	NA	NA	NA	NA	NA	NA	--	0.67	580	320	0.67
2-Nitroaniline	88-74-4	No	9	None	NA	NA	NA	NA	NA	NA	--	--	5.3	63	5.3
2-Nitrophenol	88-75-5	No	9	None	NA	NA	NA	NA	NA	NA	--	7	--	--	7
3,3'-Dichlorobenzidine	91-94-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	1.2	1.2
3- & 4-Methylphenol	MEPH3_4	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	4,000	4,000
3-Nitroaniline	99-09-2	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4,6-Dinitro-o-cresol	534-52-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.51	0.51
4-Bromophenyl phenyl ether	101-55-3	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	630	630
4-Chloroaniline	106-47-8	No	9	None	NA	NA	NA	NA	NA	NA	--	1	--	2.7	1
4-Chlorophenyl phenyl ether	7005-72-3	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4-Nitroaniline	100-01-6	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	25	25
4-Nitrophenol	100-02-7	No	9	None	NA	NA	NA	NA	NA	NA	--	7	--	--	7
Aniline	62-53-3	No	9	1	11%	0.28	0.28	SDL03	SDL03-B-3.25ft	11/3/2016	3.25 ft	--	--	44	44
Benzidine	92-87-5	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.00053	0.00053
Benzyl alcohol	100-51-6	No	9	1	11%	0.66	0.66	SDL52	SDL52-B-2.0ft	6/26/2017	2 ft	--	--	630	630
Butyl benzyl phthalate	85-68-7	No	9	None	NA	NA	NA	NA	NA	NA	--	--	90	290	90
Carbazole	86-74-8	No	9	4	44%	0.1	0.32	SDL52	SDL52-B-2.0ft	6/26/2017	2 ft	--	79	--	79
Di-n-butyl phthalate	84-74-2	No	9	None	NA	NA	NA	NA	NA	NA	--	160	0.011	630	0.011
Di-n-octyl phthalate	117-84-0	No	9	None	NA	NA	NA	NA	NA	NA	--	--	0.91	63	0.91
Dibenzofuran	132-64-9	No	9	4	44%	0.12	0.58	SDL15	SDL15-B-2.0ft	6/5/2017	2 ft	6.1		7.3	6.1
Diethylphthalate	84-66-2	No	9	None	NA	NA	NA	NA	NA	NA	--	100	3600	5,100	100
Dimethyl phthalate	131-11-3	No	9	None	NA	NA	NA	NA	NA	NA	--	10	38	--	10
Hexachlorobenzene	118-74-1	No	9	None	NA	NA	NA	NA	NA	NA	--	10	0.079	0.21	0.079
Hexachlorocyclopentadiene	77-47-4	No	9	None	NA	NA	NA	NA	NA	NA	--	10	--	0.18	0.18
Hexachloroethane	67-72-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	1.8	1.8
Isophorone	78-59-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	570	570
N-Nitroso-di-n-propylamine	621-64-7	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.078	0.078
N-Nitrosodimethylamine	62-75-9	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.002	0.002
N-Nitrosodiphenylamine	86-30-6	No	9	None	NA	NA	NA	NA	NA	NA	--	20	--	110	20
Nitrobenzene	98-95-3	No	9	None	NA	NA	NA	NA	NA	NA	--	2.2	4.8	5.1	2.2
Pentachlorophenol	87-86-5	No	9	1	11%	0.26	0.26	SDL03	SDL03-B-3.25ft	11/3/2016	3.25 ft	3	0.36	1	0.36
Phenol	108-95-2	No	9	1	11%	0.057	0.057	SDL38	SDL38-B-2.0ft	6/26/2017	2 ft	0.79	37	1,900	0.79
Pyridine	110-86-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	7.8	7.8

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	**CAS No.**	**COPEC/ COPC**	**Number of Results**	**Number of Detects**	**Percentage of Detects**	**Minimum Detected Value**	**Maximum Detected Value**	**Location of Maximum Detect**	**Field Sample ID of Maximum Detect**	**Date of Maximum Detect**	**Depth Range of Maximum Detect**	**SLERA COPEC Selection Plant/Invert. ESV**	**SLERA COPEC Selection Bird/Mammal ESV**	**COPC Selection SL**	**Minimum ESV or SL**
Semivolatile Organic Compounds (cont.)															
bis(2-chloroethoxy)methane	111-91-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	19	19
bis(2-chloroethyl)ether	111-44-4	Yes	9	1	11%	0.26	0.26	SDL35	SDL35-B-2.0ft	5/11/2017	2 ft	--	--	0.23	0.23
bis(2-chloroisopropyl)ether	108-60-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	310	310
bis(2-ethylhexyl)phthalate	117-81-7	Yes	9	5	56%	0.048	0.27	SDL35	SDL35-B-2.0ft	5/11/2017	2 ft	--	0.02	39	0.02
m-Dinitrobenzene	99-65-0	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
o-Dinitrobenzene	528-29-0	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
p-Dinitrobenzene	100-25-4	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
Volatile Organic Compounds															
Di(2-ethylhexyl)adipate	103-23-1	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	450	450
Hexachlorobutadiene	87-68-3	No	9	None	NA	NA	NA	NA	NA	NA	--	--	--	1.2	1.2

Notes:

-- Not available.
1 Exceedance ratio is rounded to two significant figures.
2 Non-detect results are reported at the reporting limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
HMW	High molecular weight
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
TEQ	Toxic equivalent

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Minimum Criteria	Percentage of Detected Results Exceeding Minimum Criteria	Exceedance Ratio (1)	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value (2)	Maximum Non-Detect Value (2)	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio (1)
Metals												
Arsenic	7440-38-2	Yes	29	100%	380	25	46%	5.9	20	25	100%	80
Cadmium	7440-43-9	Yes	3	75%	3.0	None	NA	NA	NA	None	NA	NA
Chromium	7440-47-3	Yes	14	100%	120	None	NA	NA	NA	None	NA	NA
Copper	7440-50-8	Yes	13	97%	3.4	None	NA	NA	NA	None	NA	NA
Lead	7439-92-1	Yes	55	100%	2,100	1	2%	6.3	6.3	1	100%	6.7
Manganese	7439-96-5	No	18	100%	10	None	NA	NA	NA	None	NA	NA
Mercury	7439-97-6	Yes	4	100%	27	None	NA	NA	NA	None	NA	NA
Molybdenum	7439-96-5	No	7	100%	210	11	61%	0.74	1.2	11	100%	2.3
Nickel	7440-02-0	No	6	100%	2.9	None	NA	NA	NA	None	NA	NA
Zinc	7440-66-6	Yes	34	100%	150	None	NA	NA	NA	None	NA	NA
Polycyclic Aromatic Hydrocarbons (PAHs)												
1-Methylnaphthalene	90-12-0	No	None	NA	NA	10	59%	0.0072	0.014	None	NA	NA
2-Methylnaphthalene	91-57-6	No	None	NA	NA	9	53%	0.0072	0.014	None	NA	NA
Acenaphthene	83-32-9	Yes	2	25%	3.4	9	53%	0.0072	0.014	None	NA	NA
Acenaphthylene	208-96-8	No	None	NA	NA	9	53%	0.0072	0.014	None	NA	NA
Anthracene	120-12-7	No	None	NA	NA	4	24%	0.0072	0.013	None	NA	NA
Benzo(a)anthracene	56-55-3	Yes	5	33%	4.0	2	12%	0.0077	0.012	None	NA	NA
Benzo(a)pyrene	50-32-8	Yes	8	57%	15	3	18%	0.0077	0.012	None	NA	NA
Benzo(b)fluoranthene	205-99-2	Yes	5	31%	2.6	1	6%	0.0077	0.0077	None	NA	NA
Benzo(g,h,i)perylene	191-24-2	No	None	NA	NA	3	18%	0.0077	0.012	None	NA	NA
Benzo(k)fluoranthene	207-08-9	Yes	4	29%	2.3	3	18%	0.0077	0.012	None	NA	NA
Chrysene	218-01-9	Yes	2	13%	1.4	1	6%	0.0077	0.0077	None	NA	NA
Dibenzo(a,h)anthracene	53-70-3	Yes	4	50%	1.9	9	53%	0.0072	0.014	None	NA	NA
Fluoranthene	206-44-0	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Fluorene	86-73-7	No	None	NA	NA	8	47%	0.0072	0.014	None	NA	NA
Indeno(1,2,3-c,d)pyrene	193-39-5	No	None	NA	NA	3	18%	0.0077	0.012	None	NA	NA
Naphthalene	91-20-3	No	None	NA	NA	7	41%	0.0072	0.014	None	NA	NA
Phenanthrene	85-01-8	No	None	NA	NA	1	6%	0.0072	0.0072	None	NA	NA
Pyrene	129-00-0	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Total cPAH TEQ (U=0)	cPAH TEQ	Yes	9	56%	23	1	6%	0.0077	0.0077	None	NA	NA
Total HMW PAHs (U=0)	HPAH (U=0)	Yes	8	47%	19	None	NA	NA	NA	None	NA	NA
Total LMW PAHs (U=0)	LPAH (U=0)	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Semivolatile Organic Compounds												
1,2,4-Trichlorobenzene	120-82-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
1,2-Dichlorobenzene	95-50-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
1,2-Diphenylhydrazine	122-66-7	No	None	NA	NA	8	89%	0.039	0.056	None	NA	NA
1,3-Dichlorobenzene	541-73-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
1,4-Dichlorobenzene	106-46-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,3,4,6-Tetrachlorophenol	58-90-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,3,5,6-Tetrachlorophenol	935-95-5	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,3-Dichloroaniline	608-27-5	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Minimum Criteria	Percentage of Detected Results Exceeding Minimum Criteria	Exceedance Ratio [(1)]	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value [(2)]	Maximum Non-Detect Value [(2)]	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio [(1)]
Semivolatile Organic Compounds (cont.)												
2,4,5-Trichlorophenol	95-95-4	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,4,6-Trichlorophenol	88-06-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,4-Dichlorophenol	120-83-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,4-Dimethylphenol	105-67-9	No	None	NA	NA	9	100%	0.039	0.056	9	100%	5.6
2,4-Dinitrophenol	51-28-5	No	None	NA	NA	9	100%	0.19	0.28	None	NA	NA
2,4-Dinitrotoluene	121-14-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2,6-Dinitrotoluene	606-20-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2-Chloronaphthalene	91-58-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2-Chlorophenol	95-57-8	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2-Methylphenol	95-48-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2-Nitroaniline	88-74-4	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
2-Nitrophenol	88-75-5	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
3,3'-Dichlorobenzidine	91-94-1	No	None	NA	NA	9	100%	0.19	0.28	None	NA	NA
3- & 4-Methylphenol	MEPH3_4	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
3-Nitroaniline	99-09-2	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
4,6-Dinitro-o-cresol	534-52-1	No	None	NA	NA	9	100%	0.19	0.28	None	NA	NA
4-Bromophenyl phenyl ether	101-55-3	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
4-Chloro-3-methylphenol	59-50-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
4-Chloroaniline	106-47-8	No	None	NA	NA	9	100%	0.19	0.28	None	NA	NA
4-Chlorophenyl phenyl ether	7005-72-3	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
4-Nitroaniline	100-01-6	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
4-Nitrophenol	100-02-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Aniline	62-53-3	No	None	NA	NA	8	89%	0.19	0.28	None	NA	NA
Benzidine	92-87-5	No	None	NA	NA	9	100%	0.39	0.56	9	100%	1,100
Benzyl alcohol	100-51-6	No	None	NA	NA	8	89%	0.19	0.26	None	NA	NA
Butyl benzyl phthalate	85-68-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Carbazole	86-74-8	No	None	NA	NA	5	56%	0.039	0.046	None	NA	NA
Di-n-butyl phthalate	84-74-2	No	None	NA	NA	9	100%	0.19	0.28	9	100%	25
Di-n-octyl phthalate	117-84-0	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Dibenzofuran	132-64-9	No	None	NA	NA	5	56%	0.039	0.046	None	NA	NA
Diethylphthalate	84-66-2	No	None	NA	NA	9	100%	0.19	0.28	None	NA	NA
Dimethyl phthalate	131-11-3	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Hexachlorobenzene	118-74-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Hexachlorocyclopentadiene	77-47-4	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Hexachloroethane	67-72-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Isophorone	78-59-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
N-Nitroso-di-n-propylamine	621-64-7	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
N-Nitrosodimethylamine	62-75-9	No	None	NA	NA	9	100%	0.039	0.056	9	100%	28
N-Nitrosodiphenylamine	86-30-6	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Nitrobenzene	98-95-3	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Pentachlorophenol	87-86-5	No	None	NA	NA	8	89%	0.19	0.28	None	NA	NA
Phenol	108-95-2	No	None	NA	NA	8	89%	0.039	0.056	None	NA	NA
Pyridine	110-86-1	No	None	NA	NA	9	100%	0.39	0.56	None	NA	NA

Table 2.1
FOD/FOE Site Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Minimum Criteria	Percentage of Detected Results Exceeding Minimum Criteria	Exceedance Ratio (1)	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value (2)	Maximum Non-Detect Value (2)	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio (1)
Semivolatile Organic Compounds (cont.)												
bis(2-chloroethoxy)methane	111-91-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
bis(2-chloroethyl)ether	111-44-4	Yes	1	100%	1.1	8	89%	0.039	0.056	None	NA	NA
bis(2-chloroisopropyl)ether	108-60-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
bis(2-ethylhexyl)phthalate	117-81-7	Yes	5	100%	14	4	44%	0.041	0.056	4	100%	2.8
m-Dinitrobenzene	99-65-0	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
o-Dinitrobenzene	528-29-0	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
p-Dinitrobenzene	100-25-4	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Volatile Organic Compounds												
Di(2-ethylhexyl)adipate	103-23-1	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA
Hexachlorobutadiene	87-68-3	No	None	NA	NA	9	100%	0.039	0.056	None	NA	NA

Notes:

--	Not available.
1	Exceedance ratio is rounded to two significant figures.
2	Non-detect results are reported at the reporting limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
HMW	High molecular weight
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
TEQ	Toxic equivalent

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Metals															
Arsenic	7440-38-2	Yes	13	5	38%	9.6	18	NHP-BKGD-10	NHP-BKGD-10	10/11/2018	0-6 in	6.8	0.25	0.68	0.25
Barium	7440-39-3	No	3	3	100%	290	330	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	110	17.2	1,500	17.2
Cadmium	7440-43-9	Yes	3	3	100%	0.29	0.46	SCL-LC-BG4	SCL-LC-BG4	11/3/2015	0-6 in	4	0.27	2	0.27
Chromium	7440-47-3	Yes	3	3	100%	30	37	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	0.34	23	2,000	0.34
Lead	7439-92-1	Yes	13	12	92%	6.9	27	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	50	0.94	250	0.94
Manganese	7439-96-5	No	10	10	100%	220	1,100	NHP-BKGD-11 NHP-BKGD-9	NHP-BKGD-11 NHP-BKGD-9-0	10/12/2018 10/11/2018	0-6 in	220	322	--	220
Mercury	7439-97-6	Yes	3	None	NA	NA	NA	NA	NA	NA	--	0.05	0.013	1.1	0.013
Molybdenum	7439-96-5	No	10	None	NA	NA	NA	NA	NA	NA	--	2	0.52	--	0.52
Nickel	7440-02-0	No	10	10	100%	2.1	24	NHP-BKGD-8 NHP-BKGD-10	NHP-BKGD-8 NHP-BKGD-10	10/11/2018	0-6 in	38	10	--	10
Selenium	7782-49-2	No	3	None	NA	NA	NA	NA	NA	NA	--	0.52	0.331	39	0.331
Silver	7440-22-4	No	3	None	NA	NA	NA	NA	NA	NA	--	2	2.6	39	2
Zinc	7440-66-6	Yes	10	10	100%	17	100	NHP-BKGD-9	NHP-BKGD-9-0	10/11/2018	0-6 in	6.62	12	2,300	6.62
Polycyclic Aromatic Hydrocarbons (PAHs)															
1-Methylnaphthalene	90-12-0	No	3	3	100%	0.034	0.035	SCL-LC-BG5 SCL-LC-BG4	SCL-LC-BG5 SCL-LC-BG4	11/3/2015	0-6 in	--	--	18	18
2-Methylnaphthalene	91-57-6	No	3	3	100%	0.039	0.043	SCL-LC-BG4	SCL-LC-BG4	11/3/2015	0-6 in	--	16	24	16
Acenaphthene	83-32-9	Yes	3	2	67%	0.012	0.022	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	0.25	130	360	0.25
Acenaphthylene	208-96-8	No	3	None	NA	NA	NA	NA	NA	NA	--	--	120	--	120
Anthracene	120-12-7	No	3	1	33%	0.011	0.011	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	6.8	210	1,800	6.8
Benzo(a)anthracene	56-55-3	Yes	3	None	NA	NA	NA	NA	NA	NA	--	18	0.73	1.1	0.73
Benzo(a)pyrene	50-32-8	Yes	3	None	NA	NA	NA	NA	NA	NA	--	--	1.98	0.1	0.1
Benzo(b)fluoranthene	205-99-2	Yes	3	1	33%	0.013	0.013	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	18	44	1.1	1.1
Benzo(g,h,i)perylene	191-24-2	No	3	None	NA	NA	NA	NA	NA	NA	--	--	25	--	25
Benzo(k)fluoranthene	207-08-9	Yes	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.42	0.42
Chrysene	218-01-9	Yes	3	1	33%	0.013	0.013	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	--	3.1	110	3.1
Dibenzo(a,h)anthracene	53-70-3	Yes	3	None	NA	NA	NA	NA	NA	NA	--	--	14	0.11	0.11
Fluoranthene	206-44-0	No	3	3	100%	0.011	0.019	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	10	22	240	10
Fluorene	86-73-7	No	3	3	100%	0.015	0.027	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	3.7	250	240	3.7
Indeno(1,2,3-cd)pyrene	193-39-5	No	3	None	NA	NA	NA	NA	NA	NA	--	--	71	1.1	1.1
Naphthalene	91-20-3	No	3	3	100%	0.11	0.14	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	1	3.4	3.8	1
Phenanthrene	85-01-8	No	3	3	100%	0.042	0.067	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	5.5	11	--	5.5
Pyrene	129-00-0	No	3	3	100%	0.017	0.024	SCL-LC-BG4	SCL-LC-BG4	11/3/2015	0-6 in	10	23	180	10
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	Yes	3	1	33%	0.0014	0.0014	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	--	--	0.1	0.1
Total HMW PAHs (U=0)	HPAH (U=0)	Yes	3	3	100%	0.017	0.046	SCL-LC-BG5	SCL-LC-BG5	11/3/2015	0-6 in	18	1.1	--	1.1
Total LMW PAHs (U=0)	LPAH (U=0)	No	3	3	100%	0.24	0.3	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	29	100	--	29
Semivolatile Organic Compounds															
1,2,4-Trichlorobenzene	120-82-1	No	3	None	NA	NA	NA	NA	NA	NA	--	1.2	0.27	5.8	0.27
1,2-Dichlorobenzene	95-50-1	No	3	None	NA	NA	NA	NA	NA	NA	--	20	0.92	180	0.92
1,2-Diphenylhydrazine	122-66-7	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.68	0.68
1,3-Dichlorobenzene	541-73-1	No	3	None	NA	NA	NA	NA	NA	NA	--	20	0.74	--	0.74
1,4-Dichlorobenzene	106-46-7	No	3	None	NA	NA	NA	NA	NA	NA	--	1.2	0.89	2.6	0.89

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Semivolatile Organic Compounds (cont.)															
2,3,4,6-Tetrachlorophenol	58-90-2	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	190	190
2,3,5,6-Tetrachlorophenol	935-95-5	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
2,3-Dichloroaniline	608-27-5	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
2,4,5-Trichlorophenol	95-95-4	No	3	None	NA	NA	NA	NA	NA	NA	--	4	--	630	4
2,4,6-Trichlorophenol	88-06-2	No	3	None	NA	NA	NA	NA	NA	NA	--	10	--	6.3	6.3
2,4-Dichlorophenol	120-83-2	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	19	19
2,4-Dimethylphenol	105-67-9	No	3	None	NA	NA	NA	NA	NA	NA	--	0.01	--	130	0.01
2,4-Dinitrophenol	51-28-5	No	3	None	NA	NA	NA	NA	NA	NA	--	20	--	13	13
2,4-Dinitrotoluene	121-14-2	No	3	None	NA	NA	NA	NA	NA	NA	--	6	14	1.7	1.7
2,6-Dinitrotoluene	606-20-2	No	3	None	NA	NA	NA	NA	NA	NA	--	30	4	0.36	0.36
2-Chloronaphthalene	91-58-7	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	480	480
2-Chlorophenol	95-57-8	No	3	None	NA	NA	NA	NA	NA	NA	--	--	0.39	39	0.39
2-Methylphenol	95-48-7	No	3	3	100%	0.059	0.079	SCL-LC-BG4	SCL-LC-BG4	11/3/2015	0-6 in	0.67	580	320	0.67
2-Nitroaniline	88-74-4	No	3	None	NA	NA	NA	NA	NA	NA	--	--	5.3	63	5.3
2-Nitrophenol	88-75-5	No	3	None	NA	NA	NA	NA	NA	NA	--	7	--	--	7
3,3'-Dichlorobenzidine	91-94-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	1.2	1.2
3- & 4-Methylphenol	MEPH3_4	No	3	3	100%	0.13	0.21	SCL-LC-BG4	SCL-LC-BG4	11/3/2015	0-6 in	--	--	4,000	4,000
3-Nitroaniline	99-09-2	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4,6-Dinitro-o-cresol	534-52-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.51	0.51
4-Bromophenyl phenyl ether	101-55-3	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	630	630
4-Chloroaniline	106-47-8	No	3	None	NA	NA	NA	NA	NA	NA	--	1	--	2.7	1
4-Chlorophenyl phenyl ether	7005-72-3	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	--	--
4-Nitroaniline	100-01-6	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	25	25
4-Nitrophenol	100-02-7	No	3	None	NA	NA	NA	NA	NA	NA	--	7	--	--	7
Aniline	62-53-3	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	44	44
Benzidine	92-87-5	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.00053	0.00053
Benzyl alcohol	100-51-6	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	630	630
Butyl benzyl phthalate	85-68-7	No	3	None	NA	NA	NA	NA	NA	NA	--	--	90	290	90
Carbazole	86-74-8	No	3	None	NA	NA	NA	NA	NA	NA	--	--	79	--	79
Di-n-butyl phthalate	84-74-2	No	3	None	NA	NA	NA	NA	NA	NA	--	160	0.011	630	0.011
Di-n-octyl phthalate	117-84-0	No	3	None	NA	NA	NA	NA	NA	NA	--	--	0.91	63	0.91
Dibenzofuran	132-64-9	No	3	2	67%	0.06	0.079	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	6.1		7.3	6.1
Diethylphthalate	84-66-2	No	3	None	NA	NA	NA	NA	NA	NA	--	100	3,600	5,100	100
Dimethyl phthalate	131-11-3	No	3	None	NA	NA	NA	NA	NA	NA	--	10	38	--	10
Hexachlorobenzene	118-74-1	No	3	None	NA	NA	NA	NA	NA	NA	--	10	0.079	0.21	0.079
Hexachlorocyclopentadiene	77-47-4	No	3	None	NA	NA	NA	NA	NA	NA	--	10	--	0.18	0.18
Hexachloroethane	67-72-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	1.8	1.8
Isophorone	78-59-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	570	570
N-Nitroso-di-n-propylamine	621-64-7	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.078	0.078
N-Nitrosodimethylamine	62-75-9	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.002	0.002
N-Nitrosodiphenylamine	86-30-6	No	3	None	NA	NA	NA	NA	NA	NA	--	20	--	110	20
Nitrobenzene	98-95-3	No	3	None	NA	NA	NA	NA	NA	NA	--	2.2	4.8	5.1	2.2

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Semivolatile Organic Compounds (cont.)															
Pentachlorophenol	87-86-5	No	3	None	NA	NA	NA	NA	NA	NA	--	3	0.36	1	0.36
Phenol	108-95-2	No	3	2	67%	0.24	0.26	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	0.79	37	1,900	0.79
Pyridine	110-86-1	No	3	1	33%	0.46	0.46	SCL-LC-BG3	SCL-LC-BG3	11/3/2015	0-6 in	--	--	7.8	7.8
bis(2-chloroethoxy)methane	111-91-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	19	19
bis(2-chloroethyl)ether	111-44-4	Yes	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.23	0.23
bis(2-chloroisopropyl)ether	108-60-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	310	310
bis(2-ethylhexyl)phthalate	117-81-7	Yes	3	None	NA	NA	NA	NA	NA	NA	--	--	0.02	39	0.02
m-Dinitrobenzene	99-65-0	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
o-Dinitrobenzene	528-29-0	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
p-Dinitrobenzene	100-25-4	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	0.63	0.63
Volatile Organic Compounds															
Di(2-ethylhexyl)adipate	103-23-1	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	450	450
Hexachlorobutadiene	87-68-3	No	3	None	NA	NA	NA	NA	NA	NA	--	--	--	1.2	1.2

Notes:

--	Not available.
1	Exceedance ratio is rounded to two significant figures.
2	Non-detect results are reported at the reporting limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
HMW	High molecular weight
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
TEQ	Toxic equivalent

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Criteria	Percentage of Detected Results Exceeding Criteria	Exceedance Ratio [(1)]	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value [(2)]	Maximum Non-Detect Value [(2)]	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio [(1)]
Metals												
Arsenic	7440-38-2	Yes	5	100%	72	8	62%	6.5	17	8	100%	68
Barium	7440-39-3	No	3	100%	19	None	NA	NA	NA	None	NA	NA
Cadmium	7440-43-9	Yes	None	None	NA	None	NA	NA	NA	None	100%	NA
Chromium	7440-47-3	Yes	3	100%	110	None	NA	NA	NA	None	NA	NA
Lead	7439-92-1	Yes	12	100%	29	1	8%	7.3	7.3	1	100%	7.8
Manganese	7439-96-5	No	9	90%	5.0	None	NA	NA	NA	None	NA	NA
Mercury	7439-97-6	Yes	None	NA	NA	3	100%	0.34	0.42	3	100%	32
Molybdenum	7439-96-5	No	None	NA	NA	10	100%	0.79	1	10	100%	1.9
Nickel	7440-02-0	No	7	70%	2.4	None	NA	NA	NA	None	NA	NA
Selenium	7782-49-2	No	None	NA	NA	3	100%	13	17	3	100%	51
Silver	7440-22-4	No	None	NA	NA	3	100%	1.3	1.7	None	NA	NA
Zinc	7440-66-6	Yes	10	100%	15	None	NA	NA	NA	None	NA	NA
Polycyclic Aromatic Hydrocarbons (PAHs)												
1-Methylnaphthalene	90-12-0	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
2-Methylnaphthalene	91-57-6	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Acenaphthene	83-32-9	Yes	None	NA	NA	1	33%	0.011	0.011	None	NA	NA
Acenaphthylene	208-96-8	No	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Anthracene	120-12-7	No	None	NA	NA	2	67%	0.011	0.011	None	NA	NA
Benzo(a)anthracene	56-55-3	Yes	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Benzo(a)pyrene	50-32-8	Yes	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Benzo(b)fluoranthene	205-99-2	Yes	None	NA	NA	2	67%	0.009	0.011	None	NA	NA
Benzo(g,h,i)perylene	191-24-2	No	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Benzo(k)fluoranthene	207-08-9	Yes	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Chrysene	218-01-9	Yes	None	NA	NA	2	67%	0.009	0.011	None	NA	NA
Dibenzo(a,h)anthracene	53-70-3	Yes	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Fluoranthene	206-44-0	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Fluorene	86-73-7	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Indeno(1,2,3-cd)pyrene	193-39-5	No	None	NA	NA	3	100%	0.009	0.011	None	NA	NA
Naphthalene	91-20-3	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Phenanthrene	85-01-8	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Pyrene	129-00-0	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	Yes	None	NA	NA	2	67%	0.009	0.011	None	NA	NA
Total HMW PAHs (U=0)	HPAH (U=0)	Yes	None	NA	NA	None	NA	NA	NA	None	NA	NA
Total LMW PAHs (U=0)	LPAH (U=0)	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
Semivolatile Organic Compounds												
1,2,4-Trichlorobenzene	120-82-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
1,2-Dichlorobenzene	95-50-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
1,2-Diphenylhydrazine	122-66-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
1,3-Dichlorobenzene	541-73-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
1,4-Dichlorobenzene	106-46-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Criteria	Percentage of Detected Results Exceeding Criteria	Exceedance Ratio (1)	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value (2)	Maximum Non-Detect Value (2)	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio (1)
Semivolatile Organic Compounds (cont.)												
2,3,4,6-Tetrachlorophenol	58-90-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,3,5,6-Tetrachlorophenol	935-95-5	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,3-Dichloroaniline	608-27-5	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,4,5-Trichlorophenol	95-95-4	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,4,6-Trichlorophenol	88-06-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,4-Dichlorophenol	120-83-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,4-Dimethylphenol	105-67-9	No	None	NA	NA	3	100%	0.045	0.057	3	100%	5.7
2,4-Dinitrophenol	51-28-5	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
2,4-Dinitrotoluene	121-14-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2,6-Dinitrotoluene	606-20-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2-Chloronaphthalene	91-58-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2-Chlorophenol	95-57-8	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2-Methylphenol	95-48-7	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
2-Nitroaniline	88-74-4	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
2-Nitrophenol	88-75-5	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
3,3'-Dichlorobenzidine	91-94-1	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
3- & 4-Methylphenol	MEPH3_4	No	None	NA	NA	None	NA	NA	NA	None	NA	NA
3-Nitroaniline	99-09-2	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
4,6-Dinitro-o-cresol	534-52-1	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
4-Bromophenyl phenyl ether	101-55-3	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
4-Chloro-3-methylphenol	59-50-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
4-Chloroaniline	106-47-8	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
4-Chlorophenyl phenyl ether	7005-72-3	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
4-Nitroaniline	100-01-6	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
4-Nitrophenol	100-02-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Aniline	62-53-3	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
Benzidine	92-87-5	No	None	NA	NA	3	100%	0.45	0.57	3	100%	1,100
Benzyl alcohol	100-51-6	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
Butyl benzyl phthalate	85-68-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Carbazole	86-74-8	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Di-n-butyl phthalate	84-74-2	No	None	NA	NA	3	100%	0.045	0.057	3	100%	5.2
Di-n-octyl phthalate	117-84-0	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Dibenzofuran	132-64-9	No	None	NA	NA	1	33%	0.057	0.057	None	NA	NA
Diethylphthalate	84-66-2	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
Dimethyl phthalate	131-11-3	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Hexachlorobenzene	118-74-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Hexachlorocyclopentadiene	77-47-4	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Hexachloroethane	67-72-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Isophorone	78-59-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
N-Nitroso-di-n-propylamine	621-64-7	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
N-Nitrosodimethylamine	62-75-9	No	None	NA	NA	3	100%	0.045	0.057	3	100%	29
N-Nitrosodiphenylamine	86-30-6	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Nitrobenzene	98-95-3	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA

Table 2.2
FOD/FOE Background Samples—Laboratory Analytical Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	**CAS No.**	**COPEC/ COPC**	**Number of Detected Results Exceeding Criteria**	**Percentage of Detected Results Exceeding Criteria**	**Exceedance Ratio (1)**	**Number of Non-Detects**	**Percentage of Non-Detects**	**Minimum Non-Detect Value (2)**	**Maximum Non-Detect Value (2)**	**Number of Non-Detect Results Exceeding Criteria**	**Percentage of Non-Detect Results Exceeding Criteria**	**Exceedance Ratio (1)**
Semivolatile Organic Compounds (cont.)												
Pentachlorophenol	87-86-5	No	None	NA	NA	3	100%	0.22	0.28	None	NA	NA
Phenol	108-95-2	No	None	NA	NA	1	33%	0.057	0.057	None	NA	NA
Pyridine	110-86-1	No	None	NA	NA	2	67%	0.55	0.57	None	NA	NA
bis(2-chloroethoxy)methane	111-91-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
bis(2-chloroethyl)ether	111-44-4	Yes	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
bis(2-chloroisopropyl)ether	108-60-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
bis(2-ethylhexyl)phthalate	117-81-7	Yes	None	NA	NA	3	100%	0.045	0.057	3	100%	2.9
m-Dinitrobenzene	99-65-0	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
o-Dinitrobenzene	528-29-0	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
p-Dinitrobenzene	100-25-4	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Volatile Organic Compounds												
Di(2-ethylhexyl)adipate	103-23-1	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA
Hexachlorobutadiene	87-68-3	No	None	NA	NA	3	100%	0.045	0.057	None	NA	NA

Notes:

-- Not available.
1 Exceedance ratio is rounded to two significant figures.
2 Non-detect results are reported at the reporting limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
HMW	High molecular weight
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
TEQ	Toxic equivalent

Table 2.3
FOD/FOE Site Samples—XRF Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	CAS No.	COPEC/ COPC	Number of Results	Number of Detects	Percentage of Detects	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detect	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	SLERA COPEC Selection Plant/Invert. ESV	SLERA COPEC Selection Bird/Mammal ESV	COPC Selection SL	Minimum ESV or SL
Metals $^{(3)}$															
Arsenic	7440-38-2	Yes	392	244	62%	5.5	787	T11-W-0	T11-W-0_100615_XRF	10/6/2015	--	6.8	0.25	0.68	0.25
Chromium	7440-47-3	Yes	392	42	11%	11	152	NHP-T15-C	NHP-T15-C-0.5	10/12/2018	0.5 ft	0.34	23	2,000	0.34
Copper	7440-50-8	Yes	392	75	19%	8	1,556	T11-W-0	T11-W-0_100615_XRF	10/6/2015	--	50	14	310	14
Lead	7439-92-1	Yes	392	382	97%	9	5,485	T5-C	T5-C	7/11/2014	0-6 in	50	0.94	250	0.94
Manganese	7439-96-5	No	335	330	99%	41	3,419	NHP-T21-5W	NHP-T21-5W-0.5	10/12/2018	0.5 ft	220	322	--	220
Molybdenum	7439-96-5	No	335	308	92%	7	596	T11-W-5	T11-W-5_100615_XRF	10/6/2015	--	2	0.52	--	0.52
Nickel	7440-02-0	No	335	59	18%	38	10,580	T11-W-5	T11-W-5_100615_XRF	10/6/2015	--	38	10	--	10
Zinc	7440-66-6	Yes	392	384	98%	25	2,802	T12-W-7	T12-W-7_100615_XRF	10/6/2015	--	6.62	12	2,300	6.62

Notes:

-- Not available.
1 Exceedance ratio is rounded to two significant figures.
2 Non-detect results are reported at the XRF detection limit if available.
3 Cadmiun was not included because there were no detections exceeding the XRF detection limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
XRF	X-ray fluorescence

Table 2.3
FOD/FOE Site Samples—XRF Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	CAS No.	COPEC/ COPC	Number of Detected Results Exceeding Criteria	Percentage of Detected Results Exceeding Criteria	Exceedance Ratio (1)	Number of Non-Detects	Percentage of Non-Detects	Minimum Non-Detect Value (2)	Maximum Non-Detect Value (2)	Number of Non-Detect Results Exceeding Criteria	Percentage of Non-Detect Results Exceeding Criteria	Exceedance Ratio (1)
Metals (3)												
Arsenic	7440-38-2	Yes	244	100%	3,100	148	38%	4	63	148	100%	250
Chromium	7440-47-3	Yes	42	100%	450	350	89%	5.4	269	350	100%	790
Copper	7440-50-8	Yes	61	100%	110	317	81%	5.9	53	294	93%	3.8
Lead	7439-92-1	Yes	382	100%	5,800	10	3%	8	12	10	100%	13
Manganese	7439-96-5	No	307	100%	16	5	1%	38	46	None	NA	NA
Molybdenum	7439-96-5	No	308	100%	1,100	27	8%	7	19	27	100%	37
Nickel	7440-02-0	No	59	100%	1,100	276	82%	13	126	276	100%	13
Zinc	7440-66-6	Yes	384	100%	420	8	2%	21	53	8	100%	8.0

Notes:

--	Not available.
2	Exceedance ratio is rounded to two significant figures.
1	Non-detect results are reported at the XRF detection limit if available.
3	Cadmiun was not included because there were no detections exceeding the XRF detection limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
XRF	X-ray fluorescence

Table 2.4
FOD/FOE Background Samples—XRF Data (mg/kg)

			Information about Detects									SLERA COPEC Selection ESVs and COPC Selection SLs			
Analyte	**CAS No.**	**COPEC/ COPC**	**Number of Results**	**Number of Detects**	**Percentage of Detects**	**Minimum Detected Value**	**Maximum Detected Value**	**Location of Maximum Detect**	**Field Sample ID of Maximum Detect**	**Date of Maximum Detect**	**Depth Range of Maximum Detect**	**SLERA COPEC Selection Plant/Invert. ESV**	**SLERA COPEC Selection Bird/Mammal ESV**	**COPC Selection SL**	**Minimum ESV or SL**
Metals															
Arsenic	7440-38-2	Yes	17	6	35%	6	15	NHP-BKGD-9	NHP-BKGD-9-0.5	10/11/2018	0-6 in	6.8	0.25	0.68	0.25
Chromium	7440-47-3	Yes	17	None	NA	NA	NA	NA	NA	NA	--	0.34	23	--	0.34
Copper	7440-50-8	Yes	17	None	NA	NA	NA	NA	NA	NA	--	50	14	310	14
Lead	7439-92-1	Yes	17	17	100%	10	21	NHP-BKGD-1	NHP-BKGD-1	10/11/2018	0-6 in	50	0.94	250	0.94
Manganese	7439-96-5	No	17	17	100%	173	1,153	NHP-BKGD-3	NHP-BKGD-3	10/11/2018	0-6 in	220	322	--	220
Molybdenum	7439-96-5	No	17	17	100%	10	22	NHP-BKGD-9	NHP-BKGD-9-0	10/11/2018	0-6 in	2	0.52	--	0.52
Nickel	7440-02-0	No	17	2	12%	38	52	NHP-BKGD-10	NHP-BKGD-10	10/11/2018	0-6 in	38	10	--	10
Zinc	7440-66-6	Yes	17	17	100%	24	104	NHP-BKGD-11 NHP-BKGD-9	NHP-BKGD-11 NHP-BKGD-9-0	10/12/2018 10/11/2018	0-6 in	6.62	12	2,300	6.62

Notes:

--	Not available.
1	Exceedance ratio is rounded to two significant figures.
2	Non-detect results are reported at the XRF detection limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
XRF	X-ray fluorescence

Table 2.4
FOD/FOE Background Samples—XRF Data (mg/kg)

			Information about Detect Exceedances			Information about Non-Detects				Information about Non-Detect Exceedances		
Analyte	**CAS No.**	**COPEC/ COPC**	**Number of Detected Results Exceeding Criteria**	**Percentage of Detected Results Exceeding Criteria**	**Exceedance Ratio (1)**	**Number of Non-Detects**	**Percentage of Non-Detects**	**Minimum Non-Detect Value (2)**	**Maximum Non-Detect Value (2)**	**Number of Non-Detect Results Exceeding Criteria**	**Percentage of Non-Detect Results Exceeding Criteria**	**Exceedance Ratio (1)**
Metals												
Arsenic	7440-38-2	Yes	6	100%	60	11	65%	5	6	11	100%	24
Chromium	7440-47-3	Yes	None	NA	NA	17	100%	47	77	17	100%	230
Copper	7440-50-8	Yes	None	NA	NA	17	100%	16	23	17	100%	1.6
Lead	7439-92-1	Yes	17	100%	22	None	NA	NA	NA	None	NA	NA
Manganese	7439-96-5	No	15	88%	5.2	None	NA	NA	NA	None	NA	NA
Molybdenum	7439-96-5	No	17	100%	42	None	NA	NA	NA	None	NA	NA
Nickel	7440-02-0	No	2	100%	5.2	15	88%	26	42	15	100%	4.2
Zinc	7440-66-6	Yes	17	100%	16	None	NA	NA	NA	None	NA	NA

Notes:

-- Not available.
1 Exceedance ratio is rounded to two significant figures.
2 Non-detect results are reported at the XRF detection limit.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
FOD	Frequency of detection
FOE	Frequency of exceedance
ft	Feet
in	Inches
mg/kg	Milligrams per kilogram
NA	Not applicable
SL	Screening level
SLERA	Screening-level ecological risk assessment
XRF	X-ray fluorescence

Table 3.1
Summary of COPCs

Analyte	CAS No.	COPC Selection SLs [(1)]	Maximum Detected Value	Exceedance Ratio
Metals				
Arsenic	7440-38-2	0.68	94	138
Lead	7439-92-1	250	2000	8.0
Polycyclic Aromatic Hydrocarbons				
Benzo(a)anthracene	56-55-3	1.1	2.9	2.6
Benzo(a)pyrene	50-32-8	0.1	1.5	15
Benzo(b)fluoranthene	205-99-2	1.1	2.9	2.6
Benzofluoranthenes (j+k)	BJKFLANTH	0.42	0.96	2.3
Dibenzo(a,h)anthracene	53-70-3	0.11	0.21	1.9
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	0.1	2.3	23
Semivolatile Organic Compounds				
Bis(2-chloroethyl)ether	111-44-4	0.23	0.26	1.1

Note:

1 The COPC Selection SLs are the minimum of the USEPA Regional Screening Levels (RSLs; target cancer risk = 10-6, target hazard quotient = 0.1) and MTCA Method A SLs, or the MTCA Method B SL if a MTCA Method A SL was not available.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
SL	Screening Level
TEQ	Toxic equivalent

Table 3.2
Baseline Human Health Risk Assessment Exposure Parameters

		RME Receptor Scenarios						
		Visitor		City Light Worker	Construction Worker	Residential Potential Future Use		
Exposure Parameters	**Units**	**Adult**	**Child**			**Adult**	**Child**	**Source**
Exposure Factors								
Body weight	kg	80	37	80	80	80	33	Adult from USEPA RSL User's Guide; child from EFH Table 8-1 (USEPA 2011)
Exposure frequency	days/year	20	20	20	250	365	365	City Light communications
Exposure duration	years	20	14	20	2	33	16	Ages 2-16 for child visitor; ages 0-16 for child resident
Averaging time (cancer)	days	25,550	25,550	25,550	25,550	25,550	25,550	Equal to exposure duration
Averaging time (non-cancer)	days	7,300	5,110	7,300	730	12,045	5840	Equal to exposure duration
Intake Parameters (incidental ingestion of soil, dust, and dermal absorption)								
Ingestion rate	mg/day	100	200	100	100	100	200	USEPA RSL User's Guide
Fractional intake from contaminated sources	unitless	1						USEPA RSL User's Guide
Skin surface area	cm^2	1,394	813	589	589	1,548	1,303	EFH Table 7-2 (USEPA 2011)
Adherence factor	mg/cm^2-day	0.058	0.06	0.036	0.182	0.047	0.052	EFH Table 7-4 (USEPA 2011)
Exposure time	hours/day	1	1	8	8	24	24	Best professional judgment
Particulate exposure factor	m^3/kg	4.63×10^9						RAGS Part B (USEPA 1991)

Abbreviations:

cm^2	Square centimeters
days/year	Days per year
EFH	Exposure Factors Handbook
kg	Kilograms
m^3/kg	Cubic meters per kilogram
mg/day	Milligrams per day
mg/cm^2-day	Milligrams per square centimeter per day
RAGS	Risk Assessment Guidance for Superfund
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
USEPA	U.S. Environmental Protection Agency

Table 3.3
Exposure Point Concentrations for Soil (mg/kg) for Human Health Exposure Scenarios

Contaminants of Potential Concern	Visitor (1)		NPS and City Light Workers (2)	Construction Worker (2)	Residential Potential Future Use (2)	
	Adult	Child			Adult	Child
Arsenic	20.8	20.8	20.0	20.0	20.0	20.0
Lead	377	377	343	343	343	343
Benzo(a,h)anthracene	a	a	a	a	a	a
Benzo(a)pyrene	1.14	1.14	0.850	0.850	0.850	0.850
Benzo(b)fluoranthene	a	a	a	a	a	a
Benzo(k)fluoranthene	a	a	a	a	a	a
Dibenzo(a,h)anthracene	a	a	a	a	a	a
cPAHs	5.36	5.36	1.31	1.31	1.31	1.31
Bis(2-chloroethyl)ether	b	b	0.0490	0.0490	0.0490	0.0490

Notes:

1 The soil dataset for the visitor scenario was limited to surface soil within the top 6 inches. Two samples (NHP-T16-C and NHP-T19-C) that included soil from the surface down to 1 foot bgs were also included in the soil dataset for the visitor scenario.

2 The soil dataset for these scenarios included all Site soil data (samples were collected from the ground surface down to 3.25 feet).

a Cancer risks for this COPC were evaluated as cPAHs.

b Not a COPC for this scenario.

Abbreviations:

cPAH	Carcinogenic polycyclic aromatic hydrocarbon
mg/kg	Milligrams per kilogram
NPS	National Park Service

Table 3.4
Toxicity Factors

Contaminant of Potential Concern	Oral Exposure		Inhalation Exposure	
	CSF	RfD	IUR	RfC
	1/(mg/kg-day)	mg/kg-day	1/(μg/m^3)	mg/m^3
Arsenic	1.5	0.0003	0.0043	0.000015
Benzo(a,h)anthracene	analyze as cPAH	NA	analyze as cPAH	NA
Benzo(a)pyrene	1	0.0003	0.0006	0.000002
Benzo(b)fluoranthene	analyze as cPAH	NA	analyze as cPAH	NA
Benzo(k)fluoranthene	analyze as cPAH	NA	analyze as cPAH	NA
Dibenzo(a,h)anthracene	analyze as cPAH	NA	analyze as cPAH	NA
cPAHs	1	0.0003	0.0006	0.000002
Bis(2-chloroethyl)ether	1.1	NA	0.00033	NA

Abbreviations:

cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSF	Cancer slope factor
IUR	Inhalation unit risk
μg/m^3	Micrograms per cubic meter
mg/kg-day	Milligrams per kilogram per day
mg/m^3	Milligrams per cubic meter
NA	Not applicable
RfC	Reference concentration
RfD	Reference dose

Table 3.5
Toxic Equivalent Factors for Carcinogenic Polycyclic Aromatic Hydrocarbons

Carcinogenic Polycyclic Aromatic Hydrocarbon	Toxic Equivalent Factor (unitless)
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenz(a,h)anthracene	0.1
Indeno(1,2,3-c,d)pyrene	0.1

Table 3.6
Risk Characterization Results—Non-Lead COPCs

Contaminant of Potential Concern	Exposure Route	RME Receptor Scenarios					
		Visitor		Seattle City Light Worker	Construction Worker	Residential Potential Future Use	
		Adult	Child			Adult	Child
Cancer (Excess cancer risk)							
Arsenic	Ingestion	4×10^{-7}	1×10^{-6}	4×10^{-7}	4×10^{-7}	1×10^{-5}	2×10^{-5}
	Dermal	1×10^{-8}	1×10^{-8}	4×10^{-9}	2×10^{-8}	4×10^{-7}	4×10^{-7}
	Inhalation	1×10^{-11}	9×10^{-12}	1×10^{-10}	1×10^{-10}	9×10^{-9}	4×10^{-9}
	Total	**4×10^{-7}**	**1×10^{-6}**	**4×10^{-7}**	**5×10^{-7}**	**1×10^{-5}**	**3×10^{-5}**
cPAHs	Ingestion	1×10^{-7}	3×10^{-7}	3×10^{-8}	3×10^{-8}	8×10^{-7}	2×10^{-6}
	Dermal	1×10^{-8}	1×10^{-8}	7×10^{-10}	4×10^{-9}	7×10^{-8}	8×10^{-8}
	Inhalation	5×10^{-13}	3×10^{-13}	9×10^{-13}	1×10^{-12}	8×10^{-11}	4×10^{-11}
	Total	**1×10^{-7}**	**3×10^{-7}**	**3×10^{-8}**	**4×10^{-8}**	**8×10^{-7}**	**2×10^{-6}**
Bis(2-chloroethyl)ether	Ingestion	a	a	1×10^{-9}	1×10^{-9}	3×10^{-8}	7×10^{-8}
	Dermal	a	a	2×10^{-11}	1×10^{-10}	2×10^{-9}	2×10^{-9}
	Inhalation	a	a	2×10^{-14}	2×10^{-14}	2×10^{-12}	8×10^{-13}
	Total	a	a	**1×10^{-9}**	**1×10^{-9}**	**3×10^{-8}**	**7×10^{-8}**
	Total excess risk	**5×10^{-7}**	**1×10^{-6}**	**4×10^{-7}**	**5×10^{-7}**	**1×10^{-5}**	**3×10^{-5}**
Non-Cancer (Hazard Quotient)							
Arsenic	Ingestion	0.003	0.012	0.003	0.034	0.05	0.24
	Dermal	<0.001	<0.001	<0.001	0.002	0.002	0.004
	Inhalation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Total	**0.003**	**0.012**	**0.003**	**0.036**	**0.052**	**0.25**
Benzo(a)pyrene	Ingestion	<0.001	0.001	<0.001	0.002	0.0035	0.017
	Dermal	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Inhalation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Total	**<0.001**	**0.001**	**<0.001**	**0.003**	**0.004**	**0.018**

Note:

a Not a contaminant of potential concern for this scenario.

Abbreviations:

COPC Contaminant of potential concern
RME Reasonable Maximum Exposure

Table 3.7
Integrated Exposure Uptake Biokinetic Model Results

Age Range	Air (µg/day)	Diet (µg/day)	Water (µg/day)	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
Child Visitor Scenario						
Age 2–3	0.062	1.04	1.01	1.43	3.54	1.30
Age 3–4	0.067	0.998	1.04	1.44	3.54	1.20
Age 4–5	0.067	0.959	1.08	1.07	3.18	1.10
Age 5–6	0.093	1.01	1.14	0.964	3.21	1.00
Age 6–7	0.093	1.10	1.16	0.911	3.26	0.900
Child Hypothetical Resident Scenario						
Age 0.5–1	0.021	1.03	0.364	6.78	8.19	4.40
Age 1–2	0.034	0.878	0.896	10.6	12.4	5.10
Age 2–3	0.062	0.968	0.946	10.8	12.7	4.70
Age 3–4	0.067	0.940	0.977	10.9	12.9	4.50
Age 4–5	0.067	0.922	1.04	8.28	10.3	3.70
Age 5–6	0.093	0.978	1.11	7.52	9.70	3.10
Age 6–7	0.093	1.07	1.13	7.14	9.43	2.70

Abbreviations:

IEUBK	Integrated Exposure Uptake Biokinetic
µg/day	Micrograms per day
µg/dL	Micrograms per deciliter

Table 3.8
Adult Lead Model Results

Variable	Units	Site Worker	Construction Worker	Adult Site Visitor	Adult Hypothetical Resident
Soil lead concentration	mg/kg	343	343	377	343
Geometric standard deviation PbB (1)	unitless	1.8	1.8	1.8	1.8
Baseline PbB (1)	µg/dL	0.6	0.6	0.6	0.6
Soil ingestion rate	g/day	0.1	0.1	0.1	0.1
Exposure frequency	days/year	20	250	20	350
PbB of adult (geometric mean)	µg/dL	0.7	0.7	0.7	2.2
PbB of fetuses (95th percentile)	µg/dL	1.6	1.6	1.7	5.2
Target PbB of fetuses	µg/dL	5.0	5.0	5.0	5.0
Probability that fetal PbB exceeds target PbB	%	0.02	2.4	0.02	5.6

Note:

1 Geometric standard deviation PbB and baseline PbB are from NHANES 2009-2014, per most recent update of ALM (USEPA 2017).

Abbreviations:

ALM	Adult Lead Methodology
g/day	Grams per day
µg/dL	Micrograms per deciliter
mg/kg	Milligrams per kilogram
NHANES	National Health and Nutrition Examination Survey
PbB	Blood lead concentration

Table 3.9
Surrogate Screening Values

Chemical	Maximum Site Concentration (mg/kg)	Surrogate Screening Value (mg/kg)	Source
Polycyclic Aromatic Hydrocarbons			
Acenaphthylene	0.24	11	WHO (1998); Relative potency factor of 0.01
Benzo(g,h,i)perylene	0.63	4.5	WHO (1998); Relative potency factor of 0.022
Phenanthrene	4.9	110	WHO (1998); Relative potency factor of 0.001
Other Semivolatile Organic Compounds			
1,3-Dichlorobenzene	0.056 U	18,000	MDEQ (2015a); RfD of 0.002 mg/kg-day
2,3,5,6-Tetrachlorophenol	0.056 U	190	USEPA (2020); USEPA RSL of 190 mg/kg for similar isomer 2,3,4,6-tetrachlorophenol
2,3-Dichloroaniline	0.056 U	25	USEPA (2020); USEPA RSLs of 25 and 63 mg/kg for similar compounds 2-nitroaniline and 4-nitroaniline, respectively
2-Nitrophenol	0.056 U	13	MDEQ (2015b) citing TCEQ (2003); RfD of 0.002 mg/kg-day
3-Nitroaniline	0.056 U	25	USEPA (2020); USEPA RSLs of 25 and 63 mg/kg for similar compounds 2-nitroaniline and 4-nitroaniline, respectively
4-Bromophenyl phenyl ether	0.056 U	NA	USEPA (IRIS), refer to Section 3.1.5.2 for a summary of toxicity data
4-Chlorophenyl phenyl ether	0.056 U	NA	Assume similar to 4-bromophenyl phenyl ether; refer to Section 3.1.5.2 for details
4-Nitrophenol	0.056 U	13	Assume similar to 2-nitrophenol
Carbazole	0.32	1.8	MDEQ (2015c); CSF of 0.098 per mg/kg-day
Dimethyl phthalate	0.056 U	260	USEPA (2007b); Provisional peer reviewed toxicity value (RfD) of 0.1 mg/kg-day

Abbreviations:

CSF	Cancer slope factor
IRIS	Integrated Risk Information System
MDEQ	Michigan Department of Environmental Quality
mg/kg	Milligrams per kilogram
mg/kg-day	Milligrams per kilogram per day
RfD	Reference dose
RSL	Regional Screening Level
TCEQ	Texas Commission on Environmental Quality
USEPA	U.S. Environmental Protection Agency
WHO	World Health Organization

Qualifier:

U	Analyte not detected at given reporting limit.

Table 3.10
Assessment and Measurement Endpoints for Ecological Receptors

Group	Assessment Endpoint	Measurement Endpoint
Plants	Survival, growth, reproduction of plant community	Phytotoxicity ESV
Invertebrates	Survival, growth, reproduction of earthworms	Earthworm ESV or earthworm bioaccumulation test
Birds	Survival, growth, reproduction of American robin	Dietary exposure model assuming 100% earthworm prey and incidental soil ingestion
Mammals	Survival, growth, reproduction of short-tailed shrew	Dietary exposure model assuming 100% earthworm prey and incidental soil ingestion

Abbreviation:

ESV	Ecological screening value

Table 3.11
Summary of COPECs

Analyte	CAS No.	Minimum SLERA COPEC Selection ESV	Maximum Detected Value	Exceedance Ratio
Metals				
Arsenic	7440-38-2	0.25	94	376
Cadmium	7440-43-9	0.27	0.82	3.0
Chromium	7440-47-3	0.34	40	118
Copper	7440-50-8	14	47	3.4
Lead	7439-92-1	0.94	2,000	2,128
Mercury	7439-97-6	0.013	0.35	27
Zinc	7440-66-6	6.62	980	148
Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	83-32-9	0.25	0.85	3.4
Benzo(a)anthracene	56-55-3	0.73	2.9	4.0
Chrysene	218-01-9	3.1	4.2	1.4
Total HMW PAHs (U=0)	HPAH (U=0)	1.1	21	19
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	117-81-7	0.02	0.27	14

Note:

--	Not available.

Abbreviations:

CAS	Chemical Abstracts Service
COPEC	Contaminant of potential ecological concern
ESV	Ecological Screening Value
HMW	High molecular weight
SLERA	Screening-level ecological risk assessment

Table 3.12
Screening-Level Ecological Risk Assessment Results—Plants and Invertebrates

Analytes	CAS No.	Unit	Maximum Soil Result	Plants		Invertebrates	
				Refined SLERA ESV—Plants	Plant HQ	Refined SLERA ESV—Invertebrate	Invertebrate HQ
Metals							
Arsenic	7440-38-2	mg/kg	94	18	**5.2**	60	**1.6**
Cadmium	7440-43-9	mg/kg	0.820 J	32	0.026	140	0.0059
Chromium	7440-47-3	mg/kg	40	1.0	**40**	0.40	**100**
Copper	7440-50-8	mg/kg	47	70	0.67	80	0.59
Lead	7439-92-1	mg/kg	2,000	120	**17**	1,700	**1.2**
Mercury	7439-97-6	mg/kg	0.35	0.30	**1.2**	0.10	**3.5**
Zinc	7440-66-6	mg/kg	980	160	**6.1**	120	**8.2**
Polycyclic Aromatic Hydrocarbons (PAHs)							
Acenaphthene	83-32-9	mg/kg	0.85	20	0.043	--	--
Benzo(a)anthracene	56-55-3	mg/kg	2.9	18	0.16	--	--
Chrysene	218-01-9	mg/kg	4.2	--	--	--	--
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	21	--	--	18	**1.2**
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	0.27	--	--	--	--

Notes:

--	Not available.
RED/BOLD	The HQ is greater than 1.0.

Abbreviations:

CAS	Chemical Abstracts Service
ESV	Ecological screening value
HQ	Hazard quotient
HMW	High molecular weight
mg/kg	Milligrams per kilogram
SLERA	Screening level ecological risk assessment

Table 3.13
Screening-Level Ecological Risk Assessment Results—Birds and Mammals

				Birds		Mammals	
Analytes	**CAS No.**	**Unit**	**Maximum Detected Value**	**Refined SLERA ESV—Birds**	**Bird HQ**	**Refined SLERA ESV—Mammals**	**Mammal HQ**
Metals							
Arsenic	7440-38-2	mg/kg	94	43	**2.2**	46	**2.0**
Cadmium	7440-43-9	mg/kg	0.82	0.77	**1.1**	0.36	**2.3**
Chromium	7440-47-3	mg/kg	40	23	**1.7**	63	0.63
Copper	7440-50-8	mg/kg	47	28	**1.7**	49	1.0
Lead	7439-92-1	mg/kg	2,000	11	**182**	56	**36**
Mercury	7439-97-6	mg/kg	0.35	0.013	**27**	1.7	0.21
Zinc	7440-66-6	mg/kg	980	46	**21**	79	**12**
Polcyclic Aromatic Hydrocarbons (PAHs)							
Acenaphthene	83-32-9	mg/kg	0.85	--	--	130	0.0065
Benzo(a)anthracene	56-55-3	mg/kg	2.9	0.73	**4.0**	3.4	0.85
Chrysene	218-01-9	mg/kg	4.2	--	--	3.1	**1.4**
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	21	--	--	1.1	**19**
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	0.27	0.020	**14**	0.60	0.45

Notes:

--	Not available.
RED/BOLD	The HQ is greater than 1.0.

Abbreviations:

CAS	Chemical Abstracts Service
ESV	Ecological screening value
HQ	Hazard quotient
HMW	High molecular weight
mg/kg	Milligrams per kilogram
SLERA	Screening level ecological risk assessment

Table 3.14
Summary of COPECs with Hazard Quotients Greater Than 1

COPECs	Plants	Invertebrates	Birds	Mammals
Metals				
Arsenic	X	X	X	X
Cadmium	<	<	X	X
Chromium	X	X	X	<
Copper	<	<	X	<
Lead	X	X	X	X
Mercury	X	X	X	<
Zinc	X	X	X	X
Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	<	--	--	<
Benzo(a)anthracene	<	--	X	<
Chrysene	--	--	--	X
Total HMW PAHs (U=0)	--	X	--	X
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	--	--	X	<

Notes:

< The HQ is less than 1.0.
-- A refined ESV is not available.
X The HQ is greater than 1.0.

Abbreviations:

COPEC	Contaminant of potential ecological concern
HQ	Hazard quotient
HMW	High molecular weight

Table 3.15
Ingestion Rates for Wildlife Bioaccumulation Models

Parameter	Units	Value	Reference
American Robin			
Food ingestion rate	kg food/kg BW-day	0.159	Beyer and Sample (2017)
Proportion of soil in diet	unitless	0.2	Beyer and Sample (2017)
Short-Tailed Shrew			
Food ingestion rate	kg food/kg BW-day	0.17	Mean of mean intake rates, Table 1 of Eco-SSL Attachment 4-1 (USEPA 2005)
Proportion of soil in diet	unitless	0.011	Mean value, Table 3 of Eco-SSL Attachment 4-1 (USEPA 2005)

Abbreviations:

Eco-SSL	Ecological Soil Screening Level
kg food/kg BW-day	Kilograms of food per kilogram of body weight per day

Table 3.16
Uptake Equations for Wildlife Bioaccumulation Models

Analyte	Soil to Plants (1)	Soil to Arthropods (2)	Soil to Earthworms (1)	Soil to Small Mammals (1)
Arsenic	$Cp = 0.03752 \times Cs$	$\ln(Ca) = 0.93 \times \ln(Cs) - 2.45$	$\ln(Ce) = 0.706 \times \ln(Cs) - 1.421$	$\ln(Cm) = 0.8188 \times \ln(Cs) - 4.8471$
Cadmium	$\ln(Cp) = 0.546 \times \ln(Cs) - 0.475$	$\ln(Ca) = 0.61 \times \ln(Cs) + 0.37$	$\ln(Ce) = 0.795 \times \ln(Ce) + 2.114$	$\ln(Cm) = 0.4723 \times \ln(Cs) - 1.2571$
Chromium	$Cp = 0.041 \times Cs$	assume equal to earthworms	$Ce = 0.306 \times Cs$	$\ln(Cm) = 0.7338 \times \ln(Cs) - 1.4599$
Copper	$\ln(Cp) = 0.394 \times \ln(Cs) + 0.668$	$\ln(Ca) = 0.26 \times \ln(Cs) + 2.72$	$Ce = 0.515 \times Cs$	$\ln(Cm) = 0.1444 \times \ln(Cs) + 2.042$
Lead	$\ln(Cp) = 0.561 \times \ln(Cs) - 1.328$	$\ln(Ca) = 0.70 \times \ln(Cs) - 1.63$	$\ln(Ce) = 0.807 \times \ln(Cs) - 0.218$	$\ln(Cm) = 0.4422 \times \ln(Cs) + 0.0761$
Mercury	$Cp = 0.9 \times Cs$ (3)	assume equal to earthworms	use bioaccumulation results	NA
Zinc	$\ln(Cp) = 0.554 \times \ln(Cs) + 1.575$	$\ln(Ca) = 0.22 \times \ln(Cs) + 4.38$	$\ln(Ce) = 0.328 \times \ln(Cs) + 4.449$	$\ln(Cm) = 0.0706 \times \ln(Cs) + 4.3632$
Acenaphthene	$\ln(Cp)= -0.8556 \times \ln(Cs) - 5.562$	assume equal to earthworms	$Ce = 1.47 \times Cs$	$Cm = 0$
Benzo(a)anthracene	$\ln(Cp)= 0.5944 \times \ln(Cs) - 2.7078$	assume equal to earthworms	$Ce = 1.59 \times Cs$	$Cm = 0$
Chrysene	$\ln(Cp)= 0.5944 \times \ln(Cs) - 2.7078$	assume equal to earthworms	$Ce = 2.29 \times Cs$	$Cm = 0$
Total HMW PAHs (U=0)	$\ln(Cp)= 0.9469 \times \ln(Cs) - 1.7026$	assume equal to earthworms	$Ce = 2.6 \times Cs$	$Cm = 0$
Bis(2-ethylhexyl)phthalate (4)	$Cp = 0.01 \times Cs$	$Ca = 0.01 \times Cs$	$Ce = 0.01 \times Cs$	$Cm = 0.01 \times Cs$

Notes:

1 From Attachment 4-1, Table 4a (USEPA 2005).
2 Sample and Arenal (2017).
3 Baes et al. (1984).
4 Conservative value of 0.01 chosen for each dietary item to reflect limited bioaccumulation potential (Staples et al. 1997).

Abbreviations:

Ca	Concentration in arthropod
Ce	Concentration in earthworm
Cm	Concentration in small mammal
Cs	Concentration in soil
Cp	Concentration in plant
ln	Natural logarithm
HMW	High molecular weight
NA	Not available
PAH	Polycyclic aromatic hydrocarbon

Table 3.17
Earthworm Bioaccumulation Test Results

Analyte	Concentration in Tested Soil (mg/kg)	Mean Concentration in Earthworms (mg/kg dry weight) (1)	Predicted Concentration in Earthworms Using Published Regression Equation (mg/kg dry weight)
Arsenic	11	5.76	1.31
Chromium	22	NA	6.70
Lead	120	39.0	38.3
Mercury	0.13	0.287	NA
Zinc	82	120	363

Note:

1 Mean of three replicates.

Abbreviations:

mg/kg	Milligrams per kilogram
NA	Not available

Table 3.18
Exposure Point Concentrations for Soil (mg/kg) for Ecological Receptors

Contaminants of Potential Ecological Concern	Plants	Soil Invertebrates	Birds	Mammals
Metals				
Arsenic	20.0	20.0	20.0	20.0
Cadmium	--	--	0.82	0.82
Chromium	--	--	25.8	--
Chromium(VI) (1)	1.29	1.29	--	--
Copper	--	--	31.1	--
Lead	343	343	343	343
Mercury	0.35	0.35	0.35	--
Zinc	178	178	178	178
Polcyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	--	--	--	--
Benzo(a)anthracene	--	--	1.59	--
Chrysene	--	--	--	2.14
Total HMW PAHs (U=0)	--	13.5	--	13.5
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	--	--	0.19	--

Notes:

-- The SLERA hazard quotient was less than 1 or a refined ESV was not available; therefore, the COPEC was not carried forward in the BERA (refer to Table 3.14).

1 In coordination with the National Park Service, the chromium(VI) exposure point concentration was estimated assuming that 5% of the total chromium concentration present at the Newhalem Penstock Site is chromium(VI) (refer to Section 3.2.3.1 for additional information).

Abbreviations:

BERA	Baseline ecological risk assessment
COPEC	Contaminant of potential ecological concern
ESV	Ecological Screening Value
HMW	High molecular weight
mg/kg	milligram per kilogram
PAH	Polycyclic aromatic hydrocarbon
SLERA	Screening-level ecological risk assessment

Table 3.19
Plant and Invertebrate Toxicity Reference Values

Analyte	NOAEL	LOAEL	Reference
Plants			
Arsenic	18	91	LANL ECORISK
Chromium(VI)	0.35	3.5	LANL ECORISK
Lead	120	576	LANL ECORISK
Mercury	34.9	64	LANL ECORISK
Zinc	160	812	LANL ECORISK
Chrysene	18 (1)	NA	Refined ESV
Total HMW PAHs	18 (1)	NA	Refined ESV
Bis(2-ethylhexyl)phthalate	200	NA	Efroymson et al. 1997
Invertebrates			
Arsenic	11 (2)	68	LANL ECORISK
Chromium(VI)	0.34 (3)	3.4 (3)	LANL ECORISK
Lead	1,700	8,410	LANL ECORISK
Mercury	0.287 (2)	0.5	LANL ECORISK
Zinc	120	939	LANL ECORISK
Acenaphthene	50 (4)	NA	Contreras-Ramos et al. 2006
Chrysene	18 (5)	NA	Refined ESV
Total HMW PAHs	18	NA	Refined ESV
Bis(2-ethylhexyl)phthalate	3.0	NA	Ma et al. 2017

Notes:

All toxicity reference values are in units of mg/kg.

Only chemicals with HQs greater than 1.0 in the SLERA or chemicals without screening levels are shown.

1 Used same value as benzo(a)anthracene because that compound is in the same chemical family.

2 Replaced LANL NOAEL with no effect value from site-specific bioaccumulation test.

3 No values exist for total chromium, which was measured for this study, so values for chromium(VI) are presented.

4 A NOAEL for acenaphthene was not identified, the NOAEL for phenanthrene was used as a surrogate. Earthworms exposed to 50 mg/kg phenanthrene (similar three-ring PAH to acenaphthene) showed 91% survival (Contreras-Ramos et al. 2006).

5 A NOAEL for chrysene was not identified, the NOAEL for Total HMW PAHs was used as a surrogate.

Abbreviations:

ESV	Ecological Screening Value
HMW	High molecular weight
HQ	Hazard quotient
LANL	Los Alamos National Laboratory
LOAEL	Lowest observed adverse effects level
mg/kg	Milligrams per kilogram
NA	Not available
NOAEL	No observed adverse effects level
PAH	Polycyclic aromatic hydrocarbon
SLERA	Screening level ecological risk assessment

Table 3.20
Wildlife Toxicity Reference Values

Analyte	NOAEL	LOAEL	Reference
Birds (American Robin)			
Arsenic	2.24	4.51	Eco-SSL, TechLaw 2008
Cadmium	1.47	6.35	Eco-SSL, TechLaw 2008
Chromium	2.66	15.6	Eco-SSL, TechLaw 2008
Copper	18.5	34.87	Eco-SSL, TechLaw 2008
Lead	10.9	44.63	Eco-SSL, TechLaw 2008
Mercury	0.297	NA	LANL ECORISK
Zinc	66.1	171	Eco-SSL, TechLaw 2008
Acenaphthene	22.8	228	Patton and Dieter 1980 (1)
Benzo(a)anthracene	10	100	Trust et al. 1994 (2)
Chrysene	10	100	Trust et al. 1994 (2)
Total HMW PAHs	10	100	Trust et al. 1994 (2)
Bis(2-ethylhexyl)phthalate	1.1	11	LANL ECORISK
Mammalian (Short-Tailed Shrew)			
Arsenic	2.47	4.55	Eco-SSL, TechLaw 2008
Cadmium	1.86	6.87	Eco-SSL, TechLaw 2008
Lead	40.7	186.4	Eco-SSL, TechLaw 2008
Zinc	75.4	298	Eco-SSL, TechLaw 2008
Chrysene	18	38.4	Eco-SSL, TechLaw 2008
Total HMW PAHs	18	38.4	Eco-SSL, TechLaw 2008

Notes:

All toxicity reference values are in units of mg/kg BW-day.

Only chemicals with HQs greater than 1.0 in the SLERA or chemicals without screening levels are shown.

1 No effect (400 mg/kg) and low effect (4,000 mg/kg) treatment groups were converted into TRVs using 1 kg BW and an ingestion rate of 0.059 kg/day, calculated from allometric equation from USEPA's 1993 Wildlife Exposure Factors Handbook.

2 Study results based on 7,12-dimethylbenz(a)anthracene were applied to all HMW PAHs.

Abbreviations:

Eco-SSL	Ecological Soil Screening Level
HMW	High molecular weight
HQ	Hazard quotient
kg BW	Kilograms of body weight
kg/day	Kilograms per day
LANL	Los Alamos National Laboratory
LOAEL	Lowest observed adverse effects level
mg/kg	Milligrams per kilogram
mg/kg BW-day	Milligrams per kilogram of body weight per day
NA	Not available
NOAEL	No observed adverse effects level
PAH	Polycyclic aromatic hydrocarbon
SLERA	Screening level ecological risk assessment
TRV	Toxicity reference value

Table 3.21
Plant and Invertebrate Hazard Quotients

Analyte	NOAEL HQ	LOAEL HQ	Geomean HQ
Plants			
Arsenic	1	0.2	0.5
Chromium(VI)	**4**	0.4	1
Lead	**3**	0.6	1
Mercury	0.01	0.005	0.01
Zinc	1	0.2	0.5
Chrysene	0.1	NA	NA
Total HMW PAHs	0.8	NA	NA
Bis(2-ethylhexyl)phthalate	0.0009	NA	NA
Invertebrates			
Arsenic	**2**	0.3	0.7
Chromium(VI)	**4**	0.4	1
Lead	0.2	0.04	0.09
Mercury	1	0.7	0.9
Zinc	**2**	0.2	0.5
Acenaphthene	0.08	NA	NA
Benzo(a)anthracene	NA	NA	NA
Chrysene	0.1	NA	NA
Total HMW PAHs	0.8	NA	NA
Bis(2-ethylhexyl)phthalate	0.06	NA	NA

Note:

RED/BOLD The HQ is greater than 1.

Abbreviations:

Geomean	Geometric mean
HMW	High molecular weight
HQ	Hazard quotient
LOAEL	Lowest observed adverse effects level
NA	Not available
NOAEL	No observed adverse effects level
PAH	Polycyclic aromatic hydrocarbon

Table 3.22
Bird and Mammal Hazard Quotients

Analyte	NOAEL HQ	LOAEL HQ	Geomean HQ
Birds (American Robin)			
Arsenic (with earthworm regression)	0.4	0.2	0.3
Arsenic (bioaccumulation test)	0.6	0.3	0.5
Cadmium	0.4	0.08	0.2
Chromium	0.7	0.1	0.3
Copper	0.3	0.2	0.2
Lead (with earthworm regression)	**2**	0.4	0.8
Lead (bioaccumulation test)	**2**	0.4	0.9
Mercury (bioaccumulation test)	0.4	NA	NA
Zinc (with earthworm regression)	0.9	0.3	0.5
Zinc (bioaccumulation test)	0.7	0.3	0.4
Acenaphthene	0.002	0.0002	0.0007
Benzo(a)anthracene	0.07	0.01	0.02
Chrysene	0.08	0.01	0.02
Total HMW PAHs	0.6	0.05	0.2
Bis(2-ethylhexyl)phthalate	0.01	0.001	0.002
Mammals (Short-Tailed Shrew)			
Arsenic (with earthworm regression)	0.1	0.06	0.08
Arsenic (bioaccumulation test)	0.2	0.1	0.2
Cadmium	0.2	0.05	0.1
Lead (with earthworm regression)	0.1	0.03	0.06
Lead (bioaccumulation test)	0.2	0.03	0.07
Zinc (with earthworm regression)	0.6	0.2	0.3
Zinc (bioaccumulation test)	0.5	0.1	0.3
Chrysene	0.04	0.02	0.03
Total HMW PAHs	0.3	0.1	0.2

Note:

RED/BOLD The HQ is greater than 1.

Abbreviations:

Geomean	Geometric mean
HMW	High molecular weight
HQ	Hazard quotient
LOAEL	Lowest observed adverse effects level
NOAEL	No observed adverse effects level
PAH	Polycyclic aromatic hydrocarbon

Table 3.23
Surrogate Ecological Screening Values

Chemical	Maximum Site Concentration (mg/kg)	Surrogate Ecological Screening Values (mg/kg)	Source
1-Methylnaphthalene	0.014	16	NPS (2018); SLERA COPEC Selection ESV for 2-methylnaphthalene; refer to Section 3.2.4.2 for additional details
Benzofluoranthenes (j+k)	0.012	18	NPS (2018); SLERA COPEC Selection ESVs for benzo(b)fluoranthene; refer to Section 3.2.4.2 for additional details
1,2-Diphenylhydrazine	0.056	28	ATSDR (2020); 4.8 mg/kg-day hepatic effect NOAEL dose converted to concentration by dividing by shrew food ingestion rate of 0.17 kg/kg BW-day
Aniline	0.28	176	EPA (2007c); 30 mg/kg-day development NOAEL dose converted to concentration by dividing by shrew food ingestion rate of 0.17 kg/kg BW-day
Benzyl alcohol	0.26	250	Nair (2001)
Bis(2-chloroethyl)ether	0.056	147	ATSDR (2017); 25 mg/kg-day "less serious" LOAEL dose converted to concentration by dividing by shrew food ingestion rate of 0.17 kg/kg BW-day

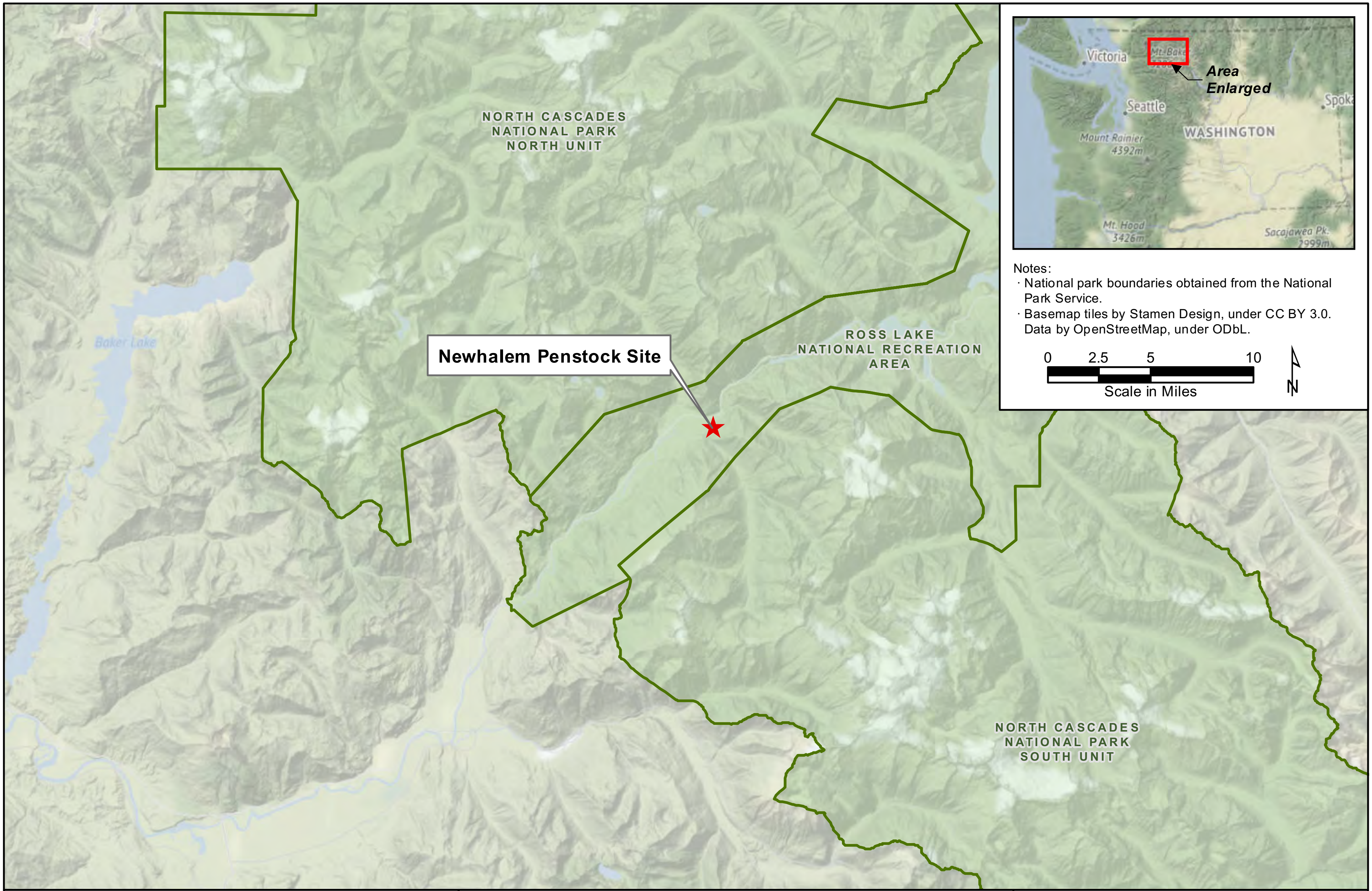
Abbreviations:

COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
kg/kg BW-day	Kilograms per kilogram of body weight per day
LOAEL	Lowest observed adverse effects level
mg/kg	Milligrams per kilogram
mg/kg-day	Milligrams per kilogram per day
NOAEL	No observed adverse effect level
SLERA	Screening-level ecological risk assessment

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Figures



Notes:
- National park boundaries obtained from the National Park Service.
- Basemap tiles by Stamen Design, under CC BY 3.0. Data by OpenStreetMap, under ODbL.

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Engineering Evaluation/Cost Analysis
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 1.1
Regional Map

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4/7/2022

Notes:
- All locations are approximate.
- Orthoimagery obtained from Esri, accessed 2020.

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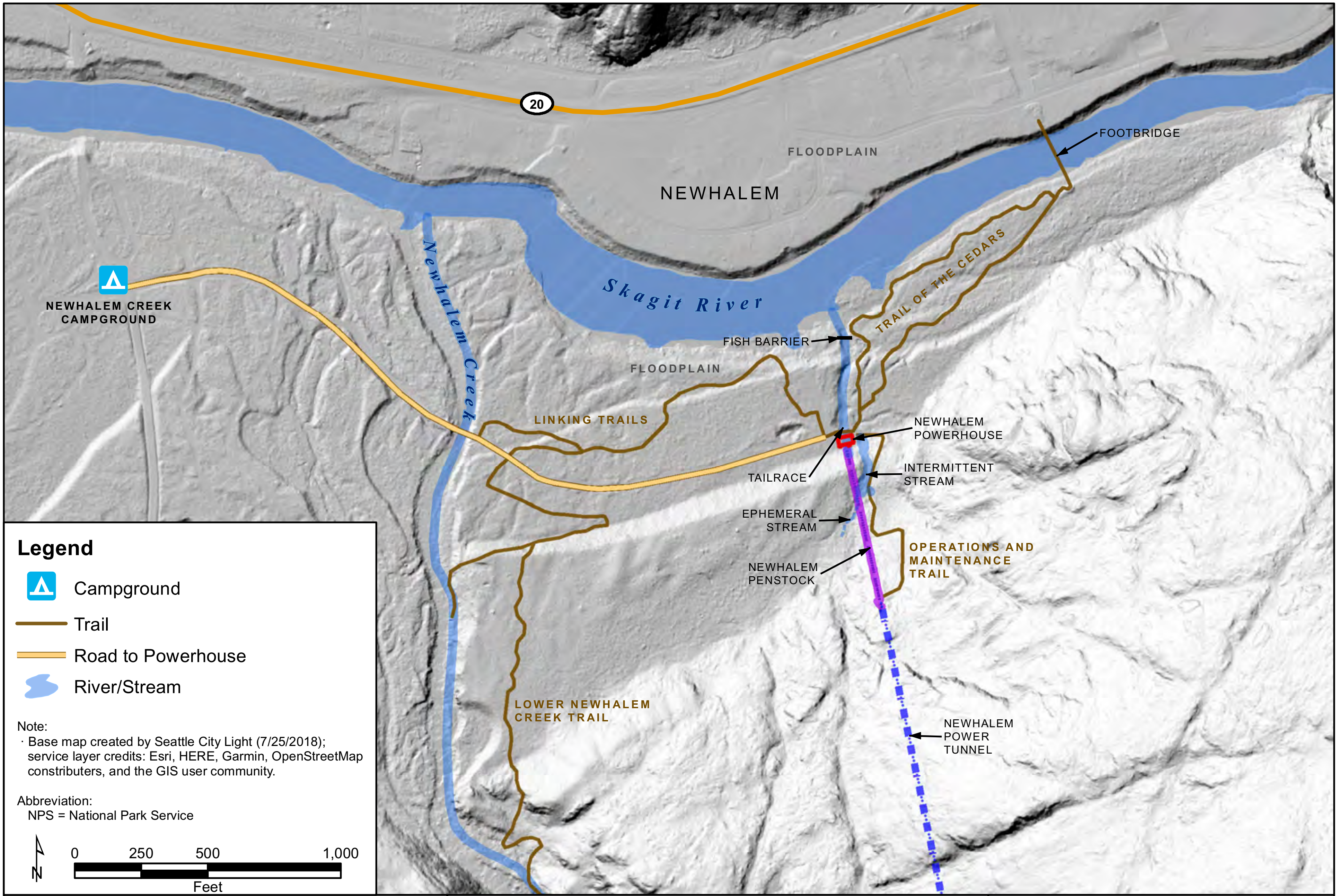
Engineering Evaluation/Cost Analysis
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 1.2
Site Features

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\Figure 1.2 Site Features.mxd
12/3/2020



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Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 2.1
Site Topography and LIDAR Map

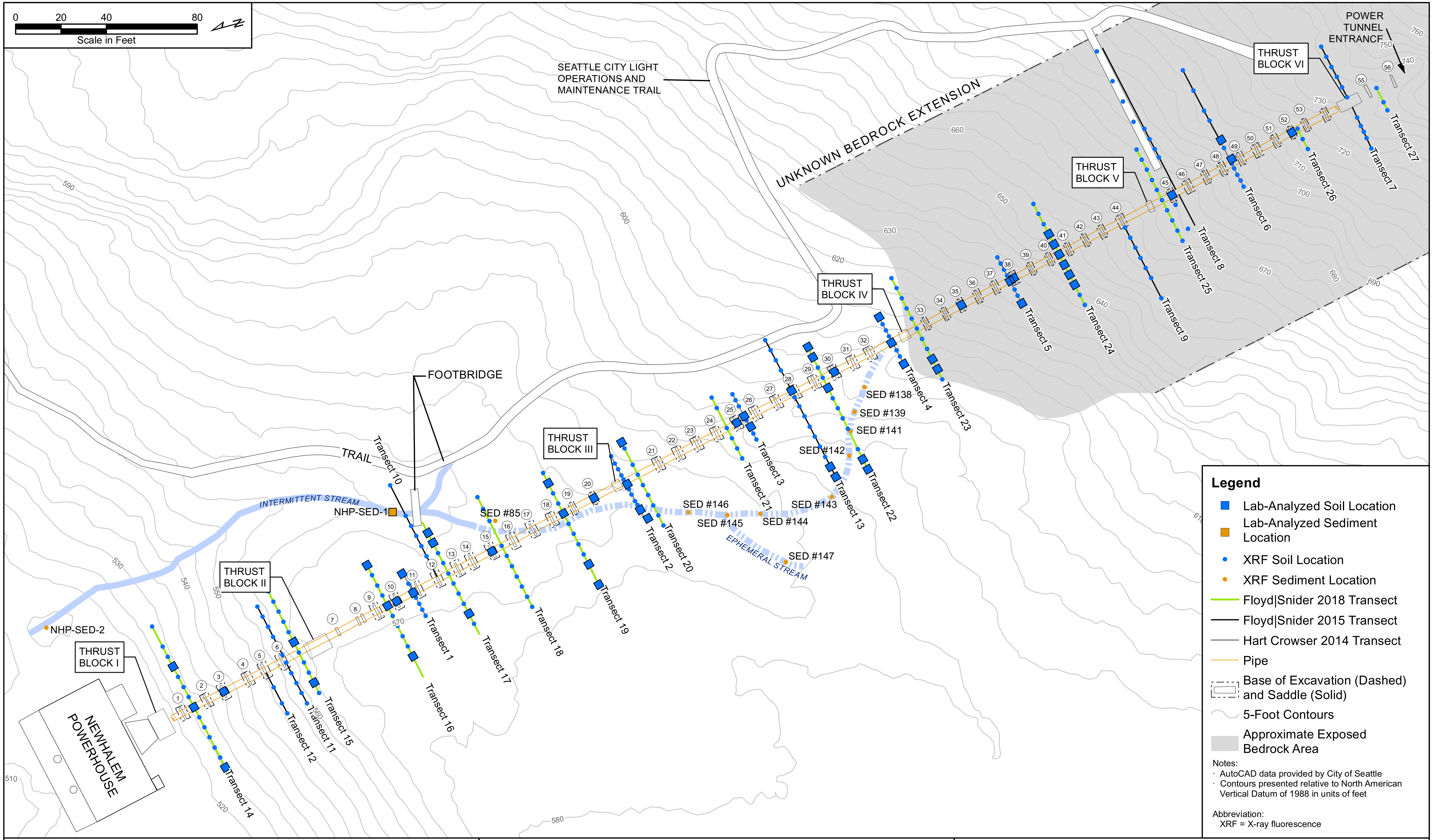

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Figure 2.2
All Transect and Data Locations

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12/3/2020

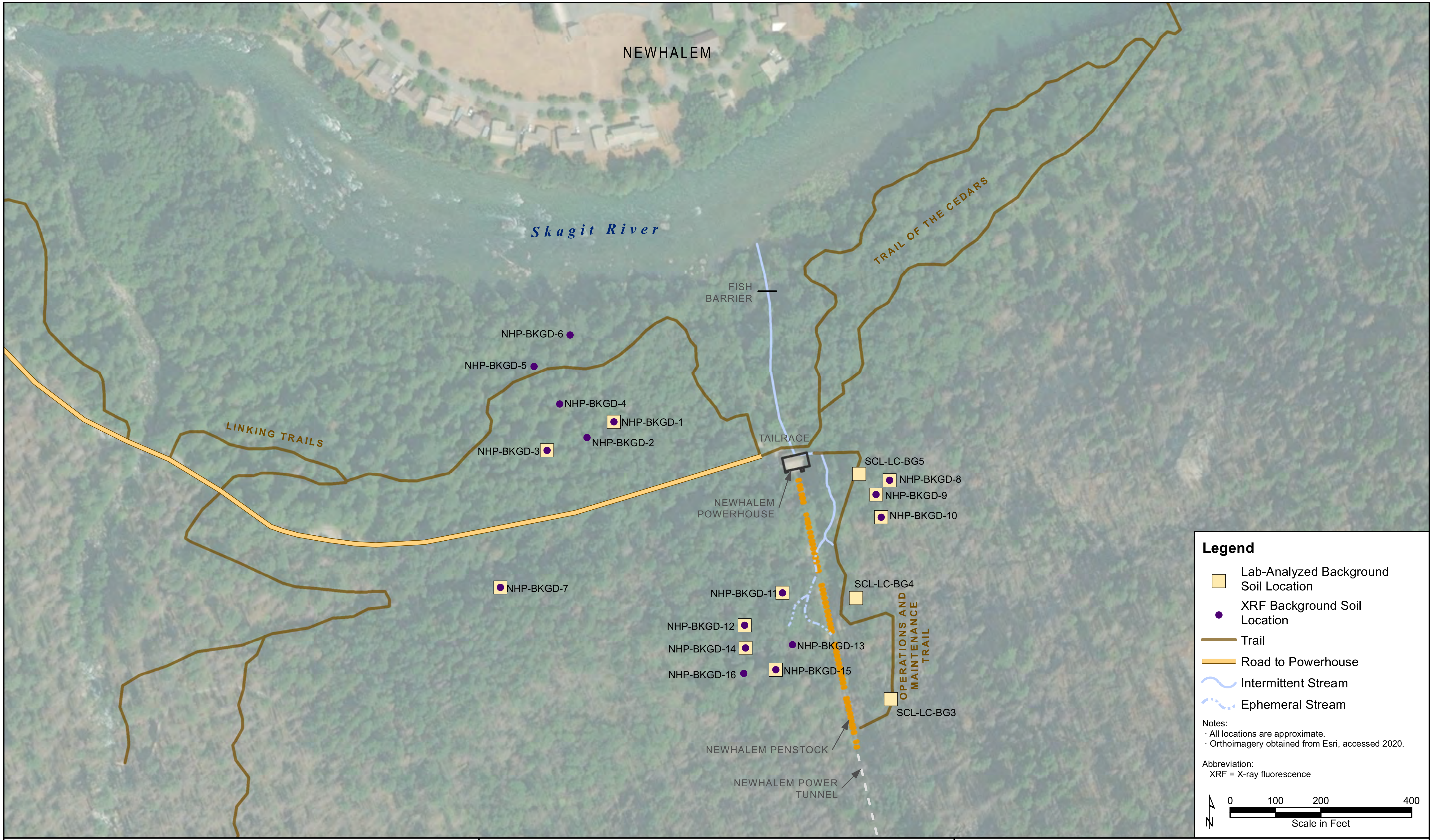

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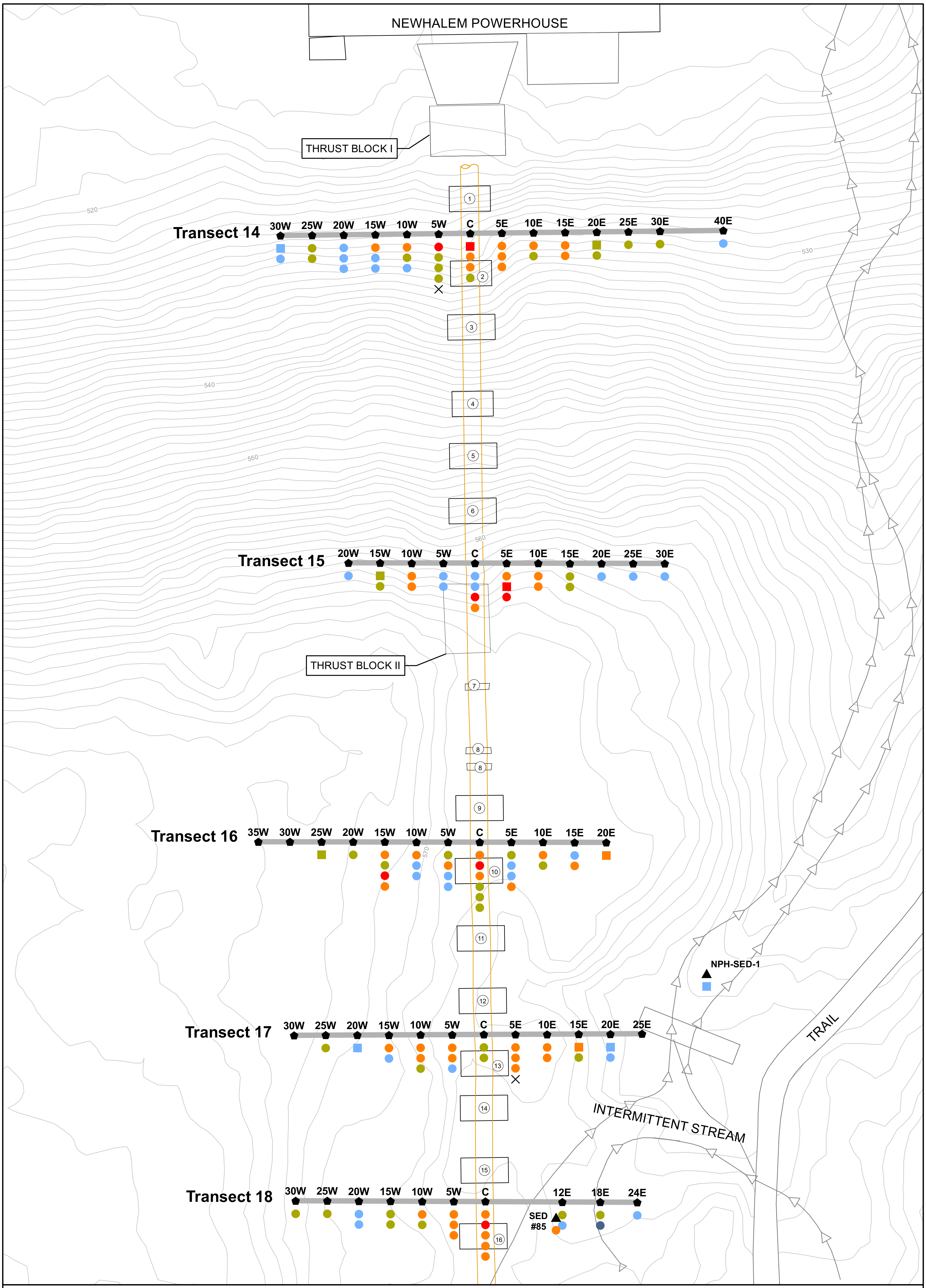
Figure 2.3
Background Sample Locations

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\Figure 2.3 Background Sample Locations.mxd
12/3/2020



Legend

⬟ Soil Sample
▲ Sediment Sample
● XREF Result
■ Lab-Analyzed Result
× Bedrock, Fractured Bedrock, or Boulder Encountered

1-Foot Contours
Pipe
Transect
▭ Saddle

Lead Results

🟥 >250 mg/kg
🟧 40–250 mg/kg
🟩 20–40 mg/kg
🟦 0–20 mg/kg
■ Not Detected

Depth Intervals (Feet bgs)

■ 0–0.5
■ 0.5–1
■ 1–1.5
■ 1.5–2
■ 2–2.5
■ 2.5–3

Notes:
1. Abundant deadfall preventing further lateral step outs.
- AutoCAD data provided by City of Seattle.
- Contours presented relative to North American Vertical Datum of 1988 (NAVD 88) in units of feet.

Abbreviations:
bgs = Below ground surface
mg/kg = milograms per kilogram
XRF = X-ray fluorescence

0 7.5 15 30
Scale in Feet

N

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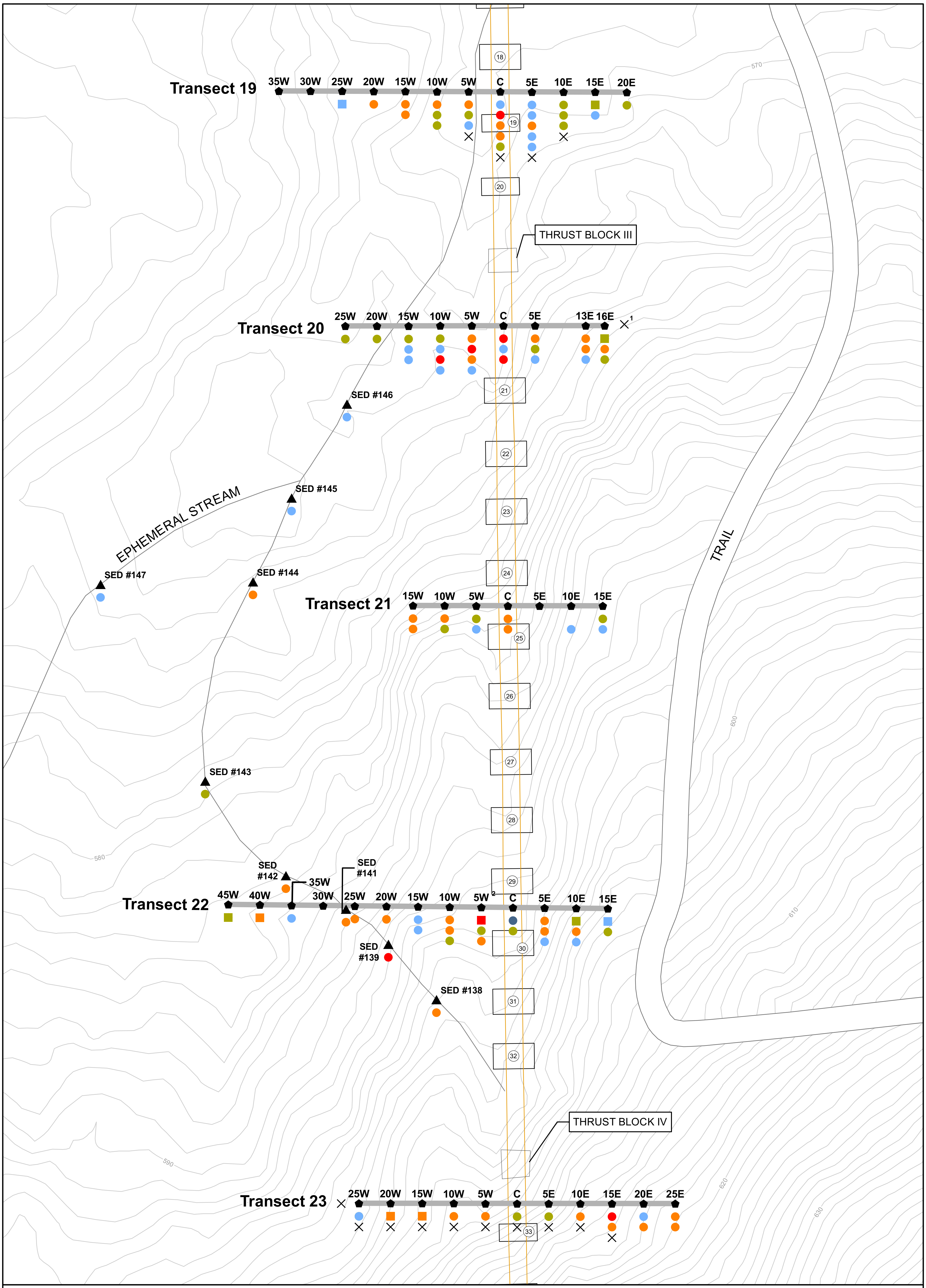
Figure 2.4 (1 of 3)
Maximum Lead Concentrations in Soil
Saddles 1 through 18

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\Figure 2.4 (1 of 3) Maximum Lead Concentrations in Soil Saddles 1 through 18.mxd
3/4/2021



Legend

- ⬟ Soil Sample
- ▲ Sediment Sample
- ● XREF Result
- ■ Lab-Analyzed Result
- × Bedrock, Fractured Bedrock, or Boulder Encountered
- 1-Foot Contours
- Pipe
- Transect
- Saddle

Lead Results

- 🟥 >250 mg/kg
- 🟧 40–250 mg/kg
- 🟩 20–40 mg/kg
- 🟦 0–20 mg/kg
- ■ Not Detected

Depth Intervals (Feet bgs)

- 0–0.5
- 0.5–1
- 1–1.5
- 1.5–2
- 2–2.5
- 2.5–3

Notes:
1. Abundant deadfall preventing further lateral step outs.
· AutoCAD data provided by City of Seattle.
· Contours presented relative to North American Vertical Datum of 1988 (NAVD 88) in units of feet.

Abbreviations:
bgs = Below ground surface
mg/kg = milograms per kilogram
XRF = X-ray fluorescence

0 7.5 15 30
Scale in Feet

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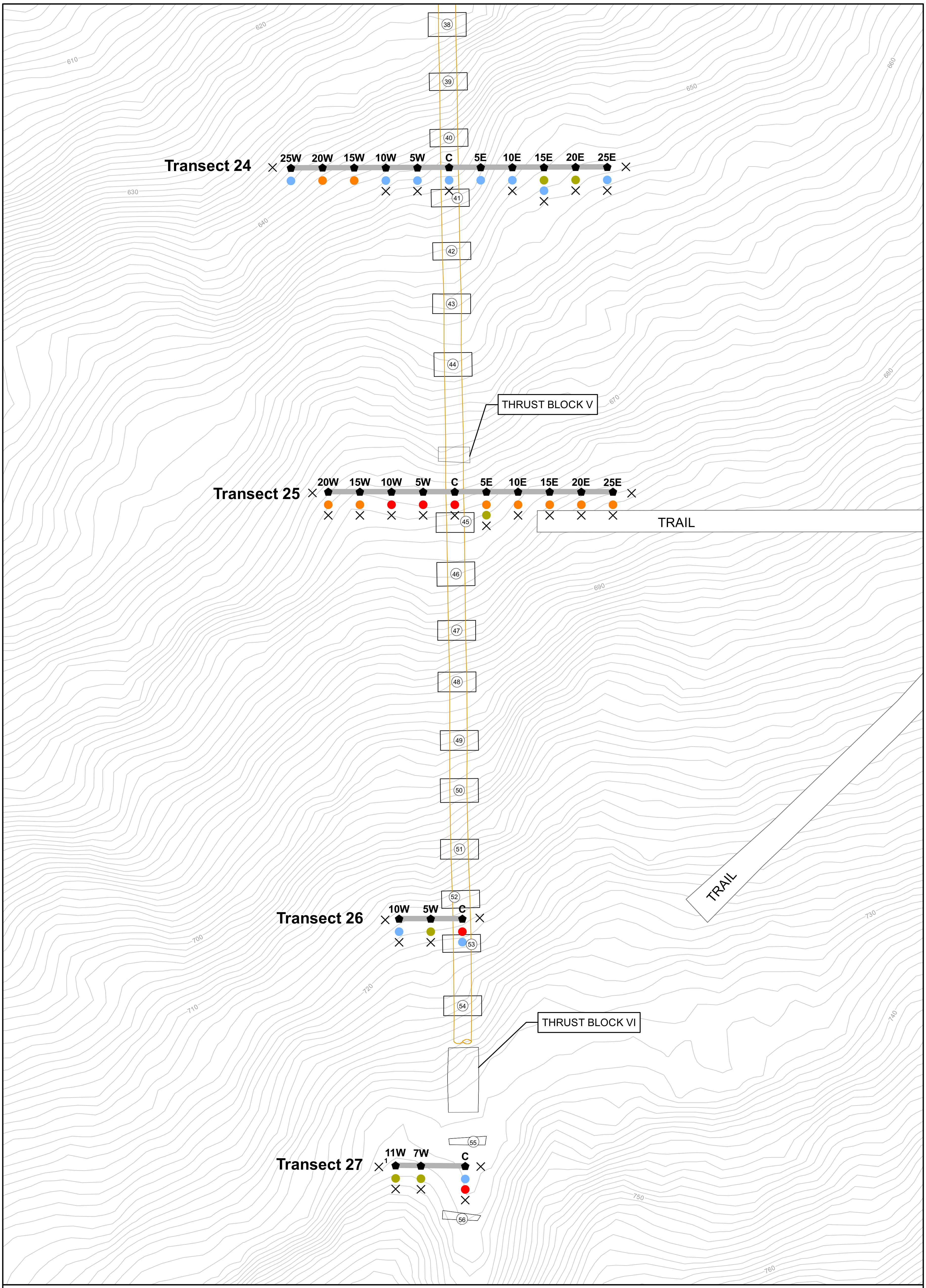
Seattle City Light Newhalem Penstock
Newhalem, Washington**

Figure 2.4 (2 of 3)
Maximum Lead Concentrations in Soil
Saddles 18 through 37

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\Figure 2.4 (2 of 3) Maximum Lead Concentrations in Soil Saddles 18 through 37.mxd
3/15/2021



Legend

- ⬟ Soil Sample
- ▲ Sediment Sample
- ● XREF Result
- ■ Lab-Analyzed Result
- × Bedrock, Fractured Bedrock, or Boulder Encountered
- — 1-Foot Contours
- — Pipe
- ▬ Transect
- ▭ Saddle

Lead Results

- 🟥 >250 mg/kg
- 🟧 40–250 mg/kg
- 🟩 20–40 mg/kg
- 🟦 0–20 mg/kg
- ■ Not Detected

Depth Intervals (Feet bgs)

- ■ 0–0.5
- ■ 0.5–1
- ■ 1–1.5
- ■ 1.5–2
- ■ 2–2.5
- ■ 2.5–3

Notes:
1. Abundant deadfall preventing further lateral step outs.
· AutoCAD data provided by City of Seattle.
· Contours presented relative to North American Vertical Datum of 1988 (NAVD 88) in units of feet.

Abbreviations:
bgs = Below ground surface
mg/kg = milograms per kilogram
XRF = X-ray fluorescence

0 7.5 15 30
Scale in Feet

N

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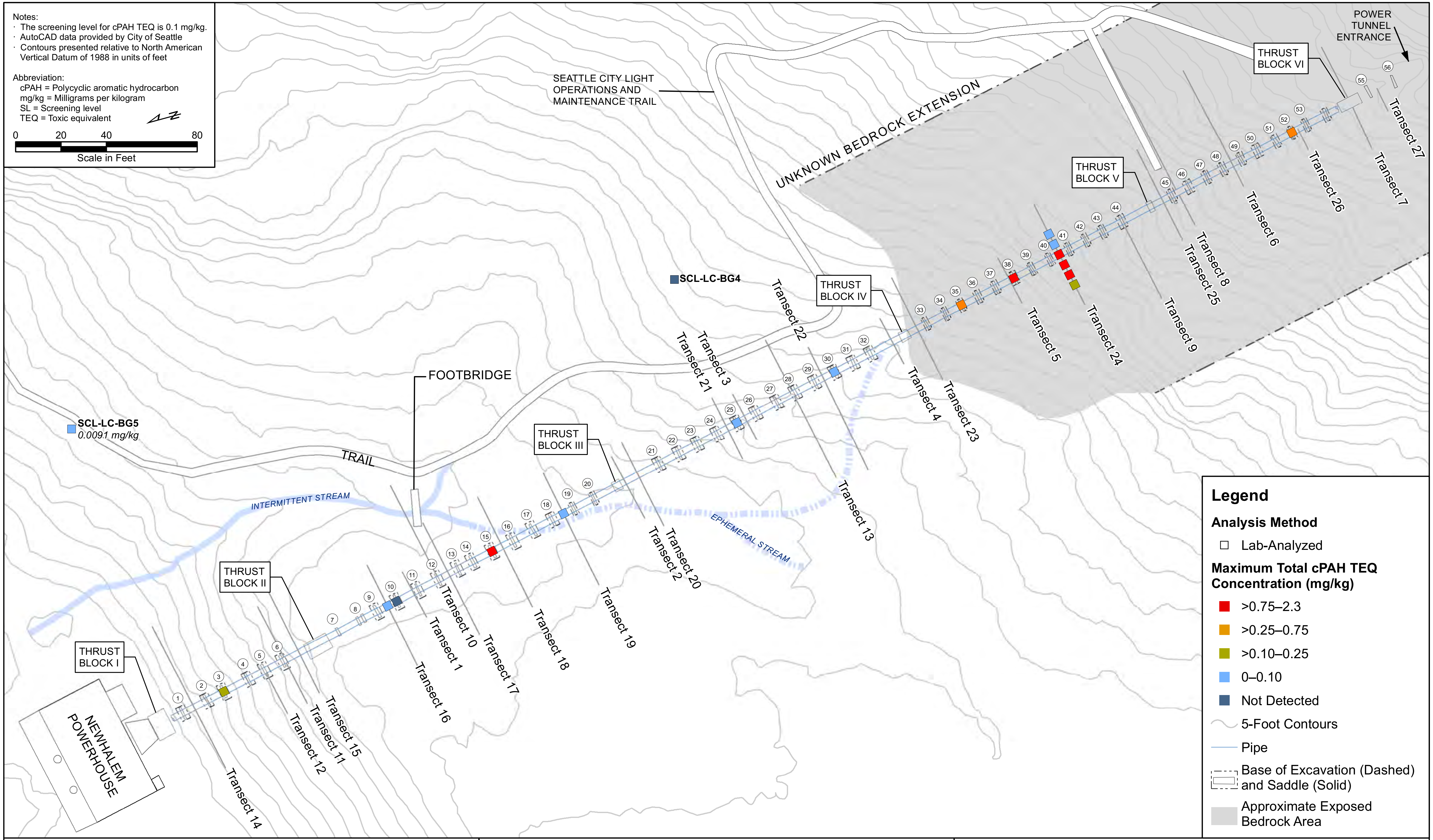
Figure 2.4 (3 of 3)
Maximum Lead Concentrations in Soil
Saddles 37 through 54

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\Figure 2.4 (3 of 3) Maximum Lead Concentrations in Soil Saddles 37 through 54.mxd
3/4/2021



Notes:
- The screening level for cPAH TEQ is 0.1 mg/kg.
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviation:
cPAH = Polycyclic aromatic hydrocarbon
mg/kg = Milligrams per kilogram
SL = Screening level
TEQ = Toxic equivalent

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Newhalem, Washington

Figure 2.5
Maximum cPAH TEQ Concentrations in Soil

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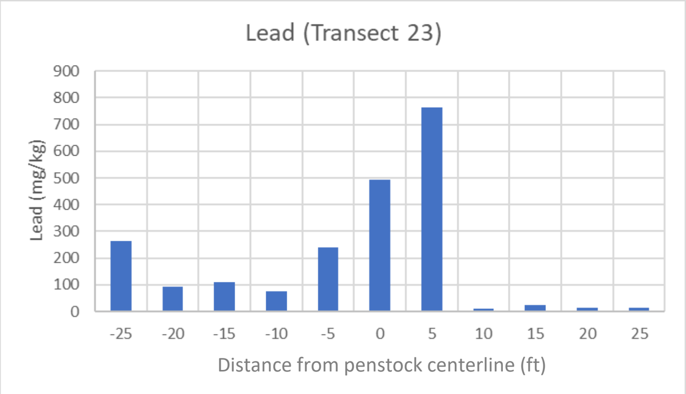

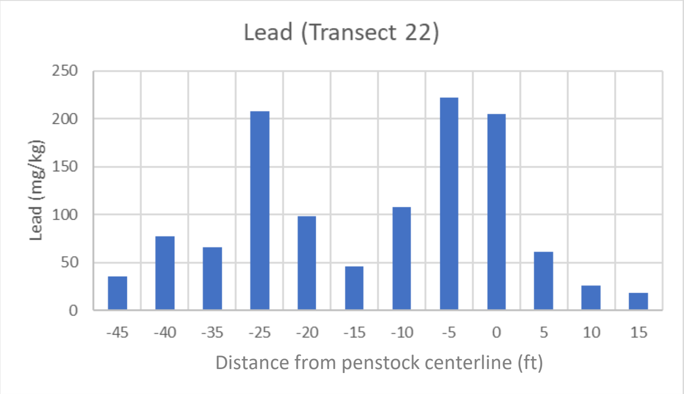

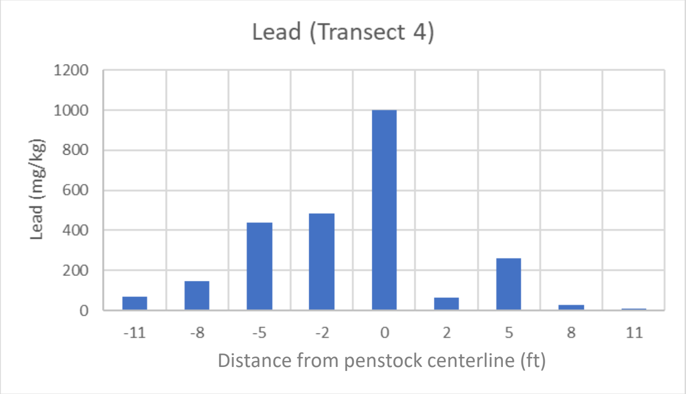

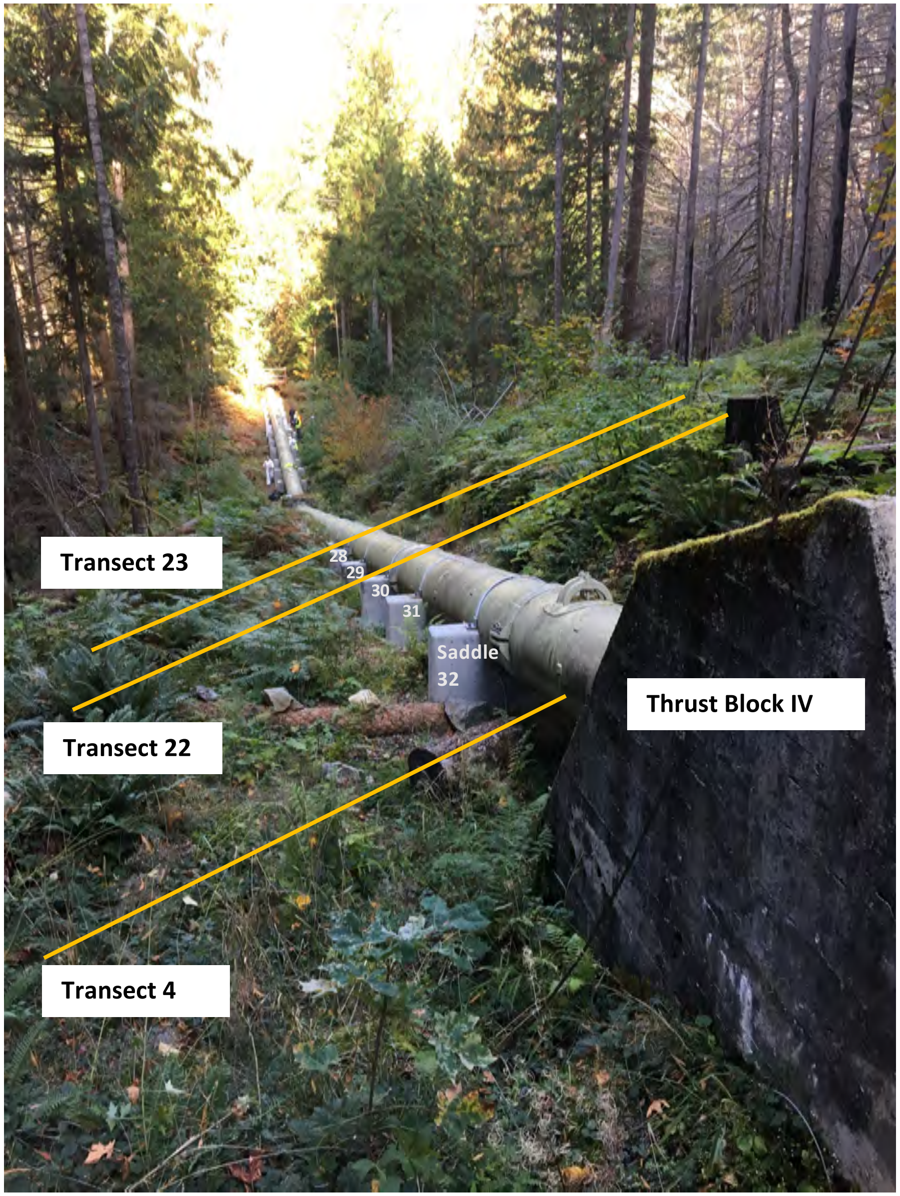

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Figure 2.6
Transect Photograph and Chemical Concentration Charts—Lead

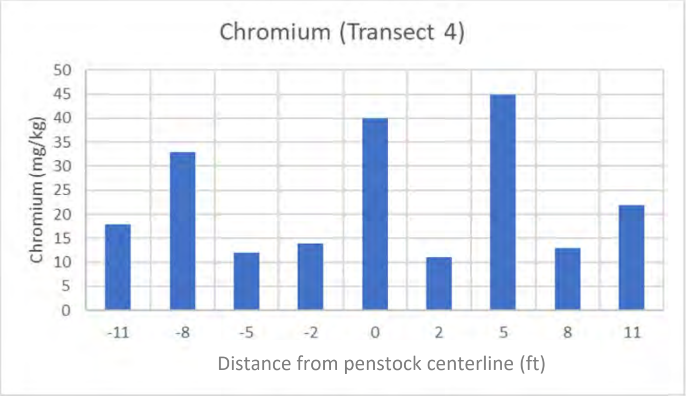

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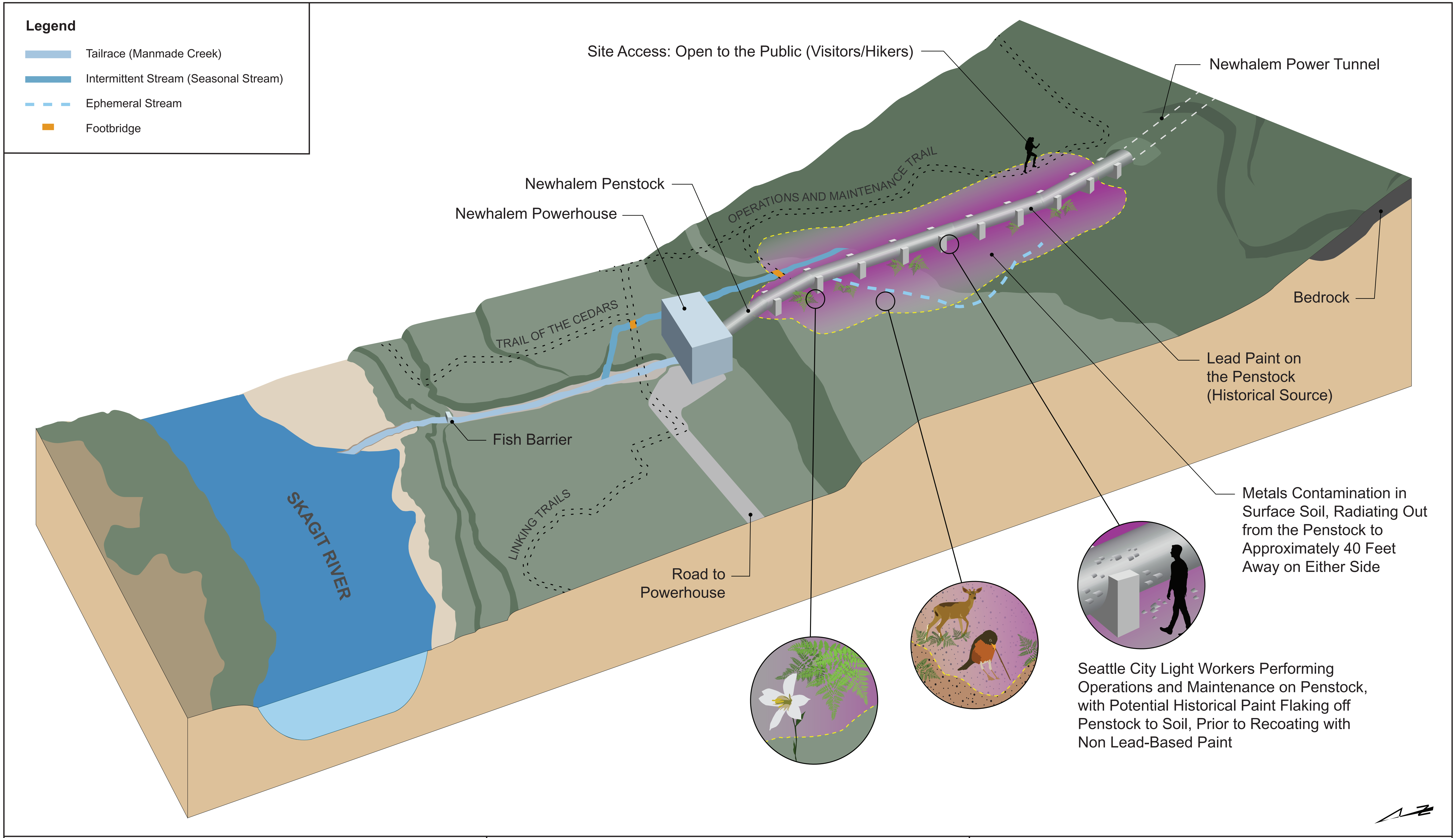
Figure 2.7
Transect Photograph and Chemical Concentration Chart—Chromium



Metals Contamination in Surface Soil, Radiating Out from the Penstock to Approximately 40 Feet Away on Either Side

Seattle City Light Workers Performing Operations and Maintenance on Penstock, with Potential Historical Paint Flaking off Penstock to Soil, Prior to Recoating with Non Lead-Based Paint

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Newhalem, Washington

Figure 2.8
Conceptual Site Model

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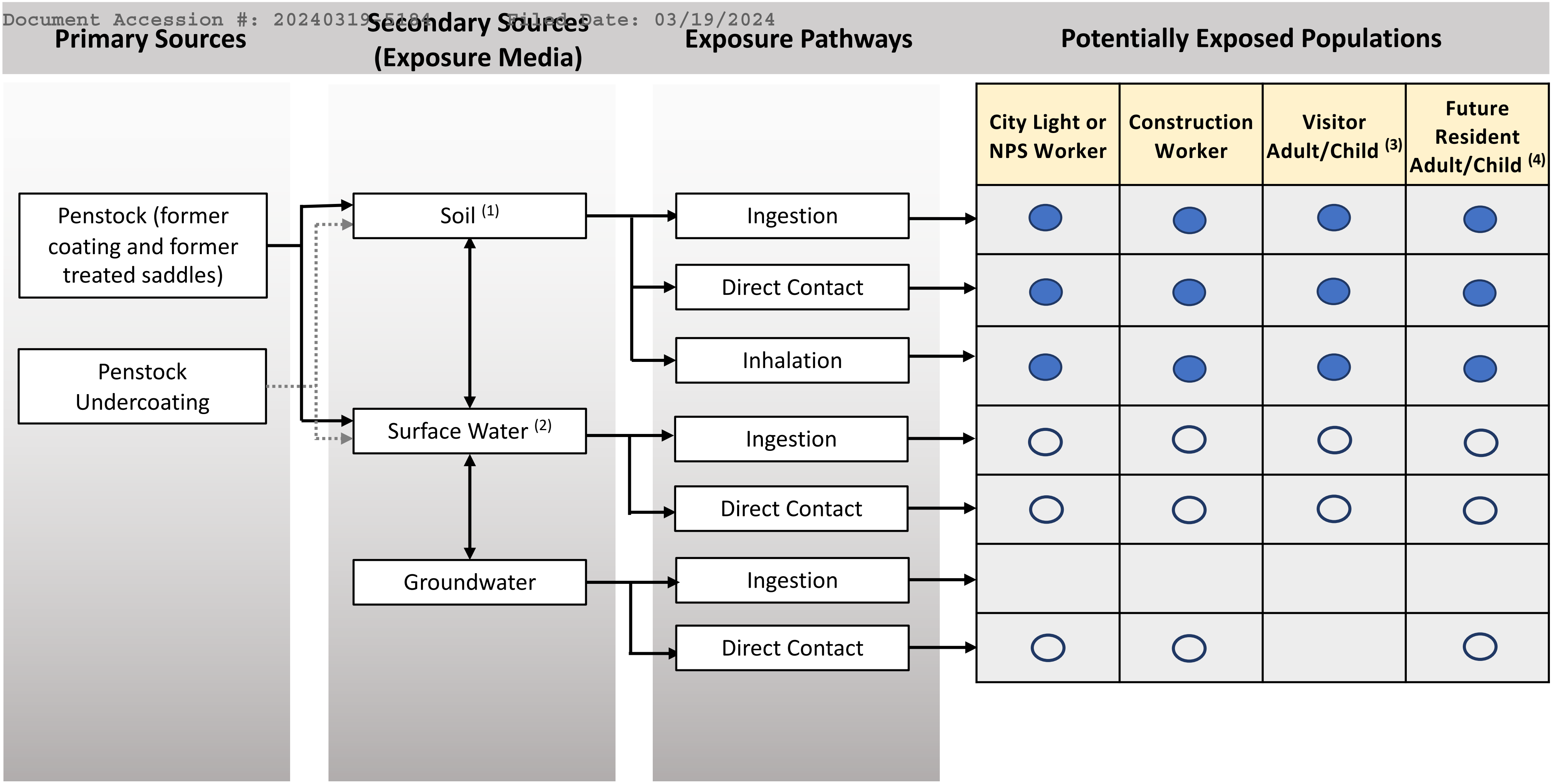
03/04/2021



Secondary Sources (Exposure Media)	Exposure Pathways	City Light or NPS Worker	Construction Worker	Visitor Adult/Child (3)	Future Resident Adult/Child (4)
Soil (1)	Ingestion	●	●	●	●
	Direct Contact	●	●	●	●
	Inhalation	●	●	●	●
Surface Water (2)	Ingestion	○	○	○	○
	Direct Contact	○	○	○	○
Groundwater	Ingestion				
	Direct Contact	○	○		○

Legend

━ Historical pathway

┈ Historical and potential ongoing pathway

● Complete exposure pathway, quantified (5) in the HHRA

○ Complete exposure pathway, not quantified (5) in the HHRA

▨ Blank cells indicate an incomplete exposure pathway

Notes:

1. The soil medium includes soil that is seasonally saturated by the intermittent stream.
2. Surface water includes water from the intermittent stream that runs adjacent to the penstock.
3. Visitors include tribal members.
4. Future residents were included for consistency with the NPS EE/CA process and comparison with other sites.
5. Risks from pathways that are quantified in the BHHRA are expected to be much greater than risks from pathways that were not quantified.

Abbreviations:

City Light = Seattle City Light
HHRA = Human Health Risk Assessment
EE/CA = Engineering Evaluation/Cost Analysis
NPS = National Park Service

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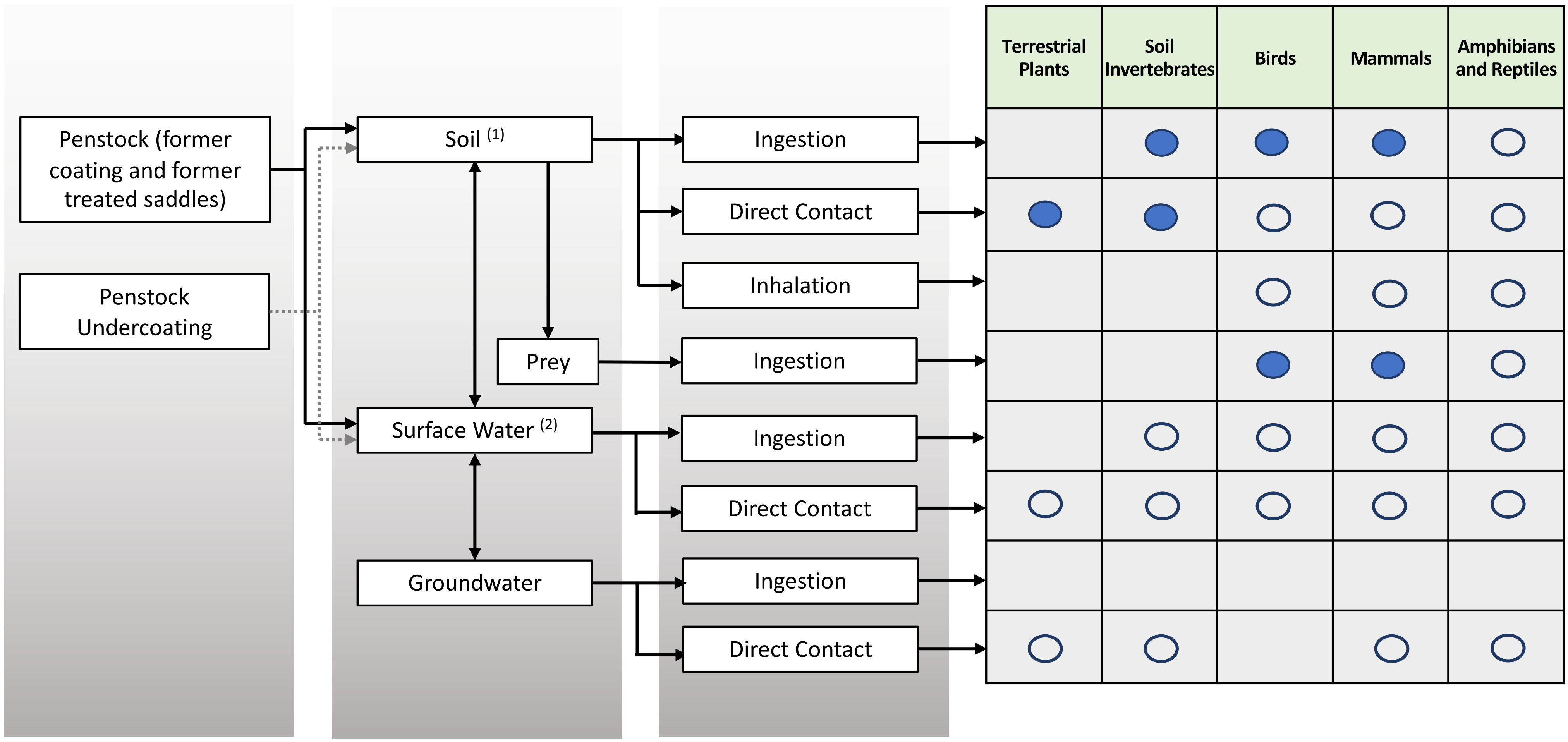
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 2.9
Human Health Pathway-Receptor Diagram

Primary Sources | **Secondary Sources (Exposure Media)** | **Exposure Pathways** | **Potentially Exposed Populations**



Secondary Sources (Exposure Media)	Exposure Pathways	Terrestrial Plants	Soil Invertebrates	Birds	Mammals	Amphibians and Reptiles
Soil (1)	Ingestion		●	●	●	○
	Direct Contact	●	●	○	○	○
	Inhalation			○	○	○
Prey	Ingestion			●	●	○
Surface Water (2)	Ingestion		○	○	○	○
	Direct Contact	○	○	○	○	○
Groundwater	Ingestion					
	Direct Contact	○	○		○	○

Legend

— Historical pathway

┈ Historical and potential ongoing pathway

● Complete exposure pathway, quantified [(3)] in the ERA

○ Complete exposure pathway, not quantified [(3)] in the ERA

▨ Blank cells indicate an incomplete exposure pathway

Notes:

1. The soil medium includes soil that is seasonally saturated by the intermittent stream.
2. Surface water includes water from the intermittent stream that runs adjacent to the penstock.
3. Risks from pathways that are quantified in the ERA are expected to be much greater than risks from pathways that were not quantified.

Abbreviations:

ERA = Ecological Risk Assessment
NPS = National Park Service

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Engineering Evaluation/Cost Analysis
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 2.10
Ecological Pathway-Receptor Diagram

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Appendix A
Photographs

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Appendix A
Photographs

Appendix A.1
October 2018 Penstock Survey Photographs

Photograph 1. Powerhouse and Thrust Block I; view to north.

Photograph 2. Thrust Block II at top of hill, and Saddles 3 to 6; view to south.

Photograph 3. Footbridge over penstock at Saddles 7 and 8.

Photograph 4. Between Thrust Blocks II and III; view to south.

Photograph 5. Flat topography between Thrust Blocks II and III; view to south.

Photograph 6. Saddles 17 to 20; view to south toward Thrust Block III.

Photograph 7. Thrust Block III in foreground; view to south.

Photograph 8. Between Thrust Blocks III and IV; view to south.

Photograph 9. Saddles 27 to 32; view to south, uphill.

Photograph 10. Thrust Block IV with slight surface flow on bedrock adjacent to saddles.

Photograph 11. Thrust Block IV; view to north.

Photograph 12. Between Thrust Blocks IV and V with exposed bedrock; view to south.

Photograph 13. Saddle 49 in foreground; view to north.

Photograph 14. Saddle 47 in foreground; view to southeast.

Photograph 15. Penstock entering tunnel; view to south.

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Appendix A
Photographs

Appendix A.2
Photographs of Site Features

Photograph 1. Two months after the August 2015 Goodell Fire: fire damage at Saddles 46 and 47 prior to the saddle replacement project; view to the south; October 2015.

Photograph 2. Three years after the August 2015 Goodell Fire: recovered vegetation around Saddle 49; view to the north; October 2018.

Photograph 3. Before saddle replacement: former creosote-treated wood saddles between Thrust Block II and III; view to south; October 2015.

Photograph 4. During saddle replacement: soil excavation during saddle replacement; view to the south; March 2017.

Photograph 5. After saddle replacement: between Thrust Block II and III just after saddle replacement; view to south toward Thrust Block III; September 2017.

Photograph 6. Surface water features: ephemeral stream flowing southwest to northeast from forest to beneath penstock at Thrust Block III; November 2017.

Photograph 7. Surface water features: ephemeral stream running adjacent to Saddle 17 (foreground); view to south; November 2017.

Photograph 8. Surface water features: footbridge over the intermittent stream leading to Saddle 12; view to west; October 2018.

Photograph 9. Surface water features: Fish barrier between powerhouse and Skagit River.

Photograph 10. Seep feature: base of Saddle 36; view to east; October 2018.

Photograph 11. Seep feature: close up of seep near Saddle 36; October 2018.

Photograph 12. Surface flow at the base of Saddle 40.

Photograph 13. Trails: Trail of the Cedars; view to west.

Photograph 14. Trails: Seattle City Light maintenance trail and evacuation route from powerhouse to top of penstock; view to southeast.

Photograph 15. Trails: Seattle City Light maintenance trail (right) from top of the penstock; view to north.

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Appendix B
Data Memorandum—Fall 2018
Newhalem Penstock Environmental Investigation Activities Summary

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Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

Memorandum

To: Tom Meyer, Seattle City Light
From: Megan King, Floyd|Snider
Date: April 1, 2021
Project No: SCL-Newhalem Task 100
Re: **Fall 2018 Newhalem Penstock Environmental Investigation Activities Summary**

This memorandum provides a summary of the Newhalem Penstock Environmental Investigation fieldwork conducted by Floyd|Snider on behalf of Seattle City Light (City Light) in October 2018. The Newhalem Penstock Site (Site) is located within Ross Lake National Recreation Area, directly across the Skagit River (on the south side of the river) from Newhalem, Whatcom County, Washington. Figure 1.1[1] of the Engineering Evaluation/Cost Analysis (EE/CA) shows the Site vicinity, Figure 1.2 of the EE/CA displays the Site features, and Figure 2.1 of the EE/CA shows the penstock and surrounding topography. The Site is located approximately 600 feet from the Skagit River.

The objective of this investigation was to delineate the lateral and vertical extent of metals and polycyclic aromatic hydrocarbon (PAH) contamination in soil in the vicinity of the penstock, resulting from historical releases from the structure. This sampling was also conducted to help determine whether contaminants found in soils have migrated or have the potential to migrate to other surrounding media (groundwater, surface water, creek sediments). This memorandum summarizes the field activities performed and the site inspection observations. In addition, this memorandum summarizes the results from this 2018 investigation and historical data collected from 2014 through 2017. The x-ray fluorescence (XRF) and laboratory results of this investigation and the historical investigations are evaluated in the EE/CA for the Site pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC §§ 9601 et seq. Samples locations and results from the historical data and 2018 investigation are not differentiated in Figures 1 through 5 or in the Summary of Results section.

All sampling activities were performed in accordance with the 2018 Draft Sampling and Analysis Plan (SAP); which was prepared in accordance with CERCLA; the National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan, 40 CFR Part 300; and a National Park Service (NPS) SAP template (NPS 2014). All field documentation,

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[1] This memorandum references figures, tables, and appendices that are included in the EE/CA.

laboratory analytical results, and data summaries are attached and described in the following sections.

BACKGROUND

The penstock at the Site was originally constructed by City Light in the 1920s as part of the power plant used during construction of the Gorge Dam on the Skagit River and is still in operation. The penstock runs downhill, south to north, in a forest clearing approximately 600 feet south of the Skagit River near Newhalem, Washington. The 30- to 33-inch-diameter penstock is 1,122 feet long, approximately 904 feet of which is aboveground. The aboveground portion of the penstock is located on a steep and somewhat rocky slope above the Newhalem Powerhouse. The upper 218 feet are located within a bedrock tunnel.

Historically, the aboveground portion of the penstock rested on wood frame supports, or pedestals, with bases of wood, concrete, or stone. All 52 original penstock saddles were made from treated wood. Several of these saddles were damaged in the August 2015 wildfire (the Goodell Fire), and temporary supports were installed at four saddle locations as an emergency project to prevent the penstock from being damaged by buckling. Between November 9, 2016, and May 5, 2017, City Light removed and replaced 52 creosote-treated wooden saddles along the exposed portion of the penstock with cast-in-place concrete supports. The wood frame supports and bases were removed from the Site and disposed of. Because remediation was not the intended purpose of the project, removal of contaminated soils was incidental to the saddle replacement work. However, because the site had been designated a Non-Time-Critical Removal Action site under CERCLA and sampling to date showed that a significant volume of the soil to be removed for the saddle replacement was contaminated, soil removal during the saddle replacement project was authorized as a Time-Critical Removal Action by an Action Memorandum signed in August 2016 by NPS. During the saddle replacement work, a total of 171.32 tons of contaminated soil was excavated and transported offsite for disposal at Waste Management facility (Herrera 2018). All excavations were backfilled with clean, imported soil and restored to original or surrounding grade.

SCOPE OF WORK

Based on previous sampling results and knowledge of site history, Floyd|Snider developed a site characterization strategy based on a series of transects, each perpendicular to the penstock, spaced relatively evenly along its length. The goal was to characterize as much of the impacted area of the site as practicable, while also specifically excluding clean soil areas—that is, those areas surrounding each saddle where clean, imported soil was placed following saddle replacement (Figure 2.2 or the EE/CA).

The environmental investigation activities conducted by Floyd|Snider included a site inspection and documentation of field observations, recording XRF measurements along transects, and collecting soil samples for laboratory analysis. Specific activities conducted during the field investigation included the following:

- XRF monitoring
    - Soil and surface water pathway XRF monitoring
    - Soil monitoring for the nature and extent of metals surrounding the penstock
    - Background soil monitoring
- Soil sampling
    - Soil sampling for the nature and extent of metals and PAHs surrounding the penstock
    - Background soil sampling
    - Soil sampling for Synthetic Precipitation Leaching Procedure (SPLP) testing and analysis of metals
- Site assessment activities
    - Penstock visual evaluation
    - Visual observations of site use, geology, and habitat and wildlife conditions

SUMMARY OF 2018 XRF MONITORING AND ASSOCIATED SITE ASSESSMENT ACTIVITIES

XRF measurements were collected with an Innov-X Alpha Series XRF analyzer calibrated for bulk metals analysis. Soil samples were tested by clearing the duff layer (including pine needles, straw, and moss), and placing a soil sample from the desired depth into a labeled, clear plastic bag. Consistent with the manufacturer's recommendations, XRF measurements were collected by holding the XRF spectrometer directly to the bagged soil sample. Each plastic bag contained a minimum thickness of 1 inch of soil. Modifications to the sampling methodology are summarized in the SAP Modifications section.

Penstock Transect Soil Screening and Sampling

Surface and subsurface soil XRF measurements were collected along 14 transects, Transects 14 through 27, on October 10 through 12, 2018. Transects were spaced at approximately 50-foot intervals along the entire Penstock system and extended laterally a minimum of 15 feet (to the degree accessible) from either side of the penstock (Figure 2.2 of the EE/CA). Field sampling and screening activities were conducted during a dry period to minimize variability between the XRF measurements and laboratory results.

For each transect, the 2018 Draft SAP specified recording XRF measurements in the surface and subsurface (6 inches below ground surface [bgs] and deeper) directly beneath the penstock and at 5-foot intervals on either side of the penstock out to a minimum of 15 feet, or until there were two consecutive lateral readings for lead, arsenic, and zinc that were either non-detect or at concentrations less than the XRF field screening levels (SLs).[2] Additionally, the 2018 Draft SAP

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[2] XRF field SLs are included in Table 2.2 of the 2018 Draft SAP.

specified that subsurface measurements were to be collected in 6-inch depth increments until measurements of lead, arsenic, and zinc were either non-detect or at concentrations less than the XRF field SLs, or refusal on bedrock was encountered. Surface and subsurface measurements for manganese, molybdenum, and nickel were also recorded.

However, the level of effort required to collect both vertical and horizontal measurements in accordance with the 2018 Draft SAP was much greater than expected, with some locations extending down to 2.5 feet and up to 40 feet out from the penstock. During the field sampling event, discussions were held with the project team, and a decision was made to prioritize lateral delineation over vertical delineation, because potential terrestrial receptors were more likely to be present in the top 6 inches of soil and the greatest XRF results from previous investigations were typically observed in the top 6 inches of soil and decreased with depths greater than 6 inches. Given this, and the assumed mechanism for release of contamination to the environment being historical releases of metals-containing material to the ground surface, vertical delineation was not completed at every sampling location for each transect. In some instances, time restrictions or other limitations prevented lateral delineation in the surface interval from being completed as well, as discussed in detail in the summary of findings. Deviations from the 2018 Draft SAP are summarized in the SAP Modifications section.

Surface Water Pathways and XRF Screening

Soil in areas within approximately 20 feet of the penstock that are not located along a sampling transect but show visible signs of surface water migration with potential for offsite movement or significant redistribution of soil within the Site was screened for metals using the XRF spectrometer. This screening was conducted in the visible channel of the ephemeral stream shown in Figure 2.2 of the EE/CA. Additionally, dry accumulated soil that is seasonally saturated by the intermittent stream was screened using the XRF spectrometer. XRF measurements continued down the ephemeral and intermittent streambeds until XRF field SLs were achieved; however, both soil samples collected in the intermittent streambed, NHP-SED-1 and NHP-SED-2, contained XRF results less than XRF field SLs. A soil sample was collected for laboratory analysis from the intermittent stream bed from the downgradient location where XRF readings were less than the XRF field SLs. This sample, location NHP-SED-1, is shown on Figure 2.2 of the EE/CA.

LABORATORY ANALYSES—2018 SOIL SAMPLES

During the 2018 field activities, a total of 84 soil samples were collected along Transects 14 through 27. A total of 30 soil samples were submitted for chemical analysis, and 55 soil samples were archived. Soil samples were analyzed from Transects 14 through 17, 19, 20, 22, 23, 24, and 26. Laboratory analyses included the following:

- 22 samples were submitted for metals analysis: 1 from the center, 9 from the east side of the penstock, 11 from the west side of the penstock, and 1 from the intermittent stream bed.

- 8 samples were submitted for PAH analysis: 3 from the center of Transects 16, 19, and 24; 2 from the east side of the penstock along Transect 24; and 3 from the west side of the penstock along Transect 24.
- 17 background samples were collected: 10 were submitted for metals analysis and the remaining 7 were archived.
- 4 soil samples were selected to be analyzed for SPLP analysis to determine leaching abilities for arsenic, lead, and zinc. Soil samples from Transects 14, 15, and 22 in sample locations that contained low to elevated concentrations of arsenic, lead, and zinc. Results are used to help determine whether additional sediment or surface water sampling is required to fully evaluate pathways of concern.

The following sections summarize the process for selecting locations to be submitted for laboratory analyses during the 2018 sampling activities. Evaluation of laboratory data is discussed in the EE/CA; this memorandum is limited to summarizing the field activities and penstock inspection.

Metals

Select soil samples that were submitted for laboratory analysis consisted of three tiers in order to delineate the extent of metal exceedances. The first tier of analytical sample locations was either 15 feet from the penstock or when there were two consecutive lateral readings of less than the XRF detection limits or at concentrations less than the XRF field SLs, based on XRF results. A second tier of analytical samples was collected, where accessible, approximately 5 feet laterally from the first tier (away from the penstock) and archived for potential future analysis if the first-tier sample results indicate exceedances of the laboratory SLs. levels. A third tier of archive samples was collected approximately 5 feet out from the second tier and were also archived for future analyses, pending results of the second-tier samples. The level of effort required to collect vertical measurements in accordance with the SAP exceeded time and resource constraints, with some locations extending down to 2.5 feet bgs, and thus vertical delineation was not completed at every sampling location for each transect; however, sufficient vertical delineation was conducted to sufficiently determine the approximate extent of metals contamination for development of removal alternatives in the EE/CA.

Select samples with metal detections with varying concentrations were submitted for SPLP testing. As stated previously, a soil sample collected within the intermittent stream was submitted for laboratory analysis at a location downgradient from the penstock where XRF readings for metals were less than the XRF field SLs.

Polycyclic Aromatic Hydrocarbons

PAH analyses were conducted along three of the transects on samples collected adjacent to and in the vicinity of the former wood saddle supports that were installed at depths ranging from

1 foot bgs to greater than 3 feet bgs. Because the source of PAHs to soil was through leaching from the former wood saddle supports, the most likely occurrence of PAHs would be in the immediate vicinity of the former wood saddles. Because of this, PAH sampling was focused around the wood saddle supports. The depths of the former wood saddles varied with minimum depths of 0 to 2 inches and maximum depths of approximately 3 to 4 feet. Soil samples collected at these varying depths help provide insight on contaminant depth for adjacent saddles with similar depths. Results from the 2018 sampling activities combined with historical samples collected from the base of the excavations during the saddle replacement project will sufficiently determine the approximate extent of contamination for development of removal alternatives in the EE/CA.

Soil samples were collected directly beneath the penstock and at 5-foot intervals on either side of the Penstock system, out to 15 feet. Two samples were collected from each location; one sample was collected from 0 to 1 foot bgs (sample A), and the second sample was collected from 1 to 2 feet bgs (sample B), as the majority of wood saddles extended to 2 feet bgs. These sample depths were determined based on information from previous sampling and the depths of the former wood saddles as described above. Deeper samples were not collected if bedrock was encountered in the top 1 foot (i.e., Transect 24). At transects where the depth of the historical wood saddle extended below 2 feet bgs and bedrock was greater than 2 feet bgs, an additional sample was collected (sample C) from 2 feet bgs to the bottom depth of the historical wood saddle. Samples were collected by evenly sampling the entire depth range (e.g., 1 to 2 feet bgs) and thoroughly mixed in a plastic bag into one homogenous sample, to provide a representative sample of the depth range.

Soil samples were submitted for chemical analysis in two phases. Phase 1 analysis included the samples from directly beneath the penstock. Phase 2 analysis occurred If the Phase 1 laboratory results exceeded the laboratory SL of 0.1 milligrams per kilogram for total carcinogenic PAH (cPAH) toxic equivalent. Phase 2 analysis included submitting the deeper sample beneath the penstock and the 0- to 1-foot-bgs samples collected 5 feet on both sides of the penstock for laboratory analysis. PAH results are presented in Tables C.2b and C.4b in Appendix C of the EE/CA.

Background Locations

Site investigation activities included collecting 16 background samples that were analyzed for metals. Background samples were collected on both the west side and east side of the penstock to establish a representative dataset in areas with the following features:

- In areas that have and have not been affected by recent forest fires
- Various degrees of tree coverage and foliage
- Various degrees of terrain, both steep and flat
- At similar and different elevations as the penstock and powerhouse

- In areas that are a sufficient distance away from the Site to not be affected by contaminants migrating from the Site
- Similar geomorphic/mineralogic terrain (e.g., bedrock/talus erosional areas vs. river floodplain alluvium)

The 2018 background sample locations, NHP-BKGD-1 to NHP-BKGD-16, are shown on Figure 2.3 of the EE/CA. Although results of the site chemistry characterization discussed above are detailed in the EE/CA and not repeated here, the results of the other site assessment activities, including penstock and support feature inspection, are presented in the following sections.

SITE OBSERVATIONS

Field staff recorded observations of the condition of the Penstock system (visual flaking, cracking or chipping of the penstock coating) and surrounding vegetation, terrain, etc., and noted changes in the current conditions compared to the conditions observed during the October 2015 survey (Floyd|Snider 2016). Observations of surface water pathways and site use by humans and wildlife were also recorded. Photographs taken during the site inspection are included in Appendix A of the EE/CA.

Penstock Inspection

Observations of the penstock condition and support structures were noted by saddle number or thrust block number on the field investigation form. This memorandum uses the saddle numbers from City Light's CAD figure. Field investigation forms are included in Attachment 1, and site photographs taken of the Penstock system during the site inspection are included in Appendix A of the EE/CA. The following is a summary of the observations recorded between thrust blocks.

Thrust Blocks I and II:

- The terrain is steep between Thrust Block I and Thrust Block II (Saddles 1 to 6), and slopes to the north toward the Newhalem Powerhouse.
- On the west side, adjacent to the Penstock system, an exposed, well-worn operations and maintenance dirt trail is present. Vegetation has been cleared adjacent to the penstock, and straw has been placed on the operations and maintenance trail to minimize erosion. West of the operations and maintenance trail and to the east of the Penstock system, the vegetation is dense and consists of moss, ferns, grass, blackberries, and thimbleberries.

Thrust Blocks II and III:

- The area between Thrust Block II and Thrust Block III (Saddles 7 to 20) is generally more flat and open. There is a slight slope away from the Penstock system toward the northeast and northwest with a flat area approximately 10 to 20 feet south of Thrust Block II.

- A wooden bridge over the Penstock system is present south of Thrust Block II at Saddles 7 and 8 (Photograph 3 in Photo Appendix A.1 of the EE/CA). These saddles are in good condition and mostly below the ground surface. These were the only saddles that were not replaced in 2018.
- On the east side of the Penstock system, there is an access point to Saddle 12 via a trail spur from the main trail that spans a small stream. No visible flowing surface water was present between Thrust Block II and III at the time of the site visit. The main trail and trail spur are shown on Figures 1.2 and 2.2 of the EE/CA.
- On the west side of the Penstock system, there is low vegetation that includes ferns, Oregon grape, and alder saplings. The terrain on the west side has a slight ridge within 3 to 4 feet of the Penstock system, and then slopes downward toward the west. The vegetation on the eastern side was similar but included slightly larger alder and conifer saplings. Other minor vegetation observations included blackberries, mushrooms, and maple. There was no fire damage on either side of the Penstock system.

Thrust Blocks III and IV:

- The terrain steepness between Thrust Blocks III and IV (Saddles 21 to 32) slightly increases and slopes toward the north on both sides of the Penstock system. There is trail access to the Penstock near Saddle 28 approximately 25 feet to the east of the Penstock system.
- On the east side of the Penstock system, the terrain has a slight ridge within 2 feet of the Penstock system, and then slopes downward to the north. The vegetation is dense beginning 3 to 5 feet east of the Penstock system and consists primarily of ferns and grass. On the west side of the Penstock system, the terrain has a slight slope to the north-northwest, with some flatter areas within 5 feet of the Penstock system. There is generally low vegetation coverage consisting of ferns, grass, blackberries, and maple. The terrain becomes flat with localized micro-drainages and the vegetation changes to a forested area at approximately 20 feet to the west of the Penstock system.
- Fire scar marks are visible on trees in the proximity of the Penstock system beginning at Saddle 24.

Thrust Blocks IV and V:

- The terrain between Thrust Blocks IV and V (Saddles 33 to 44) slopes steeply to the north. A seep is present at Saddle 36 and a trickle of overland flow was observed at the footing (Photographs 10 and 11 in Appendix A.2 of the EE/CA). The footing for Saddles 38, 40, and 41 were moist at the base and bedrock was wet with surface water runoff at Saddle 40 on the west side of the penstock (Photograph 12 in Appendix A.2

of the EE/CA). The seep is likely shallow subsurface flow that surfaces at Saddle 36 and associated with the trickle of overland flow observed at the above Saddles 38, 40, and 41.

- The area in the vicinity of the Penstock system is sparsely vegetated with ferns, grass, and moss. Additionally, there are areas of exposed bedrock. Small alder and maple saplings are present on the eastern side of the Penstock system, and grasses, blackberries, salmon berries, and conifers are present. Approximately 20 feet away from the Penstock system, the area is forested. Many trees in the area have fire scar marks.

Thrust Blocks V and VI:

- The terrain between Thrust Blocks V and VI (saddles 45 to 54) slopes steeply north. A faint operations and maintenance trail is located on the west side of the Penstock system with a rope for support. There are areas of exposed bedrock and large cobbles.
- On the east side of the Penstock system, there is an access point from the trail that leads to Saddle 44. The grade from the trail to the Penstock system is relatively flat and there is exposed fractured bedrock on the east side adjacent to Saddle 46 through 49. A minor amount of surface flow was present at saddles 46 and 50, and the bases of Saddle 46 to 48 were wet (Photograph 14 in Appendix A.1 of the EE/CA). Given the time frame of the 2018 investigation activities and relatively precipitous nature of the bedrock, fracture flow, and alpine environment above the site, this runoff may have been from antecedent precipitate.
- Except for grass, the area is sparsely vegetated. There are burned, downed trees on the east side of the Penstock system.

Thrust Block VI and Tunnel:

- The terrain between Thrust Block VI (Saddles 55 and 56) and the tunnel is relatively flat with a gentle slope to the north. Approximately 5 to 10 feet to the west of the Penstock system, the terrain drops steeply to the north northwest.
- The main trail leads to the top of the Penstock system where it enters a tunnel on the south side of Thrust Block VI.
- On both sides of the Penstock system, there is exposed bedrock, little vegetation, and burned, fallen trees. The main trail leads to the Penstock system from the east side, and the terrain on the east side is relatively flat north of the tunnel.
- The area around the tunnel where the terrain is relatively level is densely vegetated with grass, alder, conifer saplings, and blackberries.
- Several inches of standing water was observed beneath the Penstock system just north of the tunnel. At the time of the 2015 site survey, a small stream was noted beneath the Penstock system between Thrust Block VI and the tunnel.

Paint Coating Observations

Measurements of the penstock pipe distance aboveground and observations of the condition of the penstock paint are summarized in the following table.

Station	Pipe Distance Aboveground (feet)	Paint Condition
Thrust Blocks I to II (Saddles 1- to 6)	Approximately 0.8	Good, with occasional minor, non-continuous chipping. Paint flaking was observed at the contact between the penstock and the saddle at Saddles 4, 5, and 6.
Thrust Blocks II to III (Saddles 7 to 20)	0.8 to 2.4	Good, with occasional minor, non-continuous chipping. Paint flaking was observed at the contact between the penstock and the saddle at Saddles 12 to 15.
Thrust Blocks III to IV (Saddles 21 to 32)	0.8 to 2.1	Good, with occasional minor chipping and a small area of exposed green paint at Saddle 22. However, chipping that exposes green paint is rare and has a surface area less than dime-sized. Paint flaking was observed at the contact between the penstock and the saddle at Saddles 24 and 25.
Thrust Blocks IV to V (Saddles 33 to 44)	1.0 to 5.2	Good, with occasional minor, non-continuous chipping. Paint flaking was observed at the contact between the penstock and the saddle at Saddles 33 and 35.
Thrust Blocks V to VI (Saddles 45 to 54)	1.0 to 3.0	Good, with occasional minor, non-continuous chipping.
Thrust Block VI to tunnel (Saddles 55 to 56)	Approximately 0 to 0.5	Good, with occasional minor, non-continuous chipping. Paint coating appears rough/uneven.

Surface Water Pathway Observations

The 2018 investigation activities occurred during a dry period, with the last recorded rainfall 11 days prior to the field activities, on September 29, 2018. Overland flow from a small stream originating near the Penstock system tunnel and Thrust Block VI was observed around many of the saddle footings between Saddle 36 and Saddle 56 (south of Thrust Block VI). Although a continuous stream was not evident along this section of the Penstock, surface water ponding and surface water flow were observed intermittently. The saddle footings appeared damp or wet at Saddles 36, 38, 40, 41, 46, and 50. Additionally, a seep approximately 3 feet across was observed on the east side of the Penstock system near Saddle 36 (just north of Thrust Block IV). Due to the lack of precipitation during the week leading up to the investigation, the surface flow and seep observed at elevation higher than Saddle 36 are likely associated with the relatively precipitous nature of the bedrock, fracture flow, and alpine environment above the site. This runoff may have been from antecedent precipitate.

In addition to surface water ponding and surface water flow observed between Saddles 36 and 56 (Photographs 10 through 12 in Appendix A.2 of the EE/CA), a dry surface water flow path was observed originating near Saddle 32 (Thrust Block IV) and bowing out to the northwest before merging with another dry surface water flow path approximately 35 feet west of Saddle 22. From this confluence point the surface water flow path continued to the northeast and crossed beneath the penstock near Saddle 17. This feature is referred to as the ephemeral stream, and is shown on Figure 2.2 of the EE/CA. Approximately 10 feet east of Saddle 17, the surface water flow path merged with the dry streambed noted on Figure 2.2 of the EE/CA.

Site Use Observations

The area surrounding the Penstock system is accessible to wildlife, although the terrain south of Thrust Block IV is steeply sloped with areas of exposed bedrock. Squirrels were observed in the forested areas in the vicinity of the Penstock system, most notable in the area between Thrust Blocks I and II. No other signs of mammals were observed. Bird calls could be heard intermittently during the investigation, generally in the forested areas.

Although open to the public, the trail leading to the upper sections of the penstock is mainly used for operations and maintenance. During this investigation, a visitor's car was observed in the parking lot at the Newhalem Powerhouse, but no visitors were observed on the trail or near the Penstock system during the field investigation.

Coatings on Penstock, Thrust Block, and Stockpile Penstock Parts

Only minor areas of rust, paint chips, or cracks in the paint coatings were observed along the length of the penstock. Very minor chips in the paint were found along the length of the Penstock system but did not appear to be continuous or extensive or to compromise the integrity of the penstock structure. In general, chipping was not deep or significant enough to expose the historical darker green paint, which was rare and observed only at Saddle 22. White paint was present and exposed beneath the chipped outer coating. The pale green outer coating was applied less than 10 years ago and covers the white primer in most areas. A darker shade of green paint or discoloring is present in the few places listed above on the underside of the penstock and on discarded components of the Penstock system, found in a stockpile at the southern end of the Penstock system. XRF readings were collected from the various paint layers and coatings; lead concentrations of the various paint layers ranged between 25 and 268 parts per million.

SAP MODIFICATIONS

This section summarizes the modifications to the sample collection and processing methodology described in the 2018 Draft SAP. All modifications to the 2018 Draft SAP were made in coordination with the Floyd|Snider and City Light project managers and in accordance with best professional judgment and the health and safety protocols outlined in the Health and Safety Plan.

Penstock Transect Soil Screening

- **Ex situ analysis:** The 2018 Draft SAP indicated that XRF measurements of surface soil would be collected in situ by clearing the duff layer and holding the XRF to the soil. The 2018 Draft SAP indicated that XRF measurements of subsurface soil would be collected ex situ by bringing subsurface soil to the surface, placing the sample on plastic, and holding the XRF to the soil. During the investigation, in situ XRF readings were not possible at the majority of locations due to access limitations on steep transects and the need for archeologists to screen samples prior to collecting readings. To maintain consistency in the XRF measurement methodology, all penstock soil samples were instead placed into disposable clear plastic bags for ex situ readings. Consistent with the manufacturer's recommendations, XRF measurements were collected by holding the XRF directly to the bagged soil sample. Each plastic bag contained a minimum of 1 inch of soil. As noted in the XRF manual, collecting XRF measurements through plastic does not affect results for lead, arsenic, zinc, manganese, molybdenum, or nickel; therefore, the modified XRF measurement approach did not affect the results of this investigation (Innov-X 2005).
- **Termination of transects:** The 2018 Draft SAP indicated that XRF measurements would be collected directly beneath the penstock and at 5-foot intervals on either side of the penstock for a minimum of 15 feet or until there were two consecutive lateral readings where concentrations were non-detect or less than the XRF field SLs. The level of effort required to collect lateral measurements in accordance with the SAP exceeded time and resource constraints, with transects extending from the penstock up to 45 feet to the west and up to 40 feet to the east. The lateral extent of lead, arsenic or zinc at Transects 14, 16, 21, 22, 23, and 24 was not identified by two consecutive readings of metals concentrations less than the XRF field SLs due to time constraints encountered in the field. However, using extrapolation based on consecutive readings less than the XRF field SLs recorded in other transects is considered sufficient for determining the approximate extent of contamination and development of removal action alternatives in the EE/CA.
- **Vertical delineation:** The 2018 Draft SAP indicated that additional subsurface measurements would be collected in 6-inch increments until measurements of metals were either non-detect or at concentrations less than the XRF field SLs, or until bedrock was encountered. The level of effort required to collect vertical measurements in accordance with the SAP exceeded time and resource constraints,

with some locations extending down to 2.5 feet. Based on discussions with the project team, lateral delineation was prioritized over vertical delineation, and thus vertical delineation was not completed at every sampling location for each transect; however, sufficient vertical delineation was conducted to determine the approximate extent of contamination for development of removal alternatives in the EE/CA.

- **XRF of wet soil samples at Transect 27:** The 2018 Draft SAP indicated field sampling and screening activities would be conducted during a dry period so moisture would not affect the XRF readings. Although there was no measurable precipitation during or 24 hours before the investigation, soil samples collected from Transect 27 were located in an area with standing surface water and several of the samples were wet. Prior to XRF analysis, excess water was decanted from the plastic bags containing the samples. Because XRF results are automatically corrected for changes to the soil matrix (such as differences in moisture), soil moisture does not have a significant effect on the accuracy of the results, except for a “dilution” effect that can cause discrepancies between the XRF results and laboratory results. As described in the XRF manual, laboratories dry samples prior to analysis and report results on a dry weight basis; therefore, the laboratory results will generally be higher than the XRF measurements by the amount of moisture content in the sample (Innov-X 2005). Thus, the XRF results from Transect 27 are accurate but are biased low. However, soil samples along Transect 27 were not submitted to the laboratory for metals analysis due to the sufficient data collected from other transects and minimal soil present (approximately 1 inch) along Transect 27.

Background Sampling for PAHs

- The 2018 SAP indicated that background samples would be analyzed for PAHs; however, because the initial samples analyzed for PAHs beneath and adjacent to the penstock had low concentrations of cPAHs, it was unnecessary to analyze background samples for PAHs. PAHs are not a risk driver at the Site.

Despite the above deviations, the available data collected during this investigation are believed to be sufficient to characterize site contamination and prepare the EE/CA.

SUMMARY OF RESULTS

Analytical results from this 2018 investigation and historical data are presented in Tables 1 through 3, and Tables C.2a, C.2b, C.4a, and C.4b of the EE/CA. The laboratory reports for the 2018 data are provided in Appendix F of the EE/CA. Concentrations of indicator chemicals are shown on Figures 1 through 5. In addition to the 2018 investigation results, the figures and tables include datasets from the following previous investigations:

- July 2014 investigation by Hart Crowser to characterize soil likely to be disturbed by saddle replacement activities (Hart Crowser 2014). In addition, Hart Crowser collected four soil samples that were analyzed for Toxicity characteristic leaching procedure (TCLP) for disposal purposes. TCLP results were less than the TCLP regulatory levels and Washington State dangerous waste levels, indicating that Site soil would not be classified as hazardous waste or dangerous waste (Table 1).

- October 2015 investigation by Floyd|Snider to provide additional soil characterization information to inform saddle replacement activities (Floyd|Snider 2016).
- November 2016 and April to June 2017 investigations by Herrera for the purpose of providing oversight of saddle replacement activities (Herrera 2018).

Data from sample locations that were excavated during saddle replacement activities in 2016 and 2017 were not included in the EE/CA soil dataset. The EE/CA provides further details and discussion, and this memorandum only presents all of the data collected at the Site.

In addition to the collection of surface soil samples, Table 2 presents all the XRF data collected at the Site. The results of XRF measurements were used primarily as a screening tool to determine the lateral and vertical extent of metals at the Site and to inform the collection of soil samples for chemical analysis. SPLP results are presented in Table 3.

The analytical data described above were compared to the project SLs developed in the EE/CA, which included the minimum human health contaminant of potential concern (COPC) selection SL and the minimum contaminant of potential ecological concern (COPEC) selection Ecological Screening Value (ESV). Tables of these levels are presented in Tables C.2a through C.2c and C.4a through C.4c in Appendix C of the EE/CA. Chemicals with results exceeding the SL or ESV are highlighted in red in the screening tables and were selected as COPCs or COPECs as described in the EE/CA.

A detailed summary of the detected analytical results of the COPCs and COPECs in Site and background soil samples collected between 2014 and 2018 is presented in Section 2.9.4.4 of the EE/CA.

CONCLUSION

This memorandum was prepared to present the Site data and to provide a summary of the field activities and observations recorded during the site inspection. The XRF and laboratory analytical data are evaluated in the EE/CA and have been determined sufficient for development of an EE/CA.

The penstock and associated coatings were observed to be in good condition, with no significant areas of coating degradation observed. Structural damage from the summer 2015 wildfires was addressed by City Light during the saddle replacement activities.

REFERENCES

Floyd|Snider. 2016. *Site Visit and Limited Environmental Investigation Summary Report*. Memorandum from Megan McCullough, Floyd|Snider, to Jennifer Kindred, Seattle City Light. 25 January.

Herrera Environmental Consultants, Inc. (Herrera). 2018. *Environmental Monitoring Report, Newhalem Penstock Saddle Replacement Project, Newhalem, Washington. Prepared for Seattle City Light.* 13 March.

Innov-X Systems, Inc. (Innov-X). 2005. *Innov-X Systems Alpha Series X-Ray Fluorescence Spectrometers Instructional Manual*. Version 2.1. August.

National Park Service (NPS). 2014. Sampling and Analysis Plan Template. Contaminated Sites Program, Environmental Compliance and Response Branch.

LIST OF ATTACHMENTS

Tables

Table 1
Toxicity Characteristic Leaching Procedure Results

				Analyte	**Arsenic**	**Barium**	**Cadmium**	**Chromium**	**Lead**	**Mercury**	**Selenium**	**Silver**
				Unit	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
				Washington State Dangerous Waste Levels	**5**	**100**	**1**	**5**	**5**	**0.2**	**1**	**5**
				TCLP Regulatory Levels	**5**	**100**	**1**	**5**	**5**	**0.2**	**1**	**5**
Location	**Field Sample ID**	**SampleDate**	**Media**	**Depth Range**								
Toxicity Characteristic Leaching Procedure												
T1-C	T1-C	7/10/14 17:41	Soil	0–6 in					4.3			
T5-C	T5-C	7/11/14 11:53	Soil	0–6 in					1.2			
T6-E-11ft	T6-E-11ft	7/11/14 11:13	Soil	0–6 in					0.2 U			
T6-E-5ft	T6-E-5ft	7/11/14 11:04	Soil	0–6 in					0.49			
Gen 20 Penstock	Gen 20 Penstock	8/25/16 14:00	Paint Chip	--	0.4 U	0.61	0.02 U	0.02 U	0.2 U	0.005 U	0.4 U	0.04 U

Notes:

	Blanks cells are intentional.
--	Not applicable.

Abbreviations:

in	Inches
mg/L	Milligrams per liter
TCLP	Toxicity characteristic leaching procedure

Qualifier:

U	Analyte was not detected at the given reporting limit.

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

			Analyte	Arsenic	Chromium	Copper	Lead	Zinc
			Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			Minimum Human Health COPC Selection SL	0.68	2000	310	250	2,300
			Minimum SLERA COPEC Selection ESV	0.25	0.34	14	0.94	6.62
			Minimum SL or ESV	0.25	0.34	14	0.94	6.62
Location Name	Field Sample ID	Sample Date	Depth					
Soil—Background								
NHP-BKGD-1	NHP-BKGD-1	10/11/18	0-6 in	5 U			21	44
NHP-BKGD-10	NHP-BKGD-10	10/11/18	0-6 in	12			13	86
NHP-BKGD-11	NHP-BKGD-11	10/12/18	0-6 in	6 U			15	104
NHP-BKGD-12	NHP-BKGD-12	10/12/18	0-6 in	6 U			12	100
NHP-BKGD-13	NHP-BKGD-13	10/12/18	0-6 in	5 U			17	63
NHP-BKGD-14	NHP-BKGD-14	10/12/18	0-6 in	5 U			12	50
NHP-BKGD-15	NHP-BKGD-15	10/12/18	0-6 in	6 U			18	54
NHP-BKGD-16	NHP-BKGD-16	10/12/18	0-6 in	5 U			18	62
NHP-BKGD-2	NHP-BKGD-2	10/11/18	0-6 in	5 U			14	27
NHP-BKGD-3	NHP-BKGD-3	10/11/18	0-6 in	6 U			15	51
NHP-BKGD-4	NHP-BKGD-4	10/11/18	0-6 in	5 U			12	70
NHP-BKGD-5	NHP-BKGD-5	10/11/18	0-6 in	7			18	57
NHP-BKGD-6	NHP-BKGD-6	10/11/18	0-6 in	9			10	30
NHP-BKGD-7	NHP-BKGD-7	10/11/18	0-6 in	5 U			11	24
NHP-BKGD-8	NHP-BKGD-8	10/11/18	0-6 in	6			12	83
NHP-BKGD-9	NHP-BKGD-9-0	10/11/18	0-6 in	8			14	104
NHP-BKGD-9	NHP-BKGD-9-0.5	10/11/18	0-6 in	15			13	74
Soil—Site								
NHP-T14-10E	NHP-T14-10E-0	10/12/18	0 ft	21			79	118
NHP-T14-10E	NHP-T14-10E-0.5	10/12/18	0.5 ft	8			25	79
NHP-T14-10W	NHP-T14-10W-0	10/12/18	0 ft	12			50	101
NHP-T14-10W	NHP-T14-10W-0.5	10/12/18	0.5 ft	6 U			22	105
NHP-T14-10W	NHP-T14-10W-1	10/12/18	1 ft	11			15	110
NHP-T14-15E	NHP-T14-15E-0	10/12/18	0 ft	13			74	105
NHP-T14-15E	NHP-T14-15E-0.5	10/12/18	0.5 ft	21			65	104
NHP-T14-15W	NHP-T14-15W-0	10/12/18	0 ft	17			118	149
NHP-T14-15W	NHP-T14-15W-0.5	10/12/18	0.5 ft	8			18	125
NHP-T14-15W	NHP-T14-15W-1	10/12/18	1 ft	7			20	111
NHP-T14-20E	NHP-T14-20E-0	10/12/18	0 ft	7			17	67
NHP-T14-20E	NHP-T14-20E-0.5	10/12/18	0.5 ft	6 U			21	88
NHP-T14-20W	NHP-T14-20W-0	10/12/18	0 ft	10			19	113
NHP-T14-20W	NHP-T14-20W-0.5	10/12/18	0.5 ft	15			12	116
NHP-T14-20W	NHP-T14-20W-1	10/12/18	1 ft	10			17	133
NHP-T14-25E	NHP-T14-25E-0	10/12/18	0 ft	7 U			26	90
NHP-T14-25W	NHP-T14-25W-0	10/12/18	0 ft	10			28	108
NHP-T14-25W	NHP-T14-25W-0.5	10/12/18	0.5 ft	7			30	122
NHP-T14-30E	NHP-T14-30E-0	10/12/18	0 ft	6 U			21	85
NHP-T14-30W	NHP-T14-30W-0	10/12/18	0 ft	7 U			28	132
NHP-T14-30W	NHP-T14-30W-0.5	10/12/18	0.5 ft	8			20	122
NHP-T14-40E	NHP-T14-40E-0	10/12/18	0 ft	6 U			20	57
NHP-T14-5E	NHP-T14-5E-0	10/12/18	0 ft	37			175	167
NHP-T14-5E	NHP-T14-5E-0.5	10/12/18	0.5 ft	45			200	194
NHP-T14-5E	NHP-T14-5E-1	10/12/18	1 ft	10			43	112
NHP-T14-5W	NHP-T14-5W-0	10/12/18	0 ft	49			314	198
NHP-T14-5W	NHP-T14-5W-0.5	10/12/18	0.5 ft	7 U			29	123
NHP-T14-5W	NHP-T14-5W-1	10/12/18	1 ft	13			37	145
NHP-T14-5W	NHP-T14-5W-1.5	10/12/18	1.5 ft	13			28	120
NHP-T14-C	NHP-T14-C-0	10/12/18	0 ft	52			217	232
NHP-T14-C	NHP-T14-C-0.5	10/12/18	0.5 ft	19			230	168
NHP-T14-C	NHP-T14-C-1	10/12/18	1 ft	10 U			92	132
NHP-T14-C	NHP-T14-C-1.5	10/12/18	1.5 ft	9			38	108
NHP-T15-10E	NHP-T15-10E-0	10/12/18	0 ft	45			112	185
NHP-T15-10E	NHP-T15-10E-0.5	10/12/18	0.5 ft	27			80	105
NHP-T15-10W	NHP-T15-10W-0	10/12/18	0 ft	21			62	107
NHP-T15-10W	NHP-T15-10W-0.5	10/12/18	0.5 ft	33			47	159
NHP-T15-15E	NHP-T15-15E-0	10/12/18	0 ft	16			26	71
NHP-T15-15E	NHP-T15-15E-0.5	10/12/18	0.5 ft	16			24	60
NHP-T15-15W	NHP-T15-15W-0	10/12/18	0 ft	18			28	85
NHP-T15-15W	NHP-T15-15W-0.5	10/12/18	0.5 ft	16			22	87
NHP-T15-20E	NHP-T15-20E-0	10/12/18	0 ft	21			17	56
NHP-T15-20W	NHP-T15-20W-0	10/12/18	0 ft	14			13	78
NHP-T15-25E	NHP-T15-25E-0	10/12/18	0 ft	19			10	66
NHP-T15-30E	NHP-T15-30E-0	10/12/18	0 ft	16			18	67
NHP-T15-5E	NHP-T15-5E-0	10/12/18	0 ft	55			201	209
NHP-T15-5E	NHP-T15-5E-0.5	10/12/18	0.5 ft	139			792	639
NHP-T15-5E	NHP-T15-5E-1	10/12/18	1 ft	75			524	322
NHP-T15-5W	NHP-T15-5W-0	10/12/18	0 ft	22			12	74
NHP-T15-5W	NHP-T15-5W-0.5	10/12/18	0.5 ft	19			15	76
NHP-T15-C	NHP-T15-C-0	10/12/18	0 ft	6			11	48
NHP-T15-C	NHP-T15-C-0.5	10/12/18	0.5 ft	9			13	34
NHP-T15-C	NHP-T15-C-1	10/12/18	1 ft	58			266	182
NHP-T15-C	NHP-T15-C-1.5	10/12/18	1.5 ft	38			98	141
NHP-T16-10E	NHP-T16-10E-0	10/10/18	0 ft	20			146	55
NHP-T16-10E	NHP-T16-10E-0.5	10/10/18	0.5 ft	7 U			25	69
NHP-T16-10W	NHP-T16-10W-0	10/10/18	0 ft	13 U			154	56
NHP-T16-10W	NHP-T16-10W-0.5	10/10/18	0.5 ft	25			86	62
NHP-T16-10W	NHP-T16-10W-1	10/10/18	1 ft	18			14	80
NHP-T16-15E	NHP-T16-15E-0	10/10/18	0 ft	16			69	73
NHP-T16-15E	NHP-T16-15E-0.5	10/10/18	0.5 ft	7			11	62
NHP-T16-15W	NHP-T16-15W-0	10/10/18	0 ft	20			257	64

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

			Analyte	Arsenic	Chromium	Copper	Lead	Zinc
			Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			Minimum Human Health COPC Selection SL	0.68	2000	310	250	2,300
			Minimum SLERA COPEC Selection ESV	0.25	0.34	14	0.94	6.62
			Minimum SL or ESV	0.25	0.34	14	0.94	6.62
Location Name	**Field Sample ID**	**Sample Date**	**Depth**					
Soil—Site (cont.)								
NHP-T16-15W	NHP-T16-15W-0.5	10/10/18	0.5 ft	**20**			**260**	**61**
NHP-T16-15W	NHP-T16-15W-1	10/10/18	1 ft	**19**			**63**	**63**
NHP-T16-15W	NHP-T16-15W-1.5	10/10/18	1.5 ft	*6 U*			**15**	**47**
NHP-T16-20E	NHP-T16-20E-0	10/10/18	0 ft	*6 U*			**37**	**87**
NHP-T16-20W	NHP-T16-20W-0	10/10/18	0 ft	*6 U*			**35**	**50**
NHP-T16-25W	NHP-T16-25W-0	10/10/18	0 ft	**10**			**23**	**71**
NHP-T16-5E	NHP-T16-5E-0	10/10/18	0 ft	*15 U*			**220**	**61**
NHP-T16-5E	NHP-T16-5E-0.5	10/10/18	0.5 ft	**18**			**80**	**67**
NHP-T16-5E	NHP-T16-5E-1	10/10/18	1 ft	**13**			**14**	**118**
NHP-T16-5E	NHP-T16-5E-1.5	10/10/18	1.5 ft	**10**			**14**	**86**
NHP-T16-5W	NHP-T16-5W-0	10/10/18	0 ft	**25**			**64**	**49**
NHP-T16-5W	NHP-T16-5W-0.5	10/10/18	0.5 ft	*17 U*			**191**	**68**
NHP-T16-5W	NHP-T16-5W-1	10/10/18	1 ft	**13**			**90**	**65**
NHP-T16-5W	NHP-T16-5W-1.5	10/10/18	1.5 ft	**17**			**10**	**40**
NHP-T16-C	NHP-T16-C-0	10/10/18	0 ft	**44**			**135**	**52**
NHP-T16-C	NHP-T16-C-0.5	10/10/18	0.5 ft	**24**			**247**	**75**
NHP-T16-C	NHP-T16-C-1	10/10/18	1 ft	**18**			**14**	**60**
NHP-T16-C	NHP-T16-C-1.5	10/10/18	1.5 ft	**16**			**10**	**52**
NHP-T16-C	NHP-T16-C-2	10/10/18	2 ft	**19**			**15**	**48**
NHP-T16-C	NHP-T16-C-2.5	10/10/18	2.5 ft	**17**			**11**	**39**
NHP-T17-10E	NHP-T17-10E-0	10/11/18	0 ft	**8**			**54**	**65**
NHP-T17-10E	NHP-T17-10E-0.5	10/11/18	0.5 ft	*8 U*			**46**	**72**
NHP-T17-10W	NHP-T17-10W-0	10/11/18	0 ft	**18**			**98**	**70**
NHP-T17-10W	NHP-T17-10W-0.5	10/11/18	0.5 ft	**14**			**94**	**84**
NHP-T17-10W	NHP-T17-10W-1	10/11/18	1 ft	**9**			**27**	**112**
NHP-T17-15E	NHP-T17-15E-0	10/11/18	0 ft	*5 U*			**24**	**75**
NHP-T17-15E	NHP-T17-15E-0.5	10/11/18	0.5 ft	*6 U*			**34**	**45**
NHP-T17-15W	NHP-T17-15W-0	10/11/18	0 ft	**11**			**63**	**81**
NHP-T17-15W	NHP-T17-15W-0.5	10/11/18	0.5 ft	**13**			**17**	**113**
NHP-T17-20E	NHP-T17-20E-0	10/11/18	0 ft	**10**			**17**	**54**
NHP-T17-20E	NHP-T17-20E-0.5	10/11/18	0.5 ft	**14**			**17**	**48**
NHP-T17-20W	NHP-T17-20W-0	10/11/18	0 ft	**16**			**13**	**79**
NHP-T17-25W	NHP-T17-25W-0	10/11/18	0 ft	**14**			**38**	**61**
NHP-T17-5E	NHP-T17-5E-0	10/11/18	0 ft	**22**			**87**	**62**
NHP-T17-5E	NHP-T17-5E-0.5	10/11/18	0.5 ft	**14**			**192**	**58**
NHP-T17-5E	NHP-T17-5E-1	10/11/18	1 ft	**15**			**107**	**48**
NHP-T17-5W	NHP-T17-5W-0	10/11/18	0 ft	*16 U*			**81**	**77**
NHP-T17-5W	NHP-T17-5W-0.5	10/11/18	0.5 ft	*9 U*			**52**	**69**
NHP-T17-5W	NHP-T17-5W-1	10/11/18	1 ft	**10**			**12**	**77**
NHP-T17-C	NHP-T17-C-0	10/11/18	0 ft	*7 U*			**30**	**44**
NHP-T17-C	NHP-T17-C-0.5	10/11/18	0.5 ft	*7 U*			**30**	**60**
NHP-T18-10W	NHP-T18-10W-0	10/11/18	0 ft	*9 U*			**79**	**63**
NHP-T18-10W	NHP-T18-10W-0.5	10/11/18	0.5 ft	*7 U*			**34**	**64**
NHP-T18-12E	NHP-T18-12E-0	10/11/18	0 ft	**11**			**53**	**55**
NHP-T18-12E	NHP-T18-12E-0.5	10/11/18	0.5 ft	**12**			**64**	**55**
NHP-T18-15W	NHP-T18-15W-0	10/11/18	0 ft	*8 U*			**63**	**70**
NHP-T18-15W	NHP-T18-15W-0.5	10/11/18	0.5 ft	**8**			**40**	**76**
NHP-T18-18E	NHP-T18-18E-0	10/11/18	0 ft	*6 U*			**25**	**53**
NHP-T18-18E	NHP-T18-18E-0.5	10/11/18	0.5 ft	*5 U*			*8 U*	**50**
NHP-T18-20W	NHP-T18-20W-0	10/11/18	0 ft	*7 U*			**37**	**54**
NHP-T18-20W	NHP-T18-20W-0.5	10/11/18	0.5 ft	**10**			**14**	**70**
NHP-T18-24E	NHP-T18-24E-0	10/11/18	0 ft	*5 U*			**16**	**36**
NHP-T18-25W	NHP-T18-25W-0	10/11/18	0 ft	**11**			**22**	**88**
NHP-T18-30W	NHP-T18-30W-0	10/11/18	0 ft	**7**			**30**	**82**
NHP-T18-5W	NHP-T18-5W-0	10/11/18	0 ft	*11 U*			**136**	**56**
NHP-T18-5W	NHP-T18-5W-0.5	10/11/18	0.5 ft	**15**			**103**	**57**
NHP-T18-5W	NHP-T18-5W-1	10/11/18	1 ft	*7 U*			**45**	**51**
NHP-T18-C	NHP-T18-C-0	10/11/18	0 ft	**16**			**160**	**59**
NHP-T18-C	NHP-T18-C-0.5	10/11/18	0.5 ft	*16 U*			**283**	**55**
NHP-T18-C	NHP-T18-C-1	10/11/18	1 ft	*13 U*			**181**	**57**
NHP-T18-C	NHP-T18-C-1.5	10/11/18	1.5 ft	**12**			**99**	**56**
NHP-T18-C	NHP-T18-C-2	10/11/18	2 ft	*8 U*			**44**	**76**
NHP-T19-10E	NHP-T19-10E-0	10/11/18	0 ft	*7 U*			**53**	**53**
NHP-T19-10E	NHP-T19-10E-0.5	10/11/18	0.5 ft	*7 U*			**38**	**49**
NHP-T19-10E	NHP-T19-10E-1	10/11/18	1 ft	*6 U*			**20**	**52**
NHP-T19-10W	NHP-T19-10W -1	10/11/18	1 ft	*6 U*			**17**	**48**
NHP-T19-10W	NHP-T19-10W-0	10/11/18	0 ft	*10 U*			**103**	**53**
NHP-T19-10W	NHP-T19-10W-0.5	10/11/18	0.5 ft	**8**			**16**	**47**
NHP-T19-15E	NHP-T19-15E-0	10/11/18	0 ft	*4 U*			**15**	**35**
NHP-T19-15E	NHP-T19-15E-0.5	10/11/18	0.5 ft	*6 U*			**20**	**42**
NHP-T19-15W	NHP-T19-15W-0	10/11/18	0 ft	**11**			**57**	**80**
NHP-T19-15W	NHP-T19-15W-0.5	10/11/18	0.5 ft	**10**			**29**	**84**
NHP-T19-20E	NHP-T19-20E-0	10/11/18	0 ft	*6 U*			**23**	**46**
NHP-T19-20W	NHP-T19-20W-0	10/11/18	0 ft	**14**			**28**	**66**
NHP-T19-25W	NHP-T19-25W-0	10/11/18	0 ft	**10**			**19**	**77**
NHP-T19-5E	NHP-T19-5E-0	10/11/18	0 ft	**16**			**216**	**53**
NHP-T19-5E	NHP-T19-5E-0.5	10/11/18	0.5 ft	**15**			**135**	**51**
NHP-T19-5E	NHP-T19-5E-1	10/11/18	1 ft	*11 U*			**95**	**44**
NHP-T19-5E	NHP-T19-5E-1.5	10/11/18	1.5 ft	**9**			**38**	**65**
NHP-T19-5E	NHP-T19-5E-2	10/11/18	2 ft	**13**			**61**	**52**

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

Analyte				Arsenic	Chromium	Copper	Lead	Zinc
Unit				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Minimum Human Health COPC Selection SL				0.68	2000	310	250	2,300
Minimum SLERA COPEC Selection ESV				0.25	0.34	14	0.94	6.62
Minimum SL or ESV				0.25	0.34	14	0.94	6.62
Location Name	**Field Sample ID**	**Sample Date**	**Depth**					
Soil—Site (cont.)								
NHP-T19-5W	NHP-T19-5W-0	10/11/18	0 ft	8 U			43	49
NHP-T19-5W	NHP-T19-5W-0.5	10/11/18	0.5 ft	6 U			14	59
NHP-T19-5W	NHP-T19-5W-1	10/11/18	1 ft	5 U			14	50
NHP-T19-5W	NHP-T19-5W-1.25	10/11/18	1.25 ft	12			50	65
NHP-T19-C	NHP-T19-C-0	10/11/18	0 ft	13			116	69
NHP-T19-C	NHP-T19-C-0.5	10/11/18	0.5 ft	20			182	54
NHP-T19-C	NHP-T19-C-1	10/11/18	1 ft	10 U			78	66
NHP-T19-C	NHP-T19-C-1.5	10/11/18	1.5 ft	11			51	54
NHP-T19-C	NHP-T19-C-2	10/11/18	2 ft	10 U			69	56
NHP-T20-10W	NHP-T20-10W-0	10/11/18	0 ft	27			181	68
NHP-T20-10W	NHP-T20-10W-0.5	10/11/18	0.5 ft	13 U			161	74
NHP-T20-10W	NHP-T20-10W-1	10/11/18	1 ft	11			64	64
NHP-T20-10W	NHP-T20-10W-1.5	10/11/18	1.5 ft	7 U			17	57
NHP-T20-13E	NHP-T20-13E-0	10/11/18	0 ft	8 U			66	68
NHP-T20-13E	NHP-T20-13E-0.5	10/11/18	0.5 ft	6			32	97
NHP-T20-13E	NHP-T20-13E-1	10/11/18	1 ft	6 U			12	105
NHP-T20-15W	NHP-T20-15W-0	10/11/18	0 ft	13			163	46
NHP-T20-15W	NHP-T20-15W-0.5	10/11/18	0.5 ft	10 U			122	40
NHP-T20-15W	NHP-T20-15W-1	10/11/18	1 ft	6 U			34	37
NHP-T20-16E	NHP-T20-16E-0	10/11/18	0 ft	6 U			25	65
NHP-T20-16E	NHP-T20-16E-0.5	10/11/18	0.5 ft	6 U			28	101
NHP-T20-16E	NHP-T20-16E-1	10/11/18	1 ft	7			26	65
NHP-T20-20W	NHP-T20-20W-0	10/11/18	0 ft	7			36	62
NHP-T20-25W	NHP-T20-25W-0	10/11/18	0 ft	6 U			18	58
NHP-T20-5E	NHP-T20-5E-0	10/11/18	0 ft	21			224	357
NHP-T20-5E	NHP-T20-5E-0.5	10/11/18	0.5 ft	19			25	175
NHP-T20-5E	NHP-T20-5E-1	10/11/18	1 ft	11			9	115
NHP-T20-5W	NHP-T20-5W-0	10/11/18	0 ft	12 U			170	62
NHP-T20-5W	NHP-T20-5W-0.5	10/11/18	0.5 ft	23			85	52
NHP-T20-5W	NHP-T20-5W-1	10/11/18	1 ft	28			158	91
NHP-T20-5W	NHP-T20-5W-1.5	10/11/18	1.5 ft	6 U			15	63
NHP-T20-C	NHP-T20-C-0	10/11/18	0 ft	26			352	72
NHP-T20-C	NHP-T20-C-0.5	10/11/18	0.5 ft	38			438	66
NHP-T20-C	NHP-T20-C-1	10/11/18	1 ft	14			18	61
NHP-T21-10E	NHP-T21-10E-0.5	10/12/18	0.5 ft	21			11	75
NHP-T21-10W	NHP-T21-10W-0	10/12/18	0 ft	18			156	104
NHP-T21-10W	NHP-T21-10W-0.5	10/12/18	0.5 ft	20			23	76
NHP-T21-15E	NHP-T21-15E-0	10/12/18	0 ft	8			25	67
NHP-T21-15E	NHP-T21-15E-0.5	10/12/18	0.5 ft	9			15	132
NHP-T21-15W	NHP-T21-15W-0	10/12/18	0 ft	21			44	61
NHP-T21-15W	NHP-T21-15W-0.5	10/12/18	0.5 ft	19			62	89
NHP-T21-5W	NHP-T21-5W-0	10/12/18	0 ft	18			34	88
NHP-T21-5W	NHP-T21-5W-0.5	10/12/18	0.5 ft	9			14	144
NHP-T21-C	NHP-T21-C-0	10/12/18	0 ft	32			102	85
NHP-T21-C	NHP-T21-C-0.5	10/12/18	0.5 ft	20			135	68
NHP-T22-10E	NHP-T22-10E-0	10/12/18	0 ft	10			32	103
NHP-T22-10E	NHP-T22-10E-0.5	10/12/18	0.5 ft	13			31	104
NHP-T22-10E	NHP-T22-10E-1	10/12/18	1 ft	19			15	98
NHP-T22-10W	NHP-T22-10W-0	10/12/18	0 ft	40			257	85
NHP-T22-10W	NHP-T22-10W-0.5	10/12/18	0.5 ft	31			45	79
NHP-T22-10W	NHP-T22-10W-1	10/12/18	1 ft	24			22	62
NHP-T22-15E	NHP-T22-15E-0	10/12/18	0 ft	12			20	97
NHP-T22-15E	NHP-T22-15E-0.5	10/12/18	0.5 ft	11			24	95
NHP-T22-15W	NHP-T22-15W-0	10/12/18	0 ft	16			47	67
NHP-T22-15W	NHP-T22-15W-0.5	10/12/18	0.5 ft	20			45	77
NHP-T22-20W	NHP-T22-20W-0	10/12/18	0 ft	13			98	70
NHP-T22-25W	NHP-T22-25W-0	10/12/18	0 ft	13 U			208	77
NHP-T22-35W	NHP-T22-35W-0	10/12/18	0 ft	8 U			66	70
NHP-T22-40W	NHP-T22-40W-0	10/12/18	0 ft	8 U			63	57
NHP-T22-45W	NHP-T22-45W-0	10/12/18	0 ft	6 U			35	55
NHP-T22-5E	NHP-T22-5E-0	10/12/18	0 ft	14			86	69
NHP-T22-5E	NHP-T22-5E-0.5	10/12/18	0.5 ft	17			85	70
NHP-T22-5E	NHP-T22-5E-1	10/12/18	1 ft	11			14	97
NHP-T22-5W	NHP-T22-5W-0	10/12/18	0 ft	50			1593	76
NHP-T22-5W	NHP-T22-5W-0.5	10/12/18	0.5 ft	44			279	79
NHP-T22-5W	NHP-T22-5W-1	10/12/18	1 ft	13			118	91
NHP-T22-C	NHP-T22-C-0	10/12/18	0 ft	29			328	80
NHP-T22-C	NHP-T22-C-0.5	10/12/18	0.5 ft	18			82	88
NHP-T23-10E	NHP-T23-10E-0	10/12/18	0 ft	5 U			9	30
NHP-T23-10W	NHP-T23-10W-0	10/12/18	0 ft	7 U			77	50
NHP-T23-15E	NHP-T23-15E-0	10/12/18	0 ft	7 U			34	50
NHP-T23-15E	NHP-T23-15E-0.5	10/12/18	0.5 ft	6 U			17	73
NHP-T23-15W	NHP-T23-15W-0	10/12/18	0 ft	6 U			49	28
NHP-T23-20E	NHP-T23-20E-0	10/12/18	0 ft	11			19	90
NHP-T23-20E	NHP-T23-20E-0.5	10/12/18	0.5 ft	12			10	70
NHP-T23-20W	NHP-T23-20W-0	10/12/18	0 ft	5 U			33	78
NHP-T23-25E	NHP-T23-25E-0	10/12/18	0 ft	7			15	84
NHP-T23-25E	NHP-T23-25E-0.5	10/12/18	0.5 ft	10			13	82
NHP-T23-25W	NHP-T23-25W-0	10/12/18	0 ft	12 U			264	35
NHP-T23-25W	NHP-T23-25W-0R	10/12/18	0 ft	10			186	27

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

Analyte				Arsenic	Chromium	Copper	Lead	Zinc
Unit				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Minimum Human Health COPC Selection SL				0.68	2000	310	250	2,300
Minimum SLERA COPEC Selection ESV				0.25	0.34	14	0.94	6.62
Minimum SL or ESV				0.25	0.34	14	0.94	6.62
Location Name	Field Sample ID	Sample Date	Depth					
Soil—Site (cont.)								
NHP-T23-5E	NHP-T23-5E-0	10/12/18	0 ft	**49**			**764**	**47**
NHP-T23-5W	NHP-T23-5W-0	10/12/18	0 ft	**31**			**240**	**101**
NHP-T23-C	NHP-T23-C-0	10/12/18	0 ft	**40**			**493**	**170**
NHP-T24-10E	NHP-T24-10E-0	10/12/18	0 ft	*6 U*			**20**	**60**
NHP-T24-10W	NHP-T24-10W-0	10/12/18	0 ft	**33**			**286**	**39**
NHP-T24-15E	NHP-T24-15E-0	10/12/18	0 ft	*7 U*			**33**	**92**
NHP-T24-15E	NHP-T24-15E-0.5	10/12/18	0.5 ft	*5 U*			**9**	**60**
NHP-T24-15W	NHP-T24-15W-0	10/12/18	0 ft	*9 U*			**136**	**25**
NHP-T24-20E	NHP-T24-20E-0	10/12/18	0 ft	*7 U*			**39**	**150**
NHP-T24-20W	NHP-T24-20W-0	10/12/18	0 ft	*8 U*			**72**	**56**
NHP-T24-25E	NHP-T24-25E-0	10/12/18	0 ft	**7**			**11**	**91**
NHP-T24-25W	NHP-T24-25W-0	10/12/18	0 ft	*5 U*			**27**	**30**
NHP-T24-5E	NHP-T24-5E-0	10/12/18	0 ft	*6 U*			**34**	**50**
NHP-T24-5W	NHP-T24-5W-0	10/12/18	0 ft	*8 U*			**91**	**73**
NHP-T24-C	NHP-T24-C-0	10/12/18	0 ft	**19**			**362**	**103**
NHP-T25-10E	NHP-T25-10E-0	10/12/18	0 ft	**19**			**149**	**66**
NHP-T25-10W	NHP-T25-10W-0	10/12/18	0 ft	*16 U*			**340**	**78**
NHP-T25-15E	NHP-T25-15E-0	10/12/18	0 ft	*8 U*			**49**	**55**
NHP-T25-15W	NHP-T25-15W-0	10/12/18	0 ft	*9 U*			**131**	**76**
NHP-T25-20E	NHP-T25-20E-0	10/12/18	0 ft	*9 U*			**82**	**94**
NHP-T25-20W	NHP-T25-20W-0	10/12/18	0 ft	*9 U*			**73**	**79**
NHP-T25-25E	NHP-T25-25E-0	10/12/18	0 ft	*13 U*			**195**	**106**
NHP-T25-5E	NHP-T25-5E-0	10/12/18	0 ft	**10**			**59**	**63**
NHP-T25-5E	NHP-T25-5E-0.5	10/12/18	0.5 ft	*7 U*			**32**	**65**
NHP-T25-5W	NHP-T25-5W-0	10/12/18	0 ft	**30**			**751**	**147**
NHP-T25-C	NHP-T25-C-0	10/12/18	0 ft	**58**			**849**	**98**
NHP-T26-10W	NHP-T26-10W-0	10/12/18	0 ft	**15**			**227**	**25**
NHP-T26-5W	NHP-T26-5W-0	10/12/18	0 ft	*11 U*			**194**	**64**
NHP-T26-C	NHP-T26-C-0	10/12/18	0 ft	**48**			**571**	**83**
NHP-T26-C	NHP-T26-C-0.5	10/12/18	0.5 ft	**34**			**614**	**83**
NHP-T27-11W	NHP-T27-11W-0	10/12/18	0 ft	**13**			**110**	**91**
NHP-T27-7W	NHP-T27-7W-0	10/12/18	0 ft	**16**			**343**	**38**
NHP-T27-C	NHP-T27-C-0	10/12/18	0 ft	**47**			**522**	**96**
NHP-T27-C	NHP-T27-C-0.5	10/12/18	0.5 ft	**65**			**837**	**94**
T10-E-10	T10-E-10_100615_XRF	10/6/15	--	*16 U*			**97**	**82**
T10-E-15	T10-E-15_100615_XRF	10/6/15	--	*7 U*			**11**	0
T10-E-20	T10-E-20_100615_XRF	10/6/15	--	*9 U*			**24**	**60**
T10-E-25	T10-E-25_100615_XRF	10/6/15	--	*6 U*			*8 U*	**64**
T10-E-30	T10-E-30_100615_XRF	10/6/15	--	*13 U*			**34**	**157**
T10-E-45	T10-E-45_100615_XRF	10/6/15	--	*9 U*			*11 U*	**76**
T11-E-1	T11-E-1_100615_XRF	10/6/15	--	**79**			**663**	**62**
T11-E-10	T11-E-10_100615_XRF	10/6/15	--	*20 U*			**156**	**110**
T11-E-15	T11-E-15_100615_XRF	10/6/15	--	**24**			**49**	**85**
T11-E-20	T11-E-20_100615_XRF	10/6/15	--	**29**			**14**	*45 U*
T11-E-25	T11-E-25_100615_XRF	10/6/15	--	*13 U*			**32**	**84**
T11-E-5	T11-E-5_100615_XRF	10/6/15	--	*23 U*			**223**	**93**
T11-W-0	T11-W-0_100615_XRF	10/6/15	--	**787**			**2378**	**67**
T11-W-10	T11-W-10_100615_XRF	10/6/15	--	**20**			**39**	**105**
T11-W-15	T11-W-15_100615_XRF	10/6/15	--	**20**			**42**	**40**
T11-W-20	T11-W-20_100615_XRF	10/6/15	--	*10 U*			**26**	**65**
T11-W-5	T11-W-5_100615_XRF	10/6/15	--	**18**			**14**	*44 U*
T12-W-15	T12-W-15_100615_XRF	10/6/15	--	**30**			**40**	**74**
T12-W-20	T12-W-20_100615_XRF	10/6/15	--	*13 U*			**35**	**88**
T12-W-7	T12-W-7_100615_XRF	10/6/15	--	**29**			**194**	**2802**
T13-E-0	T13-E-0	10/6/15	0-3 in	*27 U*			**294**	**104**
T13-E-10	T13-E-10_100615_XRF	10/6/15	--	*14 U*			**71**	**56**
T13-E-15	T13-E-15_100615_XRF	10/6/15	--	*10 U*			**17**	*53 U*
T13-E-20	T13-E-20_100615_XRF	10/6/15	--	**16**			*11 U*	0
T13-E-25	T13-E-25_100615_XRF	10/6/15	--	**11**			*10 U*	**48**
T13-E-5	T13-E-5_100615_XRF	10/6/15	--	**14**			*11 U*	**59**
T13-W-0.5	T13-W-0.5_100615_XRF	10/6/15	--	*63 U*			**1433**	**51**
T13-W-10	T13-W-10_100615_XRF	10/6/15	--	*28 U*			**299**	**72**
T13-W-15	T13-W-15_100615_XRF	10/6/15	--	*21 U*			**131**	**26**
T13-W-20	T13-W-20_100615_XRF	10/6/15	--	**16**			**55**	**173**
T13-W-25	T13-W-25_100615_XRF	10/6/15	--	**12**			**47**	**92**
T13-W-30	T13-W-30_100615_XRF	10/6/15	--	*16 U*			**110**	**63**
T13-W-35	T13-W-35	10/6/15	0-3 in	*19 U*			**148**	**343**
T13-W-40	T13-W-40	10/6/15	0-3 in	*11 U*			**41**	**110**
T13-W-5	T13-W-5_100615_XRF	10/6/15	--	*36 U*			**501**	**73**
T1-C	T1-C	7/10/14	0-6 in	**28**	**85**	**37**	**895**	**122**
T1-E-11ft	T1-E-11ft_07112014_XRF	7/10/14	--	**19.7**	**33**	**30**	**71**	**86**
T1-E-2ft	T1-E-2ft_07112014_XRF	7/10/14	--	**12**	**16**	**28**	**446**	**129**
T1-E-5ft	T1-E-5ft_07112014_XRF	7/10/14	--	**11**	*9 U*	8	**321**	**81.6**
T1-E-8ft	T1-E-8ft	7/12/14	0-6 in	**18**	*9 U*	14	**374**	**101**
T1-W-11ft	T1-W-11ft_07112014_XRF	7/10/14	--	**9.7**	*12 U*	8	**30.3**	**65.7**
T1-W-2ft	T1-W-2ft_07112014_XRF	7/10/14	--	**19**	**28**	**35**	**572**	**104**
T1-W-5ft	T1-W-5ft_07112014_XRF	7/10/14	--	**18**	**39**	**23**	**440**	**70.8**
T1-W-8ft	T1-W-8ft_07112014_XRF	7/10/14	--	**15.7**	*14 U*	**15**	**163**	**63**
T2-C	T2-C_07112014_XRF	7/10/14	--	**25**	**24**	**31**	**471**	**182**

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

Analyte				**Arsenic**	**Chromium**	**Copper**	**Lead**	**Zinc**
Unit				**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Minimum Human Health COPC Selection SL				**0.68**	**2000**	**310**	**250**	**2,300**
Minimum SLERA COPEC Selection ESV				**0.25**	**0.34**	**14**	**0.94**	**6.62**
Minimum SL or ESV				**0.25**	**0.34**	**14**	**0.94**	**6.62**
Location Name	**Field Sample ID**	**Sample Date**	**Depth**					
Soil—Site (cont.)								
T2-E-11.5ft	T2-E-11.5ft_07112014_XRF	7/10/14	--	**6.8**	*5.7 U*	*6 U*	**144**	**75.8**
T2-E-2ft	T2-E-2ft_07112014_XRF	7/10/14	--	**14**	**16**	**19**	**336**	**65.9**
T2-E-5ft	T2-E-5ft_07112014_XRF	7/10/14	--	**17**	**11**	*6 U*	**378**	**60.3**
T2-E-8ft	T2-E-8ft_07112014_XRF	7/10/14	--	**22**	**23**	9	**292**	**71.8**
T2-W-11ft	T2-W-11ft_07112014_XRF	7/10/14	--	**24**	**38**	**30**	**327**	**93**
T2-W-13ft	T2-W-13ft_07112014_XRF	7/10/14	--	**14.3**	**73**	**16**	**169**	**84**
T2-W-16ft	T2-W-16ft	7/11/14	0-6 in	**10.6**	*20 U*	*10 U*	**106**	**59**
T2-W-19ft	T2-W-19ft	7/11/14	0-6 in	**6.8**	**19**	**21**	**37.2**	**70.9**
T2-W-19ft	T2-W-19ft-FD	7/11/14	0-6 in	**5.4**	**13**	**28**	**32.7**	**66.7**
T2-W-2ft	T2-W-2ft	7/12/14	0-6 in	**28**	**24**	11	**531**	**68**
T2-W-5ft	T2-W-5ft_07112014_XRF	7/10/14	--	**19**	**19**	**28**	**373**	**61.6**
T2-W-8ft	T2-W-8ft_07112014_XRF	7/10/14	--	**11**	**22**	12	**194**	**65.4**
T3-C	T3-C_07122014_XRF	7/11/14	--	**24**	**19**	**32**	**275**	**84**
T3-E-11ft	T3-E-11ft_07122014_XRF	7/11/14	--	**17.6**	**24**	**17**	**11.8**	**170**
T3-E-2ft	T3-E-2ft	7/11/14	0-6 in	**11**	**21**	*7 U*	**392**	**56.6**
T3-E-5ft	T3-E-5ft_07122014_XRF	7/11/14	--	**13.8**	**22**	**15**	**88.4**	**119**
T3-E-8ft	T3-E-8ft_07122014_XRF	7/11/14	--	**13.2**	*13 U*	14	**53.2**	**123**
T3-W-11ft	T3-W-11ft_07122014_XRF	7/11/14	--	**19.3**	**39**	11	**14.2**	**59**
T3-W-2ft	T3-W-2ft_07122014_XRF	7/11/14	--	**28**	**26**	**23**	**315**	**92**
T3-W-5ft	T3-W-5ft	7/11/14	0-6 in	**22**	**19**	**17**	**331**	**66**
T3-W-8ft	T3-W-8ft_07122014_XRF	7/11/14	--	**26.2**	**32**	**20**	**73.5**	**88**
T4-C	T4-C	7/11/14	0-6 in	**44**	**23**	**23**	**965**	**74.8**
T4-E-11ft	T4-E-11ft	7/11/14	0-6 in	**11.8**	**22**	**33**	**17.2**	**104**
T4-E-2ft	T4-E-2ft_07122014_XRF	7/11/14	--	**5.5**	*11 U*	14	**63.8**	**77.2**
T4-E-5ft	T4-E-5ft_07122014_XRF	7/11/14	--	**13**	**45**	14	**260**	**95**
T4-E-8ft	T4-E-8ft_07122014_XRF	7/11/14	--	**9.1**	*13 U*	**23**	**29.2**	**104**
T4-W-11ft	T4-W-11ft	7/11/14	0-6 in	**15.2**	**22**	**23**	**178**	**101**
T4-W-2ft	T4-W-2ft_07122014_XRF	7/11/14	--	**32**	**14**	**27**	**483**	**94**
T4-W-5ft	T4-W-5ft_07122014_XRF	7/11/14	--	**17**	**12**	**24**	**439**	**75.2**
T4-W-8ft	T4-W-8ft_07122014_XRF	7/11/14	--	**14.9**	**33**	13	**147**	**86**
T5-C	T5-C	7/11/14	0-6 in	*29 U*	**19**	**23**	**5485**	**179**
T5-E-11ft	T5-E-11ft_07122014_XRF	7/11/14	--	**14**	*12 U*	13	**371**	**116**
T5-E-2ft	T5-E-2ft_07122014_XRF	7/11/14	--	**27**	*9 U*	*7 U*	**791**	**75.1**
T5-E-5ft	T5-E-5ft_07122014_XRF	7/11/14	--	*9 U*	*8 U*	*7 U*	**506**	**77.6**
T5-E-8ft	T5-E-8ft_07122014_XRF	7/11/14	--	**39**	**13**	11	**503**	**131**
T5-W-11ft	T5-W-11ft	7/11/14	0-6 in	**24**	**18**	**29**	**440**	**91**
T5-W-2ft	T5-W-2ft_07122014_XRF	7/11/14	--	**27**	**30**	**17**	**536**	**135**
T5-W-5ft	T5-W-5ft_07122014_XRF	7/11/14	--	**28**	*11 U*	**20**	**459**	**103**
T5-W-8ft	T5-W-8ft_07122014_XRF	7/11/14	--	*10 U*	*11 U*	**27**	**658**	**106**
T6-C	T6-C_07122014_XRF	7/11/14	--	*11 U*	*5.5 U*	*6 U*	**960**	**128**
T6-E-11ft	T6-E-11ft	7/11/14	0-6 in	**23**	*5.5 U*	*6 U*	**860**	**85.3**
T6-E-2.5ft	T6-E-2.5ft_07122014_XRF	7/11/14	--	**41**	**23**	*7 U*	**1535**	**110**
T6-E-20	T6-E-20_100615_XRF	10/6/15	--	*12 U*			**31**	**57**
T6-E-25	T6-E-25_100615_XRF	10/6/15	--	*12 U*			**21**	*21 U*
T6-E-35	T6-E-35_100615_XRF	10/6/15	--	*12 U*			**42**	**51**
T6-E-45	T6-E-45_100615_XRF	10/6/15	--	*12 U*			**21**	*47 U*
T6-E-5ft	T6-E-5ft	7/11/14	0-6 in	**79**	*7 U*	*7 U*	**1837**	**141**
T6-E-8ft	T6-E-8ft_07122014_XRF	7/11/14	--	**36**	*5.4 U*	*5.9 U*	**919**	**81.5**
T6-W-11.5ft	T6-W-11.5ft_07122014_XRF	7/11/14	--	**17**	**32**	**24**	**455**	**111**
T6-W-2.5ft	T6-W-2.5ft_07122014_XRF	7/11/14	--	*15 U*	**33**	*7 U*	**1593**	**91**
T6-W-5.5ft	T6-W-5.5ft_07122014_XRF	7/11/14	--	**58**	**12**	10	**1066**	**87**
T6-W-8.5ft	T6-W-8.5ft_07122014_XRF	7/11/14	--	**76**	**13**	**23**	**1366**	**127**
T7-C	T7-C_100615_XRF	10/6/15	--	*33 U*			**194**	**80**
T7-E-10	T7-E-10_100615_XRF	10/6/15	--	*31 U*			**180**	**77**
T7-E-15	T7-E-15_100615_XRF	10/6/15	--	*19 U*			**64**	**43**
T7-E-20	T7-E-20_100615_XRF	10/6/15	--	*16 U*			**61**	**49**
T7-E-25	T7-E-25_100615_XRF	10/6/15	--	*10 U*			**26**	**113**
T7-E-5	T7-E-5_100615_XRF	10/6/15	--	*26 U*			**149**	**159**
T7-W-12	T7-W-12_100615_XRF	10/6/15	--	*13 U*			**54**	**65**
T7-W-15	T7-W-15_100615_XRF	10/6/15	--	*15 U*			**126**	**57**
T7-W-20	T7-W-20_100615_XRF	10/6/15	--	*13 U*			**47**	**238**
T7-W-5	T7-W-5_100615_XRF	10/6/15	--	*30 U*			**211**	**53**
T7-W-9	T7-W-9_100615_XRF	10/6/15	--	*24 U*			**138**	**77**
T8-E-16	T8-E-16_100615_XRF	10/6/15	--	*29 U*			**113**	0
T8-E-20	T8-E-20_100615_XRF	10/6/15	--	*22 U*			**52**	**64**
T8-E-25	T8-E-25_100615_XRF	10/6/15	--	*16 U*			**24**	**79**
T8-E-30	T8-E-30_100615_XRF	10/6/15	--	*12 U*			**25**	**66**
T8-E-35	T8-E-35_100615_XRF	10/6/15	--	*13 U*			**31**	**51**
T8-E-45	T8-E-45_100615_XRF	10/6/15	--	*10 U*			*11 U*	**62**
T8-E-55	T8-E-55_100615_XRF	10/6/15	--	**13**			*11 U*	**43**
T8-E-70	T8-E-70_100615_XRF	10/6/15	--	**14**			*11 U*	**47**
T8-W-15	T8-W-15_100615_XRF	10/6/15	--	*24 U*			**118**	**45**
T8-W-3	T8-W-3_100615_XRF	10/6/15	--	**127**			**2737**	**58**
T9-W-0	T9-W-0_100615_XRF	10/6/15	--	**102**			**1009**	**74**
T9-W-10	T9-W-10_100615_XRF	10/6/15	--	*16 U*			**80**	**59**
T9-W-15	T9-W-15_100615_XRF	10/6/15	--	*13 U*			**46**	**35**
T9-W-20	T9-W-20_100615_XRF	10/6/15	--	*15 U*			**33**	**111**
T9-W-25	T9-W-25_100615_XRF	10/6/15	--	*12 U*			**31**	**140**
T9-W-35	T9-W-35_100615_XRF	10/6/15	--	**12**			*12 U*	**137**
T9-W-5	T9-W-5_100615_XRF	10/6/15	--	**37**			**315**	**78**

Table 2
XRF Monitoring Results—Penstock and Background Soil Samples

Analyte				**Arsenic**	**Chromium**	**Copper**	**Lead**	**Zinc**
Unit				**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Minimum Human Health COPC Selection SL				**0.68**	**2000**	**310**	**250**	**2,300**
Minimum SLERA COPEC Selection ESV				**0.25**	**0.34**	**14**	**0.94**	**6.62**
Minimum SL or ESV				**0.25**	**0.34**	**14**	**0.94**	**6.62**
Location Name	**Field Sample ID**	**Sample Date**	**Depth**					
Seasonally Saturated Soil—Site								
NHP-SED-1	NHP-SED-1	10/12/18	0-0.1 ft	*7 U*			**42**	**45**
NHP-SED-2	NHP-SED-2	10/12/18	0-0.1 ft	*6 U*			**24**	**54**
SED #138	SED #138	10/12/18	--	*12 U*			**127**	**66**
SED #139	SED #139	10/12/18	--	**72**			**1,016**	**75**
SED #141	SED #141	10/12/18	--	*14 U*			**217**	**69**
SED #142	SED #142	10/12/18	--	*10 U*			**147**	**59**
SED #143	SED #143	10/12/18	--	*8 U*			**27**	**44**
SED #144	SED #144	10/12/18	--	*8 U*			**54**	**75**
SED #145	SED #145	10/12/18	--	**8**			**13**	**61**
SED #146	SED #146	10/12/18	--	*6 U*			**13**	**67**
SED #147	SED #147	10/12/18	--	*6 U*			**19**	**50**
SED #85	SED #85	10/12/18	--	**10**			**15**	**48**
Historical Penstock Paint								
PAINT	PAINT_07112014_XRF	7/11/14	--	**47.1**	**408**	9	**210**	**23.7**

Notes:

Blank cells are intentional.
-- Not available.
Italics Reporting limit exceeds the minimum Human Health COPC Selection SL and SLERA COPEC selection ESV.
RED/BOLD Detected concentration exceeds the minimum Human Health COPC Selection SL and SLERA COPEC selection ESV.

Abbreviations:

CAS Chemical Abstracts Service
COPC Contaminant of potential concern
COPEC Contaminant of potential ecological concern
ESV Ecological screening value
mg/kg Milligrams per kilogram
SL Screening level
SLERA Screening level ecological risk assessment
XRF X-ray fluorescence

Qualifier:

U Analyte was not detected at the given reporting limit.

Table 3
Synthetic Precipitation Leaching Procedure Results

Analyte				Arsenic	Lead (1)	Zinc (1)
Unit				mg/L	mg/L	mg/L
SLERA COPEC Selection ESV				0.0031	0.00092	0.030
Refined SLERA ESVs (acute)				0.34	0.013	0.034
Refined SLERA ESVs (chronic)				0.15	0.00050	0.034
MCL or Federal Standard				0.010	0.015	6.0
Groundwater MTCA Method A				0.0050	0.015	4.8
Location Name	**Field Sample ID**	**Sample Date**	**Depth**			
NHP-T14-C	NHP-T14-C-0	10/12/18 15:40	0 feet	**0.0035**	**0.021**	0.022 U
NHP-T15-5E	NHP-T15-5E-0.5	10/12/18 16:05	0.5 feet	**0.0059**	**0.03**	0.022 U
NHP-T22-10E	NHP-T22-10E-0	10/12/18 15:25	0 feet	0.0028 U	*0.0022 U*	0.022 U
NHP-T22-5W	NHP-T22-5W-0	10/12/18 15:45	0 feet	0.0028 U	**0.03**	0.022 U

Notes:

Italics	Reporting limit exceeds the minimum SLERA COPEC selection ESV.
RED/BOLD	Detected concentration exceeds the minimum SLERA COPEC selection ESV.
1	Refined SLERA ESVs are the NRWQC presented based on a hardness of 23 mg/L $CaCO_3$ (Mt. Vernon city water).

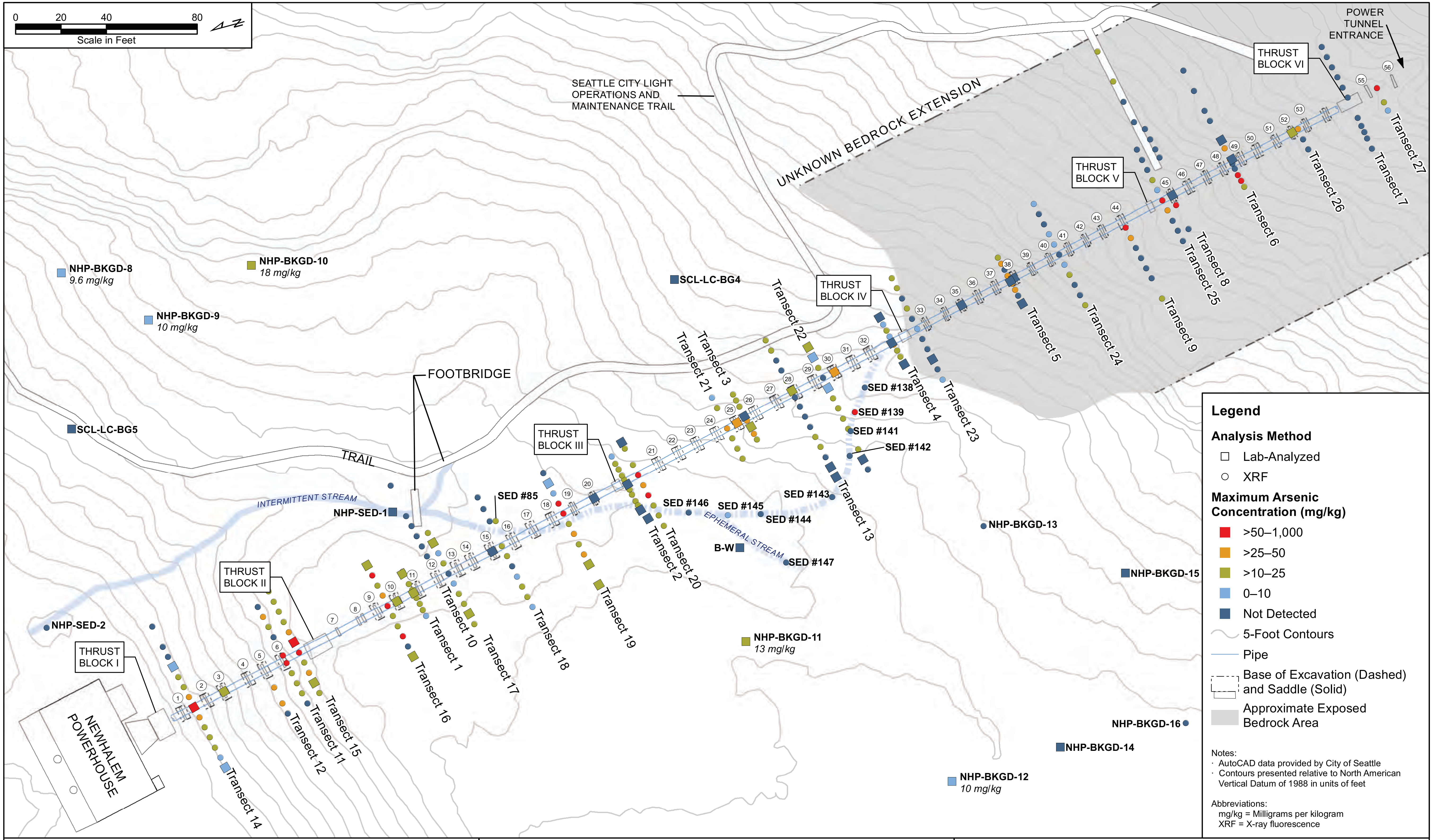
Abbreviations:

COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
MCL	Maximum contaminant level
mg/L	Milligrams per liter
MTCA	Model Toxics Control Act
NRWQC	National Recommended Water Quality Criteria
SLERA	Screening level ecological risk assessment
SPLP	Synthetic Precipitation Leaching Procedure

Qualifier:

U	Analyte was not detected at the given reporting limit.

Figures



Notes:
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviations:
mg/kg = Milligrams per kilogram
XRF = X-ray fluorescence

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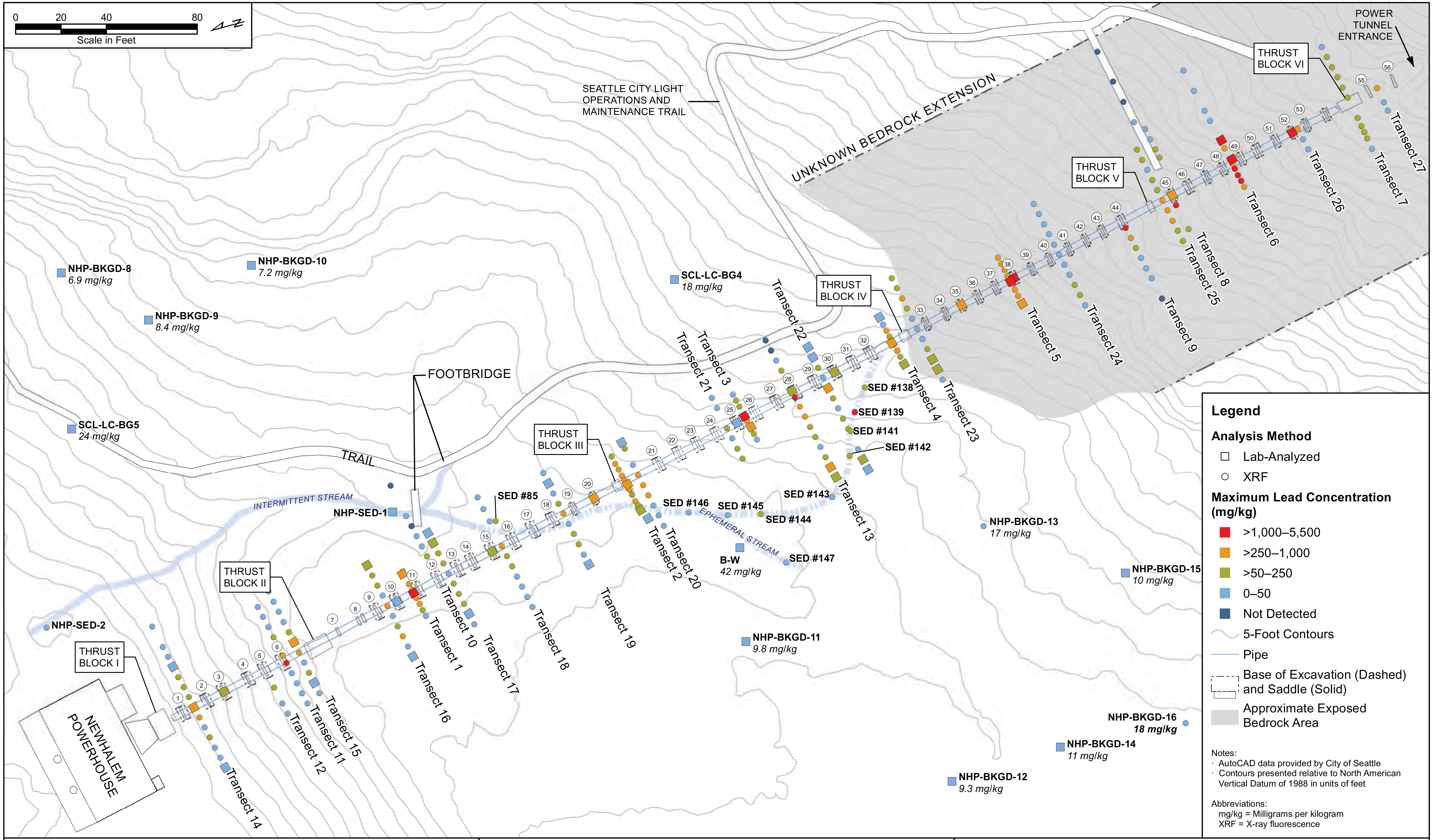
Fall 2018 Newhalem Penstock
Environmental Investigation Activities Summary
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 1
Maximum Arsenic Concentrations in Soil

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\EECA Appendix B\Figure 1 Maximum Arsenic Concentrations in Soil.mxd
3/5/2021

DRAFT



Legend

Analysis Method

☐ Lab-Analyzed

○ XRF

Maximum Lead Concentration (mg/kg)

🟥 >1,000–5,500

🟧 >250–1,000

🟩 >50–250

🟦 0–50

■ Not Detected

5-Foot Contours

Pipe

Base of Excavation (Dashed) and Saddle (Solid)

▨ Approximate Exposed Bedrock Area

Notes:
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviations:
mg/kg = Milligrams per kilogram
XRF = X-ray fluorescence

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Environmental Investigation Activities Summary
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 2
Maximum Lead Concentrations in Soil

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\EECA Appendix B\Figure 2 Maximum Lead Concentrations in Soil.mxd
3/5/2021

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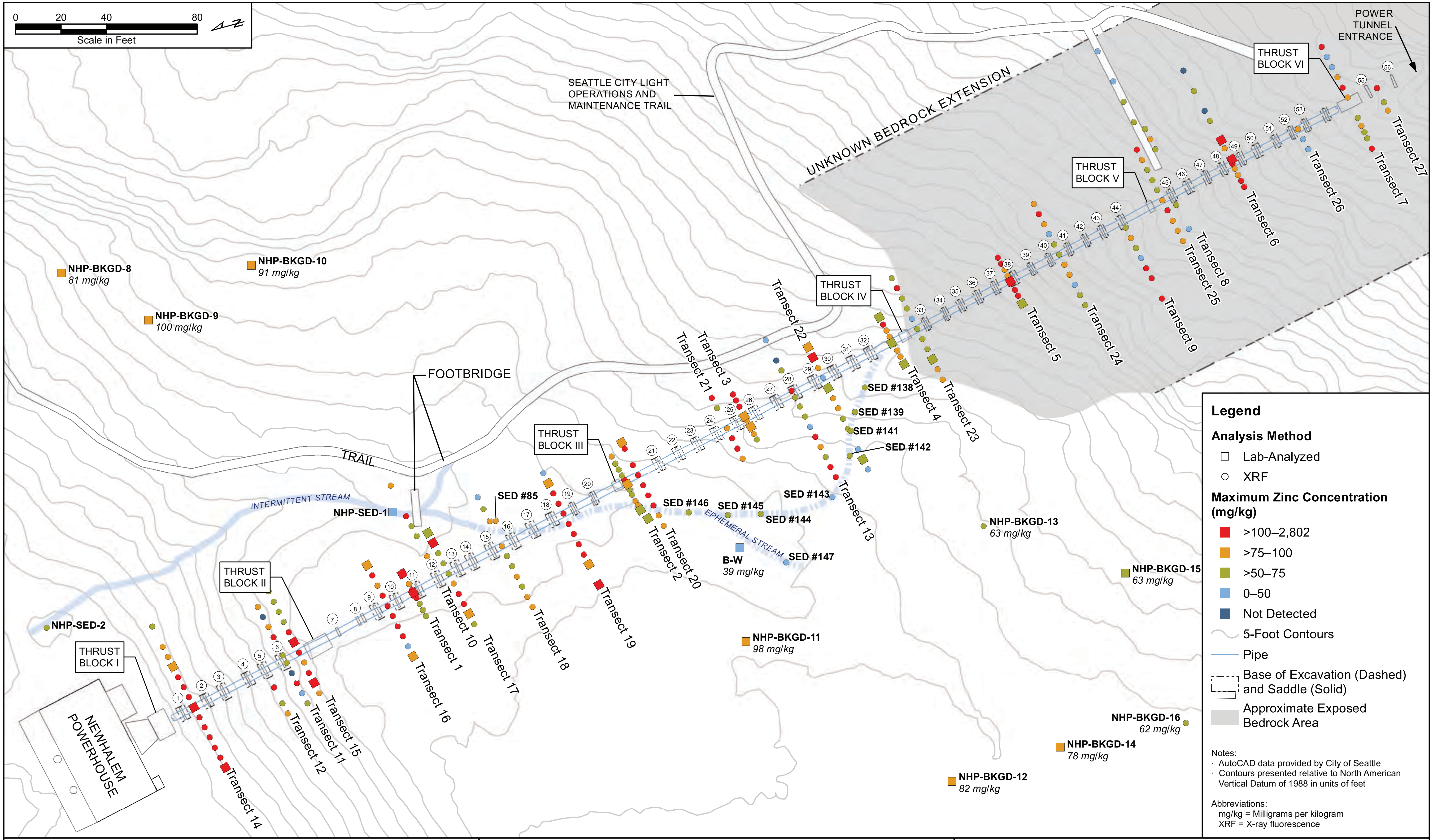

Notes:
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviations:
mg/kg = Milligrams per kilogram
XRF = X-ray fluorescence

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Environmental Investigation Activities Summary
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 3
Maximum Zinc Concentrations in Soil

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3/5/2021

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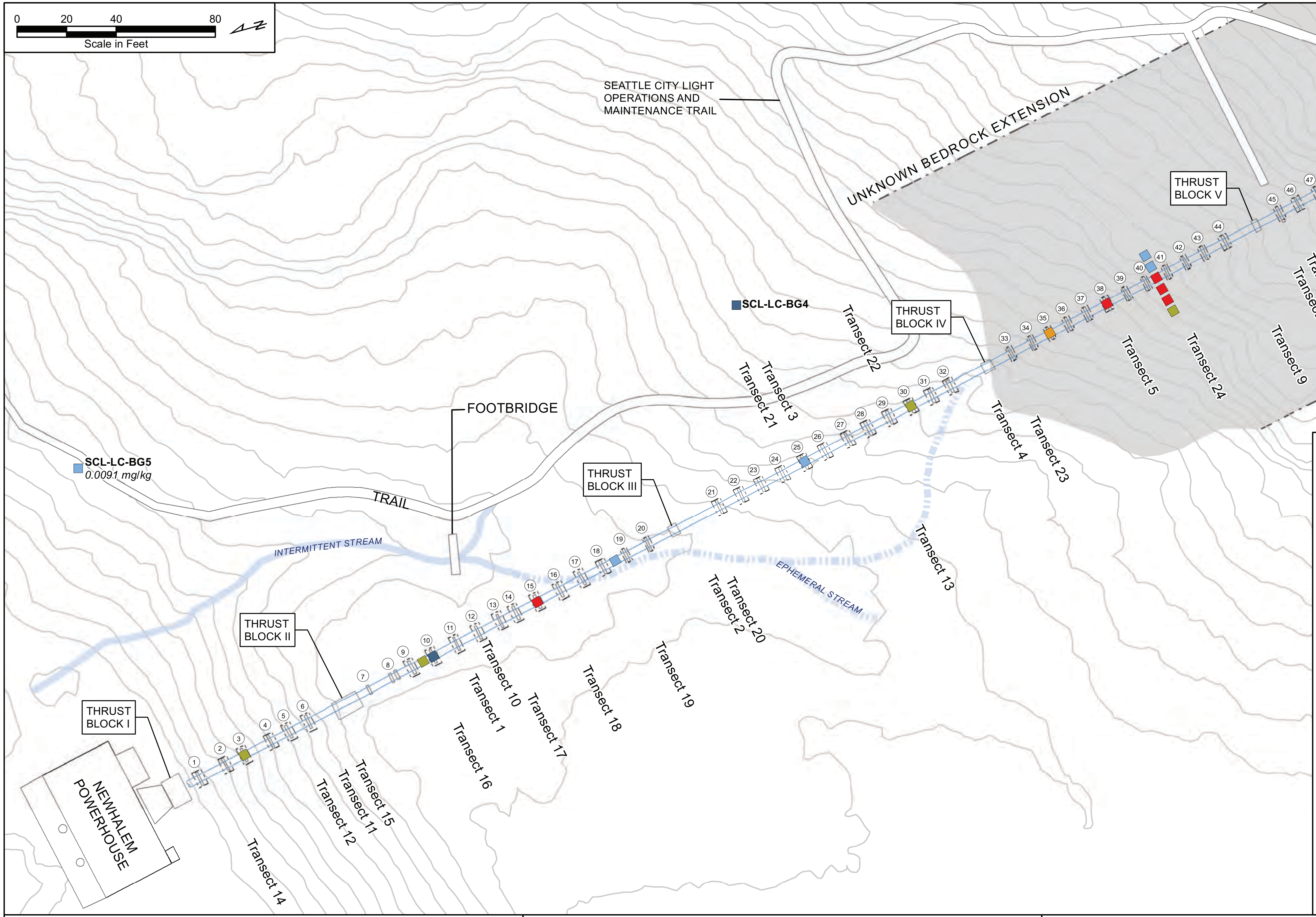

Legend

Analysis Method

☐ Lab-Analyzed

Maximum Total cPAH TEQ Concentration (mg/kg)

🟥 >0.75–2.3

🟧 >0.25–0.75

🟩 >0.05–0.25

🟦 0–0.05

■ Not Detected

5-Foot Contours

Pipe

Base of Excavation (Dashed) and Saddle (Solid)

Approximate Exposed Bedrock Area

Notes:
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviation:
cPAH = Polycyclic aromatic hydrocarbon
mg/kg = Milligrams per kilogram
TEQ = Toxic equivalent

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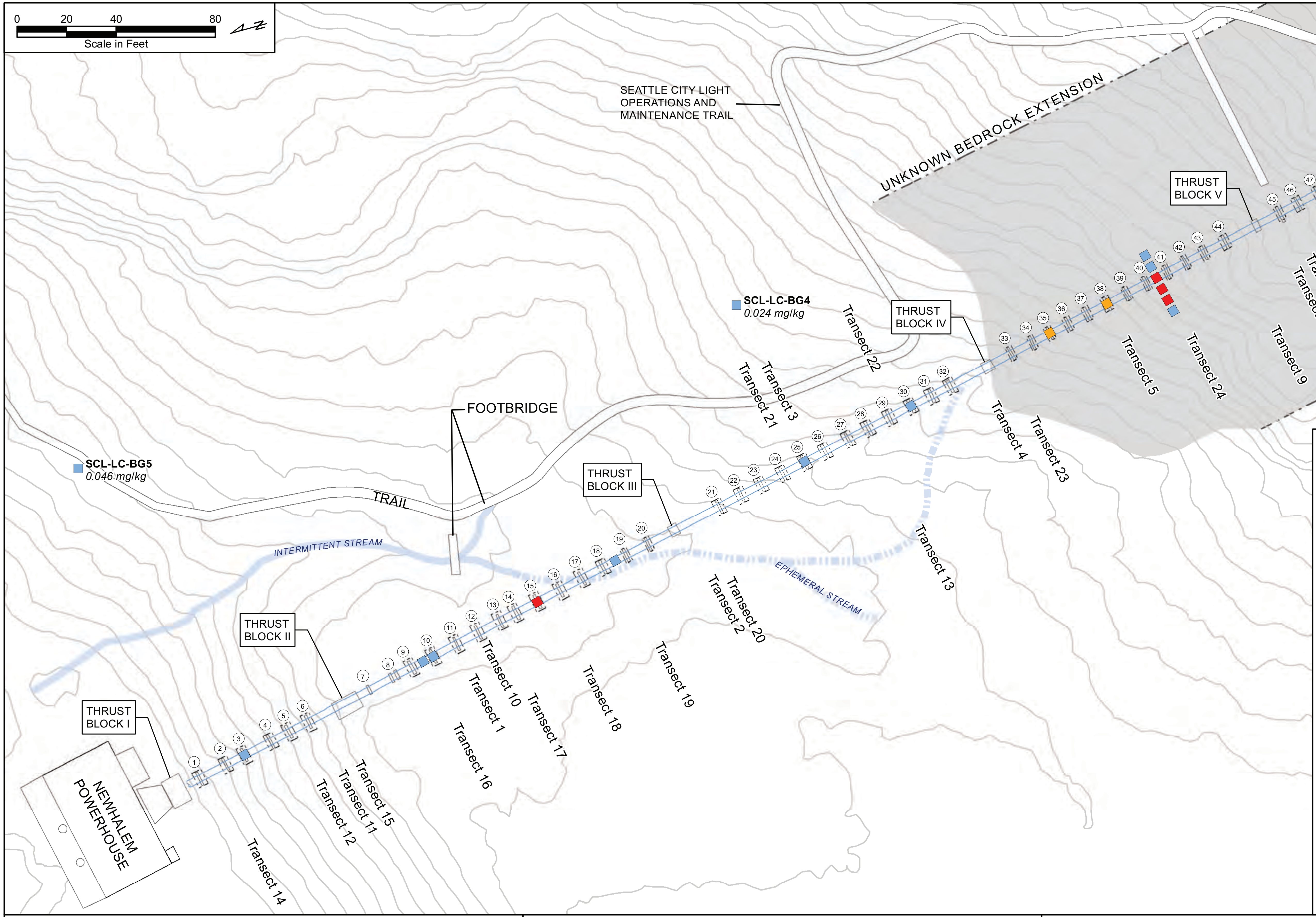
Fall 2018 Newhalem Penstock
Environmental Investigation Activities Summary
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 4
Maximum Total cPAH TEQ Concentrations in Soil

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\EECA Appendix B\Figure 4 Maximum Total cPAH TEQ Concentrations in Soil.mxd
3/5/2021

DRAFT



Legend

Analysis Method

☐ Lab-Analyzed
○ XRF

Maximum HMW PAH Concentration (mg/kg)

🟥 >10–21
🟧 >5–10
🟨 >2–5
🟦 0–2
5-Foot Contours
Pipe
Base of Excavation (Dashed) and Saddle (Solid)
▨ Approximate Exposed Bedrock Area

Notes:
- AutoCAD data provided by City of Seattle
- Contours presented relative to North American Vertical Datum of 1988 in units of feet

Abbreviations:
HMW= High molecular weight
mg/kg = Milligrams per kilogram
PAH = Polycyclic aromatic hydrocarbon
XRF = X-ray fluorescence

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Environmental Investigation Activities Summary
Seattle City Light Newhalem Penstock
Newhalem, Washington

Figure 5
Maximum Total HMW PAH Concentrations in Soil

I:\GIS\Projects\SCL-Newhalem\MXD\EECA_2020\EECA Appendix B\Figure 5 Maximum Total HMW PAH Concentrations in Soil.mxd
3/5/2021

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Attachment 1
Penstock Inspection Forms

Newhalem Penstock No.: __________

Distance from Start: __________ to __________

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Date: 10/10/18

Time: 11:21

Pipe Condition:

Station	Connection type (welded/riveted)	Pipe distance above ground (ft)	Paint type/Condition
9 to 10	welded	0.8	good
10 to 11	welded, riveted	1.1	good
11 to 12	riveted	1.2	ok - some chipping, scratches
12 to 13	riveted, welded	1.5	ok - some chipping
13 to 14	riveted	2.3	good - some flaking
14 to 15	welded, riveted	2.1	ok - significant flaking at #15

Surrounding Conditions:

Station	Condition (access to area, grade, vegetation, soil type, debris, erosion, signs of wildlife)
9 to 10	Level area, with easy access, vegetation includes ferns, oregon grape, and young alder, area around pipe lightly vegetated
10 to 11	Same as above
11 to 12	Same as above
12 to 13	same as above - Trail access at this station.
13 to 14	same as above
14 to 15	Same as above

Support Structures:

Station	Structure Type:	Condition (paint, lining around pipe, material, etc.):
9 to 11	New concreted saddles	Good condition, paint around pipelining in good condition
12 to 13	New concrete saddles	Paint at pipe-saddle contact is flaking
13 to 15	New concrete saddles	Paint flaking at pipe-saddle contact at: 14, 15

Newhalem Penstock No.: ___________

Distance from Start: __________ to ___________

Photographs Taken:

Station	Photo ID	Time	Subject	Direction
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				

Other Notes:

No visible seeps or surface water

Initials: KH

Newhalem Penstock No.: __________

Distance from Start: _________ to __________

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Date: 10/10/19
Time: 11:39

Pipe Condition:

Station	Connection type (welded/riveted)	Pipe distance above ground	Paint type/Condition
15 to 16	welded	2.4	good - minor chipping
16 to 17	welded, riveted	2.4	good - minor chipping
17 to 18	riveted	1.8 ~~1.8~~ ~~2.3~~	good - minor chipping
18 ~~7~~ to ~~18~~ 19	welded, riveted	1.8	good - minor chipping
19 to 20	riveted	1.0	ok - chipping at saddle
20 to Thrust Block III	welded	0.8	

Surrounding Conditions:

Station	Condition (access to area, grade, vegetation, soil type, debris, erosion, signs of wildlife)
15 to 16	Level area, easy access, vegetation ~~[illegible]~~ includes: ferns, Oregon grape, blackberry, mushrooms, alder, maple, area around pipe is lightly vegetated.
16 to 17	same as above - cobbles and gravel around pipe
17 to 18	same as above - cobbles and gravel around pipe
18 to 19	same as above - cobbles and gravel around pipe
19 to 20	Same as above - cobbles and gravel around pipe
20 to Thrust Block III	Same as above - cobbles and gravel around pipe

Support Structures:

Station	Structure Type:	Condition (paint, lining around pipe, material, etc.):
15 to 17	New concrete saddles	ok ~~good~~ - paint at pipe-saddle contact flaking at 16 and 17 on the up-slope side
17 to 19	"	Paint at pipe-saddle contact flaking at 18 and 19 on the up-slope side
19 to Thrust Block III	New concrete saddle and thrust block	New saddles in slightly different locations - areas at the previous pipe-saddle contact are exposed - paint in poor condition

Thrust Block III between ~~[illegible]~~ 20 and 21

Newhalem Penstock No.: __________

Distance from Start: _________ to __________

Photographs Taken:

Station	Photo ID	Time	Subject	Direction
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				
________				

Other Notes:

No visible seeps or surface water

Initials: KH

Newhalem Penstock No.: __________

Distance from Start: _________ to __________

Date: 10/10/18
Time: 13:20

Pipe Condition:

Station (Thrust Block#)	**Connection type (welded/riveted)**	**Pipe distance above ground** (ft)	**Paint type/Condition**
21 (TB III) to 25	riveted and welded	0.8 – 1.7	good – some chipping/flaking
25 to 32 (TB IV)	↓	0.8 - 2.1	good - some chipping flaking
33 (TB IV) to 44 (TBV)		1.0 – 5.2	good – some chipping flaking
45 (TB V) to (TBVI)		1.0 – ~3.0	good – some chipping flaking
________ to ________			
________ to ________			

Surrounding Conditions:

Station (Thrust Block#)	**Condition (access to area, grade, vegetation, soil type, debris, erosion, signs of wildlife)**
21 (TB III) to 25	Moderate incline, vegetation includes ferns, grasses, blackberry, conifers, maple; charring/scortch marks visible on trees starting at 24
25 to 32 (TBIV)	Same as above; charred stump near penstock at 32
33 (TBIV) to 44 (TBV)	Steep grade and bare rock, access is difficult, limited vegetation includes grasses, blackberries, ferns, salmon berry, conifers, – trees have scortch marks
45 (TBV) to (TBVI)	Same as above – vegetation is mostly grass.
________ to ________	
________ to ________	

Support Structures:

Station	**Structure Type:**	**Condition (paint, lining around pipe, material, etc.):**
21 (TB III) to 32 (TB IV)	New concrete saddles	Saddles in excellent condition. Penstock paint chipping/flaking at saddle contact at 24 and 25. └ small area of dark green paint at 22
~~32~~ 33 (TBIV) to 44 (TBV)	New concrete saddles	Excellent condition. Penstock paint chipping at saddle contact at 33 and 35
45 (TBV) to (TBVI)	New concrete saddles	Saddles in excellent condition

Newhalem Penstock No.: __________

Distance from Start: _________ to __________

Photographs Taken:

Station	Photo ID	Time	Subject	Direction
36	36	12:49	Seep and overland flow	East
38	38	12:52	Wet saddle footing	East
40	40	12:54	"	East
41	41	13:00	"	East
46	46	13:05	* Small amount of overland flow	East
50	50	13:10	Small amount of overland flow	North
~~50~~	~~50~~	~~13:15~~		

Other Notes:

- Seep at 36 - appoximately 4 feet across. Trickle of overland flow observed around the north and south side of the footing
- 38 - saddle footing is wet
- 40 - saddle footing is wet, small amount of overland flow across bedrock
- 41 - saddle footing is wet
- 46-48 - saddle footings are wet, small amount of overland flow
- Overland flow/seep starts at Thrust Block VI,

Initials: KH

Newhalem Penstock No.: __________

Distance from Start: __________ to __________

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Date: 10/10/18

Time: 13:40

Pipe Condition:

TBI to TBII

Station	Connection type (welded/riveted)	Pipe distance above ground (ft)	Paint type/Condition
1 to 6	riveted/welded	~0.8	good - minor chipping
6 to 9	riveted/welded	~0.8	good
____ to ____			
____ to ____			
____ to ____			
____ to ____			

Surrounding Conditions:

Station	Condition (access to area, grade, vegetation, soil type, debris, erosion, signs of wildlife)
1 to 6	Vegetation cleared around penstock – material looks like ~~gravel~~ fill and straw In the vicinity vegetation includes: ferns, conifers, thimble berry, grass. Area is steeply sloped, access is difficult
6 to 9	↳ Footbridge over
____ to ____	
____ to ____	
____ to ____	
____ to ____	

Support Structures:

Station	Structure Type:	Condition (paint, lining around pipe, material, etc.):
1 to 6	New concrete saddle	Saddles in excellent condition. Paint flaking ~~at~~ on penstock ~~penstock~~ at the saddle-penstock contact at 4, 5, and 6
6 to 9	old saddles	
____ to ____		

Newhalem Penstock No.: __________

Distance from Start: __________ to __________

Photographs Taken:

Station	Photo ID	Time	Subject	Direction
2	#2	13:40	Slope and vegetation	North
3	#3	#13:40	Slope and vegetation	South

Other Notes:

No visible seeps or surface water

Initials: KH

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Appendix C
Initial Screening Results

Table C.1
Summary Statistics and Frequency of Detection

			Information about Detects								Information about Nondetects			
Analytes	CAS No.	Units	Number of Results	Number of Detects	Percent of Detects	Minimum Detected Value	Maximum Detected Value	Field Sample ID of Maximum Detect	Date of Maximum Detect	Depth Range of Maximum Detect	Number of Nondetects	Percent of Nondetects	Minimum Nondetect Value $^{(1)}$	Maximum Nondetect Value $^{(1)}$
Metals														
Arsenic	7440-38-2	mg/kg	55	30	55%	4.5	94	NHP-T15-5E-0.5	10/12/2018	0.5 ft	25	45%	5.9	20
Cadmium	7440-43-9	mg/kg	4	4	100%	0.23	0.82	T6-E-11ft	7/11/2014	0-6 in	None	None	None	None
Chromium	7440-47-3	mg/kg	14	14	100%	12	40	T4-C	07/11/2014	0–6 in	None	None	None	None
Copper	7440-50-8	mg/kg	14	14	100%	14	47	T6-E-11ft	07/11/2014	0–6 in	None	None	None	None
Lead	7439-92-1	mg/kg	57	56	98%	6.9	2,000	T6-E-5ft	07/11/2014	0–6 in	1	2%	6.3	6.3
Mercury	7439-97-6	mg/kg	4	4	100%	0.031	0.35	T6-E-11ft	7/11/2014	0-6 in	None	None	None	None
Zinc	7440-66-6	mg/kg	35	35	100%	39	980	NHP-T15-5E-0.5	10/12/2018	0.5 ft	None	None	None	None
Polycyclic Aromatic Hydrocarbons														
1-Methylnaphthalene	90-12-0	mg/kg	17	7	41%	0.019	0.17	SDL15-B-2.0ft	06/05/2017	2 ft	10	59%	0.0072	0.014
2-Methylnaphthalene	91-57-6	mg/kg	17	8	47%	0.0089	0.23	SDL15-B-2.0ft	06/05/2017	2 ft	9	53%	0.0072	0.014
Acenaphthene	83-32-9	mg/kg	17	8	47%	0.034	0.85	SDL15-B-2.0ft	06/05/2017	2 ft	9	53%	0.0072	0.014
Acenaphthylene	208-96-8	mg/kg	17	8	47%	0.034	0.24	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	9	53%	0.0072	0.014
Anthracene	120-12-7	mg/kg	17	13	76%	0.0089	6.5	NHP-T24-5W-0-0.2	10/12/2018	0–0.2 ft	4	24%	0.0072	0.013
Benzo(a)anthracene	56-55-3	mg/kg	17	15	88%	0.015	2.9	NHP-T24-10W-0-0.3	10/12/2018	0–0.3 ft	2	12%	0.0077	0.012
Benzo(a)pyrene	50-32-8	mg/kg	17	14	82%	0.015	1.5	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	3	18%	0.0077	0.012
Benzo(b)fluoranthene	205-99-2	mg/kg	17	16	94%	0.012	2.9	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	1	6%	0.0077	0.0077
Benzo(g,h,i)perylene	191-24-2	mg/kg	17	14	82%	0.0078	0.63	SDL15-B-2.0ft	06/05/2017	2 ft	3	18%	0.0077	0.012
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	17	14	82%	0.0095	0.96	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	3	18%	0.0077	0.012
Chrysene	218-01-9	mg/kg	17	16	94%	0.014	4.2	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	1	6%	0.0077	0.0077
Dibenzo(a,h)anthracene	53-70-3	mg/kg	17	8	47%	0.038	0.21	SDL15-B-2.0ft NHP-T24-10W-0-0.3	06/05/2017 10/12/2018	2 ft 0–0.3 ft	9	53%	0.0072	0.014
Fluoranthene	206-44-0	mg/kg	17	17	100%	0.012	7.1	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	None	None	None	None
Fluorene	86-73-7	mg/kg	17	9	53%	0.009	1	SDL52-B-2.0ft	06/26/2017	2 ft	8	47%	0.0072	0.014
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	17	14	82%	0.0096	0.7	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	3	18%	0.0077	0.012
Naphthalene	91-20-3	mg/kg	17	10	59%	0.011	0.15	NHP-T24-5W-0-0.2	10/12/2018	0–0.2 ft	7	41%	0.0072	0.014
Phenanthrene	85-01-8	mg/kg	17	16	94%	0.0099	4.9	SDL52-B-2.0ft	06/26/2017	2 ft	1	6%	0.0072	0.0072
Pyrene	129-00-0	mg/kg	17	17	100%	0.011	7.3	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	None	None	None	None
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	mg/kg	17	16	94%	0.0024	2.3	NHP-T24-C-0-0.1	10/12/2018	0–0.1 ft	1	0.05882353	0.0077	0.0077
Semivolatile Organic Compounds														
1,2,4-Trichlorobenzene	120-82-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
1,2-Dichlorobenzene	95-50-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
1,2-Diphenylhydrazine	122-66-7	mg/kg	9	1	11%	0.63	0.63	SDL35-B-2.0ft	05/11/2017	2 ft	8	89%	0.039	0.056
1,3-Dichlorobenzene	541-73-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
1,4-Dichlorobenzene	106-46-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,3,5,6-Tetrachlorophenol	935-95-5	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,3-Dichloroaniline	608-27-5	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,4,5-Trichlorophenol	95-95-4	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,4,6-Trichlorophenol	88-06-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,4-Dichlorophenol	120-83-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,4-Dimethylphenol	105-67-9	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,4-Dinitrophenol	51-28-5	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
2,4-Dinitrotoluene	121-14-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2,6-Dinitrotoluene	606-20-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2-Chloronaphthalene	91-58-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2-Chlorophenol	95-57-8	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2-Methylphenol	95-48-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2-Nitroaniline	88-74-4	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
2-Nitrophenol	88-75-5	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056

Table C.1
Summary Statistics and Frequency of Detection

			Information about Detects								Information about Nondetects			
Analytes	**CAS No.**	**Units**	**Number of Results**	**Number of Detects**	**Percent of Detects**	**Minimum Detected Value**	**Maximum Detected Value**	**Field Sample ID of Maximum Detect**	**Date of Maximum Detect**	**Depth Range of Maximum Detect**	**Number of Nondetects**	**Percent of Nondetects**	**Minimum Nondetect Value [1]**	**Maximum Nondetect Value [1]**
Semivolatile Organic Compounds (cont.)														
3,3'-Dichlorobenzidine	91-94-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
3- & 4-Methylphenol	MEPH3_4	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
3-Nitroaniline	99-09-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
4,6-Dinitro-o-cresol	534-52-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
4-Bromophenyl phenyl ether	101-55-3	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
4-Chloro-3-methylphenol	59-50-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
4-Chloroaniline	106-47-8	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
4-Chlorophenyl phenyl ether	7005-72-3	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
4-Nitroaniline	100-01-6	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
4-Nitrophenol	100-02-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Aniline	62-53-3	mg/kg	9	1	11%	0.28	0.28	SDL03-B-3.25ft	11/03/2016	3.25 ft	8	89%	0.19	0.28
Benzidine	92-87-5	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.39	0.56
Benzyl alcohol	100-51-6	mg/kg	9	1	11%	0.66	0.66	SDL52-B-2.0ft	06/26/2017	2 ft	8	89%	0.19	0.26
Bis(2-chloroethoxy)methane	111-91-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Bis(2-chloroethyl)ether	111-44-4	mg/kg	9	1	11%	0.26	0.26	SDL35-B-2.0ft	05/11/2017	2 ft	8	89%	0.039	0.056
Bis(2-chloroisopropyl)ether	108-60-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	9	5	56%	0.048	0.27	SDL35-B-2.0ft	05/11/2017	2 ft	4	44%	0.041	0.056
Butyl benzyl phthalate	85-68-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Carbazole	86-74-8	mg/kg	9	4	44%	0.1	0.32	SDL52-B-2.0ft	06/26/2017	2 ft	5	56%	0.039	0.046
Di-n-butyl phthalate	84-74-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
Di-n-octyl phthalate	117-84-0	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Dibenzofuran	132-64-9	mg/kg	9	4	44%	0.12	0.58	SDL15-B-2.0ft	06/05/2017	2 ft	5	56%	0.039	0.046
Diethylphthalate	84-66-2	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.19	0.28
Dimethyl phthalate	131-11-3	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Dinitrobenzene, m-	99-65-0	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Dinitrobenzene, o-	528-29-0	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Dinitrobenzene, p-	100-25-4	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Hexachlorobenzene	118-74-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Hexachlorocyclopentadiene	77-47-4	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Hexachloroethane	67-72-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Isophorone	78-59-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
N-Nitroso-di-n-propylamine	621-64-7	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
N-Nitrosodimethylamine	62-75-9	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
N-Nitrosodiphenylamine	86-30-6	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Nitrobenzene	98-95-3	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Pentachlorophenol	87-86-5	mg/kg	9	1	11%	0.26	0.26	SDL03-B-3.25ft	11/03/2016	3.25 ft	8	89%	0.19	0.28
Phenol	108-95-2	mg/kg	9	1	11%	0.057	0.057	SDL38-B-2.0ft	06/26/2017	2 ft	8	89%	0.039	0.056
Pyridine	110-86-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.39	0.56
Volatile Organic Compounds														
Di(2-ethylhexyl)adipate	103-23-1	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056
Hexachlorobutadiene	87-68-3	mg/kg	9	None	None	None	None	None	None	None	9	100%	0.039	0.056

Note:

1 Non-detect results are reported at the reporting limit.

Abbreviations:

CAS	Chemical Abstracts Service
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
ft	Feet
in	Inches
mg/kg	Milligrams per kilogram
TEQ	Toxic equivalent

Table C.2a
Laboratory Analytical Results and Screening Evaluation for Metals—Human Health

Analyte Class				Metals									
Analyte				Arsenic	Barium	Cadmium (1)	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc
CAS No.				7440-38-2	7440-39-3	7440-43-9	7440-47-3	7440-50-8	7439-92-1	7439-97-6	7782-49-2	7440-22-4	7440-66-6
Units				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)				0.68	1,500	7.1	12,000	310	400	1.1	39	39	2,300
MTCA Soil Method A Unrestricted				20	--	2	2,000	--	250	2	--	--	--
MTCA Soil Method B Cancer				0.67	--	--	--	--	--	--	--	--	--
MTCA Soil Method B Noncancer				24	16,000	80	120,000	3,200	--	--	400	400	24,000
Minimum Human Health COPC Selection SL (2)				0.68	1,500	2	2,000	310	250	1.1	39	39	2,300
Location	Sample ID	Samle Date	Depth										
Background													
SCL-LC-BG3	SCL-LC-BG3	11/03/2015	0–6 in	*13 U*	290	0.29 J	30		27	0.029	13 U	1.3 U	
SCL-LC-BG4	SCL-LC-BG4	11/03/2015	0–6 in	*16 U*	320	0.46 J	31		18	0.038	16 U	1.6 U	
SCL-LC-BG5	SCL-LC-BG5	11/03/2015	0–6 in	*17 U*	330	0.39 J	37		24	0.094	17 U	1.7 U	
NHP-BKGD-1	NHP-BKGD-1	10/11/2018	0–6 in	*7.9 U*					18				53
NHP-BKGD-10	NHP-BKGD-10	10/11/2018	0–6 in	**18**					7.2				91
NHP-BKGD-3	NHP-BKGD-3	10/11/2018	0–6 in	*7 U*					9.7				59
NHP-BKGD-7	NHP-BKGD-7	10/11/2018	0–6 in	*7.3 U*					7.3 U				17
NHP-BKGD-8	NHP-BKGD-8	10/11/2018	0–6 in	**9.6**					6.9				81
NHP-BKGD-9	NHP-BKGD-9-0	10/11/2018	0–6 in	**10**					8.4				100
NHP-BKGD-11	NHP-BKGD-11	10/12/2018	0–6 in	**13**					9.8				98
NHP-BKGD-12	NHP-BKGD-12	10/12/2018	0–6 in	**10**					9.3				82
NHP-BKGD-14	NHP-BKGD-14	10/12/2018	0–6 in	*8.4 U*					11				78
NHP-BKGD-15	NHP-BKGD-15	10/12/2018	0–6 in	*6.5 U*					10				63
Site													
T1-C	T1-C	07/10/2014	0–6 in	**25**		0.46 J	26	45	**1,800**	0.031			150
T2-W-16ft	T2-W-16ft	07/11/2014	0–6 in	*12 U*			17	20	56				57
T2-W-19ft	T2-W-19ft	07/11/2014	0–6 in	*14 U*			16	22	25				57
T3-E-2ft	T3-E-2ft	07/11/2014	0–6 in	*17 U*			30	26	**1,200**				91
T3-W-5ft	T3-W-5ft	07/11/2014	0–6 in	**20**			24	33	**480**				79
T4-C	T4-C	07/11/2014	0–6 in	*13 U*			40	16	**1,000**				55
T4-E-11ft	T4-E-11ft	07/11/2014	0–6 in	*12 U*			22	18	9.6				54
T4-W-11ft	T4-W-11ft	07/11/2014	0–6 in	*13 U*			18	16	70				60
T5-C	T5-C	07/11/2014	0–6 in	*15 U*		0.23 J	20	25	**1,300**	0.11			210
T5-W-11ft	T5-W-11ft	07/11/2014	0–6 in	*14 U*			12	26	**950**				68
T6-E-11ft	T6-E-11ft	07/11/2014	0–6 in	*14 U*		0.82 J	19	47	**1,600**	0.35			210
T6-E-5ft	T6-E-5ft	07/11/2014	0–6 in	*20 U*		0.71 J	15	14	**2,000**	0.11			180
T1-E-8ft	T1-E-8ft	07/12/2014	0–6 in	**17**			22	34	**350**				120
T2-W-2ft	T2-W-2ft	07/12/2014	0–6 in	*15 U*			31	25	**610**				77
T13-0-E	T13-E-0	10/06/2015	0–3 in	**19**					230				
T13-35-W	T13-W-35	10/06/2015	0–3 in	*15 U*					**780**				
T13-40-W	T13-W-40	10/06/2015	0–3 in	*15 U*					62				
SDL03	SDL03-S-1.5ft	11/03/2016	1.5 ft	**15**					6.3 U				
SDL03	SDL03-B-3.25ft	11/03/2016	3.25 ft	**20**					99				
SDL10	SDL10-S-1.5ft	11/03/2016	1.5 ft	**24**					22				
SDL10	SDL10-B-3.0ft	11/03/2016	3 ft	**22**					7.7				
SDL25	SDL25-B-3.0ft	11/16/2016	3 ft	**24**					19				
SDL30	SDL30-S-1.5ft	11/16/2016	1.5 ft	**50**					89				
SDL30	SDL30-B-2.0ft	11/16/2016	2 ft	**15**					20				
SDL25	SDL25-B-1.5ft	04/14/2017	1.5 ft	**37**					11				
SDL25	SDL25-S-1.5ft	04/14/2017	1.5 ft	**34**					6.9				
SDL35	SDL35-B-2.0ft	05/11/2017	2 ft	*16 U*					**610**				
SDL45	SDL45-S-2.0	05/11/2017	2 ft	*14 U*					**870**				
SDL15	SDL15-B-2.0ft	06/05/2017	2 ft	*14 U*					79				
SDL15	SDL15-S-2.5ft	06/05/2017	2.5 ft	*14 U*					230				
SDL20	SDL20-S-0.5ft	06/05/2017	0.5 ft	*12 U*					**310**				
SDL38	SDL38-S-1.5ft	06/26/2017	1.5 ft	*16 U*					**1,300**				
SDL38	SDL38-B-2.0ft	06/26/2017	2 ft	*13 U*					**630**				
SDL52	SDL52-S-1.5ft	06/26/2017	1.5 ft	**13**					**1,900**				
SDL52	SDL52-B-2.0ft	06/26/2017	2 ft	*17 U*					**1,100**				
NHP-T16-20E	NHP-T16-20E-0	10/10/2018	0 ft	**15**					78				97
NHP-T16-25W	NHP-T16-25W-0	10/10/2018	0 ft	**13**					32				92
NHP-T17-15E	NHP-T17-15E-0	10/11/2018	0 ft	**11**					76				280
NHP-T17-20E	NHP-T17-20E-0	10/11/2018	0 ft						19				63
NHP-T17-20W	NHP-T17-20W-0	10/11/2018	0 ft	**17**					19				80
NHP-T19-15E	NHP-T119-15E-0	10/11/2018	0 ft	**4.5**					30				97
NHP-T19-15E	NHP-T19-15E-0	10/11/2018	0 ft	**4.5**					31				100
NHP-T19-25W	NHP-T19-25W-0	10/11/2018	0 ft	**20**					19				98
NHP-T19-35W	NHP-T19-35W-0	10/11/2018	0 ft	**14**									110
NHP-T20-16E	NHP-T20-16E-0	10/11/2018	0 ft	*8 U*					29				100
NHP-SED-1	NHP-SED-1	10/12/2018	0.1–0 ft	*5.9 U*					15				39
NHP-T14-20E	NHP-T14-20E-0	10/12/2018	0 ft	**10**					23				98
NHP-T14-30W	NHP-T14-30W-0	10/12/2018	0 ft	**7.4**					19				120
NHP-T14-C	NHP-T14-C-0	10/12/2018	0 ft	**56**					**360**				590
NHP-T15-15W	NHP-T15-15W-0	10/12/2018	0 ft	**24**					35				120
NHP-T15-5E	NHP-T15-5E-0.5	10/12/2018	0.5 ft	**94**					**720**				980
NHP-T22-10E	NHP-T22-10E-0	10/12/2018	0 ft	**10**					31				110
NHP-T22-15E	NHP-T22-15E-0	10/12/2018	0 ft	**13**					13				95
NHP-T22-40W	NHP-T22-40W-0	10/12/2018	0 ft	*7.6 U*					77				59
NHP-T22-45W	NHP-T22-45W-0	10/12/2018	0 ft						36				
NHP-T22-5W	NHP-T22-5W-0	10/12/2018	0 ft	**9**					**270**				72
NHP-T23-15W	NHP-T23-15W-0	10/12/2018	0 ft	*8.9 U*					110				54
NHP-T23-20W	NHP-T23-20W-0	10/12/2018	0 ft						94				

Notes:

Blank cells are intentional.

-- Not available.

RED/BOLD Detected concentration exceeds the minimum human health COPC selection SL.

Italics Reporting limit exceeds the minimum human health COPC selection SL.

1 Non-detect results are reported at the Method Detection Limit.

2 The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA Method A values, or the minimum MTCA Method B value if a MTCA Method A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service	ft	Feet	mg/kg	Milligrams per kilogram	SL	Screening level
COPC	Contaminant of potential concern	HQ	Hazard quotient	MTCA	Model Toxics Control Act	TR	Target cancer risk
EPA	U.S. Environmental Protection Agency	in	Inches	RSL	Regional Screening Level		

Qualifier:

U Analyte was not detected at the given reporting limit.

Table C.2b
Laboratory Analytical Results and Screening Evaluation for PAHs—Human Health

Area								Background			Site			
Location								SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03	SDL10	SDL25	SDL30
Sample ID								SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03-B-3.25ft	SDL10-B-3.0ft	SDL25-B-3.0ft	SDL30-B-2.0ft
Sample Date								11/03/2015	11/03/2015	11/03/2015	11/03/2016	11/03/2016	11/16/2016	11/16/2016
Depth								0–6 in	0–6 in	0–6 in	3.25 ft	3 ft	3 ft	2 ft
Analyte	CAS No.	Units	EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)	MTCA Soil Method A Unrestricted	MTCA Soil Method B Cancer	MTCA Soil Method B Noncancer	Minimum Human Health COPC Selection SL [(1)]							
Polycyclic Aromatic Hydrocarbons (PAHs)														
1-Methylnaphthalene	90-12-0	mg/kg	18	--	34	5,600	18	0.034	0.035	0.035	0.0084 U	0.0077 U	0.0093 U	0.0083 U
2-Methylnaphthalene	91-57-6	mg/kg	24	--	--	320	24	0.039	0.043	0.042	0.0089	0.0077 U	0.0093 U	0.0083 U
Acenaphthene	83-32-9	mg/kg	360	--	--	4,800	360	0.022	0.011 U	0.012	0.034	0.0077 U	0.0093 U	0.0083 U
Acenaphthylene	208-96-8	mg/kg	--	--	--	--	--	0.009 U	0.011 U	0.011 U	0.034	0.0077 U	0.0093 U	0.0083 U
Anthracene	120-12-7	mg/kg	1,800	--	--	24,000	1,800	0.011	0.011 U	0.011 U	0.12	0.0077 U	0.024	0.044
Benzo(a)anthracene	56-55-3	mg/kg	1.1	--	--	--	1.1	0.009 U	0.011 U	0.011 U	0.2	0.0077 U	0.033	0.042
Benzo(a)pyrene	50-32-8	mg/kg	0.11	0.1	0.19	24	0.1	0.009 U	0.011 U	0.011 U	**0.15**	0.0077 U	0.024	0.041
Benzo(b)fluoranthene	205-99-2	mg/kg	1.1	--	--	--	1.1	0.009 U	0.011 U	0.013	0.34	0.0077 U	0.046	0.087
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	--	--	0.009 U	0.011 U	0.011 U	0.11	0.0077 U	0.011	0.021
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	0.42	--	--	--	0.42	0.009 U	0.011 U	0.011 U	0.12	0.0077 U	0.016	0.03
Chrysene	218-01-9	mg/kg	110	--	--	--	110	0.009 U	0.011 U	0.013	0.28	0.0077 U	0.042	0.066
Dibenzo(a,h)anthracene	53-70-3	mg/kg	0.11	--	--	--	0.11	0.009 U	0.011 U	0.011 U	0.038	0.0077 U	0.0093 U	0.0083 U
Fluoranthene	206-44-0	mg/kg	240	--	--	3,200	240	0.019	0.011	0.015	0.49	0.012	0.068	0.098
Fluorene	86-73-7	mg/kg	240	--	--	3,200	240	0.027	0.019	0.015	0.053	0.0077 U	0.0093 U	0.009
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	1.1	--	--	--	1.1	0.009 U	0.011 U	0.011 U	0.081	0.0077 U	0.014	0.025
Naphthalene	91-20-3	mg/kg	3.8	5	--	1,600	3.8	0.11	0.12	0.14	0.011	0.0077 U	0.0093 U	0.0083 U
Phenanthrene	85-01-8	mg/kg	--	--	--	--	--	0.067	0.043	0.042	0.14	0.0099	0.025	0.016
Pyrene	129-00-0	mg/kg	180	--	--	2,400	180	0.017	0.024	0.02	0.56	0.011	0.082	0.099
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	mg/kg	0.11	0.1	0.19	24	0.1	0.009 U	0.011 U	0.0014	**0.23**	0.0077 U	0.035	0.06
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	--	--	--	--	--	0.017	0.024	0.046	1.8	0.011	0.27	0.41
Total LMW PAHs (U=0)	LPAH (U=0)	mg/kg	--	--	--	--	--	0.3	0.24	0.27	0.89	0.022	0.12	0.17

Notes:

--	Not available.
RED/BOLD	Detected concentration exceeds the minimum human health COPC selection SL.
Italics	Reporting limit exceeds the minimum human health COPC selection SL.
1	The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA A values, or the minimum MTCA B value if a MTCA A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service	LMW	Low molecular weight
COPC	Contaminant of potential concern	mg/kg	Milligrams per kilogram
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	MTCA	Model Toxics Control Act
EPA	U.S. Environmental Protection Agency	RSL	Regional Screening Level
ft	Feet	SL	Screening level
HMW	High molecular weight	TEQ	Toxic equivalent
HQ	Hazard quotient	TR	Target cancer risk
in	Inches		

Qualifiers:

J	Analyte was detected at the given concentration, which is considered to be an estimate.
U	Analyte was not detected at the given reporting limit.
UJ	Analyte was not detected at the given reporting limit, which is considered to be an estimate.

Table C.2b
Laboratory Analytical Results and Screening Evaluation for PAHs—Human Health

							Area	Site (cont.)						
							Location	SDL25	SDL35	SDL15	SDL38	SDL52	NHP-T16-C	NHP-T19-C
							Sample ID	SDL25-B-1.5ft	SDL35-B-2.0ft	SDL15-B-2.0ft	SDL38-B-2.0ft	SDL52-B-2.0ft	NHP-T16-C-0-1	NHP-T19-C-0-1
							Sample Date	04/14/2017	05/11/2017	06/05/2017	06/26/2017	06/26/2017	10/10/2018	10/11/2018
							Depth	1.5 ft	2 ft	2 ft	2 ft	2 ft	0–1 ft	0–1 ft
Analyte	CAS No.	Units	EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)	MTCA Soil Method A Unrestricted	MTCA Soil Method B Cancer	MTCA Soil Method B Noncancer	Minimum Human Health COPC Selection SL (1)							
Polycyclic Aromatic Hydrocarbons (PAHs)														
1-Methylnaphthalene	90-12-0	mg/kg	18	--	34	5,600	18	0.0079 U	0.047	0.17	0.019	0.033	0.0086 U	0.0072 U
2-Methylnaphthalene	91-57-6	mg/kg	24	--	--	320	24	0.0079 U	0.093	0.23	0.037	0.067	0.0086 U	0.0072 U
Acenaphthene	83-32-9	mg/kg	360	--	--	4,800	360	0.0079 U	0.47	0.85	0.17	0.23	0.0086 U	0.0072 U
Acenaphthylene	208-96-8	mg/kg	--	--	--	--	--	0.0079 U	0.068	0.14	0.11	0.09	0.0086 U	0.0072 U
Anthracene	120-12-7	mg/kg	1,800	--	--	24,000	1,800	0.0089	1.1	1.5	0.53	2	0.021	0.0072 U
Benzo(a)anthracene	56-55-3	mg/kg	1.1	--	--	--	1.1	0.015	0.67	**1.8**	0.72	0.92	0.084	0.018
Benzo(a)pyrene	50-32-8	mg/kg	0.11	0.1	0.19	24	0.1	0.0079 U	**0.33**	**1.3**	**0.55**	**0.47**	0.04	0.015
Benzo(b)fluoranthene	205-99-2	mg/kg	1.1	--	--	--	1.1	0.012	0.68	**2.8**	**1.3**	0.9	0.089	0.032
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	--	--	0.0079 U	0.13	0.63	0.33	0.17	0.017	0.0078
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	0.42	--	--	--	0.42	0.0079 U	0.18	**0.67**	0.32	0.3	0.032	0.0095
Chrysene	218-01-9	mg/kg	110	--	--	--	110	0.014	0.84	2.6	1.2	1.2	0.093	0.026
Dibenzo(a,h)anthracene	53-70-3	mg/kg	0.11	--	--	--	0.11	0.0079 U	0.046	**0.21**	0.096	0.065	0.0086 U	0.0072 U
Fluoranthene	206-44-0	mg/kg	240	--	--	3,200	240	0.073	2.4	4.2	2.5	4.1	0.2	0.027
Fluorene	86-73-7	mg/kg	240	--	--	3,200	240	0.0079 U	0.8	0.98	0.28	1	0.0086 U	0.0072 U
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	1.1	--	--	--	1.1	0.0079 U	0.14	0.6	0.34	0.18	0.019	0.0096
Naphthalene	91-20-3	mg/kg	3.8	5	--	1,600	3.8	0.0079 U	0.042	0.097	0.034	0.051	0.0086 U	0.0072 U
Phenanthrene	85-01-8	mg/kg	--	--	--	--	--	0.031	2.3	4.5	1.2	4.9	0.065	0.0072 U
Pyrene	129-00-0	mg/kg	180	--	--	2,400	180	0.064	2.2	3.4	2.4	3.6	0.21	0.033
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	mg/kg	0.11	0.1	0.19	24	0.1	0.0028	**0.51**	**1.9**	**0.84**	**0.72**	0.063	0.022
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	--	--	--	--	--	0.11	5.2	14	7.2	7.7	0.58	0.15
Total LMW PAHs (U=0)	LPAH (U=0)	mg/kg	--	--	--	--	--	0.11	7.3	12	4.9	12	0.29	0.027

Notes:

--	Not available.
RED/BOLD	Detected concentration exceeds the minimum human health COPC selection SL.
Italics	Reporting limit exceeds the minimum human health COPC selection SL.
1	The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA A values, or the minimum MTCA B value if a MTCA A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service	LMW	Low molecular weight
COPC	Contaminant of potential concern	mg/kg	Milligrams per kilogram
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	MTCA	Model Toxics Control Act
EPA	U.S. Environmental Protection Agency	RSL	Regional Screening Level
ft	Feet	SL	Screening level
HMW	High molecular weight	TEQ	Toxic equivalent
HQ	Hazard quotient	TR	Target cancer risk
in	Inches		

Qualifiers:

J	Analyte was detected at the given concentration, which is considered to be an estimate.
U	Analyte was not detected at the given reporting limit.
UJ	Analyte was not detected at the given reporting limit, which is considered to be an estimate.

Table C.2b
Laboratory Analytical Results and Screening Evaluation for PAHs—Human Health

							Area	Site (cont.)					
							Location	NHP-T24-C	NHP-T24-5E	NHP-T24-5W	NHP-T24-10E	NHP-T24-10W	NHP-T24-15W
							Sample ID	NHP-T24-C-0-0.1	NHP-T24-5E-0-0.3	NHP-T24-5W-0-0.2	NHP-T24-10E-0-0.3	NHP-T24-10W-0-0.3	NHP-T24-15W-0
							Sample Date	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018
							Depth	0–0.1 ft	0–0.3 ft	0–0.2 ft	0–0.3 ft	0–0.3 ft	0 ft
Analyte	CAS No.	Units	EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)	MTCA Soil Method A Unrestricted	MTCA Soil Method B Cancer	MTCA Soil Method B Noncancer	Minimum Human Health COPC Selection SL [(1)]						
Polycyclic Aromatic Hydrocarbons (PAHs)													
1-Methylnaphthalene	90-12-0	mg/kg	18	--	34	5,600	18	0.05	0.012 U	0.055	0.013 U	0.019	0.014 UJ
2-Methylnaphthalene	91-57-6	mg/kg	24	--	--	320	24	0.082	0.012 U	0.092	0.013 U	0.029	0.014 UJ
Acenaphthene	83-32-9	mg/kg	360	--	--	4,800	360	0.1	0.012 U	0.071	0.013 U	0.046	0.014 UJ
Acenaphthylene	208-96-8	mg/kg	--	--	--	--	--	0.24	0.012 U	0.15	0.013 U	0.18	0.014 UJ
Anthracene	120-12-7	mg/kg	1,800	--	--	24,000	1,800	2.4	0.012 U	6.5	0.013 U	0.96	0.032 J
Benzo(a)anthracene	56-55-3	mg/kg	1.1	--	--	--	1.1	**2.8**	0.012 U	**2.3**	0.039	**2.9**	0.14 J
Benzo(a)pyrene	50-32-8	mg/kg	0.11	0.1	0.19	24	0.1	**1.5**	0.012 U	**1.4**	0.019	**1.1**	0.066 J
Benzo(b)fluoranthene	205-99-2	mg/kg	1.1	--	--	--	1.1	**2.9**	0.022	**2.5**	0.062	**2.7**	0.18 J
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	--	--	0.59	0.012 U	0.47	0.014	0.46	0.033 J
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	0.42	--	--	--	0.42	**0.96**	0.012 U	**0.81**	0.016	**0.79**	0.054 J
Chrysene	218-01-9	mg/kg	110	--	--	--	110	4.2	0.021	2.9	0.052	3.5	0.21 J
Dibenzo(a,h)anthracene	53-70-3	mg/kg	0.11	--	--	--	0.11	**0.14**	0.012 U	**0.18**	0.013 U	**0.21**	0.014 UJ
Fluoranthene	206-44-0	mg/kg	240	--	--	3,200	240	7.1	0.028	4.4	0.092	6.8	0.38 J
Fluorene	86-73-7	mg/kg	240	--	--	3,200	240	0.26	0.012 U	0.69	0.013 U	0.084	0.014 UJ
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	1.1	--	--	--	1.1	0.7	0.012 U	0.63	0.018	0.57	0.04 J
Naphthalene	91-20-3	mg/kg	3.8	5	--	1,600	3.8	0.099	0.021	0.15	0.027	0.057	0.014 UJ
Phenanthrene	85-01-8	mg/kg	--	--	--	--	--	0.89	0.02	2.1	0.037	0.69	0.069 J
Pyrene	129-00-0	mg/kg	180	--	--	2,400	180	7.3	0.024	4.5	0.082	6.6	0.36 J
Total cPAH TEQ (U=0)	cPAH TEQ (U=0)	mg/kg	0.11	0.1	0.19	24	0.1	**2.3**	0.0024	**2.1**	0.033	**1.9**	**0.11 J**
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	--	--	--	--	--	21	0.067	16	0.3	19	1.1 J
Total LMW PAHs (U=0)	LPAH (U=0)	mg/kg	--	--	--	--	--	11	0.069	14	0.16	8.8	0.48 J

Notes:

-- Not available.

RED/BOLD Detected concentration exceeds the minimum human health COPC selection SL.

Italics Reporting limit exceeds the minimum human health COPC selection SL.

1 The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA A values, or the minimum MTCA B value if a MTCA A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service	LMW	Low molecular weight
COPC	Contaminant of potential concern	mg/kg	Milligrams per kilogram
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	MTCA	Model Toxics Control Act
EPA	U.S. Environmental Protection Agency	RSL	Regional Screening Level
ft	Feet	SL	Screening level
HMW	High molecular weight	TEQ	Toxic equivalent
HQ	Hazard quotient	TR	Target cancer risk
in	Inches		

Qualifiers:

J Analyte was detected at the given concentration, which is considered to be an estimate.

U Analyte was not detected at the given reporting limit.

UJ Analyte was not detected at the given reporting limit, which is considered to be an estimate.

Table C.2c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Human Health

							Area	**Background**			**Site**			
							Location	**SCL-LC-BG3**	**SCL-LC-BG4**	**SCL-LC-BG5**	**SDL03**	**SDL10**	**SDL25**	**SDL30**
							Sample ID	**SCL-LC-BG3**	**SCL-LC-BG4**	**SCL-LC-BG5**	**SDL03-B-3.25ft**	**SDL10-B-3.0ft**	**SDL25-B-3.0ft**	**SDL30-B-2.0ft**
							Sample Date	**11/03/2015**	**11/03/2015**	**11/03/2015**	**11/03/2016**	**11/03/2016**	**11/16/2016**	**11/16/2016**
							Depth	**0–6 in**	**0–6 in**	**0–6 in**	**3.25 ft**	**3 ft**	**3 ft**	**2 ft**
Analyte	**CAS No.**	**Units**	**EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)**	**MTCA Soil Method A Unrestricted**	**MTCA Soil Method B Cancer**	**MTCA Soil Method B Noncancer**	**Minimum Human Health COPC Selection SL [(1)]**							
Semivolatile Organic Compounds (SVOCs)														
1,2,4-Trichlorobenzene	120-82-1	mg/kg	5.8	--	34	800	5.8	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,2-Dichlorobenzene	95-50-1	mg/kg	180	--	--	7,200	180	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,2-Diphenylhydrazine	122-66-7	mg/kg	0.68	--	1.3	--	0.68	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,3-Dichlorobenzene	541-73-1	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,4-Dichlorobenzene	106-46-7	mg/kg	2.6	--	190	5,600	2.6	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	190	--	--	2,400	190	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3,5,6-Tetrachlorophenol	935-95-5	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3-Dichloroaniline	608-27-5	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4,5-Trichlorophenol	95-95-4	mg/kg	630	--	--	8,000	630	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4,6-Trichlorophenol	88-06-2	mg/kg	6.3	--	91	80	6.3	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4-Dichlorophenol	120-83-2	mg/kg	19	--	--	240	19	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4-Dimethylphenol	105-67-9	mg/kg	130	--	--	1,600	130	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4-Dinitrophenol	51-28-5	mg/kg	13	--	--	160	13	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
2,4-Dinitrotoluene	121-14-2	mg/kg	1.7	--	3.2	160	1.7	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,6-Dinitrotoluene	606-20-2	mg/kg	0.36	--	0.67	24	0.36	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Chloronaphthalene	91-58-7	mg/kg	480	--	--	6,400	480	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Chlorophenol	95-57-8	mg/kg	39	--	--	400	39	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Methylphenol	95-48-7	mg/kg	320	--	--	4,000	320	0.067	0.079	0.059	0.042 U	0.039 U	0.046 U	0.041 U
2-Nitroaniline	88-74-4	mg/kg	63	--	--	800	63	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Nitrophenol	88-75-5	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
3,3'-Dichlorobenzidine	91-94-1	mg/kg	1.2	--	2.2	--	1.2	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
3- & 4-Methylphenol	MEPH3_4	mg/kg	--	--	--	4,000	4,000	0.19	0.21	0.13	0.042 U	0.039 U	0.046 U	0.041 U
3-Nitroaniline	99-09-2	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4,6-Dinitro-o-cresol	534-52-1	mg/kg	0.51	--	--	6.4	0.51	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
4-Bromophenyl phenyl ether	101-55-3	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Chloro-3-methylphenol	59-50-7	mg/kg	630	--	--	8,000	630	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Chloroaniline	106-47-8	mg/kg	2.7	--	5	320	2.7	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
4-Chlorophenyl phenyl ether	7005-72-3	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Nitroaniline	100-01-6	mg/kg	25	--	--	320	25	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Nitrophenol	100-02-7	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Aniline	62-53-3	mg/kg	44	--	180	560	44	0.22 U	0.27 U	0.28 U	0.28	0.19 U	0.23 U	0.21 U
Benzidine	92-87-5	mg/kg	0.00053	--	0.0043	240	0.00053	*0.45 U*	*0.55 U*	*0.57 U*	*0.42 U*	*0.39 U*	*0.46 U*	*0.41 U*
Benzyl alcohol	100-51-6	mg/kg	630	--	--	8,000	630	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
Butyl benzyl phthalate	85-68-7	mg/kg	290	--	530	16,000	290	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Carbazole	86-74-8	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Di-n-butyl phthalate	84-74-2	mg/kg	630	--	--	8,000	630	0.045 U	0.055 U	0.057 U	0.21 U	0.19 U	0.23 U	0.21 U
Di-n-octyl phthalate	117-84-0	mg/kg	63	--	--	800	63	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Dibenzofuran	132-64-9	mg/kg	7.3	--	--	80	7.3	0.079	0.06	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Diethylphthalate	84-66-2	mg/kg	5,100	--	--	64,000	5,100	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
Dimethyl phthalate	131-11-3	mg/kg	--	--	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorobenzene	118-74-1	mg/kg	0.21	--	0.63	64	0.21	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorocyclopentadiene	77-47-4	mg/kg	0.18	--	--	480	0.18	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U

Table C.2c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Human Health

							Area	**Site (cont.)**				
							Location	**SDL25**	**SDL35**	**SDL15**	**SDL38**	**SDL52**
							Sample ID	**SDL25-B-1.5ft**	**SDL35-B-2.0ft**	**SDL15-B-2.0ft**	**SDL38-B-2.0ft**	**SDL52-B-2.0ft**
							Sample Date	**04/14/2017**	**05/11/2017**	**06/05/2017**	**06/26/2017**	**06/26/2017**
							Depth	**1.5 ft**	**2 ft**	**2 ft**	**2 ft**	**2 ft**
Analyte	**CAS No.**	**Units**	**USEPA RSL - Residential Soil (TR=1E-06, HQ=0.1)**	**MTCA Soil Method A Unrestricted**	**MTCA Soil Method B Cancer**	**MTCA Soil Method B Noncancer**	**Minimum Human Health COPC Selection SL [(1)]**					
Semivolatile Organic Compounds (SVOCs)												
1,2,4-Trichlorobenzene	120-82-1	mg/kg	5.8	--	34	800	5.8	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,2-Dichlorobenzene	95-50-1	mg/kg	180	--	--	7,200	180	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,2-Diphenylhydrazine	122-66-7	mg/kg	0.68	--	1.3	--	0.68	0.04 U	0.63	0.048 U	0.044 U	0.056 U
1,3-Dichlorobenzene	541-73-1	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,4-Dichlorobenzene	106-46-7	mg/kg	2.6	--	190	5,600	2.6	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	190	--	--	2,400	190	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3,5,6-Tetrachlorophenol	935-95-5	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3-Dichloroaniline	608-27-5	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4,5-Trichlorophenol	95-95-4	mg/kg	630	--	--	8,000	630	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4,6-Trichlorophenol	88-06-2	mg/kg	6.3	--	91	80	6.3	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4-Dichlorophenol	120-83-2	mg/kg	19	--	--	240	19	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4-Dimethylphenol	105-67-9	mg/kg	130	--	--	1,600	130	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4-Dinitrophenol	51-28-5	mg/kg	13	--	--	160	13	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
2,4-Dinitrotoluene	121-14-2	mg/kg	1.7	--	3.2	160	1.7	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,6-Dinitrotoluene	606-20-2	mg/kg	0.36	--	0.67	24	0.36	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Chloronaphthalene	91-58-7	mg/kg	480	--	--	6,400	480	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Chlorophenol	95-57-8	mg/kg	39	--	--	400	39	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Methylphenol	95-48-7	mg/kg	320	--	--	4,000	320	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Nitroaniline	88-74-4	mg/kg	63	--	--	800	63	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Nitrophenol	88-75-5	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
3,3'-Dichlorobenzidine	91-94-1	mg/kg	1.2	--	2.2	--	1.2	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
3- & 4-Methylphenol	MEPH3_4	mg/kg	--	--	--	4,000	4,000	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
3-Nitroaniline	99-09-2	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4,6-Dinitro-o-cresol	534-52-1	mg/kg	0.51	--	--	6.4	0.51	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
4-Bromophenyl phenyl ether	101-55-3	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Chloro-3-methylphenol	59-50-7	mg/kg	630	--	--	8,000	630	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Chloroaniline	106-47-8	mg/kg	2.7	--	5	320	2.7	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
4-Chlorophenyl phenyl ether	7005-72-3	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Nitroaniline	100-01-6	mg/kg	25	--	--	320	25	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Nitrophenol	100-02-7	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Aniline	62-53-3	mg/kg	44	--	180	560	44	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Benzidine	92-87-5	mg/kg	0.00053	--	0.0043	240	0.00053	*0.4 U*	*0.53 U*	*0.48 U*	*0.44 U*	*0.56 U*
Benzyl alcohol	100-51-6	mg/kg	630	--	--	8,000	630	0.2 U	0.26 U	0.24 U	0.22 U	0.66
Butyl benzyl phthalate	85-68-7	mg/kg	290	--	530	16,000	290	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Carbazole	86-74-8	mg/kg	--	--	--	--	--	0.04 U	0.17	0.16	0.1	0.32
Di-n-butyl phthalate	84-74-2	mg/kg	630	--	--	8,000	630	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Di-n-octyl phthalate	117-84-0	mg/kg	63	--	--	800	63	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Dibenzofuran	132-64-9	mg/kg	7.3	--	--	80	7.3	0.04 U	0.32	0.58	0.12	0.28
Diethylphthalate	84-66-2	mg/kg	5,100	--	--	64,000	5,100	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Dimethyl phthalate	131-11-3	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorobenzene	118-74-1	mg/kg	0.21	--	0.63	64	0.21	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorocyclopentadiene	77-47-4	mg/kg	0.18	--	--	480	0.18	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U

Table C.2c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Human Health

Area								Background			Site			
Location								SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03	SDL10	SDL25	SDL30
Sample ID								SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03-B-3.25ft	SDL10-B-3.0ft	SDL25-B-3.0ft	SDL30-B-2.0ft
Sample Date								11/03/2015	11/03/2015	11/03/2015	11/03/2016	11/03/2016	11/16/2016	11/16/2016
Depth								0–6 in	0–6 in	0–6 in	3.25 ft	3 ft	3 ft	2 ft
Analyte	CAS No.	Units	EPA RSL - Residential Soil (TR=1E-06, HQ=0.1)	MTCA Soil Method A Unrestricted	MTCA Soil Method B Cancer	MTCA Soil Method B Noncancer	Minimum Human Health COPC Selection SL (1)							
SVOCs (cont.)														
Hexachloroethane	67-72-1	mg/kg	1.8	--	25	56	1.8	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Isophorone	78-59-1	mg/kg	570	--	1,100	16,000	570	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
N-Nitroso-di-n-propylamine	621-64-7	mg/kg	0.078	--	0.14	--	0.078	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
N-Nitrosodimethylamine	62-75-9	mg/kg	0.002	--	0.02	0.64	0.002	*0.045 U*	*0.055 U*	*0.057 U*	*0.042 U*	*0.039 U*	*0.046 U*	*0.041 U*
N-Nitrosodiphenylamine	86-30-6	mg/kg	110	--	200	--	110	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Nitrobenzene	98-95-3	mg/kg	5.1	--	--	160	5.1	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Pentachlorophenol	87-86-5	mg/kg	1	--	2.5	400	1	0.22 U	0.27 U	0.28 U	0.26	0.19 U	0.23 U	0.21 U
Phenol	108-95-2	mg/kg	1,900	--	--	24,000	1,900	0.26	0.24	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Pyridine	110-86-1	mg/kg	7.8	--	--	80	7.8	0.46	0.55 U	0.57 U	0.42 U	0.39 U	0.46 U	0.41 U
Bis(2-chloroethoxy)methane	111-91-1	mg/kg	19	--	--	--	19	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-chloroethyl)ether	111-44-4	mg/kg	0.23	--	0.91	--	0.23	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-chloroisopropyl)ether	108-60-1	mg/kg	310	--	14	3,200	310	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	39	--	71	1,600	39	0.045 U	0.055 U	0.057 U	0.048	0.065	0.046 U	0.041 U
m-Dinitrobenzene	99-65-0	mg/kg	0.63	--	--	8	0.63	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
o-Dinitrobenzene	528-29-0	mg/kg	0.63	--	--	8	0.63	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
p-Dinitrobenzene	100-25-4	mg/kg	0.63	--	--	8	0.63	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Volatile Organic Compounds (VOCs)														
Di(2-ethylhexyl)adipate	103-23-1	mg/kg	450	--	830	48,000	450	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorobutadiene	87-68-3	mg/kg	1.2	--	13	80	1.2	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U

Notes:

--	Not available.
RED/BOLD	Detected concentration exceeds the minimum human health COPC selection SL.
Italics	Reporting limit exceeds the minimum human health COPC selection SL.
1	The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA Method A values, or the minimum MTCA Method B value if a MTCA Method A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
EPA	U.S. Environmental Protection Agency
ft	Feet
HQ	Hazard quotient
in	Inches
mg/kg	Milligrams per kilogram
MTCA	Model Toxics Control Act
RSL	Regional Screening Level
SL	Screening level
TR	Target cancer risk

Qualifier:

U	Analyte was not detected at the given reporting limit.

Table C.2c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Human Health

							Area	**Site (cont.)**				
							Location	**SDL25**	**SDL35**	**SDL15**	**SDL38**	**SDL52**
							Sample ID	**SDL25-B-1.5ft**	**SDL35-B-2.0ft**	**SDL15-B-2.0ft**	**SDL38-B-2.0ft**	**SDL52-B-2.0ft**
							Sample Date	**04/14/2017**	**05/11/2017**	**06/05/2017**	**06/26/2017**	**06/26/2017**
							Depth	**1.5 ft**	**2 ft**	**2 ft**	**2 ft**	**2 ft**
Analyte	**CAS No.**	**Units**	**USEPA RSL - Residential Soil (TR=1E-06, HQ=0.1)**	**MTCA Soil Method A Unrestricted**	**MTCA Soil Method B Cancer**	**MTCA Soil Method B Noncancer**	**Minimum Human Health COPC Selection SL (1)**					
SVOCs (cont.)												
Hexachloroethane	67-72-1	mg/kg	1.8	--	25	56	1.8	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Isophorone	78-59-1	mg/kg	570	--	1,100	16,000	570	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
N-Nitroso-di-n-propylamine	621-64-7	mg/kg	0.078	--	0.14	--	0.078	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
N-Nitrosodimethylamine	62-75-9	mg/kg	0.002	--	0.02	0.64	0.002	*0.04 U*	*0.053 U*	*0.048 U*	*0.044 U*	*0.056 U*
N-Nitrosodiphenylamine	86-30-6	mg/kg	110	--	200	--	110	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Nitrobenzene	98-95-3	mg/kg	5.1	--	--	160	5.1	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Pentachlorophenol	87-86-5	mg/kg	1	--	2.5	400	1	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Phenol	108-95-2	mg/kg	1,900	--	--	24,000	1,900	0.04 U	0.053 U	0.048 U	0.057	0.056 U
Pyridine	110-86-1	mg/kg	7.8	--	--	80	7.8	0.4 U	0.53 U	0.48 U	0.44 U	0.56 U
Bis(2-chloroethoxy)methane	111-91-1	mg/kg	19	--	--	--	19	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Bis(2-chloroethyl)ether	111-44-4	mg/kg	0.23	--	0.91	--	0.23	0.04 U	**0.26**	0.048 U	0.044 U	0.056 U
Bis(2-chloroisopropyl)ether	108-60-1	mg/kg	--	--	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	39	--	71	1,600	39	0.048	0.27	0.071	0.044 U	0.056 U
m-Dinitrobenzene	99-65-0	mg/kg	0.63	--	--	8	0.63	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
o-Dinitrobenzene	528-29-0	mg/kg	0.63	--	--	8	0.63	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
p-Dinitrobenzene	100-25-4	mg/kg	0.63	--	--	8	0.63	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Volatile Organic Compounds (VOCs)												
Di(2-ethylhexyl)adipate	103-23-1	mg/kg	450	--	830	48,000	450	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorobutadiene	87-68-3	mg/kg	1.2	--	13	80	1.2	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U

Notes:
-- Not available.
RED/BOLD Detected concentration exceeds the minimum human health COPC selection SL.
Italics Reporting limit exceeds the minimum human health COPC selection SL.
1 The minimum human health COPC selection SLs are the minimum of the EPA RSLs (TR=1E-06, HQ=0.1) and MTCA Method A values, or the minimum MTCA Method B value if a MTCA Method A value was not available.

Abbreviations:

CAS	Chemical Abstracts Service
COPC	Contaminant of potential concern
EPA	U.S. Environmental Protection Agency
ft	Feet
HQ	Hazard quotient
in	Inches
mg/kg	Milligrams per kilogram
MTCA	Model Toxics Control Act
RSL	Regional Screening Level
SL	Screening level
TR	Target cancer risk

Qualifier:
U Analyte was not detected at the given reporting limit.

Table C.3
Analytes Eliminated from the Baseline Human Health Risk Assesment

Analytes	CAS No.	Rationale for Elimination
Metals by EPA 6010C/7471B		
Barium	7440-39-3	No site data (1)
Cadmium	7440-43-9	Maximum concentration < SL
Chromium	7440-47-3	Maximum concentration < SL
Copper	7440-50-8	Maximum concentration < SL
Mercury	7439-97-6	Maximum concentration < SL
Selenium	7782-49-2	No site data (1)
Silver	7440-22-4	No site data (1)
Zinc	7440-66-6	Maximum concentration < SL
Polycyclic Aromatic Hydrocarbons by EPA 8270D/8270D-SIM		
1-Methylnaphthalene	90-12-0	Maximum concentration < SL
2-Methylnaphthalene	91-57-6	Maximum concentration < SL
Acenaphthene	83-32-9	Maximum concentration < SL
Acenaphthylene	208-96-8	No SL (2)
Anthracene	120-12-7	Maximum concentration < SL
Benzo(g,h,i)perylene	191-24-2	No SL (2)
Chrysene	218-01-9	Maximum concentration < SL
Fluoranthene	206-44-0	Maximum concentration < SL
Fluorene	86-73-7	Maximum concentration < SL
Indeno(1,2,3-c,d)pyrene	193-39-5	Maximum concentration < SL
Naphthalene	91-20-3	Maximum concentration < SL
Phenanthrene	85-01-8	No SL (2)
Pyrene	129-00-0	Maximum concentration < SL
Semivolatile Organic Compounds by EPA 8270D/8270D-SIM		
1,2,4-Trichlorobenzene	120-82-1	Maximum concentration < SL
1,2-Dichlorobenzene	95-50-1	Maximum concentration < SL
1,2-Diphenylhydrazine	122-66-7	Maximum concentration < SL
1,3-Dichlorobenzene	541-73-1	No SL, no detected data (2)
1,4-Dichlorobenzene	106-46-7	Maximum concentration < SL
2,3,4,6-Tetrachlorophenol	58-90-2	Maximum concentration < SL
2,3,5,6-Tetrachlorophenol	935-95-5	No SL, no detected data (2)
2,3-Dichloroaniline	608-27-5	No SL, no detected data (2)
2,4,5-Trichlorophenol	95-95-4	Maximum concentration < SL
2,4,6-Trichlorophenol	88-06-2	Maximum concentration < SL
2,4-Dichlorophenol	120-83-2	Maximum concentration < SL
2,4-Dimethylphenol	105-67-9	Maximum concentration < SL
2,4-Dinitrophenol	51-28-5	Maximum concentration < SL
2,4-Dinitrotoluene	121-14-2	Maximum concentration < SL
2,6-Dinitrotoluene	606-20-2	Maximum concentration < SL
2-Chloronaphthalene	91-58-7	Maximum concentration < SL
2-Chlorophenol	95-57-8	Maximum concentration < SL
2-Methylphenol	95-48-7	Maximum concentration < SL
2-Nitroaniline	88-74-4	Maximum concentration < SL
2-Nitrophenol	88-75-5	No SL, no detected data (2)
3,3'-Dichlorobenzidine	91-94-1	Maximum concentration < SL
3- & 4-Methylphenol	MEPH3_4	Maximum concentration < SL
3-Nitroaniline	99-09-2	No SL, no detected data (2)
4,6-Dinitro-o-cresol	534-52-1	Maximum concentration < SL
4-Bromophenyl phenyl ether	101-55-3	No SL, no detected data (2)
4-Chloro-3-methylphenol	59-50-7	Maximum concentration < SL
4-Chloroaniline	106-47-8	Maximum concentration < SL
4-Chlorophenyl phenyl ether	7005-72-3	No SL, no detected data (2)
4-Nitroaniline	100-01-6	Maximum concentration < SL
4-Nitrophenol	100-02-7	No SL, no detected data (2)
Aniline	62-53-3	Maximum concentration < SL
Benzidine	92-87-5	Maximum non-detect concentration > SL, no detected results, no history of site use
Benzyl alcohol	100-51-6	Maximum concentration < SL
Butyl benzyl phthalate	85-68-7	Maximum concentration < SL
Carbazole	86-74-8	No SL (2)
Di-n-butyl phthalate	84-74-2	Maximum concentration < SL
Di-n-octyl phthalate	117-84-0	Maximum concentration < SL
Dibenzofuran	132-64-9	Maximum concentration < SL
Diethylphthalate	84-66-2	Maximum concentration < SL
Dimethyl phthalate	131-11-3	No SL, no detected data (2)
Hexachlorobenzene	118-74-1	Maximum concentration < SL
Hexachlorocyclopentadiene	77-47-4	Maximum concentration < SL
Hexachloroethane	67-72-1	Maximum concentration < SL
Isophorone	78-59-1	Maximum concentration < SL
N-Nitroso-di-n-propylamine	621-64-7	Maximum concentration < SL
N-Nitrosodimethylamine	62-75-9	Maximum non-detect concentration > SL, no detected results, no history of site use
N-Nitrosodiphenylamine	86-30-6	Maximum concentration < SL
Nitrobenzene	98-95-3	Maximum concentration < SL
Pentachlorophenol	87-86-5	Maximum concentration < SL
Phenol	108-95-2	Maximum concentration < SL
Pyridine	110-86-1	Maximum concentration < SL
Bis(2-chloroethoxy)methane	111-91-1	Maximum concentration < SL
Bis(2-chloroisopropyl)ether	108-60-1	Maximum concentration < SL
Bis(2-ethylhexyl)phthalate	117-81-7	Maximum concentration < SL
m-Dinitrobenzene	99-65-0	Maximum concentration < SL
o-Dinitrobenzene	528-29-0	Maximum concentration < SL
p-Dinitrobenzene	100-25-4	Maximum concentration < SL
Volatile Organic Compounds by EPA 8270D		
Di(2-ethylhexyl)adipate	103-23-1	Maximum concentration < SL
Hexachlorobutadiene	87-68-3	Maximum concentration < SL

Notes:

1 Not analyzed in site samples; site-specific background data are available. Background concentrations are less than the minimum human health COPC selection SL.

2 An analysis of available toxicity information was conducted for chemicals without screening values. The results of that analysis are discussed in Section 3.1.5.2 and are presented in Table 3.9.

Abbreviations:

CAS	Chemical Abstracts Service	FOD	Frequency of detection
COPC	Contaminant of potential concern	SL	Screening level

Table C.4a
Laboratory Analytical Results and Screening Evaluation for Metals—Ecological

Analyte Class				Metals									
Analyte				**Arsenic**	**Barium**	**Cadmium (1)**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Selenium**	**Silver**	**Zinc**
CAS No.				**7440-38-2**	**7440-39-3**	**7440-43-9**	**7440-47-3**	**7440-50-8**	**7439-92-1**	**7439-97-6**	**7782-49-2**	**7440-22-4**	**7440-66-6**
Units				**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Plant and Invertebrate SLERA COPEC Selection ESV				**6.8**	**110**	**4**	**0.34**	**50**	**50**	**0.05**	**0.52**	**2**	**6.62**
Bird and Mammal SLERA COPEC Selection ESV				**0.25**	**17.2**	**0.27**	**23**	**14**	**0.94**	**0.013**	**0.331**	**2.6**	**12**
Minimum SLERA COPEC Selection ESV				**0.25**	**17.2**	**0.27**	**0.34**	**14**	**0.94**	**0.013**	**0.331**	**2**	**6.62**
Location	**Sample ID**	**Samle Date**	**Depth**										
Background													
SCL-LC-BG3	SCL-LC-BG3	11/03/2015	0–6 in	*13 U*	**290**	**0.29 J**	**30**		**27**	**0.029**	*13 U*	1.3 U	
SCL-LC-BG4	SCL-LC-BG4	11/03/2015	0–6 in	*16 U*	**320**	**0.46 J**	**31**		**18**	**0.038**	*16 U*	1.6 U	
SCL-LC-BG5	SCL-LC-BG5	11/03/2015	0–6 in	*17 U*	**330**	**0.39 J**	**37**		**24**	**0.094**	*17 U*	1.7 U	
NHP-BKGD-1	NHP-BKGD-1	10/11/2018	0–6 in	*7.9 U*					**18**				**53**
NHP-BKGD-10	NHP-BKGD-10	10/11/2018	0–6 in	**18**					**7.2**				**91**
NHP-BKGD-3	NHP-BKGD-3	10/11/2018	0–6 in	*7 U*					**9.7**				**59**
NHP-BKGD-7	NHP-BKGD-7	10/11/2018	0–6 in	*7.3 U*					*7.3 U*				**17**
NHP-BKGD-8	NHP-BKGD-8	10/11/2018	0–6 in	**9.6**					**6.9**				**81**
NHP-BKGD-9	NHP-BKGD-9-0	10/11/2018	0–6 in	**10**					**8.4**				**100**
NHP-BKGD-11	NHP-BKGD-11	10/12/2018	0–6 in	**13**					**9.8**				**98**
NHP-BKGD-12	NHP-BKGD-12	10/12/2018	0–6 in	**10**					**9.3**				**82**
NHP-BKGD-14	NHP-BKGD-14	10/12/2018	0–6 in	*8.4 U*					**11**				**78**
NHP-BKGD-15	NHP-BKGD-15	10/12/2018	0–6 in	*6.5 U*					**10**				**63**
Site													
T1-C	T1-C	07/10/2014	0–6 in	**25**		**0.46 J**	**26**	**45**	**1,800**	**0.031**			**150**
T2-W-16ft	T2-W-16ft	07/11/2014	0–6 in	*12 U*			**17**	**20**	**56**				**57**
T2-W-19ft	T2-W-19ft	07/11/2014	0–6 in	*14 U*			**16**	**22**	**25**				**57**
T3-E-2ft	T3-E-2ft	07/11/2014	0–6 in	*17 U*			**30**	**26**	**1,200**				**91**
T3-W-5ft	T3-W-5ft	07/11/2014	0–6 in	**20**			**24**	**33**	**480**				**79**
T4-C	T4-C	07/11/2014	0–6 in	*13 U*			**40**	**16**	**1,000**				**55**
T4-E-11ft	T4-E-11ft	07/11/2014	0–6 in	*12 U*			**22**	**18**	**9.6**				**54**
T4-W-11ft	T4-W-11ft	07/11/2014	0–6 in	*13 U*			**18**	**16**	**70**				**60**
T5-C	T5-C	07/11/2014	0–6 in	*15 U*		0.23 J	**20**	**25**	**1,300**	**0.110**			**210**
T5-W-11ft	T5-W-11ft	07/11/2014	0–6 in	*14 U*			**12**	**26**	**950**				**68**
T6-E-11ft	T6-E-11ft	07/11/2014	0–6 in	*14 U*		**0.82 J**	**19**	**47**	**1,600**	**0.350**			**210**
T6-E-5ft	T6-E-5ft	07/11/2014	0–6 in	*20 U*		**0.71 J**	**15**	14	**2,000**	**0.110**			**180**
T1-E-8ft	T1-E-8ft	07/12/2014	0–6 in	**17**			**22**	**34**	**350**				**120**
T2-W-2ft	T2-W-2ft	07/12/2014	0–6 in	*15 U*			**31**	**25**	**610**				**77**
T13-0-E	T13-E-0	10/06/2015	0–3 in	**19**					**230**				
T13-35-W	T13-W-35	10/06/2015	0–3 in	*15 U*					**780**				
T13-40-W	T13-W-40	10/06/2015	0–3 in	*15 U*					**62**				
SDL03	SDL03-S-1.5ft	11/03/2016	1.5 ft	**15**					*6.3 U*				
SDL03	SDL03-B-3.25ft	11/03/2016	3.25 ft	**20**					**99**				
SDL10	SDL10-S-1.5ft	11/03/2016	1.5 ft	**24**					**22**				
SDL10	SDL10-B-3.0ft	11/03/2016	3 ft	**22**					**7.7**				
SDL25	SDL25-B-3.0ft	11/16/2016	3 ft	**24**					**19**				
SDL30	SDL30-S-1.5ft	11/16/2016	1.5 ft	**50**					**89**				
SDL30	SDL30-B-2.0ft	11/16/2016	2 ft	**15**					**20**				
SDL25	SDL25-B-1.5ft	04/14/2017	1.5 ft	**37**					**11**				
SDL25	SDL25-S-1.5ft	04/14/2017	1.5 ft	**34**					**6.9**				
SDL35	SDL35-B-2.0ft	05/11/2017	2 ft	*16 U*					**610**				
SDL45	SDL45-S-2.0	05/11/2017	2 ft	*14 U*					**870**				
SDL15	SDL15-B-2.0ft	06/05/2017	2 ft	*14 U*					**79**				
SDL15	SDL15-S-2.5ft	06/05/2017	2.5 ft	*14 U*					**230**				
SDL20	SDL20-S-0.5ft	06/05/2017	0.5 ft	*12 U*					**310**				
SDL38	SDL38-S-1.5ft	06/26/2017	1.5 ft	*16 U*					**1,300**				
SDL38	SDL38-B-2.0ft	06/26/2017	2 ft	*13 U*					**630**				
SDL52	SDL52-S-1.5ft	06/26/2017	1.5 ft	**13**					**1,900**				
SDL52	SDL52-B-2.0ft	06/26/2017	2 ft	*17 U*					**1,100**				
NHP-T16-20E	NHP-T16-20E-0	10/10/2018	0 ft	**15**					**78**				**97**
NHP-T16-25W	NHP-T16-25W-0	10/10/2018	0 ft	**13**					**32**				**92**
NHP-T17-15E	NHP-T17-15E-0	10/11/2018	0 ft	**11**					**76**				**280**
NHP-T17-20E	NHP-T17-20E-0	10/11/2018	0 ft						**19**				**63**
NHP-T17-20W	NHP-T17-20W-0	10/11/2018	0 ft	**17**					**19**				**80**
NHP-T19-15E	NHP-T119-15E-0	10/11/2018	0 ft	**4.5**					**30**				**97**
NHP-T19-15E	NHP-T19-15E-0	10/11/2018	0 ft	**4.5**					**31**				**100**
NHP-T19-25W	NHP-T19-25W-0	10/11/2018	0 ft	**20**					**19**				**98**
NHP-T19-35W	NHP-T19-35W-0	10/11/2018	0 ft	**14**									**110**
NHP-T20-16E	NHP-T20-16E-0	10/11/2018	0 ft	*8 U*					**29**				**100**
NHP-SED-1	NHP-SED-1	10/12/2018	0–0.1 ft	*5.9 U*					**15**				**39**
NHP-T14-20E	NHP-T14-20E-0	10/12/2018	0 ft	**10**					**23**				**98**
NHP-T14-30W	NHP-T14-30W-0	10/12/2018	0 ft	**7.4**					**19**				**120**
NHP-T14-C	NHP-T14-C-0	10/12/2018	0 ft	**56**					**360**				**590**
NHP-T15-15W	NHP-T15-15W-0	10/12/2018	0 ft	**24**					**35**				**120**
NHP-T15-5E	NHP-T15-5E-0.5	10/12/2018	0.5 ft	**94**					**720**				**980**
NHP-T22-10E	NHP-T22-10E-0	10/12/2018	0 ft	**10**					**31**				**110**
NHP-T22-15E	NHP-T22-15E-0	10/12/2018	0 ft	**13**					**13**				**95**
NHP-T22-40W	NHP-T22-40W-0	10/12/2018	0 ft	*7.6 U*					**77**				**59**
NHP-T22-45W	NHP-T22-45W-0	10/12/2018	0 ft						**36**				
NHP-T22-5W	NHP-T22-5W-0	10/12/2018	0 ft	**9**					**270**				**72**
NHP-T23-15W	NHP-T23-15W-0	10/12/2018	0 ft	*8.9 U*					**110**				**54**
NHP-T23-20W	NHP-T23-20W-0	10/12/2018	0 ft						**94**				

Notes:

Blank cells are intentional.
RED/BOLD Detected concentration exceeds the minimum SLERA COPEC selection ESV.
Italics Reporting limit exceeds the minimum SLERA COPEC selection ESV.
1 Non-detect results are reported at the method detection limit.

Abbreviations:

CAS Chemical Abstracts Service
COPEC Contaminant of potential ecological concern
ESV Ecological screening value
ft Feet
in Inches
mg/kg Milligrams per kilogram
SLERA Screening level ecological risk assessment

Qualifier:

U Analyte was not detected at the given reporting limit.

Table C.4b
Laboratory Analytical Results and Screening Evaluation for PAHs—Ecological

Area						Background			In Situ								
Location						SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03	SDL10	SDL25	SDL30	SDL25	SDL35	SDL15	SDL38	SDL52
Sample ID						SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03-B-3.25ft	SDL10-B-3.0ft	SDL25-B-3.0ft	SDL30-B-2.0ft	SDL25-B-1.5ft	SDL35-B-2.0ft	SDL15-B-2.0ft	SDL38-B-2.0ft	SDL52-B-2.0ft
Sample Date						11/03/2015	11/03/2015	11/03/2015	11/03/2016	11/03/2016	11/16/2016	11/16/2016	04/14/2017	05/11/2017	06/05/2017	06/26/2017	06/26/2017
Depth						0–6 in	0–6 in	0–6 in	3.25 ft	3 ft	3 ft	2 ft	1.5 ft	2 ft	2 ft	2 ft	2 ft
Analyte	CAS No.	Units	Plant and Invertebrate SLERA COPEC Selection ESV	Bird and Mammal SLERA COPEC Selection ESV	Minimum SLERA COPEC Selection ESV												
Polycyclic Aromatic Hydrocarbons (PAHs)																	
1-Methylnaphthalene	90-12-0	mg/kg	--	--	--	0.034	0.035	0.035	0.0084 U	0.0077 U	0.0093 U	0.0083 U	0.0079 U	0.047	0.17	0.019	0.033
2-Methylnaphthalene	91-57-6	mg/kg	--	16	16	0.039	0.043	0.042	0.0089	0.0077 U	0.0093 U	0.0083 U	0.0079 U	0.093	0.23	0.037	0.067
Acenaphthene	83-32-9	mg/kg	0.25	130	0.25	0.022	0.011 U	0.012	0.034	0.0077 U	0.0093 U	0.0083 U	0.0079 U	**0.47**	**0.85**	0.17	0.23
Acenaphthylene	208-96-8	mg/kg	--	120	120	0.009 U	0.011 U	0.011 U	0.034	0.0077 U	0.0093 U	0.0083 U	0.0079 U	0.068	0.14	0.11	0.09
Anthracene	120-12-7	mg/kg	6.8	210	6.8	0.011	0.011 U	0.011 U	0.12	0.0077 U	0.024	0.044	0.0089	1.1	1.5	0.53	2
Benzo(a)anthracene	56-55-3	mg/kg	18	0.73	0.73	0.009 U	0.011 U	0.011 U	0.2	0.0077 U	0.033	0.042	0.015	0.67	**1.8**	0.72	**0.92**
Benzo(a)pyrene	50-32-8	mg/kg	--	1.98	1.98	0.009 U	0.011 U	0.011 U	0.15	0.0077 U	0.024	0.041	0.0079 U	0.33	1.3	0.55	0.47
Benzo(b)fluoranthene	205-99-2	mg/kg	18	44	18	0.009 U	0.011 U	0.013	0.34	0.0077 U	0.046	0.087	0.012	0.68	2.8	1.3	0.9
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	25	25	0.009 U	0.011 U	0.011 U	0.11	0.0077 U	0.011	0.021	0.0079 U	0.13	0.63	0.33	0.17
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	--	--	--	0.009 U	0.011 U	0.011 U	0.12	0.0077 U	0.016	0.03	0.0079 U	0.18	0.67	0.32	0.3
Chrysene	218-01-9	mg/kg	--	3.1	3.1	0.009 U	0.011 U	0.013	0.28	0.0077 U	0.042	0.066	0.014	0.84	2.6	1.2	1.2
Dibenzo(a,h)anthracene	53-70-3	mg/kg	--	14	14	0.009 U	0.011 U	0.011 U	0.038	0.0077 U	0.0093 U	0.0083 U	0.0079 U	0.046	0.21	0.096	0.065
Fluoranthene	206-44-0	mg/kg	10	22	10	0.019	0.011	0.015	0.49	0.012	0.068	0.098	0.073	2.4	4.2	2.5	4.1
Fluorene	86-73-7	mg/kg	3.7	250	3.7	0.027	0.019	0.015	0.053	0.0077 U	0.0093 U	0.009	0.0079 U	0.8	0.98	0.28	1
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	--	71	71	0.009 U	0.011 U	0.011 U	0.081	0.0077 U	0.014	0.025	0.0079 U	0.14	0.6	0.34	0.18
Naphthalene	91-20-3	mg/kg	1	3.4	1	0.11	0.12	0.14	0.011	0.0077 U	0.0093 U	0.0083 U	0.0079 U	0.042	0.097	0.034	0.051
Phenanthrene	85-01-8	mg/kg	5.5	11	5.5	0.067	0.043	0.042	0.14	0.0099	0.025	0.016	0.031	2.3	4.5	1.2	4.9
Pyrene	129-00-0	mg/kg	10	23	10	0.017	0.024	0.02	0.56	0.011	0.082	0.099	0.064	2.2	3.4	2.4	3.6
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	18	1.1	1.1	0.017	0.024	0.046	**1.8**	0.011	0.27	0.41	0.11	**5.2**	**14**	**7.2**	**7.7**
Total LMW PAHs (U=0)	LPAH (U=0)	mg/kg	29	100	29	0.3	0.24	0.27	0.89	0.022	0.12	0.17	0.11	7.3	12	4.9	12

Notes:
-- Not available.
RED/BOLD Detected concentration exceeds the minimum SLERA COPEC selection ESV.
Italics Reporting limit exceeds the minimum SLERA COPEC selection ESV.

Abbreviations:
CAS Chemical Abstracts Service
COPEC Contaminant of potential ecological concern
ESV Ecological screening value
ft Feet
HMW High molecular weight
in Inches
LMW Low molecular weight
mg/kg Milligrams per kilogram
SLERA Screening level ecological risk assessment

Qualifiers:
J Analyte was detected at the given concentration, which is considered to be an estimate.
U Analyte was not detected at the given reporting limit.
UJ Analyte was not detected at the given reporting limit, which is considered to be an estimate.

Table C.4b
Laboratory Analytical Results and Screening Evaluation for PAHs—Ecological

					Area	In Situ (cont.)							
					Location	NHP-T16-C	NHP-T19-C	NHP-T24-C	NHP-T24-5E	NHP-T24-5W	NHP-T24-10E	NHP-T24-10W	NHP-T24-15W
					Sample ID	NHP-T16-C-0-1	NHP-T19-C-0-1	NHP-T24-C-0-0.1	NHP-T24-5E-0-0.3	NHP-T24-5W-0-0.2	NHP-T24-10E-0-0.3	NHP-T24-10W-0-0.3	NHP-T24-15W-0
					Sample Date	10/10/2018	10/11/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018
					Depth	0–1 ft	0–1 ft	0–0.1 ft	0–0.3 ft	0–0.2 ft	0–0.3 ft	0–0.3 ft	0 ft
Analyte	**CAS No.**	**Units**	**Plant and Invertebrate SLERA COPEC Selection ESV**	**Bird and Mammal SLERA COPEC Selection ESV**	**Minimum SLERA COPEC Selection ESV**								
Polycyclic Aromatic Hydrocarbons (PAHs)													
1-Methylnaphthalene	90-12-0	mg/kg	--	--	--	0.0086 U	0.0072 U	0.05	0.012 U	0.055	0.013 U	0.019	0.014 UJ
2-Methylnaphthalene	91-57-6	mg/kg	--	16	16	0.0086 U	0.0072 U	0.082	0.012 U	0.092	0.013 U	0.029	0.014 UJ
Acenaphthene	83-32-9	mg/kg	0.25	130	0.25	0.0086 U	0.0072 U	0.1	0.012 U	0.071	0.013 U	0.046	0.014 UJ
Acenaphthylene	208-96-8	mg/kg	--	120	120	0.0086 U	0.0072 U	0.24	0.012 U	0.15	0.013 U	0.18	0.014 UJ
Anthracene	120-12-7	mg/kg	6.8	210	6.8	0.021	0.0072 U	2.4	0.012 U	6.5	0.013 U	0.96	0.032 J
Benzo(a)anthracene	56-55-3	mg/kg	18	0.73	0.73	0.084	0.018	**2.8**	0.012 U	**2.3**	0.039	**2.9**	0.14 J
Benzo(a)pyrene	50-32-8	mg/kg	--	1.98	1.98	0.04	0.015	1.5	0.012 U	1.4	0.019	1.1	0.066 J
Benzo(b)fluoranthene	205-99-2	mg/kg	18	44	18	0.089	0.032	2.9	0.022	2.5	0.062	2.7	0.18 J
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	25	25	0.017	0.0078	0.59	0.012 U	0.47	0.014	0.46	0.033 J
Benzofluoranthenes (j+k)	BJKFLANTH	mg/kg	--	--	--	0.032	0.0095	0.96	0.012 U	0.81	0.016	0.79	0.054 J
Chrysene	218-01-9	mg/kg	--	3.1	3.1	0.093	0.026	**4.2**	0.021	2.9	0.052	**3.5**	0.21 J
Dibenzo(a,h)anthracene	53-70-3	mg/kg	--	14	14	0.0086 U	0.0072 U	0.14	0.012 U	0.18	0.013 U	0.21	0.014 UJ
Fluoranthene	206-44-0	mg/kg	10	22	10	0.2	0.027	7.1	0.028	4.4	0.092	6.8	0.38 J
Fluorene	86-73-7	mg/kg	3.7	250	3.7	0.0086 U	0.0072 U	0.26	0.012 U	0.69	0.013 U	0.084	0.014 UJ
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	--	71	71	0.019	0.0096	0.7	0.012 U	0.63	0.018	0.57	0.04 J
Naphthalene	91-20-3	mg/kg	1	3.4	1	0.0086 U	0.0072 U	0.099	0.021	0.15	0.027	0.057	0.014 UJ
Phenanthrene	85-01-8	mg/kg	5.5	11	5.5	0.065	0.0072 U	0.89	0.02	2.1	0.037	0.69	0.069 J
Pyrene	129-00-0	mg/kg	10	23	10	0.21	0.033	7.3	0.024	4.5	0.082	6.6	0.36 J
Total HMW PAHs (U=0)	HPAH (U=0)	mg/kg	18	1.1	1.1	0.58	0.15	**21**	0.067	**16**	0.3	**19**	1.1 J
Total LMW PAHs (U=0)	LPAH (U=0)	mg/kg	29	100	29	0.29	0.027	11	0.069	14	0.16	8.8	0.48 J

Notes:

--	Not available.
RED/BOLD	Detected concentration exceeds the minimum SLERA COPEC selection ESV.
Italics	Reporting limit exceeds the minimum SLERA COPEC selection ESV.

Abbreviations:

CAS	Chemical Abstracts Service
COPEC	Contaminant of potential ecological concern
ESV	Ecological screening value
ft	Feet
HMW	High molecular weight
in	Inches
LMW	Low molecular weight
mg/kg	Milligrams per kilogram
SLERA	Screening level ecological risk assessment

Qualifiers:

J	Analyte was detected at the given concentration, which is considered to be an estimate.
U	Analyte was not detected at the given reporting limit.
UJ	Analyte was not detected at the given reporting limit, which is considered to be an estimate.

Table C.4c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Ecological

					Area	Background			In Situ			
					Location	SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03	SDL10	SDL25	SDL30
					Sample ID	SCL-LC-BG3	SCL-LC-BG4	SCL-LC-BG5	SDL03-B-3.25ft	SDL10-B-3.0ft	SDL25-B-3.0ft	SDL30-B-2.0ft
					Sample Date	11/03/2015	11/03/2015	11/03/2015	11/03/2016	11/03/2016	11/16/2016	11/16/2016
					Depth	0–6 in	0–6 in	0–6 in	3.25 ft	3 ft	3 ft	2 ft
Analyte	CAS No.	Units	Plant and Invertebrate SLERA COPEC Selection ESV	Bird and Mammal SLERA COPEC Selection ESV	Minimum SLERA COPEC Selection ESV							
Semivolatile Organic Compounds (SVOCs)												
1,2,4-Trichlorobenzene	120-82-1	mg/kg	1.2	0.27	0.27	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,2-Dichlorobenzene	95-50-1	mg/kg	20	0.92	0.92	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,2-Diphenylhydrazine	122-66-7	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,3-Dichlorobenzene	541-73-1	mg/kg	20	0.74	0.74	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
1,4-Dichlorobenzene	106-46-7	mg/kg	1.2	0.89	0.89	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3,5,6-Tetrachlorophenol	935-95-5	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,3-Dichloroaniline	608-27-5	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4,5-Trichlorophenol	95-95-4	mg/kg	4	--	4	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4,6-Trichlorophenol	88-06-2	mg/kg	10	--	10	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4-Dichlorophenol	120-83-2	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,4-Dimethylphenol	105-67-9	mg/kg	0.01	--	0.01	*0.045 U*	*0.055 U*	*0.057 U*	*0.042 U*	*0.039 U*	*0.046 U*	*0.041 U*
2,4-Dinitrophenol	51-28-5	mg/kg	20	--	20	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
2,4-Dinitrotoluene	121-14-2	mg/kg	6	14	6	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2,6-Dinitrotoluene	606-20-2	mg/kg	30	4	4	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Chloronaphthalene	91-58-7	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Chlorophenol	95-57-8	mg/kg	--	0.39	0.39	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Methylphenol	95-48-7	mg/kg	0.67	580	0.67	0.067	0.079	0.059	0.042 U	0.039 U	0.046 U	0.041 U
2-Nitroaniline	88-74-4	mg/kg	--	5.3	5.3	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
2-Nitrophenol	88-75-5	mg/kg	7	--	7	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
3,3'-Dichlorobenzidine	91-94-1	mg/kg	--	--	--	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
3- & 4-Methylphenol	MEPH3_4	mg/kg	--	--	--	0.19	0.21	0.13	0.042 U	0.039 U	0.046 U	0.041 U
3-Nitroaniline	99-09-2	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4,6-Dinitro-o-cresol	534-52-1	mg/kg	--	--	--	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
4-Bromophenyl phenyl ether	101-55-3	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Chloro-3-methylphenol	59-50-7	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Chloroaniline	106-47-8	mg/kg	1	--	1	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
4-Chlorophenyl phenyl ether	7005-72-3	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Nitroaniline	100-01-6	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
4-Nitrophenol	100-02-7	mg/kg	7	--	7	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Aniline	62-53-3	mg/kg	--	--	--	0.22 U	0.27 U	0.28 U	0.28	0.19 U	0.23 U	0.21 U
Benzidine	92-87-5	mg/kg	--	--	--	0.45 U	0.55 U	0.57 U	0.42 U	0.39 U	0.46 U	0.41 U
Benzyl alcohol	100-51-6	mg/kg	--	--	--	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
Butyl benzyl phthalate	85-68-7	mg/kg	--	90	90	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Carbazole	86-74-8	mg/kg	--	79	79	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U

Table C.4c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Ecological

					Area	In Situ (cont.)				
					Location	SDL25	SDL35	SDL15	SDL38	SDL52
					Sample ID	SDL25-B-1.5ft	SDL35-B-2.0ft	SDL15-B-2.0ft	SDL38-B-2.0ft	SDL52-B-2.0ft
					Sample Date	04/14/2017	05/11/2017	06/05/2017	06/26/2017	06/26/2017
					Depth	1.5 ft	2 ft	2 ft	2 ft	2 ft
Analyte	CAS No.	Units	Plant and Invertebrate SLERA COPEC Selection ESV	Bird and Mammal SLERA COPEC Selection ESV	Minimum SLERA COPEC Selection ESV					
Semivolatile Organic Compounds (SVOCs)										
1,2,4-Trichlorobenzene	120-82-1	mg/kg	1.2	0.27	0.27	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,2-Dichlorobenzene	95-50-1	mg/kg	20	0.92	0.92	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,2-Diphenylhydrazine	122-66-7	mg/kg	--	--	--	0.04 U	0.63	0.048 U	0.044 U	0.056 U
1,3-Dichlorobenzene	541-73-1	mg/kg	20	0.74	0.74	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
1,4-Dichlorobenzene	106-46-7	mg/kg	1.2	0.89	0.89	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3,5,6-Tetrachlorophenol	935-95-5	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,3-Dichloroaniline	608-27-5	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4,5-Trichlorophenol	95-95-4	mg/kg	4	--	4	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4,6-Trichlorophenol	88-06-2	mg/kg	10	--	10	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4-Dichlorophenol	120-83-2	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,4-Dimethylphenol	105-67-9	mg/kg	0.01	--	0.01	*0.04 U*	*0.053 U*	*0.048 U*	*0.044 U*	*0.056 U*
2,4-Dinitrophenol	51-28-5	mg/kg	20	--	20	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
2,4-Dinitrotoluene	121-14-2	mg/kg	6	14	6	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2,6-Dinitrotoluene	606-20-2	mg/kg	30	4	4	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Chloronaphthalene	91-58-7	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Chlorophenol	95-57-8	mg/kg	--	0.39	0.39	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Methylphenol	95-48-7	mg/kg	0.67	580	0.67	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Nitroaniline	88-74-4	mg/kg	--	5.3	5.3	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
2-Nitrophenol	88-75-5	mg/kg	7	--	7	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
3,3'-Dichlorobenzidine	91-94-1	mg/kg	--	--	--	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
3- & 4-Methylphenol	MEPH3_4	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
3-Nitroaniline	99-09-2	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4,6-Dinitro-o-cresol	534-52-1	mg/kg	--	--	--	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
4-Bromophenyl phenyl ether	101-55-3	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Chloro-3-methylphenol	59-50-7	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Chloroaniline	106-47-8	mg/kg	1	--	1	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
4-Chlorophenyl phenyl ether	7005-72-3	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Nitroaniline	100-01-6	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
4-Nitrophenol	100-02-7	mg/kg	7	--	7	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Aniline	62-53-3	mg/kg	--	--	--	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Benzidine	92-87-5	mg/kg	--	--	--	0.4 U	0.53 U	0.48 U	0.44 U	0.56 U
Benzyl alcohol	100-51-6	mg/kg	--	--	--	0.2 U	0.26 U	0.24 U	0.22 U	0.66
Butyl benzyl phthalate	85-68-7	mg/kg	--	90	90	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Carbazole	86-74-8	mg/kg	--	79	79	0.04 U	0.17	0.16	0.1	0.32

Table C.4c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Ecological

					Area	Background			In Situ			
					Location	**SCL-LC-BG3**	**SCL-LC-BG4**	**SCL-LC-BG5**	**SDL03**	**SDL10**	**SDL25**	**SDL30**
					Sample ID	**SCL-LC-BG3**	**SCL-LC-BG4**	**SCL-LC-BG5**	**SDL03-B-3.25ft**	**SDL10-B-3.0ft**	**SDL25-B-3.0ft**	**SDL30-B-2.0ft**
					Sample Date	**11/03/2015**	**11/03/2015**	**11/03/2015**	**11/03/2016**	**11/03/2016**	**11/16/2016**	**11/16/2016**
					Depth	**0–6 in**	**0–6 in**	**0–6 in**	**3.25 ft**	**3 ft**	**3 ft**	**2 ft**
Analyte	**CAS No.**	**Units**	**Plant and Invertebrate SLERA COPEC Selection ESV**	**Bird and Mammal SLERA COPEC Selection ESV**	**Minimum SLERA COPEC Selection ESV**							
SVOCs (cont.)												
Di-n-butyl phthalate	84-74-2	mg/kg	160	0.011	0.011	*0.045 U*	*0.055 U*	*0.057 U*	*0.21 U*	*0.19 U*	*0.23 U*	*0.21 U*
Di-n-octyl phthalate	117-84-0	mg/kg	--	0.91	0.91	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Dibenzofuran	132-64-9	mg/kg	6.1	--	6.1	0.079	0.06	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Diethylphthalate	84-66-2	mg/kg	100	3,600	100	0.22 U	0.27 U	0.28 U	0.21 U	0.19 U	0.23 U	0.21 U
Dimethyl phthalate	131-11-3	mg/kg	10	38	10	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorobenzene	118-74-1	mg/kg	10	0.079	0.079	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorocyclopentadiene	77-47-4	mg/kg	10	--	10	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachloroethane	67-72-1	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Isophorone	78-59-1	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
N-Nitroso-di-n-propylamine	621-64-7	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
N-Nitrosodimethylamine	62-75-9	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
N-Nitrosodiphenylamine	86-30-6	mg/kg	20	--	20	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Nitrobenzene	98-95-3	mg/kg	2.2	4.8	2.2	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Pentachlorophenol	87-86-5	mg/kg	3	0.36	0.36	0.22 U	0.27 U	0.28 U	0.26	0.19 U	0.23 U	0.21 U
Phenol	108-95-2	mg/kg	0.79	37	0.79	0.26	0.24	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Pyridine	110-86-1	mg/kg	--	--	--	0.46	0.55 U	0.57 U	0.42 U	0.39 U	0.46 U	0.41 U
Bis(2-chloroethoxy)methane	111-91-1	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-chloroethyl)ether	111-44-4	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-chloroisopropyl)ether	108-60-1	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	--	0.02	0.02	*0.045 U*	*0.055 U*	*0.057 U*	**0.048**	**0.065**	*0.046 U*	*0.041 U*
m-Dinitrobenzene	99-65-0	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
o-Dinitrobenzene	528-29-0	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
p-Dinitrobenzene	100-25-4	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Volatile Organic Compounds (VOCs)												
Di(2-ethylhexyl)adipate	103-23-1	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U
Hexachlorobutadiene	87-68-3	mg/kg	--	--	--	0.045 U	0.055 U	0.057 U	0.042 U	0.039 U	0.046 U	0.041 U

Notes:

--	Not available.
RED/BOLD	Detected concentration exceeds the minimum SLERA COPEC selection ESV.
Italics	Reporting limit exceeds the minimum SLERA COPEC selection ESV.

Abbreviations:

CAS	Chemical Abstracts Service	in	Inches
COPEC	Contaminant of potential ecological concern	mg/kg	Milligrams per kilogram
ESV	Ecological screening value	SLERA	Screening level ecological risk assessment
ft	Feet		

Qualifier:

U Analyte was not detected at the given reporting limit.

Table C.4c
Laboratory Analytical Results and Screening Evaluation for SVOCs and VOCs—Ecological

Area						**In Situ (cont.)**				
Location						**SDL25**	**SDL35**	**SDL15**	**SDL38**	**SDL52**
Sample ID						**SDL25-B-1.5ft**	**SDL35-B-2.0ft**	**SDL15-B-2.0ft**	**SDL38-B-2.0ft**	**SDL52-B-2.0ft**
Sample Date						**04/14/2017**	**05/11/2017**	**06/05/2017**	**06/26/2017**	**06/26/2017**
Depth						**1.5 ft**	**2 ft**	**2 ft**	**2 ft**	**2 ft**
Analyte	**CAS No.**	**Units**	**Plant and Invertebrate SLERA COPEC Selection ESV**	**Bird and Mammal SLERA COPEC Selection ESV**	**Minimum SLERA COPEC Selection ESV**					
SVOCs (cont.)										
Di-n-butyl phthalate	84-74-2	mg/kg	160	0.011	0.011	*0.2 U*	*0.26 U*	*0.24 U*	*0.22 U*	*0.28 U*
Di-n-octyl phthalate	117-84-0	mg/kg	--	0.91	0.91	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Dibenzofuran	132-64-9	mg/kg	6.1	--	6.1	0.04 U	0.32	0.58	0.12	0.28
Diethylphthalate	84-66-2	mg/kg	100	3,600	100	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Dimethyl phthalate	131-11-3	mg/kg	10	38	10	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorobenzene	118-74-1	mg/kg	10	0.079	0.079	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorocyclopentadiene	77-47-4	mg/kg	10	--	10	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachloroethane	67-72-1	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Isophorone	78-59-1	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
N-Nitroso-di-n-propylamine	621-64-7	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
N-Nitrosodimethylamine	62-75-9	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
N-Nitrosodiphenylamine	86-30-6	mg/kg	20	--	20	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Nitrobenzene	98-95-3	mg/kg	2.2	4.8	2.2	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Pentachlorophenol	87-86-5	mg/kg	3	0.36	0.36	0.2 U	0.26 U	0.24 U	0.22 U	0.28 U
Phenol	108-95-2	mg/kg	0.79	37	0.79	0.04 U	0.053 U	0.048 U	0.057	0.056 U
Pyridine	110-86-1	mg/kg	--	--	--	0.4 U	0.53 U	0.48 U	0.44 U	0.56 U
Bis(2-chloroethoxy)methane	111-91-1	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Bis(2-chloroethyl)ether	111-44-4	mg/kg	--	--	--	0.04 U	0.26	0.048 U	0.044 U	0.056 U
Bis(2-chloroisopropyl)ether	108-60-1	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	--	0.02	0.02	**0.048**	**0.27**	**0.071**	*0.044 U*	*0.056 U*
m-Dinitrobenzene	99-65-0	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
o-Dinitrobenzene	528-29-0	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
p-Dinitrobenzene	100-25-4	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Volatile Organic Compounds (VOCs)										
Di(2-ethylhexyl)adipate	103-23-1	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U
Hexachlorobutadiene	87-68-3	mg/kg	--	--	--	0.04 U	0.053 U	0.048 U	0.044 U	0.056 U

Notes:

-- Not available.

RED/BOLD Detected concentration exceeds the minimum SLERA COPEC selection ESV.

Italics Reporting limit exceeds the minimum SLERA COPEC selection ESV.

Abbreviations:

CAS Chemical Abstracts Service
COPEC Contaminant of potential ecological concern
ESV Ecological screening value
ft Feet
in Inches
mg/kg Milligrams per kilogram
SLERA Screening level ecological risk assessment

Qualifier:

U Analyte was not detected at the given reporting limit.

Table C.5
Analytes Eliminated from the Ecological Risk Assessment

Analytes	CAS No.	Rationale for Elimination
Metals by EPA 6010C/7471B		
Barium (1)	7440-39-3	No site data
Selenium (1)	7782-49-2	No site data
Silver (1)	7440-22-4	No site data
Polycyclic Aromatic Hydrocarbons by EPA 8270D/8270D-SIM		
1-Methylnaphthalene	90-12-0	No ESV (2)
2-Methylnaphthalene	91-57-6	Maximum concentration < ESV
Acenaphthylene	208-96-8	Maximum concentration < ESV
Anthracene	120-12-7	Maximum concentration < ESV
Benzo(a)pyrene	50-32-8	Maximum concentration < ESV
Benzo(b)fluoranthene	205-99-2	Maximum concentration < ESV
Benzo(g,h,i)perylene	191-24-2	Maximum concentration < ESV
Benzofluoranthenes (j+k)	BJKFLANTH	No ESV (2)
Dibenzo(a,h)anthracene	53-70-3	Maximum concentration < ESV
Fluorene	86-73-7	Maximum concentration < ESV
Fluoranthene	206-44-0	Maximum concentration < ESV
Pyrene	129-00-0	Maximum concentration < ESV
Indeno(1,2,3-c,d)pyrene	193-39-5	Maximum concentration < ESV
Naphthalene	91-20-3	Maximum concentration < ESV
Phenanthrene	85-01-8	Maximum concentration < ESV
Total LMW PAHs (U=0)	LPAH (U=0)	Maximum concentration < ESV
Semivolatile Organic Compounds by EPA 8270D/8270D-SIM		
1,2,4-Trichlorobenzene	120-82-1	Maximum concentration < ESV
1,2-Dichlorobenzene	95-50-1	Maximum concentration < ESV
1,2-Diphenylhydrazine	122-66-7	No ESV (2)
1,3-Dichlorobenzene	541-73-1	Maximum concentration < ESV
1,4-Dichlorobenzene	106-46-7	Maximum concentration < ESV
2,3,4,6-Tetrachlorophenol	58-90-2	No ESV, no detected results
2,3,5,6-Tetrachlorophenol	935-95-5	No ESV, no detected results
2,3-Dichloroaniline	608-27-5	No ESV, no detected results
2,4,5-Trichlorophenol	95-95-4	Maximum concentration < ESV
2,4,6-Trichlorophenol	88-06-2	Maximum concentration < ESV
2,4-Dichlorophenol	120-83-2	No ESV, no detected results
2,4-Dimethylphenol	105-67-9	Maximum non-detect concentration > ESV, no detected results, no history of site use
2,4-Dinitrophenol	51-28-5	Maximum concentration < ESV
2,4-Dinitrotoluene	121-14-2	Maximum concentration < ESV
2,6-Dinitrotoluene	606-20-2	Maximum concentration < ESV
2-Chloronaphthalene	91-58-7	No ESV, no detected results
2-Chlorophenol	95-57-8	Maximum concentration < ESV
2-Methylphenol	95-48-7	Maximum concentration < ESV
2-Nitroaniline	88-74-4	Maximum concentration < ESV
2-Nitrophenol	88-75-5	Maximum concentration < ESV
3,3'-Dichlorobenzidine	91-94-1	No ESV, no detected results
3- & 4-Methylphenol	MEPH3_4	No ESV, no detected results
3-Nitroaniline	99-09-2	No ESV, no detected results
4,6-Dinitro-o-cresol	534-52-1	No ESV, no detected results
4-Bromophenyl phenyl ether	101-55-3	No ESV, no detected results
4-Chloro-3-methylphenol	59-50-7	No ESV, no detected results
4-Chloroaniline	106-47-8	Maximum concentration < ESV
4-Chlorophenyl phenyl ether	7005-72-3	No ESV, no detected results
4-Nitroaniline	100-01-6	No ESV, no detected results
4-Nitrophenol	100-02-7	Maximum concentration < ESV
Aniline	62-53-3	No ESV (2)
Benzidine	92-87-5	No ESV, no detected results
Benzyl alcohol	100-51-6	No ESV (2)
Butyl benzyl phthalate	85-68-7	Maximum concentration < ESV
Carbazole	86-74-8	Maximum concentration < ESV
Di-n-octyl phthalate	117-84-0	Maximum concentration < ESV
Dibenzofuran	132-64-9	Maximum concentration < ESV
Diethylphthalate	84-66-2	Maximum concentration < ESV
Dimethyl phthalate	131-11-3	Maximum concentration < ESV
Di-n-butyl phthalate	84-74-2	Maximum non-detect concentration > ESV, no detected results, no history of site use
Hexachlorobenzene	118-74-1	Maximum concentration < ESV
Hexachlorocyclopentadiene	77-47-4	Maximum concentration < ESV
Hexachloroethane	67-72-1	No ESV, no detected results
Isophorone	78-59-1	No ESV, no detected results
N-Nitroso-di-n-propylamine	621-64-7	No ESV, no detected results
N-Nitrosodimethylamine	62-75-9	No ESV, no detected results
N-Nitrosodiphenylamine	86-30-6	Maximum concentration < ESV
Nitrobenzene	98-95-3	Maximum concentration < ESV
Pentachlorophenol	87-86-5	Maximum concentration < ESV
Phenol	108-95-2	Maximum concentration < ESV
Pyridine	110-86-1	No ESV, no detected results
Bis(2-chloroethoxy)methane	111-91-1	No ESV, no detected results
Bis(2-chloroethyl)ether	111-44-4	No ESV (2)
Bis(2-chloroisopropyl)ether	108-60-1	No ESV, no detected results
m-Dinitrobenzene	99-65-0	No ESV, no detected results
o-Dinitrobenzene	528-29-0	No ESV, no detected results
p-Dinitrobenzene	100-25-4	No ESV, no detected results
Volatile Organic Compounds by EPA 8270D		
Di(2-ethylhexyl)adipate	103-23-1	No ESV, no detected results
Hexachlorobutadiene	87-68-3	No ESV, no detected results

Notes:

1 No history of site use and not analyzed in site samples. Maximum background concentration is non-detect and exceeds the minimum SLERA COPEC selection ESV.

2 An analysis of available toxicity information was conducted for chemicals with detected results but without screening values. The results of that analysis are discussed in Section 3.2.4.1 and are presented in Table 3.23.

Abbreviations:

CAS	Chemical Abstracts Service	FOD	Frequency of detection
COPEC	Contaminant of potential ecological concern	LMW	Low molecular weight
ESV	Ecological screening value	SLERA	Screening level ecological risk assessment

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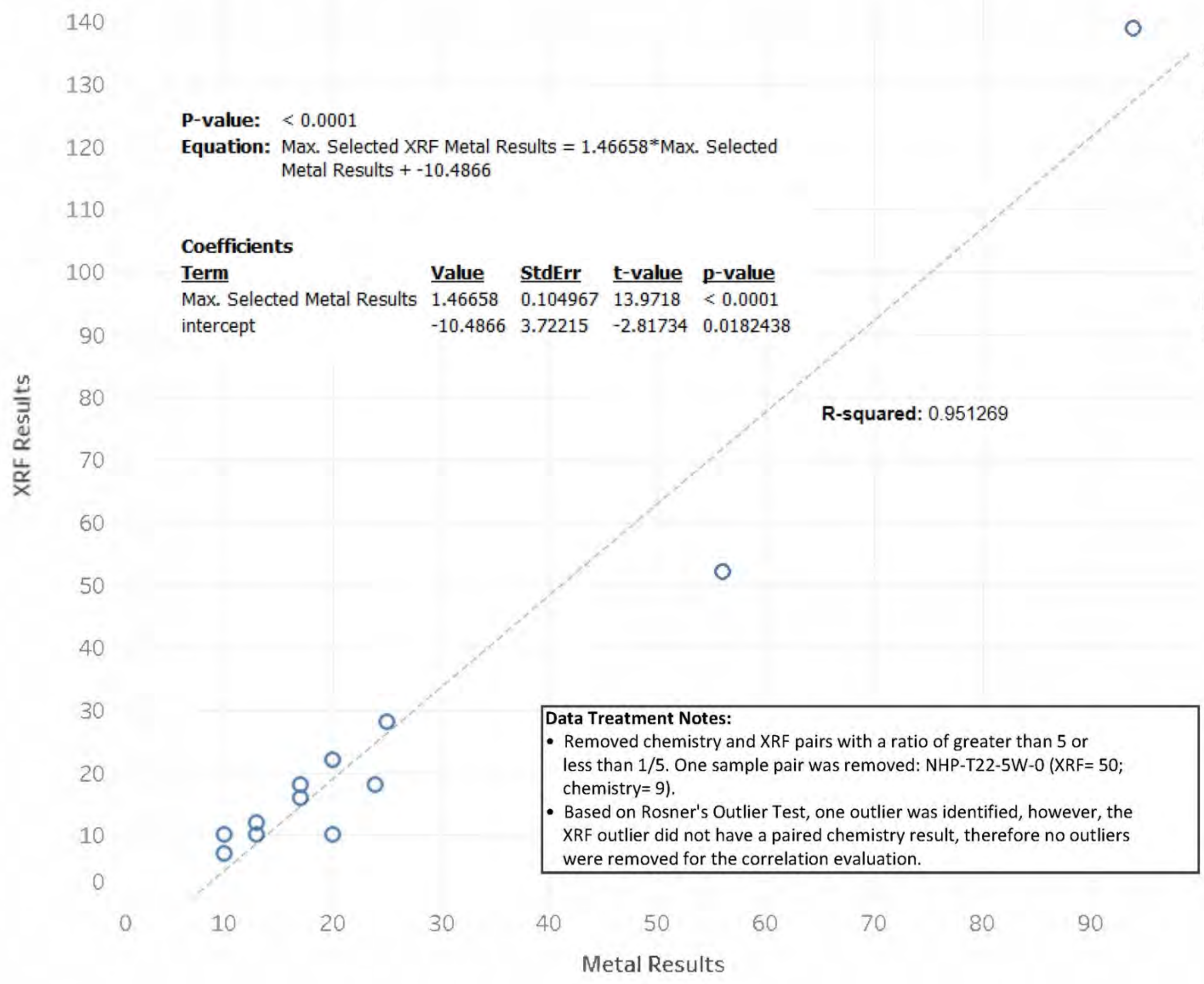
Appendix D
Chemistry and XRF Data Correlation Analysis

```
Outlier Tests for Selected Variables excluding nondetects
User Selected Options
Date/Time of Computation        ProUCL 5.110/29/2020 6:23:40 PM
From File                                   WorkSheet.xls
Full Precision                              OFF


Rosner's Outlier Test for 1 Outliers in Result (arsenic)


Total N                          393
Number NDs                       148
Number Detects                   245
Mean of Detects                    24.79
SD of Detects                      52.09
Number of data                  245
Number of suspected outliers    1
NDs not included in the following:

                              Potential  Obs.     Test      Critical    Critical
#          Mean       sd       outlier    Number   value     value (5%)  value (1%)
1            24.79      51.98    787        176       14.66      3.664      4.034

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 787 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier


Rosner's Outlier Test for 1 Outliers in result (chromium)


Total N                            58
Number NDs                         18
Number Detects                     40
Mean of Detects                    26.23
SD of Detects                      14.91
Number of data                  40
Number of suspected outliers    1
NDs not included in the following:

                              Potential  Obs.     Test      Critical    Critical
#          Mean       sd       outlier    Number   value     value (5%)  value (1%)
1            26.23      14.73     85          1        3.991     3.04       3.38

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 85 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier


Rosner's Outlier Test for 1 Outliers in result (copper)


Total N                            58
Number NDs                         12
Number Detects                     46
Mean of Detects                    20.5
SD of Detects                       7.825
Number of data                  46
Number of suspected outliers    1
NDs not included in the following:

                              Potential  Obs.     Test      Critical    Critical
#          Mean       sd       outlier    Number   value     value (5%)  value (1%)
1            20.5        7.74     37          1        2.132     3.09       3.45

For 5% Significance Level, there is no Potential Outlier

For 1% Significance Level, there is no Potential Outlier
```

```
Outlier Tests for Selected Variables excluding nondetects
User Selected Options
Date/Time of Computation      ProUCL 5.110/29/2020 6:23:40 PM
From File                                WorkSheet.xls
Full Precision                           OFF


Rosner's Outlier Test for 1 Outliers in Result (lead)


Total N                          393
Number NDs                        10
Number Detects                   383
Mean of Detects                  191.6
SD of Detects                    417.1
Number of data                  383
Number of suspected outliers    1
NDs not included in the following:

                             Potential   Obs.     Test     Critical    Critical
#         Mean      sd       outlier     Number   value    value (5%)  value (1%)
1           191.6    416.5     5485        338      12.71     3.789      4.159

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 5485 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier
Therefore, Observation 5485 is a Potential Statistical Outlier


Rosner's Outlier Test for 1 Outliers in (zinc)


Total N                          390
Number NDs                         5
Number Detects                   385
Mean of Detects                    91.13
SD of Detects                    147.2
Number of data                  385
Number of suspected outliers    1
NDs not included in the following:

                             Potential   Obs.     Test     Critical    Critical
#         Mean      sd       outlier     Number   value    value (5%)  value (1%)
1            91.13    147      2802        285      18.44     3.79       4.16

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 2802 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier
```

Check for Correlation Between Metals Analytical and XRF Results: Arsenic in Soil



P-value: < 0.0001

Equation: Max. Selected XRF Metal Results = 1.46658*Max. Selected Metal Results + -10.4866

Coefficients

Term	Value	StdErr	t-value	p-value
Max. Selected Metal Results	1.46658	0.104967	13.9718	< 0.0001
intercept	-10.4866	3.72215	-2.81734	0.0182438

R-squared: 0.951269

Data Treatment Notes:

- Removed chemistry and XRF pairs with a ratio of greater than 5 or less than 1/5. One sample pair was removed: NHP-T22-5W-0 (XRF= 50; chemistry= 9).
- Based on Rosner's Outlier Test, one outlier was identified, however, the XRF outlier did not have a paired chemistry result, therefore no outliers were removed for the correlation evaluation.

Fraction
☐ Leachate
☑ NA
☑ Total

XRF Analytes Param..
Arsenic

Metal & Inorganic A..
Arsenic

Include Outliers
Yes

Number of Std Devi..
3 Std Dev ~ 99%

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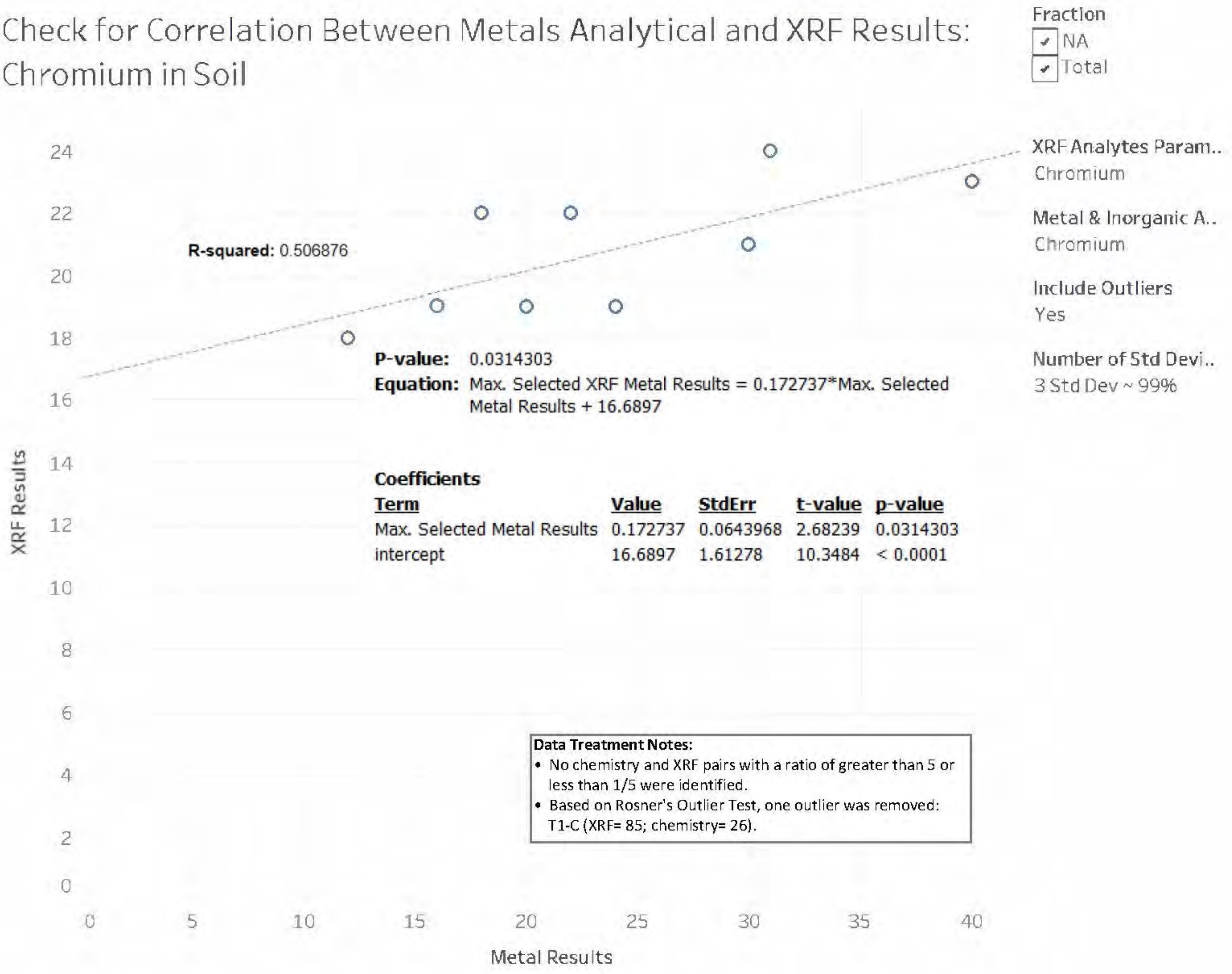
Appendix D: Chemistry and XRF Data Correlation Analysis—Arsenic

12/1/2020



Check for Correlation Between Metals Analytical and XRF Results: Chromium in Soil

P-value: 0.0314303

Equation: Max. Selected XRF Metal Results = 0.172737*Max. Selected Metal Results + 16.6897

Coefficients

Term	Value	StdErr	t-value	p-value
Max. Selected Metal Results	0.172737	0.0643968	2.68239	0.0314303
intercept	16.6897	1.61278	10.3484	< 0.0001

Data Treatment Notes:

- No chemistry and XRF pairs with a ratio of greater than 5 or less than 1/5 were identified.
- Based on Rosner's Outlier Test, one outlier was removed: T1-C (XRF= 85; chemistry= 26).

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Appendix D: Chemistry and XRF Data Correlation Analysis—Chromium

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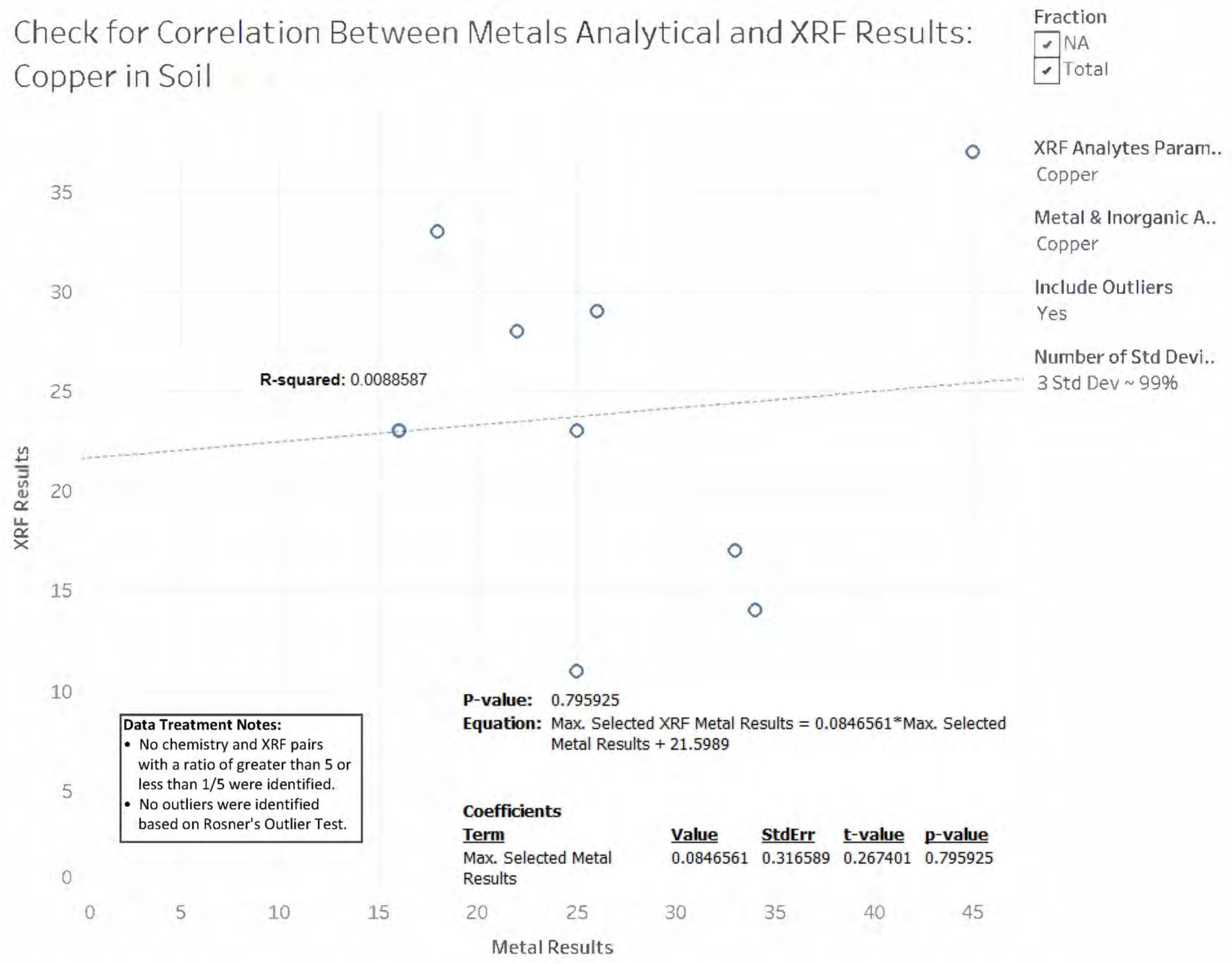
Check for Correlation Between Metals Analytical and XRF Results: Copper in Soil



Fraction
☑ NA
☑ Total

XRF Analytes Param..
Copper

Metal & Inorganic A..
Copper

Include Outliers
Yes

Number of Std Devi..
3 Std Dev ~ 99%

R-squared: 0.0088587

Data Treatment Notes:
- No chemistry and XRF pairs with a ratio of greater than 5 or less than 1/5 were identified.
- No outliers were identified based on Rosner's Outlier Test.

P-value: 0.795925

Equation: Max. Selected XRF Metal Results = 0.0846561*Max. Selected Metal Results + 21.5989

Coefficients

Term	Value	StdErr	t-value	p-value
Max. Selected Metal Results	0.0846561	0.316589	0.267401	0.795925

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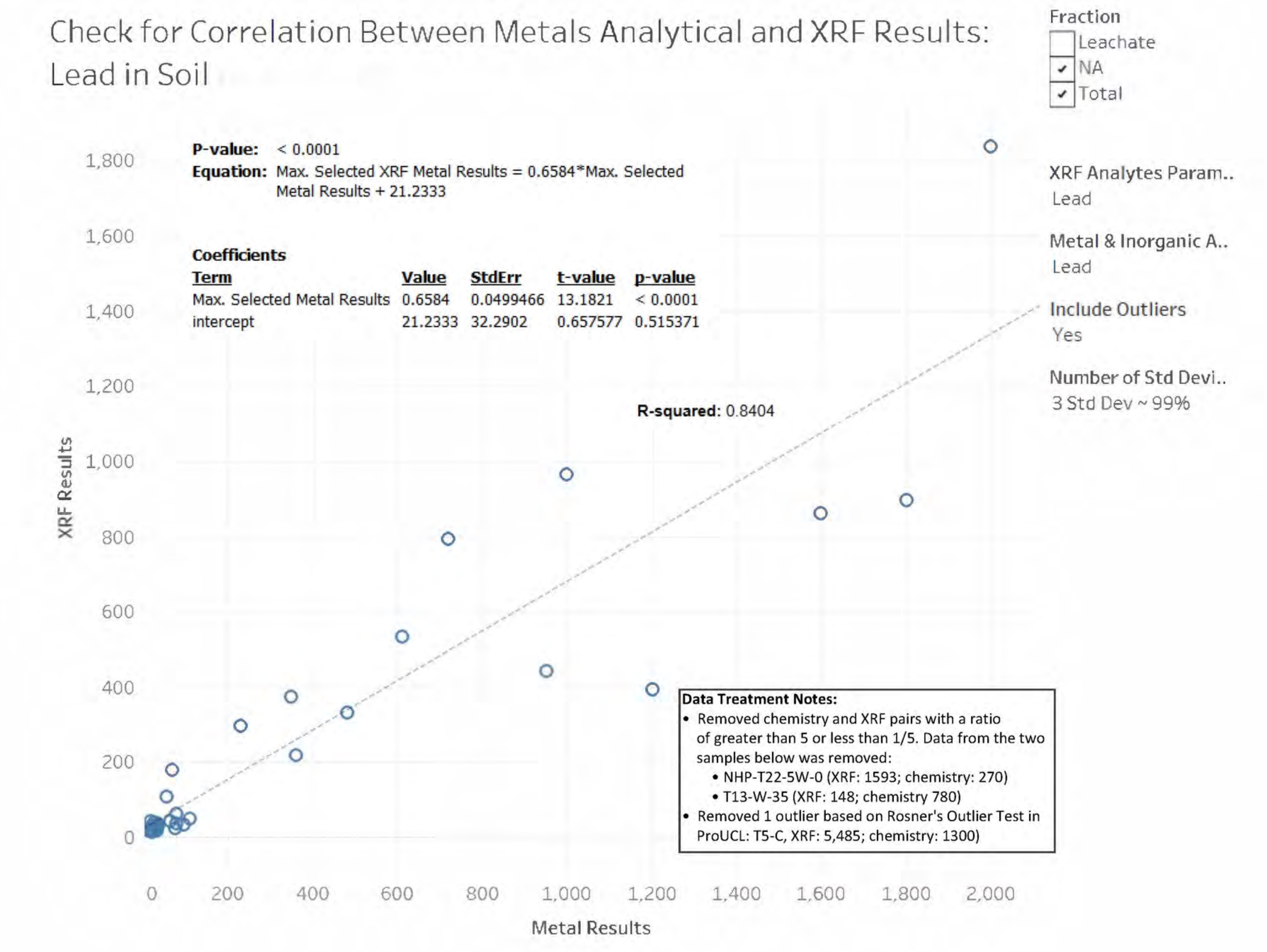
Appendix D: Chemistry and XRF Data Correlation Analysis—Copper

12/1/2020



Check for Correlation Between Metals Analytical and XRF Results: Lead in Soil

Fraction
☐ Leachate
☑ NA
☑ Total

XRF Analytes Param..
Lead

Metal & Inorganic A..
Lead

Include Outliers
Yes

Number of Std Devi..
3 Std Dev ~ 99%

P-value: < 0.0001
Equation: Max. Selected XRF Metal Results = 0.6584*Max. Selected Metal Results + 21.2333

Coefficients

Term	Value	StdErr	t-value	p-value
Max. Selected Metal Results	0.6584	0.0499466	13.1821	< 0.0001
intercept	21.2333	32.2902	0.657577	0.515371

R-squared: 0.8404

Data Treatment Notes:

- Removed chemistry and XRF pairs with a ratio of greater than 5 or less than 1/5. Data from the two samples below was removed:
  - NHP-T22-5W-0 (XRF: 1593; chemistry: 270)
  - T13-W-35 (XRF: 148; chemistry 780)
- Removed 1 outlier based on Rosner's Outlier Test in ProUCL: T5-C, XRF: 5,485; chemistry: 1300)

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Appendix D: Chemistry and XRF Data Correlation Analysis—Lead

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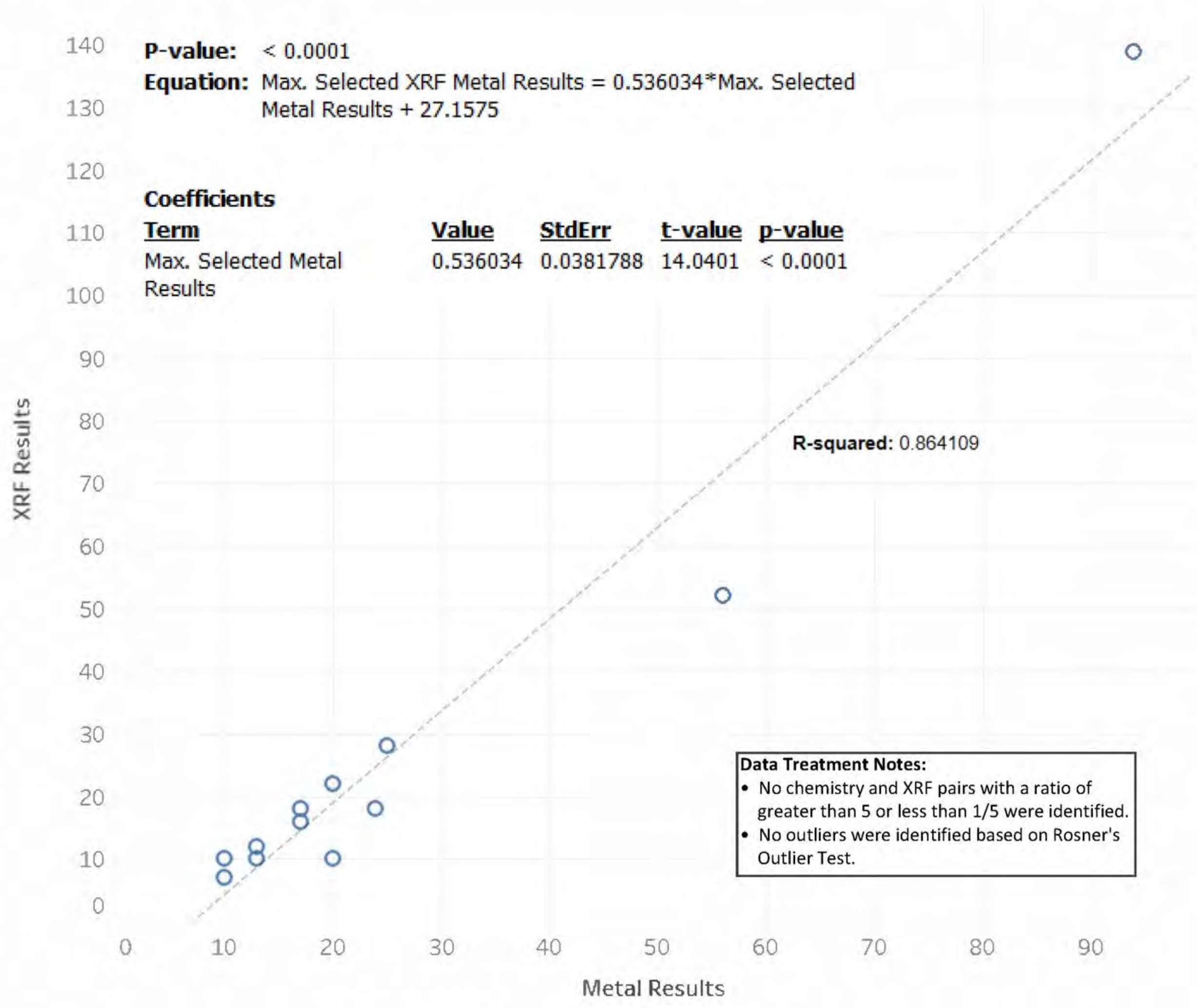
Check for Correlation Between Metals Analytical and XRF Results: Arsenic in Soil



Data Treatment Notes:

- No chemistry and XRF pairs with a ratio of greater than 5 or less than 1/5 were identified.
- No outliers were identified based on Rosner's Outlier Test.

Fraction
☐ Leachate
☑ NA
☑ Total

XRF Analytes Param..
Arsenic

Metal & Inorganic A..
Arsenic

Include Outliers
Yes

Number of Std Devi..
3 Std Dev ~ 99%

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Appendix D: Chemistry and XRF Data Correlation Analysis—Zinc

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Appendix E
ProUCL Output

ProUCL Output—Metals 0–3ft

```
                                UCL Statistics for Data Sets with Non-Detects

              User Selected Options
       Date/Time of Computation   ProUCL 5.111/5/2020 10:55:49 AM
                      From File   07 - Data for ProUCL_FD parent max.xls
                 Full Precision   OFF
         Confidence Coefficient   95%
 Number of Bootstrap Operations   2000

UseResult_Final Value (arsenic***7440-38-2)

                                        General Statistics
          Total Number of Observations  408          Number of Distinct Observations  101
                     Number of Detects  249                     Number of Non-Detects  159
            Number of Distinct Detects  82             Number of Distinct Non-Detects  30
                        Minimum Detect  4.5                       Minimum Non-Detect  5
                        Maximum Detect  543.8                     Maximum Non-Detect  63
                      Variance Detects  1239                     Percent Non-Detects  38.97%
                          Mean Detects  23.76                             SD Detects  35.21
                        Median Detects  18.06                             CV Detects  1.482
                      Skewness Detects  13.2                        Kurtosis Detects  193.8
                 Mean of Logged Detects  2.988                   SD of Logged Detects  0.468

                                 Normal GOF Test on Detects Only
             Shapiro Wilk Test Statistic  0.258      Normal GOF Test on Detected Observations Only
               5% Shapiro Wilk P Value  0          Detected Data Not Normal at 5% Significance Level
              Lilliefors Test Statistic  0.337                  Lilliefors GOF Test
           5% Lilliefors Critical Value  0.0566     Detected Data Not Normal at 5% Significance Level
                        Detected Data Not Normal at 5% Significance Level

            Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                               KM Mean  16.89                 KM Standard Error of Mean  1.436
                                 KM SD  28.87                        95% KM (BCA) UCL  19.98
                         95% KM (t) UCL  19.25        95% KM (Percentile Bootstrap) UCL  19.55
                         95% KM (z) UCL  19.25                   95% KM Bootstrap t UCL  21.83
                  90% KM Chebyshev UCL  21.19                    95% KM Chebyshev UCL  23.15
                97.5% KM Chebyshev UCL  25.85                    99% KM Chebyshev UCL  31.17

                            Gamma GOF Tests on Detected Observations Only
                     A-D Test Statistic  4.016E+28               Anderson-Darling GOF Test
                   5% A-D Critical Value  0.76    Detected Data Not Gamma Distributed at 5% Significance Level
                     K-S Test Statistic  0.2                  Kolmogorov-Smirnov GOF
                   5% K-S Critical Value  0.0584  Detected Data Not Gamma Distributed at 5% Significance Level
                     Detected Data Not Gamma Distributed at 5% Significance Level

                                 Gamma Statistics on Detected Data Only
                             k hat (MLE)  2.933                  k star (bias corrected MLE)  2.9
                         Theta hat (MLE)  8.101              Theta star (bias corrected MLE)  8.192
                            nu hat (MLE)  1461                    nu star (bias corrected)  1444
                          Mean (detects)  23.76

                              Gamma ROS Statistics using Imputed Non-Detects
                 GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
   GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                           For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                      This is especially true when the sample size is small.
            For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                                 Minimum  0.01                                        Mean  14.79
                                 Maximum  543.8                                     Median  13.97
                                      SD  29.72                                         CV  2.009
                             k hat (MLE)  0.302                  k star (bias corrected MLE)  0.301
                         Theta hat (MLE)  49                 Theta star (bias corrected MLE)  49.1
                            nu hat (MLE)  246.3                   nu star (bias corrected)  245.9
          Adjusted Level of Significance (β)  0.0494
      Approximate Chi Square Value (245.85, α)  210.5        Adjusted Chi Square Value (245.85, β)  210.4
   95% Gamma Approximate UCL (use when n>=50)  17.27     95% Gamma Adjusted UCL (use when n<50)  17.28

                                Estimates of Gamma Parameters using KM Estimates
                               Mean (KM)  16.89                                     SD (KM)  28.87
                           Variance (KM)  833.3                             SE of Mean (KM)  1.436
                              k hat (KM)  0.342                                  k star (KM)  0.341
                             nu hat (KM)  279.3                                 nu star (KM)  278.5
                          theta hat (KM)  49.34                              theta star (KM)  49.47
                80% gamma percentile (KM)  26.62                  90% gamma percentile (KM)  48.95
                95% gamma percentile (KM)  74.05                  99% gamma percentile (KM)  138.3
```

ProUCL Output—Metals 0–3ft

```
                                          Gamma Kaplan-Meier (KM) Statistics
              Approximate Chi Square Value (278.54, α)   240.9                   Adjusted Chi Square Value (278.54, β)   240.8
      95% Gamma Approximate KM-UCL (use when n>=50)    19.53         95% Gamma Adjusted KM-UCL (use when n<50)    19.54

                                      Lognormal GOF Test on Detected Observations Only
                 Shapiro Wilk Approximate Test Statistic    0.892                        Shapiro Wilk GOF Test
                                  5% Shapiro Wilk P Value    0                 Detected Data Not Lognormal at 5% Significance Level
                                    Lilliefors Test Statistic    0.144                          Lilliefors GOF Test
                             5% Lilliefors Critical Value    0.0566            Detected Data Not Lognormal at 5% Significance Level
                                          Detected Data Not Lognormal at 5% Significance Level

                                        Lognormal ROS Statistics Using Imputed Non-Detects
                                     Mean in Original Scale    17.63                                         Mean in Log Scale    2.615
                                        SD in Original Scale    28.58                                            SD in Log Scale    0.628
               95% t UCL (assumes normality of ROS data)    19.96                        95% Percentile Bootstrap UCL    20.2
                                  95% BCA Bootstrap UCL    21.81                                       95% Bootstrap t UCL    22.94
                                       95% H-UCL (Log ROS)    17.63

                          Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                                           KM Mean (logged)    2.484                                              KM Geo Mean    11.98
                                             KM SD (logged)    0.776                          95% Critical H Value (KM-Log)    1.941
                  KM Standard Error of Mean (logged)    0.0404                                    95% H-UCL (KM -Log)    17.45
                                             KM SD (logged)    0.776                          95% Critical H Value (KM-Log)    1.941
                  KM Standard Error of Mean (logged)    0.0404

                                                            DL/2 Statistics
                   DL/2 Normal                                                         DL/2 Log-Transformed
                                     Mean in Original Scale    16.81                                         Mean in Log Scale    2.468
                                        SD in Original Scale    28.92                                            SD in Log Scale    0.804
                          95% t UCL (Assumes normality)    19.17                                          95% H-Stat UCL    17.62
                   DL/2 is not a recommended method, provided for comparisons and historical reasons

                                              Nonparametric Distribution Free UCL Statistics
                                      Data do not follow a Discernible Distribution at 5% Significance Level

                                                            Suggested UCL to Use
                                              95% KM (t) UCL    19.25                                                  KM H-UCL    17.45
                                           95% KM (BCA) UCL    19.98

         Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                                           Recommendations are based upon data size, data distribution, and skewness.
          These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
      However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult_Final Value (chromium***7440-47-3)

                                                           General Statistics
                                  Total Number of Observations    14                            Number of Distinct Observations    13
                                                                                                Number of Missing Observations     0
                                                           Minimum    12                                                          Mean    22.29
                                                           Maximum    40                                                        Median    21
                                                                  SD    7.477                                          Std. Error of Mean    1.998
                                      Coefficient of Variation    0.336                                                      Skewness    1.017

                                                            Normal GOF Test
                              Shapiro Wilk Test Statistic    0.936                        Shapiro Wilk GOF Test
                           5% Shapiro Wilk Critical Value    0.874             Data appear Normal at 5% Significance Level
                                    Lilliefors Test Statistic    0.158                          Lilliefors GOF Test
                             5% Lilliefors Critical Value    0.226             Data appear Normal at 5% Significance Level
                                            Data appear Normal at 5% Significance Level

                                                    Assuming Normal Distribution
                 95% Normal UCL                                                     95% UCLs (Adjusted for Skewness)
                                       95% Student's-t UCL    25.82                       95% Adjusted-CLT UCL (Chen-1995)    26.15
                                                                                          95% Modified-t UCL (Johnson-1978)    25.92

                                                            Gamma GOF Test
                                          A-D Test Statistic    0.177                     Anderson-Darling Gamma GOF Test
                                        5% A-D Critical Value    0.735        Detected data appear Gamma Distributed at 5% Significance Level
                                          K-S Test Statistic    0.118                   Kolmogorov-Smirnov Gamma GOF Test
                                        5% K-S Critical Value    0.229        Detected data appear Gamma Distributed at 5% Significance Level
                                 Detected data appear Gamma Distributed at 5% Significance Level
```

ProUCL Output—Metals 0–3ft

```
                                              Gamma Statistics
                          k hat (MLE)    10.4                            k star (bias corrected MLE)    8.222
                        Theta hat (MLE)   2.142                       Theta star (bias corrected MLE)    2.711
                           nu hat (MLE)  291.3                               nu star (bias corrected)  230.2
               MLE Mean (bias corrected)  22.29                                MLE Sd (bias corrected)   7.772
                                                                  Approximate Chi Square Value (0.05)  196.1
          Adjusted Level of Significance  0.0312                             Adjusted Chi Square Value  191.9

                                       Assuming Gamma Distribution
   95% Approximate Gamma UCL (use when n>=50))  26.16          95% Adjusted Gamma UCL (use when n<50)  26.73

                                            Lognormal GOF Test
             Shapiro Wilk Test Statistic   0.991              Shapiro Wilk Lognormal GOF Test
           5% Shapiro Wilk Critical Value  0.874         Data appear Lognormal at 5% Significance Level
                Lilliefors Test Statistic  0.0983                Lilliefors Lognormal GOF Test
             5% Lilliefors Critical Value  0.226         Data appear Lognormal at 5% Significance Level
                             Data appear Lognormal at 5% Significance Level

                                            Lognormal Statistics
               Minimum of Logged Data      2.485                                 Mean of logged Data   3.055
               Maximum of Logged Data      3.689                                   SD of logged Data   0.321

                                      Assuming Lognormal Distribution
                             95% H-UCL     26.5                               90% Chebyshev (MVUE) UCL  28.07
              95% Chebyshev (MVUE) UCL     30.69                             97.5% Chebyshev (MVUE) UCL  34.34
              99% Chebyshev (MVUE) UCL     41.51

                                  Nonparametric Distribution Free UCL Statistics
                          Data appear to follow a Discernible Distribution at 5% Significance Level

                                       Nonparametric Distribution Free UCLs
                           95% CLT UCL     25.57                                     95% Jackknife UCL  25.82
              95% Standard Bootstrap UCL   25.52                                   95% Bootstrap-t UCL  26.75
                 95% Hall's Bootstrap UCL  27.23                          95% Percentile Bootstrap UCL  25.71
                    95% BCA Bootstrap UCL  25.93
           90% Chebyshev(Mean, Sd) UCL     28.28                           95% Chebyshev(Mean, Sd) UCL  31
         97.5% Chebyshev(Mean, Sd) UCL     34.77                           99% Chebyshev(Mean, Sd) UCL  42.17

                                            Suggested UCL to Use
                    95% Student's-t UCL    25.82

         Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                                  Recommendations are based upon data size, data distribution, and skewness.
              These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
        However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult_Final Value (copper***7440-50-8)

                                              General Statistics
              Total Number of Observations  14                            Number of Distinct Observations  11
                                                                          Number of Missing Observations   0
                                   Minimum  14                                                      Mean  26.21
                                   Maximum  47                                                    Median  25
                                        SD  10.29                                      Std. Error of Mean  2.75
                     Coefficient of Variation  0.393                                               Skewness  0.953

                                               Normal GOF Test
             Shapiro Wilk Test Statistic   0.896                         Shapiro Wilk GOF Test
           5% Shapiro Wilk Critical Value  0.874             Data appear Normal at 5% Significance Level
                Lilliefors Test Statistic  0.223                            Lilliefors GOF Test
             5% Lilliefors Critical Value  0.226             Data appear Normal at 5% Significance Level
                                Data appear Normal at 5% Significance Level

                                         Assuming Normal Distribution
                   95% Normal UCL                                  95% UCLs (Adjusted for Skewness)
                    95% Student's-t UCL    31.08                       95% Adjusted-CLT UCL (Chen-1995)  31.49
                                                                       95% Modified-t UCL (Johnson-1978)  31.2

                                               Gamma GOF Test
                      A-D Test Statistic   0.343                     Anderson-Darling Gamma GOF Test
                    5% A-D Critical Value  0.736      Detected data appear Gamma Distributed at 5% Significance Level
                      K-S Test Statistic   0.175                   Kolmogorov-Smirnov Gamma GOF Test
                    5% K-S Critical Value  0.229      Detected data appear Gamma Distributed at 5% Significance Level
                          Detected data appear Gamma Distributed at 5% Significance Level

                                              Gamma Statistics
                          k hat (MLE)     7.663                           k star (bias corrected MLE)    6.069
                        Theta hat (MLE)   3.421                        Theta star (bias corrected MLE)   4.319
                           nu hat (MLE)  214.6                               nu star (bias corrected)  169.9
               MLE Mean (bias corrected)  26.21                                MLE Sd (bias corrected)  10.64
                                                                  Approximate Chi Square Value (0.05)  140.8
          Adjusted Level of Significance  0.0312                             Adjusted Chi Square Value  137.3
```

ProUCL Output—Metals 0–3ft

```
                                          Assuming Gamma Distribution
   95% Approximate Gamma UCL (use when n>=50))    31.64            95% Adjusted Gamma UCL (use when n<50)    32.45

                                               Lognormal GOF Test
                   Shapiro Wilk Test Statistic    0.954             Shapiro Wilk Lognormal GOF Test
                 5% Shapiro Wilk Critical Value    0.874      Data appear Lognormal at 5% Significance Level
                      Lilliefors Test Statistic    0.152              Lilliefors Lognormal GOF Test
                    5% Lilliefors Critical Value    0.226      Data appear Lognormal at 5% Significance Level
                                 Data appear Lognormal at 5% Significance Level

                                              Lognormal Statistics
                       Minimum of Logged Data    2.639                            Mean of logged Data    3.2
                       Maximum of Logged Data    3.85                               SD of logged Data    0.374

                                          Assuming Lognormal Distribution
                                     95% H-UCL    32.24                       90% Chebyshev (MVUE) UCL    34.15
                      95% Chebyshev (MVUE) UCL    37.76                     97.5% Chebyshev (MVUE) UCL    42.78
                      99% Chebyshev (MVUE) UCL    52.64

                                   Nonparametric Distribution Free UCL Statistics
                        Data appear to follow a Discernible Distribution at 5% Significance Level

                                       Nonparametric Distribution Free UCLs
                                   95% CLT UCL    30.74                               95% Jackknife UCL    31.08
                     95% Standard Bootstrap UCL    30.54                            95% Bootstrap-t UCL    32.64
                       95% Hall's Bootstrap UCL    32.42                    95% Percentile Bootstrap UCL    30.64
                          95% BCA Bootstrap UCL    31.14
                   90% Chebyshev(Mean, Sd) UCL    34.46                    95% Chebyshev(Mean, Sd) UCL    38.2
                 97.5% Chebyshev(Mean, Sd) UCL    43.39                    99% Chebyshev(Mean, Sd) UCL    53.58

                                               Suggested UCL to Use
                          95% Student's-t UCL    31.08

       Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                          Recommendations are based upon data size, data distribution, and skewness.
            These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
       However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult_Final Value (lead***7439-92-1)

                                                General Statistics
                  Total Number of Observations    410                    Number of Distinct Observations    235
                            Number of Detects    399                              Number of Non-Detects    11
                   Number of Distinct Detects    233                     Number of Distinct Non-Detects    5
                              Minimum Detect     1.164                              Minimum Non-Detect    6.3
                              Maximum Detect   4125                                 Maximum Non-Detect    12
                            Variance Detects  221333                                Percent Non-Detects    2.683%
                                Mean Detects    249.6                                       SD Detects    470.5
                              Median Detects    64.96                                       CV Detects    1.885
                            Skewness Detects    3.91                                  Kurtosis Detects    20.85
                       Mean of Logged Detects    4.245                             SD of Logged Detects    1.665

                                          Normal GOF Test on Detects Only
                   Shapiro Wilk Test Statistic    0.562        Normal GOF Test on Detected Observations Only
                      5% Shapiro Wilk P Value    0             Detected Data Not Normal at 5% Significance Level
                      Lilliefors Test Statistic    0.299                      Lilliefors GOF Test
                    5% Lilliefors Critical Value    0.0447       Detected Data Not Normal at 5% Significance Level
                                  Detected Data Not Normal at 5% Significance Level

                      Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                                      KM Mean    243                           KM Standard Error of Mean    23
                                        KM SD    465.2                                 95% KM (BCA) UCL    281.9
                                95% KM (t) UCL    280.9                   95% KM (Percentile Bootstrap) UCL    280.9
                                95% KM (z) UCL    280.9                           95% KM Bootstrap t UCL    286.3
                          90% KM Chebyshev UCL    312                             95% KM Chebyshev UCL    343.3
                        97.5% KM Chebyshev UCL    386.7                           99% KM Chebyshev UCL    471.9
```

ProUCL Output—Metals 0–3ft

```
                         Gamma GOF Tests on Detected Observations Only
                    A-D Test Statistic    13                        Anderson-Darling GOF Test
                 5% A-D Critical Value    0.823        Detected Data Not Gamma Distributed at 5% Significance Level
                    K-S Test Statistic    0.125                       Kolmogorov-Smirnov GOF
                 5% K-S Critical Value    0.0479       Detected Data Not Gamma Distributed at 5% Significance Level
                    Detected Data Not Gamma Distributed at 5% Significance Level

                              Gamma Statistics on Detected Data Only
                          k hat (MLE)     0.499                      k star (bias corrected MLE)    0.497
                      Theta hat (MLE)     500.5                  Theta star (bias corrected MLE)    502.6
                         nu hat (MLE)     397.9                         nu star (bias corrected)    396.2
                       Mean (detects)     249.6

                           Gamma ROS Statistics using Imputed Non-Detects
             GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
   GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                    For such situations, GROS method may yield incorrect values of UCLs and BTVs
                               This is especially true when the sample size is small.
         For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                              Minimum     0.01                                              Mean    242.9
                              Maximum    4125                                             Median    61.96
                                   SD     465.8                                               CV    1.918
                          k hat (MLE)     0.437                      k star (bias corrected MLE)    0.435
                      Theta hat (MLE)     555.8                  Theta star (bias corrected MLE)    557.8
                         nu hat (MLE)     358.3                         nu star (bias corrected)    357
         Adjusted Level of Significance (β)   0.0494
    Approximate Chi Square Value (357.02, α)   314.2           Adjusted Chi Square Value (357.02, β)    314.1
  95% Gamma Approximate UCL (use when n>=50)   275.9      95% Gamma Adjusted UCL (use when n<50)    276.1

                         Estimates of Gamma Parameters using KM Estimates
                            Mean (KM)     243                                            SD (KM)    465.2
                        Variance (KM)  216405                                     SE of Mean (KM)    23
                           k hat (KM)     0.273                                        k star (KM)    0.273
                          nu hat (KM)     223.8                                       nu star (KM)    223.5
                       theta hat (KM)     890.5                                    theta star (KM)    891.7
              80% gamma percentile (KM)   363.1                        90% gamma percentile (KM)    724.2
              95% gamma percentile (KM)  1146                          99% gamma percentile (KM)   2255

                              Gamma Kaplan-Meier (KM) Statistics
    Approximate Chi Square Value (223.48, α)   189.9           Adjusted Chi Square Value (223.48, β)    189.8
95% Gamma Approximate KM-UCL (use when n>=50)   286      95% Gamma Adjusted KM-UCL (use when n<50)    286.2

                         Lognormal GOF Test on Detected Observations Only
      Shapiro Wilk Approximate Test Statistic     0.956                    Shapiro Wilk GOF Test
                  5% Shapiro Wilk P Value  4.401E-12       Detected Data Not Lognormal at 5% Significance Level
                   Lilliefors Test Statistic     0.11                       Lilliefors GOF Test
                 5% Lilliefors Critical Value    0.0447       Detected Data Not Lognormal at 5% Significance Level
                          Detected Data Not Lognormal at 5% Significance Level

                         Lognormal ROS Statistics Using Imputed Non-Detects
                 Mean in Original Scale    243                                     Mean in Log Scale    4.167
                   SD in Original Scale    465.8                                     SD in Log Scale    1.71
     95% t UCL (assumes normality of ROS data)   280.9                    95% Percentile Bootstrap UCL    284.4
                   95% BCA Bootstrap UCL    284.2                              95% Bootstrap t UCL    286
                    95% H-UCL (Log ROS)    351.5

           Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                       KM Mean (logged)     4.174                                       KM Geo Mean    65
                         KM SD (logged)     1.698                      95% Critical H Value (KM-Log)    2.739
         KM Standard Error of Mean (logged)  0.0842                           95% H-UCL (KM -Log)    346
                         KM SD (logged)     1.698                      95% Critical H Value (KM-Log)    2.739
         KM Standard Error of Mean (logged)  0.0842

                                         DL/2 Statistics
                DL/2 Normal                                              DL/2 Log-Transformed
                 Mean in Original Scale    243                                     Mean in Log Scale    4.174
                   SD in Original Scale    465.8                                     SD in Log Scale    1.697
           95% t UCL (Assumes normality)    280.9                                    95% H-Stat UCL    345.4
                DL/2 is not a recommended method, provided for comparisons and historical reasons

                            Nonparametric Distribution Free UCL Statistics
                        Data do not follow a Discernible Distribution at 5% Significance Level
```

ProUCL Output—Metals 0–3ft

```
                                        Suggested UCL to Use
                       95% KM (Chebyshev) UCL    343.3

          Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                              Recommendations are based upon data size, data distribution, and skewness.
                 These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
         However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult_Final Value (zinc***7440-66-6)

                                        General Statistics
              Total Number of Observations    385                    Number of Distinct Observations    163
                       Number of Detects    380                             Number of Non-Detects      5
                Number of Distinct Detects    158                    Number of Distinct Non-Detects      5
                          Minimum Detect      5.303                         Minimum Non-Detect     21
                          Maximum Detect    5177                            Maximum Non-Detect     53
                        Variance Detects   75309                            Percent Non-Detects      1.299%
                            Mean Detects    118.6                                 SD Detects    274.4
                          Median Detects     85.52                                CV Detects      2.314
                        Skewness Detects     16.74                          Kurtosis Detects    306.7
                   Mean of Logged Detects      4.448                   SD of Logged Detects      0.691

                                    Normal GOF Test on Detects Only
                Shapiro Wilk Test Statistic      0.212          Normal GOF Test on Detected Observations Only
                     5% Shapiro Wilk P Value      0             Detected Data Not Normal at 5% Significance Level
                     Lilliefors Test Statistic      0.345                    Lilliefors GOF Test
                 5% Lilliefors Critical Value      0.0458         Detected Data Not Normal at 5% Significance Level
                                  Detected Data Not Normal at 5% Significance Level

          Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                                 KM Mean    117.4                  KM Standard Error of Mean     13.9
                                   KM SD    272.5                           95% KM (BCA) UCL    146.4
                           95% KM (t) UCL    140.3          95% KM (Percentile Bootstrap) UCL    144.8
                           95% KM (z) UCL    140.3                    95% KM Bootstrap t UCL    183.4
                    90% KM Chebyshev UCL    159.1                      95% KM Chebyshev UCL    178
                  97.5% KM Chebyshev UCL    204.3                      99% KM Chebyshev UCL    255.8

                                 Gamma GOF Tests on Detected Observations Only
                        A-D Test Statistic  2.632E+28                  Anderson-Darling GOF Test
                      5% A-D Critical Value      0.77         Detected Data Not Gamma Distributed at 5% Significance Level
                        K-S Test Statistic      0.132                   Kolmogorov-Smirnov GOF
                      5% K-S Critical Value      0.0473        Detected Data Not Gamma Distributed at 5% Significance Level
                             Detected Data Not Gamma Distributed at 5% Significance Level

                                    Gamma Statistics on Detected Data Only
                               k hat (MLE)      1.671                    k star (bias corrected MLE)      1.66
                           Theta hat (MLE)     70.96                 Theta star (bias corrected MLE)     71.45
                              nu hat (MLE)   1270                          nu star (bias corrected)   1261
                           Mean (detects)    118.6

                                 Gamma ROS Statistics using Imputed Non-Detects
                      GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
             GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                                For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                          This is especially true when the sample size is small.
                  For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                                  Minimum      0.01                                          Mean    117
                                  Maximum   5177                                            Median     83.66
                                       SD    273                                              CV      2.332
                               k hat (MLE)      1.297                    k star (bias corrected MLE)      1.289
                           Theta hat (MLE)     90.23                 Theta star (bias corrected MLE)     90.82
                              nu hat (MLE)    998.8                         nu star (bias corrected)    992.4
                Adjusted Level of Significance (β)      0.0494
          Approximate Chi Square Value (992.37, α)    920.2                 Adjusted Chi Square Value (992.37, β)    920
       95% Gamma Approximate UCL (use when n>=50)    126.2           95% Gamma Adjusted UCL (use when n<50)    126.3

                                Estimates of Gamma Parameters using KM Estimates
                                Mean (KM)    117.4                                        SD (KM)    272.5
                            Variance (KM)  74240                                  SE of Mean (KM)     13.9
                                k hat (KM)      0.186                                   k star (KM)      0.186
                               nu hat (KM)    143                                      nu star (KM)    143.2
                            theta hat (KM)    632.3                                  theta star (KM)    631.3
                  80% gamma percentile (KM)    148.6                        90% gamma percentile (KM)    354.6
                  95% gamma percentile (KM)    616.2                        99% gamma percentile (KM)   1345
```

ProUCL Output—Metals 0–3ft

```
                                   Gamma Kaplan-Meier (KM) Statistics
             Approximate Chi Square Value (143.22, α)   116.6             Adjusted Chi Square Value (143.22, β)   116.5
        95% Gamma Approximate KM-UCL (use when n>=50)   144.3      95% Gamma Adjusted KM-UCL (use when n<50)   144.4

                               Lognormal GOF Test on Detected Observations Only
                  Shapiro Wilk Approximate Test Statistic   0.975                  Shapiro Wilk GOF Test
                                 5% Shapiro Wilk P Value   0.00968    Detected Data Not Lognormal at 5% Significance Level
                                 Lilliefors Test Statistic   0.0572                  Lilliefors GOF Test
                               5% Lilliefors Critical Value   0.0458    Detected Data Not Lognormal at 5% Significance Level
                                  Detected Data Not Lognormal at 5% Significance Level

                               Lognormal ROS Statistics Using Imputed Non-Detects
                                Mean in Original Scale   117.4                                 Mean in Log Scale   4.433
                                  SD in Original Scale   272.8                                   SD in Log Scale   0.698
                 95% t UCL (assumes normality of ROS data)   140.4                   95% Percentile Bootstrap UCL   143.2
                              95% BCA Bootstrap UCL   161.3                            95% Bootstrap t UCL   185
                                  95% H-UCL (Log ROS)   115.1

                   Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                                     KM Mean (logged)   4.432                                       KM Geo Mean   84.07
                                       KM SD (logged)   0.703                    95% Critical H Value (KM-Log)   1.912
                      KM Standard Error of Mean (logged)   0.036                             95% H-UCL (KM -Log)   115.3
                                       KM SD (logged)   0.703                    95% Critical H Value (KM-Log)   1.912
                      KM Standard Error of Mean (logged)   0.036

                                              DL/2 Statistics
                   DL/2 Normal                                          DL/2 Log-Transformed
                                Mean in Original Scale   117.3                                 Mean in Log Scale   4.429
                                  SD in Original Scale   272.9                                   SD in Log Scale   0.707
                        95% t UCL (Assumes normality)   140.2                                95% H-Stat UCL   115.3
                   DL/2 is not a recommended method, provided for comparisons and historical reasons

                                   Nonparametric Distribution Free UCL Statistics
                              Data do not follow a Discernible Distribution at 5% Significance Level

                                            Suggested UCL to Use
                              95% KM (Chebyshev) UCL   178

          Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                             Recommendations are based upon data size, data distribution, and skewness.
               These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
         However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.
```

ProUCL Output—PAHs 0–3ft

```
UCL Statistics for Data Sets with Non-Detects

User Selected Options
Date/Time of Computation          ProUCL 5.19/11/2020 3:28:31 PM
From File                         20-0706_Newhalem_AllData_2020-0910_e.xls
Full Precision                    OFF
Confidence Coefficient            95%
Number of Bootstrap Operations    2000

UseResult (2,4-dimethylphenol***105-67-9)

General Statistics
Total Number of Observations                    9      Number of Distinct Observations          9
Number of Detects                               0      Number of Non-Detects                    9
Number of Distinct Detects                      0      Number of Distinct Non-Detects           9

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable UseResult (2,4-dimethylphenol***105-67-9) was not processed!


UseResult (acenaphthene***83-32-9)

General Statistics
Total Number of Observations                    17     Number of Distinct Observations          17
Number of Detects                               8      Number of Non-Detects                    9
Number of Distinct Detects                      8      Number of Distinct Non-Detects           9
Minimum Detect                                  0.034  Minimum Non-Detect                       0.0072
Maximum Detect                                  0.85   Maximum Non-Detect                       0.014
Variance Detects                                0.0797 Percent Non-Detects                      52.94%
Mean Detects                                    0.246  SD Detects                               0.282
Median Detects                                  0.135  CV Detects                               1.146
Skewness Detects                                1.731  Kurtosis Detects                         2.675
Mean of Logged Detects                         -1.946  SD of Logged Detects                     1.122

Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                     0.78   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.818  Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                       0.273  Lilliefors GOF Test
5% Lilliefors Critical Value                    0.283  Detected Data appear Normal at 5% Significance Level
Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                         0.12   KM Standard Error of Mean                0.0563
KM SD                                           0.217    95% KM (BCA) UCL                       0.226
95% KM (t) UCL                                  0.218  95% KM (Percentile Bootstrap) UCL        0.211
  95% KM (z) UCL                                0.212    95% KM Bootstrap t UCL                 0.372
90% KM Chebyshev UCL                            0.289  95% KM Chebyshev UCL                     0.365
97.5% KM Chebyshev UCL                          0.471  99% KM Chebyshev UCL                     0.679

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                              0.311  Anderson-Darling GOF Test
5% A-D Critical Value                           0.735  Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                              0.177  Kolmogorov-Smirnov GOF
5% K-S Critical Value                           0.301  Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                     1.053  k star (bias corrected MLE)              0.741
Theta hat (MLE)                                 0.234  Theta star (bias corrected MLE)          0.332
nu hat (MLE)                                    16.84  nu star (bias corrected)                 11.86
Mean (detects)                                  0.246

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                         0.01   Mean                                     0.121
Maximum                                         0.85   Median                                   0.01
SD                                              0.223  CV                                       1.838
k hat (MLE)                                     0.509  k star (bias corrected MLE)              0.459
Theta hat (MLE)                                 0.238  Theta star (bias corrected MLE)          0.264
nu hat (MLE)                                    17.31  nu star (bias corrected)                 15.59
Adjusted Level of Significance (β)              0.0346
Approximate Chi Square Value (15.59, α)         7.675  Adjusted Chi Square Value (15.59, β)     7.099
95% Gamma Approximate UCL (use when n>=50)      0.246  95% Gamma Adjusted UCL (use when n<50)   0.266

Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                       0.12   SD (KM)                                  0.217
Variance (KM)                                   0.0471 SE of Mean (KM)                          0.0563
k hat (KM)                                      0.305  k star (KM)                              0.29
nu hat (KM)                                     10.36  nu star (KM)                             9.864
theta hat (KM)                                  0.393  theta star (KM)                          0.413
80% gamma percentile (KM)                       0.182  90% gamma percentile (KM)                0.355
95% gamma percentile (KM)                       0.554  99% gamma percentile (KM)                1.073
```

ProUCL Output—PAHs 0–3ft

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (9.86, α)	3.857	Adjusted Chi Square Value (9.86, β)	3.472
95% Gamma Approximate KM-UCL (use when n>=50)	0.306	95% Gamma Adjusted KM-UCL (use when n<50)	0.34

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.119	Mean in Log Scale	-3.702
SD in Original Scale	0.224	SD in Log Scale	1.861
95% t UCL (assumes normality of ROS data)	0.214	95% Percentile Bootstrap UCL	0.219
95% BCA Bootstrap UCL	0.251	95% Bootstrap t UCL	0.37
95% H-UCL (Log ROS)	0.953		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.528	KM Geo Mean	0.0294
KM SD (logged)	1.656	95% Critical H Value (KM-Log)	3.76
KM Standard Error of Mean (logged)	0.429	95% H-UCL (KM -Log)	0.549
KM SD (logged)	1.656	95% Critical H Value (KM-Log)	3.76
KM Standard Error of Mean (logged)	0.429		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.119	Mean in Log Scale	-3.747
SD in Original Scale	0.224	SD in Log Scale	1.91
95% t UCL (Assumes normality)	0.214	95% H-Stat UCL	1.095

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.218

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzidine*92-87-5)**

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	0	Number of Non-Detects	9
Number of Distinct Detects	0	Number of Distinct Non-Detects	9

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable UseResult (benzidine*92-87-5) was not processed!**

UseResult (benzo(a)anthracene*56-55-3)**

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	15	Number of Non-Detects	2
Number of Distinct Detects	15	Number of Distinct Non-Detects	2
Minimum Detect	0.015	Minimum Non-Detect	0.0077
Maximum Detect	2.9	Maximum Non-Detect	0.012
Variance Detects	1.139	Percent Non-Detects	11.76%
Mean Detects	0.845	SD Detects	1.067
Median Detects	0.2	CV Detects	1.262
Skewness Detects	1.105	Kurtosis Detects	-0.321
Mean of Logged Detects	-1.426	SD of Logged Detects	1.919

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.747	KM Standard Error of Mean	0.252
KM SD	1.005	95% KM (BCA) UCL	1.135
95% KM (t) UCL	1.188	95% KM (Percentile Bootstrap) UCL	1.185
95% KM (z) UCL	1.162	95% KM Bootstrap t UCL	1.341
90% KM Chebyshev UCL	1.504	95% KM Chebyshev UCL	1.847
97.5% KM Chebyshev UCL	2.323	99% KM Chebyshev UCL	3.258

ProUCL Output—PAHs 0–3ft

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.603	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.793	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.162	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.234	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.504	k star (bias corrected MLE)	0.448
Theta hat (MLE)	1.677	Theta star (bias corrected MLE)	1.888
nu hat (MLE)	15.13	nu star (bias corrected)	13.43
Mean (detects)	0.845		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.747
Maximum	2.9	Median	0.14
SD	1.036	CV	1.387
k hat (MLE)	0.431	k star (bias corrected MLE)	0.394
Theta hat (MLE)	1.733	Theta star (bias corrected MLE)	1.896
nu hat (MLE)	14.65	nu star (bias corrected)	13.4
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (13.40, α)	6.163	Adjusted Chi Square Value (13.40, β)	5.656
95% Gamma Approximate UCL (use when n>=50)	1.624	95% Gamma Adjusted UCL (use when n<50)	1.77

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.747	SD (KM)	1.005
Variance (KM)	1.011	SE of Mean (KM)	0.252
k hat (KM)	0.552	k star (KM)	0.494
nu hat (KM)	18.76	nu star (KM)	16.78
theta hat (KM)	1.353	theta star (KM)	1.513
80% gamma percentile (KM)	1.226	90% gamma percentile (KM)	2.026
95% gamma percentile (KM)	2.882	99% gamma percentile (KM)	4.99

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (16.78, α)	8.519	Adjusted Chi Square Value (16.78, β)	7.907
95% Gamma Approximate KM-UCL (use when n>=50)	1.472	95% Gamma Adjusted KM-UCL (use when n<50)	1.585

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.746	Mean in Log Scale	-1.947
SD in Original Scale	1.037	SD in Log Scale	2.321
95% t UCL (assumes normality of ROS data)	1.185	95% Percentile Bootstrap UCL	1.174
95% BCA Bootstrap UCL	1.3	95% Bootstrap t UCL	1.329
95% H-UCL (Log ROS)	38.07		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.831	KM Geo Mean	0.16
KM SD (logged)	2.065	95% Critical H Value (KM-Log)	4.507
KM Standard Error of Mean (logged)	0.518	95% H-UCL (KM -Log)	13.83
KM SD (logged)	2.065	95% Critical H Value (KM-Log)	4.507
KM Standard Error of Mean (logged)	0.518		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.747	Mean in Log Scale	-1.886
SD in Original Scale	1.037	SD in Log Scale	2.218
95% t UCL (Assumes normality)	1.185	95% H-Stat UCL	25.26

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5	1.585

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzo(a)pyrene*50-32-8)**

ProUCL Output—PAHs 0–3ft

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	14	Number of Non-Detects	3
Number of Distinct Detects	14	Number of Distinct Non-Detects	3
Minimum Detect	0.015	Minimum Non-Detect	0.0077
Maximum Detect	1.5	Maximum Non-Detect	0.012
Variance Detects	0.328	Percent Non-Detects	17.65%
Mean Detects	0.5	SD Detects	0.573
Median Detects	0.24	CV Detects	1.145
Skewness Detects	0.857	Kurtosis Detects	-1.011
Mean of Logged Detects	-1.734	SD of Logged Detects	1.737

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.793	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.413	KM Standard Error of Mean	0.135
KM SD	0.535	95% KM (BCA) UCL	0.639
95% KM (t) UCL	0.649	95% KM (Percentile Bootstrap) UCL	0.635
95% KM (z) UCL	0.635	95% KM Bootstrap t UCL	0.703
90% KM Chebyshev UCL	0.817	95% KM Chebyshev UCL	1.001
97.5% KM Chebyshev UCL	1.255	99% KM Chebyshev UCL	1.754

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.623	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.785	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.189	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.24	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.594	k star (bias corrected MLE)	0.514
Theta hat (MLE)	0.843	Theta star (bias corrected MLE)	0.973
nu hat (MLE)	16.63	nu star (bias corrected)	14.4
Mean (detects)	0.5		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.414
Maximum	1.5	Median	0.066
SD	0.551	CV	1.332
k hat (MLE)	0.472	k star (bias corrected MLE)	0.428
Theta hat (MLE)	0.877	Theta star (bias corrected MLE)	0.968
nu hat (MLE)	16.04	nu star (bias corrected)	14.54
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (14.54, α)	6.944	Adjusted Chi Square Value (14.54, β)	6.4
95% Gamma Approximate UCL (use when n>=50)	0.867	95% Gamma Adjusted UCL (use when n<50)	0.94

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.413	SD (KM)	0.535
Variance (KM)	0.286	SE of Mean (KM)	0.135
k hat (KM)	0.597	k star (KM)	0.531
nu hat (KM)	20.29	nu star (KM)	18.04
theta hat (KM)	0.693	theta star (KM)	0.779
80% gamma percentile (KM)	0.68	90% gamma percentile (KM)	1.105
95% gamma percentile (KM)	1.555	99% gamma percentile (KM)	2.655

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.04, α)	9.423	Adjusted Chi Square Value (18.04, β)	8.775
95% Gamma Approximate KM-UCL (use when n>=50)	0.792	95% Gamma Adjusted KM-UCL (use when n<50)	0.85

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.89	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.413	Mean in Log Scale	-2.429
SD in Original Scale	0.552	SD in Log Scale	2.2
95% t UCL (assumes normality of ROS data)	0.646	95% Percentile Bootstrap UCL	0.637
95% BCA Bootstrap UCL	0.676	95% Bootstrap t UCL	0.747
95% H-UCL (Log ROS)	13.6		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.287	KM Geo Mean	0.102
KM SD (logged)	1.932	95% Critical H Value (KM-Log)	4.261
KM Standard Error of Mean (logged)	0.486	95% H-UCL (KM -Log)	5.135
KM SD (logged)	1.932	95% Critical H Value (KM-Log)	4.261
KM Standard Error of Mean (logged)	0.486		

ProUCL Output—PAHs 0–3ft

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.413	Mean in Log Scale	-2.382
SD in Original Scale	0.552	SD in Log Scale	2.13
95% t UCL (Assumes normality)	0.647	95% H-Stat UCL	10.49

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5	0.85

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzo(b)fluoranthene*205-99-2)**

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	1
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	0.012	Minimum Non-Detect	0.0077
Maximum Detect	2.9	Maximum Non-Detect	0.0077
Variance Detects	1.301	Percent Non-Detects	5.882%
Mean Detects	0.916	SD Detects	1.14
Median Detects	0.26	CV Detects	1.246
Skewness Detects	0.979	Kurtosis Detects	-0.827
Mean of Logged Detects	-1.339	SD of Logged Detects	1.909

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.749	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.862	KM Standard Error of Mean	0.274
KM SD	1.092	95% KM (BCA) UCL	1.324
95% KM (t) UCL	1.34	95% KM (Percentile Bootstrap) UCL	1.301
95% KM (z) UCL	1.312	95% KM Bootstrap t UCL	1.507
90% KM Chebyshev UCL	1.683	95% KM Chebyshev UCL	2.055
97.5% KM Chebyshev UCL	2.571	99% KM Chebyshev UCL	3.585

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.677	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.796	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.227	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.507	k star (bias corrected MLE)	0.453
Theta hat (MLE)	1.807	Theta star (bias corrected MLE)	2.019
nu hat (MLE)	16.22	nu star (bias corrected)	14.51
Mean (detects)	0.916		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.862
Maximum	2.9	Median	0.18
SD	1.126	CV	1.306
k hat (MLE)	0.465	k star (bias corrected MLE)	0.422
Theta hat (MLE)	1.856	Theta star (bias corrected MLE)	2.044
nu hat (MLE)	15.8	nu star (bias corrected)	14.34
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (14.34, α)	6.807	Adjusted Chi Square Value (14.34, β)	6.269
95% Gamma Approximate UCL (use when n>=50)	1.817	95% Gamma Adjusted UCL (use when n<50)	1.973

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.862	SD (KM)	1.092
Variance (KM)	1.193	SE of Mean (KM)	0.274
k hat (KM)	0.623	k star (KM)	0.552
nu hat (KM)	21.18	nu star (KM)	18.78
theta hat (KM)	1.384	theta star (KM)	1.561
80% gamma percentile (KM)	1.42	90% gamma percentile (KM)	2.284
95% gamma percentile (KM)	3.196	99% gamma percentile (KM)	5.42

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.78, α)	9.955	Adjusted Chi Square Value (18.78, β)	9.287
95% Gamma Approximate KM-UCL (use when n>=50)	1.626	95% Gamma Adjusted KM-UCL (use when n<50)	1.743

ProUCL Output—PAHs 0–3ft

```
Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                        0.914   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                     0.887   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                          0.152   Lilliefors GOF Test
5% Lilliefors Critical Value                       0.213   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                             0.862   Mean in Log Scale                          -1.611
SD in Original Scale                               1.126   SD in Log Scale                             2.163
  95% t UCL (assumes normality of ROS data)        1.339     95% Percentile Bootstrap UCL              1.301
  95% BCA Bootstrap UCL                            1.416     95% Bootstrap t UCL                       1.485
  95% H-UCL (Log ROS)                              26.21

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                  -1.546   KM Geo Mean                                 0.213
KM SD (logged)                                     1.976     95% Critical H Value (KM-Log)             4.343
KM Standard Error of Mean (logged)                 0.495     95% H-UCL (KM -Log)                       12.83
KM SD (logged)                                     1.976     95% Critical H Value (KM-Log)             4.343
KM Standard Error of Mean (logged)                 0.495

DL/2 Statistics
DL/2 Normal                                                DL/2 Log-Transformed
Mean in Original Scale                             0.862   Mean in Log Scale                          -1.587
SD in Original Scale                               1.126   SD in Log Scale                             2.113
  95% t UCL (Assumes normality)                    1.339     95% H-Stat UCL                            21.63
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use
Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5    1.743

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzofluoranthenes (j+k)***bjkflanth)

General Statistics
Total Number of Observations                       17      Number of Distinct Observations             16
Number of Detects                                  14      Number of Non-Detects                       3
Number of Distinct Detects                         13      Number of Distinct Non-Detects              3
Minimum Detect                                     0.0095  Minimum Non-Detect                          0.0077
Maximum Detect                                     0.96    Maximum Non-Detect                          0.012
Variance Detects                                   0.121   Percent Non-Detects                         17.65%
Mean Detects                                       0.308   SD Detects                                  0.348
Median Detects                                     0.15    CV Detects                                  1.129
Skewness Detects                                   0.899   Kurtosis Detects                           -0.855
Mean of Logged Detects                            -2.133   SD of Logged Detects                        1.648

Normal GOF Test on Detects Or
Shapiro Wilk Test Statistic                        0.804   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                     0.874   Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                          0.215   Lilliefors GOF Test
5% Lilliefors Critical Value                       0.226   Detected Data appear Normal at 5% Significance Level
Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                            0.255   KM Standard Error of Mean                   0.0817
KM SD                                              0.325     95% KM (BCA) UCL                          0.41
95% KM (t) UCL                                     0.397   95% KM (Percentile Bootstrap) UCL           0.391
  95% KM (z) UCL                                   0.389     95% KM Bootstrap t UCL                    0.435
90% KM Chebyshev UCL                               0.5     95% KM Chebyshev UCL                        0.611
97.5% KM Chebyshev UCL                             0.765   99% KM Chebyshev UCL                        1.068

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                 0.531   Anderson-Darling GOF Test
5% A-D Critical Value                              0.78    Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                 0.166   Kolmogorov-Smirnov GOF
5% K-S Critical Value                              0.239   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                        0.641   k star (bias corrected MLE)                 0.551
Theta hat (MLE)                                    0.48    Theta star (bias corrected MLE)             0.558
nu hat (MLE)                                       17.96   nu star (bias corrected)                    15.44
Mean (detects)                                     0.308
```

ProUCL Output—PAHs 0–3ft

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0095	Mean	0.255
Maximum	0.96	Median	0.054
SD	0.334	CV	1.311
k hat (MLE)	0.524	k star (bias corrected MLE)	0.471
Theta hat (MLE)	0.487	Theta star (bias corrected MLE)	0.542
nu hat (MLE)	17.82	nu star (bias corrected)	16.01
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (16.01, α)	7.967	Adjusted Chi Square Value (16.01, β)	7.378
95% Gamma Approximate UCL (use when n>=50)	0.513	95% Gamma Adjusted UCL (use when n<50)	0.554

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.255	SD (KM)	0.325
Variance (KM)	0.105	SE of Mean (KM)	0.0817
k hat (KM)	0.616	k star (KM)	0.546
nu hat (KM)	20.94	nu star (KM)	18.57
theta hat (KM)	0.414	theta star (KM)	0.466
80% gamma percentile (KM)	0.42	90% gamma percentile (KM)	0.676
95% gamma percentile (KM)	0.948	99% gamma percentile (KM)	1.611

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.57, α)	9.808	Adjusted Chi Square Value (18.57, β)	9.145
95% Gamma Approximate KM-UCL (use when n>=50)	0.483	95% Gamma Adjusted KM-UCL (use when n<50)	0.518

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.254	Mean in Log Scale	-2.777
SD in Original Scale	0.335	SD in Log Scale	2.067
95% t UCL (assumes normality of ROS data)	0.396	95% Percentile Bootstrap UCL	0.392
95% BCA Bootstrap UCL	0.413	95% Bootstrap t UCL	0.449
95% H-UCL (Log ROS)	5.428		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.611	KM Geo Mean	0.0734
KM SD (logged)	1.773	95% Critical H Value (KM-Log)	3.971
KM Standard Error of Mean (logged)	0.446	95% H-UCL (KM -Log)	2.058
KM SD (logged)	1.773	95% Critical H Value (KM-Log)	3.971
KM Standard Error of Mean (logged)	0.446		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.254	Mean in Log Scale	-2.71
SD in Original Scale	0.335	SD in Log Scale	1.966
95% t UCL (Assumes normality)	0.396	95% H-Stat UCL	3.85

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.397

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (bis(2-ethylhexyl)phthalate*117-81-7)**

General Statistics

Total Number of Observations	9	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	4
Number of Distinct Detects	4	Number of Distinct Non-Detects	4
Minimum Detect	0.048	Minimum Non-Detect	0.041
Maximum Detect	0.27	Maximum Non-Detect	0.056
Variance Detects	0.00909	Percent Non-Detects	44.44%
Mean Detects	0.1	SD Detects	0.0954
Median Detects	0.065	CV Detects	0.95
Skewness Detects	2.172	Kurtosis Detects	4.77
Mean of Logged Detects	-2.552	SD of Logged Detects	0.717

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

ProUCL Output—PAHs 0–3ft

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.644	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.421	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0743	KM Standard Error of Mean	0.0261
KM SD	0.07	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.123	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.117	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.153	95% KM Chebyshev UCL	0.188
97.5% KM Chebyshev UCL	0.237	99% KM Chebyshev UCL	0.334

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.834	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.684	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.395	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.36	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.123	k star (bias corrected MLE)	0.983
Theta hat (MLE)	0.0473	Theta star (bias corrected MLE)	0.102
nu hat (MLE)	21.23	nu star (bias corrected)	9.827
Mean (detects)	0.1		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0602
Maximum	0.27	Median	0.048
SD	0.0826	CV	1.371
k hat (MLE)	0.893	k star (bias corrected MLE)	0.67
Theta hat (MLE)	0.0674	Theta star (bias corrected MLE)	0.0899
nu hat (MLE)	16.08	nu star (bias corrected)	12.06
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (12.06, α)	5.263	Adjusted Chi Square Value (12.06, β)	4.355
95% Gamma Approximate UCL (use when n>=50)	0.138	95% Gamma Adjusted UCL (use when n<50)	0.167

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0743	SD (KM)	0.07
Variance (KM)	0.00489	SE of Mean (KM)	0.0261
k hat (KM)	1.128	k star (KM)	0.826
nu hat (KM)	20.31	nu star (KM)	14.87
theta hat (KM)	0.0659	theta star (KM)	0.0899
80% gamma percentile (KM)	0.121	90% gamma percentile (KM)	0.179
95% gamma percentile (KM)	0.238	99% gamma percentile (KM)	0.377

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.87, α)	7.173	Adjusted Chi Square Value (14.87, β)	6.081
95% Gamma Approximate KM-UCL (use when n>=50)	0.154	95% Gamma Adjusted KM-UCL (use when n<50)	0.182

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.751	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.352	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0636	Mean in Log Scale	-3.222
SD in Original Scale	0.0804	SD in Log Scale	0.952
95% t UCL (assumes normality of ROS data)	0.113	95% Percentile Bootstrap UCL	0.109
95% BCA Bootstrap UCL	0.136	95% Bootstrap t UCL	0.195
95% H-UCL (Log ROS)	0.18		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.831	KM Geo Mean	0.059
KM SD (logged)	0.571	95% Critical H Value (KM-Log)	2.366
KM Standard Error of Mean (logged)	0.213	95% H-UCL (KM -Log)	0.112
KM SD (logged)	0.571	95% Critical H Value (KM-Log)	2.366
KM Standard Error of Mean (logged)	0.213		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0662	Mean in Log Scale	-3.09
SD in Original Scale	0.0787	SD in Log Scale	0.819
95% t UCL (Assumes normality)	0.115	95% H-Stat UCL	0.145

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

ProUCL Output—PAHs 0–3ft

```
Suggested UCL to Use
95% KM (Chebyshev) UCL                              0.188

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (chrysene***218-01-9)

General Statistics
Total Number of Observations                        17      Number of Distinct Observations                  16
Number of Detects                                   16      Number of Non-Detects                            1
Number of Distinct Detects                          15      Number of Distinct Non-Detects                   1
Minimum Detect                                      0.014   Minimum Non-Detect                               0.0077
Maximum Detect                                      4.2     Maximum Non-Detect                               0.0077
Variance Detects                                    2.013   Percent Non-Detects                              5.882%
Mean Detects                                        1.078   SD Detects                                       1.419
Median Detects                                      0.245   CV Detects                                       1.317
Skewness Detects                                    1.209   Kurtosis Detects                                 0.0962
Mean of Logged Detects                             -1.309   SD of Logged Detects                             2.012

Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                         0.765   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.887   Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                           0.276   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.213   Detected Data Not Normal at 5% Significance Level
Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                             1.015   KM Standard Error of Mean                        0.34
KM SD                                               1.356     95% KM (BCA) UCL                               1.617
  95% KM (t) UCL                                    1.608     95% KM (Percentile Bootstrap) UCL              1.596
  95% KM (z) UCL                                    1.574     95% KM Bootstrap t UCL                         1.821
90% KM Chebyshev UCL                                2.034   95% KM Chebyshev UCL                             2.496
97.5% KM Chebyshev UCL                              3.137   99% KM Chebyshev UCL                             4.396

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                  0.655   Anderson-Darling GOF Test
5% A-D Critical Value                               0.804   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                  0.187   Kolmogorov-Smirnov GOF
5% K-S Critical Value                               0.228   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                         0.464   k star (bias corrected MLE)                      0.419
Theta hat (MLE)                                     2.32    Theta star (bias corrected MLE)                  2.572
nu hat (MLE)                                        14.86   nu star (bias corrected)                         13.41
Mean (detects)                                      1.078

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                             0.01    Mean                                             1.015
Maximum                                             4.2     Median                                           0.21
SD                                                  1.398   CV                                               1.378
k hat (MLE)                                         0.429   k star (bias corrected MLE)                      0.392
Theta hat (MLE)                                     2.367   Theta star (bias corrected MLE)                  2.586
nu hat (MLE)                                        14.58   nu star (bias corrected)                         13.34
Adjusted Level of Significance (β)                  0.0346
Approximate Chi Square Value (13.34, α)             6.123   Adjusted Chi Square Value (13.34, β)             5.617
95% Gamma Approximate UCL (use when n>=50)          2.211   95% Gamma Adjusted UCL (use when n<50)           2.411

Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                           1.015   SD (KM)                                          1.356
Variance (KM)                                       1.84    SE of Mean (KM)                                  0.34
k hat (KM)                                          0.56    k star (KM)                                      0.5
nu hat (KM)                                         19.03   nu star (KM)                                     17
theta hat (KM)                                      1.813   theta star (KM)                                  2.029
80% gamma percentile (KM)                           1.667   90% gamma percentile (KM)                        2.745
95% gamma percentile (KM)                           3.898   99% gamma percentile (KM)                        6.732

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (17.00, α)             8.676   Adjusted Chi Square Value (17.00, β)             8.057
95% Gamma Approximate KM-UCL (use when n>=50)       1.989   95% Gamma Adjusted KM-UCL (use when n<50)        2.142

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                         0.911   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.887   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                           0.151   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.213   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level
```

ProUCL Output—PAHs 0–3ft

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.014	Mean in Log Scale	-1.596
SD in Original Scale	1.398	SD in Log Scale	2.281
95% t UCL (assumes normality of ROS data)	1.607	95% Percentile Bootstrap UCL	1.599
95% BCA Bootstrap UCL	1.693	95% Bootstrap t UCL	1.829
95% H-UCL (Log ROS)	44.94		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.518	KM Geo Mean	0.219
KM SD (logged)	2.067	95% Critical H Value (KM-Log)	4.511
KM Standard Error of Mean (logged)	0.518	95% H-UCL (KM -Log)	19.1
KM SD (logged)	2.067	95% Critical H Value (KM-Log)	4.511
KM Standard Error of Mean (logged)	0.518		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.015	Mean in Log Scale	-1.559
SD in Original Scale	1.398	SD in Log Scale	2.204
95% t UCL (Assumes normality)	1.607	95% H-Stat UCL	33.02

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5	2.142

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (cpahs (mtca teq-halfnd)*bapeq (u=1/2))**

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
Number of Detects	16	Number of Non-Detects	1
Number of Distinct Detects	15	Number of Distinct Non-Detects	1
Minimum Detect	0.008	Minimum Non-Detect	0.0058
Maximum Detect	2.3	Maximum Non-Detect	0.0058
Variance Detects	0.742	Percent Non-Detects	5.882%
Mean Detects	0.678	SD Detects	0.861
Median Detects	0.17	CV Detects	1.271
Skewness Detects	1.031	Kurtosis Detects	-0.661
Mean of Logged Detects	-1.711	SD of Logged Detects	1.978

Normal GOF Test on Detects Or

Shapiro Wilk Test Statistic	0.752	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.638	KM Standard Error of Mean	0.206
KM SD	0.824	95% KM (BCA) UCL	0.965
95% KM (t) UCL	0.999	95% KM (Percentile Bootstrap) UCL	0.956
95% KM (z) UCL	0.978	95% KM Bootstrap t UCL	1.084
90% KM Chebyshev UCL	1.258	95% KM Chebyshev UCL	1.538
97.5% KM Chebyshev UCL	1.928	99% KM Chebyshev UCL	2.693

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.67	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.8	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.187	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.228	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.483	k star (bias corrected MLE)	0.434
Theta hat (MLE)	1.403	Theta star (bias corrected MLE)	1.561
nu hat (MLE)	15.46	nu star (bias corrected)	13.89
Mean (detects)	0.678		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.008	Mean	0.639
Maximum	2.3	Median	0.11
SD	0.85	CV	1.33
k hat (MLE)	0.451	k star (bias corrected MLE)	0.41
Theta hat (MLE)	1.417	Theta star (bias corrected MLE)	1.556
nu hat (MLE)	15.32	nu star (bias corrected)	13.95
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (13.95, α)	6.538	Adjusted Chi Square Value (13.95, β)	6.013
95% Gamma Approximate UCL (use when n>=50)	1.363	95% Gamma Adjusted UCL (use when n<50)	1.482

ProUCL Output—PAHs 0–3ft

```
Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                        0.638   SD (KM)                                       0.824
Variance (KM)                                    0.68    SE of Mean (KM)                               0.206
k hat (KM)                                       0.6     k star (KM)                                   0.533
nu hat (KM)                                     20.39    nu star (KM)                                 18.12
theta hat (KM)                                   1.065   theta star (KM)                               1.198
80% gamma percentile (KM)                        1.051   90% gamma percentile (KM)                     1.704
95% gamma percentile (KM)                        2.397   99% gamma percentile (KM)                     4.09

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (18.12, α)          9.479   Adjusted Chi Square Value (18.12, β)          8.829
95% Gamma Approximate KM-UCL (use when n>=50)    1.22    95% Gamma Adjusted KM-UCL (use when n<50)     1.31

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                      0.914   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                   0.887   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                        0.138   Lilliefors GOF Test
5% Lilliefors Critical Value                     0.213   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                           0.638   Mean in Log Scale                            -1.993
SD in Original Scale                             0.85    SD in Log Scale                               2.242
  95% t UCL (assumes normality of ROS data)      0.998     95% Percentile Bootstrap UCL                0.978
  95% BCA Bootstrap UCL                          1.016     95% Bootstrap t UCL                         1.074
  95% H-UCL (Log ROS)                           25.3

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                -1.913   KM Geo Mean                                   0.148
KM SD (logged)                                   2.027     95% Critical H Value (KM-Log)               4.436
KM Standard Error of Mean (logged)               0.508     95% H-UCL (KM -Log)                        10.9
KM SD (logged)                                   2.027     95% Critical H Value (KM-Log)               4.436
KM Standard Error of Mean (logged)               0.508

DL/2 Statistics
DL/2 Normal                                              DL/2 Log-Transformed
Mean in Original Scale                           0.638   Mean in Log Scale                            -1.954
SD in Original Scale                             0.85    SD in Log Scale                               2.162
  95% t UCL (Assumes normality)                  0.998     95% H-Stat UCL                             18.47
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use
Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5     1.31

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (cpahs (mtca teq-zerond)***bapeq (u=0))

General Statistics
Total Number of Observations                    17       Number of Distinct Observations              16
Number of Detects                               16       Number of Non-Detects                         1
Number of Distinct Detects                      15       Number of Distinct Non-Detects                1
Minimum Detect                                   0.0024  Minimum Non-Detect                            0.0077
Maximum Detect                                   2.3     Maximum Non-Detect                            0.0077
Variance Detects                                 0.743   Percent Non-Detects                           5.882%
Mean Detects                                     0.677   SD Detects                                    0.862
Median Detects                                   0.17    CV Detects                                    1.274
Skewness Detects                                 1.029   Kurtosis Detects                             -0.663
Mean of Logged Detects                          -1.879   SD of Logged Detects                          2.268

Normal GOF Test on Detects Or
Shapiro Wilk Test Statistic                      0.754   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                   0.887   Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                        0.26    Lilliefors GOF Test
5% Lilliefors Critical Value                     0.213   Detected Data Not Normal at 5% Significance Level
Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                          0.637   KM Standard Error of Mean                     0.207
KM SD                                            0.825     95% KM (BCA) UCL                            1.009
  95% KM (t) UCL                                 0.998     95% KM (Percentile Bootstrap) UCL           0.972
  95% KM (z) UCL                                 0.977     95% KM Bootstrap t UCL                      1.103
90% KM Chebyshev UCL                             1.257   95% KM Chebyshev UCL                          1.538
97.5% KM Chebyshev UCL                           1.928   99% KM Chebyshev UCL                          2.694

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                               0.504   Anderson-Darling GOF Test
5% A-D Critical Value                            0.81    Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                               0.162   Kolmogorov-Smirnov GOF
5% K-S Critical Value                            0.229   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level
```

ProUCL Output—PAHs 0–3ft

Gamma Statistics on Detected Data Only

k hat (MLE)	0.436	k star (bias corrected MLE)	0.396
Theta hat (MLE)	1.552	Theta star (bias corrected MLE)	1.709
nu hat (MLE)	13.95	nu star (bias corrected)	12.67
Mean (detects)	0.677		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0024	Mean	0.638
Maximum	2.3	Median	0.11
SD	0.85	CV	1.334
k hat (MLE)	0.414	k star (bias corrected MLE)	0.38
Theta hat (MLE)	1.541	Theta star (bias corrected MLE)	1.678
nu hat (MLE)	14.07	nu star (bias corrected)	12.92
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (12.92, α)	5.839	Adjusted Chi Square Value (12.92, β)	5.347
95% Gamma Approximate UCL (use when n>=50)	1.411	95% Gamma Adjusted UCL (use when n<50)	1.541

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.637	SD (KM)	0.825
Variance (KM)	0.681	SE of Mean (KM)	0.207
k hat (KM)	0.596	k star (KM)	0.53
nu hat (KM)	20.26	nu star (KM)	18.02
theta hat (KM)	1.069	theta star (KM)	1.202
80% gamma percentile (KM)	1.049	90% gamma percentile (KM)	1.703
95% gamma percentile (KM)	2.397	99% gamma percentile (KM)	4.095

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.02, α)	9.405	Adjusted Chi Square Value (18.02, β)	8.758
95% Gamma Approximate KM-UCL (use when n>=50)	1.221	95% Gamma Adjusted KM-UCL (use when n<50)	1.311

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.14	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.637	Mean in Log Scale	-2.094
SD in Original Scale	0.851	SD in Log Scale	2.369
95% t UCL (assumes normality of ROS data)	0.997	95% Percentile Bootstrap UCL	0.966
95% BCA Bootstrap UCL	1.016	95% Bootstrap t UCL	1.123
95% H-UCL (Log ROS)	41.15		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.119	KM Geo Mean	0.12
KM SD (logged)	2.336	95% Critical H Value (KM-Log)	5.016
KM Standard Error of Mean (logged)	0.585	95% H-UCL (KM -Log)	34.47
KM SD (logged)	2.336	95% Critical H Value (KM-Log)	5.016
KM Standard Error of Mean (logged)	0.585		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.637	Mean in Log Scale	-2.095
SD in Original Scale	0.851	SD in Log Scale	2.37
95% t UCL (Assumes normality)	0.997	95% H-Stat UCL	41.45

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 5	1.311

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (dibenzo(a,h)anthracene*53-70-3)**

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
Number of Detects	8	Number of Non-Detects	9
Number of Distinct Detects	7	Number of Distinct Non-Detects	9
Minimum Detect	0.038	Minimum Non-Detect	0.0072
Maximum Detect	0.21	Maximum Non-Detect	0.014
Variance Detects	0.00513	Percent Non-Detects	52.94%
Mean Detects	0.123	SD Detects	0.0716
Median Detects	0.118	CV Detects	0.582
Skewness Detects	0.108	Kurtosis Detects	-1.98
Mean of Logged Detects	-2.279	SD of Logged Detects	0.685

ProUCL Output—PAHs 0–3ft

```
Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                         0.887   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.818   Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic                           0.166   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.283   Detected Data appear Normal at 5% Significance Level
Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                             0.0618  KM Standard Error of Mean                     0.0192
KM SD                                               0.0739    95% KM (BCA) UCL                            0.0946
95% KM (t) UCL                                      0.0952  95% KM (Percentile Bootstrap) UCL             0.0924
  95% KM (z) UCL                                    0.0933    95% KM Bootstrap t UCL                      0.0991
90% KM Chebyshev UCL                                0.119   95% KM Chebyshev UCL                          0.145
97.5% KM Chebyshev UCL                              0.181   99% KM Chebyshev UCL                          0.252

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                  0.395   Anderson-Darling GOF Test
5% A-D Critical Value                               0.722   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                  0.185   Kolmogorov-Smirnov GOF
5% K-S Critical Value                               0.296   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                         2.874   k star (bias corrected MLE)                   1.879
Theta hat (MLE)                                     0.0428  Theta star (bias corrected MLE)               0.0655
nu hat (MLE)                                        45.98   nu star (bias corrected)                      30.07
Mean (detects)                                      0.123

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                             0.01    Mean                                          0.0632
Maximum                                             0.21    Median                                        0.01
SD                                                  0.0751  CV                                            1.187
k hat (MLE)                                         0.793   k star (bias corrected MLE)                   0.692
Theta hat (MLE)                                     0.0798  Theta star (bias corrected MLE)               0.0914
nu hat (MLE)                                        26.96   nu star (bias corrected)                      23.53
Adjusted Level of Significance (β)                  0.0346
Approximate Chi Square Value (23.53, α)             13.5    Adjusted Chi Square Value (23.53, β)          12.7
95% Gamma Approximate UCL (use when n>=50)          0.11    95% Gamma Adjusted UCL (use when n<50)        0.117

Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                           0.0618  SD (KM)                                       0.0739
Variance (KM)                                       0.00546 SE of Mean (KM)                               0.0192
k hat (KM)                                          0.698   k star (KM)                                   0.614
nu hat (KM)                                         23.74   nu star (KM)                                  20.89
theta hat (KM)                                      0.0884  theta star (KM)                               0.101
80% gamma percentile (KM)                           0.102   90% gamma percentile (KM)                     0.16
95% gamma percentile (KM)                           0.22    99% gamma percentile (KM)                     0.367

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (20.89, α)             11.51   Adjusted Chi Square Value (20.89, β)          10.78
  95% Gamma Approximate KM-UCL (use when n>=50)     0.112     95% Gamma Adjusted KM-UCL (use when n<50)   0.12

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                         0.895   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.818   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                           0.176   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.283   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                              0.0661  Mean in Log Scale                             -3.281
SD in Original Scale                                0.0729  SD in Log Scale                               1.075
  95% t UCL (assumes normality of ROS data)         0.097     95% Percentile Bootstrap UCL                0.0962
  95% BCA Bootstrap UCL                             0.099     95% Bootstrap t UCL                         0.108
  95% H-UCL (Log ROS)                               0.141

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                    -3.684  KM Geo Mean                                   0.0251
KM SD (logged)                                      1.396     95% Critical H Value (KM-Log)               3.306
KM Standard Error of Mean (logged)                  0.362     95% H-UCL (KM -Log)                         0.211
KM SD (logged)                                      1.396     95% Critical H Value (KM-Log)               3.306
KM Standard Error of Mean (logged)                  0.362

DL/2 Statistics
DL/2 Normal                                                 DL/2 Log-Transformed
Mean in Original Scale                              0.0605  Mean in Log Scale                             -3.904
SD in Original Scale                                0.0771  SD in Log Scale                               1.652
  95% t UCL (Assumes normality)                     0.0932    95% H-Stat UCL                              0.372
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level
```

ProUCL Output—PAHs 0–3ft

```
Suggested UCL to Use
95% KM (t) UCL                                        0.0952

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (di-n-butyl phthalate***84-74-2)

General Statistics
Total Number of Observations              9       Number of Distinct Observations           8
Number of Detects                         0       Number of Non-Detects                     9
Number of Distinct Detects                0       Number of Distinct Non-Detects            8

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable UseResult (di-n-butyl phthalate***84-74-2) was not processed!



UseResult (fluoranthene***206-44-0)

General Statistics
Total Number of Observations              17      Number of Distinct Observations           17
                                                  Number of Missing Observations            0
Minimum                                   0.012   Mean                                      1.939
Maximum                                   7.1     Median                                    0.38
SD                                        2.487   Std. Error of Mean                        0.603
Coefficient of Variation                  1.283   Skewness                                  1.06

Normal GOF Test
Shapiro Wilk Test Statistic               0.77    Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value            0.892   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                 0.308   Lilliefors GOF Test
5% Lilliefors Critical Value              0.207   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                    95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                     2.993     95% Adjusted-CLT UCL (Chen-1995)        3.097
                                                    95% Modified-t UCL (Johnson-1978)       3.018

Gamma GOF Test
A-D Test Statistic                        0.833   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                     0.815   Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                        0.192   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                     0.223   Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics
k hat (MLE)                               0.423   k star (bias corrected MLE)               0.388
Theta hat (MLE)                           4.58    Theta star (bias corrected MLE)           4.999
nu hat (MLE)                              14.4    nu star (bias corrected)                  13.19
MLE Mean (bias corrected)                 1.939   MLE Sd (bias corrected)                   3.114
                                                  Approximate Chi Square Value (0.05)       6.02
Adjusted Level of Significance            0.0346  Adjusted Chi Square Value                 5.519

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)  4.249   95% Adjusted Gamma UCL (use when n<50)  4.634

Lognormal GOF Test
Shapiro Wilk Test Statistic               0.902   Shapiro Wilk Lognormal GOF T
5% Shapiro Wilk Critical Value            0.892   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                 0.2     Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value              0.207   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                    -4.423  Mean of logged Data                       -0.878
Maximum of Logged Data                    1.96    SD of logged Data                         2.192

Assuming Lognormal Distribution
  95% H-UCL                               61.82     90% Chebyshev (MVUE) UCL                9.224
  95% Chebyshev (MVUE) UCL                11.95    97.5% Chebyshev (MVUE) UCL               15.75
  99% Chebyshev (MVUE) UCL                23.19

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                             2.932     95% Jackknife UCL                       2.993
  95% Standard Bootstrap UCL              2.925     95% Bootstrap-t UCL                     3.295
  95% Hall's Bootstrap UCL                3.009     95% Percentile Bootstrap UCL            2.912
  95% BCA Bootstrap UCL                   3.011
  90% Chebyshev(Mean, Sd) UCL             3.749     95% Chebyshev(Mean, Sd) UCL             4.569
 97.5% Chebyshev(Mean, Sd) UCL            5.707     99% Chebyshev(Mean, Sd) UCL             7.942
```

ProUCL Output—PAHs 0–3ft

Suggested UCL to Use

95% Adjusted Gamma UCL	4.634

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (na)

General Statistics

Total Number of Observations	133	Number of Distinct Observations	60
Number of Detects	56	Number of Non-Detects	77
Number of Distinct Detects	44	Number of Distinct Non-Detects	21
Minimum Detect	0.0014	Minimum Non-Detect	0.0068
Maximum Detect	39	Maximum Non-Detect	0.58
Variance Detects	57.84	Percent Non-Detects	57.89%
Mean Detects	2.605	SD Detects	7.605
Median Detects	0.125	CV Detects	2.92
Skewness Detects	4.213	Kurtosis Detects	18.27
Mean of Logged Detects	-1.748	SD of Logged Detects	2.401

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.385	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.366	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.118	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.101	KM Standard Error of Mean	0.442
KM SD	5.056	95% KM (BCA) UCL	1.981
95% KM (t) UCL	1.834	95% KM (Percentile Bootstrap) UCL	1.929
95% KM (z) UCL	1.829	95% KM Bootstrap t UCL	3.004
90% KM Chebyshev UCL	2.428	95% KM Chebyshev UCL	3.029
97.5% KM Chebyshev UCL	3.864	99% KM Chebyshev UCL	5.503

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.333	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.883	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.237	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.13	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.261	k star (bias corrected MLE)	0.259
Theta hat (MLE)	9.988	Theta star (bias corrected MLE)	10.07
nu hat (MLE)	29.21	nu star (bias corrected)	28.98
Mean (detects)	2.605		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0014	Mean	1.103
Maximum	39	Median	0.01
SD	5.075	CV	4.603
k hat (MLE)	0.209	k star (bias corrected MLE)	0.209
Theta hat (MLE)	5.279	Theta star (bias corrected MLE)	5.271
nu hat (MLE)	55.56	nu star (bias corrected)	55.64
Adjusted Level of Significance (β)	0.0482		
Approximate Chi Square Value (55.64, α)	39.49	Adjusted Chi Square Value (55.64, β)	39.35
95% Gamma Approximate UCL (use when n>=50)	1.553	95% Gamma Adjusted UCL (use when n<50)	1.559

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.101	SD (KM)	5.056
Variance (KM)	25.56	SE of Mean (KM)	0.442
k hat (KM)	0.0474	k star (KM)	0.0514
nu hat (KM)	12.62	nu star (KM)	13.67
theta hat (KM)	23.21	theta star (KM)	21.43
80% gamma percentile (KM)	0.164	90% gamma percentile (KM)	1.74
95% gamma percentile (KM)	5.912	99% gamma percentile (KM)	23.7

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (13.67, α)	6.343	Adjusted Chi Square Value (13.67, β)	6.289
95% Gamma Approximate KM-UCL (use when n>=50)	2.372	95% Gamma Adjusted KM-UCL (use when n<50)	2.393

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.938	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.0098	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.121	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.118	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

ProUCL Output—PAHs 0–3ft

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.098	Mean in Log Scale	-4.839
SD in Original Scale	5.076	SD in Log Scale	3.388
95% t UCL (assumes normality of ROS data)	1.827	95% Percentile Bootstrap UCL	1.88
95% BCA Bootstrap UCL	2.253	95% Bootstrap t UCL	3.054
95% H-UCL (Log ROS)	10.88		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.226	KM Geo Mean	0.0146
KM SD (logged)	2.752	95% Critical H Value (KM-Log)	4.205
KM Standard Error of Mean (logged)	0.258	95% H-UCL (KM -Log)	1.765
KM SD (logged)	2.752	95% Critical H Value (KM-Log)	4.205
KM Standard Error of Mean (logged)	0.258		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.117	Mean in Log Scale	-3.231
SD in Original Scale	5.072	SD in Log Scale	2.202
95% t UCL (Assumes normality)	1.846	95% H-Stat UCL	0.874

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	3.029

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (n-nitrosodiphenylamine*86-30-6)**

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	0	Number of Non-Detects	9
Number of Distinct Detects	0	Number of Distinct Non-Detects	9

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable UseResult (n-nitrosodiphenylamine*86-30-6) was not processed!**

UseResult (phenol*108-95-2)**

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	1	Number of Non-Detects	8
Number of Distinct Detects	1	Number of Distinct Non-Detects	8

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV

The data set for variable UseResult (phenol*108-95-2) was not processed!**

UseResult (pyrene*129-00-0)**

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	0.011	Mean	1.854
Maximum	7.3	Median	0.36
SD	2.427	Std. Error of Mean	0.589
Coefficient of Variation	1.309	Skewness	1.215

Normal GOF Test

Shapiro Wilk Test Statistic	0.773	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.882	95% Adjusted-CLT UCL (Chen-1995)	3.008
		95% Modified-t UCL (Johnson-1978)	2.911

Gamma GOF Test

A-D Test Statistic	0.715	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.814	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.19	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.223	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

ProUCL Output—PAHs 0–3ft

```
Gamma Statistics
k hat (MLE)                                        0.428   k star (bias corrected MLE)                       0.392
Theta hat (MLE)                                    4.329   Theta star (bias corrected MLE)                   4.731
nu hat (MLE)                                       14.57   nu star (bias corrected)                          13.33
MLE Mean (bias corrected)                          1.854   MLE Sd (bias corrected)                           2.962
                                                           Approximate Chi Square Value (0.05)               6.114
Adjusted Level of Significance                    0.0346   Adjusted Chi Square Value                         5.609

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)       4.042     95% Adjusted Gamma UCL (use when n<50)          4.407

Lognormal GOF Test
Shapiro Wilk Test Statistic                        0.915   Shapiro Wilk Lognormal GOF T
5% Shapiro Wilk Critical Value                     0.892   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                          0.193   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                       0.207   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                             -4.51   Mean of logged Data                              -0.902
Maximum of Logged Data                             1.988   SD of logged Data                                 2.174

Assuming Lognormal Distribution
  95% H-UCL                                        55.71     90% Chebyshev (MVUE) UCL                        8.685
  95% Chebyshev (MVUE) UCL                         11.25    97.5% Chebyshev (MVUE) UCL                       14.81
  99% Chebyshev (MVUE) UCL                          21.8

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                      2.823     95% Jackknife UCL                               2.882
  95% Standard Bootstrap UCL                       2.779     95% Bootstrap-t UCL                             3.156
  95% Hall's Bootstrap UCL                         3.067     95% Percentile Bootstrap UCL                     2.83
  95% BCA Bootstrap UCL                            3.087
  90% Chebyshev(Mean, Sd) UCL                      3.621     95% Chebyshev(Mean, Sd) UCL                     4.421
 97.5% Chebyshev(Mean, Sd) UCL                     5.531     99% Chebyshev(Mean, Sd) UCL                     7.712

Suggested UCL to Use
95% Adjusted Gamma UCL                             4.407

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (total hpah (u=0)***t_hpah (u=0))

General Statistics
Total Number of Observations                       17      Number of Distinct Observations                  17
                                                           Number of Missing Observations                   0
Minimum                                            0.011   Mean                                             5.582
Maximum                                            21      Median                                           1.1
SD                                                 7.364   Std. Error of Mean                               1.786
Coefficient of Variation                           1.319   Skewness                                         1.144

Normal GOF Test
Shapiro Wilk Test Statistic                        0.761   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                     0.892   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                          0.284   Lilliefors GOF Test
5% Lilliefors Critical Value                       0.207   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                             95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                              8.7       95% Adjusted-CLT UCL (Chen-1995)                9.05
                                                             95% Modified-t UCL (Johnson-1978)               8.783

Gamma GOF Test
A-D Test Statistic                                 0.546   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                              0.816   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                 0.169   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                              0.223   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                        0.416   k star (bias corrected MLE)                       0.381
Theta hat (MLE)                                    13.43   Theta star (bias corrected MLE)                   14.63
nu hat (MLE)                                       14.13   nu star (bias corrected)                          12.97
MLE Mean (bias corrected)                          5.582   MLE Sd (bias corrected)                           9.038
                                                           Approximate Chi Square Value (0.05)               5.872
Adjusted Level of Significance                    0.0346   Adjusted Chi Square Value                         5.379

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)       12.33     95% Adjusted Gamma UCL (use when n<50)          13.46
```

ProUCL Output—PAHs 0–3ft

```
Lognormal GOF Test
Shapiro Wilk Test Statistic                         0.937   Shapiro Wilk Lognormal GOF T
5% Shapiro Wilk Critical Value                      0.892   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                           0.156   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                        0.207   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                              -4.51   Mean of logged Data                              0.146
Maximum of Logged Data                              3.045   SD of logged Data                                2.288

Assuming Lognormal Distribution
  95% H-UCL                                         264.8     90% Chebyshev (MVUE) UCL                       31.08
  95% Chebyshev (MVUE) UCL                          40.4    97.5% Chebyshev (MVUE) UCL                       53.35
  99% Chebyshev (MVUE) UCL                          78.78

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                       8.52      95% Jackknife UCL                              8.7
  95% Standard Bootstrap UCL                        8.427     95% Bootstrap-t UCL                            9.365
  95% Hall's Bootstrap UCL                          8.486     95% Percentile Bootstrap UCL                   8.479
  95% BCA Bootstrap UCL                             9.044
  90% Chebyshev(Mean, Sd) UCL                       10.94     95% Chebyshev(Mean, Sd) UCL                    13.37
 97.5% Chebyshev(Mean, Sd) UCL                      16.74     99% Chebyshev(Mean, Sd) UCL                    23.35

Suggested UCL to Use
95% Adjusted Gamma UCL                              13.46

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (total hpah (u=1/2)***t_hpah (u=1/2))

General Statistics
Total Number of Observations                        17      Number of Distinct Observations                  17
                                                            Number of Missing Observations                   0
Minimum                                             0.038   Mean                                             5.586
Maximum                                             21      Median                                           1.1
SD                                                  7.361   Std. Error of Mean                               1.785
Coefficient of Variation                            1.318   Skewness                                         1.145

Normal GOF Test
Shapiro Wilk Test Statistic                         0.761   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.892   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                           0.285   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.207   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                              95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                               8.703     95% Adjusted-CLT UCL (Chen-1995)               9.052
                                                              95% Modified-t UCL (Johnson-1978)              8.786

Gamma GOF Test
A-D Test Statistic                                  0.684   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                               0.811   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                  0.184   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                               0.223   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                         0.44    k star (bias corrected MLE)                      0.401
Theta hat (MLE)                                     12.71   Theta star (bias corrected MLE)                  13.92
nu hat (MLE)                                        14.95   nu star (bias corrected)                         13.64
MLE Mean (bias corrected)                           5.586   MLE Sd (bias corrected)                          8.819
                                                            Approximate Chi Square Value (0.05)              6.326
Adjusted Level of Significance                      0.0346  Adjusted Chi Square Value                        5.811

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)        12.05     95% Adjusted Gamma UCL (use when n<50)         13.11

Lognormal GOF Test
Shapiro Wilk Test Statistic                         0.921   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                      0.892   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                           0.159   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                        0.207   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                              -3.27   Mean of logged Data                              0.246
Maximum of Logged Data                              3.045   SD of logged Data                                2.109
```

ProUCL Output—PAHs 0–3ft

Assuming Lognormal Distribution

95% H-UCL	133.1	90% Chebyshev (MVUE) UCL	24.12
95% Chebyshev (MVUE) UCL	31.17	97.5% Chebyshev (MVUE) UCL	40.95
99% Chebyshev (MVUE) UCL	60.17		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8.523	95% Jackknife UCL	8.703
95% Standard Bootstrap UCL	8.575	95% Bootstrap-t UCL	9.554
95% Hall's Bootstrap UCL	8.332	95% Percentile Bootstrap UCL	8.628
95% BCA Bootstrap UCL	9.129		
90% Chebyshev(Mean, Sd) UCL	10.94	95% Chebyshev(Mean, Sd) UCL	13.37
97.5% Chebyshev(Mean, Sd) UCL	16.73	99% Chebyshev(Mean, Sd) UCL	23.35

Suggested UCL to Use

95% Adjusted Gamma UCL	13.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output—Metals 0–0.5ft

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.111/5/2020 10:57:03 AM
From File	07 - Data for ProUCL_FD parent max.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

UseResult_Final Value (arsenic*7440-38-2)**

General Statistics

Total Number of Observations	339	Number of Distinct Observations	97
Number of Detects	202	Number of Non-Detects	137
Number of Distinct Detects	77	Number of Distinct Non-Detects	30
Minimum Detect	4.5	Minimum Non-Detect	5
Maximum Detect	543.8	Maximum Non-Detect	63
Variance Detects	1503	Percent Non-Detects	40.41%
Mean Detects	24.58	SD Detects	38.76
Median Detects	18.74	CV Detects	1.577
Skewness Detects	12.15	Kurtosis Detects	162.1
Mean of Logged Detects	3.003	SD of Logged Detects	0.487

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.255	Normal GOF Test on Detected Observations Only
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.339	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0628	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	17.14	KM Standard Error of Mean	1.708
KM SD	31.29	95% KM (BCA) UCL	20.83
95% KM (t) UCL	19.96	95% KM (Percentile Bootstrap) UCL	20.29
95% KM (z) UCL	19.95	95% KM Bootstrap t UCL	23.03
90% KM Chebyshev UCL	22.27	95% KM Chebyshev UCL	24.59
97.5% KM Chebyshev UCL	27.81	99% KM Chebyshev UCL	34.14

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.950E+28	Anderson-Darling GOF Test
5% A-D Critical Value	0.762	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.064	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.662	k star (bias corrected MLE)	2.626
Theta hat (MLE)	9.235	Theta star (bias corrected MLE)	9.363
nu hat (MLE)	1075	nu star (bias corrected)	1061
Mean (detects)	24.58		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	14.87
Maximum	543.8	Median	13.97
SD	32.16	CV	2.163
k hat (MLE)	0.286	k star (bias corrected MLE)	0.285
Theta hat (MLE)	52.05	Theta star (bias corrected MLE)	52.15
nu hat (MLE)	193.6	nu star (bias corrected)	193.3
Adjusted Level of Significance (β)	0.0493		
Approximate Chi Square Value (193.27, α)	162.1	Adjusted Chi Square Value (193.27, β)	162
95% Gamma Approximate UCL (use when n>=50)	17.72	95% Gamma Adjusted UCL (use when n<50)	17.74

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	17.14	SD (KM)	31.29
Variance (KM)	979	SE of Mean (KM)	1.708
k hat (KM)	0.3	k star (KM)	0.299
nu hat (KM)	203.5	nu star (KM)	203
theta hat (KM)	57.11	theta star (KM)	57.24
80% gamma percentile (KM)	26.28	90% gamma percentile (KM)	50.57
95% gamma percentile (KM)	78.46	99% gamma percentile (KM)	151

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (203.04, α)	171.1	Adjusted Chi Square Value (203.04, β)	170.9
95% Gamma Approximate KM-UCL (use when n>=50)	20.35	95% Gamma Adjusted KM-UCL (use when n<50)	20.36

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.893	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0628	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

ProUCL Output—Metals 0–0.5ft

```
                         Lognormal ROS Statistics Using Imputed Non-Detects
                 Mean in Original Scale   17.84                          Mean in Log Scale   2.603
                   SD in Original Scale   31.04                            SD in Log Scale   0.651
  95% t UCL (assumes normality of ROS data)  20.62           95% Percentile Bootstrap UCL   21.1
                95% BCA Bootstrap UCL   23.03                         95% Bootstrap t UCL   24.3
                   95% H-UCL (Log ROS)   17.83

            Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                      KM Mean (logged)   2.475                                KM Geo Mean   11.89
                        KM SD (logged)   0.791              95% Critical H Value (KM-Log)   1.966
       KM Standard Error of Mean (logged)   0.0453                     95% H-UCL (KM -Log)   17.69
                        KM SD (logged)   0.791              95% Critical H Value (KM-Log)   1.966
       KM Standard Error of Mean (logged)   0.0453

                                          DL/2 Statistics
           DL/2 Normal                                         DL/2 Log-Transformed
                 Mean in Original Scale   17.1                           Mean in Log Scale   2.465
                   SD in Original Scale   31.34                            SD in Log Scale   0.815
          95% t UCL (Assumes normality)   19.91                             95% H-Stat UCL   17.9
           DL/2 is not a recommended method, provided for comparisons and historical reasons

                              Nonparametric Distribution Free UCL Statistics
                        Data do not follow a Discernible Distribution at 5% Significance Level

                                         Suggested UCL to Use
                         95% KM (t) UCL   19.96                                     KM H-UCL   17.69
                       95% KM (BCA) UCL   20.83

    Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                         Recommendations are based upon data size, data distribution, and skewness.
      These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
   However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult_Final Value (chromium***7440-47-3)

                                          General Statistics
            Total Number of Observations   14                   Number of Distinct Observations   13
                                                                 Number of Missing Observations   0
                                Minimum   12                                               Mean   22.29
                                Maximum   40                                             Median   21
                                     SD    7.477                              Std. Error of Mean   1.998
                   Coefficient of Variation    0.336                                     Skewness   1.017

                                           Normal GOF Test
               Shapiro Wilk Test Statistic   0.936                     Shapiro Wilk GOF Test
            5% Shapiro Wilk Critical Value   0.874      Data appear Normal at 5% Significance Level
                  Lilliefors Test Statistic   0.158                      Lilliefors GOF Test
               5% Lilliefors Critical Value   0.226      Data appear Normal at 5% Significance Level
                             Data appear Normal at 5% Significance Level

                                     Assuming Normal Distribution
          95% Normal UCL                                     95% UCLs (Adjusted for Skewness)
                  95% Student's-t UCL   25.82                   95% Adjusted-CLT UCL (Chen-1995)   26.15
                                                                95% Modified-t UCL (Johnson-1978)   25.92

                                            Gamma GOF Test
                      A-D Test Statistic   0.177               Anderson-Darling Gamma GOF Test
                     5% A-D Critical Value   0.735   Detected data appear Gamma Distributed at 5% Significance Level
                      K-S Test Statistic   0.118            Kolmogorov-Smirnov Gamma GOF Test
                     5% K-S Critical Value   0.229   Detected data appear Gamma Distributed at 5% Significance Level
                     Detected data appear Gamma Distributed at 5% Significance Level

                                           Gamma Statistics
                              k hat (MLE)   10.4                      k star (bias corrected MLE)   8.222
                          Theta hat (MLE)   2.142                 Theta star (bias corrected MLE)   2.711
                             nu hat (MLE)   291.3                       nu star (bias corrected)   230.2
                   MLE Mean (bias corrected)   22.29                       MLE Sd (bias corrected)   7.772
                                                                Approximate Chi Square Value (0.05)   196.1
                   Adjusted Level of Significance   0.0312                    Adjusted Chi Square Value   191.9

                                     Assuming Gamma Distribution
     95% Approximate Gamma UCL (use when n>=50))   26.16       95% Adjusted Gamma UCL (use when n<50)   26.73

                                          Lognormal GOF Test
               Shapiro Wilk Test Statistic   0.991                Shapiro Wilk Lognormal GOF Test
            5% Shapiro Wilk Critical Value   0.874       Data appear Lognormal at 5% Significance Level
                  Lilliefors Test Statistic   0.0983                Lilliefors Lognormal GOF Test
               5% Lilliefors Critical Value   0.226       Data appear Lognormal at 5% Significance Level
                           Data appear Lognormal at 5% Significance Level

                                          Lognormal Statistics
                   Minimum of Logged Data   2.485                           Mean of logged Data   3.055
                   Maximum of Logged Data   3.689                             SD of logged Data   0.321
```

ProUCL Output—Metals 0–0.5ft

```
                                  Assuming Lognormal Distribution
                     95% H-UCL    26.5                         90% Chebyshev (MVUE) UCL    28.07
      95% Chebyshev (MVUE) UCL    30.69                      97.5% Chebyshev (MVUE) UCL    34.34
      99% Chebyshev (MVUE) UCL    41.51

                           Nonparametric Distribution Free UCL Statistics
                    Data appear to follow a Discernible Distribution at 5% Significance Level

                                 Nonparametric Distribution Free UCLs
                   95% CLT UCL    25.57                                95% Jackknife UCL    25.82
      95% Standard Bootstrap UCL  25.54                              95% Bootstrap-t UCL    26.49
        95% Hall's Bootstrap UCL  27.2                      95% Percentile Bootstrap UCL    25.43
          95% BCA Bootstrap UCL   26.14
    90% Chebyshev(Mean, Sd) UCL   28.28                      95% Chebyshev(Mean, Sd) UCL    31
  97.5% Chebyshev(Mean, Sd) UCL   34.77                      99% Chebyshev(Mean, Sd) UCL    42.17

                                        Suggested UCL to Use
            95% Student's-t UCL   25.82

         Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                              Recommendations are based upon data size, data distribution, and skewness.
               These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
        However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult_Final Value (copper***7440-50-8)

                                          General Statistics
    Total Number of Observations  14                        Number of Distinct Observations    11
                                                             Number of Missing Observations    0
                         Minimum  14                                                   Mean    26.21
                         Maximum  47                                                 Median    25
                              SD  10.29                                    Std. Error of Mean   2.75
        Coefficient of Variation   0.393                                           Skewness     0.953

                                           Normal GOF Test
      Shapiro Wilk Test Statistic  0.896                      Shapiro Wilk GOF Test
    5% Shapiro Wilk Critical Value 0.874            Data appear Normal at 5% Significance Level
        Lilliefors Test Statistic  0.223                       Lilliefors GOF Test
      5% Lilliefors Critical Value 0.226            Data appear Normal at 5% Significance Level
                         Data appear Normal at 5% Significance Level

                                    Assuming Normal Distribution
           95% Normal UCL                                    95% UCLs (Adjusted for Skewness)
            95% Student's-t UCL   31.08                       95% Adjusted-CLT UCL (Chen-1995)    31.49
                                                              95% Modified-t UCL (Johnson-1978)   31.2

                                            Gamma GOF Test
               A-D Test Statistic  0.343                  Anderson-Darling Gamma GOF Test
             5% A-D Critical Value 0.736    Detected data appear Gamma Distributed at 5% Significance Level
               K-S Test Statistic  0.175                  Kolmogorov-Smirnov Gamma GOF Test
             5% K-S Critical Value 0.229    Detected data appear Gamma Distributed at 5% Significance Level
                   Detected data appear Gamma Distributed at 5% Significance Level

                                           Gamma Statistics
                      k hat (MLE)  7.663                           k star (bias corrected MLE)    6.069
                  Theta hat (MLE)  3.421                       Theta star (bias corrected MLE)    4.319
                     nu hat (MLE)  214.6                             nu star (bias corrected)    169.9
        MLE Mean (bias corrected)  26.21                              MLE Sd (bias corrected)    10.64
                                                          Approximate Chi Square Value (0.05)    140.8
     Adjusted Level of Significance 0.0312                          Adjusted Chi Square Value    137.3

                                     Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50))  31.64         95% Adjusted Gamma UCL (use when n<50)    32.45

                                          Lognormal GOF Test
      Shapiro Wilk Test Statistic  0.954                  Shapiro Wilk Lognormal GOF Test
    5% Shapiro Wilk Critical Value 0.874          Data appear Lognormal at 5% Significance Level
        Lilliefors Test Statistic  0.152                   Lilliefors Lognormal GOF Test
      5% Lilliefors Critical Value 0.226          Data appear Lognormal at 5% Significance Level
                        Data appear Lognormal at 5% Significance Level

                                         Lognormal Statistics
         Minimum of Logged Data    2.639                                   Mean of logged Data    3.2
         Maximum of Logged Data    3.85                                      SD of logged Data    0.374

                                   Assuming Lognormal Distribution
                     95% H-UCL    32.24                        90% Chebyshev (MVUE) UCL    34.15
      95% Chebyshev (MVUE) UCL    37.76                      97.5% Chebyshev (MVUE) UCL    42.78
      99% Chebyshev (MVUE) UCL    52.64

                           Nonparametric Distribution Free UCL Statistics
                    Data appear to follow a Discernible Distribution at 5% Significance Level
```

ProUCL Output—Metals 0–0.5ft

Nonparametric Distribution Free UCLs

95% CLT UCL	30.74	95% Jackknife UCL	31.08
95% Standard Bootstrap UCL	30.64	95% Bootstrap-t UCL	33
95% Hall's Bootstrap UCL	33.5	95% Percentile Bootstrap UCL	31.14
95% BCA Bootstrap UCL	31.29		
90% Chebyshev(Mean, Sd) UCL	34.46	95% Chebyshev(Mean, Sd) UCL	38.2
97.5% Chebyshev(Mean, Sd) UCL	43.39	99% Chebyshev(Mean, Sd) UCL	53.58

Suggested UCL to Use

95% Student's-t UCL	31.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult_Final Value (lead*7439-92-1)**

General Statistics

Total Number of Observations	341	Number of Distinct Observations	214
Number of Detects	331	Number of Non-Detects	10
Number of Distinct Detects	213	Number of Distinct Non-Detects	4
Minimum Detect	1.164	Minimum Non-Detect	8
Maximum Detect	4125	Maximum Non-Detect	12
Variance Detects	241948	Percent Non-Detects	2.933%
Mean Detects	269.4	SD Detects	491.9
Median Detects	76	CV Detects	1.826
Skewness Detects	3.85	Kurtosis Detects	20
Mean of Logged Detects	4.356	SD of Logged Detects	1.676

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.574	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.293	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0491	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	261.7	KM Standard Error of Mean	26.35
KM SD	485.9	95% KM (BCA) UCL	304.8
95% KM (t) UCL	305.1	95% KM (Percentile Bootstrap) UCL	304.1
95% KM (z) UCL	305	95% KM Bootstrap t UCL	310.2
90% KM Chebyshev UCL	340.7	95% KM Chebyshev UCL	376.5
97.5% KM Chebyshev UCL	426.2	99% KM Chebyshev UCL	523.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.433	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.821	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.112	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0528	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.511	k star (bias corrected MLE)	0.508
Theta hat (MLE)	527.7	Theta star (bias corrected MLE)	530.4
nu hat (MLE)	338	nu star (bias corrected)	336.2
Mean (detects)	269.4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	261.5
Maximum	4125	Median	67.99
SD	486.7	CV	1.861
k hat (MLE)	0.44	k star (bias corrected MLE)	0.438
Theta hat (MLE)	594.4	Theta star (bias corrected MLE)	597
nu hat (MLE)	300	nu star (bias corrected)	298.7
Adjusted Level of Significance (β)	0.0493		
Approximate Chi Square Value (298.71, α)	259.7	Adjusted Chi Square Value (298.71, β)	259.5
95% Gamma Approximate UCL (use when n>=50)	300.8	95% Gamma Adjusted UCL (use when n<50)	301

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	261.7	SD (KM)	485.9
Variance (KM)	236119	SE of Mean (KM)	26.35
k hat (KM)	0.29	k star (KM)	0.289
nu hat (KM)	197.7	nu star (KM)	197.3
theta hat (KM)	902.4	theta star (KM)	904.3
80% gamma percentile (KM)	397.6	90% gamma percentile (KM)	774.9
95% gamma percentile (KM)	1211	99% gamma percentile (KM)	2349

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (197.34, α)	165.8	Adjusted Chi Square Value (197.34, β)	165.7
95% Gamma Approximate KM-UCL (use when n>=50)	311.4	95% Gamma Adjusted KM-UCL (use when n<50)	311.6

ProUCL Output—Metals 0–0.5ft

```
                              Lognormal GOF Test on Detected Observations Only
   Shapiro Wilk Approximate Test Statistic    0.961                 Shapiro Wilk GOF Test
               5% Shapiro Wilk P Value  4.6022E-7       Detected Data Not Lognormal at 5% Significance Level
                   Lilliefors Test Statistic    0.1                    Lilliefors GOF Test
                 5% Lilliefors Critical Value   0.0491          Detected Data Not Lognormal at 5% Significance Level
                              Detected Data Not Lognormal at 5% Significance Level

                              Lognormal ROS Statistics Using Imputed Non-Detects
                        Mean in Original Scale   261.6                              Mean in Log Scale     4.27
                          SD in Original Scale   486.7                                SD in Log Scale     1.726
       95% t UCL (assumes normality of ROS data)   305.1                  95% Percentile Bootstrap UCL    306.4
                         95% BCA Bootstrap UCL   314.6                          95% Bootstrap t UCL    310.1
                           95% H-UCL (Log ROS)   412

              Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                              KM Mean (logged)    4.275                                  KM Geo Mean     71.91
                                KM SD (logged)    1.716                 95% Critical H Value (KM-Log)     2.795
             KM Standard Error of Mean (logged)   0.0933                      95% H-UCL (KM -Log)    406.3
                                KM SD (logged)    1.716                 95% Critical H Value (KM-Log)     2.795
             KM Standard Error of Mean (logged)   0.0933

                                              DL/2 Statistics
              DL/2 Normal                                         DL/2 Log-Transformed
                        Mean in Original Scale   261.6                              Mean in Log Scale     4.276
                          SD in Original Scale   486.6                                SD in Log Scale     1.714
                   95% t UCL (Assumes normality)   305.1                              95% H-Stat UCL     405
              DL/2 is not a recommended method, provided for comparisons and historical reasons

                                  Nonparametric Distribution Free UCL Statistics
                          Data do not follow a Discernible Distribution at 5% Significance Level

                                              Suggested UCL to Use
                       95% KM (Chebyshev) UCL    376.5

      Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                           Recommendations are based upon data size, data distribution, and skewness.
            These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
     However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult_Final Value (na)

                                              General Statistics
                   Total Number of Observations   418                   Number of Distinct Observations   204
                             Number of Detects   351                          Number of Non-Detects    67
                    Number of Distinct Detects   195                 Number of Distinct Non-Detects    22
                                Minimum Detect     1.164                           Minimum Non-Detect     4
                                Maximum Detect   8299                             Maximum Non-Detect    29
                              Variance Detects 276951                              Percent Non-Detects    16.03%
                                  Mean Detects   138.1                                  SD Detects   526.3
                                Median Detects    26.24                                 CV Detects     3.81
                              Skewness Detects    11.62                            Kurtosis Detects   168.6
                         Mean of Logged Detects     3.684                      SD of Logged Detects     1.273

                                        Normal GOF Test on Detects Only
                      Shapiro Wilk Test Statistic    0.255            Normal GOF Test on Detected Observations Only
                         5% Shapiro Wilk P Value    0                Detected Data Not Normal at 5% Significance Level
                       Lilliefors Test Statistic    0.397                        Lilliefors GOF Test
                    5% Lilliefors Critical Value   0.0477             Detected Data Not Normal at 5% Significance Level
                               Detected Data Not Normal at 5% Significance Level

                  Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                                       KM Mean   116.6                       KM Standard Error of Mean     23.71
                                         KM SD   484.1                            95% KM (BCA) UCL   164.2
                               95% KM (t) UCL   155.7               95% KM (Percentile Bootstrap) UCL   157.7
                               95% KM (z) UCL   155.6                        95% KM Bootstrap t UCL   189.3
                          90% KM Chebyshev UCL   187.8                         95% KM Chebyshev UCL   220
                        97.5% KM Chebyshev UCL   264.7                         99% KM Chebyshev UCL   352.6

                              Gamma GOF Tests on Detected Observations Only
                               A-D Test Statistic    35.36                  Anderson-Darling GOF Test
                           5% A-D Critical Value    0.821     Detected Data Not Gamma Distributed at 5% Significance Level
                               K-S Test Statistic    0.212                  Kolmogorov-Smirnov GOF
                           5% K-S Critical Value   0.0513     Detected Data Not Gamma Distributed at 5% Significance Level
                          Detected Data Not Gamma Distributed at 5% Significance Level

                                     Gamma Statistics on Detected Data Only
                                  k hat (MLE)    0.509                     k star (bias corrected MLE)     0.507
                              Theta hat (MLE)   271.3                  Theta star (bias corrected MLE)   272.6
                                 nu hat (MLE)   357.5                       nu star (bias corrected)   355.7
                              Mean (detects)   138.1
```

ProUCL Output—Metals 0–0.5ft

```
                                   Gamma ROS Statistics using Imputed Non-Detects
                  GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
         GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                          For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                      This is especially true when the sample size is small.
             For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                                  Minimum    0.01                                              Mean    116
                                  Maximum  8299                                              Median     22
                                       SD   484.8                                                CV     4.179
                              k hat (MLE)    0.289                            k star (bias corrected MLE)     0.289
                          Theta hat (MLE)   401                              Theta star (bias corrected MLE)   401.6
                             nu hat (MLE)   241.8                                  nu star (bias corrected)   241.4
               Adjusted Level of Significance (β)    0.0494
      Approximate Chi Square Value (241.44, α)    206.5                  Adjusted Chi Square Value (241.44, β)    206.4
    95% Gamma Approximate UCL (use when n>=50)    135.6               95% Gamma Adjusted UCL (use when n<50)    135.7

                                   Estimates of Gamma Parameters using KM Estimates
                                Mean (KM)    116.6                                            SD (KM)    484.1
                            Variance (KM) 234319                                      SE of Mean (KM)     23.71
                               k hat (KM)      0.0581                                     k star (KM)      0.0592
                              nu hat (KM)     48.54                                      nu star (KM)     49.53
                           theta hat (KM)   2009                                      theta star (KM)   1969
                 80% gamma percentile (KM)     27.16                        90% gamma percentile (KM)    216.7
                 95% gamma percentile (KM)    651.9                         99% gamma percentile (KM)   2366

                                        Gamma Kaplan-Meier (KM) Statistics
          Approximate Chi Square Value (49.53, α)     34.37                  Adjusted Chi Square Value (49.53, β)     34.33
  95% Gamma Approximate KM-UCL (use when n>=50)    168.1           95% Gamma Adjusted KM-UCL (use when n<50)    168.3

                                   Lognormal GOF Test on Detected Observations Only
           Shapiro Wilk Approximate Test Statistic     0.911                        Shapiro Wilk GOF Test
                       5% Shapiro Wilk P Value     0                 Detected Data Not Lognormal at 5% Significance Level
                      Lilliefors Test Statistic     0.139                         Lilliefors GOF Test
                     5% Lilliefors Critical Value     0.0477             Detected Data Not Lognormal at 5% Significance Level
                                  Detected Data Not Lognormal at 5% Significance Level

                                   Lognormal ROS Statistics Using Imputed Non-Detects
                       Mean in Original Scale    116.6                                    Mean in Log Scale     3.279
                         SD in Original Scale    484.7                                      SD in Log Scale     1.509
          95% t UCL (assumes normality of ROS data)    155.7                        95% Percentile Bootstrap UCL    157.6
                        95% BCA Bootstrap UCL    175.5                                 95% Bootstrap t UCL    191.8
                           95% H-UCL (Log ROS)    100.1

                     Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                            KM Mean (logged)     3.263                                       KM Geo Mean    26.14
                              KM SD (logged)     1.544                         95% Critical H Value (KM-Log)     2.587
               KM Standard Error of Mean (logged)     0.0823                          95% H-UCL (KM -Log)    104.7
                              KM SD (logged)     1.544                         95% Critical H Value (KM-Log)     2.587
               KM Standard Error of Mean (logged)     0.0823

                                                  DL/2 Statistics
              DL/2 Normal                                                  DL/2 Log-Transformed
                       Mean in Original Scale    116.8                                    Mean in Log Scale     3.327
                         SD in Original Scale    484.6                                      SD in Log Scale     1.435
                  95% t UCL (Assumes normality)    155.8                                    95% H-Stat UCL     92.91
                       DL/2 is not a recommended method, provided for comparisons and historical reasons

                                        Nonparametric Distribution Free UCL Statistics
                                Data do not follow a Discernible Distribution at 5% Significance Level

                                                 Suggested UCL to Use
                        95% KM (Chebyshev) UCL    220

              Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                                  Recommendations are based upon data size, data distribution, and skewness.
               These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
         However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult_Final Value (zinc***7440-66-6)

                                                 General Statistics
                   Total Number of Observations    333                        Number of Distinct Observations    155
                             Number of Detects    328                                Number of Non-Detects      5
                    Number of Distinct Detects    150                       Number of Distinct Non-Detects      5
                                Minimum Detect      5.303                               Minimum Non-Detect     21
                                Maximum Detect   5177                                   Maximum Non-Detect     53
                              Variance Detects  86052                                    Percent Non-Detects      1.502%
                                  Mean Detects    120.7                                          SD Detects    293.3
                                Median Detects     86.45                                         CV Detects      2.431
                              Skewness Detects     15.86                                   Kurtosis Detects    272.1
                         Mean of Logged Detects      4.454                             SD of Logged Detects      0.69
```

ProUCL Output—Metals 0–0.5ft

```
                                   Normal GOF Test on Detects Only
              Shapiro Wilk Test Statistic   0.203        Normal GOF Test on Detected Observations Only
                  5% Shapiro Wilk P Value   0            Detected Data Not Normal at 5% Significance Level
                    Lilliefors Test Statistic 0.35                  Lilliefors GOF Test
               5% Lilliefors Critical Value 0.0493       Detected Data Not Normal at 5% Significance Level
                        Detected Data Not Normal at 5% Significance Level

                 Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
                                  KM Mean   119.3                       KM Standard Error of Mean   15.97
                                    KM SD   290.9                                95% KM (BCA) UCL   150.2
                            95% KM (t) UCL  145.6                   95% KM (Percentile Bootstrap) UCL 150.6
                            95% KM (z) UCL  145.6                           95% KM Bootstrap t UCL   201.1
                     90% KM Chebyshev UCL   167.2                            95% KM Chebyshev UCL   188.9
                   97.5% KM Chebyshev UCL   219                              99% KM Chebyshev UCL   278.2

                                Gamma GOF Tests on Detected Observations Only
                        A-D Test Statistic  3.049E+28                 Anderson-Darling GOF Test
                       5% A-D Critical Value 0.771    Detected Data Not Gamma Distributed at 5% Significance Level
                        K-S Test Statistic   0.151                    Kolmogorov-Smirnov GOF
                       5% K-S Critical Value 0.051    Detected Data Not Gamma Distributed at 5% Significance Level
                     Detected Data Not Gamma Distributed at 5% Significance Level

                                   Gamma Statistics on Detected Data Only
                                k hat (MLE)   1.621                       k star (bias corrected MLE)   1.608
                            Theta hat (MLE)   74.43                   Theta star (bias corrected MLE)   75.03
                               nu hat (MLE)   1064                            nu star (bias corrected)  1055
                             Mean (detects)   120.7

                                 Gamma ROS Statistics using Imputed Non-Detects
                   GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
          GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
                         For such situations, GROS method may yield incorrect values of UCLs and BTVs
                                   This is especially true when the sample size is small.
                 For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
                                    Minimum   0.01                                              Mean   118.9
                                    Maximum   5177                                            Median   85.52
                                         SD   291.5                                               CV   2.452
                                k hat (MLE)   1.227                       k star (bias corrected MLE)   1.218
                            Theta hat (MLE)   96.88                   Theta star (bias corrected MLE)   97.6
                               nu hat (MLE)   817.1                           nu star (bias corrected)  811.1
               Adjusted Level of Significance (β) 0.0493
            Approximate Chi Square Value (811.09, α) 746          Adjusted Chi Square Value (811.09, β)   745.7
      95% Gamma Approximate UCL (use when n>=50) 129.2     95% Gamma Adjusted UCL (use when n<50)   129.3

                                Estimates of Gamma Parameters using KM Estimates
                                  Mean (KM)   119.3                                          SD (KM)   290.9
                              Variance (KM)   84629                                  SE of Mean (KM)   15.97
                                 k hat (KM)   0.168                                       k star (KM)   0.169
                                nu hat (KM)   112                                        nu star (KM)   112.3
                             theta hat (KM)   709.4                                   theta star (KM)   707.4
                   80% gamma percentile (KM)   141.8                        90% gamma percentile (KM)   358.3
                   95% gamma percentile (KM)   640.7                        99% gamma percentile (KM)   1442

                                       Gamma Kaplan-Meier (KM) Statistics
            Approximate Chi Square Value (112.32, α) 88.86        Adjusted Chi Square Value (112.32, β)   88.77
   95% Gamma Approximate KM-UCL (use when n>=50) 150.8    95% Gamma Adjusted KM-UCL (use when n<50)   151

                                  Lognormal GOF Test on Detected Observations Only
          Shapiro Wilk Approximate Test Statistic  0.966                    Shapiro Wilk GOF Test
                     5% Shapiro Wilk P Value 4.7426E-5   Detected Data Not Lognormal at 5% Significance Level
                    Lilliefors Test Statistic  0.0666                     Lilliefors GOF Test
               5% Lilliefors Critical Value  0.0493     Detected Data Not Lognormal at 5% Significance Level
                          Detected Data Not Lognormal at 5% Significance Level

                                  Lognormal ROS Statistics Using Imputed Non-Detects
                       Mean in Original Scale   119.3                                Mean in Log Scale   4.438
                         SD in Original Scale   291.3                                  SD in Log Scale   0.699
          95% t UCL (assumes normality of ROS data) 145.6                  95% Percentile Bootstrap UCL   148.6
                         95% BCA Bootstrap UCL   168.1                              95% Bootstrap t UCL   203.3
                            95% H-UCL (Log ROS)   116.1

                  Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
                            KM Mean (logged)   4.435                                       KM Geo Mean   84.37
                              KM SD (logged)   0.705                          95% Critical H Value (KM-Log)   1.909
               KM Standard Error of Mean (logged) 0.0389                          95% H-UCL (KM -Log)   116.5
                              KM SD (logged)   0.705                          95% Critical H Value (KM-Log)   1.909
               KM Standard Error of Mean (logged) 0.0389

                                              DL/2 Statistics
              DL/2 Normal                                          DL/2 Log-Transformed
                       Mean in Original Scale   119.2                                Mean in Log Scale   4.432
                         SD in Original Scale   291.4                                  SD in Log Scale   0.709
                   95% t UCL (Assumes normality) 145.5                                 95% H-Stat UCL   116.5
                 DL/2 is not a recommended method, provided for comparisons and historical reasons
```

ProUCL Output—Metals 0–0.5ft

```
                    Nonparametric Distribution Free UCL Statistics
                 Data do not follow a Discernible Distribution at 5% Significance Level

                                 Suggested UCL to Use
              95% KM (Chebyshev) UCL    188.9

       Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
                       Recommendations are based upon data size, data distribution, and skewness.
          These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
   However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.
```

ProUCL Output—PAHs 0–0.5ft

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.19/11/2020 3:37:33 PM
From File	20-0706_Newhalem_AllData_2020-0910_e.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

UseResult (acenaphthene*83-32-9)**

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	3	Number of Non-Detects	5
Number of Distinct Detects	3	Number of Distinct Non-Detects	5
Minimum Detect	0.046	Minimum Non-Detect	0.0072
Maximum Detect	0.1	Maximum Non-Detect	0.014
Variance Detects	7.3033E-4	Percent Non-Detects	62.5%
Mean Detects	0.0723	SD Detects	0.027
Median Detects	0.071	CV Detects	0.374
Skewness Detects	0.221	Kurtosis Detects	N/A
Mean of Logged Detects	-2.676	SD of Logged Detects	0.389

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.998	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.186	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0316	KM Standard Error of Mean	0.0149
KM SD	0.0343	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0598	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0561	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0762	95% KM Chebyshev UCL	0.0964
97.5% KM Chebyshev UCL	0.124	99% KM Chebyshev UCL	0.179

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	10.34	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00699	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	62.06	nu star (bias corrected)	N/A
Mean (detects)	0.0723		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0334
Maximum	0.1	Median	0.01
SD	0.0353	CV	1.059
k hat (MLE)	1.177	k star (bias corrected MLE)	0.819
Theta hat (MLE)	0.0284	Theta star (bias corrected MLE)	0.0408
nu hat (MLE)	18.83	nu star (bias corrected)	13.1
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (13.10, α)	5.961	Adjusted Chi Square Value (13.10, β)	4.799
95% Gamma Approximate UCL (use when n>=50)	0.0734	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0316	SD (KM)	0.0343
Variance (KM)	0.00118	SE of Mean (KM)	0.0149
k hat (KM)	0.85	k star (KM)	0.614
nu hat (KM)	13.6	nu star (KM)	9.832
theta hat (KM)	0.0372	theta star (KM)	0.0515
80% gamma percentile (KM)	0.0521	90% gamma percentile (KM)	0.0818
95% gamma percentile (KM)	0.113	99% gamma percentile (KM)	0.188

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (9.83, α)	3.837	Adjusted Chi Square Value (9.83, β)	2.95
95% Gamma Approximate KM-UCL (use when n>=50)	0.081	95% Gamma Adjusted KM-UCL (use when n<50)	0.105

ProUCL Output—PAHs 0–0.5ft

```
Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                          0.995   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.767   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.198   Lilliefors GOF Test
5% Lilliefors Critical Value                         0.425   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                               0.0371  Mean in Log Scale                          -3.592
SD in Original Scale                                 0.0326  SD in Log Scale                             0.787
  95% t UCL (assumes normality of ROS data)          0.0589    95% Percentile Bootstrap UCL              N/A
  95% BCA Bootstrap UCL                              N/A       95% Bootstrap t UCL                       N/A
  95% H-UCL (Log ROS)                                0.0895

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                    -4.087   KM Geo Mean                                 0.0168
KM SD (logged)                                       1.11      95% Critical H Value (KM-Log)             3.703
KM Standard Error of Mean (logged)                   0.481     95% H-UCL (KM -Log)                       0.147
KM SD (logged)                                       1.11      95% Critical H Value (KM-Log)             3.703
KM Standard Error of Mean (logged)                   0.481

DL/2 Statistics
DL/2 Normal                                                  DL/2 Log-Transformed
Mean in Original Scale                               0.0306  Mean in Log Scale                          -4.277
SD in Original Scale                                 0.0375  SD in Log Scale                             1.36
  95% t UCL (Assumes normality)                      0.0557    95% H-Stat UCL                            0.329
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL                                       0.0598

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzo(a)anthracene***56-55-3)

General Statistics
Total Number of Observations                         8       Number of Distinct Observations             8
Number of Detects                                    7       Number of Non-Detects                       1
Number of Distinct Detects                           7       Number of Distinct Non-Detects              1
Minimum Detect                                       0.018   Minimum Non-Detect                          0.012
Maximum Detect                                       2.9     Maximum Non-Detect                          0.012
Variance Detects                                     1.962   Percent Non-Detects                         12.5%
Mean Detects                                         1.183   SD Detects                                  1.401
Median Detects                                       0.14    CV Detects                                  1.184
Skewness Detects                                     0.437   Kurtosis Detects                           -2.578
Mean of Logged Detects                              -1.254   SD of Logged Detects                        2.181

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                          0.736   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.803   Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                            0.343   Lilliefors GOF Test
5% Lilliefors Critical Value                         0.304   Detected Data Not Normal at 5% Significance Level
Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                              1.037   KM Standard Error of Mean                   0.486
KM SD                                                1.273     95% KM (BCA) UCL                          1.799
  95% KM (t) UCL                                     1.958     95% KM (Percentile Bootstrap) UCL         1.751
95% KM (z) UCL                                       1.836   95% KM Bootstrap t UCL                      2.22
90% KM Chebyshev UCL                                 2.495   95% KM Chebyshev UCL                        3.156
97.5% KM Chebyshev UCL                               4.073   99% KM Chebyshev UCL                        5.875

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                   0.703   Anderson-Darling GOF Test
5% A-D Critical Value                                0.759   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                   0.277   Kolmogorov-Smirnov GOF
5% K-S Critical Value                                0.329   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                          0.454   k star (bias corrected MLE)                 0.354
Theta hat (MLE)                                      2.608   Theta star (bias corrected MLE)             3.338
nu hat (MLE)                                         6.35    nu star (bias corrected)                    4.962
Mean (detects)                                       1.183
```

ProUCL Output—PAHs 0–0.5ft

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.036
Maximum	2.9	Median	0.112
SD	1.362	CV	1.314
k hat (MLE)	0.387	k star (bias corrected MLE)	0.325
Theta hat (MLE)	2.677	Theta star (bias corrected MLE)	3.186
nu hat (MLE)	6.195	nu star (bias corrected)	5.205
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (5.21, α)	1.248	Adjusted Chi Square Value (5.21, β)	0.827
95% Gamma Approximate UCL (use when n>=50)	4.322	95% Gamma Adjusted UCL (use when n<50)	6.52

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.037	SD (KM)	1.273
Variance (KM)	1.621	SE of Mean (KM)	0.486
k hat (KM)	0.663	k star (KM)	0.498
nu hat (KM)	10.6	nu star (KM)	7.961
theta hat (KM)	1.564	theta star (KM)	2.084
80% gamma percentile (KM)	1.702	90% gamma percentile (KM)	2.808
95% gamma percentile (KM)	3.989	99% gamma percentile (KM)	6.896

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.96, α)	2.712	Adjusted Chi Square Value (7.96, β)	2.001
95% Gamma Approximate KM-UCL (use when n>=50)	3.043	95% Gamma Adjusted KM-UCL (use when n<50)	4.124

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.035	Mean in Log Scale	-1.908
SD in Original Scale	1.362	SD in Log Scale	2.738
95% t UCL (assumes normality of ROS data)	1.948	95% Percentile Bootstrap UCL	1.758
95% BCA Bootstrap UCL	1.82	95% Bootstrap t UCL	2.23
95% H-UCL (Log ROS)	32124		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.65	KM Geo Mean	0.192
KM SD (logged)	2.16	95% Critical H Value (KM-Log)	6.589
KM Standard Error of Mean (logged)	0.825	95% H-UCL (KM -Log)	429.9
KM SD (logged)	2.16	95% Critical H Value (KM-Log)	6.589
KM Standard Error of Mean (logged)	0.825		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.036	Mean in Log Scale	-1.737
SD in Original Scale	1.362	SD in Log Scale	2.438
95% t UCL (Assumes normality)	1.948	95% H-Stat UCL	3095

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL	2.22	Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 bu	4.124

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzo(a)pyrene*50-32-8)**

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	7	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	0.015	Minimum Non-Detect	0.012
Maximum Detect	1.5	Maximum Non-Detect	0.012
Variance Detects	0.496	Percent Non-Detects	12.5%
Mean Detects	0.591	SD Detects	0.705
Median Detects	0.066	CV Detects	1.191
Skewness Detects	0.479	Kurtosis Detects	-2.441
Mean of Logged Detects	-1.895	SD of Logged Detects	2.092

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use

guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

ProUCL Output—PAHs 0–0.5ft

```
Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                          0.748  Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.803  Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                            0.344  Lilliefors GOF Test
5% Lilliefors Critical Value                         0.304  Detected Data Not Normal at 5% Significance Level
Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                              0.519  KM Standard Error of Mean                        0.244
KM SD                                                0.64     95% KM (BCA) UCL                               0.868
  95% KM (t) UCL                                     0.982    95% KM (Percentile Bootstrap) UCL              0.89
95% KM (z) UCL                                       0.921  95% KM Bootstrap t UCL                           1.138
90% KM Chebyshev UCL                                 1.252  95% KM Chebyshev UCL                             1.584
97.5% KM Chebyshev UCL                               2.044  99% KM Chebyshev UCL                             2.949

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                   0.758  Anderson-Darling GOF Test
5% A-D Critical Value                                0.757  Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                                   0.293  Kolmogorov-Smirnov GOF
5% K-S Critical Value                                0.328  Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                          0.469  k star (bias corrected MLE)                      0.363
Theta hat (MLE)                                      1.262  Theta star (bias corrected MLE)                  1.629
nu hat (MLE)                                         6.56   nu star (bias corrected)                         5.082
Mean (detects)                                       0.591

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                              0.01   Mean                                             0.519
Maximum                                              1.5    Median                                           0.053
SD                                                   0.684  CV                                               1.318
k hat (MLE)                                          0.415  k star (bias corrected MLE)                      0.343
Theta hat (MLE)                                      1.251  Theta star (bias corrected MLE)                  1.514
nu hat (MLE)                                         6.637  nu star (bias corrected)                         5.481
Adjusted Level of Significance (β)                   0.0195
Approximate Chi Square Value (5.48, α)               1.381  Adjusted Chi Square Value (5.48, β)              0.929
95% Gamma Approximate UCL (use when n>=50)           2.059  95% Gamma Adjusted UCL (use when n<50)           3.061

Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                            0.519  SD (KM)                                          0.64
Variance (KM)                                        0.409  SE of Mean (KM)                                  0.244
k hat (KM)                                           0.659  k star (KM)                                      0.495
nu hat (KM)                                          10.54  nu star (KM)                                     7.92
theta hat (KM)                                       0.788  theta star (KM)                                  1.049
80% gamma percentile (KM)                            0.852  90% gamma percentile (KM)                        1.407
95% gamma percentile (KM)                            2.001  99% gamma percentile (KM)                        3.463

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (7.92, α)               2.689  Adjusted Chi Square Value (7.92, β)              1.981
95% Gamma Approximate KM-UCL (use when n>=50)        1.529  95% Gamma Adjusted KM-UCL (use when n<50)        2.075

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                          0.819  Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.803  Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.258  Lilliefors GOF Test
5% Lilliefors Critical Value                         0.304  Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                               0.518  Mean in Log Scale                               -2.516
SD in Original Scale                                 0.685  SD in Log Scale                                  2.616
  95% t UCL (assumes normality of ROS data)          0.976    95% Percentile Bootstrap UCL                   0.894
  95% BCA Bootstrap UCL                              0.952    95% Bootstrap t UCL                            1.154
  95% H-UCL (Log ROS)                               6063

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                    -2.211  KM Geo Mean                                      0.11
KM SD (logged)                                       1.995    95% Critical H Value (KM-Log)                  6.121
KM Standard Error of Mean (logged)                   0.762    95% H-UCL (KM -Log)                           81.1
KM SD (logged)                                       1.995    95% Critical H Value (KM-Log)                  6.121
KM Standard Error of Mean (logged)                   0.762

DL/2 Statistics
DL/2 Normal                                                 DL/2 Log-Transformed
Mean in Original Scale                               0.518  Mean in Log Scale                               -2.297
SD in Original Scale                                 0.684  SD in Log Scale                                  2.247
  95% t UCL (Assumes normality)                      0.977    95% H-Stat UCL                               416.2
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Gamma Distributed at 5% Significance Level
```

ProUCL Output—PAHs 0–0.5ft

```
Suggested UCL to Use
95% KM Bootstrap t UCL                          1.138   Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 bu   2.075

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (benzo(b)fluoranthene***205-99-2)

General Statistics
Total Number of Observations                    8       Number of Distinct Observations              8
                                                        Number of Missing Observations               0
Minimum                                         0.022   Mean                                         1.061
Maximum                                         2.9     Median                                       0.135
SD                                              1.363   Std. Error of Mean                           0.482
Coefficient of Variation                        1.285   Skewness                                     0.663

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                     0.7     Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.818   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                       0.366   Lilliefors GOF Test
5% Lilliefors Critical Value                    0.283   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                          95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                           1.973     95% Adjusted-CLT UCL (Chen-1995)           1.974
                                                          95% Modified-t UCL (Johnson-1978)          1.992

Gamma GOF Test
A-D Test Statistic                              0.833   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                           0.772   Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                              0.275   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                           0.311   Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics
k hat (MLE)                                     0.444   k star (bias corrected MLE)                  0.361
Theta hat (MLE)                                 2.391   Theta star (bias corrected MLE)              2.941
nu hat (MLE)                                    7.099   nu star (bias corrected)                     5.77
MLE Mean (bias corrected)                       1.061   MLE Sd (bias corrected)                      1.766
                                                        Approximate Chi Square Value (0.05)          1.524
Adjusted Level of Significance                  0.0195  Adjusted Chi Square Value                    1.04

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)    4.017     95% Adjusted Gamma UCL (use when n<50)     5.886

Lognormal GOF Test
Shapiro Wilk Test Statistic                     0.841   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                  0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                       0.243   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                    0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                         -3.817   Mean of logged Data                         -1.4
Maximum of Logged Data                          1.065   SD of logged Data                            2.078

Assuming Lognormal Distribution
  95% H-UCL                                     314.2     90% Chebyshev (MVUE) UCL                   3.82
  95% Chebyshev (MVUE) UCL                      4.991   97.5% Chebyshev (MVUE) UCL                   6.617
  99% Chebyshev (MVUE) UCL                      9.811

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                   1.853     95% Jackknife UCL                          1.973
  95% Standard Bootstrap UCL                    1.808     95% Bootstrap-t UCL                        2.125
  95% Hall's Bootstrap UCL                      1.508     95% Percentile Bootstrap UCL               1.757
  95% BCA Bootstrap UCL                         1.792
  90% Chebyshev(Mean, Sd) UCL                   2.506     95% Chebyshev(Mean, Sd) UCL                3.16
97.5% Chebyshev(Mean, Sd) UCL                   4.069     99% Chebyshev(Mean, Sd) UCL                5.854

Suggested UCL to Use
95% Adjusted Gamma UCL                          5.886
```

ProUCL Output—PAHs 0–0.5ft

Recommended UCL exceeds the maximum observation

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (benzofluoranthenes (j+k)***bjkflanth)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	7	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	0.0095	Minimum Non-Detect	0.012
Maximum Detect	0.96	Maximum Non-Detect	0.012
Variance Detects	0.198	Percent Non-Detects	12.5%
Mean Detects	0.382	SD Detects	0.445
Median Detects	0.054	CV Detects	1.165
Skewness Detects	0.429	Kurtosis Detects	-2.573
Mean of Logged Detects	-2.234	SD of Logged Detects	2.013

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.744	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.341	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.304	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.335	KM Standard Error of Mean	0.154
KM SD	0.404	95% KM (BCA) UCL	0.568
95% KM (t) UCL	0.628	95% KM (Percentile Bootstrap) UCL	0.554
95% KM (z) UCL	0.589	95% KM Bootstrap t UCL	0.673
90% KM Chebyshev UCL	0.798	95% KM Chebyshev UCL	1.008
97.5% KM Chebyshev UCL	1.299	99% KM Chebyshev UCL	1.871

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.736	Anderson-Darling GOF Test	
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.278	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.327	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.5	k star (bias corrected MLE)	0.381
Theta hat (MLE)	0.764	Theta star (bias corrected MLE)	1.002
nu hat (MLE)	6.997	nu star (bias corrected)	5.332
Mean (detects)	0.382		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0095	Mean	0.335
Maximum	0.96	Median	0.043
SD	0.432	CV	1.289
k hat (MLE)	0.449	k star (bias corrected MLE)	0.364
Theta hat (MLE)	0.746	Theta star (bias corrected MLE)	0.92
nu hat (MLE)	7.189	nu star (bias corrected)	5.827
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (5.83, α)	1.552	Adjusted Chi Square Value (5.83, β)	1.062
95% Gamma Approximate UCL (use when n>=50)	1.258	95% Gamma Adjusted UCL (use when n<50)	1.839

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.335	SD (KM)	0.404
Variance (KM)	0.163	SE of Mean (KM)	0.154
k hat (KM)	0.687	k star (KM)	0.513
nu hat (KM)	10.99	nu star (KM)	8.204
theta hat (KM)	0.488	theta star (KM)	0.654
80% gamma percentile (KM)	0.551	90% gamma percentile (KM)	0.902
95% gamma percentile (KM)	1.276	99% gamma percentile (KM)	2.193

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.20, α)	2.854	Adjusted Chi Square Value (8.20, β)	2.119
95% Gamma Approximate KM-UCL (use when n>=50)	0.963	95% Gamma Adjusted KM-UCL (use when n<50)	1.298

ProUCL Output—PAHs 0–0.5ft

```
Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                     0.839   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.803   Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                       0.268   Lilliefors GOF Test
5% Lilliefors Critical Value                    0.304   Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                          0.335   Mean in Log Scale                                   -2.616
SD in Original Scale                            0.433   SD in Log Scale                                      2.154
  95% t UCL (assumes normality of ROS data)     0.624     95% Percentile Bootstrap UCL                       0.564
  95% BCA Bootstrap UCL                         0.603     95% Bootstrap t UCL                                0.674
  95% H-UCL (Log ROS)                           156.9

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                               -2.537   KM Geo Mean                                         0.0791
KM SD (logged)                                  1.918     95% Critical H Value (KM-Log)                      5.904
KM Standard Error of Mean (logged)              0.733     95% H-UCL (KM -Log)                                36.02
KM SD (logged)                                  1.918     95% Critical H Value (KM-Log)                      5.904
KM Standard Error of Mean (logged)              0.733

DL/2 Statistics
DL/2 Normal                                             DL/2 Log-Transformed
Mean in Original Scale                          0.335   Mean in Log Scale                                   -2.594
SD in Original Scale                            0.433   SD in Log Scale                                      2.124
  95% t UCL (Assumes normality)                 0.624     95% H-Stat UCL                                     130
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use
95% KM Bootstrap t UCL                          0.673   Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 bu    1.298

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (chrysene***218-01-9)

General Statistics
Total Number of Observations                    8       Number of Distinct Observations                     8
                                                        Number of Missing Observations                      0
Minimum                                         0.021   Mean                                                1.375
Maximum                                         4.2     Median                                              0.152
SD                                              1.822   Std. Error of Mean                                  0.644
Coefficient of Variation                        1.325   Skewness                                            0.779

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                     0.735   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.818   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                       0.364   Lilliefors GOF Test
5% Lilliefors Critical Value                    0.283   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                          95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                           2.595     95% Adjusted-CLT UCL (Chen-1995)                   2.624
                                                          95% Modified-t UCL (Johnson-1978)                  2.625

Gamma GOF Test
A-D Test Statistic                              0.747   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                           0.78    Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                              0.262   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                           0.313   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                     0.399   k star (bias corrected MLE)                         0.333
Theta hat (MLE)                                 3.447   Theta star (bias corrected MLE)                     4.134
nu hat (MLE)                                    6.383   nu star (bias corrected)                            5.323
MLE Mean (bias corrected)                       1.375   MLE Sd (bias corrected)                             2.384
                                                        Approximate Chi Square Value (0.05)                 1.304
Adjusted Level of Significance                  0.0195  Adjusted Chi Square Value                           0.87

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)     5.613     95% Adjusted Gamma UCL (use when n<50)             8.413
```

ProUCL Output—PAHs 0–0.5ft

```
Lognormal GOF Test
Shapiro Wilk Test Statistic                          0.85    Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                       0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.231   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                         0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                              -3.863   Mean of logged Data                              -1.332
Maximum of Logged Data                               1.435   SD of logged Data                                 2.256

Assuming Lognormal Distribution
  95% H-UCL                                        1174        90% Chebyshev (MVUE) UCL                        5.451
  95% Chebyshev (MVUE) UCL                           7.154   97.5% Chebyshev (MVUE) UCL                        9.517
  99% Chebyshev (MVUE) UCL                          14.16

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                        2.435     95% Jackknife UCL                               2.595
  95% Standard Bootstrap UCL                         2.345     95% Bootstrap-t UCL                             3.095
  95% Hall's Bootstrap UCL                           2.053     95% Percentile Bootstrap UCL                    2.402
  95% BCA Bootstrap UCL                              2.466
  90% Chebyshev(Mean, Sd) UCL                        3.307     95% Chebyshev(Mean, Sd) UCL                     4.182
 97.5% Chebyshev(Mean, Sd) UCL                       5.397     99% Chebyshev(Mean, Sd) UCL                     7.783

Suggested UCL to Use
95% Adjusted Gamma UCL                               8.413

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (cpahs (mtca teq-halfnd)***bapeq (u=1/2))

General Statistics
Total Number of Observations                         8       Number of Distinct Observations                   8
                                                             Number of Missing Observations                    0
Minimum                                              0.011   Mean                                              0.818
Maximum                                              2.3     Median                                            0.087
SD                                                   1.068   Std. Error of Mean                                0.377
Coefficient of Variation                             1.306   Skewness                                          0.68

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                          0.704   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.818   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                            0.371   Lilliefors GOF Test
5% Lilliefors Critical Value                         0.283   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                               95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                                1.533     95% Adjusted-CLT UCL (Chen-1995)                1.536
                                                               95% Modified-t UCL (Johnson-1978)               1.548

Gamma GOF Test
A-D Test Statistic                                   0.817   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                                0.778   Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                                   0.287   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                                0.313   Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics
k hat (MLE)                                          0.41    k star (bias corrected MLE)                       0.34
Theta hat (MLE)                                      1.995   Theta star (bias corrected MLE)                   2.409
nu hat (MLE)                                         6.558   nu star (bias corrected)                          5.432
MLE Mean (bias corrected)                            0.818   MLE Sd (bias corrected)                           1.403
                                                             Approximate Chi Square Value (0.05)               1.357
Adjusted Level of Significance                       0.0195  Adjusted Chi Square Value                         0.911

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)         3.274     95% Adjusted Gamma UCL (use when n<50)          4.879

Lognormal GOF Test
Shapiro Wilk Test Statistic                          0.852   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                       0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.241   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                         0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level
```

ProUCL Output—PAHs 0–0.5ft

```
Lognormal Statistics
Minimum of Logged Data                                  -4.51   Mean of logged Data                                  -1.8
Maximum of Logged Data                                  0.833   SD of logged Data                                   2.209

Assuming Lognormal Distribution
  95% H-UCL                                             521.6     90% Chebyshev (MVUE) UCL                          3.159
  95% Chebyshev (MVUE) UCL                              4.141    97.5% Chebyshev (MVUE) UCL                         5.504
  99% Chebyshev (MVUE) UCL                              8.182

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                           1.439     95% Jackknife UCL                                 1.533
  95% Standard Bootstrap UCL                            1.404     95% Bootstrap-t UCL                               1.674
  95% Hall's Bootstrap UCL                              1.17      95% Percentile Bootstrap UCL                      1.375
  95% BCA Bootstrap UCL                                 1.457
  90% Chebyshev(Mean, Sd) UCL                           1.95      95% Chebyshev(Mean, Sd) UCL                       2.463
 97.5% Chebyshev(Mean, Sd) UCL                          3.175     99% Chebyshev(Mean, Sd) UCL                       4.573

Suggested UCL to Use
95% Adjusted Gamma UCL                                  4.879

Recommended UCL exceeds the maximum observation

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (cpahs (mtca teq-zerond)***bapeq (u=0))

General Statistics
Total Number of Observations                            8       Number of Distinct Observations                      8
                                                                Number of Missing Observations                       0
Minimum                                                 0.0024  Mean                                                 0.816
Maximum                                                 2.3     Median                                               0.0865
SD                                                      1.069   Std. Error of Mean                                   0.378
Coefficient of Variation                                1.309   Skewness                                             0.679

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                             0.706   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                          0.818   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                               0.371   Lilliefors GOF Test
5% Lilliefors Critical Value                            0.283   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                                  95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                                   1.532     95% Adjusted-CLT UCL (Chen-1995)                  1.535
                                                                  95% Modified-t UCL (Johnson-1978)                 1.547

Gamma GOF Test
A-D Test Statistic                                      0.657   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                                   0.785   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                      0.259   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                                   0.314   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                             0.37    k star (bias corrected MLE)                          0.315
Theta hat (MLE)                                         2.204   Theta star (bias corrected MLE)                      2.593
nu hat (MLE)                                            5.926   nu star (bias corrected)                             5.037
MLE Mean (bias corrected)                               0.816   MLE Sd (bias corrected)                              1.455
                                                                Approximate Chi Square Value (0.05)                  1.169
Adjusted Level of Significance                          0.0195  Adjusted Chi Square Value                            0.768

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)            3.516     95% Adjusted Gamma UCL (use when n<50)            5.355

Lognormal GOF Test
Shapiro Wilk Test Statistic                             0.898   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                          0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                               0.227   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                            0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                                  -6.032  Mean of logged Data                                  -2.002
Maximum of Logged Data                                  0.833   SD of logged Data                                    2.527
```

ProUCL Output—PAHs 0–0.5ft

```
Assuming Lognormal Distribution
  95% H-UCL                                      4861    90% Chebyshev (MVUE) UCL                  4.353
  95% Chebyshev (MVUE) UCL                      5.743  97.5% Chebyshev (MVUE) UCL                  7.671
  99% Chebyshev (MVUE) UCL                      11.46

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                   1.438    95% Jackknife UCL                         1.532
  95% Standard Bootstrap UCL                    1.382    95% Bootstrap-t UCL                       1.694
  95% Hall's Bootstrap UCL                      1.169    95% Percentile Bootstrap UCL              1.381
  95% BCA Bootstrap UCL                         1.458
  90% Chebyshev(Mean, Sd) UCL                   1.95     95% Chebyshev(Mean, Sd) UCL               2.463
97.5% Chebyshev(Mean, Sd) UCL                   3.176    99% Chebyshev(Mean, Sd) UCL               4.576

Suggested UCL to Use
95% Adjusted Gamma UCL                          5.355

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (dibenzo(a,h)anthracene***53-70-3)

General Statistics
Total Number of Observations                    8      Number of Distinct Observations             8
Number of Detects                               3      Number of Non-Detects                       5
Number of Distinct Detects                      3      Number of Distinct Non-Detects              5
Minimum Detect                                  0.14   Minimum Non-Detect                          0.0072
Maximum Detect                                  0.21   Maximum Non-Detect                          0.014
Variance Detects                                0.00123 Percent Non-Detects                        62.5%
Mean Detects                                    0.177  SD Detects                                  0.0351
Median Detects                                  0.18   CV Detects                                  0.199
Skewness Detects                               -0.423  Kurtosis Detects                            N/A
Mean of Logged Detects                         -1.747  SD of Logged Detects                        0.205

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.


Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                     0.993  Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.767  Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic                       0.204  Lilliefors GOF Test
5% Lilliefors Critical Value                    0.425  Detected Data appear Normal at 5% Significance Level
Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                         0.0708 KM Standard Error of Mean                   0.0363
KM SD                                           0.0839   95% KM (BCA) UCL                          N/A
95% KM (t) UCL                                  0.14   95% KM (Percentile Bootstrap) UCL           N/A
  95% KM (z) UCL                                0.131    95% KM Bootstrap t UCL                    N/A
90% KM Chebyshev UCL                            0.18   95% KM Chebyshev UCL                        0.229
97.5% KM Chebyshev UCL                          0.298  99% KM Chebyshev UCL                        0.432

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only
k hat (MLE)                                     36.67  k star (bias corrected MLE)                 N/A
Theta hat (MLE)                                 0.00482 Theta star (bias corrected MLE)            N/A
nu hat (MLE)                                    220    nu star (bias corrected)                    N/A
Mean (detects)                                  0.177

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                         0.0544 Mean                                        0.1
Maximum                                         0.21   Median                                      0.0544
SD                                              0.066  CV                                          0.658
k hat (MLE)                                     3.022  k star (bias corrected MLE)                 1.972
Theta hat (MLE)                                 0.0332 Theta star (bias corrected MLE)             0.0509
nu hat (MLE)                                    48.35  nu star (bias corrected)                    31.55
Adjusted Level of Significance (β)              0.0195
Approximate Chi Square Value (31.55, α)         19.72  Adjusted Chi Square Value (31.55, β)        17.39
95% Gamma Approximate UCL (use when n>=50)      0.16   95% Gamma Adjusted UCL (use when n<50)      N/A
```

ProUCL Output—PAHs 0–0.5ft

```
Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                           0.0708   SD (KM)                                        0.0839
Variance (KM)                                       0.00704  SE of Mean (KM)                                0.0363
k hat (KM)                                          0.711    k star (KM)                                    0.528
nu hat (KM)                                         11.38    nu star (KM)                                   8.444
theta hat (KM)                                      0.0995   theta star (KM)                                0.134
80% gamma percentile (KM)                           0.116    90% gamma percentile (KM)                      0.189
95% gamma percentile (KM)                           0.267    99% gamma percentile (KM)                      0.456

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (8.44, α)              2.995    Adjusted Chi Square Value (8.44, β)            2.237
  95% Gamma Approximate KM-UCL (use when n>=50)     0.199      95% Gamma Adjusted KM-UCL (use when n<50)    0.267

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Test Statistic                         0.981    Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.767    Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                           0.23     Lilliefors GOF Test
5% Lilliefors Critical Value                        0.425    Detected Data appear Lognormal at 5% Significance Level
Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                              0.117    Mean in Log Scale                              -2.222
SD in Original Scale                                0.0527   SD in Log Scale                                0.408
  95% t UCL (assumes normality of ROS data)         0.152      95% Percentile Bootstrap UCL                 N/A
  95% BCA Bootstrap UCL                             N/A        95% Bootstrap t UCL                          N/A
  95% H-UCL (Log ROS)                               0.166

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                    -3.739   KM Geo Mean                                    0.0238
KM SD (logged)                                      1.546      95% Critical H Value (KM-Log)                4.867
KM Standard Error of Mean (logged)                  0.669      95% H-UCL (KM -Log)                          1.35
KM SD (logged)                                      1.546      95% Critical H Value (KM-Log)                4.867
KM Standard Error of Mean (logged)                  0.669

DL/2 Statistics
DL/2 Normal                                                  DL/2 Log-Transformed
Mean in Original Scale                              0.0697   Mean in Log Scale                              -3.929
SD in Original Scale                                0.0906   SD in Log Scale                                1.823
  95% t UCL (Assumes normality)                     0.13       95% H-Stat UCL                               5.029
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL                                      0.14

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (fluoranthene***206-44-0)

General Statistics
Total Number of Observations                        8        Number of Distinct Observations                8
                                                             Number of Missing Observations                 0
Minimum                                             0.027    Mean                                           2.378
Maximum                                             7.1      Median                                         0.29
SD                                                  3.184    Std. Error of Mean                             1.126
Coefficient of Variation                            1.339    Skewness                                       0.848

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                         0.727    Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.818    Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                           0.36     Lilliefors GOF Test
5% Lilliefors Critical Value                        0.283    Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                               95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                               4.511      95% Adjusted-CLT UCL (Chen-1995)             4.591
                                                               95% Modified-t UCL (Johnson-1978)            4.567

Gamma GOF Test
A-D Test Statistic                                  0.637    Anderson-Darling Gamma GOF Test
5% A-D Critical Value                               0.782    Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                  0.247    Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                               0.314    Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level
```

ProUCL Output—PAHs 0–0.5ft

```
Gamma Statistics
k hat (MLE)                                          0.386   k star (bias corrected MLE)                         0.324
Theta hat (MLE)                                      6.164   Theta star (bias corrected MLE)                      7.33
nu hat (MLE)                                         6.174   nu star (bias corrected)                            5.192
MLE Mean (bias corrected)                            2.378   MLE Sd (bias corrected)                             4.175
                                                             Approximate Chi Square Value (0.05)                 1.242
Adjusted Level of Significance                      0.0195   Adjusted Chi Square Value                           0.823

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)         9.944     95% Adjusted Gamma UCL (use when n<50)            15.01

Lognormal GOF Test
Shapiro Wilk Test Statistic                          0.869   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                       0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.213   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                         0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                              -3.612   Mean of logged Data                                -0.849
Maximum of Logged Data                                1.96   SD of logged Data                                    2.36

Assuming Lognormal Distribution
  95% H-UCL                                         4124       90% Chebyshev (MVUE) UCL                          10.46
  95% Chebyshev (MVUE) UCL                           13.76   97.5% Chebyshev (MVUE) UCL                          18.34
  99% Chebyshev (MVUE) UCL                           27.33

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                         4.23     95% Jackknife UCL                                 4.511
  95% Standard Bootstrap UCL                         4.145     95% Bootstrap-t UCL                               5.944
  95% Hall's Bootstrap UCL                           3.508     95% Percentile Bootstrap UCL                      4.109
  95% BCA Bootstrap UCL                              4.432
  90% Chebyshev(Mean, Sd) UCL                        5.755     95% Chebyshev(Mean, Sd) UCL                       7.285
 97.5% Chebyshev(Mean, Sd) UCL                       9.408     99% Chebyshev(Mean, Sd) UCL                       13.58

Suggested UCL to Use
95% Adjusted Gamma UCL                               15.01

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UseResult (na)

General Statistics
Total Number of Observations                        304      Number of Distinct Observations                    130
Number of Detects                                   162      Number of Non-Detects                              142
Number of Distinct Detects                          103      Number of Distinct Non-Detects                      45
Minimum Detect                                      0.0014   Minimum Non-Detect                                 0.0058
Maximum Detect                                       39      Maximum Non-Detect                                  0.58
Variance Detects                                     24.11   Percent Non-Detects                                46.71%
Mean Detects                                         1.718   SD Detects                                           4.91
Median Detects                                       0.235   CV Detects                                          2.858
Skewness Detects                                     5.902   Kurtosis Detects                                    40.77
Mean of Logged Detects                              -1.449   SD of Logged Detects                                2.093

Normal GOF Test on Detects Only
Shapiro Wilk Test Statistic                          0.378   Normal GOF Test on Detected Observations Only
5% Shapiro Wilk P Value                              0       Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                            0.363   Lilliefors GOF Test
5% Lilliefors Critical Value                        0.07     Detected Data Not Normal at 5% Significance Level
Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs
KM Mean                                              0.922   KM Standard Error of Mean                           0.211
KM SD                                                3.673     95% KM (BCA) UCL                                  1.333
  95% KM (t) UCL                                     1.271     95% KM (Percentile Bootstrap) UCL                 1.273
  95% KM (z) UCL                                      1.27     95% KM Bootstrap t UCL                            1.536
90% KM Chebyshev UCL                                 1.556   95% KM Chebyshev UCL                                1.843
97.5% KM Chebyshev UCL                               2.242   99% KM Chebyshev UCL                                3.025

Gamma GOF Tests on Detected Observations Only
A-D Test Statistic                                   7.078   Anderson-Darling GOF Test
5% A-D Critical Value                                0.859   Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                                   0.154   Kolmogorov-Smirnov GOF
5% K-S Critical Value                               0.0793   Detected Data Not Gamma Distributed at 5% Significance Level
Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only
k hat (MLE)                                           0.34   k star (bias corrected MLE)                         0.337
Theta hat (MLE)                                       5.06   Theta star (bias corrected MLE)                     5.093
nu hat (MLE)                                        110      nu star (bias corrected)                           109.3
Mean (detects)                                       1.718
```

ProUCL Output—PAHs 0–0.5ft

```
Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates
Minimum                                            0.0014   Mean                                            0.92
Maximum                                            39       Median                                          0.0125
SD                                                 3.679    CV                                              3.998
k hat (MLE)                                        0.25     k star (bias corrected MLE)                     0.25
Theta hat (MLE)                                    3.68     Theta star (bias corrected MLE)                 3.684
nu hat (MLE)                                       152      nu star (bias corrected)                        151.9
Adjusted Level of Significance (β)                 0.0492
Approximate Chi Square Value (151.88, α)           124.4    Adjusted Chi Square Value (151.88, β)           124.3
95% Gamma Approximate UCL (use when n>=50)         1.124    95% Gamma Adjusted UCL (use when n<50)          1.125

Estimates of Gamma Parameters using KM Estimates
Mean (KM)                                          0.922    SD (KM)                                         3.673
Variance (KM)                                      13.49    SE of Mean (KM)                                 0.211
k hat (KM)                                         0.063    k star (KM)                                     0.0646
nu hat (KM)                                        38.31    nu star (KM)                                    39.26
theta hat (KM)                                     14.63    theta star (KM)                                 14.28
80% gamma percentile (KM)                          0.271    90% gamma percentile (KM)                       1.859
95% gamma percentile (KM)                          5.242    99% gamma percentile (KM)                       18.01

Gamma Kaplan-Meier (KM) Statistics
Approximate Chi Square Value (39.26, α)            25.91    Adjusted Chi Square Value (39.26, β)            25.86
  95% Gamma Approximate KM-UCL (use when n>=50)    1.397      95% Gamma Adjusted KM-UCL (use when n<50)     1.4

Lognormal GOF Test on Detected Observations Only
Shapiro Wilk Approximate Test Statistic            0.968    Shapiro Wilk GOF Test
5% Shapiro Wilk P Value                            0.0233   Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic                          0.0859   Lilliefors GOF Test
5% Lilliefors Critical Value                       0.07     Detected Data Not Lognormal at 5% Significance Level
Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects
Mean in Original Scale                             0.919    Mean in Log Scale                               -3.422
SD in Original Scale                               3.68     SD in Log Scale                                 2.783
  95% t UCL (assumes normality of ROS data)        1.267      95% Percentile Bootstrap UCL                  1.293
  95% BCA Bootstrap UCL                            1.443      95% Bootstrap t UCL                           1.557
  95% H-UCL (Log ROS)                              2.963

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution
KM Mean (logged)                                   -3.327   KM Geo Mean                                     0.0359
KM SD (logged)                                     2.664      95% Critical H Value (KM-Log)                 3.839
KM Standard Error of Mean (logged)                 0.182      95% H-UCL (KM -Log)                           2.243
KM SD (logged)                                     2.664      95% Critical H Value (KM-Log)                 3.839
KM Standard Error of Mean (logged)                 0.182

DL/2 Statistics
DL/2 Normal                                                 DL/2 Log-Transformed
Mean in Original Scale                             0.937    Mean in Log Scale                               -2.656
SD in Original Scale                               3.676    SD in Log Scale                                 2.193
  95% t UCL (Assumes normality)                    1.285      95% H-Stat UCL                                1.177
DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL                             1.843

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (pyrene***129-00-0)

General Statistics
Total Number of Observations                       8        Number of Distinct Observations                 8
                                                            Number of Missing Observations                  0
Minimum                                            0.024    Mean                                            2.389
Maximum                                            7.3      Median                                          0.285
SD                                                 3.199    Std. Error of Mean                              1.131
Coefficient of Variation                           1.339    Skewness                                        0.845

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                        0.736    Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                      0.818    Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                          0.362    Lilliefors GOF Test
5% Lilliefors Critical Value                       0.283    Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level
```

ProUCL Output—PAHs 0–0.5ft

```
Assuming Normal Distribution
  95% Normal UCL                                            95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                            4.531      95% Adjusted-CLT UCL (Chen-1995)              4.61
                                                            95% Modified-t UCL (Johnson-1978)             4.588

Gamma GOF Test
A-D Test Statistic                               0.63     Anderson-Darling Gamma GOF Test
5% A-D Critical Value                            0.783    Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                               0.254    Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                            0.314    Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                      0.384    k star (bias corrected MLE)                     0.323
Theta hat (MLE)                                  6.225    Theta star (bias corrected MLE)                 7.391
nu hat (MLE)                                     6.14     nu star (bias corrected)                        5.171
MLE Mean (bias corrected)                        2.389    MLE Sd (bias corrected)                         4.202
                                                          Approximate Chi Square Value (0.05)             1.232
Adjusted Level of Significance                   0.0195   Adjusted Chi Square Value                       0.815

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)     10.03      95% Adjusted Gamma UCL (use when n<50)        15.15

Lognormal GOF Test
Shapiro Wilk Test Statistic                      0.878    Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                   0.818    Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                        0.216    Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                     0.283    Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                           -3.73    Mean of logged Data                             -0.856
Maximum of Logged Data                           1.988    SD of logged Data                               2.366

Assuming Lognormal Distribution
  95% H-UCL                                      4294       90% Chebyshev (MVUE) UCL                      10.5
  95% Chebyshev (MVUE) UCL                       13.81    97.5% Chebyshev (MVUE) UCL                      18.41
  99% Chebyshev (MVUE) UCL                       27.44

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                    4.249      95% Jackknife UCL                             4.531
  95% Standard Bootstrap UCL                     4.123      95% Bootstrap-t UCL                           5.85
  95% Hall's Bootstrap UCL                       3.89       95% Percentile Bootstrap UCL                  4.184
  95% BCA Bootstrap UCL                          4.359
  90% Chebyshev(Mean, Sd) UCL                    5.782      95% Chebyshev(Mean, Sd) UCL                   7.319
97.5% Chebyshev(Mean, Sd) UCL                    9.452      99% Chebyshev(Mean, Sd) UCL                   13.64

Suggested UCL to Use
95% Adjusted Gamma UCL                           15.15

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (total hpah (u=0)***t_hpah (u=0))

General Statistics
Total Number of Observations                     8        Number of Distinct Observations                 8
                                                          Number of Missing Observations                  0
Minimum                                          0.067    Mean                                            7.275
Maximum                                          21       Median                                          0.84
SD                                               9.534    Std. Error of Mean                              3.371
Coefficient of Variation                         1.311    Skewness                                        0.715

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                      0.72     Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                   0.818    Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                        0.366    Lilliefors GOF Test
5% Lilliefors Critical Value                     0.283    Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                            95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                            13.66      95% Adjusted-CLT UCL (Chen-1995)              13.73
                                                            95% Modified-t UCL (Johnson-1978)             13.8
```

ProUCL Output—PAHs 0–0.5ft

```
Gamma GOF Test
A-D Test Statistic                              0.698   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                           0.781   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                              0.261   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                           0.313   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                     0.395   k star (bias corrected MLE)                        0.33
Theta hat (MLE)                                 18.43   Theta star (bias corrected MLE)                    22.04
nu hat (MLE)                                    6.315   nu star (bias corrected)                           5.28
MLE Mean (bias corrected)                       7.275   MLE Sd (bias corrected)                            12.66
                                                        Approximate Chi Square Value (0.05)                1.284
Adjusted Level of Significance                  0.0195  Adjusted Chi Square Value                          0.855

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)    29.92     95% Adjusted Gamma UCL (use when n<50)           44.95

Lognormal GOF Test
Shapiro Wilk Test Statistic                     0.878   Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                  0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                       0.231   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                    0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                         -2.703   Mean of logged Data                                0.313
Maximum of Logged Data                          3.045   SD of logged Data                                  2.315

Assuming Lognormal Distribution
  95% H-UCL                                   9341        90% Chebyshev (MVUE) UCL                         31.05
  95% Chebyshev (MVUE) UCL                      40.8     97.5% Chebyshev (MVUE) UCL                        54.33
  99% Chebyshev (MVUE) UCL                      80.91

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                   12.82     95% Jackknife UCL                                13.66
  95% Standard Bootstrap UCL                    12.42     95% Bootstrap-t UCL                              15.53
  95% Hall's Bootstrap UCL                      10.52     95% Percentile Bootstrap UCL                     12.43
  95% BCA Bootstrap UCL                         13.33
  90% Chebyshev(Mean, Sd) UCL                   17.39     95% Chebyshev(Mean, Sd) UCL                      21.97
 97.5% Chebyshev(Mean, Sd) UCL                  28.33     99% Chebyshev(Mean, Sd) UCL                      40.81

Suggested UCL to Use
95% Adjusted Gamma UCL                          44.95

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.


UseResult (total hpah (u=1/2)***t_hpah (u=1/2))

General Statistics
Total Number of Observations                    8       Number of Distinct Observations                    8
                                                        Number of Missing Observations                     0
Minimum                                         0.097   Mean                                               7.278
Maximum                                         21      Median                                             0.84
SD                                              9.531   Std. Error of Mean                                 3.37
Coefficient of Variation                        1.309   Skewness                                           0.715

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test
Shapiro Wilk Test Statistic                     0.719   Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                  0.818   Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                       0.367   Lilliefors GOF Test
5% Lilliefors Critical Value                    0.283   Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                          95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                           13.66     95% Adjusted-CLT UCL (Chen-1995)                 13.73
                                                          95% Modified-t UCL (Johnson-1978)                13.8

Gamma GOF Test
A-D Test Statistic                              0.745   Anderson-Darling Gamma GOF Test
5% A-D Critical Value                           0.779   Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                              0.267   Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                           0.313   Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level
```

ProUCL Output—PAHs 0–0.5ft

```
Gamma Statistics
k hat (MLE)                                           0.404   k star (bias corrected MLE)                           0.336
Theta hat (MLE)                                       18.01   Theta star (bias corrected MLE)                       21.66
nu hat (MLE)                                          6.468   nu star (bias corrected)                              5.376
MLE Mean (bias corrected)                             7.278   MLE Sd (bias corrected)                               12.56
                                                              Approximate Chi Square Value (0.05)                   1.33
Adjusted Level of Significance                       0.0195   Adjusted Chi Square Value                             0.89

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)          29.43     95% Adjusted Gamma UCL (use when n<50)              43.98

Lognormal GOF Test
Shapiro Wilk Test Statistic                           0.86    Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                        0.818   Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                             0.233   Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                          0.283   Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                               -2.333   Mean of logged Data                                   0.36
Maximum of Logged Data                                3.045   SD of logged Data                                     2.248

Assuming Lognormal Distribution
  95% H-UCL                                          6009       90% Chebyshev (MVUE) UCL                            29.2
  95% Chebyshev (MVUE) UCL                            38.32    97.5% Chebyshev (MVUE) UCL                           50.97
  99% Chebyshev (MVUE) UCL                            75.81

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                         12.82     95% Jackknife UCL                                   13.66
  95% Standard Bootstrap UCL                          12.57     95% Bootstrap-t UCL                                 15.5
  95% Hall's Bootstrap UCL                            10.51     95% Percentile Bootstrap UCL                        12.48
  95% BCA Bootstrap UCL                               12.81
  90% Chebyshev(Mean, Sd) UCL                         17.39     95% Chebyshev(Mean, Sd) UCL                         21.97
 97.5% Chebyshev(Mean, Sd) UCL                        28.32     99% Chebyshev(Mean, Sd) UCL                         40.81

Suggested UCL to Use
95% Adjusted Gamma UCL                                43.98

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.
```

Seattle City Light
Newhalem Penstock

Engineering Evaluation/Cost Analysis

Appendix F
Laboratory Reports

eurofins | Environment Testing America

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ANALYTICAL REPORT

Eurofins TestAmerica, Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

Laboratory Job ID: 580-96958-1
Client Project/Site: Floyd Snider
Revision: 1

For:
TestAmerica Laboratories, Inc.
1100 NE Circle Blvd
Suite 310
Corvallis, Oregon 97330

Attn: Michael Stanaway

Authorized for release by:
11/4/2020 3:39:29 PM

Nathan Lewis, Project Manager I
(253)922-2310
Nathan.Lewis@Eurofinset.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-1

Job ID: 580-96958-1

Laboratory: Eurofins TestAmerica, Seattle

Narrative

Job Narrative
580-96958-1

Comments

This report was revised to include results for chromium and zinc.

Receipt

The sample was received on 8/22/2020 9:30 AM; the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 6.4º C.

Receipt Exceptions

The following sample was received at the laboratory outside the required temperature criteria at 6.6c: B4777-01 SCL NEW HALEM (580-96958-1).

Metals

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Definitions/Glossary

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Client Sample Results

Client Sample ID: B4777-01 SCL NEW HALEM

Lab Sample ID: 580-96958-1

Date Collected: 08/21/20 11:34
Date Received: 08/22/20 09:30

Matrix: Solid
Percent Solids: 67.4

Method: 6020B - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11**		0.50	0.10	mg/Kg	☼	08/31/20 10:28	08/31/20 14:29	10
Lead	**120**		0.50	0.048	mg/Kg	☼	08/31/20 10:28	08/31/20 14:29	10
Zinc	**82**		5.5	1.6	mg/Kg	☼	08/31/20 10:28	08/31/20 14:29	10
Chromium	**22**		1.0	0.063	mg/Kg	☼	08/31/20 10:28	08/31/20 14:29	10

General Chemistry

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**67.4**		0.1	0.1	%			09/01/20 19:53	1
Percent Moisture	**32.6**		0.1	0.1	%			09/01/20 19:53	1

QC Sample Results

Method: 6020B - Metals (ICP/MS)

Lab Sample ID: MB 580-337121/22-A
Matrix: Solid
Analysis Batch: 337148

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 337121

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.25	0.050	mg/Kg		08/31/20 10:28	08/31/20 14:25	5
Lead	ND		0.25	0.024	mg/Kg		08/31/20 10:28	08/31/20 14:25	5
Zinc	ND		2.8	0.81	mg/Kg		08/31/20 10:28	08/31/20 14:25	5
Chromium	ND		0.50	0.032	mg/Kg		08/31/20 10:28	08/31/20 14:25	5

Lab Sample ID: LCS 580-337121/23-A
Matrix: Solid
Analysis Batch: 337148

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 337121

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Arsenic			50.0	51.7		mg/Kg		103	80 - 120		
Lead			50.0	48.5		mg/Kg		97	80 - 120		
Zinc			50.0	51.8		mg/Kg		104	80 - 120		
Chromium			50.0	51.4		mg/Kg		103	80 - 120		

Lab Sample ID: LCSD 580-337121/24-A
Matrix: Solid
Analysis Batch: 337148

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 337121

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic			50.0	51.8		mg/Kg		104	80 - 120	0	20
Lead			50.0	48.4		mg/Kg		97	80 - 120	0	20
Zinc			50.0	51.7		mg/Kg		103	80 - 120	0	20
Chromium			50.0	51.0		mg/Kg		102	80 - 120	1	20

Lab Chronicle

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-1

Client Sample ID: B4777-01 SCL NEW HALEM

Lab Sample ID: 580-96958-1

Date Collected: 08/21/20 11:34
Date Received: 08/22/20 09:30

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1	337289	09/01/20 19:53	RJL	TAL SEA

Client Sample ID: B4777-01 SCL NEW HALEM

Lab Sample ID: 580-96958-1

Date Collected: 08/21/20 11:34
Date Received: 08/22/20 09:30

Matrix: Solid
Percent Solids: 67.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			337121	08/31/20 10:28	TMH	TAL SEA
Total/NA	Analysis	6020B		10	337148	08/31/20 14:29	FCW	TAL SEA

Laboratory References:

TAL SEA = Eurofins TestAmerica, Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Accreditation/Certification Summary

Laboratory: Eurofins TestAmerica, Seattle

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	17-024	02-19-22
ANAB	Dept. of Defense ELAP	L2236	01-19-22
ANAB	ISO/IEC 17025	L2236	01-19-22
California	State	2901	11-05-20
Montana (UST)	State	NA	04-13-21
Oregon	NELAP	WA100007	11-06-20
US Fish & Wildlife	US Federal Programs	058448	07-31-21
USDA	US Federal Programs	P330-20-00031	02-10-23
Washington	State	C553	02-18-21

Sample Summary

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
580-96958-1	B4777-01 SCL NEW HALEM	Solid	08/21/20 11:34	08/22/20 09:30	

Eurofins TestAmerica, Seattle
5755 8th Street East
Tacoma, WA 98424
Phone (253) 922-2310 Fax (253) 922-5047

Chain of Custody Record

eurofins Environment Testing TestAmerica

Client Information

Client Contact: Michael Stanaway
Company: TestAmerica Laboratories, Inc.
Address: 1100 NE Circle Blvd Suite 310
City: Corvallis
State, Zip: OR, 97330
Phone: 541-243-0973(Tel)
Email: michael.stanaway@testamericainc.com
Project Name: Floyd Snider
Site:

Sampler: Mike Stanaway
Phone:
Due Date Requested:
TAT Requested (days): 5 Day TAT
PO #: Purchase Order not required
WO #:
Project #:
SSOW#:

Lab PM: Lewis, Nathan A
E-Mail: nathan.lewis@testamericainc.com
Carrier Tracking No(s):
COC No: 580-36623-11747.1
Page: Page of
Job #:

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Total lead and arsenic	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N		
B4777-01 SCL New Halem	8/21/20	11:34	C	S			X		5 day TAT
									WA Cert. Required For analysis

Therm. ID: 8 Cor: 6.6 ° Unc: 7.1 °
Cooler Dsc: LR
Packing: Blue Bub
Cust. Seal: Yes X No
Blue Ice, [✓ Wet], Dry, None
FedEx: PO
UPS:
Lab Cour:
Other:

580-96958 Chain of Custody

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Special Instructions/QC Requirements:

Empty Kit Relinquished by:
Date:
Time:
Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Mike Stanaway	8-21-20 1203	Eurofins		8-22-20 0930	TASea

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks:

Ver: 01/16/2019

Login Sample Receipt Checklist

Client: TestAmerica Laboratories, Inc. Job Number: 580-96958-1

Login Number: 96958 **List Source: Eurofins TestAmerica, Seattle**
List Number: 1
Creator: Vallelunga, Diana L

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

Laboratory Job ID: 580-96958-2
Client Project/Site: Floyd Snider

For:
TestAmerica Laboratories, Inc.
1100 NE Circle Blvd
Suite 310
Corvallis, Oregon 97330

Attn: Michael Stanaway

Authorized for release by:
11/4/2020 2:13:44 PM

Nathan Lewis, Project Manager I
(253)922-2310
Nathan.Lewis@Eurofinset.com

Table of Contents

Case Narrative

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Job ID: 580-96958-2

Laboratory: Eurofins TestAmerica, Seattle

Narrative

Job Narrative
580-96958-2

Comments

No additional comments.

Receipt

The sample was received on 8/22/2020 9:30 AM; the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 6.4º C.

Receipt Exceptions

The following sample was received at the laboratory outside the required temperature criteria at 6.6c: B4777-01 SCL NEW HALEM (580-96958-1).

Metals

Method 7471A: The following sample was analyzed outside of holding time at client request: B4777-01 SCL NEW HALEM (580-96958-1).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Definitions/Glossary

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Qualifiers

Metals

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Client Sample Results

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Client Sample ID: B4777-01 SCL NEW HALEM

Lab Sample ID: 580-96958-1

Date Collected: 08/21/20 11:34

Matrix: Solid

Date Received: 08/22/20 09:30

Percent Solids: 67.4

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.13**	**H**	0.033	0.0099	mg/Kg	☼	11/02/20 11:24	11/03/20 12:48	1

QC Sample Results

Method: 7471A - Mercury (CVAA)

Lab Sample ID: MB 580-342187/19-A
Matrix: Solid
Analysis Batch: 342319

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 342187

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.030	0.0090	mg/Kg		11/02/20 11:24	11/03/20 12:41	1

Lab Sample ID: LCS 580-342187/20-A
Matrix: Solid
Analysis Batch: 342319

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 342187

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.167	0.158		mg/Kg		95	80 - 120		

Lab Sample ID: LCSD 580-342187/21-A
Matrix: Solid
Analysis Batch: 342319

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 342187

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury			0.167	0.154		mg/Kg		92	80 - 120	3	20

Lab Chronicle

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Client Sample ID: B4777-01 SCL NEW HALEM

Date Collected: 08/21/20 11:34
Date Received: 08/22/20 09:30

Lab Sample ID: 580-96958-1

Matrix: Solid
Percent Solids: 67.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	7471A			342187	11/02/20 11:24	JCP	TAL SEA
Total/NA	Analysis	7471A		1	342319	11/03/20 12:48	FCW	TAL SEA

Laboratory References:

TAL SEA = Eurofins TestAmerica, Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Accreditation/Certification Summary

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Laboratory: Eurofins TestAmerica, Seattle

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	17-024	02-19-22
ANAB	Dept. of Defense ELAP	L2236	01-19-22
ANAB	ISO/IEC 17025	L2236	01-19-22
California	State	2901	11-05-20
Montana (UST)	State	NA	04-13-21
Oregon	NELAP	WA100007	11-06-20
US Fish & Wildlife	US Federal Programs	058448	07-31-21
USDA	US Federal Programs	P330-20-00031	02-10-23
Washington	State	C553	02-18-21

Sample Summary

Client: TestAmerica Laboratories, Inc.
Project/Site: Floyd Snider

Job ID: 580-96958-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
580-96958-1	B4777-01 SCL NEW HALEM	Solid	08/21/20 11:34	08/22/20 09:30	

Login Sample Receipt Checklist

Client: TestAmerica Laboratories, Inc.

Job Number: 580-96958-2

Login Number: 96958
List Number: 1
Creator: Vallelunga, Diana L

List Source: Eurofins TestAmerica, Seattle

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

EA **Enthalpy Analytical**

Enthalpy Analytical
1 Lafayette Rd, Unit 6
Hampton, NH 03842
p 603-926-3345

Kara Hitchko
Floyd | Snider
601 Union Street
Suite 600
Seattle, WA 98101

PO Number: None
Report Number: 34601-R2
Date Received: 10/21/20
Date Reported: 11/02/20

Project: Earthworm Tissue Analysis

Attached please find a revision to the report originally issued on 10/30/20 for samples received on 10/21/20 at 1200. The report has been updated to include results for mercury and the quality control samples, as well as include a notation that the metals data is reported on a wet weight basis.

Samples were received in acceptable condition, except where noted, and under chain of custody.

Instruments used in analysis were calibrated with the appropriate frequency and to the specifications of the referenced methods.

Analytes in blanks were below levels affecting sample results.

Matrix effects as monitored by matrix spike recovery or unusual physical properties were not apparent unless otherwise noted.

Accuracy and precision as monitored by laboratory control sample analyses were within acceptance limits unless otherwise noted.

Accreditations may be viewed at www.enthalpy.com/accreditations.

The results presented in this report relate only to the samples described on the chain(s) of custody and sample receipt log(s), and are intended to be used only by the submittor.

Enthalpy Analytical

Renee Ashley McIsaac

Renee Ashley McIsaac 11/02/20
Project Manager - Authorized Signature Date

Attachment
Report

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: NHP-Tissue-1
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-001	82.1	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-001	1.15	0.05	ug/g	10/27/20 0800	10/27/20 1727	AS /SW846 3rd Ed. 6020
Lead, total	34601-001	6.41	0.03	ug/g	10/27/20 0800	10/27/20 1727	AS /SW846 3rd Ed. 6020
Mercury, total	34601-001	0.05	0.02	ug/g	10/27/20 0800	10/27/20 1727	AS /SW846 3rd Ed. 6020
Zinc, total	34601-001	21.1	0.5	ug/g	10/27/20 0800	10/27/20 1727	AS /SW846 3rd Ed. 6020

Notes:

Metals results are reported on a wet weight basis.

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: NHP-Tissue-2
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-002	83.6	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-002	0.92	0.05	ug/g	10/27/20 0800	10/27/20 1805	AS /SW846 3rd Ed. 6020
Lead, total	34601-002	8.04	0.03	ug/g	10/27/20 0800	10/27/20 1805	AS /SW846 3rd Ed. 6020
Mercury, total	34601-002	0.05	0.02	ug/g	10/27/20 0800	10/27/20 1805	AS /SW846 3rd Ed. 6020
Zinc, total	34601-002	19.9	0.5	ug/g	10/27/20 0800	10/27/20 1805	AS /SW846 3rd Ed. 6020

Notes:

Metals results are reported on a wet weight basis.

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: NHP-Tissue-3
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-003	81.9	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-003	0.95	0.05	ug/g	10/27/20 0800	10/27/20 1825	AS /SW846 3rd Ed. 6020
Lead, total	34601-003	5.8	0.03	ug/g	10/27/20 0800	10/27/20 1825	AS /SW846 3rd Ed. 6020
Mercury, total	34601-003	0.05	0.02	ug/g	10/27/20 0800	10/27/20 1825	AS /SW846 3rd Ed. 6020
Zinc, total	34601-003	21.8	0.5	ug/g	10/27/20 0800	10/27/20 1825	AS /SW846 3rd Ed. 6020

Notes:

Metals results are reported on a wet weight basis.

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: Cont-Tissue-1
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-004	82.2	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-004	0.7	0.05	ug/g	10/27/20 0800	10/27/20 1831	AS /SW846 3rd Ed. 6020
Lead, total	34601-004	0.14	0.03	ug/g	10/27/20 0800	10/27/20 1831	AS /SW846 3rd Ed. 6020
Mercury, total	34601-004	ND	0.02	ug/g	10/27/20 0800	10/27/20 1831	AS /SW846 3rd Ed. 6020
Zinc, total	34601-004	21.4	0.5	ug/g	10/27/20 0800	10/27/20 1831	AS /SW846 3rd Ed. 6020

Notes:

ND = Not Detected

Metals results are reported on a wet weight basis.

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: Cont-Tissue-2
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-005	83.1	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-005	0.79	0.05	ug/g	10/27/20 0800	10/27/20 1838	AS /SW846 3rd Ed. 6020
Lead, total	34601-005	0.08	0.03	ug/g	10/27/20 0800	10/27/20 1838	AS /SW846 3rd Ed. 6020
Mercury, total	34601-005	ND	0.02	ug/g	10/27/20 0800	10/27/20 1838	AS /SW846 3rd Ed. 6020
Zinc, total	34601-005	20.3	0.5	ug/g	10/27/20 0800	10/27/20 1838	AS /SW846 3rd Ed. 6020

Notes:

ND = Not Detected

Metals results are reported on a wet weight basis.

Report No: 34601
Project: Earthworm Tissue Analysis

Sample ID: Cont-Tissue-3
Matrix: Tissue
Sampled: 10/16/20

Parameter		Result	Quant Limit	Units	Date Prepared	Date of Analysis	INIT/Method/Reference
Percent Moisture	34601-006	83.8	0.1	%	10/28/20 0810	10/28/20 1630	AS /160.3 EPA 600/4/79/020
Arsenic, total	34601-006	0.7	0.05	ug/g	10/27/20 0800	10/27/20 1844	AS /SW846 3rd Ed. 6020
Lead, total	34601-006	0.16	0.03	ug/g	10/27/20 0800	10/27/20 1844	AS /SW846 3rd Ed. 6020
Mercury, total	34601-006	ND	0.02	ug/g	10/27/20 0800	10/27/20 1844	AS /SW846 3rd Ed. 6020
Zinc, total	34601-006	19.1	0.5	ug/g	10/27/20 0800	10/27/20 1844	AS /SW846 3rd Ed. 6020

Notes:

ND = Not Detected

Metals results are reported on a wet weight basis.

Method: **SW846 3rd Ed. 6020**
Matrix: **Tissue**
QC Batch: **784S**

ID	Code	Parameter	Result	True	Reference	RL	Qual	Units	Sampled	Prepared	Analyzed	Comment	%R	%RSD
PB784S	PB	Arsenic, total	ND			0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1707	A-5958/A-5880		
LCS784S	LCS	Arsenic, total	50.3	50		0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1714	LCS 101%R (Limit 85-115)	101	
LCSD784S	LCSD	Arsenic, total	49.8	50	50.3	0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1720	LCSD 100% (Limit 85-115) 1%RR (Limit 20)	100	1
34601-001D	S1D	Arsenic, total	1.08		1.15	0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1746	Dup 6%RR (Limit 20)		6
34601-001S	S1S	Arsenic, total	51	51.5	1.15	0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1753	MS 97%R (Limit 80-120)	97	
34601-001SD	S1SD	Arsenic, total	51.2	51	51	0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1759	MSD 98% (Limit 80-120) 1%RR (Limit 20)	98	1
SRM784S	SRM	Arsenic, total	13.6	13.3		0.1		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1851	102	102	
PB784S	PB	Lead, total	ND			0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1707	A-5958/A-5880		
LCS784S	LCS	Lead, total	10.3	10		0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1714	LCS 103%R (Limit 85-115)	103	
LCSD784S	LCSD	Lead, total	10.3	10	10.3	0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1720	LCSD 103% (Limit 85-115) 0%RR (Limit 20)	103	0
34601-001D	S1D	Lead, total	5.93		6.41	0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1746	Dup 8%RR (Limit 20)		8
34601-001S	S1S	Lead, total	16.4	10.3	6.41	0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1753	MS 97%R (Limit 80-120)	97	
34601-001SD	S1SD	Lead, total	15.8	10.2	16.4	0.03		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1759	MSD 92% (Limit 80-120) 5%RR (Limit 20)	92	5
SRM784S	SRM	Lead, total	1.24	1.19		0.05		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1851	104	104	
PB784S	PB	Mercury, total	ND			0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1707	A-5958/A-5880		
LCS784S	LCS	Mercury, total	0.2	0.2		0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1714	LCS 100%R (Limit 85-115)	100	
LCSD784S	LCSD	Mercury, total	0.2	0.2	0.2	0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1720	LCSD 100% (Limit 85-115) 0%RR (Limit 20)	100	0
34601-001D	S1D	Mercury, total	0.051		0.0513	0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1746	Dup 1%RR (Limit 20)		1
34601-001S	S1S	Mercury, total	0.243	0.206	0.0513	0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1753	MS 93%R (Limit 80-120)	93	
34601-001SD	S1SD	Mercury, total	0.245	0.204	0.243	0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1759	MSD 95% (Limit 80-120) 2%RR (Limit 20)	95	2
SRM784S	SRM	Mercury, total	0.072	0.061		0.02		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1851	118	118	
PB784S	PB	Zinc, total	ND			0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1707	A-5958/A-5880		
LCS784S	LCS	Zinc, total	102	100		0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1714	LCS 102%R (Limit 85-115)	102	
LCSD784S	LCSD	Zinc, total	104	100	102	0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1720	LCSD 104% (Limit 85-115) 2%RR (Limit 20)	104	2
34601-001D	S1D	Zinc, total	21.4		21.1	0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1746	Dup 1%RR (Limit 20)		1
34601-001S	S1S	Zinc, total	126	103	21.1	0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1753	MS 102%R (Limit 80-120)	102	
34601-001SD	S1SD	Zinc, total	127	102	126	0.5		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1759	MSD 104% (Limit 80-120) 2%RR (Limit 20)	104	2
SRM784S	SRM	Zinc, total	165	137		1		ug/g	10/27/20 0800	10/27/20 0800	10/27/20 1851	120	120	

EA

SAMPLE RECEIPT AND CONDITION DOCUMENTATION

Page 1 of 1

STUDY NO: 34601
SDG No:
Project: Earthworm Tissue Analysis
Delivered via: Fedex
Date and Time Received: 10/21/20 1200
Date and Time Logged into Lab: 10/22/20 0900
Received By: JLH
Logged into Lab by: JLH

Air bill / Way bill: Yes
Custody Seals present/intact: Yes
Cooler on ice/packs: Dry Ice
Cooler blank temp (C) at arrival: < -20C
Thermometer ID: T-307
Number of COC Pages: 1
Were VOC vials free of headspace? N/A
COC Complete: Yes
pH Test strip lot ID: N/A

Were samples received within holding time? Yes
Does the info on the COC match the samples? Yes

Client notification/authorization: N/A

Field ID	Lab ID	Mx	Analysis Requested	Bottle	Req'd Pres'n	Verified Pres'n
NHP-Tissue-1	34601-001	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes
NHP-Tissue-2	34601-002	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes
NHP-Tissue-3	34601-003	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes
Cont-Tissue-1	34601-004	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes
Cont-Tissue-2	34601-005	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes
Cont-Tissue-3	34601-006	T	%H2O,Total Metals As,Zn,Pb;	60P	<-20C	Yes

Notes and qualifications:

Enthalpy Analytical
1 Lafayette Road
Hampton, NH 03842
603-926-3345

Enthalpy Study Number: 34601

CHAIN OF CUSTODY DOCUMENTATION

Client: Floyd Snider
Contact:
Project Name:
Report to: Kara Hitchco
Address:
Purchase Order:
Invoice to: Kara Hitchco
Address:
Project Manager:
Voice:
email: Kara.Hitchco@Floydsnider.com
Protocol:
cc:

Lab Number (assigned by lab)	Field ID	Date Sampled	Time Sampled	Sampled By	Grab or Composite (G/C)	Container No	Container Size (mL)	Container Type (P/G)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested
001	NHP-Tissue-1	10-16-20	MS	→	C	1	30	P	Frozen	S		Pb, As, Zn
002	NHP-Tissue-2		MS	→	C	1				S		
003	NHP-Tissue-3		MS	→	C	1				S		
004	Cont-Tissue-1		MS	→	C	1				S		
005	Cont-Tissue-2		MS	→	C	1				S		
006	Cont-Tissue-3		MS	→	C	1				S		

Relinquished By: Date: 10-20-20 Time: 1230 Received By: Date: 10/21/20 Time: 12⁰⁰ Temp (C): < -20C Meter ID: T-307

Relinquished By: Date: Time: Received By: Date: Time: Temp (C): Meter ID:

Relinquished By: Date: Time: Received By: Date: Time: Temp (C): Meter ID:

ORIGIN ID:CVOA   (541) 243-0980
SAMPLE RECEIVING
TESTAMERICAASL
1100 NE CIRCLE BLVD SUITE 310

CORVALLIS, OR 97330
UNITED STATES US

SHIP DATE: 20OCT20
ACTWGT: 12.50 LB
CAD: 111146638/INET4280
DIMS: 14x11x10 IN
DRY ICE: 4.23 KG
BILL SENDER

TO

ENTHALPY ANALYTICAL
1 LAFAYETTE RD

HAMPTON NH 03842
(603) 926-3345   REF:
INV:
PO: DEPT:

56BJ2/A27E/B766

FedEx Express

E

J202020080701uv

WED - 21 OCT 10:30A
PRIORITY OVERNIGHT
ICE
03842
NH-US MHT

TRK# 0201 **7718 5154 7408**

XH IGGA

RRDB EXP 03/21

United States Department of the Interior

NATIONAL PARK SERVICE
Interior Regions 8, 9, 10, and 12
555 Battery Street, Suite 122
San Francisco, CA 94111

IN REPLY REFE

1A2 (9470)

To: Lead, Environmental Compliance and Cleanup Division

From: Acting Regional Director, Interior Regions 8, 9, 10, and 12

RANDOLPH LAVASSEUR
Digitally signed by RANDOLPH LAVASSEUR
Date: 2023.09.25 09:06:17 -07'00'

Subject: Recommendation to Select the No Action Alternative for the Non-Time Critical Removal Action at the Newhalem Penstock, North Cascades National Park Service Complex

I. PURPOSE ANDAUTHORITY

The purpose of this Action Memorandum is to recommend and document the decision by the National Park Service (NPS) to select the No Action alternative for the Newhalem Penstock Site (Site) located within North Cascades National Park Service Complex (NOCA), Washington. This Action Memorandum has been prepared pursuant to authority delegated to NPS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. §§ 9601 *et seq*., and pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300, commonly called the National Contingency Plan (NCP). The No Action alternative is recommended because risks to public health or welfare or the environment as a result of the release or threat of release of hazardous substances at the Site have been addressed by a previous time-critical removal action (TCRA). The Engineering Evaluation/Cost Analysis (EE/CA) conducted at the Site determined that no unacceptable risks remain at the Site.

The No Action decision was based on the EE/CA Report and is summarized below.

II. SITE CONDITIONS AND BACKGROUND

A. Site Description

The Site is in a lowland region of NOCA, on the south side of the Skagit River, directly across the river from the community of Newhalem in Whatcom County, Washington, and on lands managed by NPS. Current uses at or near the Site include resource conservation; recreational use by the public; and usual and accustomed activities, including hunting and gathering by local tribes. The Site is approximately 1.5 acres and consists of an exposed penstock that is 1,122 feet long, approximately 904 feet of which rests aboveground on cast-in-place concrete supports. The remaining 218 feet is located within a bedrock tunnel. The penstock is part of the Newhalem Creek Hydroelectric Facility project, operated by Seattle City Light (SCL) under a Federal Energy Regulatory Commission (FERC) license. The penstock is part of the power plant used during construction of the Gorge Dam and was built to convey water to the Newhalem Powerhouse for power generation. In January 2022, SCL filed a license surrender application with FERC to decommission the Newhalem Creek Hydroelectric Project. The details of the decommissioning process are under consideration.

The aboveground portion of the penstock is located on a steep and somewhat rocky slope above the Newhalem powerhouse, and terminates roughly 600 feet from the Skagit River, where the diverted water of Newhalem Creek enters the Skagit River, a tributary to Puget Sound. An intermittent stream runs adjacent to a portion of the penstock and flows down the slope to the powerhouse. Intermittent stream outflow enters the tailrace of Newhalem Creek and after passing over a fish barrier, discharges into the Skagit River. A trail system between the NPS Newhalem Campground (approximately one quarter mile west of the powerhouse) and "downtown" Newhalem (approximately one quarter mile east of the penstock) parallels the Skagit River immediately downslope from the penstock at the site of the Newhalem powerhouse, and a steep trail leads up the slope past the powerhouse and upper sections of the penstock.

The penstock and powerhouse are not currently operating. Originally constructed in the 1920s by SCL, the aboveground portion of the penstock formerly rested on wood frame supports, or pedestals, with bases of wood, concrete, or stone. Of the original penstock saddles, 52 were made from treated wood and had been painted several times throughout its history, likely at some point with lead-based paint. Several of these saddles were damaged in the August 2015 wildfire (the Goodell Fire), and temporary supports were installed at four saddle locations as an emergency project to prevent the penstock from being damaged by buckling.

B. Previous Actions

To comply with FERC dam safety guidelines, in the mid-2010s, SCL began preparation for a support saddle replacement project, which included soil sampling in the immediate vicinity of the penstock. SCL conducted sampling in 2014 and additional sampling in 2015 to further evaluate the extent of soil contamination and determine proper handling and disposal of soil to be removed during the saddle replacement work. Samples were also collected in 2016 from the wood saddles to determine the specific type of preservatives in the wood.

Results of the soil sampling indicated that soil in the vicinity of the penstock contained elevated concentrations of metals greater than project screening levels (SLs). Samples collected from the wood saddles indicated the use of coal-tar creosote preservative, and soil sampling also indicated the presence of polycyclic aromatic hydrocarbons (PAHs) at concentrations exceeding project SLs in soils within approximately 3 inches of the wood saddles.

In response to these findings, in 2016, NPS issued an Action Memorandum authorizing the conduct of a TCRA for the removal of contaminated soil in conjunction with SCL's penstock saddle replacement project. In 2016-2017, in performance of the TCRA subject to NPS's oversight, SCL removed a total of 171 tons of contaminated soil from the Site.

Following completion of the TCRA, NPS determined that Site conditions warranted the conduct of an EE/CA to fully characterize the extent of the contamination at the Site, evaluate risk to human health and ecological receptors, and evaluate removal alternatives. This determination was formalized in an EE/CA Approval Memorandum, signed on December 19, 2017, by the Acting Regional Director, NPS Pacific West Region, and is included in the Administrative Record for the Site.

C. Engineering Evaluation/Cost Analysis

In 2018, an EE/CA investigation was performed to delineate the remaining lateral and vertical extent of metals and PAH contamination in the soil in the vicinity of the penstock. The investigation activities included a site inspection and documentation of field observations, recording X-ray fluorescence (XRF) measurements along 14 transects, and collecting soil samples for comparison of XRF measurements to laboratory data. XRF monitoring and soil sampling were conducted to evaluate the extent of soil contamination, conditions within sediment (within the footprints of the intermittent and ephemeral streams), and background conditions. Sampling included 16 background locations. Based on the XRF results, select soil samples were submitted for laboratory analysis for select metals, PAHs, and synthetic precipitation leaching procedure testing. The soil and sediment data from this investigation are the basis of the EE/CA dataset and the risk assessments presented in the EE/CA.

The EE/CA report included a Site-specific baseline human health risk assessment (HHRA) and an ecological risk assessment, including both a screening-level ecological risk assessment (SLERA) and a baseline ecological risk assessment (BERA). The risk assessments focused on soil as the exposure pathway and the relevant receptors – Site workers and Site visitors for the HHRA and plants, soil invertebrates, birds, mammals, amphibians, and reptiles for the ecological risk assessments. The SLERA and BERA included problem formulation, exposure and effects assessment, and risk characterization. As noted in the EE/CA Report, the HHRA and the ecological risk assessments concluded that Site soil does not pose an unacceptable risk to people and ecological receptors.

The EE/CA report concluded that based on the risk assessments, the work conducted during the TCRA, and the comparative analysis evaluation criteria, that the Site currently poses no unacceptable risk to people or ecological receptors and that additional removal action in the form of implementation of a non-time critical removal action is not required. Therefore, the EE/CA report only retained the No Action alternative. Continuation of current environmental conditions under the No Action alternative is protective of human health or welfare or the environment, complies with applicable or relevant and appropriate requirements, and is protective of short- and long-term public health and the community. The No Action alternative would also protect and preserve the NOCA natural resources, conditions, and values over the long term and would enable park managers to manage the park in such a manner as to achieve the purposes for which the park was established.

The EE/CA and the Administrative Record supporting the EE/CA was made available for public comment for thirty (30) days starting on January 10, 2023. Although one comment was received on February 8, 2023, the comment did not pertain to the EE/CA.

D. State and Local Authorities' Role

There have been no State or local actions taken at the Site to date. Prior to finalizing the EE/CA report, NPS coordinated with State of Washington Department of Ecology to ensure that State ARARs were considered.

III. PROPOSED ACTIONS AND ESTIMATED COSTS

This Action Memorandum recommends selection of the No Action alternative for the Site. Under the No Action alternative, no additional activities, maintenance, or monitoring would be required; therefore, there would be no costs associated with this alternative.

IV. EXPECTED CHANGE IN SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Under the No Action alternative, there is no expected change in the situation should the action be delayed or not taken.

V. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with the No Action alternative.

VI. ENFORCEMENT

The potentially responsible party for the Site is SCL. SCL conducted the TCRA and EE/CA investigation/report under NPS's oversight. NPS recovered its costs associated with the conduct of the removal actions conducted at the Site.

VII. RECOMMENDATION

For the reasons outlined in this Action Memorandum and presented more fully in the EE/CA report prepared for this Site, we recommend you sign this Action Memorandum selecting the recommended No Action alternative.

VIII. APPROVAL

Based upon the information and analysis presented in this Action Memorandum and the Administrative Record established for this Site, ECCD is issuing this Action Memorandum in concurrence with the recommendations contained herein.

Approved: SHAWN MULLIGAN Digitally signed by SHAWN MULLIGAN Date: 2023.09.25 14:21:45 -06'00'   Date: 9/25/23

Shawn P. Mulligan
Lead - WASO Environmental Compliance and Cleanup Division

Document Content(s)