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Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Prepared for

US Army Corps of Engineers®

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
µg/dL	microgram(s) per deciliter
µg/kg	microgram(s) per kilogram
AOPC	area of potential concern
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
BaPEQ	benzo(a)pyrene equivalent
BCC	Birds of Conservation Concern
BCY	bank cubic yard(s)
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
BIA	U.S. Bureau of Indian Affairs
BMP	best management practice
BPA	Bonneville Power Administration
C&D	construction and demolition
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
COC	chemical of concern
COEC	chemical of ecological concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
CTE	central tendency exposure
CWM Arlington	Chemical Waste Management of the Northwest Landfill
cy	cubic yard(s)
DDT	dichlorodiphenyltrichloroethane
DEHP	~~di~~bis(2-ethylhexyl) phthalate
DoD	U.S. Department of Defense
DRO	diesel-range organics
EE/CA	Engineering Evaluation and Cost Analysis

EIA	enzyme immunoassay
ELA	Equipment Laydown Area
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FID	flame ionization detector
FR	*Federal Register*
FRS	Facility Registry Service
FS	feasibility study
ft/s	feet per second
GPO	U.S. Government Publishing Office
HGL	HydroGeoLogic, Inc.
HHRA	human health risk assessment
HI	hazard index
HMSA	Hazardous Materials Storage Area
HPAH	high molecular weight polycyclic aromatic hydrocarbon
HQ	hazard quotient
IC	institutional control
IRAF	infant risk adjustment factor
ISM	incremental sampling methodology
KM	Kaplan-Meier
LCY	loose cubic yard(s)
LDR	Land Disposal Restriction
LOAEL	lowest observed adverse effect level
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LUC	land use control
MDL	method detection limit
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MP	management plan
msl	mean sea level
National Archives	U.S. National Archives and Records Administration
NAVD88	North American Vertical Datum of 1988
NAVFAC	Naval Facilities Engineering Systems Command

NCP	National Contingency Plan
ND	non-detect
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPCC	Northwest Power and Conservation Council
NPL	National Priorities List
NTCRA	non-time critical removal action
O&M	operations and maintenance
OAR	Oregon Administrative Rule
OMB	White House Office of Management and Budget
Oregon DEQ	Oregon Department of Environmental Quality
Oregon DFW	Oregon Department of Fish and Wildlife
Oregon DOA	Oregon Department of Agriculture
ORNL	Oak Ridge National Laboratory
OU	operable unit
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PAL	project action level
PbB	blood lead level
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAO	removal action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RM	river mile
RME	reasonable maximum exposure
RRO	residual-range organics
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act
SEMS	Superfund Enterprise Management System
SGDA	Sandblast Grit Disposal Area
SGSA	Sandblast Grit Storage Area
SI	site inspection

SLV	screening level value
SSI	supplemental site inspection
SVOC	semivolatile organic compound
SWPPP	Storm Water Pollution Prevention Plan
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TOC	total organic carbon
TPV	total present value
TRV	toxicity reference values
TSD	treatment, storage, and disposal
U.S.C.	*United States Code*
UCL	upper confidence limit
UPL	upper prediction limit
URS	URS Corporation
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
WA DFW	Washington Department of Fish and Wildlife
WAFWA	Western Association of Fish and Wildlife Agencies
WDF	Washington Department of Fisheries
WRCC	Western Regional Climate Center
XRF	X-ray fluorescence
XSIC	Xerces Society for Invertebrate Conservation

SECTION 1

Introduction

This Engineering Evaluation and Cost Analysis (EE/CA) evaluates potential removal alternatives for soil within the Upland Operable Unit (OU) at the Bradford Island National Priorities List (NPL) Site (the site). The site was added to the U.S. Environmental Protection Agency's (EPA) NPL in February 2022 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The U.S. Army Corps of Engineers (USACE) acts as the lead federal agency in accordance with Executive Order 12580.

Jacobs prepared this document under the Department of the Army, USACE Kansas City District, Contract No. W912DQ-21-D-3006, Task Order No. W912DQ23F3038. This EE/CA presents potential removal alternatives for a Non-Time Critical Removal Action (NTCRA) to address unacceptable human health and ecological risks within the Upland OU.

The Bradford Island NPL Site consists of two OUs, known as the Upland OU and the River OU. The Upland OU encompasses the eastern, upland portion of Bradford Island in Cascade Locks, Oregon, and is located approximately 40 miles east of Portland, Oregon, and approximately 145 miles upstream of the Columbia River mouth (Figure 1-1). The Upland OU was designated in the early stages of the Remedial Investigation (RI) as a result of preliminary investigations into the Bradford Island landfill area and other adjacent locations with visible signs of contamination (URS-USACE 2012). The Upland OU includes four areas of potential concern (AOPCs): Landfill AOPC, Bulb Slope AOPC, Sandblast Area AOPC, and Pistol Range AOPC, which are the focus of this EE/CA.

Bradford Island is part of the Bonneville Dam and Lock complex (Bonneville Dam complex), located on the Columbia River. The Bonneville Dam complex is operated by USACE.

1.1 Purpose

The purpose of an EE/CA is to present the removal action objectives (RAOs), identify removal action alternatives that satisfy those objectives, and evaluate the effectiveness, implementability, and cost of those alternatives for implementing an NTCRA under CERCLA. When an NTCRA has been determined to be appropriate, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires preparation of an EE/CA (40 *Code of Federal Regulations* [CFR] 300.415(b)(4)(i)).

An NTCRA has been determined to be appropriate at the Upland OU to address sources of contamination, including waste debris, sandblast grit, and bullet fragments, and contaminated soils that present a current and imminent threat. Therefore, this EE/CA has been prepared as a requirement of the NCP to document the removal action alternatives and evaluation process for an NTCRA at the Upland OU. This EE/CA was prepared based on *Guidance on Conducting Non-Time Critical Removal Actions under CERCLA* (EPA 1993a). Other media types, including groundwater, ~~and~~ surface water, and sediment, will not be directly addressed as part of this EE/CA and the subsequent NTCRA. The NTCRA is not the CERCLA final remedy, and if determined necessary, additional remedial actions, including land use controls (LUCs) and operation and maintenance (O&M), would be addressed in the CERCLA final remedy. Other site media, such as groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

1.2 Regulatory Framework

This EE/CA was prepared under the authority of USACE in accordance with Executive Order 12580, as amended in 1996. This Executive Order delegated the President's authority under CERCLA and SARA to the heads of various Executive departments and agencies such as the U.S. Department of Defense (DoD). DoD officials have subsequently delegated certain authorities to the Department of the Army and

USACE. USACE was given responsibility for conducting response actions to clean up actual or potential releases of hazardous substances, pollutants, or contaminants at its facilities. Section 104 of CERCLA allows an authorized agency to remove or arrange for removal of, and provide for remedial action relating to hazardous substances, pollutants, or contaminants at any time, or take any other response measures consistent with the NCP as deemed necessary to protect public health or welfare and the environment (40 CFR Part 300).

NTCRAs are defined by 40 CFR 300.415 under the NCP. This part of the CFR provides regulations specific to removal actions and requires the lead agency to conduct an EE/CA when an NTCRA is planned for a site. CERCLA Section 101(23) defines a removal action as follows:

> *The terms "remove" or "removal" means the cleanup or removal of released hazardous substances from the environment, such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release. The term includes, in addition, without being limited to, security fencing or other measures to limit access, provision of alternative water supplies, temporary evacuation and housing of threatened individuals not otherwise provided for, action taken under section 9604(b) of this title, and any emergency assistance which may be provided under the Disaster Relief and Emergency Assistance Act.*

1.2.1 NCP Requirements

The NCP requires a 30-day public comment period for the alternatives presented in the EE/CA. An announcement of the 30-day public comment period is required in a local newspaper. All documents supporting the NTCRA are placed in the Administrative Record file (USACE 2023~~a~~). The Administrative Record file contains the documents that form the basis for the selection of a removal action at Bradford Island. Written responses to comments are prepared after the close of the public comment period and are included in the Administrative Record file. The basis for the selection of an appropriate removal action will be documented in an Action Memorandum.

1.2.2 Applicable or Relevant and Appropriate Requirements

Applicable or relevant and appropriate requirements (ARARs) are Federal and State public health and environmental requirements used to define the extent of site cleanup, identify sensitive land areas or land uses, develop remedial alternatives, and direct site remediation.

The NCP defines two ARAR components: (1) applicable requirements, and (2) relevant and appropriate requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstance found at a CERCLA site. State standards that may be considered applicable are those that have been identified by the State in a timely manner, are consistently enforced, and are more stringent than Federal requirements.

Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive requirements under Federal and State environmental and facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, address situations sufficiently similar to those encountered at the CERCLA site so that their use is well suited to the particular site. Only State standards that are identified in a timely manner and are more stringent than Federal requirements may be considered relevant and appropriate.

Other requirements to be considered are Federal and State non-promulgated advisories or guidance, which are not legally binding and do not have the status of potential ARARs (i.e., they have not been promulgated by statute or regulation). However, if there are no specific ARARs for a chemical or site condition, or if ARARs are deemed insufficiently protective, then guidance or advisory criteria may be identified and used to ensure the protection of human health and the environment.

Under the description of ARARs set forth in the NCP and Superfund Amendments and Reauthorization Act (SARA), State and Federal ARARs are categorized as chemical-specific (i.e., governing the extent of site remediation with regard to specific contaminants and pollutants), location-specific (i.e., governing site features such as wetland, floodplains, and sensitive ecosystems and pertaining to existing natural and manmade site features such as historical or archaeological sites), and action-specific (i.e., pertaining to the proposed site remedies and governing the implementation of the selected site remedy).

To the extent practicable, USACE is considering ARARs for this NTCRA at the Upland OU (see Appendix A).

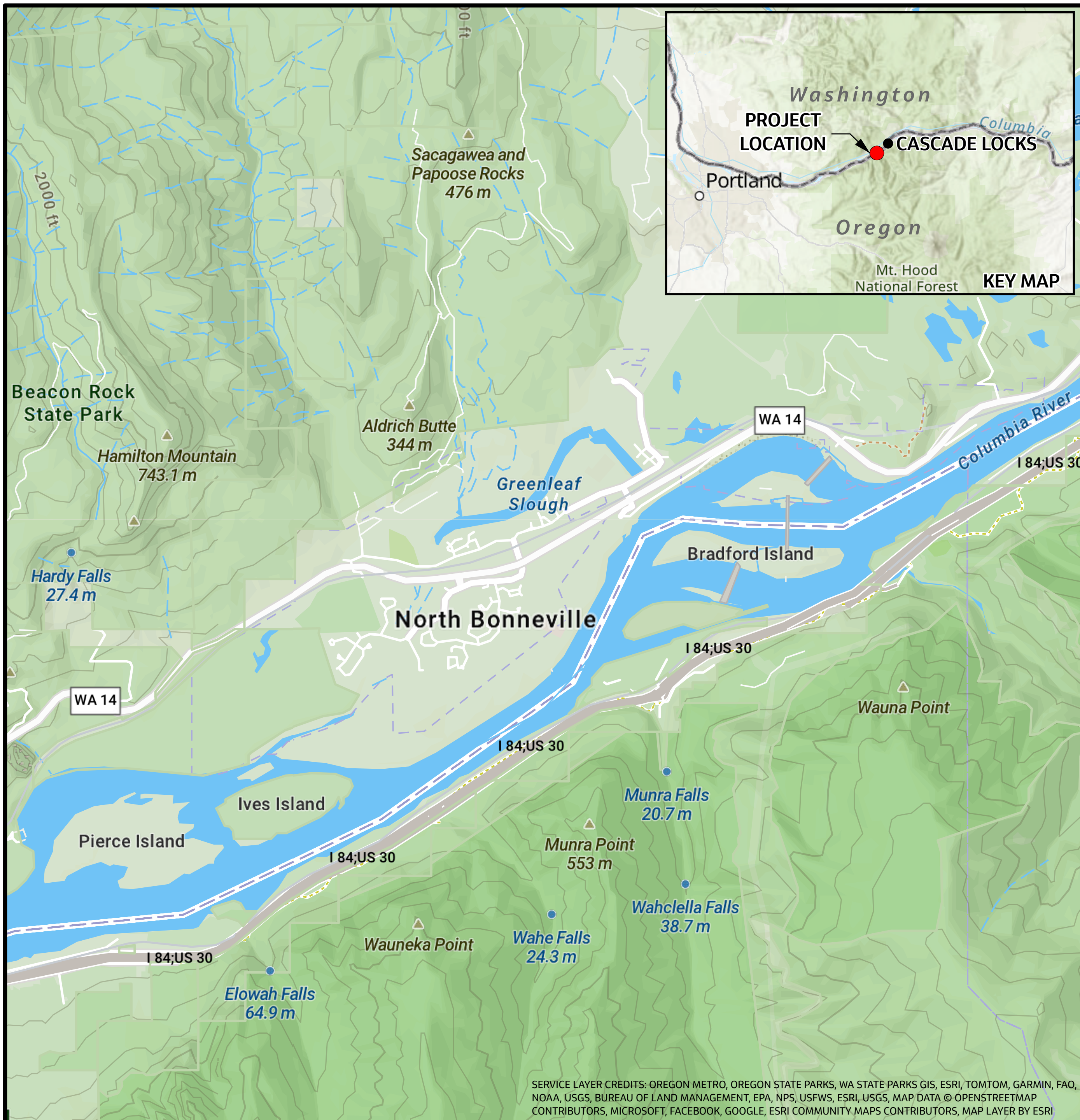
1.3 Document Organization

This EE/CA is divided into the following sections:

- Section 1: Introduction. This section explains the purpose, the regulatory framework, and the organization of this EE/CA.
- Section 2: Background. This section describes the Upland OU and AOPCs addressed in this EE/CA. This section includes OU history, previous investigations, environmental setting, current and future land uses, and background concentration levels used during site assessments.
- Section 3: Landfill AOPC. This section presents the relevant site information and engineering evaluation for the Landfill AOPC, including the conceptual site model (CSM), a summary of human health and ecological risks, RAOs and project action levels (PALs), removal media types and estimated quantities, work schedule, and descriptions of the removal action alternatives considered.
- Section 4: Bulb Slope AOPC. This section presents the relevant site information ~~and engineering evaluation~~ for the Bulb Slope AOPC, including the CSM, a summary of human health and ecological risks, work determination, description of the excavation activities, and removal media types and estimated quantities~~, and work schedule~~.
- Section 5: Sandblast Area AOPC. This section presents the relevant site information and engineering evaluation for the Sandblast Area AOPC, including the CSM, a summary of human health and ecological risks, RAOs and PALs, removal media types and estimated quantities, work schedule, and descriptions of the removal action alternatives considered.
- Section 6: Pistol Range AOPC. This section presents the relevant site information and engineering evaluation for the Pistol Range AOPC, including the CSM, a summary of human health and ecological risks, RAOs and PALs, removal media types and estimated quantities, work schedule, and descriptions of the removal action alternatives considered.
- Section 7: Assessment of Removal Action Alternatives. This section individually analyzes and then compares the removal action alternatives based on effectiveness, implementability, and cost criteria.
- Section 8: Recommended Removal Action Alternative. This section recommends a removal action alternative based on the evaluation and comparative analysis described in Section 7.
- Section 9: References. This section presents references used to prepare this EE/CA.
- Appendix A: Potentially Applicable or Relevant and Appropriate Requirements. This appendix presents a list of promulgated federal and state environmental laws, cleanup standards, standards

of control, and other substantive requirements, criteria, or limitations that are to be potentially considered during this phase of the CERCLA process at the Upland OU.

- Appendix B: Conceptual Design Drawings. This appendix includes conceptual design drawings that show the proposed extent of removal, the initial ground surface grades, and the recommended final surface grades after site restoration. Plan and cross-sectional views are provided.
- Appendix C: Alternative Cost Estimate. This appendix presents the detailed cost estimates for each proposed removal action alternative, including the calculated total present value (TPV) of each alternative. Alternative-specific cost detail reports, estimate notes, and a cost comparison summary are provided.
- Appendix D: Human Health Lead Exposure Reevaluation Technical Memorandum. This appendix presents a reevaluation of the potential exposures to lead in site soil in the Upland OU based on recent EPA updates to available lead exposure models and a notable change to the target blood lead level (PbB). The findings from the reevaluation were used in the discussion of human health lead risks and PALs provided in Sections 3 through 6, accordingly.



LEGEND

STATE BOUNDARY

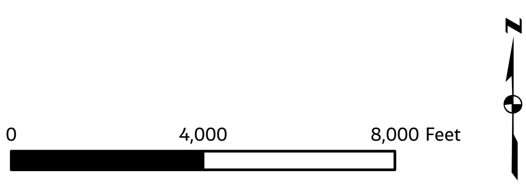


FIGURE 1-1

BRADFORD ISLAND VICINITY MAP

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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Background

2.1 Site Description and Location

Bonneville Dam is the most downstream dam within the Columbia-Snake River navigation system. It consists of eight dam and lock complexes and is at the upper limit of tidal influence from the Pacific Ocean. Bonneville Pool is a 48-mile reservoir that extends upstream from the Bonneville Dam to the Dalles Dam. The pool is up to 100 feet deep within the Forebay of the Bonneville Dam spillway.

The Bonneville Dam complex is a multipurpose facility that consists of the First and Second Powerhouses, the old and new navigation locks, a fish hatchery, and a spillway with a capacity of 1.6 million cubic feet per second (cfs) (Figure 2-1) (URS-USACE 2016). The old lock is no longer in use.

The Columbia River at the Bonneville Dam is divided into three channels by two islands: Bradford Island and Cascades Island (Figure 2-1). Bradford Island is located at the south end of the spillway and the north end of the First Powerhouse. A third island, Robins Island, located between the Oregon shore and Bradford Island, serves as the southern terminus for the First Powerhouse, and is an island only by virtue of the navigation channel (second lock) excavated between the Oregon shore and what is now Robins Island. Significant features on Bradford Island include the Bradford Island visitor center, fish ladders, the service center building, and the equipment building.

The Bradford Island NPL Site consists of two OUs known as the Upland OU and the River OU. The Upland OU encompasses the portion of Bradford Island east of the Bonneville Dam and contains the Landfill AOPC, Bulb Slope AOPC, Sandblast Area AOPC, and Pistol Range AOPC. The Landfill access road traverses the northern shore of Bradford Island and connects the Landfill AOPC, Bulb Slope AOPC, and parts of the Sandblast Area AOPC to the rest of the Bonneville Dam complex (Figure 2-2). The River OU includes the submerged portions of the Columbia River from the Bonneville complexes dams and locks to approximately 0.7 mile upstream (Figure 2-1). The Upland OU is fenced and is not accessible to the public. The service center building, the equipment building, a hazardous materials storage area, and equipment laydown areas are on the eastern portion of the island (Figure 2-2). A Former Sandblast Building was partially demolished in 2012 after being previously damaged in a storm; the concrete foundation and basement have been abandoned-in-place.

The fish hatchery, a main office, and the navigation lock visitor center are located on the Oregon shore of the Columbia River. A warehouse and automotive garage facility, and navigation lock support facilities are located on Robins Island, between the Oregon shore and Bradford Island. Another fish ladder is located on Cascades Island, and a third visitor center is located on the north shore of the Columbia River in Washington State (URS-USACE 2012).

The Bradford Island NPL Site is located at approximately 45° 38’ 29.7132’’ latitude, -121° 56’ 36.8412’’ longitude. The EPA Superfund Enterprise Management System (SEMS) ID is ORSFN1002228 and EPA Facility Registry Service (FRS) ID is 110071102738 (EPA 2023, 2024a, 2024b).

2.2 Facility History

The Bonneville Dam complex was constructed between 1933 and 1938, and operations continue to the present. Bonneville Dam, built and operated by USACE since 1938, was the first federal lock and dam on the Columbia and Snake Rivers. The First Powerhouse, spillway, and original navigation lock were also completed in 1938 to improve navigation on Columbia River and provide hydropower to the Pacific Northwest (Figure 2-1). A second powerhouse was completed in 1981, and a larger navigation lock was constructed in 1993 (USACE 2024a).

Bonneville Dam is currently an active hydro-electric power plant. USACE operates and maintains the Bonneville Dam complex for hydropower, fish and wildlife conservation, recreation, and navigation. Two federally authorized power plants are included in the complex and provide power to the Bonneville Power Administration (BPA) for the regional power grid. BPA markets and transmits the hydroelectricity generated at the Bonneville Dam complex.

2.3 Investigation History

Site investigations on Bradford Island began at the Landfill. The Bradford Island Landfill was used from the early 1940s until the early 1980s. In 1996, USACE informed EPA and the Oregon Department of Environmental Quality (Oregon DEQ) of the presence of the Landfill (Figure 2-2). The Landfill was added to the Oregon DEQ Environmental Cleanup Site Information database in April 1997, and added to EPA's Federal Agency Hazardous Waste Compliance Docket on 12 June 2000 under docket number FRL-6713-9 (65 *Federal Register* [FR] 36994; GPO 2024). Bradford Island was added to EPA's NPL in February 2022. USACE continues to coordinate with hazardous waste regulators, interested tribes, and the broader community in responding to the releases at the Bradford Island NPL Site under CERCLA.

Numerous investigations focusing on both the Upland OU and the River OU have been performed by USACE and its contractors since 1997. A review of site records, including employee interviews, site environmental audits, and multiple environmental investigations completed in the Upland OU resulted in the identification of four AOPCs: Landfill AOPC, Bulb Slope AOPC, Sandblast Area AOPC, and Pistol Range AOPC, which are the focus of this EE/CA (Figure 2-2).

The *Remedial Investigation Report: Upland and River Operable Units* (RI Report) (URS-USACE 2012) documented the RI performed at both OUs, identified source areas, defined the nature and extent of the environmental contamination, and identified the chemicals of potential concern (COPCs) for human health and chemicals of potential ecological concern (COPECs) in the media from the Upland and River OUs. The *Baseline Human Health and Ecological Risk Assessment, Upland Operable Unit* (BHHRA/BERA) (URS-USACE 2016); *Addendum, Bradford Island Upland OU, Reevaluation of Baseline Risk Assessment Calculations* (USACE 2017a)~~; and 2023 *Reevaluation of Baseline Risk Assessment Calculations for the Bradford Island Upland Operable Unit* (USACE 2023b)~~ assessed the human health and ecological risks at the four AOPCs and identified the chemicals of concern (COCs) for human health and the chemicals of ecological concern, hereafter abbreviated as COECs to be consistent with USACE guidance (USACE 2010).

Table 2-1 presents a chronology of historical investigations, remedial actions, and key reports prepared ~~based on the preliminary assessment/site investigation (PA/SI), RI, supplemental fieldwork, data collection, risk assessments, and feasibility study (FS) completed~~ for each AOPC in the Upland OU.

Table 2-1. Summary of Historical Investigations

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Year	Investigation/Report	Area	Summary	Reference[a]
1998	SI	Upland OU – Landfill AOPC	• The SI included a historical (1936–1982) aerial photograph review, summary of USACE employee interviews, excavation and sampling of eight test pits and installation of one soil boring within the Landfill footprint, collection and analysis of four surface soil samples from background locations and downgradient of the pesticide mixing area, installation and sampling of four groundwater monitoring wells (MW-1 through MW-4), and a groundwater seep visual survey along the shores of Bradford Island. The findings of the aerial photograph review were presented without photographic images. • Landfill debris encountered in the test pit excavations included mercury vapor lamps, electrical equipment, and asbestos-containing materials. The SI concluded that past disposal practices have impacted soil and groundwater in the Landfill with organochlorine pesticides, PCBs (Aroclor 1260), PCE, SVOCs, arsenic, lead, and petroleum hydrocarbons.	Tetra Tech, Inc.–USACE 1998, URS-USACE 2012, USACE 2017b
1999/2000	SSI	Upland OU – Landfill AOPC	• The SSI included collection and analysis of soil, seep soil, and water samples; installation of one groundwater monitoring well (MW-5) and sampling of wells MW-1 through MW-5; further visual assessment for groundwater seeps; an erosion potential evaluation; a biological characterization site survey; and a screening level HHRA and ERA. • The SSI concluded that surface and subsurface soils contained low concentrations of VOCs, SVOCs, metals, chlorinated herbicides, organochlorine pesticides, and PCBs. Groundwater contained low concentrations of VOCs, SVOCs, metals, and petroleum hydrocarbons. Low concentrations of metals were detected in the water from one seep.	URS-USACE 2000
2000/2001	In-water and Storm Drain System Investigation	Upland and River OU – Landfill, Bulb Slope, and Sandblast Area AOPC	• In response to four PCB-containing light ballasts being discovered along the river shoreline and northern slope near the Landfill site in March 2000 and March 2001 an in-water investigation was completed. • Waste-related items were observed in three former in-water debris piles located on the eastern and northern edges of the island. The approximate extent and volume (313 cy) of electrical debris in the water were delineated. Former Debris Piles #1 and #2 were located along the eastern and northern shorelines of the Landfill AOPC, and former Debris Pile #3 was located at the shoreline of the Bulb Slope AOPC. Divers recovered approximately 60 electrical items from former Debris Pile #1 in December 2000. Analytical chemistry results from the sediment sampling conducted during the December 2000 recovery operations indicated the presence of PCBs at concentrations ranging from 0.15 to 8.3 mg/kg. • In response to releases and migration of PCB-containing oil, sandblast grit, and compressor blowdown water into the storm drain system within the Sandblast Area AOPC, an investigation of the storm drain system was conducted. Sediment samples were collected from two of the stormwater catch basins and outfalls (Catch Basins #1 and #2) and were analyzed for PCBs, TOC, SVOCs, VOC, metals, hydrocarbons, and butyltins. Elevated concentrations of PCBs (Aroclor 1260) were detected in sediments from both catch basins and near the outfalls into the river. Catch basins and Outfall #1 exhibited concentrations above the selected benchmark screening value for PCBs. Several PAHs and metals were present above screening values in all locations. Acetone and carbon disulfide were detected at concentrations above selected benchmark values in both catch basins, and tributyltin was detected above the selected benchmark value at Catch Basin #2. • It was concluded that maintenance activities conducted near the catch basins had impacted the sediment within the catch basins, and impacted sediment was transported into the river.	URS-USACE 2002a
2001	Storm Drain Cleaning	Upland and River OU – Sandblast Area AOPC	• On 16 November 2001, accumulated sediment was removed from three storm drain systems (two systems north and one east of the Former Sandblast Building), including approximately 300 feet of buried pipelines and four catch basins. All the catch basins had existing socks, except Catch Basin #3, which was filled with sediment. • The stormwater drain systems were cleaned using vacuum truck and water jetting methods. The cleaning was considered complete based on a visual inspection of the effluent (i.e., lack of sediment). New felt sediment socks were placed within each of the four catch basins after system cleaning concluded. • A total of 947 gallons of water and 2 cubic yards of sediment and felt socks were generated during the cleaning activities. • Sediment analytical results indicated that PCBs were present up to 9.2 parts per million, and lead was present above toxicity characteristic levels (5 mg/L as measured by TCLP). The sediment was characterized as hazardous waste (D008) and was transported and disposed of at the Chemical Waste of the Northwest RCRA C landfill in Arlington, Oregon, on 20 February 2002.	URS-USACE 2002b
2001 and 2015	Slope Stability Assessment	Upland OU – Landfill AOPC	• The assessment concluded there is no evidence that significant and/or multiple rock slope failures have occurred along the north bank slope of the island, and the possibility that slope failure transported waste from the Landfill into the river is low. • In conjunction with the stability assessment, underwater surveys to locate and map the extent of all waste materials in the river were conducted in October and November 2000, and in May 2001. All wastes identified were removed in December 2000 and March 2002. • In 2015, USACE conducted a follow-up investigation to reassess slope stability in the area of the Landfill. The investigation included a limited review of the geologic literature, review of design documents, review of previous investigation reports related to the Landfill and bank slope stability, review of historical aerial photographs and 2010 LiDAR/bathymetry data, and site observations and measurements by USACE civil and geotechnical personnel. Based on site observations and review of historical information, it was concluded that the north bank slope adjacent to the Landfill is experiencing erosion in the form of wave erosion.	USACE 2017b
2001/2002	Phase II Landfill SSI/ Site Characterization	Upland OU – Landfill AOPC	• The Phase 2 SSI/site characterization included the installation of four monitoring wells (MW-6 through MW-9), groundwater sampling at wells MW-1 through MW-9, soil sampling throughout the landfill (primarily at three test pit areas), a geophysical reconnaissance consisting of seismic refraction and electrical resistivity survey, aquifer testing, and removal of landfill wastes. • The site characterization report concluded that wastes disposed of within the Landfill included household waste and project-related wastes such as grease, light bulbs, sandblast grit, and miscellaneous metal. • Landfill materials and visibly impacted soils did not appear to extend beyond 15 feet in depth. There was no evidence that significant and/or multiple past slope failures have occurred along the north bank slope of the island. Consequently, the possibility that slope failures have transported electrical debris to the river was considered low to negligible.	URS-USACE 2004a

Table 2-1. Summary of Historical Investigations
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Year	Investigation/Report	Area	Summary	Reference[a]
2002	Level I Ecological Scoping Assessment and Human Health Problem Formulation	Upland OU – Landfill AOPC	• The report qualitatively presented potentially complete exposure pathways, identified COIs for human and ecological receptors, and recommended a Level II Ecological Screening Assessment to provide a more thorough evaluation of the potential exposure pathways for ecological receptors based on soil, sediment, groundwater, surface water, and food-web contamination. • The report recommended completion of a BHHRA.	URS-USACE 2002c
2001/2002	Stormwater System Sampling and Cleaning / In Water Investigation Report	Upland OU – Sandblast Area AOPC	• Solid materials from the catch basins and near the stormwater system outfalls on the northern perimeter of the Sandblast Area AOPC were sampled in May 2001. • Based on the results of the catch basin and stormwater system outfall sampling, the stormwater system was identified as a potential pathway for conveying contaminants from the Sandblast Area AOPC to the river.	URS-USACE 2002a, URS-USACE 2002d
2001/2002	PA/SI Sandblast Area, Transformer Release Area, and Former Drum Storage Area	Upland OU – Sandblast Area AOPC	• A PA/SI of the Sandblast Area was conducted in 2001 to aid in the characterization of environmental concerns associated with the transformer maintenance area, and the Former HMSA (also referred to as the former drum storage area). • The burn pit located southeast of the Former Sandblast Building and a septic tank northwest of the building were identified at that time as additional potential sources of contamination within the Sandblast Area AOPC. In addition, evidence of localized solvent-impacted soil was discovered south of the Current HMSA. • The PA/SI report estimated that a volume of approximately 20,000 square feet and 1 to 3 feet deep (1,500 to 2,000 cy) might be regulated as hazardous waste if excavated based on lead and chromium concentrations. The total volume of sandblast grit present was estimated at between 1,410 and 2,025 cy.	URS-USACE 2002e
2002	In-water Removal Action	Upland OU – Landfill and Bulb Slope AOPC	• Based on the 2000 in-water investigation, USACE determined that identified in-water electrical equipment containing PCBs at former Debris Piles #1, #2, and #3 were to be removed to protect human and ecological receptors. • Between 14 February and 4 March 2002, a spud barge mounted with a crane, a flat deck material barge, and divers removed a total of 32 tons of solid waste from in-water and upland areas at former Debris Piles #1, #2, and #3. • Four 55-gallon drums of PCB-containing electrical debris were recovered and seven 55-gallon drums of sediment and water were generated. PCBs as Aroclor 1242 and 1248 were detected in the sediment up to 6,470 mg/kg. • Removal activities included sediment removal from beneath and around intact electrical items that contained liquid or solid PCBs. Sediment was removed from beneath two light ballasts at former Debris Pile #2, and five Inerteen capacitors and one ballast at former Debris Pile #1. A total of seven 55-gallon drums of sediment and water were generated during the sediment removal activities. • The debris, sediment, and water were transported offsite by USACE for disposal.	URS-USACE 2002f
2002	PA/SI	Upland OU – Pistol Range AOPC	• Seventy-three soil samples were collected from 42 sample locations (in some locations, samples were collected at different depths). The area investigated was approximately 200 feet long and between 20 to 30 feet wide (approximately 4,550 square feet). • The maximum soil analytical concentrations indicated that lead was the only metal elevated above relevant screening criteria at the time (EPA Region 9 PALs), and it was found primarily near the former firing shed and around the backstop. • The report also concluded that concentrations of both lead and zinc exceeded sediment screening values, which are protective of the benthic community. These exceedances of lead and zinc could cause a potential concern if the upland soils were transported to the river.	URS-USACE 2003a, USACE 2017b
2002	Reconnaissance Investigation and Evaluation of Potential Remedial Options	Upland OU – Bulb Slope AOPC	• The investigation included soil samples collected from eight locations. • The investigation report concluded that PCBs as Aroclor 1260, lead, and mercury are present in soils within the area of visually observed glass debris at the Bulb Slope AOPC. The report estimated that approximately 95 to 125 cy of debris and impacted soil are present at the Bulb Slope on top of a bedrock base.	URS-USACE 2003b, USACE 2017b
2004	Level II Screening Ecological Risk Assessment and Baseline Human Health Risk Assessment	Upland OU – Landfill AOPC	• The BHHRA concluded that risks to human health at the site were considered acceptable under current land use conditions and that risk reduction measures were not necessary to protect human health. • The Level II Ecological Screening Risk Assessment deferred a quantitative evaluation of risks posed to aquatic habitat until after sediment remediation. • An EE/CA (URS-USACE 2005) for in-water sediment removal work was prepared in 2005 and provides an evaluation of human health and ecological risks related to the aquatic environment (primarily from contaminated sediment). Sediment removal was subsequently performed by USACE in 2007 along the north shore of Bradford Island.	URS-USACE 2004b, URS-USACE 2005 URS-USACE 2022a
2004	Soil Sampling	Upland OU – Sandblast Area AOPC	• In April and May 2004, USACE cleared the vegetation and graded an area of approximately 1,600 square feet near Catch Basin 1. • This work was performed to provide space for the storage of dam gates on several concrete piers. • After grading the area, USACE personnel collected surface soil samples from the cleared area as well as soil samples from soil placed in a roll-off. Based on the results, the soil was disposed of as hazardous waste.	USACE 2017b

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Year	Investigation/Report	Area	Summary	Reference[a]
2004 to 2006	SSI	Upland OU – Sandblast Area AOPC	• The SSI concluded that in addition to metals and butyltins detected during previous investigations, PCBs, SVOCs, and VOCs are also COIs from four potential sources of contamination: – Incidental spills of hazardous materials at the southwest corner of the Current HMSA. – Storage of dam-related equipment along the Landfill access road. Oil-stained soil, metal painted with lead-based paint, and potentially PCB-containing equipment and insulators were observed in this area in 1996. – Disposal and incineration of wastes in a former burn pit at the east end of the Sandblast Area AOPC. – Transformer maintenance documented in the PA/SI (URS-USACE 2002e). A small release of PCB-contaminated oil occurred in 1995 at the paved area east of the Former Sandblast Building during a transformer rehabilitation project. • Low levels of VOCs, SVOCs, pesticides, butyltins, and petroleum hydrocarbons were detected in several groundwater samples in the Sandblast Area AOPC. • During a previous investigation, air compressor blow-down water was identified as a potential source for lead and DEHP identified in river sediments proximate to a drainage outfall north of the Former Sandblast Building (URS-USACE 2002e). As part of the SSI, one sample of blow-down water was collected from a pipe that conveys compressor blow-down water from the current sandblasting area in the service center building to the drainage ditch near the Former Sandblast Building. Neither DEHP nor lead were detected in the blow-down water sample, but low concentrations of select metals were detected, and estimated concentrations of three SVOCs and four VOCs were detected at less than 0.5 µg/L and less than 1 µg/L, respectively.	URS-USACE 2002e URS-USACE 2006
2007	Upland Source Evaluation	Upland OU – Landfill AOPC	• The Upland Source Evaluation for the Landfill concluded that since both slopes are covered with surface vegetation, there appeared to be a low potential for soil migration via overland transport but that a quantitative erodibility study was needed to further assess the potential for soil loss.	URS-USACE 2007a
2007	RI/FS Management Plan	Upland and River OUs	• The RI/FS MP identified data gaps under three categories: gaps with respect to understanding nature of contamination, gaps with respect to understanding the extent of contamination, and gaps with the respect to the ability to perform risk evaluations.	URS-USACE 2007b, URS-USACE 2012, USACE 2017b
2008 to 2012	Supplemental Fieldwork and Data Collection	Upland OU – Landfill AOPC	• Fieldwork conducted in the Landfill AOPC after the September 2007 RI/FS MP was completed included the following: – Collection of groundwater samples from the nine monitoring wells (MW-1 through MW-9) located in the Landfill AOPC during four quarters (March 2008, July 2008, October 2008, and January 2009). – Survey for groundwater seeps during each quarterly groundwater sampling event. – Collection of samples from each observed seep along with the surface water immediately adjacent to the seep. – Collection of soil samples from depth intervals of 0 to 1 foot bgs and 1 to 3 feet bgs from four test pits. • Results are summarized in the RI Report.	URS-USACE 2008a URS-USACE 2012
2008 to 2012	Supplemental Fieldwork and Data Collection	Upland OU – Sandblast Area AOPC	• Routine maintenance activities in July 2008 included scraping and stockpiling surface soils to extend the eastern portion of the laydown area. The activity exposed soils that appeared to have tar-like residue (URS-USACE 2009a). USACE elected to perform additional SIs on the newly exposed soils. The investigations in the Sandblast Area AOPC included the following: – Installation of five groundwater monitoring wells (MW-11 through MW-15) in the Sandblast Area AOPC – Quarterly collection/analysis of groundwater samples from the five monitoring wells located in the Sandblast Area AOPC – Collection of surface and near-surface soil samples within known areas of sandblast grit disposal to be sieved into two size fractions and analyzed for lead only – Collection/analysis of five soil gas samples – Collection/analysis of five soil samples from five test pits in the newly exposed laydown area – Collection/analysis of six surface soils from stockpiled soils in the laydown area • Results are summarized in the RI Report.	URS-USACE 2009a URS-USACE 2012
2008 to 2012	Supplemental Fieldwork and Data Collection	Upland OU – Pistol Range AOPC	• Supplemental fieldwork completed between 2008 and 2012 in the Pistol Range AOPC included the collection and analysis of groundwater samples and lagoon sediment samples. Results are summarized in the RI Report.	URS-USACE 2012, USACE 2017b
2007-2009	Data Gap Sampling	Upland and River OUs	• Data gap sampling for the Upland and River OUs was completed in 2007 through 2009, • Data gap sampling for the Upland OU was reported in the *Upland OU Data Gap Sampling January-March 2009 Technical Memorandum* (URS-USACE 2009b). • The Upland OU Data Sufficiency Report (URS-USACE 2009c) and the River OU Data Sufficiency Report concluded that the data met project objectives outlined in the RI/FS MP, and the data were sufficient and usable for the completion of this RI and the risk assessments. Results are summarized in the RI Report.	URS-USACE 2007a, URS-USACE 2008a, URS-USACE 2008b URS-USACE 2009a, URS-USACE 2009b, URS-USACE 2009c, URS-USACE 2012

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2008/2009		Upland OU – Reference Area	• The objective of establishing a Reference Area was to determine site-specific background concentrations of inorganic COIs in soil and groundwater. • The specific location was selected because it was upgradient of an area unaffected by site-related waste handling activities. The Reference Area was also found to have samples that generally reflected background or ambient concentrations of all COIs. Lastly, the Reference Area exhibited similar physical soil characteristics relative to the soil sampled in the four AOPCs in the Upland OU. • The field activities for the Reference Area included the following: – Installation of the Reference Area groundwater monitoring well (MW-10) – Collection/analysis of groundwater samples from the Reference Area monitoring well during four quarters (March 2008, July 2008, October 2008, and January 2009) – Collection/analysis of 14 surface soil samples (R1 through R14)	URS-USACE 2008a, USACE 2017b
2009	Upland Erodibility Studies	Upland OU – Landfill, Sandblast Area, and Pistol Range AOPCs	• The erodibility study identified only a limited portion of the Sandblast Area AOPC, where soils had been temporarily exposed during construction activities, as having a potentially complete pathway associated with stormwater runoff to the river. No currently erodible soils were identified in the Landfill AOPC or in the Bulb Slope or Pistol Range AOPCs.	USACE 2017b
2012	RI	Upland OU – Landfill, Sandblast Area, Pistol Range, and Bulb Slope AOPCs	• Landfill AOPC: The RI concluded that soil throughout the Landfill AOPC is impacted by metals, PAHs, and other SVOCs. Impacts to soil from butyltins, herbicides, pesticides, PCBs, TPH, and VOCs are much more limited. Similarly, metals, TPHs, and VOCs were detected in groundwater throughout the Landfill AOPC, as well as at low concentrations in seep water sampled along the northern perimeter of the AOPC. Butyltins, herbicides, pesticides, PCBs, PAHs, and SVOCs had generally limited detections in groundwater and were not detected in seep water. The majority of the ground surface at the Landfill AOPC is relatively flat, well vegetated, and showed minimal evidence of surface runoff, soil erosion, or sediment deposition, indicating that the ground surface is stable and there is minimal potential for offsite migration of contaminated soil or buried debris. The north and east sides of the Landfill AOPC include steep slopes leading down to the Columbia River. Although the potential for mass wasting was considered low, soil on these slopes has the potential to migrate to the Columbia River via mass wasting. • Sandblast Area AOPC: The RI concluded that the SGDA, the ELA, and an inferred VOC release at the Current HMSA appear to be the primary sources of contamination. Metals, pesticides, PCBs, PAHs, SVOCs, and VOCs were detected in soil samples from throughout the Sandblast Area AOPC. The type and magnitude of contamination are variable, consistent with the variable hazardous substance and waste management, storage, and disposal practices that occurred at the various subareas within the Sandblast Area AOPC. Metals, butyltins, pesticides, PAHs, TPHs, SVOCs, and VOCs were detected at low concentrations in groundwater, indicating that these contaminants are leaching from source area soils to groundwater. PCBs were not detected in groundwater. VOCs were detected in soil gas at locations corresponding to the footprint of the VOC plume originating at the Current HMSA. • Pistol Range AOPC: The RI concluded that historical use of the Pistol Range AOPC as a firing range has resulted in the contamination of surface soil with lead and zinc. It is unlikely that significant concentrations of lead or zinc are leaching to groundwater. The Pistol Range AOPC may also be a historical source of zinc to the adjacent lagoon sediment. Currently, the area is well vegetated and does not show evidence of surface runoff, soil erosion, or sediment deposition. • Bulb Slope AOPC: The RI concluded that placement of debris at the Bulb Slope AOPC has resulted in the contamination of soil with lead, mercury, and PCBs. Eleven of the 12 detected concentrations of lead, six of the 12 detected concentrations of mercury, and all of the eight detected concentrations of PCBs exceeded the sediment SLVs. The lateral extent of contamination is well constrained by the visible presence of debris in the soil and the underlying siltstone bedrock defines the vertical extent of contamination. Groundwater is not present. Soils may potentially be transported to the adjacent Columbia River by mass wasting.	URS-USACE 2008a, URS-USACE 2009b, URS-USACE 2009d, URS-USACE 2012, USACE 2017b
2016	BHHRA/BERA	Upland OU – Landfill, Sandblast Area, Pistol Range, and Bulb Slope AOPCs	• The BHHRA results identified cPAHs as COCs for occupational receptors at the Landfill AOPC and Sandblast Area AOPC based on carcinogenic risk within the CERCLA risk management range of 10^{-4} to 10^{-6}. Arsenic, total PCBs, cPAHs, and DEHP (Sandblast Area only) were identified as COCs for hypothetical fishing platform users at the same AOPCs. No COCs were identified for the Bulb Slope AOPC and Pistol Range AOPC. No further evaluation or action was recommended for groundwater at either the Landfill or Sandblast Area AOPCs or for soil gas at the Sandblast Area AOPC. No further upland evaluation of soils at the Pistol Range or Bulb Slope was recommended. Further evaluation was recommended for soils at the Landfill and Sandblast Area AOPCs based on risks falling above the Oregon DEQ risk thresholds, although they are within the acceptable CERCLA risk management range for the evaluated receptors. • All four AOPCs in the Upland OU were retained for evaluation in the BERA. Only soil was identified as a medium of concern for terrestrial ecological receptors. Risk estimates were calculated for each COEC carried into the BERA from the RI (URS-USACE 2012) for all selected receptors (terrestrial plants, soil invertebrates, Canada goose, American robin, American kestrel, vagrant shrew, and American mink) potentially present at a given AOPC. Both low SLVs/NOAELs and high SLVs/LOAELs were selected for each receptor to develop a range of HQs and HIs for consideration by risk managers. COECs were identified for the Landfill AOPC (chromium, copper, lead, mercury, nickel, chlordane, and HPAHs), Sandblast Area AOPC (antimony, chromium, lead, nickel, HPAHs), and Pistol Range AOPC (lead only). No COECs were identified for the Bulb Slope AOPC. No further upland evaluation of the Bulb Slope was recommended based on the estimation of low ecological risk. However, further evaluation was recommended for the three remaining AOPCs based on exceedances of site-specific RBCs for one or more of the ecological receptors evaluated.	URS-USACE 2016
2017	Reevaluation of Baseline Risk Assessment Addendum	Upland OU – Landfill and Sandblast Area AOPCs	• Based on updated hypothetical fishing platform users exposure assumptions and toxicological data for benzo(a)pyrene, revised cancer and noncancer risk estimates were calculated for the Landfill and Sandblast Area AOPCs. Because there was no unacceptable human health risk in the Pistol Range or Bulb Slope AOPCs during the 2016 BHHRA, revised risk scenarios were not calculated as part of this reevaluation. For the Landfill AOPC, the multi-pathway ELCR for the tribal subsistence fisher for cPAH was re-estimated to be 4.3×10^{-4}, which accounts for 93 percent of the cumulative risk in the Landfill AOPC. For the Sandblast Area AOPC, the multi-pathway ELCR for the tribal subsistence fisher for cPAH was 2.9×10^{-5}, which accounts for 59 percent of the cumulative risk in the Sandblast Area AOPC. Risk was only calculated for the most sensitive occupational receptor, represented by the outdoor maintenance worker. The multi-pathway ELCR associated with cPAH for the outdoor maintenance worker in the Sandblast Area AOPC was 6.0×10^{-6}, which accounts for 68 percent of the cumulative risk in the Sandblast Area AOPC. Risk was not calculated for the occupational receptor in the Landfill AOPC with the updated toxicity values for cPAH as the tribal fishing receptor is the more sensitive pathway and drives risk at the AOPC.	URS-USACE 2016, USACE 2017a

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2017	Slope Stability Assessment	Upland OU – Bulb Slope	• A visual inspection of the Bulb Slope AOPC in spring of 2017 suggests that possible erosion or mass wasting is occurring from the north face of the Bulb Slope AOPC.	USACE 2017b~~,~~ ~~USACE 2017c~~
2017	Feasibility Study	Upland OU – Landfill and Sandblast Area AOPCs	• A FS to identify and evaluate remedial alternatives to address the risks posed by COCs and COECs at the Upland OU. The FS performed the following: – Summarized the results of the 2016 RI, the baseline human health and ecological risk assessments, and related documents, as well as refining the physical CSM for the Upland OU. – Developed RAOs that specify the COCs and COECs or risk driver contaminants, exposure pathways, and PALs used to evaluate a range of remedial alternatives and to consider federal and state objectives for the site. – Identified ARARs to comply with both state and federal regulations identifying general response actions for the site, including removal, disposal, containment, and treatment. – Estimated the soil volumes or land areas to which the general response actions could be applied. – Identified and screened remedial technology types and specific process options best suited to achieve cleanup objectives for the RAOs. – Assembled the technology types and process options into remedial alternatives specific for different AOPCs. – Completed a detailed evaluation and comparative analysis of the remedial alternatives that is consistent with CERCLA requirements. • Five remedial alternatives were identified and evaluated for the Landfill AOPC, including No Action (L1); Landfill Cutback and LUCs (L2); Landfill Cutback, Additional Shallow Excavation and Backfill, and LUCs (L3); Landfill Cutback, Capping, and LUCs (L4); and Landfill Cutback, Complete Landfill Excavation, and Backfill (L5). Alternatives L1 and L2 did not pass the threshold criteria for overall protectiveness and ARAR compliance. • Three remedial alternatives were identified and evaluated for the Pistol Range AOPC, including No Action (PR1), Shallow Excavation and Backfill (PR2), and Capping and LUCs (PR3). Alternative PR1 did not pass the threshold criteria. • A three-level relative ranking system and present-value estimates were used to compare alternatives. In general, the ranking order from greatest to least was Alternatives L5, L3, and L4 for the Landfill AOPC and Alternatives PR2 and PR3 for the Pistol Range AOPC. Present-value estimates ranged from $883,000 (L4) to $2,433,000 (L5) for the Landfill AOPC and $76,000 (PR2) to $123,000 (PR3) for the Pistol Range AOPC.	USACE 2017b
2018	Catch Basin Solids Data Report	Upland OU – Sandblast Area AOPC	• To plan for a more detailed source control assessment, an initial sampling assessment of catch basin solids within the storm drain system at the Sandblast Area AOPC was performed on 22 May 2018. Samples were obtained from Catch Basins #1 through #5 and analyzed for metals, PAHs, PCBs, organochlorine pesticides, and TOC. • Overall, detects were common for metals, PAHs, and PCBs as Aroclor 1260. The few pesticides that were detected were typically detected close to or below the limit of quantitation, with an exception being the relatively higher concentrations of 4,4'-DDT and endrin ketone in Catch Basins #3 and #4. • The storm drain line that flows to Outfall 1 (Catch Basins #1, #3, and #4) showed generally greater concentrations of analytes than the line that drains to Outfall 2 (Catch Basins #2 and #5). Within that line, the analytes were more concentrated in Catch Basin #3 and Catch Basin #4, and less concentrated in Catch Basin #1. Within the line that drains to Outfall 2, Catch Basin #5 generally had similar concentrations of analytes to Catch Basin #1, and Catch Basin #2 had the lowest concentrations of analytes.	USACE 2018
2019	Stormwater Sampling and Data Assessment	Upland OU – Sandblast Area AOPC	• An initial assessment of stormwater discharging from the storm drain system at the Sandblast Area AOPC was conducted in November 2018. Stormwater samples were obtained from Drainage Outfall #1 (OF-1), Drainage Outfall #2 (OF-2), and Catch Basin #1 (CB-1) at the Sandblast Area AOPC. Contributions to the stormwater leaving the storm drain system include inflowing water during storms, any solid material that passes through the catch basin filter socks, and water and solid material present in the storm drain system before the storm. At the time of sampling, the catch basins contained solids that had accumulated for 17 years, which were last cleared out in November 2001. Since that time, the catch basin filter socks had been changed on a quarterly basis. • Results of the sampling indicate the following: – In general, metals were the analytes detected in the highest frequency. – Zinc and copper were detected at the highest concentrations and were similar in OF-2 and CB-1, lower in OF-1. – Lead and chromium were found at lower concentrations than zinc and copper and were higher in OF-1 and similarly low in OF-2 and CB-1. – PAHs and organochlorine pesticides were either non-detect or detected below their respective limits of quantitation. • PCBs were detected at greater frequency and concentrations in OF-1 than OF-2 and CB-1, with the maximum concentration of 4.7 nanograms per liter for PCB congener 180.	USACE 2019
2021	Geotechnical Data Investigation	Upland OU – Bulb Slope AOPC	• The field explorations consisted of two test pit excavations and a geophysical survey. Collected data were used to infer and identify the top of bedrock/boulders, degree of bedrock slope, and variation along the Landfill access road above the Bulb Slope and upper slope. The test pits were designated as T-3 and T-4, and each was excavated to a depth of 15 feet bgs on 17 November 2021. Two suites of soil classification laboratory tests, consisting of moisture content, Atterberg limits, and particle size analyses, were performed on soil samples from the test pits. Seismic refraction surveys consisting of three refractory arrays were performed on 25 and 26 October 2021. Two defined geotechnical unites were identified: (1) Bonneville Landslide Deposits consisting of silty sand with gravel (SM), with cobbles; and (2) Bonneville Landslide Deposits consisting of well graded gravel with silt and sand (GW-GM) and poorly graded gravel with silt and sand (GP-GM), with cobbles and boulders. Groundwater was not encountered during excavation of the test pits. Seismic refraction determined that the velocities of surficial soil are within the range of 900 to 1,100 ft/s with layer thickness that varies between 1 and 12 feet. The underlying layer has an average velocity of 2,300 ft/s and was interpreted as weathered rock or till with a layer thickness that varies between 5 and 25 feet. The underlying basal layer had an average velocity of 7,500 ft/s and was is interpreted as competent rock.	Shannon & Wilson, Inc.–USACE 2021

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2021	Optimization Review	Upland and River OUs	• An optimization review of Bradford Island, the four AOPCs investigated in the 2012 RI (URS-USACE 2012), and potential impacts to the River OU was completed to provide recommendations aimed to increase remedy effectiveness, improve technical performance, reduce costs, and move the site to completion. The following recommendations for the Upland OU were suggested: – The updated FS for the Upland OU should evaluate as rigorously as possible the additional costs and benefits of remediation to unrestricted use. – Long-term costs for alternatives that leave waste in place should be estimated conservatively (e.g., sufficiently high) in the updated FS, so those costs can be compared to the costs of remediation to unrestricted use. – Additional pre-design samples should be taken subsequent to the remedy selection to further delineate/refine the excavation footprint and depth (or capping footprint) before final design. – Long-term planning for potential excavation should incorporate an adaptive approach to excavation and associated contracting. – Preliminary TCLP sampling should be performed early enough to allow for an improved estimate of the percentage of hazardous versus nonhazardous soil in each AOPC to be incorporated within the updated FS (rather than assuming 100 percent hazardous). – Preliminary TCLP sampling should evaluate surficial and subsurface soil separately, given the potential for much lower subsurface concentrations. – Sandblast grit should be removed to the extent possible from the Sandblast Area AOPC, with clean fill placed at the surface to minimize potential ecological risks and/or impacts to the river such as via the stormwater management system. – Further efforts should be ended to treat stormwater by various means if actions are planned to address the upslope sources of the contaminants. – Stormwater outfall sampling should continue to include TPH and PCBs to address possible co-solvency concerns, and sampling should be conducted in a manner likely to capture any buoyant hydrocarbon globules (if any). – Existing groundwater monitoring wells should be sampled to assess current water quality and water levels, and analysis should include the complete target analyte list for metals, pesticides, VOCs, PAHs (full scan), butyltin, PCBs, and both diesel- and gasoline-range hydrocarbons. – Risk assessments should not be redone based on newly collected groundwater data, assuming the concentrations are reasonably consistent with (or lower than) results from the RI on a qualitative basis. – Soil in that vicinity of the Current HMSA should be sampled for VOCs in conjunction with recommended updated groundwater sampling. – Results of the shallow sampling during the planned 2021 ISM sampling at the Sandblast Area AOPC should be considered prior to performing the deeper samples. If the shallow ISM results indicate no impacts for the Sandblast Area AOPC decision unit, then no deeper samples would be needed within that Sandblast Area AOPC decision unit. – Slope stability issues at the Bulb Slope AOPC should be addressed to include the placement of a slope toe buttress in the river adjacent to the bank or, alternatively, relocating the access road at the top of the slope and flattening (reducing) the slope grade via earthwork. – Remedial design should include a cost-benefit analysis of preserving wells versus replacing wells. – Implementation of active remedial actions in the Upland OU with greatest potential to mitigate future impacts to the river should be prioritized (in addition to steps to minimize any future spills or releases).	HGL and the USACE Environmental and Munitions Center of Expertise 2021
2022	Supplemental Fieldwork and Data Collection	Upland OU – Sandblast Area AOPC	• ISM was used to characterize surface soil in two exposure units (EU1 and EU2) within the Sandblast Area AOPC from 16 to 26 August 2021. A total of nine decision units were defined and sampled (DUs 1, 2a, 2b, and 3 through 8). • Ten surface (SA-01-TCLP through SA-10-TCLP) and 30 subsurface (SA-1-SB through SA-30-SB) soil samples were collected at predetermined locations using a hand auger. • Soil samples were analyzed for metals (SW6010D/SW6020B), mercury (EPA 7471B), TCLP metals (SW6010D), PCB Aroclors (SW80821A), PCB congeners (EPA1668C), SVOCs (SW8270D), organochlorine pesticides (SW8081B), organotins (PSEP), and total organic carbon (EPA 9060A). • Data results were presented in tables in the report without further findings evaluation or conclusions. The report recommended that the data and relevant statistical analysis be further incorporated into a Revised FS Report for the Upland OU. • Results from the data and subsequent analysis are to be used to inform the alternatives development for remedial action in the Sandblast Area AOPC.	USACE 2022a

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Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Year	Investigation/Report	Area	Summary	Reference[a]
2022	Stormwater and Catch Basin Solids Assessment	Upland OU – Sandblast Area AOPC	• A stormwater runoff and catch basin solids assessment to determine the presence or absence of contaminants in stormwater discharging from the drainage system within the Sandblast Area AOPC with the goal of assisting in planning potential source control actions. • Within the Sandblast Area AOPC, a portion of the stormwater runoff from impervious surfaces drains into five catch basins (CB-1 through CB-5) that then discharge to the Columbia River through two outfalls (OF-1 and OF-2), located on the northern perimeter of the AOPC. • Five stormwater sampling events were conducted at OF-1 and OF-2 outfalls during both dry and wet seasons between November 2018 and March 2020. • Copper and seven PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) were the only analytes detected in stormwater above benchmark criteria. Copper was detected in stormwater above benchmark levels in both outfalls for all but one storm event. PAHs, generally, were detected more frequently in OF-1/CB-1. OF-2 only had detected PAHs during Storm 2. The seven PAHs detected above benchmark criteria in OF-1/CB-1 occurred throughout all the storm events. • For catch basin solids, metals, PAHs, and PCBs were the most frequently detected chemicals. Some SVOCs, pesticides, and petroleum organics were detected, and no organotins were detected. No benchmark criteria were established for catch basin solids. Based on stormwater analysis, there is no clear significant pathway for transport or exposure associated with the catch basin solids. • Dilution modeling of the results for copper, PAHs, and PCBs was conducted to predict concentrations of these compounds in the receiving water at the point of discharge. Receiving water concentrations were predicted to be two to five orders of magnitude lower than stormwater collected from the outfalls and the potential for recontamination of the River OU following remedial action is anticipated to be low. None of the modeled receiving water concentrations exceeded Oregon's Water Quality Criteria for aquatic life or human health (organism only) except total PCBs, which exceeded the human health criteria by approximately one order of magnitude. Both the modeled concentration and human health criteria are below analytical practical quantitation limits for PCBs. • The stormwater assessment and dilution modeling were incorporated into an independent optimization study for Bradford Island, which concluded that (1) further efforts to treat stormwater by various means were not recommended if actions are planned to address the upslope sources of contamination and (2) any technologies implemented for stormwater source control should consider metals, PAHs, and PCBs. • USACE determined that the existing BMPs currently in place at the site are sufficient for stormwater management (filter socks, straw waddles, and periodic cleanout of catch basin solids). And no additional efforts are warranted to mitigate contaminant releases to the River OU based on the findings of this analysis, which suggest there is no notable transport currently occurring via the stormwater conveyance system.	USACE 2022b
~~2023~~	~~Reevaluation of Baseline Risk Assessment Memorandum~~	~~Upland OU~~	• ~~A memorandum summarizing the findings from the 2017 addendum and updating the BHHRA calculations for the Sandblast Area AOPC and Landfill AOPC.~~ • ~~Based on additional comments from the Yakama Nation, the exposure duration of hypothetical fishing platform users was revised for both the Sandblast and Landfill AOPCs to include a 12-hour exposure to reflect accessing the site for fishing activities during daylight hours (averaged to 12 hours per day annually). The previous 2017 addendum included a 4-hour transiting scenario for the Sandblast Area AOPC.~~ • ~~Additionally, the EPA Integrated Risk Information System National Center for Environmental Assessment released a revised toxicological review for benzo(a)pyrene in 2017, which provided an updated, lower cancer slope factor for both oral and inhalation pathways and a RfD for noncancer risks. Previously there was no RfD value for benzo(a)pyrene.~~ • ~~Based on these updates, the total cancer and noncancer risks for the Hypothetical Fishing Platform User and the Occupational Worker for all pathways were recalculated.~~ • ~~For the Landfill AOPC, the updated multi-pathway ELCR for the Hypothetical Fishing Platform User is 1.2×10^{-4}. The cancer risk for cPAHs is 9.6×10^{-5} and accounts for 89 percent of the cumulative risk. The noncancer risk is 3.2 and 2.6 for the child and adult Hypothetical Fishing Platform User, respectively. The multi-pathway ELCR for Outdoor Maintenance Workers at the Landfill AOPC is 9.7×10^{-6}. The cancer risk for cPAHs is 7.8×10^{-6}, accounting for 81 percent of the cumulative risk. Noncancer risk is 0.06 for the adult Occupational Worker.~~ • ~~For the Sandblast Area AOPC, the updated multi-pathway ELCR for the Hypothetical Fishing Platform User is 7.4×10^{-5}. The risk for cPAHs is 2.3×10^{-5} and accounts for 30 percent of the cumulative cancer risk in the Sandblast Area AOPC. Arsenic comprises 48 percent of the total cancer risk for the Sandblast Area AOPC. The cumulative ELCR for the Occupational Worker for multiple pathways at the Sandblast Area AOPC is 3.3×10^{-6}. The cancer risk for cPAHs is 1.4×10^{-6} and accounts for 42 percent of the cumulative risk in the Sandblast Area AOPC. Arsenic comprises 53 percent of the total cancer risk for the Sandblast Area AOPC. Noncancer risk is 0.25 for the adult Occupational Worker.~~	~~USACE 2023b~~

Table 2-1. Summary of Historical Investigations

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Notes:

bgs = below ground surface
BMP = best management practice
COI = chemical of interest
cPAH = carcinogenic polycyclic aromatic hydrocarbon
cy = cubic yard(s)
DDT = dichlorodiphenyltrichloroethane
DEHP = ~~di~~bis(2-ethylhexyl) phthalate
ELA = Equipment Laydown Area
ELCR = excess lifetime cancer risk
ERA = ecological risk assessment
FS = feasibility study
ft/s = feet per second
HGL = HydroGeoLogic, Inc.
HHRA = human health risk assessment
HI = hazard index
HMSA = Hazardous Material Storage Area
HPAH = high molecular weight polycyclic aromatic hydrocarbon
HQ = hazard quotient
ISM = incremental sampling methodology
LOAEL = lowest observed adverse effects level
~~LUC = land use control~~
mg/kg = milligram(s) per kilogram
mg/L = milligram(s) per liter
MP = management plan
NOAEL = no observed adverse effects level
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
PCE = tetrachloroethene
RBC = risk-based concentration
RCRA = Resource Conservation and Recovery Act
RfD = reference dose
SGDA = Sandblast Grit Disposal Area
SI = site inspection
SLV = screening level value
SSI = supplemental site investigation
SVOC = semivolatile organic compound
TCLP = toxicity characteristic leaching procedure
TOC = total organic carbon
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

2.4 Environmental Setting

This section summarizes the physical and environmental aspects associated with Bradford Island, the Upland OU, and surrounding area.

2.4.1 Land Surface Characteristics

Bradford Island includes two areas of higher elevation ranging from 174 to 198 feet (North American Vertical Datum of 1988 [NAVD88]) within the center of the island. Elevation contours are based on standard 1-meter resolution digital elevation model (DEM) geospatial data (Universal Transverse Mercator Zone 10) projected to horizontal datum North American Datum of 1983 (2011) State Plane Oregon North FIPS 3601 and vertical datum NAVD88 (international feet) (USGS 2019). The four AOPCs are greater than 60 feet lower with the approximate elevation ranges of each AOPC as follows:

- Landfill AOPC: 82 to 119 feet NAVD88
- Bulb Slope AOPC: 78 to 102 feet NAVD88
- Sandblast Area AOPC: 86 to 114 feet NAVD88
- Pistol Range AOPC: 82 to 110 feet NAVD88

The average river stage elevation at Bradford Island was calculated as approximately 74.5 feet mean sea level (msl) National Geodetic Vertical Datum of 1929 (NGVD29) (USACE 2024b; University of Washington 2024a, 2024b). To compare to ground surface elevations, the calculated average river stage elevation converts to 77.8 feet NAVD88 (NOAA 2023).

Along the northern side of Landfill AOPC, the land surface drops steeply by approximately 30 to 35 feet to the Columbia River (Figure 2-2). The topography east of the Landfill AOPC also drops steeply to the Columbia River. West of the Landfill AOPC, the topography slopes gently down to the west. Bedrock outcrops of conglomerate, sandstone, and limited siltstone are exposed along the north bank slope of the island.

The Bulb Slope AOPC is situated entirely on the steeply sloping northern shore of the island with the Landfill access road traversing the southern edge of the Bulb Slope AOPC (Figure 2-2). Topography in the Sandblast Area AOPC slopes down to the north with areas of varying steepness. The riverbank is armored with riprap along the northern edge of the Sandblast Area AOPC. The land rises moderately south of the Landfill, Bulb Slope, and Sandblast Area AOPCs, and southwest of the Landfill AOPC. The Pistol Range AOPC consists of a pair of vegetated topographic benches stepping down toward the Columbia River to the south. The shoreline is very gently sloped into the adjacent lagoon.

~~Bedrock outcrops of conglomerate, sandstone, and limited siltstone are exposed along the north bank slope of the island.~~

Surface water drainage generally follows sloping topography as sheet flow, before infiltrating into the porous soils, particularly in vegetated areas.

Precipitation that infiltrates the soil at the island may percolate to groundwater. Under both wet season and dry season conditions, shallow groundwater at the island likely flows to the north on the north half of the island and to the south on the south half of the island. Groundwater discharge to surface water occurs as diffuse flow in the high permeability materials ~~in the steep slopes on the northern~~along the northern and southern edge of the island as well as ~~in~~ through seeps from vertical fractures in the underlying low-permeability materials. Groundwater may enter the river through bottom sediments or above-water surface seeps.

2.4.2 Climate

A meteorological observation station has been in operation at Bonneville Dam complex since 9 November 1937. During an 87-year period of meteorological records (1937 through 2024), the station recorded an average July maximum temperature of 85.81 degrees Fahrenheit (°F) and an average December maximum temperature of 48.9°F (WRCC 2024). Temperature extremes at the Bonneville Dam complex have varied from a low of 0°F in December 1968 to a high of 111°F in June 2021.

The average annual precipitation at Bonneville Dam for the period of record is 76.33 inches. November through January are the months with the highest precipitation rates, while July is the month with the lowest. Recorded daily maximum precipitation rates have exceeded 1 inch for every month, with the maximum daily rate of 6.23 inches recorded in December 1937. Average annual snowfall at the dam is 16.63 inches, normally occurring from November through March (WRCC 2024).

2.4.3 Geology

Bradford Island is located in the Columbia River Gorge, a 50-mile canyon that cuts through the Cascade Range physiographic province (Orr and Orr 1999). The canyon has formed through time as the Columbia River incised through various geologic formations, including the Western Cascade Group, the Columbia River Basalt Group, and the High Cascade Group, in response to the uplift of the Cascades over the last 2 million years (Beeson and Tolan 1987).

Three bedrock formations are present near the Bonneville Dam complex: the Ohanapecosh Formation (also referred to as the Weigle Formation), the Eagle Creek Formation, and the Columbia River Basalt Group (Holdredge 1937; Wise 1970). The Ohanapecosh Formation consists of late Oligocene-aged volcaniclastic siltstones and sandstones with minor conglomerates. As much as two-thirds of the clasts in this formation consist of glass fragments. The fragments have subsequently altered to a dominantly clay mineral assemblage, greatly weakening the formation.

Folding and faulting have significantly disturbed the Ohanapecosh Formation. Bedding generally strikes northeast and north, with a dip of 5 to 20 degrees to the southeast and east. Two predominant fault/shear zone orientations have been identified in association with the development and construction of Bonneville Dam. They include northwest-striking features dipping moderately to steeply to the northeast and northeast-striking features dipping gently to moderately to the northwest. These features do not continue into the overlying Eagle Creek Formation, indicating that fault movement ceased before the Eagle Creek sediments were deposited. No outcrops of the Ohanapecosh formation are found at the site.

The Miocene (approximately 23- to 17-million-year-old) Eagle Creek Formation overlies the Ohanapecosh Formation and is differentiated primarily by larger clast size and lack of alteration. The Eagle Creek Formation consists primarily of stream-deposited sandstones and conglomerates, with individual units of sedimentary tuffs. Bedding in the unit is near horizontal. The Eagle Creek Formation crops out close to the waterline of the river near the Bonneville Dam complex.

The Columbia River Basalt Group disconformably overlies the Eagle Creek Formation. These flood basalts are generally flat lying, Miocene in age, and originated from a series of fissures in eastern Washington, Oregon, and western Idaho. In the vicinity of Bonneville Dam, the basalts have been uplifted several hundred feet above the current river level and form the steep basaltic cliffs visible throughout the Columbia River Gorge.

Two landslides have significantly modified the topography in the vicinity of the site (Sager 1989). The slides are believed to have been at least partly the result of catastrophic floods during the late Pleistocene that scoured away the talus slopes from the Columbia Gorge. That action over steepened the walls of the Gorge and effectively removed the buttressing effect of the talus slopes. Scouring also exposed the clay-rich Ohanapecosh Formation, which may have contributed to the landslides. The Tooth Rock Landslide is a large rotational block failure that originated on the Oregon side of the Columbia Gorge, south of Bradford Island. The slide is reported to have incurred only rotational movement, without lateral expansion. Large slide blocks of the Eagle Creek Formation contributed to the formation of Bradford Island. Because of the slide's rotational nature, the blocks are relatively undisturbed and form a local, but variable, bedrock surface beneath Bradford Island. Portions of the slide block extend into the Columbia River and are submerged. Therefore, the river bottom in the immediate vicinity of Bradford Island consists of Eagle Creek Formation overlain by a thin layer of sand and silt that have been deposited in lower velocity areas.

A second large-scale landslide in the area known as the Bonneville (Cascade) slide originated on the Washington side of the Columbia Gorge between 400 and 800 years ago. The toe of the landslide forms the northern abutment of the Second Powerhouse. Debris from the slide has been observed to overlie the Tooth Rock slide on portions of Bradford Island.

The Tooth Rock slide blocks at the site are also overlain by up to 30 feet of alluvium associated with Holocene to recent flooding of the Columbia River. The alluvium consists of silty sand and gravel that contain increasing amounts of Eagle Creek Formation clasts with depth.

2.4.4 Hydrogeology

Occurrences of shallow groundwater have been evaluated as part of the previous environmental investigations near the former Landfill and the Former Sandblast Building. As part of these investigations, 15 monitoring wells (MW-1 through MW-15) have been constructed in the Upland OU to date. Based on these investigations, three shallow hydrostratigraphic units have been encountered beneath the Upland OU on the eastern side of Bradford Island (URS-USACE 2012). The characteristics of each unit are as follows:

- Colluvium/Alluvium – Unconsolidated mixtures of gravel, sand, silt, and clay ranging from 15 to 30 feet in thickness. The mixtures generally become more fine-grained with depth and contain irregularly distributed cobbles and boulders with various degrees of weathering. Silt and clay lenses create the potential for small zones of perched water and semi-confined groundwater conditions in this interval. This unit occurs beneath the upland portion of the site and pinches out near the northern shore of Bradford Island.
- Weathered Slide Block – Semi-consolidated mixtures of gravel, sand, silt, and clay or weathered siltstone of the Eagle Creek Formation. Fractures in the siltstone are partially or completely filled with silts and clays. This unit also contains irregularly distributed cobbles and boulders with various degrees of weathering.
- Slide Block (Eagle Creek Formation Bedrock) – Fresh to slightly weathered, dark grey or greenish-grey volcaniclastic siltstone of the Eagle Creek Formation that also contains irregularly distributed sandstone, cobbles, and boulders with various degrees of weathering. Based on the slug test results, the slide block material has low hydraulic conductivity. However, fractures as well as sand and gravel lenses in the siltstone may enhance the hydraulic conductivity in some intervals, as appears to be the case at the MW-14 location. The distribution, interconnectivity, and extent of these sand and gravel lenses are unknown. The uppermost 2 to 5 feet of this unit are fractured.

Groundwater beneath the Upland OU appears to be perched in the colluvium/alluvium and/or weathered slide block above the less-permeable Eagle Creek slide block. Where the fractured bedrock crops out on the north shore of the island, seeps form in the winter months. The slide block forms the base of the river near the island with little to no sediment found on top of the slide block. Based on the horizontal hydraulic gradient measured in the fill/alluvium, the direction of groundwater flow beneath the Landfill AOPC is to the north. ~~At the Sandblast Area AOPC, g~~Groundwater flow is also to the north and northwest within the northern portions of the Sandblast Area AOPC. However, groundwater flow is likely southerly beneath the southern portions of the Sandblast Area AOPC but remains unconfirmed due to the absence of monitoring wells in these areas. Groundwater discharge via seepage along the northern riverbank is considered to be the greatest contributor of groundwater discharge to the Columbia River. The vertical migration of groundwater into the underlying, competent bedrock slide block and subsequent migration to the river are considered to be less significant or negligible (HGL-USACE 2021).

There are no active drinking water wells on Bradford Island. Former water supply well DW2 (Figure 2-2) was used for drinking water until 2000 and was decommissioned in 2008 (USACE 2017b). However, nine potable water wells supplying the Bonneville Lock and Dam are present on Robins Island, Cascades Island, and the Washington shore (Figure 2-1). Seven hatchery wells installed between 1986 and 1991 are located on the western end of Robins Island where groundwater is extracted from a former alluvial unit. The alluvium overlies the Ohanapecosh Formation in this location and is up to 100 feet thick (Scofield 1998). These wells provide water to the hatchery and, either individually or combined, also provide drinking water. Two former water supply wells also located on the western end of Robins Island have run dry and are no longer in use (USACE 2017b). The remaining two additional active potable water wells are located on Cascades Island and the Washington shore, with one well at each location.

The local population within a 4-mile radius of Bradford Island relies on municipal water supplies obtained from other community groundwater supply wells, not the nine wells supplying the Bonneville Lock and Dam (USACE 2017b). The Columbia River hydraulically separates Bradford Island from the drinking water wells on Robins Island, Cascades Island, and the Washington shore. Potential releases to groundwater from the Bradford Island NPL Site do not pose a threat to adjacent well users due to the lack of hydraulic connection to the perched water-bearing unit beneath the island.

2.4.5 Hydrology

Flow within the Columbia River is modified by the operations of several federal and non-federal dams. Bonneville Dam at river mile (RM) 146.1 is the dam farthest downstream on the Columbia River. Hydrologic conditions immediately upstream and downstream of the dam are the primary focus of this section; however, regional hydrology is addressed given its influence on local hydrologic processes and the Columbia River's evolution (USACE 2017b).

2.4.5.1 Regional Hydrology

The Columbia River drains an area of 259,000 square miles and is ranked seventh in length and fourth in stream flow among United States rivers. It flows 1,243 miles from its headwaters in the Canadian Rockies of British Columbia, across Washington State, and along the border of Washington and Oregon to the Pacific Ocean. There are 11 dams on the Columbia River's mainstem in the United States and 162 dams that form reservoirs with capacities greater than 5,000 acre-feet in the United States and Canadian parts of the basin (USGS 1996).

Climate in the Columbia River Basin varies considerably, but river hydrology is dominated by snowmelt from high-elevation areas, with the majority of annual flow occurring between April and July. High flows also occur between November and March, caused by heavy winter precipitation (NPCC 2004).

All of the major dams and reservoirs within the basin operate in coordination with each other to control floods, manage fish migration, and produce power. The general operating year for the dams and reservoirs within the basin is divided into three periods:

- September through December – A fixed reservoir drawdown occurs because a forecasted volume of runoff that will occur in the spring is not yet available. Flows are managed to enhance the spawning of chum salmon below Bonneville Dam.
- January through mid-March to April – A variable drawdown occurs to meet the forecasted volume of the spring runoff based on snowpack measurements. Water must be present in April for juvenile fish migration.
- April through August – Refill season; the reservoirs are managed in an effort to fill the reservoirs and allow fish migration.

2.4.5.2 Local Hydrology

Most technical publications concerning the Columbia River focus on the basin and subbasins, specifically as they relate to water quality and specific habitats. Publications addressing details of individual hydrologic inputs in the immediate vicinity of Bonneville Dam are not readily available. The position of the Columbia River as a border between Oregon and Washington may contribute to the disjunction of available information. A series of subbasin plans and water quality reports were reviewed to obtain general information about the Columbia River Basin within the area of interest, which runs approximately from RM 142 (Pierce and Ives Islands) to RM 148 (Bridge of the Gods).

Bonneville Dam is considered a run-of-river project. Run-of-river projects, by definition, have limited storage and were developed primarily for navigation and hydropower. These types of projects pass water at the dam at nearly the same rate it enters the reservoir, with an average variance of water level behind the dam of 3 to 5 feet.

The tailwater elevation below Bonneville Dam varies in direct relationship to the river discharges, and ranges from about 7.0 feet msl NGVD29 (10.3 feet NAVD88 [converted]) at a river flow of 70,000 cfs to 36.3 feet msl NGVD29 (39.6 feet NAVD88 [converted]) at a river flow of 660,000 cfs (Wooley 1998; NOAA 2023). From Bonneville Dam to the ocean, the slope of the Columbia River is very flat and subject to tidal action. The daily tidal influence on water level during low water periods ranges from 1 to 2 feet at the dam (WDF et al. 1990).

Within the Columbia River Basin are numerous subbasins formed by tributaries of the mainstem river. Although the layouts of the subbasins in their entirety extend beyond the area of interest, they each contain tributaries of the Columbia River, as identified below, within the area of interest. Hydrologic inputs immediately upstream of the dam include Ruckel and Eagle Creeks on the Oregon side of the river. Washington maps do not indicate any named creeks immediately upstream of the dam, although drainage features are presumed to exist. Hydrologic inputs immediately downstream of the dam include Tanner and Moffett Creeks on the Oregon side with Greenleaf and Hamilton Creeks contributing on the Washington side.

Streams draining the Oregon side of the Columbia River Basin (within the area of interest) originate and flow through the Hatfield Wilderness, a 39,000-acre portion of land managed by the United States Forest Service. Although streams discharging to the Columbia River originate and primarily flow through the protected wilderness, they also pass through the privately held and often developed properties located along the waterfront. Development such as roadways and railroads with riprap bisect the lower reaches of the tributaries and are presumed to have the greatest influence on the flow rate and water quality at the point where the tributaries join the Columbia River.

Urbanization of the land along the Columbia River has substantially altered original drainage and subsequent hydrologic inputs (USACE 2017b). A major roadway (two-lane highway in Washington and four-lane interstate in Oregon), railroad, and associated riprap also cross tributaries along the riverfront on both sides.

Forestry is a major industry upstream and downstream of the dam, especially in Washington. Timber practices are typically clear-cut and slash-and-burn, subject to Forest Practices Act regulations of both states (WDF et al. 1990). The significance of this industry, and to a lesser degree agriculture, is its effect on runoff and subsequent water quality. A damaged or destroyed riparian buffer, due to deforestation and agriculture, can substantially alter the morphology of streambeds and, in some cases, whole drainage basins. An example of the altered morphology would be increased flow rates, which can result in aggressive streambed scour, increased turbidity, elevated concentrations of dissolved minerals, and habitat destruction. Not only is the tributary being affected, but also subsequent discharge can potentially influence water quality, habitat, and flow in the mainstem (USACE 2017b).

2.4.6 Site Ecology

This section describes the terrestrial ecology of the Upland OU.

2.4.6.1 Terrestrial ~~Ecological~~ Habitats

Bradford Island is physically isolated from the Oregon and Washington shorelines by the Bonneville Dam facilities and the Columbia River. This isolation provides a barrier to terrestrial wildlife that require large areas of habitat, are not mobile or are poor swimmers, or are generally intolerant to human activity. The small size of the island renders it unsuitable for supporting viable populations of many terrestrial vertebrate species. Colonization would come from animals swimming across the river. Birds would not be limited by the isolation of the island, but resident or migratory populations would be limited by the amount of habitat present.

Vegetation. Four primary habitat types are present on Bradford Island: upland meadow, shrub and forest fringe, upland conifer forest, and clifftop opening (URS-USACE 2022b).

- Upland Meadow. Upland meadow habitat on the island is dominated by common tansy (*Tanacetum vulgare*), colonial bentgrass (*Agrostis tenuis*), and velvet grass (*Holcus lanatus*). Less common species include Canada bluegrass (*Poa compressa*), soft brome (*Bromus mollis*), slender rush (*Juncus tenuis*), bedstraw (*Galium* sp.), yellow-and-blue forget-me-not (*Myosotis bicolor*), lanceleaf plantain (*Plantago lanceolata*), dock (*Rumex* sp.), aster (*Aster* sp.) and bracken fern (*Pteridium aquilinum*).
- Shrub and Forest Fringe. The fringe area is characterized by rocky outcrop areas along the edges of the island and the margin of the flat meadow area adjacent to the forested habitat. Shrub and tree species observed in this area include non-native ornamental cherry (*Prunus* sp.), Himalayan blackberry (*Rubus discolor*), and scots broom (*Cytisus scoparius*). Native shrubs and trees include red osier dogwood (*Cornus stolonifera*), hazelnut (*Corylus cornuta*), poison oak (*Rhus triloba*), black cottonwood (*Populus balsamifera*), oceanspray (*Holodiscus discolor*), and training blackberry (*Rubus ursinus*). The understory is dominated by common tansy, reed canarygrass (*Phalaris arundinacea*), and other non-native grasses.
- Upland Conifer Forest. The upland conifer forest is the least disturbed habitat on the island and is composed of mostly native species. Indications of past logging or land contouring and replanting are not visible, indicating the forest is likely naturally seeded. Species observed adjacent to the upland meadow area are dominated by Douglas fir (*Pseudotsuga menziesii*) and bigleaf maple (*Acer macrophyllum*). Scattered Oregon white oak (*Quercus garryana*), red alder (*Alnus rubra*), European birch (*Betula pendula*), and willow (*Salix* sp.) are also found in the canopy. The dominant understory shrubs include vine maple (*Acer circinatum*), snowberry (*Symphoricarpos albus*), poison oak, and oceanspray. Other shrubs observed include honeysuckle (*Lonicera ciliata*), indian plum (*Oemlaria cerasiformis*), red osier dogwood, serviceberry (*Amelanchier alnifolia*), tall Oregon grape (*Mahonia aquifolium*), Oregon viburnum (*Viburnum ellipticum*), thimbleberry (*Rubus parviflorus*), red-flowering currant (*Ribes* sp.), baldhip rose (*Rosa gymnocarpa*), redstem ceanothus (*Ceanoths sanguineum*), and scots broom. Herbaceous species in the forest include mosses, aster (*Aster* sp.), firewood (*Epilobium angustifolium*), licorice fern (*Polypodium hesperium*), swordfern (*Polystichum munitum*), horsetail (*Equisetum* sp.), geranium (*Geranium dissectum*), goldenrod (*Solidago* sp.), and lupine (*Lupinus* sp.).
- Clifftop Opening. The clifftop opening is located at the eastern tip of the island and is less than 0.25 acre. Shrub similar to the forest habitat are present, but the area is mostly open. Scattered common tansy, pearly everlasting (*Anaphalis margaritacea*), lanceleaf plantain, knapweek (*Centaurea sp*.), Deptford pink (*Dianthus armeria*), cheatgrass (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), owl clover (*Orthocarpus* sp.), Queen Anne's lace (*Daucus carota*), and rat-tail fescue (*Vulpia myures*) may occur.

Wildlife. The meadow and shrub/forest fringe communities provide habitat for a variety of wildlife (URS-USACE 2022b). The meadow area is used for nesting and foraging by Canada goose (*Branta canadensis*) and is covered by a management plan developed by USACE in cooperation with the U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (Oregon DFW), and Washington Department of Fish and Wildlife (WA DFW). Other species observed in the meadow and shrub/forest fringe include song sparrow (*Melospiza melodia*), American crow (*Corvus brachyrhynchos*), and scrub jay (*Aphelocoma coerulescens*). Black capped chickadees (*Parus atricapillus*) and bushtits (*Psaltriparius minimus*) have been observed in the forest area. Great blue heron (*Ardea herodia*) feathers have been found in the forest area, indicating that some roosting may occur. Mammals found on the island include small mammal such as voles (*Microtus sp*.), deer mice (*Peromyscus sp*.), shrews (*Sorex sp*.), and California ground squirrel (*Spermophilus beecheyi*).

2.4.6.2 Special Status Species

A list of sensitive species with potential to occur near Bradford Island are presented in the RI and FS reports (URS-USACE 2012; USACE 2017b) and the Supplemental SI (URS-USACE 2022b). The species list was originally derived from data for species recorded within 5 miles of the Upland OU, correspondence with multiple federal and state agencies and interested parties, reference books, and reports of studies focused on protected species in the Bonneville Dam vicinity.

The list of terrestrial special-status (federally and state-listed endangered or threatened, Bald and Golden Eagle Protection Act of 1940, and Migratory Bird Treaty Act of 1918) species was updated based on the current information from the USFWS, National Oceanic and Atmospheric Administration (NOAA), Oregon DFW, Oregon Department of Agriculture (Oregon DOA), WA DFW, and Oregon Biodiversity Information Center (OBIC) (USFWS 2025a, 2025b, 2025c; NOAA 2024, 2025a, 2025b; Oregon DFW 2024; Oregon DOA 2024; WA DFW 2025; OBIC 2019, 2023a, 2023b).

Federally and state-listed endangered, threatened, or protected terrestrial species that are known to occur or could potentially occur within 10 miles of the Upland OU are described below. Those listed only include terrestrial species known to or believed to occur within either the Cascades ecoregion or Multnomah, Hood River, and/or Skamania counties. Negative impacts or "takes" to special-status species will be avoided during the NTCRA and are not anticipated to occur.

Wildlife Species. The following wildlife species that are indigenous to this area of the Columbia River Gorge are federally and/or state listed as endangered, threatened, or protected:

- Gray wolf (*Canis lupus*) – Federally and Washington endangered species
- North American wolverine (*Gulo gulo luscus*) – Federal and Oregon threatened species
- Columbian white-tailed deer (*Odocoileus virginianus leucurus*) – Federal and Washington threatened species (Columbia River Distinct Population Segment)
- Canada lynx (*Lynx canadensis*) – Federal, Oregon, and Washington threatened species
- Cascade red fox (*Vulpes vulpes cascadensis*) – Washington endangered species
- Western gray squirrel (*Sciurus griseus*) – Washington endangered species
- Northern spotted owl (*Strix occidentalis caurina*) – Washington endangered and Federal and Oregon threatened species
- Yellow-billed Cuckoo (*Coccyzus americanus*) – Washington endangered and Federal threatened species (Western Distinct Population Segment)
- Sandhill crane (*Grus canadensis*) – Washington endangered species

- Streaked horned lark (*Eremophila alpestris strigata*) – Washington endangered and Federal threatened species
- Northwestern pond turtle (*Actinemys marmorata*) – Washington endangered and Proposed Federal threatened species
- Oregon spotted frog (*Rana pretiosa*) – Federal and Washington endangered species
- Monarch butterfly (*Danaus Plexippus*) – Proposed Federal threatened species
- Bald eagle (*Haliaeetus leucocephalus*) – Bald and Golden Eagle Protection Act protected species
- Golden eagle (*Aquila chrysaetos*) – Bald and Golden Eagle Protection Act protected species
- Ancient murrelet (*Synthliboramphus antiquus*) – Migratory Bird Treaty Act protected species
- Black swift (*Cypseloides* niger) – Migratory Bird Treaty Act protected species
- California gull (*Larus californicus*) – Migratory Bird Treaty Act protected species
- Cassin's finch (*Haemorhous cassinii*) – Migratory Bird Treaty Act protected species
- Chestnut-backed chickadee (*Poecile rufescens rufescens*) – Migratory Bird Treaty Act protected species
- Clark's grebe (*Aechmophorus clarkii*) – Migratory Bird Treaty Act protected species
- Evening grosbeak (*Coccothraustes vespertinus*) – Migratory Bird Treaty Act protected species
- Olive-sided flycatcher (*Contopus cooperi*) – Migratory Bird Treaty Act protected species
- Rufous hummingbird (*Selasphorus rufus*) – Migratory Bird Treaty Act protected species
- Western grebe (*aechmophorus occidentalis*) – Migratory Bird Treaty Act protected species
- Western gull (*Larus occidentalis*) – Migratory Bird Treaty Act protected species
- Western screech-owl (*Megascops kennicottii cardonensis*) – Migratory Bird Treaty Act protected species

Gray wolves range in the conifer forests of the Cascade Mountains of both Oregon and Washington, as well as forested areas within eastern Oregon and Washington (USFWS 2025a). The nearest area estimated to be used by gray wolves is located south-southeast of Mount Hood within the Mount Hood National Forest, western end of the Lower White River Wilderness Area, and the northwestern corner of the Warm Springs Reservation (Oregon DFW 2019). However, due to their adaptability and expansive range, the gray wolf is known to or is believed to occur in Multnomah, Hood River, and Skamania counties adjacent to Bradford Island.

The North American wolverine occurs throughout the Cascade Mountains of both Oregon and Washington in addition to northeastern Oregon and southwestern Washington (USFWS 2025a). The North American wolverine is known to or is believed to occur in Multnomah, Hood River, and Skamania counties adjacent to Bradford Island.

The Columbian white-tailed deer (*Odocoileus virginianus leucurus*) is a subspecies of white-tailed deer found primarily along the lower Columbia River in Oregon and Washington. They historical range is known to or is believed to extend within the lower Columbia River basin from Astoria to Troutdale, Oregon (USFWS 2025a). However, due to their expansive range and adaptability, further spread up the Columbia River Gorge to Bradford Island is plausible.

Canada lynx is not commonly found in Oregon, and sightings are quite rare but could occur at higher elevations within the Cascade Range. Thought possible, it is very unlikely that Canada lynx would inhabit or traverse Bradford Island.

Cascade red fox have been recently detected within the Gifford Pinchot National Forest as far south as the Indian Heaven Wilderness Area approximately 30 miles northeast of Bradford Island. Due to their adaptability, Cascade red fox could occur at Bradford Island, though improbable.

The western gray squirrel was once found in Columbia River Gorge and on the eastern slope of the Cascades Mountains. Its range is now limited to three isolated populations within Washington, including the oak woodlands and conifer forests of southern Klickitat and Yakima counties. The remaining populations of the western gray squirrel in Washington are isolated and therefore unlikely to occur on Bradford Island, though possible.

The northern spotted owl lives in old-growth forests of the nearby Mount Hood and Gifford Pinchot National Forests and Columbia River National Scenic Area. Critical habitat for the northern spotted owl occurs in several areas in Oregon and Washington within the vicinity (10-mile radius) of the Upland OU; although no old-growth forest exists on Bradford or Cascades Islands (USFWS 2025a). It is unlikely that adult spotted owls occur on Bradford Island due to lack of suitable nesting habitat. However, juvenile spotted owls might pass through the area.

Yellow-billed cuckoos are migratory birds, and development of their preferred riparian habitat has led to population declines and the possible extirpation of yellow-billed cuckoos from Oregon and Washington. However, the riparian habitat on Bradford Island may provide suitable habitat for nesting and/or foraging. Yellow-billed cuckoos are known to or are believed to occur in Multnomah and Skamania counties, including on Bradford Island (USFWS 2025a).

Sandhill cranes are large migratory birds that are known to breed and nest in open wetlands, marshes, and grasslands within the lower Columbia River Gorge. Sandhill cranes are known to occur in nearby Franz Lake National Wildlife Refuge, located approximately 7 miles downriver of Bradford Island (USFWS 2025c).

Streaked horned lark is a coastal subspecies only found in southwest Washington and western Oregon. In Washington, larks are found on prairie and grasslands, coastal beaches, dredge spoil islands, and sparsely vegetated shoreline sites on the lower Columbia River. They are also found on agricultural fields and drying seasonal wetlands in Oregon. Observations of banded birds throughout the winter suggests that some of these birds may overwinter in the Columbia River, Willamette Valley, and the Washington coast.

The northwestern pond turtle occurs throughout the Columbia River Gorge and is known to or is believed to occur in Multnomah, Hood River, and Skamania counties, including on Bradford Island (USFWS 2025a). The northwestern pond turtle inhabits a variety of aquatic and terrestrial environments, including in rivers and other water sources, oak-pine savanna, and open forests, especially in regions like the Columbia River Gorge.

Oregon spotted frog populations occur in large shallow wetland systems associated with a stream or stream network. The historical range for Oregon spotted frogs includes the southern extent of the Cascades ecoregion, in Skamania and Klickitat counties in Washington. Oregon spotted frogs have been observed in northwestern Klickitat, eastern Skamania, and southern Clark Counties (WA DFW 2025).

The monarch butterfly is a migratory insect that is known to or is believed to occur throughout the entire contiguous U.S., including Multnomah, Hood River, and Skamania counties and on Bradford Island (USFWS 2025a). The monarch butterfly lives for an extended period of time and breeds year-round. Both breeding and migratory habitats are often synonymous and essentially features native milkweeds for larval development, flower nectar for adults, and trees or shrubs for shading and roosting (WAFWA 2019; XSIC 2025).

Bald and golden eagles and their habitats are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act of 1940. Bald and golden eagles are likely present within the vicinity

(10-mile radius) of the Upland OU (USFWS 2025a). Bald eagles are known to reside year-round within the Columbia River Gorge, while golden eagles may reside in the forests of the Cascade Mountains during their post-breeding migration and non-breeding seasons from August through February (Cornell University 2025).

In addition to bald and golden eagles, the other migratory birds species and their habitats presented above occur within the vicinity (10-mile radius) of the Upland OU (USFWS 2025a). These species of particular concern are included because they occur on the USFWS Birds of Conservation Concern (BCC) list for either a specific bird conservation region or throughout the entire U.S. range. BCC are migratory protected bird species that pose special management challenges because of a variety of factors, including documented or apparent population declines, small or restricted populations, dependence on restricted or vulnerable habitats, or overabundance to the point of causing ecological and economic damage.

Plant Species. The following indigenous plant species are federally and/or state listed as endangered or threatened:

- Whitebark pine (*Pinus albicaulis*) – Federal and Oregon threatened species
- Northern wormwood (*Artemisia campestris var. wormskioldii*) - Oregon listed endangered species

Whitebark pine is the only stone pine in North America and is a hardy pine that generally grows at cold, windy, subalpine tree lines or with other high-mountain conifers just below the tree line and subalpine zone at high elevations of 2,950 to 12,000 feet above mean sea level (Oregon DOA 2024, OBIC 2023b). In Oregon, whitebark pine are distributed along the Cascade Mountain Range with isolated stands occurring in the Blue and Wallowa Mountains. The nearest estimate range of the whitebark pine is approximately 8 miles east of Bradford Island within the Mark O. Hatfield Wilderness area (USFWS 2024a).

Northern wormwood is a low-growing, tap-rooted biennial or perennial that grows up to 12 inches in height (Oregon DOA 2024, OBIC 2023b). The historical range extends along the Columbia River from the mouth of the John Day River in Sherman County, Oregon, westward to Bingen, Washington. This species is restricted to basalt, compacted cobble, and sand on the banks of the Columbia River. The species is now believed to be extirpated in Oregon, with only two known extant populations occurring in Grant County and Klickitat County, Washington (Oregon DOA 2024).

~~2.4.5.3~~2.4.6.3 AOPC Ecological Setting

Landfill AOPC. Upland meadow and shrub/forest fringe communities occupy the Landfill AOPC (USACE 2017b). This area once served as a temporary nursery for landscape plants used at Bonneville Dam and adjacent facilities. Adjacent to the Landfill AOPC is a larger area of conifer-dominated forest. The upland meadow habitat that occupies the surface of the Landfill AOPC has been disturbed by various field investigative activities (e.g., test pits, drilling operations) but has since been recolonized by surrounding vegetation.

The shrub and forest fringe area is characterized by rocky outcrops at the edges of the island and at the margin of the flat meadow area adjacent to the forested habitat. The substrate consists of a mixture of soils, rock that may have been placed, and what appear to be natural rock outcrops. The Landfill AOPC terrain is flat at the top and slopes steeply to the north and east into the Columbia River. The slopes are more densely vegetated with shrubs and trees than the flatter areas adjacent to the meadow.

The conifer forest in the Upland OU located in the central portions of the eastern side of Bradford Island is referred to as the Reference Area as it appears to be the least disturbed habitat on the island, as it is composed of mostly native species (Figure 2-3). This forest is apparently relatively young; USACE photographs from the 1930s show much smaller trees. It is likely that this forest was naturally seeded rather than planted. No stumps are present, indicating that past logging either did not occur, or was followed by recontouring the land that included removal of stumps. The larger trees are up to 18 inches in diameter at breast height and form a closed canopy. The substrate in the forest area consists of relatively thin topsoil and rocky outcrops. Dead and downed woody material is common.

Bulb Slope AOPC. The Bulb Slope AOPC, so named because of historical disposal of light bulbs in the area, including incandescent, fluorescent, and mercury vapor lamps, consists of a steeply sloped area between the Landfill access road and the Columbia River on the north side of the Upland OU (USACE 2017b). The substrate consists of a mixture of soils, rock that may have been placed, and what appear to be natural rock outcrops, all of which is underlain by siltstone bedrock. The majority of the Bulb Slope AOPC is vegetated and/or covered with organic debris.

Sandblast Area AOPC. The Sandblast Area AOPC is the portion of Upland OU surrounding the Former Sandblast Building and includes the ELA adjacent to the Columbia River and vegetated/forested areas adjacent to the ~~current Hazardous Materials Storage Area (~~Current HMSA~~)~~ (USACE 2017b). To the northwest of the Former Sandblast Building is a relatively flat, herbaceously vegetated area, followed by a recently disturbed slope, then a paved road. Excavation and filling activities on the northwest slope in 2009 removed vegetation and exposed bare, erodible soils at the ground surface. During the following year, the disturbed area naturally revegetated and is currently vegetated with a dense scrub-shrub community. The ELA is a gravel and paved flat area used for historical and current storage and maintenance of industrial equipment and materials.

The portion of the AOPC surrounding the Current HMSA is located uphill from the ELA. Sandblast grit was placed immediately east of the Former Sandblast Building. South of the Current HMSA, the AOPC is dominated by mature Douglas fir forest. This area is densely vegetated with steep slopes. The area is bounded to the south by a cleared dirt road leading to an old water tower. On the south side of the dirt road is the Former HMSA.

Pistol Range AOPC. Once the Pistol Range AOPC ceased being used for small arms practice in the late 1960s or early 1970s, the firing range was recolonized by surrounding herbaceous vegetation (USACE 2017b). The topography of the area consists of a series of cuts and fills, resulting in a sequence of slopes and flat areas. Currently, the ground surface is heavily vegetated with a mix of scrub-shrub and herbaceous vegetation. An upland meadow community, similar to the Landfill AOPC meadow community, covers the former firing range. The hillside behind the backstop is moderately steep (15 to 30 degree slopes) and is densely vegetated with herbaceous vegetation and shrub/forest fringe communities. Along the southern portion of the former firing range and south of the access road, a densely vegetated scrub-shrub community is present.

~~2.4.5.4 Listed Species and Other Important Fish~~

~~A list of sensitive species with potential to occur at the Bonneville Dam complex and Forebay are presented in the RI and FS reports (URS-USACE 2012; USACE 2017b). The list of species was originally derived from correspondence with multiple agencies and interested parties, reference books, and reports of studies focused on protected species in the Bonneville Dam vicinity. The status of the species in the list was updated based on the U.S. Fish and Wildlife Service (USFWS) and Oregon Department of Fish and Wildlife's (Oregon DFW) *Threatened, Endangered, and Candidate Fish and Wildlife Species in Oregon* list and the Oregon Biodiversity Information Center's *Rare, Threatened, and Endangered Species of Oregon* list (USFWS 2014; Oregon DFW 2014; and Oregon Biodiversity Information Center 2019).~~

~~The special-status (federally and state-listed endangered or threatened) wildlife, plant, and fish species that are known to occur or could potentially occur at the site are described below. No negative impacts or "takes" to special-status species are anticipated to occur during the NTCRA. This section also presents a brief discussion of important non-listed fish species that may occur in the Forebay.~~

~~Wildlife Species. The following wildlife species that are indigenous to this area of the Columbia River Gorge are federally and/or state listed as endangered or threatened:~~

- ~~Columbia white-tailed deer (*Odocoileus virginianus leucurus*) – Federally listed endangered~~
- ~~Northern spotted owl (*Strix occidentalis caurina*) – Federally and state-listed threatened~~
- ~~Northern (Stellar) sea lion (*Eumetopias jubatus*) – Federally listed threatened~~

~~Columbia white-tailed deer are very unlikely to occur on Bradford or Cascades Islands. Habitat for this species most frequently consists of riparian zones and bottomland hardwood forests and agricultural areas, including islands within the Columbia River downstream of Portland, Oregon (between RM 32 and RM 50), approximately 100 miles downriver from Bonneville Dam.~~

~~The northern spotted owl lives in old-growth forests of the nearby Mount Hood and Gifford Pinchot National Forests. No old-growth forest exists on Bradford or Cascades Islands, and it is unlikely that adult spotted owls occur there due to lack of suitable nesting habitat. However, juvenile spotted owls might pass through the area.~~

~~Northern sea lions have been observed foraging in the Bonneville pool downstream of the dam, but they are not known to occur above the dam in the Bonneville Forebay.~~

~~Plant Species. The following indigenous plant species are federally and/or state listed as endangered or threatened:~~

- ~~Golden Indian-paintbrush (*Castilleja levisecta*) – Federally listed threatened and state listed as endangered~~
- ~~Howellia (*Howellia aquatilus*) – Federally and state-listed as threatened~~

~~Golden Indian-paintbrush and howellia are very unlikeunlikely to occur on Bradford Island as there is no suitable habitat available. Neither species has been observed on Bradford Island. Golden Indian-paintbrush has not been seen in Oregon for over 45 years.~~

~~Non-listed fish found in the Lower Columbia River include white sturgeon (*Acipenser transmontanus*), longnose suckers (*Catostomus catostomus*), Pacific lamprey (*Lampetra tridentata*), and minnows (e.g., chiselmouth [*Acrocheilus alutaceus*]). Other non-listed native species that are found throughout the Columbia River include non-listed trout (e.g., cutthroat trout [*Oncorhynchus clarkii clarkii*]), non-listed whitefish (e.g., mountain whitefish [*Prosopium williamsoni*]), and a variety of non-listed sculpins (*Cottidae*) (Troffe 1999; USACE 2001).~~

~~Popular recreational fish species such as largemouth (*Micropterus salmoides*) and smallmouth (*Micropterus dolomieui*) bass are common to the lower Columbia River and could reside in the Bradford Island vicinity. Other introduced fish species such as catfish (*Ameiurus* spp.), yellow perch (*Perca flavescens*), and walleye (*Stizostedion vitreum*) are also important sport fish that may be present near Bradford Island for prolonged periods throughout the year.~~

~~2.4.6~~2.4.7 Cultural Setting and Sites

Cultural resources are vital to protecting the religious freedom and cultural identity of various groups. A cultural resource management plan of the Bonneville Dam complex was completed in 1988 and includes a regional and project overview, site features and conditions, site impacts, site evaluations, site priorities and management, program guide, and maps of the various sites. Areas of archaeological and religious significance are protected from public disclosure under the Columbia River Gorge National Scenic Act (16 U.S.C. 544 through 544p) and Freedom of Information Act (16 U.S.C. 470hh, 36 CFR 296.18) (USACE 1997).

~~2.4.6.1~~2.4.7.1 Native American Precontact Background

Native Americans have made use of the Columbia River Gorge for over 10,000 years (Cressman et al. 1960; USACE 1997). Archaeological resources identified in the region include village sites along the banks of the Columbia River and its tributaries, as well as fishing sites. Based on changes in subsistence patterns and land use, the cultural sequence is broken into the following time periods.

- Early Period (approximately 10,000 to 4,500 years before present [BP]) – This period is characterized by highly mobile lifeways, becoming sedentary toward the end of the period. Subsistence patterns transitioned from a focus on large game to riverine resources supplemented by roots and vegetables. The period transitions from a near-absence of permanent residential structures to increasingly common semi-subterranean house settlements (Griffin and Churchill 2020).
- Middle Period (approximately 4,500 to 250 years BP) – This period exhibits greater intensification within the Columbia River Gorge. Winter sedentism is established where semi-subterranean houses gain greater importance, and food storage structures appear in the archaeological record (Griffin and Churchill 2020). Hunting is largely replaced by riverine and vegetable subsistence sources. Archaeological sites increase in number and spatial distribution, including villages, fishing camps, and hunting camps.
- Late period (250 to 100 BP) – This period starts with the introduction of the horse and Euro-American trade. Mobility and access to trade goods changed land use and native economic structure. Fishing was of principal importance since fish could easily be caught during seasonal runs and traded for other goods. Seasonally available vegetables, such as roots, tubers, berries, and nuts, supplemented a diet of fish. Semi-subterranean houses covered with vertical planks were occupied in the winter, and summer houses were above-ground structures covered with tule mats (Griffin and Churchill 2020).

~~2.4.6.2~~2.4.7.2 Native American Historic Background

In the mid 19th-century, multiple treaties were made by which Tribes ceded title to many lands to the United States in exchange for protection, services, and in some cases cash payments. But Tribes also reserved certain lands (reservations) and rights for themselves and future generations by these treaties. There are seven f~~F~~ederally recognized Tribes with treaty rights or other expressed interest in the Bradford Island environment: the Yakama Nation, the Cowlitz Indian Tribe, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes of Siletz Indians of Oregon. Under 1855 treaties, the Umatilla, Warm Springs, Yakama, and Nez Perce Indian tribes ceded to the Federal Government all title to Tribal lands other than the reservations they then occupied and reserved for themselves the right to fish at their usual and accustomed fishing sites along the banks of the lower Columbia River (USACE 1997). In 1905 and in 1919, these fishing rights were upheld by the United States Supreme Court. Construction of the Bonneville Dam created a pool that inundated multiple usual and accustomed Indian fishing places from the dam site to The Dalles, Oregon (USACE 1997; BIA 1995). An agreement with the four Tribes was negotiated in 1939 and called for the Federal Government to acquire more than 400 acres of land at six described sites to serve as “in lieu” fishing sites. Congress, via the Rivers and Harbors Act of 1945, later authorized five fishing sites to partially compensate for their losses. These five tracts, totaling 40 acres, were purchased for traditional treaty fishing use by the four Tribes. In 1988, Public Law 100-581, Title IV, provided the construction authority for the United States to provide additional sites to the four Tribes in Oregon (USACE 1997; BIA 1995). The law references sites adjacent to the Columbia River in Oregon and Washington for development and transfer to the Bureau of Indian Affairs. The following is a description of the sites located on the Bonneville Pool within 5 miles of Bradford Island.

- Bonneville Treaty Fishing Access Site – This site is located on the Washington shore near RM 147 of the Columbia River and 0.85 mile northeast of Bonneville Dam. It contains a prehistoric archeological site with a probable cemetery component that is listed on the National Register of Historic Places.

- Cascade Locks Existing In-Lieu Fishing Site – This site is on the Oregon shore at the western edge of Cascade Locks, near RM 148.5 of the Columbia River, approximately 2.45 miles northeast of Bonneville Dam. The site is a small wedge-shaped area about 400 feet long and 150 feet across situated between Lake Bonneville and the railroad tracks~~, and~~ located directly downstream of Cascade Locks Park. It is currently used as a treaty fishing access site for 3 to 4 months a year.

~~2.4.6.3~~2.4.7.3 Euro-American Historic Background

The Columbia River provided the first vehicle for Euro-American exploration, travel, and settlement of the Pacific Northwest. In 1805, Lewis and Clark were dispatched to explore the Missouri River to its source and to find a passageway through the Rocky Mountains to the Columbia. Initially used for maritime trade, navigation of the Columbia River led to exploitation of the region's resources, and the establishment of permanent settlements. As Euro-American settlers entered the area, they brought devastating diseases, such as smallpox, to the I~~i~~ndigenous P~~p~~eoples of the region.

By the late-19th century, portage railroads were constructed along both banks of the Columbia River to transport passengers and cargo around impassable sections of the river. The mining, railroad, fisheries, and fur trade industries helped shape the future of the region and because of this development, there are many cultural sites that historically mark this time period, none likely more significant than the Bonneville Dam complex.

Construction of the Bonneville Lock and Dam began in 1933 and was completed in 1938 (USACE 2018). It was the first federal dam along the Columbia River. The Bonneville Dam complex project was one of the most massive construction efforts mounted in North America to-date and was a foremost effort of the New Deal Administration of President Franklin Delano Roosevelt to combat the Great Depression (1929 to 1939) (National Archives 2024a, 2024b). Construction of the dam complex was overseen by the Portland District Office of USACE (National Archives 2024a, 2024b). On 30 June 1987, the Bonneville Dam Historic District was listed as a National Historic Landmark for its significance in the areas of engineering, industry, and politics/government under National Register of Historic Places and National Historic Landmarks Reference Number 86000727_HNL (NPS 2024; National Archives 2024a, 2024b).

Additional historic sites on the National Register of Historic Places include the Columbia River Highway and Fort Cascades (NPS 2024; USACE 1997). Completed in 1916, the historic Columbia River Highway was nominated to the National Register of Historic Places in 1985 and then listed as a National Historic Landmark on 16 May 2000. Envisioned by Samuel C. Hill, and designed by engineer Samuel C. Lancaster, the highway negotiated previously impassable cliffs of the Columbia Gorge. Fort Cascades was formerly an Army town site from 1850 to 1894 located on the Washington shore approximately 1 mile west of Bonneville Dam. Fort Cascades was placed on the National Register of Historic Places in 1987.

~~2.4.7~~2.4.8 Land Use and Resources

The Bonneville Dam complex lands set aside specifically for project operations include 173 acres of land managed, operated, and occupied by USACE (The Urban Collaborative, LLC–USACE 2020). As previously discussed, the Bonneville Dam complex is a multipurpose facility, managed for hydropower, navigation, recreation, and fish and wildlife conservation. The Bonneville Master Plan (USACE 1997; The Urban Collaborative, LLC–USACE 2020) summaries land use details. The land on Bradford Island is specifically managed for Bonneville Dam complex operations (approximately 14 acres), high-density recreation (e.g., visitor facilities and day use areas) (approximately 14 acres), and multiple resource management uses, including low-density recreation (e.g., fishing, hunting, hiking, wildlife viewing, and primitive camping) (approximately 36 acres) and wildlife management (approximately 13 acres) (The Urban Collaborative, LLC–USACE 2020).

The Upland OU is exclusively managed for Bonneville Dam complex operations (approximately 8 acres) and wildlife management (approximately 13 acres). Wooded and open areas within the Upland OU are managed primarily as goose nesting and foraging areas (USACE 1997). Geese also use lawn areas associated with the visitor facilities for foraging. No environmentally sensitive areas or mitigation areas exist within the Upland OU (e.g., lands acquired or designated specifically for the purpose of offsetting losses associated with Bonneville Dam complex development) (The Urban Collaborative, LLC–USACE 2020). Future land uses are not reasonably anticipated to change.

Four Native American tribes have treaty rights to engage in fishing from Bradford Island as a usual and accustomed fishing ground. The tribes include the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Warm Springs Reservation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation. The treaties that the U.S. entered into with these tribes in the 1850s reserve the rights of the tribal members to fish at all usual and accustomed places or sites, and erect buildings for curing fish. As an example, the Treaty with the Yakama Nation states that "[t]he exclusive right of taking fish in all the streams, where running through or bordering said reservation, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them: together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land" (Treaty with the Yakama, 9 June 1855, Art. 3 [12 Stat. 951]). The treaties with the Confederated Tribes of the Warm Springs Reservation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation contain similar language. Members of the treaty tribes have historically fished and erected fishing platforms on the Bradford Island NPL Site, within the Upland OU, and in other locations in the Forebay. Photographic evidence shows these wooden platforms erected along the steep shoreline of Bradford Island, suitable for possibly holding one or two individuals for fishing purposes. Platforms such as those historically seen along the shores of Bradford Island are most common on the larger rivers in the Columbia Basin. These wooden structures are constructed during low-water periods with engineering techniques that have been handed down for generations. Platform sites belong to individual families, and tribal fishers using these scaffolds are likely fishing in the same location their own ancestors did.

There are no plans to change the above land uses at the Bonneville Dam complex; therefore, these appear to be the likely future land uses (USACE 2017b). However, consideration is given for potential tribal fishing use of Bradford Island, as this area is within several treaty tribes' usual and accustomed fishing boundaries. Fishing has strong spiritual and cultural significance for tribes, and fishing along the Columbia River is a historic practice protected by treaty rights. The exercise of this treaty right is the basis for Native American cultural and economic self-sufficiency. Successful remedial or removal action may allow future tribal fishing to resume on Bradford Island, including at the Landfill AOPC, Bulb Slope AOPC, Sandblast AOPC, and Pistol Range AOPC, with appropriate risk reduction at the site. Tribes will be permitted to ingress and egress for fishing and other treaty rights. Although there are no such current tribal uses, future tribal fishing use is anticipated upon completion of remediation for the Upland and River OUs. ~~Anticipated future use is quantified for the Upland OU as use for 12 hours per day for an entire lifetime (estimated at 70 years), as representative of tribal fishers using the eastern portions of Bradford Island, including the Landfill AOPC, Bulb Slope AOPC, Sandblast AOPC, and Pistol Range AOPC for fishing activities during daylight hours (USACE 2017a; USACE 2023a).~~

There are four distinct human populations in the general site area that use the land: site staff, site visitors, nearby residents, and Native American tribes (USACE 2017b). Site staff include USACE employees at the Bonneville Dam complex, which are currently estimated at 150 full-time-equivalent positions. Staff duties include a wide range of occupations, including maintenance, construction, office staff, visitor services, and natural resource management. Approximately 10 additional staff members from the Portland District headquarters are stationed at the dam. Approximately 300 fisheries-related personnel (contractors/researchers from state and federal agencies) work at the dam from April through September.

The number of construction and service contractors at the Bonneville Dam complex varies depending on workloads but can number approximately 175 people.

A road from Interstate 84 provides access for site visitors to the Bonneville Dam complex. Visitor access is monitored at the front gate, and visitors are allowed to visit several notable dam facilities, including the visitor center, fish ladders, and some other areas within the western portion of Bradford Island. The eastern portion of Bradford Island, including the Upland OU, is currently restricted. Only USACE personnel and authorized visitors are allowed into these areas.

No permanent residential dwellings are located on Bradford Island. The primary population center in proximity to the dam is the town of North Bonneville, situated on the Columbia River just west of the dam on the Washington side of the river. The current population is estimated at approximately 1,050 persons (Census Reporter 2022). Major population centers to the west include Portland, Astoria, and St. Helens in Oregon, and Vancouver, Longview-Kelso, and Camas-Washougal in Washington. The cities of Cascade Locks, Hood River, and The Dalles in Oregon and Stevenson, Carson, and White Salmon in Washington lie upstream of the dam. Municipal and industrial pollution from these urban areas is expected to have affected the water quality of the mainstem Columbia River. Population growth is anticipated to result in the conversion of forest, rural residential, and agricultural land uses to high-density residential uses, with potential impacts to habitat conditions (Lower Columbia Fish Recovery Board 2004).

~~2.4.7.1~~2.4.8.1 Beneficial Uses

According to Oregon DEQ guidance for determining beneficial water uses (Oregon DEQ 1998), groundwater may be classified as unlikely to be suitable for potable water uses if it meets the criteria of greater than 10,000 mg/L of total dissolved solids and yields less than 0.5 gallon per minute (720 gallons per day). Both the shallow perched groundwater and the deeper groundwater at Bradford Island have suitable total dissolved solids concentrations~~,~~ but have insufficient yield for potable uses. A water supply well originally drilled at Bradford Island to supply potable water to onsite workers was left inactive due to inadequate yield. The well was formally abandoned in 2008, resulting in no active drinking water wells on Bradford Island. Currently, drinking water is supplied to the Bonneville Dam complex by supply wells located on Robins Island and Cascades Island (Figure 2-1). Therefore, potable water supply use is a highly unlikely potential beneficial use for groundwater (USACE 2017b).

Designated beneficial uses for surface water in the mainstem of the Columbia River are described in Oregon Administrative Rule (OAR) 340-41-0101 (Oregon DEQ 2009). They include a variety of high-quality uses such as public and private domestic water supply, fishing, water contact recreation, and protection of fish and aquatic life. Beneficial use designations for fish uses include salmon and steelhead migration corridors as well as shad and sturgeon spawning and rearing (USACE 2017b).

~~2.4.8~~2.4.9 Background Concentration Levels

As shown on Figure 2-3, an approximately 5-acre forested area within the center of the Upland OU is defined as the Reference Area to provide site-specific background concentrations of inorganic COIs in soil and groundwater (URS-USACE 2012). Reference Area samples were also analyzed for selected organic analytes to evaluate the potential contribution, if any, of non-site-specific, anthropogenic sources to organic COIs to site risk. Fourteen surface soil reference samples (R1 through R14) collected from 0 to 1 foot bgs were analyzed and evaluated as site-specific background concentrations, which is sufficient for statistical comparison to AOPC soils. Reference Area sample locations are shown on Figure 2-3, and background concentration levels are summarized in Table 2-2. However, site-specific background concentrations were only used to establish screening level values for inorganic analytes in soil (URS-USACE 2012).

Table 2-2. Statistical Summary for Reference Area Background Concentration Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Analyte Type/Group	Analyte	Depth (feet)	Units	No. of Samples	No. of Detections	Mean of Detects	Median of Detects	Maximum Detected Value	Statistical ~~Distribution~~Method	Site-specific Background Concentration Level[a]~~*~~
Inorganic/ Metals	Aluminum	0 to 1	mg/kg	14	14	22,700	22,000	33,200	Normal	31,400
	Antimony	0 to 1	mg/kg	14	14	0.128	0.13	0.18	Normal	0.176
	Arsenic	0 to 1	mg/kg	14	14	3.1	3.22	5.18	Normal	5.4
	Barium	0 to 1	mg/kg	14	14	110	105	182	Normal	169
	Beryllium	0 to 1	mg/kg	14	14	0.491	0.498	0.629	Normal	0.659
	Cadmium	0 to 1	mg/kg	14	14	0.162	0.156	0.34	Gamma	0.271
	Chromium	0 to 1	mg/kg	14	14	21.8	21.8	27.3	Normal	28.1
	Cobalt	0 to 1	mg/kg	14	14	16.5	17.4	19.9	Non-parametric	19.9
	Copper	0 to 1	mg/kg	14	14	39	36.6	58.2	Normal	56.7
	Lead	0 to 1	mg/kg	14	14	17.7	16.4	26.5	Normal	25.5
	Manganese	0 to 1	mg/kg	14	14	627	624	920	Normal	885
	Mercury	0 to 1	mg/kg	14	14	0.0494	0.048	0.068	Normal	0.066
	Nickel	0 to 1	mg/kg	14	14	18.7	19.2	26.1	Normal	26.5
	Selenium	0 to 1	mg/kg	14	0	-	-	-	Non-parametric	0.5
	Silver	0 to 1	mg/kg	14	12	0.0635	0.0483	0.187	Non-parametric	0.187
	Thallium	0 to 1	mg/kg	14	8	0.158	0.15	0.203	Non-parametric	0.203
	Vanadium	0 to 1	mg/kg	14	14	78.8	80.2	99.3	Normal	104
	Zinc	0 to 1	mg/kg	14	14	58.8	57.6	68.5	Normal	71.7

Table 2-2. Statistical Summary for Reference Area Background Concentration Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Analyte Type/Group	Analyte	Depth (feet)	Units	No. of Samples	No. of Detections	Mean of Detects	Median of Detects	Maximum Detected Value	Statistical ~~Distribution~~Method	Site-specific Background Concentration Level[a]~~*~~
Organic/ SVOCs	Acenaphthene	0 to 1	µg/kg	14	9	1.75	1.6	3.4	Non-parametric	3.4
	Acenaphthylene	0 to 1	µg/kg	14	1	-	-	1.6	Non-parametric	1.6
	Anthracene	0 to 1	µg/kg	14	12	2.47	2.05	4.9	Non-parametric	4.9
	Fluorene	0 to 1	µg/kg	14	1	-	-	3.2	Non-parametric	3.2
	Naphthalene	0 to 1	µg/kg	14	6	1.7	1.65	2.2	Gamma	29.4
	Phenanthrene	0 to 1	µg/kg	14	14	13.2	12	34	Non-parametric	2.2
	Benzo(a)anthracene	0 to 1	µg/kg	14	14	14	12.5	34	Gamma	28.7
	Benzo(a)pyrene	0 to 1	µg/kg	14	14	18.2	16	45	Gamma	37
	Benzo(b)fluoranthene	0 to 1	µg/kg	14	14	23.4	21	55	Gamma	46.4
	Benzo(g,h,i)perylene	0 to 1	µg/kg	14	14	13.7	12.5	32	Gamma	26.5
	Benzo(k)fluoranthene	0 to 1	µg/kg	14	14	8	7.45	19	Gamma	16.2
	Chrysene	0 to 1	µg/kg	14	14	18.3	16	45	Gamma	37.4
	Dibenz(a,h)anthracene	0 to 1	µg/kg	14	7	4.36	4.3	6.9	Non-parametric	6.9
	Fluoranthene	0 to 1	µg/kg	14	14	27	24	66	Gamma	55.1
	Indeno(1,2,3-cd)pyrene	0 to 1	µg/kg	14	14	14.1	12	34	Gamma	27
	Pyrene	0 to 1	µg/kg	14	14	26.8	25	64	Gamma	53.3
	cPAHs as BaPEQ (KM-capped, MDL-based)	0 to 1	µg/kg	14	14	26	22.7	64.8	95% UPL(t)	51.6
	Total LPAHs (KM, capped; sat MDL)	0 to 1	µg/kg	14	14	21.2	19.8	49.3	Non-parametric	49.3
	Total HPAHs (KM, capped; ND sat MDL)	0 to 1	µg/kg	14	14	167	147	401	Non-parametric	401

Table 2-2. Statistical Summary for Reference Area Background Concentration Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

~~*~~[a] Background concentration levels are defined as the 95% UPL.
[b] Site-specific reference concentrations were used to establish screening level values for inorganic analytes in soil only.

Notes:

For soil, analytes with less than 100 percent detection rate, but at least one detection, the maximum detected value was assessed as the non-parametric UPL.

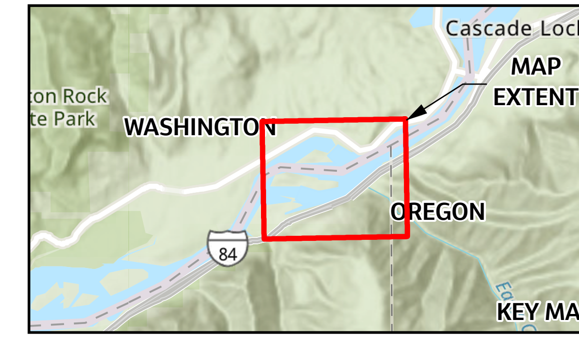
For soil, analytes with no detections (0 percent detection rate), the maximum MDL is shown as the non-parametric UPL.

UPLs were not calculated when fewer than eight samples were available.

UPLs are a point-based statistic and are not relevant for comparison to statistical averages which rely on a UCL, including risk-based EPCs.

- = not available/applicable
µg/kg = microgram(s) per kilogram
BaPEQ = benzo(a)pyrene equivalent(s)
EPC = exposure point concentration
KM = Kaplan-Meier
LPAH = low molecular weight polycyclic aromatic hydrocarbon
MDL = method detection limit
ND = non-detect
UCL = upper confidence limit
UPL = upper prediction limit

Source: URS-USACE 2016



LEGEND

- UPLAND OPERABLE UNIT
- RIVER OPERABLE UNIT

NOTES:

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0 800 1,600 Feet

N

FIGURE 2-1
BONNEVILLE DAM AND LOCK COMPLEX AND OPERABLE UNITS

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

LEGEND

- DRINKING WATER SUPPLY WELL (NO LONGER IN USE)
- WATER TOWER
- ROAD
- 5- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- UPLAND OPERABLE UNIT
- SANDBLAST AREA AOPC (135844 SQUARE FEET)
- LANDFILL AOPC (59094 SQUARE FEET)
- PISTOL RANGE AOPC (11393 SQUARE FEET)
- BULB SLOPE AOPC (2350 SQUARE FEET)
- SPENT SANDBLAST GRIT DISPOSAL AREA (APPROXIMATE)
- CURRENT HAZARDOUS MATERIALS STORAGE
- FORMER HAZARDOUS MATERIALS STORAGE

NOTES:

AOPC = AREA OF POTENTIAL CONCERN

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0 150 300 Feet

N

FIGURE 2-2
UPLAND OPERABLE UNIT AREAS OF POTENTIAL CONCERN

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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LEGEND

- WATER TOWER
- BACKGROUND CONCENTRATION SURFACE SOIL SAMPLE LOCATION
- 5- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- UPLAND OPERABLE UNIT

NOTES:

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

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0 150 300 Feet

N

FIGURE 2-3
REFERENCE AREA BACKGROUND SAMPLE LOCATIONS

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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SECTION 3

Landfill AOPC

3.1 Conceptual Site Model

The purpose of the CSM is as follows:

- Provide a fundamental understanding of the environmental setting at the site.
- Identify any potential sources of contamination based on former site activities.
- Assess the known nature and extent of contamination based on available data.
- Identify possible contaminant release pathways, transport mechanisms and routes of human and environmental exposure.

The CSM was developed with information gathered from both historical and recent investigations. Because the CSM is "conceptual," it is not dependent on the quantification of the chemical nature, extent, fate, and transport.

The CSM for the Landfill AOPC is summarized in the following sections.

3.1.1 Site History

The Landfill AOPC was historically used by USACE to dispose of waste materials from approximately 1942 to 1982, with its greatest use in 1952 (Figure 3-1). Some additional wastes were disposed of over the northern and eastern edges of the island. In addition to the placement of wastes within the Landfill AOPC, other historical activities included pesticide/herbicide mixing and rinsing activities and use for historical equipment storage. Stained soils have been observed in the center of the Landfill AOPC, indicating possible historical open burning practices. By 1982, the landfill was closed and a soil cover had been placed over the landfill. In 1989, approximately 8 inches of additional soil cover was placed over the landfill by USACE, and the site was subsequently managed as a wildlife habitat for geese (USACE 1997). Active goose habitat management included periodic mowing; however, this activity ceased in the middle to late 1990s to prevent geese from laying eggs at the site (URS-USACE 2012). The former landfill is no longer in use for Bonneville Dam operations.

3.1.2 Physical Setting

The Landfill AOPC is located on the northeastern tip of the Upland OU at an elevation of approximately 116 feet NAVD88, which is approximately 38 feet above the average elevation (77.8 feet NAVD88) of the Bonneville Dam Forebay immediately upstream of the dam and adjacent to the Upland OU (Figures 2-3 and 3-1).

The topography of the Landfill AOPC is generally level except for where the north and east ends of the Landfill AOPC steeply slope downward to the Columbia River. To the north of the landfill, the land surface drops steeply (30 to 35 feet) to the Columbia River. The steepness of these slopes locally exceeds 1 horizontal to 1 vertical (1H:1V). The topography to the east of the landfill also drops steeply to the Columbia River, exceeding 0.5H:1V. These steep slopes provide potential for erosion and mass wasting of landfill soils to the river. The land surface rises moderately to the south and southwest of the landfill site. West of the landfill, the topography slopes downward gently to the west-northwest. The topography to the south and southwest of the Landfill AOPC slopes steeply upward to points of higher elevations within the center of the Upland OU. Access to the Landfill AOPC is provided by an unimproved access road from the west of the site (Figure 3-1). The Landfill AOPC surface is currently densely vegetated with forest, scrub-shrub, and herbaceous vegetation. The access road that traverses along the southern margin of the Landfill AOPC is more sparsely vegetated with herbaceous vegetation.

Soil at the Landfill AOPC predominantly consists of alluvium composed of silty sands and gravels down to a depth of 15 to 30 feet bgs (URS-USACE 2012). Increasing amounts of sandstone and conglomerate bedrock clasts from the underlying Eagle Creek Formation slide block occur with depth.

Groundwater beneath the Upland OU is generally within the alluvium and is indicated to be largely perched above the less-permeable Eagle Creek Formation slide block. The groundwater elevation fluctuates seasonally and has been measured to range between approximately 56 and 109 feet msl NGVD29 (59.3 to 112.3 feet NAVD88 [converted]) (URS-USACE 2012; NOAA 2023). And depending on location and season, groundwater could be encountered between approximately 7 and 57 feet bgs beneath the Landfill AOPC. During wetter portions of the year (winter and spring), the water elevation can rise high enough to encounter buried waste materials in certain areas of the Landfill AOPC. Groundwater flows to the north under both wet season and dry season conditions. Horizontal hydraulic gradients range from 0.10 to 0.13 foot per foot and hydraulic conductivities range from 14 to 320 feet per day in the fill/alluvium beneath the Landfill AOPC (URS-USACE 2012, 2022a).

Seeps are observed from fractured bedrock outcrops along on the north shore of the island when there are higher levels of precipitation (URS-USACE 2012, 2022b). Boring log data from within the Landfill AOPC shows that the top of the competent slide block to generally be above the average Bonneville Dam Forebay river elevation (URS-USACE 2022b). A single seep has been observed at the base of the slope located along the southern margin of the Landfill AOPC, which flows west along the access road before infiltrating back into the ground between the access road and the river (URS-USACE 2009b). The flow from this seep is minor and not observed to be causing any appreciable soil erosion.

3.1.3 Source of Contamination and Affected Media

Past investigations have identified historical waste disposal and management practices to be the primary source of contamination at the Landfill AOPC. Wastes known to have been disposed of at the landfill includes the following:

- Electrical equipment and debris (mercury vapor lamps, light bulbs, ballasts, and ceramic insulators)
- Project-related wastes (grease, sandblast grit, paint solids, and metallic slag)
- Asbestos-containing materials
- Empty drums, buckets, and cans
- General construction and demolition (C&D) debris, including concrete, glass, metal, and wood debris, steel and metal cables, and rubber tires
- Burned debris
- Household and miscellaneous waste

Waste was buried in discrete, individual pits within the landfill, rather than a single large disposal pit (URS-USACE 2012). Some exposed wastes have been observed on the northern edge and the surface of the landfill. The condition of any drums, buckets, and cans at the time of disposal remains unknown, including if contents were present. Investigation findings indicate that waste debris had entered the Columbia River along the northern and eastern shorelines of the AOPC, upland of in-water former Debris Piles #1 and #2 (URS-USACE 2002a). It is thought that either historical surface disposal directly into the river, upland soil mass wasting, or a combination of both mechanisms resulted in the formation of in-water former Debris Piles #1 and #2. Other historical activities included pesticide/herbicide mixing and rinsing activities, equipment storage, and possibly open burning activities (as evidenced by stained soils onsite).

The Landfill AOPC encompasses an area of approximately 59,094 square feet (1.36 acres) (Figure 3-1). Based on historical aerial photograph, geophysical, test pit, boring log, and ground surface observation data, the landfill volume has been estimated to be between 7,500 and 9,900 cy, with an estimated maximum depth of 15 feet bgs (Tetra Tech, Inc.–USACE 1998; URS-USACE 2004a).

Historical use of the Landfill AOPC to manage, store, and dispose of waste materials has resulted in contamination of soil with chemicals associated with the wastes. The type and magnitude of contamination is variable, consistent with the variable waste management, storage, and disposal activities that occurred at the Landfill AOPC.

3.1.4 Nature and Extent of CERCLA Contaminants

Results of previous investigations at the Landfill AOPC evaluated during the 2012 RI confirmed past disposal practices have impacted soil with chemicals associated with wastes. The type and magnitude of contamination in the Landfill AOPC are variable, which is consistent with the variable waste management, storage, and disposal activities that occurred at the Landfill AOPC.

During the 2012 RI, soil concentration data were compared to the project SLVs selected for human and ecological exposure scenarios, based on a hierarchy of sources current at the time (URS-USACE 2012). All SLVs used in this EE/CA refer to the 2012 screening values (2012 SLVs) utilized in the RI Report and the subsequent risk assessment documents (URS-USACE 2012, 2016; USACE 2017a). The 2012 SLVs were based on the following sources:

- Oregon DEQ RBCs for occupational, construction, and excavation workers
- EPA industrial regional screening levels (RSLs)
- 95% UPL of site-specific Reference Area soil concentrations (inorganic analytes only)
- EPA non-residential RSLs (PCBs only)
- EPA ecological soil screening levels protective of plants, soil invertebrates, birds, and mammals (2005–2008)
- Oregon DEQ level II SLVs for soil protective of plants, soil invertebrates, birds, and mammals
- Oak Ridge National Laboratory (ORNL) PALs for ecological endpoints protective of birds and mammals
- ORNL screening levels for plants and soil invertebrates
- EPA toxicity reference values (TRVs) protective of plants and invertebrates
- Background soil concentrations levels (refer to Section 2.4.9)

Soil investigations were conducted across the Landfill AOPC, including the collection of 37 surface and shallow samples. Eighteen deeper soil samples were collected from two limited areas: the Gully test pit and the Mercury Vapor-Lamp test pit. The RI concluded that soils throughout the Landfill AOPC are impacted by metals, PAHs, and other SVOCs. Impacts to soil from herbicides, pesticides, PCBs, and VOCs are much more limited (USACE 2017b). The following analytes were detected at concentrations exceeding their respective 2012 SLVs based on potential human and/or ecological exposure. The maximum detected concentrations are presented. Estimated concentration values are flagged with a "J" qualifier.

- Metals
  - Antimony (11.6 mg/kg)
  - Arsenic (30.1 mg/kg)
  - Barium (251 mg/kg)
  - Cadmium (3.93 mg/kg)
  - Calcium (13,100 mg/kg)
  - Chromium (2,300 mg/kg)
  - Cobalt (42.3 mg/kg)
  - Copper (494 mg/kg)
  - Iron (56,100 mg/kg)
  - Lead (1,660 J mg/kg)
  - Magnesium (88,300 mg/kg)
  - Manganese (2,520 J mg/kg)
  - Mercury (5.5 mg/kg)
  - Nickel (1,760 J mg/kg)
  - Selenium (1.08 J mg/kg)
  - Silver (1.52 mg/kg)
  - Sodium (570 mg/kg)
  - Thallium (0.378 mg/kg)
  - Zinc (1,180 J mg/kg)

- VOCs
  - Ethylbenzene (2.7 J mg/kg)
  - o-Xylene (4.26 J mg/kg)
  - PCE (403 mg/kg)
- SVOCs
  - ~~Bis(2-ethylhexyl) phthalate~~DEHP (21 mg/kg)
  - Carbazole (2.84 mg/kg)
  - Dibenzofuran (0.81 mg/kg)
  - Di-n-butyl phthalate (1.8 mg/kg)
- PAHs
  - Anthracene (8.44 mg/kg)
  - Benzo(a)anthracene (32 mg/kg)
  - Benzo(a)pyrene (34 mg/kg)
  - Benzo(b)fluoranthene (65 mg/kg)
  - Benzo(k)fluoranthene (65 mg/kg)
  - Chrysene (35.3 J mg/kg)
  - Dibenz(a,h)anthracene (9.9 mg/kg)
  - Indeno(1,2,3-cd)pyrene (20 mg/kg)
  - Naphthalene (8.36 mg/kg)
  - Pyrene (67.1 mg/kg)
  - Total benzofluoranthene (31.3 mg/kg)
  - Total LPAHs (34.767 mg/kg)
  - Total HPAHs (367.9 mg/kg)
- Herbicides/Pesticides
  - 2,4,5-Trichlorophenoxyacetic acid (0.093 mg/kg)
  - Dichloroprop (0.0180 mg/kg)
  - Methylchlorophenoxypropionic acid (14 mg/kg)
  - 4,4'-DDT (0.028 mg/kg)
- PCBs
  - Aroclor 1248 (0.968 mg/kg)
  - Aroclor 1254 (0.499 mg/kg)
  - Aroclor 1260 (0.445 mg/kg)
  - Total PCBs (0.996 J mg/kg)

The estimated lateral extent of waste debris and soil concentrations exceeding the 2012 SLVs at the Landfill AOPC is estimated to be approximately 255 feet long and 135 feet wide in total, though the impacted area appears to be more consistent with two isolated, noncontiguous areas consisting of the area of buried landfill debris (Area L1) and a smaller area of soil contamination along the eastern slope of the AOPC (Area L2) (Figure 3-1) (URS-USACE 2012). The smaller area of soil contamination is located immediately upland of the in-water former Debris Pile #1 (URS-USACE 2002a). The vertical extent of waste debris and soil concentrations exceeding the 2012 SLVs is estimated to not exceed 15 feet bgs within the area of buried landfill debris and 3 feet bgs within the smaller area of soil contamination upland of in-water former Debris Pile #1.

Additional site-specific details of the nature and extent of contamination at the Landfill AOPC are provided in the RI Report (URS-USACE 2012).

3.1.5 Fate and Transport Characteristics

The potential mechanisms for offsite transport of contaminants from the Landfill AOPC is direct mass wasting (slope failures) of soil and landfill contents into the river and surface soil erosion. The northern and eastern perimeter of the Landfill AOPC consists of steep slopes leading down to the Columbia River. Soil on these slopes has an ongoing potential to migrate into the Columbia River via mass wasting. Wave erosion from wind and boat wakes is actively undercutting the base of the Bradford Island shoreline slopes at the waterline. At the same time, the surficial soils along the middle to upper slopes are weathering and weakening and are slowly creeping downslope. This combination results in an overall destabilization of the Bradford Island shoreline slopes resulting in periodic slope failure. These failures are most likely preceded by, or in conjunction with, heavy rainfall events.

At least two slope failures (East Landslide Scarp and West Landslide Scarp) have been historically identified along the northern shoreline of the Landfill AOPC and investigated for stability, specifically related to the landfill (USACE 2017b, URS-USACE 2022c). The East Landslide failed to a depth of approximately 5 feet, with most of the original slide material failing into the river and subsequently eroding away. The resulting scarp is steep, approximately 45 to 50 degrees. The East Landslide appears to have primarily mobilized the surficial weathered soils. Landslide movement in this area post-dates the placement of at least some of the fill material and landfill materials have been exposed along the upper part of the scarp. Based on review of aerial photographs, the West Landslide was present prior to dam construction; although more recent sloughing and soil creep have been observed. The scarp generally slopes down from 38 to 40 degrees. The base of the bluff has eroded 15 feet since dam construction (from 1935 to 2010) and is estimated to continue to erode at an average recession rate of 2.4 inches per year. If the same rate occurs in the future, the base of the bluff could recede an additional 10 feet in the next 50 years.

The majority of the ground surface at the Landfill AOPC is relatively flat and well vegetated with minimal stormwater erosion and sediment deposition observed. However, surface runoff has been observed at the Landfill AOPC, and more significant erosion could occur during extreme weather events thereby transporting contaminants into the river.

3.1.6 Exposure Pathways and Receptors

3.1.6.1 Human Health Exposure Pathways and Receptors

Multiple potential current and future receptor groups and exposure pathways for soil were identified in the screening level HHRA (completed as part of the RI Report) and BHHRA/BERA for the Landfill AOPC (URS-USACE 2012, 2016). The potential receptor groups and exposure pathways are summarized below:

- Current/future outdoor maintenance workers (adults) – surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Current/future construction/excavation workers (adults) – surface and subsurface soil from 0 to 10 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Hypothetical future fishing platform users (adults and children) – surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors) by adults and children
- Nursing infants – maternal milk (ingestion) from mothers who are hypothetical future fishing platform users with soil exposures from 0 to 3 feet bgs.

These potential human health receptors and exposure pathways were further evaluated in the BHHRA, as described in Section 3.2.1.

3.1.6.2 Ecological Exposure Pathways and Receptors

Potentially complete ecological exposure pathways for the Landfill AOPC were identified in the Level I/Level II ERA completed in 2012 as part of the RI Report (URS-USACE 2012) and refined in the Level III BERA (URS-USACE 2016). Exposure media that may provide a potentially complete exposure pathway to ~~ecological~~ terrestrial receptors at the Landfill AOPC are summarized below:

- Terrestrial Plants
  - Soil – Root uptake of COPECs in surface and shallow soil
- Soil Invertebrates
  - Soil – Direct contact (ingestion or dermal contact) of COPECs in surface and shallow soil

- Birds (upland species)
  - Soil – Incidental ingestion of COPECs in surface and shallow soil
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
  - Surface water – Incidental ingestion of COPECs in surface water
- Mammals (upland species)
  - Soil – Incidental ingestion of COPECs in surface and shallow soil
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
  - Surface water – Incidental ingestion of COPECs in surface water
- ~~Aquatic biota (invertebrates, fish, and wildlife)~~
  - ~~Groundwater – Ingestion or direct contact with COPECs in groundwater~~
  - ~~Seep water – Ingestion or direct contact with COPECs in seep water~~
  - ~~Surface water – Ingestion or direct contact with COPECs in surface water~~

3.2 Evaluation of Receptor Risks

Potential exposures to site soil were qualitatively evaluated in the screening level HHRA (URS-USACE 2012) and quantitatively evaluated in the BHHRA/BERA (URS-USACE 2016), the *Reevaluation of Baseline Risk Assessment Calculations* (USACE 2017a~~, 2023b~~), and the lead modeling update (Appendix D). This included an evaluation of current and reasonably foreseeable (as well as hypothetical future) exposures to chemicals in site soil and estimates of ELCR and noncancer HI and PbB modeling for human receptors. In addition, site-specific PALs were calculated for the chemicals recommended for further evaluation (COCs).

~~Potential risk~~Risks to ecological receptors were quantitatively evaluated in the Level I/Level II ERA (URS-USACE 2012) and the Level III BERA (URS-USACE 2016).

3.2.1 Human Health Risk Summary

The following sections provide a summary of the screening level HHRA, BHHRA, reevaluation of the BHHRA, and updated lead modeling (URS-USACE 2012, 2016; USACE 2017a, ~~2023b,~~ Appendix D).

3.2.1.1 Human Health Risk Approach and Risk Estimates

A screening level HHRA was performed as part of the RI Report (URS-USACE 2012), whereby detected concentrations of chemicals in soil were compared to agency-approved screening levels. EPCs were calculated for each chemical as the lesser of the 95th percentile upper confidence limit (95% UCL) and the maximum detected concentration. The chemicals with EPCs exceeding screening levels were identified as COPCs, and it was recommended that a site-specific BHHRA be prepared for the COPCs.

The subsequent 2016 BHHRA addressed the following exposure scenarios for current and future potential receptor groups (URS-USACE 2016):

- Current/future outdoor maintenance workers – Surface soil (0 to 3 feet bgs; via ingestion, dermal contact, and inhalation of dusts and vapors).
- Current/future construction/excavation workers – Surface and subsurface soil (0 to 10 feet bgs; via ingestion, dermal contact, and inhalation of dusts and vapors).

- Future hypothetical fishing platform users – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors) for adults and children of the four treaty tribes; the tribes were assumed to exercise their treaty rights to engage in fishing from Bradford Island, construct and use fishing platforms along the upland shoreline of Bradford Island, and camp in the interior of Bradford Island.
- Nursing infants – Maternal milk (via ingestion) for nursing infants of mothers who are hypothetical future fishing platform users or workers with soil exposures.

For the BHHRA (URS-USACE 2016), the soil COPCs for each receptor group were identified using agency-approved screening levels. Both reasonable maximum exposure (RME) and central tendency exposure (CTE) were evaluated for receptor exposures to represent a range of upper-end and average exposures.

The BHHRA calculations for the future hypothetical fishing platform user RME scenario were reevaluated in response to comments received from the Yakama Nation and Oregon DEQ on the draft version of the FS regarding the tribal subsistence fisher scenario (USACE 2017a, 2017b~~, 2023a~~). In addition, the reevaluation calculations incorporated the revised toxicity values for benzo(a)pyrene that were released by EPA in 2017. The reevaluation calculations used the same surface soil dataset and COPCs as the BHHRA and addressed the following scenarios:

- Future hypothetical fishing platform users – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors) for adults and children using a revised exposure duration for adults and revised exposure time for both adults and children.
- Nursing infants – Maternal milk (via ingestion) for nursing infants of mothers who are hypothetical future fishing platform users with soil exposures.
- ~~Current/future outdoor maintenance workers – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors).~~

Potential exposures to lead in site soil were initially assessed in the 2016 BHHRA but were reassessed in 2024 due to updates to the Adult Lead Methodology (ALM) and the Integrated Exposure Uptake Biokinetic (IEUBK) Model and use of a lower target PbB of 5 micrograms per deciliter (µg/dL). For this reassessment of lead exposures, the most current versions of the ALM (version date 14 June 2017) and IEUBK (Version 2.0 Build 1.72, May 2021) Model available from EPA were used.

Results of the most recent risk estimates (and lead modeling results) for each receptor group (and the source of the estimates) are summarized in Table 3-1.

Table 3-1. Human Health Updated Risk Estimate Results – Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Receptor Type	ELCR	HI	Probability That Receptor Has PbB > 5 µg/dL[a]
Outdoor Maintenance Worker[b]	6~~1~~ × 10^{-5}	0.02~~6~~	0.28%
Construction/Excavation Worker[b~~c~~]	5 × 10^{-6}	1	0.28%
Hypothetical Fishing Platform User[c~~b~~]	5~~1~~ × 10^{-4} (child/adult aggregate) 1 × 10^{-6} (nursing infant)	3 (child) 3~~2~~ (adult) 2 (nursing infant)	0.30% (adult) 5.6% (child)

[a] Source: Appendix D; the ALM was used to evaluate PbB for adult workers, and results were used to represent outdoor maintenance workers and construction/excavation workers; the higher probability considering both the 0- to 1-foot-bgs and 0- to 3-foot-bgs intervals is presented.

[b] ELCR and HI value source: ~~USACE 2023b.~~URS-USACE 2016.

[c] ELCR and HI value source: ~~URS-USACE 2016.~~USACE 2017a.

Bold = value exceeds an ELCR of 1 x 10^{-4}~~.~~, an HI of 1, or ~~exceeds~~ a 5 percent probability of having a PbB greater than 5 µg/dL.

3.2.1.2 Human Health Chemicals of Concern and Project Action Levels

The human health COCs for the EE/CA were identified based on consideration of the outdoor maintenance worker scenario, the construction/excavation worker scenario, and the hypothetical fishing platform user scenario. Based on the risk estimates presented above, the hypothetical fishing platform user ~~no~~ exposure scenario~~s~~ has~~ve~~ a cumulative ELCR estimate above the CERCLA risk management range of 10^{-4} to 10^{-6} (40 CFR 300.430[e][2][i][A][2]). In addition~~However~~, one exposure scenario (the hypothetical fishing platform user) has target organ specific HIs above 1 for child, adult, and nursing infant receptors. These exceedances~~,~~ warrant~~ing~~ identification of COCs. For the hypothetical fishing platform user, the risk estimates for cPAHs account for 93 percent of the cumulative risk in the Landfill AOPC, and therefore cPAHs were identified as final COCs. Also, site-related chemicals posing an HQ above 0.1 were identified as final COCs. In addition, since the probability of hypothetical fishing platform users (child) having a PbB above 5 µg/dL was above the EPA target of 5 percent, lead was considered a COC for that receptor.

Three~~wo~~ final COCs (carcinogenic PAHs, benzo[a]pyrene, and lead) were identified for the Landfill AOPC. The associated ELCR and hazard estimates and the PbB modeling results are presented in Table 3-2. However, the risks to hypothetical fishing platform users are not considered current and imminent site risks warranting an NTCRA (see Section 3.3); therefore, these COCs do not advance as PALs presented in Section 3.3.2.

Table 3-2. Human Health Chemicals of Concern and Proposed Project Action Levels – Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

		Landfill AOPC				
Receptor	Soil COC	Chemical-specific EPC (mg/kg)	Chemical-specific ELCR	Chemical-specific HQ	Probability That Receptor Has PbB > 5 µg/dL	Proposed Human Health Soil PAL (mg/kg)
Hypothetical Fishing Platform User[a]	cPAHs (expressed as B~~(a)~~aP ~~T~~EQ) ~~Benzo(a)pyrene~~	11.2	4×10^{-4}	3 (child~~), 2 (~~ and adult), 2(~~ and~~ nursing infant)	--	0.073~~4.5~~[b]
Hypothetical Fishing Platform User[b~~c~~]	Lead	211	--	--	5.6% (child)	200

[a] From USACE 2017a.
[b] From Table 2 of Appendix D.

Notes:

Soil exposure depth is 0 to 3 feet bgs

3.2.2 Ecological Risk Summary

The following sections provide a summary of the Level I/Level II ERA and Level III BERAs performed for the Landfill AOPC.

3.2.2.1 Ecological Risk Assessment Approach and Results

A Level I/Level II ERA was completed for the Landfill AOPC to support the RI Report (URS-USACE 2012) and a Level III BERA was completed in 2016 (URS-USACE 2016). The primary objectives of the ERAs were to determine if site-related chemicals were present at concentrations that could have adverse effects to ecological receptors that may use the Upland OU. The ERAs were completed in accordance with Oregon DEQ and EPA guidance (Oregon DEQ 2001; EPA 1998).

Media evaluated for ~~potential risk~~risks to ecological receptors at the Landfill AOPC included soil, seep, and surface water. Potentially complete exposure pathways evaluated in the Level I/Level II ERA for the Landfill AOPC included the following:

- Terrestrial plants – Root uptake of surface (0 to 1 foot bgs) and subsurface soils (0 to 3 feet bgs)
- Soil invertebrates – Direct contact (ingestion and dermal contact) with surface (0 to 1 foot bgs) and subsurface soils (0 to 3 feet bgs)
- Birds and mammals – Incidental ingestion of surface (0 to 1 foot bgs) and subsurface soils (0 to 3 feet bgs) and dietary intake of forage/prey

COPECs retained for evaluation in the Level II ERA were identified using the following Oregon DEQ criteria (URS-USACE 2012):

- Analytes with less than 5 percent frequency of detection were excluded from further evaluation if the sample reporting limits were protective of ecological receptors.
- Inorganics analytes detected below background concentrations (site-specific or regional) using a statistical evaluation were excluded as COPECs.
- Analytes below 2012 SLVs either individually or cumulative for all media and routes of exposure were excluded as COPECs.
- Bioaccumulative analytes that were detected at least once (regardless of the frequency of detection) were retained as COPECs if the SLV was not based on potential for bioaccumulation.
- Analytes without 2012 SLVs were retained as COPECs.

EPCs used in the Level II ERA were the maximum detected concentrations for receptors with limited or no mobility (plants, invertebrates) and the lower of the 95% UCL calculated using EPA's ProUCL software and the maximum detected concentration for birds and mammals (EPA 2011; URS-USACE 2012).

For the Level II ERA, EPCs for each combined media, receptor, and COPEC scenario were compared to media-specific 2012 SLVs protective of individual receptor groups to arrive at a toxicity ratio (URS-USACE 2012). In addition, potential cumulative effects for all COPECs in a given exposure media were estimated through a summation of the individual toxicity ratios.

COPECs in surface and shallow soils retained for further evaluation in the Level III BERA for the Landfill AOPC included metals, tributyl tin, organochlorine pesticides, HPAHs, SVOCs, and VOCs (URS-USACE 2016).

The Level III BERA was completed in 2016 and refined the risk evaluation for potential ecological receptors that may use the Landfill AOPC (URS-USACE 2016). Receptors and exposure pathways evaluated in the BERA for the Landfill AOPC included the following:

- Terrestrial plants – Root uptake from surface and shallow soils
- Soil invertebrates – Direct contact (ingestion and dermal contact) with surface and shallow soils
- Birds (Canada goose, American robin, American kestrel) – Incidental ingestion of surface and shallow soil, ingestion of forage or prey, and ingestion of surface water
- Upland mammals (vagrant shrew) – Incidental ingestion of surface and shallow soil, ingestion of prey, and ingestion of surface water
- Piscivorous mammals (American mink) – Incidental ingestion of surface soil, upland prey, and surface water

For ingestion of soils and food chain uptake into forage/prey, surface soils were defined as 0 to 1 foot bgs and shallow soils were defined as 0 to 3 feet bgs. For the water ingestion pathway, it was assumed that the American robin, Canada goose, and vagrant shrew ingested surface water from puddles in the Upland OU whereas the American kestrel and mink were assumed to ingest water from the Columbia River (River OU). The mink was included in the BERA assuming that a small portion of its diet could include upland mammals.

Exposure and toxicity assumptions utilized in the BERA were as follows:

- EPCs – Soil EPCs were the lower of the 95% UCL and maximum detected concentrations. Upland surface water data were not collected but were modeled using the surface soil EPC and soil-to-water equilibrium portioning equations. River water EPCs were the maximum detected concentrations.
- Bioaccumulation – Literature bioaccumulation factors and regression models were used to estimate uptake into forage and prey items.
- Dietary composition – It was assumed that each bird and mammal receptor consumed 100 percent of a single dietary item (plants, invertebrates, small mammals) with the exception of the mink, which was only assumed to consume 15 percent of an upland dietary item (small mammals).
- Toxicity values – Both low SLVs/NOAELs and high SLVs/LOAELs were utilized to provide a risk range. Uncertainty factors were applied to normalize endpoints where necessary.

The risk characterization included HQs computed for each receptor/COPEC group using both the low SLVs/NOAELs and high SLV/LOAELs, cumulative risk estimates or HIs for groups of chemicals with similar modes of toxicity, and an uncertainty evaluation. The following decision criteria were utilized:

- Estimated exposures with low SLV/NOAEL HQs below 1 were considered to not pose adverse effects to ecological receptors because of the inherent conservatism built into the exposure and effects assessments.
- Estimated exposures with high SLV/LOAEL HQs greater than 1 indicate that the exposure exceeds a known effect level for a test organism, and risk management may be warranted.
- Estimated exposures with low SLV/NOAEL HQs greater than 1 but high SLV/LOAEL HQs less than 1 were evaluated further as part of the uncertainty assessment to develop conclusions about the likelihood that a ~~potential risk~~risk or hazard was present.

COPECs that were determined to pose a ~~potential risk~~risk to ecological receptors at the conclusion of the BERA were identified as COECs and were recommended for further evaluation. The soil COECs for the Landfill AOPC were as follows:

- Chromium – American robin, vagrant shrew
- Copper – American robin, vagrant shrew
- Lead – American robin, vagrant shrew
- Mercury – Terrestrial plants, soil invertebrates, American robin, vagrant shrew
- Nickel – Terrestrial plants, American robin, vagrant shrew
- Chlordane – Terrestrial plants, American robin, vagrant shrew
- HPAHs – Terrestrial plants, soil invertebrates, vagrant shrew

3.2.2.2 Ecological Chemicals of Concern and Project Action Levels

Ecological PALs for the Landfill AOPC were identified for each COEC/receptor group using the high 2012 SLVs for plants and invertebrates, the LOAEL-based RBCs for birds (robin) and mammals (shrew) developed in the BERA (URS-USACE 2016), and the site-specific background value (95% UPL).

The 2012 SLVs and RBCs for the receptor groups showing ~~potential risk~~risk to each COEC, the site-specific background values, and the ecological PALs are presented in Table 3-3. The ecological PAL is the lowest SLV or RBC unless that value is below the background value in which case the background value is selected as the ecological PAL.

Table 3-3. Ecological Chemicals of Concerns and Proposed Project Action Levels – Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Plant High SLV (mg/kg)	Invertebrate High SLV (mg/kg)	American Robin LOAEL RBC (mg/kg)	Vagrant Shrew LOAEL RBC (mg/kg)	Site-specific Background 95% UPL[a] (mg/kg)	Proposed Ecological Soil PAL~~*~~[b] (mg/kg)	Exposure Depth (feet bgs)
Chromium	<bkg	<bkg	218	177	28.1	28.1~~177~~	0 to 3
Copper	--	--	114	78	56.7	78	0 to 3
Lead	--	--	54	149	25.5	54	0 to 3
Mercury	1.5	0.5	0.21	0.19	0.066	0.19	0 to 3
Nickel	190	--	140	<bkg	26.5	26.5	0 to 3
Chlordane	1.12	--	1.38	0.98	--	0.98	0 to 3
Total HPAHs	6	90	--	5.92	--	5.92	0 to 3

[a] Site-specific background concentrations were only used to establish screening level values for inorganic analytes in soil (URS-USACE 2012).

~~*~~[b] Proposed ecological PALs are only developed for the receptor groups that showed potential for adverse effects in the BERA (URS-USACE 2016). The ecological PAL is the lowest LOAEL RBC or high SLV unless it is less than background.~~,~~ ~~i~~In which case, the site-specific background 95% UPL is shown.

Notes:

All values are shown in mg/kg.

-- = analyte was not identified as a COEC for this receptor or SLV/RBC not available
<bkg = below background

3.3 Removal Action Scope and Objectives

An NTCRA is being undertaken at the Landfill AOPC to address current and imminent site risks due to direct mass wasting, surface soil erosion, and COECs in soil and sources of contamination (i.e., waste debris) (40 CFR 300.415).

Although not an NTCRA objective, the NTCRA is anticipated to also reduce site risks to future hypothetical fishing platform users.

RAOs, PALs, and estimated quantities of contaminated media are presented in the following subsections.

3.3.1 Removal Action Objectives

RAOs are specific goals for addressing risks and hazards associated with site-related contamination. RAOs can be accomplished by ensuring exposure pathways are not completed or by reducing concentrations of COECs at exposure points to below protective concentrations. RAOs define the extent to which sites require cleanup to meet the protectiveness objectives.

The RAOs developed for the Landfill AOPC are as follows:

- RAO LF1 – Reduce mass wasting: Reduce sources of contamination and contaminated soil from further contributing contaminants into Columbia River sediments due to mass wasting along the northern and eastern boundaries of the Landfill AOPC.
- RAO LF2 – Prevent unacceptable exposure to sources of contamination and contaminated soil: Prevent ingestion and dermal contact by ecological receptors of COECs in excess of the risk-based

PALs (Table 3-4) within sources of contamination and contaminated soil and reduce potential leaching of contaminants into the Columbia River that may negatively affect aquatic biota.

3.3.2 Project Action Levels

To achieve the RAOs listed above, the risk-based PALs for the Landfill AOPC are established in Table 3-4. These PALs are considered in evaluating the overall effectiveness of removal process options and alternatives and are considered protective of the environment for the COECs identified at the Landfill AOPC.

Table 3-4. Landfill AOPC Project Action Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Soil PAL (mg/kg)
Total HPAHs	5.92[a]
Chromium	~~177[a]~~28.1[b]
Copper	78[a]
Lead	54[a]
Mercury	0.19[a]
Nickel	26.5[~~a,~~b]
Chlordane	0.98[a]

[a] Based on unacceptable health risks to ecological receptors (e.g., plants, invertebrates, American robin, and vagrant shrew).
[b] Based on the site-specific background concentration level as defined by the 95% UPL.

Note:

Soil PALs are based on the proposed PALs in Table 3-3 only. The human health COCs presented in Section 3.2.1.2 do not present a current and imminent site risk warranting an NTCRA and therefore are not included in Table 3-4.~~.~~

3.3.3 Media and Areas Requiring Removal Action

A conceptual understanding of the media types, location, and quantities of debris and contamination is necessary to effectively develop a removal strategy for the Landfill AOPC. Based on the findings in Sections 3.1.4, 3.2, and 3.3.2, waste debris and metals, PAH, and chlordane soil contamination exceeding the PALs has been identified within the known extents of landfill debris and one small area on the northeastern slope of the Landfill AOPC. Figure 3-1 shows the location of known waste debris, sample exceedances, and proposed removal extents (corresponding to estimated quantities) at the Landfill AOPC (URS-USACE 2004a, 2012, 2016). If additional areas are identified during the removal action to contain waste debris and/or COECs in soil exceeding the PALs, then the waste debris and/or soil from the additional areas will also be removed during the NTCRA if practical.

3.3.4 Quantity of Contaminated Media

The estimated quantity of waste debris and contaminated soil exceeding PALs and considered during removal action alternative development and cost estimating is summarized in Table 3-5. These quantities were conservatively estimated based on the most current data inputs and assumptions available during development of this EE/CA. As additional data become available, these estimates may be further refined. The following data inputs and assumptions were used during quantity calculations:

- Data inputs:
  - The project RAOs and PALs
  - Human health and ecological exposure scenarios and depths

   - Relevant historical analytical and geophysical data from the *Bradford Island Landfill Site Inspection Report*, *Bradford Island Landfill Site Characterization Report,* the RI Report, BHHRA/BERA, and associated previous reports (Tetra Tech, Inc.–USACE 1998; URS-USACE 2004a, 2012, 2016)
   - An estimated volume of waste debris (3,758 cy) presented in Section 6.1.3 and 10.1 of the *Bradford Island Landfill Site Characterization Report* (URS-USACE 2004a)
   - Data graphically presented on figures using ArcGIS software; areas and volumes calculated using ArcGIS tools
   - Site photographs and aerial imagery from the RI Report, *Bradford Island Landfill Supplemental Site Inspection Report*, a project site visit on 8 November 2023, and other available sources (URS-USACE 2012, 2022b)
   - Landowner tolerance for future environmental liabilities and remedial or removal actions
- Assumptions:
   - The removal action will address the lateral extent of waste debris and contaminated soil exceeding the PALs (source area) down to an estimated maximum depth of 15 feet bgs based on the previously presented RAOs, rationale, and data inputs.
   - The removal area was estimated based on the extent of known waste debris and soil contamination exceeding the PALs (source areas), as shown on Figure 3-1.
   - If additional areas are identified during the removal action to contain waste debris and/or COECs in soil exceeding the PALs, then the waste debris and/or soil from the additional areas will also be removed during the NTCRA if practical.
   - The NTCRA is not the CERCLA final remedy, and if determined necessary, additional remedial actions~~,~~ would be addressed in the CERCLA final remedy.
   - Potential specific conflicts with onsite anthropogenic features, including utilities, will be mitigated during subsequent remedy planning and implementation.
   - The excavated soil is assumed to have a swell factor of 1.25 (25 percent increase). This factor was used to convert in situ bank volumes to ex situ loose volumes during loading and transportation.
   - The contaminated soil is assumed to be predominantly moist silty sand and gravel (SM/GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons per bank cubic yard [BCY]) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001). This in situ bulk density was used to convert volume estimates to mass (weight) estimates.
   - The waste debris is assumed to be equally composed of electrical equipment; sandblast grit; metal drums, buckets, and cans; general C&D wastes; asbestos-containing materials; burned debris; and compacted industrial municipal waste with an estimated in situ (bank) bulk density of 31 pounds per cubic foot (0.42 tons/BCY) This in situ bulk density was used to convert volume estimates to mass (weight) estimates (EPA 2016).
   - Other site media, such as groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

Table 3-5. Estimated Removal Area Quantities for the Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Item Description	Removal Area Quantity[a]
Lateral Extent of Source	
Area L1 – Landfill Debris Area	31,480 square feet[b] (0.723 acres)

Table 3-5. Estimated Removal Area Quantities for the Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Area L2 – Landfill Northeastern Slope Hotspot	594 square feet[b] (0.014 acres)
Total area	32,074 square feet[b] (0.736 acres)
Vertical Extent of Source	
Area L1 – Landfill Debris Area	15 feet bgs
Area L2 – Landfill Northeastern Slope Hotspot	3 feet bgs
Volume	
Area L1 – Landfill Debris Area	17,489 BCY
Area L2 – Landfill Northeastern Slope Hotspot	66 BCY
Estimated total bank volume (in situ waste debris and soil)	17,555 BCY
Estimated bank volume (in situ waste debris)	3,758 BCY[c]
Estimated bank volume (in situ soil)	13,797 BCY
Soil swell factor	1.25 (25%)
Estimated total loose soil volume (ex situ soil)	17,246 LCY
Mass (soil)	
Estimated bulk soil density	1.49 tons/BCY[d]
Area L1 – Landfill Debris Area	20,459 tons[e]
Area L2 – Landfill Northeastern Slope Hotspot	98 tons
Estimated soil mass	20,557 tons
Mass (waste debris)	
Estimated bulk waste density	0.42 tons/BCY[f]
Area L1 – Landfill Debris Area	1,578 tons
Estimated waste debris mass	1,578 tons

[a] Estimated extent or quantity of waste debris and soil contamination exceeding PALs as shown on Figure 3-1.

[b] For estimating purposes, assumes a source area based on the extents of waste debris and/or soil contamination determined by geophysical survey, visual inspection, and/or analytical sample data.

[c] An estimated volume of waste debris (3,758 cy) determined by geophysical survey as documented in the *Bradford Island Landfill Site Characterization Report* (URS-USACE 2004a).

[d] Assumed value based on a predominantly moist silty sand (GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001).

[e] Assumes that the entire volume of in situ waste debris is contained within Area L1. This value was calculated by subtracting the volume of in situ waste debris (3,758 BCY) from the total volume of Area L1 (17,489 BCY) and then multiplying the remaining soil volume for Area L1 (13,731 BCY) by the estimated bulk soil density (1.49 tons/BCY).

[f] Assumed value based on mixed industrial and C&D waste with an estimated bulk density of 31 pounds per bulk cubic yard (0.42 tons/BCY) (EPA 2016).

Notes:

LCY = loose cubic yard(s)
ton(s) = U.S. short ton or 2,000 pounds (907.18 kilograms)

3.3.5 Removal Action Schedule

NTCRA field activities are planned to begin during ~~summer 2026~~2025 and are expected to be completed within approximately 12 months. The required duration to perform removal action activities at the Landfill AOPC is estimated to be 12 to 16 weeks. Additional schedule details will be provided in a future NTCRA work plan.

3.4 Presumptive Remedy Considerations

Federal facilities, like the Bradford Island NPL Site, are encouraged to accelerate and develop streamlined approaches to the cleanup of contaminated sites, including through the use of NTCRAs and presumptive remedies (EPA 1994). Per EPA guidance, presumptive remedies are being considered in this EE/CA to focus the removal action development and screening process and target alternatives known to be effective, feasible, and cost-efficient (EPA 1993b, 1997). Presumptive remedies are preferred technologies for common categories of sites that EPA believes will generally be the most appropriate remedy for a specified type of contaminated site (EPA 1993b, 1993c, 1997). Presumptive remedies are based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of presumptive remedies is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions (EPA 1993b). Over time, presumptive remedies are expected to ensure consistency in alternative selection and reduce the cost and time required to clean up similar types of sites. Use of the presumptive remedy eliminates the need for the initial identification and screening of alternatives, including eliminating the technology screening step from the EE/CA process (EPA 1993b, 1993c, 1994). Presumptive remedies are expected to be used at all appropriate CERCLA sites except under unusual circumstances such as uncommon soil characteristics, mixtures of contaminants not treated by the remedy, demonstration of significant advantages of alternate (or innovative) technologies over the presumptive remedies, or extraordinary community and state concerns. A presumptive remedy is considered only if it is effective in addressing all source area COCs and COECs solely or in combination with another remedy. This approach assumes that the presumptive remedy does not exacerbate other source area concerns or impede the effectiveness of associated cooperative remedies.

Based on CSM similarities, the Landfill AOPC was compared to EPA's evaluation of CERCLA municipal landfill sites in the following EPA guidance: *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA 1993c). CERCLA municipal landfill sites predominantly contain household, commercial, and C&D refuse and debris, as well as asbestos-containing materials, batteries, industrial solid wastes, paints and paint thinners, pesticides, electrical wastes (including transformer oil), and other solvents (EPA 1993b, 1993c).

EPA guidance has prescribed "source containment" as the presumptive remedy for CERCLA landfill sites similar to the Landfill AOPC (EPA 1993c). Generally, EPA expects that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat or where treatment is impracticable. In most instances, treatment is considered impractical at landfill sites because of the size and heterogeneity of the contents (55 FR 8704) (EPA 1993c). Therefore, EPA generally considers containment to be the appropriate response action (presumptive remedy) for the source areas of municipal landfill sites.

EPA conducted an analysis of potentially available technologies for municipal landfills and found that certain technologies are routinely and appropriately screened out on the basis of effectiveness, feasibility, or cost (EPA 1993c). Based on this analysis, the universe of technologies that could be analyzed in detail are limited to the components of the source containment remedy, unless site-specific conditions dictate otherwise. The source containment presumptive remedy includes the following components: (1) landfill cap, (2) source area groundwater control to contain a plume(s), (3) leachate collection and treatment, (4) landfill gas collection and treatment, and/or (5) institutional controls (ICs) to supplement engineering controls (e.g., LUCs) (EPA 1993c).

To accelerate and streamline the cleanup~~ of the Landfill AOPC~~, this EE/CA incorporates the source containment presumptive remedy for the Landfill AOPC, thereby eliminating the need for further identification and screening of alternatives for the NTCRA beyond what is presented in the following removal alternative descriptions in Section 3.5 (EPA 1993c, 1994).

3.5 Removal Action Alternatives

3.5.1 Alternative Descriptions

A range of removal action alternatives has been identified to achieve the RAOs and corresponding PALs. The No Action Alternative was included for comparative purposes per the NCP.

3.5.1.1 Alternative L0 – No Action

The no action alternative provides a baseline against which to compare the performance and effectiveness of the other alternatives (EPA 2018). With Alternative L0, no action would be conducted in the near-term to address buried landfill waste debris and impacted soil at the Landfill AOPC, and no controls would be implemented in the short-term to control or monitor potential receptor exposures to site COECs. The landfill waste debris and all associated contaminated soil would remain in place, contamination will continue to migrate into the Columbia River, and ecological receptors will continue to be exposed to contamination until a long-term remedy is implemented for the AOPC. No NTCRA would be implemented to remove the source or prevent unacceptable exposures to current and potential future human and ecological receptors onsite. It is assumed that the current level of maintenance would be sustained. Alternative L0 will not achieve the RAOs (Section 3.3.1). This alternative has no ($0) capital, ~~operations and maintenance (~~O&M~~)~~, or periodic costs.

3.5.1.2 Alternative L1 – ~~Complete~~ Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration

Alternative L1 primarily consists of (1) ~~complete~~ excavation and removal of sources of contamination and contaminated soil exceeding the PALs down to the maximum depth of waste debris, bedrock, or groundwater, whichever is least; (2) transporting and disposing of removed sources of contamination and contaminated soil at a permitted, offsite RCRA Subtitle C and/or D landfill(s); (3) reducing and stabilizing the slope along the northern and eastern boundaries of the Landfill AOPC; (4) installing a riprap revetment along the river shoreline; and (5) general site restoration.

Alternative L1 would achieve all RAOs following completion of the removal action, which is expected within a duration of 12 to 16 weeks once work commences at the AOPC. The need for LUCs or O&M is not currently anticipated to control exposure to contaminants in soil ~~No LUCs or O&M would be required to control exposure to contaminants in soil~~ for this alternative because the waste debris and impacted soil would be removed from the site. If necessary, additional remedial actions, including LUCs and O&M, will be addressed in the CERCLA final remedy. Figure 3-1 and Appendix B, Sheet 2 show the proposed areas of sources of contamination and contaminated soil removal.

Alternative L1 involves first clearing and grubbing the surface of the Landfill AOPC and then excavating Area L1 (Appendix B, Sheets 2 through 5 and Table 3-5) down to the vertical extent of landfill source material (waste debris) and contaminated soil in excess of the PALs. The maximum depth of waste debris is estimated to not exceed 15 feet bgs.

No contaminated source materials, only ~~total cPAHs,~~ total HPAHs, lead, and mercury soil concentrations exceeding the PALs, are known to occur within Area L2 (Figure 3-1). Therefore, contaminated soil exceeding the PALs will be excavated and removed down to the vertical extent of contamination or a maximum depth of potential exposure of 10 feet bgs is achieved, whichever is less (Appendix B, Sheets 2 through 5 and Table 3-5).

Additionally, if bedrock or groundwater is encountered during excavation of either area, then the vertical extent of removal will be terminated. Removal will occur during seasonal low groundwater to achieve the greatest excavation depth without requiring additional excavation stabilization and continuous dewatering, treatment, and discharge.

Clearing, grubbing, and excavation will be performed using traditional excavation and earthwork equipment. The removal action at the Landfill AOPC will require extensive use of the existing access road at the north side of Bradford Island, which crosses the Bulb Slope AOPC. The width of the access road is at its narrowest along the Bulb Slope and is in poor condition. The slope on the south side of the access road in this area is very steep and is marginally stable based on visual inspection, while the slope to the north is also very steep. Equipment driving along the access road while hauling materials in and out from the Landfill AOPC during the NTCRA will likely further damage the access road, creating ruts and degradation especially during rain events. As such, the access road will be refurbished and upgraded to withstand frequent use by heavy equipment as part of the Landfill AOPC removal action.~~As such, the asphalt access road will be replaced as part of the Landfill AOPC removal action.~~

The lateral and vertical extents of removal will be continuously assessed during excavation using a combination of visual inspection, geophysical instrumentation (e.g., portable magnetometer), and soil field screening. Field screening for PAHs, metals, and chlordane may include employing portable flame ionization detectors (FIDs), enzyme immunoassay (EIA) soil test kits, handheld X-ray fluorescence (XRF) analyzers, and/or an onsite gas chromatograph. Once the extents of removal are thought to have been achieved, confirmation samples will be collected from the floor and walls of the open excavations and analyzed for site COECs (PAHs, metals, and chlordane) to confirm that all contaminated soil above PALs was removed. Confirmation sample results will be assessed on a point-by-point basis, and excavation will continue at any removal location that exceeds the PALs until follow-on confirmation samples can confirm that the extent of contamination exceeding the PALs has been successfully removed. The exception being where a maximum depth of potential exposure of 10 feet bgs or refusal at bedrock or groundwater is achieved, whichever is least.

During excavation, contaminated source material, contaminated soil, and clean soil will be actively segregated based on field screening for offsite disposal or use as clean backfill (URS-USACE 2022c). Clean soil will be stacked into open stockpiles and ~~soil sampled~~tested to confirm acceptability for onsite reuse as backfill. Removed contaminated soil and wooden debris will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or Chemical Waste Management of the Northwest (CWM Arlington) Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). During excavation and loading, contaminated source materials and contaminated soil are to be managed separately and not commingled onsite or prior to delivery at an offsite landfill.

Waste characterization samples will be collected from the excavated contaminated soil to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for TCLP metals and site COECs, including PAHs, metals, and chlordane. For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste soil disposal is subject to RCRA Land Disposal Restrictions (LDRs) (40 CFR 268). In this case, the contaminated soil would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit.

Following excavation and once confirmation sampling establishes that RAOs have been achieved, excavated areas would be backfilled, and any disturbed areas would be restored to their pre-removal action conditions (Appendix B, Sheets 2, 4, and 5). Backfilling, slope reduction, and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Clean backfill should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c).

During backfilling, excavated shoreline slope areas will be reduced in grade to improve shoreline slope stability and prevent future mass wasting (Appendix B, Sheets 3 through 5). These areas will be excavated and graded to slopes of less than 2.5H:1V with the toes of each new slope beginning at the nearest extent of excavation to the river as shown in Appendix B, Sheets 4 and 5 (grades of 5.3H:1V and 12.3H:1V, respectively) (URS-USACE 2022c). The final backfilled grade will be contoured to the surrounding landscape. The volume of required clean backfill is estimated to be approximately 2,365 BCY (2,957 LCY; 3,524 tons), which may be obtained from clean soil adjacent to the site or imported from offsite. Potential adjacent areas of clean backfill are located northeast, east, and south of the Landfill AOPC. Slope reduction of the Landfill AOPC may require some rerouting and/or reconstruction of the Landfill access road (Figure 3-1 and Appendix B, Sheet 2).

Any disturbed shoreline slopes will be stabilized and armored with a riprap revetment up to or beyond the maximum Forebay elevation of 85.9 feet NAVD88 (approximately 8 feet above the average river elevation upstream of the dam) (USACE 2024b; NOAA 2023). All remaining disturbed areas, including excavation, staging, and loading areas, would be restored by covering with 4 to 6 inches of topsoil, revegetating with suitable native, perennial scrub-shrub and herbaceous species, and stabilized in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Following reseeding, a stabilizing jute net would be loosely placed over the restored areas in the direction of flow and secured with ground staples and check slots. Larger native vegetation species may also be planted to aid in surface stabilization. Construction monitoring and a post-construction survey would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~ applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into the Columbia River (URS-USACE 2022c). All stockpiled soil will be contained on an impermeable ground liner and protected from adverse weather by a secured rain sheet. Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once removal activities are complete, the interim site controls would be discontinued.

Alternative L1 has capital costs but no anticipated O&M or periodic costs.

3.5.1.3 Alternative L2 – Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, Institutional Controls, and Long-term Operation and Maintenance

Alternative L2 was developed based on EPA's presumptive remedy for CERCLA landfill sites to provide containment of the sources of contamination and contaminated soil exceeding the PALs within the Landfill AOPC. Per Sections 3.1.6 and 3.2, the primary potential complete exposure pathway at the Landfill AOPC is direct exposure (ingestion, dermal contact, inhalation of dusts and vapors, and root uptake) to sources of contamination and contaminated soil by human and ecological receptors. Alternative L2 prevents direct contact by physically and administratively restricting human and ecological receptors from accessing the contamination source. Additionally, potential mass wasting into the Columbia River is also addressed.

Alternative L2 primarily consists of (1) limited reduction and stabilization of the slopes along the northern and eastern boundaries of the Landfill AOPC; (2) installing an engineered soil cover over the entire source area; (3) installing a riprap revetment along the river shoreline; (4) general site restoration; (5) establishing ICs that restrict specific land uses and activities that could damage the soil cover and/or cause receptor exposure; and (6) implementing long-term O&M to maintain the integrity and protectiveness of the remedy.

Alternative L2 would achieve all RAOs following completion of removal action activities and the establishment of ICs. Removal action activities are expected to be complete within a duration of 12 to 16 weeks once work commences at the AOPC, but establishment of ICs is anticipated to take approximately 6 to 9 months. ICs and O&M would be required for the life of the remedy (greater than 30 years) to continue to control exposure to the covered contaminant source. Figure 3-2 shows the proposed areas of contaminated source and soil containment and application of ICs.

Alternative L2 involves first clearing and grubbing the surface of the Landfill AOPC and then excavating and contouring Area L1, Area L2, and adjacent areas to minimally reduce the overall slope of the site and northern and eastern shorelines. Clearing, grubbing, and excavation will be performed using traditional earthwork equipment. A pre-construction survey and assessment of the Landfill access road would be completed prior to commencing onsite work.

Areas of limited slope reduction for Alternative L2 will be decreased in grade to improve shoreline slope stability and prevent future mass wasting, although slope reduction will be significantly less than Alternative L1. These areas will be graded to slopes of approximately 2.5H:1V (steeper than Alternative L1) with the toes of each new slope beginning at the nearest extent of excavation to the river (URS-USACE 2022c). The final backfilled grade will be contoured to the surrounding landscape. The removal action at the Landfill AOPC will require extensive use of the existing access road at the north side of Bradford Island, which crosses the Bulb Slope AOPC. The width of the access road is at its narrowest along the Bulb Slope and is in poor condition. The slope on the south side of the access road in this area is very steep and is marginally stable based on visual inspection, while the slope to the north is also very steep. Equipment driving along the access road while hauling materials in and out from the Landfill AOPC during the NTCRA will likely further damage the access road, creating ruts and degradation especially during rain events. As such, the asphalt access road will be replaced as part of the Landfill AOPC removal action.

It is anticipated that the upper portions (approximately 2,160 BCY) of the contaminated source materials and intermingled contaminated soil will be encountered and removed during slope reduction activities. An estimated 364 tons of source material, 1,188 BCY of contaminated soil, and 972 BCY of clean soil will be excavated as part of the limited slope reduction.

Unearthed materials will be continuously assessed during excavation using a combination of visual inspection, geophysical instrumentation (e.g., portable magnetometer), and soil field screening. Field screening for PAHs, metals, and chlordane may include employing portable FIDs, EIA soil test kits, and/or handheld XRF analyzers. Once the excavation extents have been achieved, confirmation samples will be collected from the floor and walls of the open excavations and analyzed for site COECs (PAHs, metals, and chlordane) to document the soil concentrations immediately beneath the newly installed engineered soil cover.

During excavation, contaminated source materials, contaminated soil, and clean soil will be actively segregated based on field screening for offsite disposal or use as clean backfill (URS-USACE 2022c). Clean soil will be stacked into open stockpiles and ~~soil sampled~~tested to confirm acceptability for onsite reuse as backfill. Removed contaminated source material and soil will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or CWM Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). During excavation and loading, contaminated source materials and contaminated soil are to be managed separately and not commingled onsite or prior to delivery at an offsite landfill.

Waste characterization samples will be collected from the excavated contaminated soil to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for TCLP metals and site COECs, including PAHs, metals, and chlordane. For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste soil disposal is subject to RCRA LDRs (40 CFR 268). In this case, the contaminated soil would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit.

Once the slope reduction is complete, an engineered soil cover with a minimum total thickness of 3 feet will be constructed over Areas L1 and L2 to physically eliminate direct human and ecological exposure, reduce precipitation from percolating into the underlying landfill source, and prevent erosion of contaminated soil (Figure 3-2). The total soil cover thickness is based on the anticipated exposure depths for outdoor maintenance workers, hypothetical future fishing platform users, and ecological receptors (Sections 3.1.6 and 3.2). The engineered soil cover will consist of a minimum of 2.5 feet of clean soil beneath a minimum of 0.5 foot of topsoil to allow for revegetation. All clean soil excavated and stockpiled during the slope reduction (972 BCY) will be used to construct the soil cover. An estimated total of 3,287 BCY (4,109 LCY) of clean soil and 657 BCY (822 LCY) of topsoil will need to be obtained from areas adjacent to the site or imported from offsite. Backfilling and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). If needed, clean backfill should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c).

After final grading, the engineered soil cover will be revegetated with suitable native, perennial grass and herbaceous species to minimize erosion. Following reseeding, a stabilizing jute net would be loosely placed over the restored areas in the direction of flow and secured with ground staples and check slots. Larger native vegetation species may also be planted to aid in surface stabilization.

Any disturbed shoreline slopes will be stabilized and armored with a riprap revetment up to or beyond the maximum Forebay elevation of 85.9 feet NAVD88 (approximately 8 feet above the average river elevation upstream of the dam) (USACE 2024b; NOAA 2023). All remaining disturbed areas, including excavation, staging, and loading areas, would be restored by covering with 4 to 6 inches of topsoil; revegetating with suitable native, perennial scrub-shrub and herbaceous species; and stabilized in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Construction monitoring and a post-construction survey would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into the Columbia River (URS-USACE 2022c). All stockpiled soil will be contained on an impermeable ground liner and protected from adverse weather by a secured rain sheet. Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once earthwork activities are complete, the interim site controls would be discontinued.

Lastly, administrative ICs, including signage, environmental deed restrictions or covenants, and access restrictions and control features, will be established at the Landfill AOPC to accomplish the following:

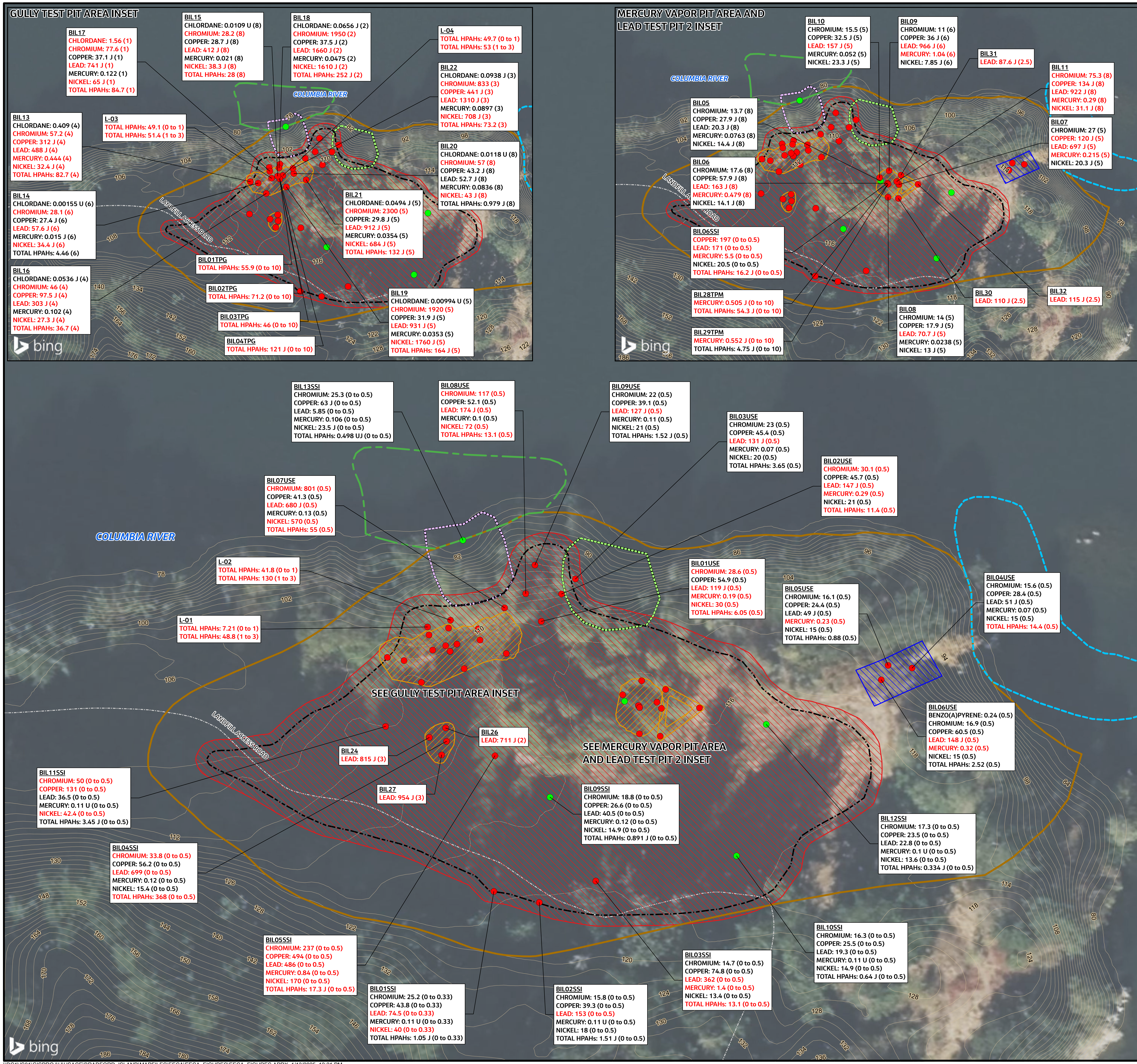
- Control potential exposure to the buried contaminated source materials and contaminated soil by current and future construction/excavation workers and other potential receptors.

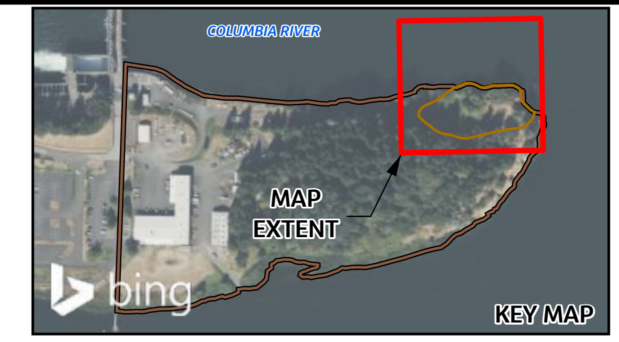
- Restrict future site construction and excavation.
- Ensure land usage is compatible with agreed upon acceptable land uses, controls, and remedial design assumptions.
- Limit any unauthorized activities that would compromise the soil cover (e.g., excavation, drilling, or vehicular traffic).
- Warn of potential site hazards from buried media.
- Prevent impacted media from being transported offsite.
- Educate site workers and the public about access restrictions and potential site dangers.

Warning signage and perimeter barriers such as gates or bollards will be installed at possible site access locations (e.g., landfill access road) restricting motors vehicles onto the soil cover but still allowing foot traffic. Limited low impact vehicles may be allowed onsite for maintenance and inspections as necessary.

Additionally, an O&M program will be implemented to focus on verifying the continued protectiveness of the remedy and ensuring assumptions made during remedy selection remain valid. O&M will consist of semiannual site inspections of the engineered soil cover and signage, necessary maintenance of the soil cover, IC maintenance (such as sign maintenance and administrative reviews), and routine monitoring of site access and conditions.

Alternative L2 has capital costs, O&M, and periodic costs. ~~Five-year reviews will be required for the life of the remedy.~~





LEGEND

- SOIL CONCENTRATION DOES NOT EXCEED PAL
- SOIL CONCENTRATION EXCEEDS PAL

BIL32 — LOCATION NAME
LEAD: 115 J (2.5) — SAMPLE DEPTH (feet BGS) — DATA FLAG — RESULT (mg/kg) — ANALYTE

- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- LANDFILL AOPC (59094 SQUARE FEET)
- EXTENT OF LANDFILL DEBRIS (APPROXIMATE)
- WEST LANDSLIDE SCARP AREA (APPROXIMATE)
- EAST LANDSLIDE SCARP AREA (APPROXIMATE)
- HISTORICAL TEST PIT AREA
- SOURCE AREA – AREA L1 (31480 SQUARE FEET)
- SOURCE AREA – AREA L2 (594 SQUARE FEET)
- FORMER DEBRIS PILE #1
- FORMER DEBRIS PILE #2

COEC	SOIL PAL[a] (mg/kg)
TOTAL HPAHs	5.92
CHROMIUM	177
COPPER	78
LEAD	54
MERCURY	0.19
NICKEL	26.5
CHLORDANE	0.98

[a] BASED ON UNACCEPTABLE RISK TO PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND/OR VAGRANT SHREW.

NOTES:

RED TEXT INDICATES ANALYTE RESULT EXCEEDS THE PAL

AOPC = AREA OF POTENTIAL CONCERN

BGS = BELOW GROUND SURFACE

COEC = CHEMICAL OF ECOLOGICAL CONCERN

HPAH = HIGH-MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBON

J = THE REPORTED VALUE IS AN ESTIMATE

mg/kg = MILLIGRAMS PER KILOGRAM

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

PAL = PROJECT ACTION LEVEL

U = THE ANALYTE WAS NOT DETECTED AT OR ABOVE THE MDL

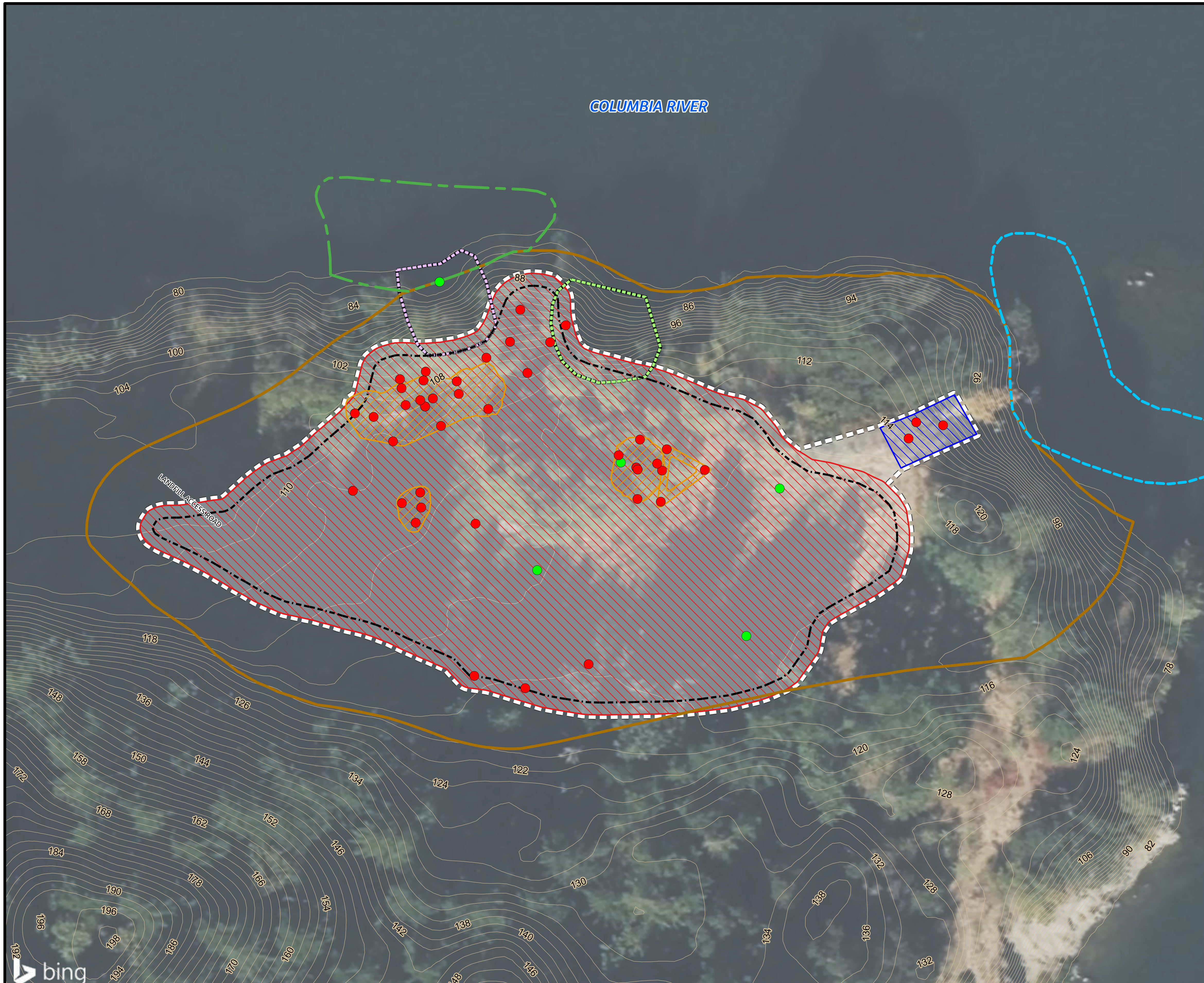
UJ = THE ANALYTE WAS NOT DETECTED, THE REPORTED MDL/MRL IS AN ESTIMATE

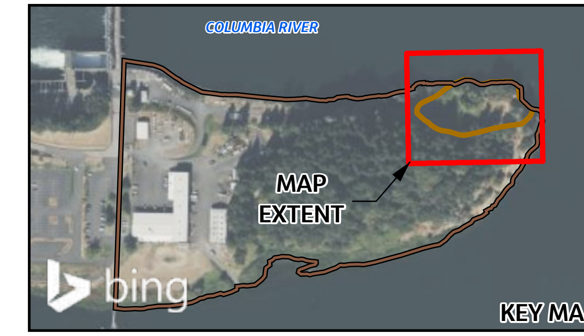
0 30 60 Feet

N

FIGURE 3-1
LANDFILL AOPC
ALTERNATIVE L1

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON





LEGEND

- SOIL SAMPLE DOES NOT EXCEED PAL
- SOIL SAMPLE EXCEEDS PAL
- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- LANDFILL AOPC (59094 SQUARE FEET)
- EXTENT OF LANDFILL DEBRIS (APPROXIMATE)
- WEST LANDSLIDE SCARP AREA (APPROXIMATE)
- EAST LANDSLIDE SCARP AREA (APPROXIMATE)
- HISTORICAL TEST PIT AREA
- SOURCE AREA – AREA L1 (31480 SQUARE FEET)
- SOURCE AREA – AREA L2 (594 SQUARE FEET)
- FORMER DEBRIS PILE #1
- FORMER DEBRIS PILE #2
- SOIL COVER AREA

COEC	SOIL PAL[a] (mg/kg)
TOTAL HPAHs	5.92
CHROMIUM	177
COPPER	78
LEAD	54
MERCURY	0.19
NICKEL	26.5
CHLORDANE	0.98

[a] BASED ON UNACCEPTABLE RISK TO PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND/OR VAGRANT SHREW.

NOTES:

AOPC = AREA OF POTENTIAL CONCERN
BGS = BELOW GROUND SURFACE
COEC = CHEMICAL OF ECOLOGICAL CONCERN
HPAH = HIGH-MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBON
J = THE REPORTED VALUE IS AN ESTIMATE
mg/kg = MILLIGRAMS PER KILOGRAM
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
PAL = PROJECT ACTION LEVEL
U = THE ANALYTE WAS NOT DETECTED AT OR ABOVE THE MDL
UJ = THE ANALYTE WAS NOT DETECTED, THE REPORTED MDL/MRL IS AN ESTIMATE

0 40 80 Feet

N

FIGURE 3-2
LANDFILL AOPC
ALTERNATIVE L2

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

SECTION 4

Bulb Slope AOPC

4.1 Conceptual Site Model

As initially introduced in Section 3.1, the purpose of the CSM is to provide a fundamental understanding of the environmental setting based on information gathered from both historical and recent investigations. The CSM for the Bulb Slope AOPC is summarized in the following sections.

4.1.1 Site History

The Bulb Slope AOPC was first identified in 2002 during the remedial activities for the removal of three former piles of electrical debris located in the Columbia River offshore of the north and east sides of the Upland OU (URS-USACE 2002a, 2022d). The Bulb Slope AOPC is located on the northern shoreline slope of the Upland OU, upland of former Debris Pile #3 (Figure 4-1). The Bulb Slope AOPC was identified to contain a large quantity of broken glass and electrical light bulb sockets (crushed light bulbs) among other similar debris types. The waste debris is concentrated in the center of the slope and is variably intermixed with silt, sand, gravel, cobbles, and concrete rubble. Concrete rubble and a small amount of glass debris have been observed within the Columbia River, proximate to the riverbank at the base of the bulb slope. Like the Landfill AOPC, it is probable that the disposal of waste electrical debris occurred between approximately 1942 and 1982.

4.1.2 Physical Setting

The Bulb Slope AOPC is a fan-shaped accumulation of glass and electrical debris located on the north shoreline of the Upland OU that extends across an approximately 32 foot tall by 80 foot wide slope between the Columbia River and the access road that leads to the Landfill AOPC (Figure 4-1) (URS-USACE 2012). The AOPC slopes steeply from the Landfill access road (98 to 103 feet NAVD88 [converted]) down to the Columbia River (74 to 80 feet NAVD88 [converted]) on the north side of the Upland OU (Wooley 1998; NOAA 2023). One slight break in the slope was observed uphill of several small trees approximately midway between the Landfill access road and the river level. The slope angle is near vertical at the base of the slope for a height of approximately 4 feet above the river level. Based on this information, the base of the AOPC is partially submerged during some periods of high water in the river. Access to the Bulb Slope AOPC is provided by the same unimproved access road that parallels the northern shoreline of the island to the Landfill AOPC and is located approximately 115 feet east of the access road gate (Figure 2-3).

The Bulb Slope AOPC is well vegetated with small trees, shrubs, grasses, and mosses, covered with plant detritus, and exhibits no evidence of overland flow, surface erosion, or groundwater seeping into the river.

The subsurface consists of a mixture of alluvium composed of silty sands and gravels, placed concrete rubble and rock boulders, and natural rock outcrops, all of which is underlain by siltstone bedrock encountered at a depth between 0 and 5 feet bgs (URS-USACE 2012, 2022d). Surface soil generally consists of dark brown, organic clayey silts with sand and gravel. Brown-gray silty gravels and concrete rubble and cobbles are encountered beneath the glass and electrical debris within the center of the disposal area at a depth of 1 to 1.5 feet bgs. Historically, rubble and cobbles are generally encountered directly beneath areas of high concentrations of waste debris. Along the riverbank near the base of the slope, concrete rubble and rock boulders were deposited approximately 3 to 5 feet thick.

Groundwater beneath the Upland OU is generally within the alluvium and is indicated to be largely perched above the less-permeable Eagle Creek Formation slide block. No groundwater monitoring wells have been installed at the Bulb Slope AOPC; however, nearby monitoring wells MW-1 and MW-15 suggest a groundwater elevation range between approximately 73 to 98 feet msl NGVD29 (76.3 to 101.3 feet

NAVD88 [converted]) (URS-USACE 2012; NOAA 2023). Groundwater is estimated to be encountered within the alluvium at depths between approximately 7 and 29 feet bgs beneath the Bulb Slope AOPC. Groundwater flows to the north under both wet season and dry season conditions. Horizontal hydraulic gradients and conductivities are anticipated to be similar to those encountered at the Landfill AOPC.

At the base of the slope, wave erosion has resulted in mass wasting of soil with some debris into the river (URS-USACE 2012). One area of greater shoreline erosion has caused an acute slope that has the potential to compromise the stability of the Landfill access road.

4.1.3 Source of Contamination and Affected Media

Past investigations have identified historical waste disposal practices to be the primary source of contamination at the Bulb Slope AOPC (URS-USACE 2012; USACE 2022e). Waste types confirmed to have been disposed of at the AOPC include the following:

- Electrical equipment and debris (fluorescent, automotive, and indoor/outdoor light bulbs)
- Glass debris (glass tubes, clear windowpane glass, white molded glass [possibly lamppost light covers], and glass beverage containers)
- Concrete rubble and cobbles

The Bulb Slope AOPC encompasses an area of approximately 2,350 square feet (0.054 acre) (Figure 4-1). The waste debris is concentrated in the center of the slope, and the waste deposit ranges in thickness from about 4 inches near the top of the slope to 5 feet at the base of the slope. Based on historical ground surface observation and boring log data, the volume of the waste deposit, including surrounding soil, is estimated to be between 185 and 445 cy, with a maximum depth of 5 feet bgs (Tetra Tech, Inc.–USACE 1998; URS-USACE 2004a, 2022d). Historical disposal of waste materials at the Bulb Slope AOPC has resulted in contamination of soil with chemicals associated with the wastes.

4.1.4 Nature and Extent of CERCLA Contaminants

Placement of waste debris at the Bulb Slope AOPC has resulted in the contamination of soil with low concentrations of lead, mercury, and PCBs (URS-USACE 2012). Twelve surface soil samples were collected down to 4 inches bgs from within the area visibly impacted by waste debris and analyzed for lead, mercury, and PCBs (as Aroclors).

During the RI, soil concentration data were compared to the project 2012 SLVs as previously listed in Section 3.1.4 (URS-USACE 2012). Lead and mercury were detected in all 12 surface soil samples and were the only analytes to exceed their respective project 2012 SLVs (URS-USACE 2012). Maximum concentrations of lead and mercury were detected at 597 mg/kg and 1.54 mg/kg, respectively. PCBs did not exceed the project 2012 SLVs with a maximum total PCB concentration of 0.251 mg/kg (URS-USACE 2012).

The lateral extent of contamination is well ~~constrained~~ defined by the visible presence of debris in the soil. The underlying siltstone bedrock defines the vertical extent of waste debris and soil contamination. The estimated lateral extent of waste debris and soil contamination at the Bulb Slope AOPC is estimated to be approximately 34 feet wide and 80 feet long, as shown on Figure 4-1. The vertical extent of waste debris and soil contamination is estimated to not exceed 5 feet bgs.

Additional site-specific details of the nature and extent of contamination at the Bulb Slope AOPC are provided in the RI Report (URS-USACE 2012).

4.1.5 Fate and Transport Characteristics

The potential mechanism for offsite transport of contaminants from the Bulb Slope AOPC is direct mass wasting (slope failures) of soil and source materials into the Columbia River. The Bulb Slope AOPC consists of very steep slopes leading down to the river, in which contaminated soil and source materials will likely continue to migrate into the river. There is visual evidence of current sloughing and shoreline undercutting from wind and boat wakes at the base of the Bulb Slope that could lead to ongoing mass wasting into the river as a result of slope failures.

4.1.6 Exposure Pathways and Receptors

4.1.6.1 Human Health Exposure Pathways and Receptors

Multiple potential current and future receptor groups and exposure pathways were identified in the screening level HHRA (completed as part of the RI Report) and the BHHRA for the Bulb Slope AOPC (URS-USACE 2012, 2016). The potential receptor groups and exposure pathways are summarized below:

- Current/future outdoor maintenance workers (adults) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Hypothetical future fishing platform users (adults and children) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors) by adults and children
- Nursing infants – Maternal milk (ingestion) from mothers who are hypothetical future fishing platform users or workers with soil exposures from 0 to 3 feet bgs

These potential human health receptors and exposure pathways were evaluated in the BHHRA as described in Section 4.2.1.

4.1.6.2 Ecological Exposure Pathways and Receptors

Potentially complete ecological exposure pathways for the Bulb Slope AOPC were identified in the Level I/Level II ERA completed in 2012 as part of the RI Report (URS-USACE 2012) and refined in the Level III Baseline BERA (URS-USACE 2016). Exposure media that may provide a potentially complete exposure pathway to ecological receptors at the Bulb Slope AOPC are summarized below:

- Terrestrial Plants
  - Soil – Root uptake of COPECs in surface soil (0 to 1 foot bgs)
- Soil Invertebrates
  - Soil – Direct contact (ingestion or dermal contact) of COPECs in surface soil (0 to 1 foot bgs)
- Birds (upland species)
  - Soil – Incidental ingestion of COPECs in surface soil (0 to 1 foot bgs)
  - Food Chain Uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
- Mammals (upland species)
  - Soil – Incidental ingestion of COPECs in surface soil (0 to 1 foot bgs)
  - Food Chain Uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil

4.2 Evaluation of Receptor Risks

Potential exposures to site soil were qualitatively evaluated in the screening level HHRA (URS-USACE 2012) and quantitatively evaluated in the BHHRA/BERA (URS-USACE 2016) and the lead modeling update (Appendix D). This included an evaluation of current and reasonably foreseeable (as well as hypothetical future) exposures to chemicals in site soil and estimates of ELCR and noncancer HI and PbB modeling for human receptors. In addition, site-specific PALs were calculated for the chemicals recommended for further evaluation (COCs).

Potential risks to ecological receptors were quantitatively evaluated in the Level I/Level II ERA (URS-USACE 2012) and the Level III BERA (URS-USACE 2016).

4.2.1 Human Health Risk Summary

The following sections provide a summary of the screening level HHRA, BHHRA, and updated lead modeling (URS-USACE 2012, 2016, Appendix D).

4.2.1.1 Human Health Risk Approach and Risk Estimates

A screening level HHRA was performed as part of the RI Report (URS-USACE 2012), whereby detected concentrations of chemicals in soil were compared to agency-approved screening levels. The EPCs were calculated for each chemical as the lesser of the 95% UCL and the maximum detected concentration. No EPCs exceeded screening levels; therefore, no soil COPCs were identified.

The subsequent 2016 BHHRA addressed the following exposure scenarios for current and future potential receptor groups (URS-USACE 2016):

- Future hypothetical fishing platform users – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors) for adults and children of the four treaty tribes; the tribes were assumed to exercise their treaty rights to engage in fishing from Bradford Island, construct and use fishing platforms along the upland shoreline of Bradford Island, and camp in the interior of Bradford Island.
- Nursing infants – Maternal milk (via ingestion) for nursing infants of mothers who are hypothetical future fishing platform users with soil exposures.

For the BHHRA (URS-USACE 2016), the soil COPCs for each receptor group were identified using agency-approved screening levels. Lead was the only soil COPC identified for fishing platform users (0 to 3 feet bgs), and no COPCs were identified for nursing infants.

Potential exposures to lead in site soil were initially assessed in the 2016 BHHRA but were reassessed in 2024 due to updates to the ALM and the IEUBK Model and use of a lower target PbB of 5 µg/dL. For this reassessment of lead exposures, the most current versions of the ALM (version date 14 June 2017) and IEUBK (Version 2.0 Build 1.72, May 2021) Model available from EPA were used.

Results of the most recent risk estimates (and lead modeling results) for each receptor group (and the source of the estimates) are summarized in Table 4-1:

Table 4-1. Human Health Updated Risk Estimate Results – Bulb Slope AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Receptor Type	Probability That Receptor Has PbB > 5 µg/dL*
Outdoor Maintenance Worker	0.11%
Construction/Excavation Worker	0.11%
Hypothetical Fishing Platform User	0.34% (adult) 6.3% (child)

* Source: Appendix D; the ALM was used to evaluate PbB for adult workers, and results were used to represent outdoor maintenance workers and construction/excavation workers; the higher probability considering both the 0- to 1-foot-bgs and 0- to 3-foot-bgs intervals is presented.

Bold = value exceeds a 5 percent probability of having a PbB greater than 5 µg/dL.

4.2.1.2 Human Health Chemicals of Concern and Project Action Levels

The human health COCs for the EE/CA were identified based on consideration of the outdoor maintenance worker scenario, the construction/excavation worker scenario, and the hypothetical fishing platform user scenario. Based on the lead modeling results presented above, the probability of hypothetical fishing platform users (child) having a PbB above 5 µg/dL was above the EPA target of 5 percent; therefore, lead was considered a COC for that receptor.

Lead was identified as a COC in soil at the Bulb Slope AOPC. The associated PbB modeling result~~;~~ ~~therefore, a human health PAL was identified for lead and~~ is presented in Table 4-2. However, the risks to hypothetical fishing platform users are not considered current and imminent site risks warranting an NTCRA; therefore, this COC does not advance as a PAL (see Section 4.3).

Table 4-2. Human Health Chemical~~s~~ of Concern and Proposed Project Action Level~~s~~ – Bulb Slope AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Receptor	Exposure Depth (feet bgs)	Soil COC	Bulb Slope AOPC: Chemical-specific EPC (mg/kg)	Bulb Slope AOPC: Probability That Receptor Has PbB > 5 µg/dL	Proposed Human Health Soil PAL (mg/kg)
Hypothetical Fishing Platform User*	0 to 3	Lead	222	6.3% (child)	200

* From Table 2 of Appendix D.

4.2.2 Ecological Risk Summary

The following sections provide a summary of the Level I/Level II and Level III ERAs performed for the Bulb Slope AOPC.

4.2.2.1 Ecological Risk Assessment Approach and Results

A Level I/Level II ERA was completed for the Bulb Slope AOPC to support the Upland OU RI (URS-USACE 2012), and a Level III BERA was completed in 2016 (URS-USACE 2016). The primary objectives of the ERAs were to determine if site-related chemicals were present at concentrations that could have adverse effects to ecological receptors that may use the Upland OU. The Level I/Level II ERA was completed in accordance with Oregon DEQ and EPA guidance (Oregon DEQ 2001; EPA 1998).

Media evaluated for ~~potential risk~~risks to ecological receptors at the Bulb Slope AOPC were limited to surface soils (0 to 1 foot bgs) since the Bulb Slope AOPC only has a thin layer of soils underlain by bedrock. Potentially complete exposure pathways evaluated in the Level I/Level II ERA for the Bulb Slope AOPC included the following:

- Terrestrial plants – Root uptake of surface soil (0 to 1 foot bgs)
- Soil invertebrates – Direct contact (ingestion or dermal contact) with surface soil (0 to 1 foot bgs)
- Birds and mammals – Incidental ingestion of surface soil (0 to 1 foot bgs) and dietary intake of forage/prey.

COPECs retained for evaluation in the Level II ERA were identified using the following Oregon DEQ criteria (URS-USACE 2012):

- Analytes with less than 5 percent frequency of detection were excluded from further evaluation if the sample reporting limits were protective of ecological receptors.
- Inorganics analytes detected below background concentrations (site-specific or regional) using a statistical evaluation were excluded as COPECs.

- Analytes below 2012 SLVs either individually or cumulatively for all media and routes of exposure were excluded as COPECs.
- Bioaccumulative analytes that were detected at least once (regardless of the frequency of detection) were retained as COPECs if the SLV was not based on potential for bioaccumulation.
- Analytes without 2012 SLVs were retained as COPECs.

EPCs used in the Level II ERA were the maximum detected concentrations for receptors with limited or no mobility (plants, invertebrates) and the lower of the 95% UCL calculated using EPAs ProUCL software and the maximum detected concentration for birds and mammals (EPA 2011; URS-USACE 2012).

For the Level II ERA, EPCs for each combined media, receptor, and COPEC scenario were compared to media-specific 2012 SLVs protective of individual receptor groups to arrive at a toxicity ratio (URS-USACE 2012). In addition, potential cumulative effects for all COPECs in a given exposure media were estimated through a summation of the individual toxicity ratios.

COPECs in surface soils retained for further evaluation in the Level III BERA for the Bulb Slope AOPC were limited to lead and mercury.

The Level III BERA was completed in 2016 and refined the risk evaluation for potential ecological receptors that may use the Bulb Slope AOPC (URS-USACE 2016). Receptors and exposure pathways evaluated in the BERA for the Bulb Slope AOPC included the following:

- Terrestrial plants and soil invertebrates – Root uptake and direct contact with surface soil
- Birds (Canada goose, American robin, American kestrel) – Incidental ingestion of surface soil, ingestion of forage, and ingestion of surface water
- Upland mammals (vagrant shrew) – Incidental ingestion of surface soil, ingestion of prey, and ingestion of surface water
- Piscivorous mammals (American mink) – Incidental ingestion of surface soil, upland prey, and surface water

For ingestion of soils and food chain uptake onto forage/prey, surface soils (0 to 1 foot bgs) were the only soils evaluated for the Bulb Slope AOPC. For the water ingestion pathway, it was assumed that the American robin, Canada goose, and vagrant shrew ingested surface water from puddles in the Upland OU whereas the American kestrel and mink were assumed to ingest water from the Columbia River. The mink was included in the BERA, assuming that a small portion of its diet could include upland mammals.

Exposure and toxicity assumptions utilized in the BERA were as follows:

- EPCs – Soil EPCs were the lower of the 95% UCL and maximum detected concentrations. Upland OU surface water data were not collected but were modeled using the surface soil EPC and soil-to-water equilibrium portioning equations. River water EPCs were the maximum detected concentrations.
- Bioaccumulation – Literature bioaccumulation factors and regression models were used to estimate uptake into forage and prey items.
- Dietary composition – It was assumed that each bird and mammal receptor consumed 100 percent of a single dietary item (plants, invertebrates, or small mammals) with the exception of the mink, which was only assumed to consume 15 percent of an upland dietary item (small mammals).
- Toxicity values – Both low SLVs/NOAELs and high SLVs/LOAELs were utilized to provide a risk range. Uncertainty factors were applied to normalize endpoints where necessary.

The risk characterization included HQs computed for each receptor/COPEC using both the low SLVs/NOAELs and high SLV/LOAELs, cumulative risk estimates or HIs for groups of chemicals with similar modes of toxicity, and an uncertainty evaluation. The following decision criteria were utilized:

- Estimated exposures with low SLV/NOAEL HQs below 1 were considered to not pose adverse effects to ecological receptors because of the inherent conservatism built into the exposure and effects assessments.
- Estimated exposures with high SLV/LOAEL HQs greater than 1 indicate that the exposure exceeds a known effect level for a test organism, and risk management may be warranted.
- Estimated exposures with low SLV/NOAEL HQs greater than 1 but high SLV/LOAEL HQs less than 1 were evaluated further as part of the uncertainty assessment to develop conclusions about the likelihood that a ~~potential risk~~risk or hazard was present.

Identified COPECs were determined to not pose a ~~potential risk~~risk to ecological receptors at the conclusion of the BERA for the Bulb Slope AOPC; therefore, no COECs were identified.

4.2.2.2 Ecological Chemicals of Concern and Project Action Levels

No COECs were identified for soil at the Bulb Slope AOPC; therefore, no ecological PALs were identified.

4.3 Work Determination

Because the waste debris and impacted soil at the Bulb Slope AOPC is not a current and imminent risk, an NTCRA at that site is not justified according to the factors in 40 CFR 300.415. However, the removal action at the Landfill AOPC (see Section 3) will require extensive usage of the existing access road at the north side of Bradford Island, which crosses the Bulb Slope AOPC. The width of the access road is at its narrowest along the Bulb Slope and is in poor condition. The slope on the south side of the access road in this area is very steep and is marginally stable based on visual inspection, while the slope to the north is also very steep. Equipment driving along the access road while hauling materials in and out from the Landfill AOPC during the removal action will likely further damage the access road, creating ruts and degradation especially during rain events. ~~As such, the asphalt access road will be replaced as part of the Landfill AOPC NTCRA.~~ As such, the access road will be refurbished and upgraded to withstand frequent~~ly~~ use by heavy equipment as part of the Landfill AOPC removal action. The effort to ~~replace~~ refurbish the ~~asphalt~~ access road will encroach on the top part of the Bulb Slope, which increases the likelihood of mass wasting into the Columbia River. Therefore, stabilizing the Bulb Slope will occur as part of the road replacement. In order to do so, construction will require the excavation of the waste debris and impacted soil in the Bulb Slope AOPC. Therefore, contamination in the Bulb Slope AOPC will be removed in conjunction with the Landfill AOPC removal action.

4.4 Excavation Activities

The Bulb Slope AOPC excavation primarily consists of (1) ~~complete~~ excavation and removal of contaminated source materials (debris) and intermingled contaminated soil down to the maximum depth of contaminated source materials (5 feet bgs), bedrock, or groundwater, whichever is least; (2) transporting and disposing of removed contaminated source materials and soil at a permitted, offsite RCRA Subtitle C and/or D landfill(s); (3) installing a riprap revetment along the river shoreline; (4) stabilizing the upper portion of the slope above the revetment; and (5) general site restoration.

The Bulb Slope AOPC excavation is expected within a duration of 3 to 6 weeks once work commences at the AOPC. Figure 4-1 and Appendix B, Sheet 6 show the proposed areas of contaminated source materials and soil excavation.

The Bulb Slope AOPC excavation involves first clearing and grubbing the surface of the Bulb Slope AOPC and then excavating to remove encountered contaminated source materials and intermingled contaminated soil down to the maximum depth of contaminated source materials (Appendix B, Sheets 6 through 8 and Table 4-3). The depth of contaminated materials is estimated to be 0.33 foot bgs at the crest (top) of the slope, 1.5 feet bgs in the center of disposal area, and 5 feet bgs at the base of the slope. The maximum depth of contaminated materials is estimated to not exceed 5 feet bgs. Additionally, if bedrock or groundwater is encountered during excavation, then the vertical extent of removal will be terminated.

Clearing, grubbing, and excavation will be performed using traditional and specialized excavation and earthwork equipment (e.g., spider excavator or standard excavator from a barge).

The lateral and vertical extents of excavation will be continuously assessed using a combination of visual inspection, geophysical instrumentation (e.g., portable magnetometer), and soil field screening. Field screening may include employing handheld XRF analyzers and soil test kits. ~~Once the extent of excavation is thought to have been achieved,~~ Once the excavation extents have been achieved, characterization samples will be collected from the open excavation and analyzed to document the soil concentrations at the excavation extents ~~soil samples will be collected from the base of the open excavation for characterization purposes, analyzed, and compared~~and compared to accepted screening levels. ~~to the proposed risk-based human health soil PAL (200 mg/kg for lead for the Hypothetical Fishing Platform User) presented in Table 4-2.~~

During excavation, waste debris, contaminated soil, and clean soil will be actively segregated based on field screening for offsite disposal or use as clean backfill (URS-USACE 2022c). Clean soil will be stacked into open stockpiles and ~~soil sampled~~tested to confirm acceptability for onsite reuse as backfill. Removed contaminated source materials and soil will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or the CWM Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b).

Removed contaminated source materials will be inspected and classified by material type, and waste characterization samples will be collected from the associated excavated contaminated soil to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for TCLP metals and the site COC (lead). For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste soil disposal is subject to RCRA LDRs (40 CFR 268). In this case, the contaminated soil would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit.

Following excavation, any disturbed shoreline slopes will be stabilized and armored with a riprap revetment up to or beyond the maximum Forebay elevation of 85.9 feet NAVD88 (approximately 8 feet above the average river elevation upstream of the dam) (USACE 2024b; NOAA 2023). Then the excavated and exposed slope above the revetment will be stabilized by installation of a geosynthetic cellular confinement system, backfilled with 4 inches of topsoil, and revegetated. The geosynthetic cellular confinement system will be secured with anchor trenches, stakes, and tendon systems or twist anchors as needed.

All disturbed areas, including excavation, staging, and loading areas, would be restored and revegetated by reseeding with suitable native scrub-shrub, and herbaceous species in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Following seeding, a jute net will be placed over the areas that have been reseeded. The jute net should be placed loosely over the ground in the direction of flow and secured with ground staples and check slots. Construction monitoring and a post-construction survey would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into the Columbia River (URS-USACE 2022c). Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once removal activities are complete, the interim site controls would be discontinued.

The Bulb Slope AOPC excavation has capital costs but ~~no O&M~~ no anticipated O&M or periodic costs.

4.5 Quantity of Excavated Media

The estimated quantity of waste debris and associated soil to be excavated at the Bulb Slope AOPC is summarized in Table 4-3. The quantity was conservatively estimated based on the most current data inputs and assumptions available during development of this EE/CA. As additional data become available, the estimate may be further refined. The following data inputs and assumptions were used during quantity calculations:

- Data inputs:
  - The depth of waste debris estimated to be 0.33 feet bgs at the crest (top) of the slope, 1.5 feet bgs in the center of disposal area, and 5 feet bgs at the base of the slope (Tetra Tech, Inc.–USACE 1998; URS-USACE 2004a, 2012)
  - Relevant data from the *Bulb Slope Reconnaissance Investigation & Evaluation of Potential Remedial Options Report* (Bulb Slope Reconnaissance Report), RI Report, BHHRA/BERA, and associated previous reports (Tetra Tech, Inc.–USACE 1998; URS-USACE 2004a, 2012, 2016)
  - Data graphically presented on figures using ArcGIS software; areas and volumes calculated using ArcGIS tools
  - Site photographs and aerial imagery from the Bulb Slope Reconnaissance Report, RI Report, a project site visit on 8 November 2023, and other available sources (URS-USACE 2012; USACE 2022d)
- Assumptions:
  - The excavation will address the lateral extent of waste debris (source area) down to an estimated maximum depth of 5 feet bgs based on the previously presented RAOs, rationale, and data inputs.
  - The excavation area was estimated based on the extent of waste debris as shown on Figure 4-1.
  - The NTCRA is not the CERCLA final remedy, and if determined necessary, additional remedial actions~~,~~ would be addressed in the CERCLA final remedy.
  - The excavated soil is assumed to have a swell factor of 1.25 (25 percent increase). This factor was used to convert in situ bank volumes to ex situ loose volumes during loading and transportation.
  - The contaminated soil is assumed to be predominantly moist silty sand and gravel (SM/GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001). This in situ bulk density was used to convert volume estimates to mass (weight) estimates.
  - The waste debris is assumed to be equally composed of glass, electronics, and concrete and metal C&D wastes with an estimated in situ (bank) bulk density of 17 pounds per cubic foot

(0.226 tons/BCY). This in situ bulk density was used to convert volume estimates to mass (weight) estimates (EPA 2016).

– Other site media, such as groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

Table 4-3. Estimated Excavation Area Quantities for the Bulb Slope AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Item Description	Removal Area Quantity[a]
Lateral Extent of Source	
Bulb Slope Debris Area	2,350 square feet[b] (0.059 acre)
Vertical Extent of Source	
Bulb Slope Debris Area	0.33 to 5 feet bgs (2.67 feet bgs avg.)
*Volume **(waste debris and soil combined)***	
Bulb Slope Debris Area	232 BCY
Estimated total bank volume (in situ)	232 BCY
Soil swell factor	1.25 (25%)
Estimated total loose volume (ex situ)	290 LCY
Mass (waste debris and soil combined)	
Estimated bulk density	0.86 tons/BCY[c]
Bulb Slope Debris Area	200 tons
Estimated total mass	200 tons

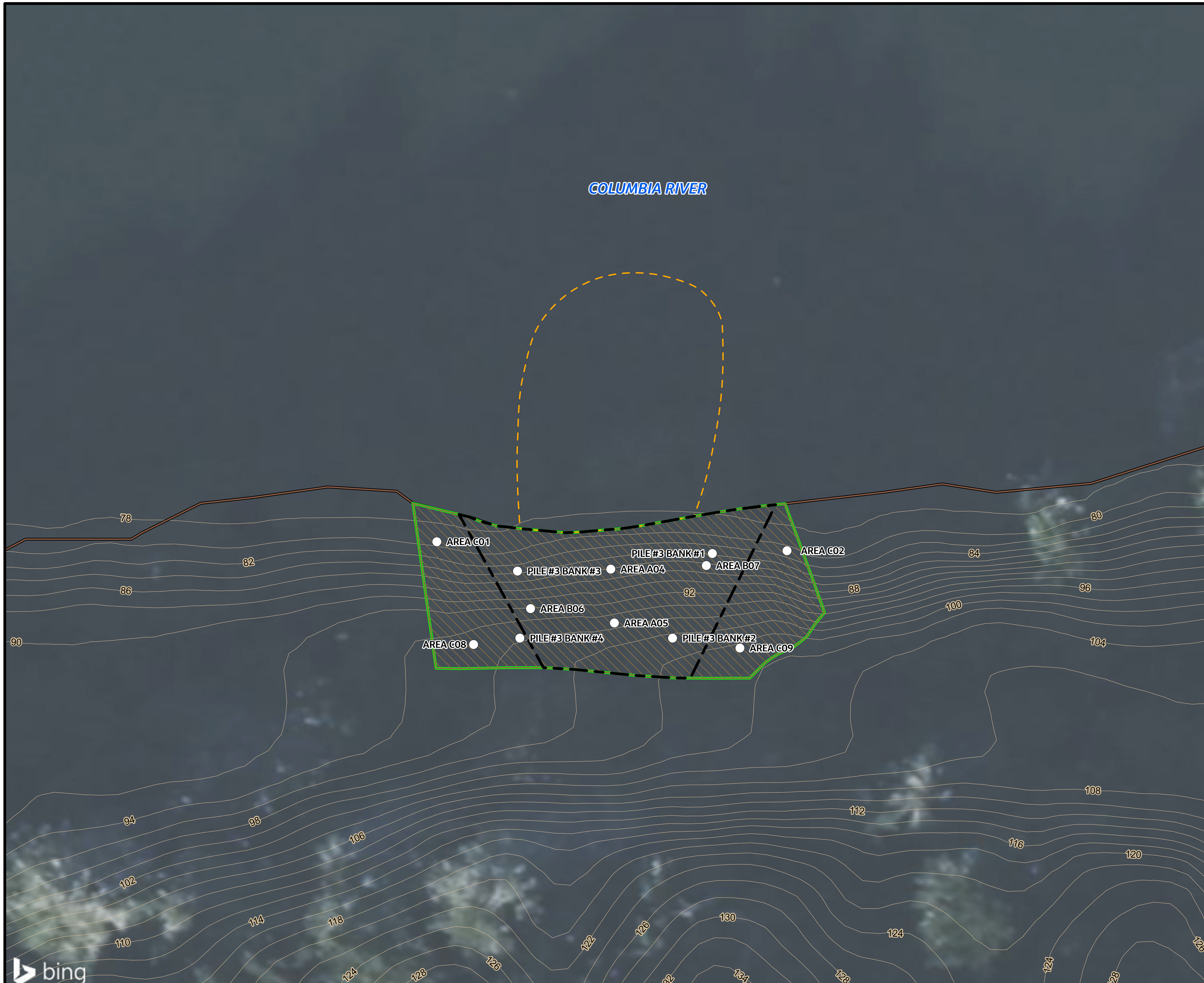
[a] Estimated extent or quantity of waste debris and intermingled contaminated soil, as shown on Figure 4-1.

[b] For estimating purposes, assumes a source area based on the extents of waste debris determined through visual surface inspection.

[c] Assumes that the removed volume is approximately 50 percent mixed industrial waste (equally composed of glass, electronics, and concrete and metal C&D wastes) with an estimated bulk density of 0.226 tons/BCY and 50 percent moist silty sand (GM) with an estimated in situ bulk density of 1.49 tons/BCY (EPA 2016; Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001).

4.6 Removal Action Schedule

NTCRA field activities are planned to begin during 2025 and are expected to be completed within approximately 12 months. The required duration to perform removal action activities at the Bulb Slope AOPC (and Landfill AOPC) is estimated to be 12 to 16 weeks. Additional schedule details will be provided in a future NTCRA work plan.



LEGEND

- SOIL SAMPLE
- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- UPLAND OPERABLE UNIT
- BULB SLOPE AOPC (2350 SQUARE FEET)
- FORMER DEBRIS PILE #3
- EXTENT OF WASTE DEBRIS (APPROXIMATE)
- SOURCE AREA (2350 SQUARE FEET)

NOTES:

NO COECS OR ASSOCIATED PROJECT ACTION LEVELS IDENTIFIED FOR THE BULB SLOPE AOPC.

AOPC = AREA OF POTENTIAL CONCERN

COEC = CONTAMINANT OF ECOLOGICAL CONCERN

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

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0 20 40 Feet

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FIGURE 4-1
BULB SLOPE AOPC EXCAVATION AREA

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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SECTION 5

Sandblast Area AOPC

5.1 Conceptual Site Model

As initially introduced in Section 3.1, the purpose of the CSM is to provide a fundamental understanding of the environmental setting based on information gathered from both historical and recent investigations. Therefore, the CSM for the Sandblast Area AOPC is summarized in the following sections.

5.1.1 Site History

The Sandblast Area AOPC includes the area surrounding the Former Sandblast Building, which was historically used for sandblasting operations and painting of equipment from approximately 1958 to 1988 (Figures 5-1 and 5-2) (URS-USACE 2012). A variety of equipment associated with the Bonneville Dam complex were historically painted with materials that contained metallic (including lead and zinc chromate systems) and organometallic compounds. This equipment was periodically stripped with blast material and then repainted at the Former Sandblast Building. No records of sandblast grit disposal activities were kept from 1958 to 1994. However, the presence of spent sandblast grit has been identified adjacent to the Former Sandblast Building (Figures 5-1 and 5-2), which was historically spread onsite for an unknown period prior to 1994. The application of lead-based paints had reportedly ceased at the dam complex by the early 1980s. Historical records from 1994 state that 215,680 pounds of sandblast grit were disposed of offsite as RCRA hazardous waste, and waste disposal records from 1997 and later indicate that approximately 70 tons of spent blast media were generated per year from sandblasting operations (URS-USACE 2022e).

In addition to sandblasting and painting operations, portions of the AOPC were also historically used for industrial equipment laydown, transformer maintenance and disassembly, and hazardous waste storage. Past storage of industrial equipment may have contaminated the soil within the laydown area with oil, metallic debris, or other contaminants. Approximately 1 quart of PCB-containing oil was released on 22 November 1995 within the former transformer maintenance and disassembly area. Additionally, a historical VOC release occurred from an approximately 300-gallon waste paint aboveground storage tank (AST) located an estimated 50 feet southeast of the Former Sandblast Building near the southwest corner of the Current HMSA. Waste paints were temporarily stored in the AST until the late 1990s, at which time, the tank was removed and the tank and the waste within it were appropriately disposed of offsite.

5.1.2 Physical Setting

The Sandblast Area AOPC is located within the western portion of the Upland OU along the northern shoreline of Bradford Island and encompasses 135,844 square feet (3.12 acres) (Figure 2-3). Elevations within the AOPC range from approximately 125 feet NAVD88 near the southern boundary of the AOPC to the average river stage elevation of 77.8 feet NAVD88 along the northern boundary (Figures 5-1 and 5-2).

Topography in the northern portion of the Sandblast Area AOPC slopes down to the north with areas of varying steepness. Topography in the southern portion of the Sandblast Area AOPC slopes to the west. Upslope of the Former Sandblast Building is a relatively undisturbed and densely forested hill slope with some mature conifers. Below the upper hill slope is a relatively flat and paved area around the Former Sandblast Building. Downslope (to the north-northeast) of the Former Sandblast Building and the adjacent paved area is a short, steep, and densely vegetated hill slope leading to the ELA and Landfill access road leading east to the Bulb Slope AOPC and Landfill AOPC. Immediately to the northwest of the Former Sandblast Building is a relatively flat, vegetated area, followed by a lightly vegetated slope, then a paved road. The ELA is bisected by the Landfill access road and is relatively flat with northern portions gently sloping down to the shoreline of the Columbia River. The shoreline is armored with riprap north along the northern boundary of the Sandblast Area AOPC.

Soil at the Sandblast Area AOPC predominantly consists of fill and alluvium composed of silty sands and gravels down to a depth of 15 to 30 feet bgs (URS-USACE 2012). Increasing amounts of sandstone and conglomerate bedrock clasts from the Eagle Creek Formation slide block below occurs with depth. The ground surface in some areas of the Sandblast Area AOPC is covered by a layer of asphalt and/or spent sandblast grit.

Groundwater beneath the Upland OU is generally within the alluvium and is indicated to be largely perched above the fractured but less-permeable Eagle Creek Formation slide block. The groundwater elevation fluctuates seasonally and has been measured to range between approximately 73 and 92 feet msl NGVD29 (76.3 to 95.3 feet NAVD88 [converted]) (URS-USACE 2012; NOAA 2023). Depending on location and season, groundwater could be encountered between approximately 6 and 26 feet bgs beneath the AOPC. Shallow groundwater flows to the north and northwest in the northern portion of the Sandblast Area AOPC under both wet season and dry season conditions. Horizontal hydraulic gradients range between 0.07 and 0.11 foot per foot, and hydraulic conductivities range from 0.02 to 285 feet per day, indicating significant heterogeneity in this area. The monitoring wells adjacent to the river (MW-14 and MW-15) are indicative of good hydraulic connection between the groundwater and the river in this area; this is evidenced by groundwater elevations that are similar to, and fluctuate with changes to the Forebay elevation, as well as by high hydraulic conductivities in each well. Groundwater within the vicinity of the other monitoring wells (MW-11, MW-12, and MW-13) does not appear to be influenced by Forebay elevations, which have much lower hydraulic conductivities. Shallow groundwater flow beneath the southern portions of the Sandblast Area AOPC is likely southerly but remains unconfirmed due to the absence of monitoring wells in these areas. Seeps are not observed in the Sandblast Area AOPC, and groundwater is instead assumed to discharge to the river as base flow.

Within the Sandblast Area AOPC, a portion of the stormwater runoff from impervious surfaces (asphalt) drains to five catch basins that discharge to the Columbia River through two outfalls (Figures 5-1 and 5-2) (USACE 2019, 2022b). However, it appears that most of the runoff from asphalt immediately southeast of the Former Sandblast Building flows northeast and discharges onto a short, steep, forested hill slope, where it causes rills to develop on the hill slope. Eroded soil from the rills combined with sandblast grit from further upslope has been observed accumulated at the base of the slope and behind one of two concrete curbs that run along the base of the slope at the ELA (URS-USACE 2009b). Source control measures currently practiced include the emplacement of filter socks and straw waddles at the catch basins, as well as periodic cleanouts of the catch basins.

5.1.3 Source of Contamination and Affected Media

Contamination at the Sandblast Area AOPC resulted from a variety of historical and ongoing uses that include storage and disposal of various hazardous materials and wastes, as well as equipment storage and management. The type and magnitude of contamination are variable, consistent with the variable hazardous substance and waste management, storage, and disposal practices that occurred at the various subareas within the Sandblast Area AOPC. Some contaminants are widespread in soil and groundwater and are not associated with a discrete source within the Sandblast Area AOPC. Other contaminants appear to be specifically associated with defined contaminant source areas. The Sandblast Area AOPC consists of the following subareas that are associated with different sources of contamination (Figures 2-3, 5-1, and 5-2):

- Former SGDA – A disposal area where spent sandblast grit was placed and buried immediately east of the Former Sandblast Building, resulting in the direct release of metallic constituents to surface and subsurface soils in the surrounding area. Windblown transport of spent sandblast grit during historical operations at the Former Sandblast Building also resulted in surface soil contamination throughout the Sandblast Area AOPC. The spent sandblast grit is thought to consist of spent green diamond abrasive grit, which is high efficiency blasting grit prepared by selective screening of nickel slag (URS-USACE 2022e; Target Products Ltd. 2019, 2024).

- ELA – A laydown area used for historical and current storage of industrial equipment and materials located along the north and south sides of the Landfill access road, which appears to have resulted in the contamination of soil with metals, pesticides, PCBs, and SVOCs (including PAHs).
- Former Transformer Maintenance and Disassembly Area – A paved former transformer maintenance area east of the Former Sandblast Building where approximately 1 quart of PCB-containing oil was released in 1995, and which may have been transported to adjacent soils (secondary source) and possibly the river via the stormwater drainage system.
- Former HMSA – The Former HMSA is located east of the equipment building, which has potentially resulted in limited soil contamination with metals, pesticides, and PAHs, both at the surface and subsurface.
- Former Waste Paint AST Release Area and Current HMSA – The location of an inferred historical AST release of waste paint located near the southwest corner of the Current HMSA, which resulted in the contamination of soil and groundwater with VOCs. The historical release is inferred by very high concentrations of PCE and trichloroethene (TCE) that were reported in soil near this area.

Based on the highest potential for receptor exposure and contaminant transport, this EE/CA specifically focuses on the removal of (1) contaminated surface and shallow soil (0 to 3 feet bgs) in the northern portion of the ELA (ELA North; Area S1) and (2) a 6-inch-thick layer of visible spent sandblast grit overlaying the asphalt pavement within a triangular equipment laydown area (herein called the Sandblast Grit Storage Area [SGSA] or Area S2) located northeast of the Former Sandblast Building within the SGDA (Figures 5-1 and 5-2). Although originally constructed for equipment laydown purposes, the asphalt pavement overlying the SGSA now acts a physical boundary separating the overlying spent sandblast grit from any potentially contaminated soil beneath the pavement, which would otherwise require cleanup. This asphalt pavement was not designed for, nor acceptably serves in capping the underlying potentially contaminated soil. Further remedies for the SGSA and other source subareas and media types (e.g., groundwater and surface water) within the Sandblast Area AOPC will not be further discussed in this EE/CA but rather will be addressed in the future FS and record of decision.

ELA North (Area S1) encompasses an area of 15,588 square feet (Figure 5-1). Based on soil sample data, the source volume within ELA North is estimated to be approximately 1,732 BCY with an average depth of 3 feet bgs (URS-USACE 2012).

The SGSA (Area S2) encompasses an area of 3,016 square feet (Figure 5-2). Based on field observations, the volume of spent sandblast grit is estimated to be approximately 56 BCY, with an average depth of 0.5 foot bgs (URS-USACE 2012).

5.1.4 Nature and Extent of CERCLA Contaminants

Since 2001, several investigations have occurred throughout the Sandblast Area AOPC and its subareas, as well as along stormwater flow paths and adjacent to catch basins. These investigations focused on individual subareas within the Sandblast Area AOPC and/or the media associated with the individual subareas. Results of these investigations have confirmed that past waste management, storage, and disposal practices have impacted soil, groundwater, and stormwater runoff onsite.

Metals, pesticides, PCBs, PAHs, SVOCs, and VOCs were detected in soil samples from throughout the Sandblast Area AOPC. The type and magnitude of contamination is variable, consistent with the variable hazardous substance and waste management, storage, and disposal practices that occurred at the various subareas within the Sandblast Area AOPC (USACE 2017b).

During the RI, soil concentration data were compared to the project 2012 SLVs as previously listed in Section 3.1.4 (URS-USACE 2012). One hundred and eighteen surface and shallow soil samples have been collected across the Sandblast Area AOPC. Deeper soil samples are limited to nine locations at the Current HMSA and the Former Sandblast Building septic system. Focusing on ELA North and the SGSA, seven surface and shallow soil samples were collected at each subarea. No deep soil samples were collected at ELA North or SGSA. Within these two subareas, the following analytes were detected at concentrations exceeding their respective project 2012 SLVs based on potential human and/or ecological exposure. The maximum detected concentrations for each subarea from the 2012 RI are presented. These concentrations do not include any subsequent soil sampling conducted after the 2012 RI, including those in the *Final Field Report and Data Report, Sandblast AOPC* (USACE 2022a). Estimated concentration values are flagged with a "J" qualifier.

- ELA North (Locations HA1, HA2, HA3, LD-01, LD-02, LD-03, and SB-01)
  - Metals
    - Antimony (1.72 J mg/kg)
    - Arsenic (7.26 mg/kg)
    - Cadmium (7.92 mg/kg)
    - Chromium (94.9 J mg/kg)
    - Copper (195 J mg/kg)
    - Iron (44,800 mg/kg)
    - Lead (3,260 mg/kg)
    - Mercury (0.497 mg/kg)
    - Nickel (57.7 J mg/kg)
    - Silver (0.406 mg/kg)
    - Selenium (0.900 J mg/kg)
    - Sodium (547 mg/kg)
    - Zinc (456 J mg/kg)
  - SVOCs
    - ~~Bis(2-Ethylhexyl) phthalate~~DEHP (9.2 mg/kg)
    - Dibenzofuran (022 mg/kg)
  - PAHs
    - Benzo(a)anthracene (6.44 mg/kg)
    - Benzo(a)pyrene (6.47 mg/kg)
    - Dibenz(a,h)anthracene (1.43 mg/kg)
    - Benzo(b)fluoranthene (4.1 mg/kg)
    - Benzo(k)fluoranthene (1.4 mg/kg)
    - Chrysene (7.59 mg/kg)
    - Indeno(1,2,3-cd)pyrene (3.91 mg/kg)
    - Total benzofluoranthene (12.1 mg/kg)
    - Total HPAHs (72.27 mg/kg)
  - Pesticides
    - 4,4'-DDT (0.130 mg/kg)
  - PCBs
    - Aroclor 1254 (0.70 mg/kg)
    - Aroclor 1260 (0.69 mg/kg)
    - Total PCBs (1.39 mg/kg)
- SGSA (Locations HA7, HA8, SBB01, SBB10, SBB15, SBB23, and SBB24)
  - Metals
    - Antimony (1.81 J mg/kg)
    - Arsenic (6.02 mg/kg)
    - Cadmium (2.61 mg/kg)
    - Chromium (2,480 mg/kg)
    - Cobalt (25.6 mg/kg)
    - Copper (82.8 mg/kg)
    - Iron (44,500 mg/kg)
    - Lead (280 J mg/kg)
    - Magnesium (47,500 J mg/kg)
    - Nickel (1,080 mg/kg)
    - Selenium (0.511 J mg/kg)
    - Zinc (1,160 mg/kg)

The estimated lateral extent of soil contamination exceeding 2012 SLVs at ELA North is estimated to be approximately 400 feet long and 44 feet wide, as shown on Figure 5-1. The vertical extent of soil contamination exceeding the 2012 SLVs is estimated to average between 3 and 5 feet bgs.

At the SGSA, the lateral extent of spent sandblast grit is approximately 70 feet long and 67 feet wide, as shown on Figure 5-2. The average thickness of the spent sandblast grit layer is estimated to be 0.5 foot.

Additional site-specific details of the nature and extent of contamination at the Sandblast Area AOPC are provided in the RI Report (URS-USACE 2012).

5.1.5 Fate and Transport Characteristics

The potential mechanisms for offsite transport of soil and spent sandblast grit contaminants from the Sandblast Area AOPC include (1) stormwater erosion of contaminants from areas of exposed soil and/or spent sandblast grit; (2) windblown transport of soil and spent sandblast grit, including dust; and (3) offsite transport of contaminants that adhere to onsite vehicles or personnel.

Site observations confirm that stormwater erosion is a historical and ongoing process that has mobilized and transported contaminated surface soil and spent sandblast grit within portions of the AOPC. The transport of soil contaminants is the result of runoff from impervious surfaces (e.g., pavement) and disturbance or exposure of contaminated soils or spent sandblast grit. For example, the ELA has been periodically graded to expand the storage capacity of the area.

Stormwater from the northwest portion of the Sandblast Area AOPC drains into five catch basins before discharging from two stormwater outfalls to the Columbia River (USACE 2019; USACE 2022b). The catch basin drainage areas include areas where stormwater erosion and transport has been documented. Metals, PCBs, pesticides, SVOCs, PAHs, and VOCs were detected in soil within the drainage area of the five stormwater catch basins. Based on multiple investigations of the storm drain system at the Sandblast Area AOPC, elevated concentrations of PCBs, PAHs, metals, VOCs, pesticides, and tributyltin above screening levels have historically been detected in accumulated sediment within the catch basins and near the river outfalls (URS-USACE 2002a; USACE 2018, 2019). Lead was present above hazardous waste toxicity characteristic levels (5 mg/L as measured by TCLP) (URS-USACE 2002b). Accumulated sediment was cleaned from the storm drain system in 2001 and 2018, after which catch basin filter socks were installed and have been changed quarterly (URS-USACE 2002b; USACE 2019). Recent stormwater investigations have found only limited detections of contaminants above screening levels (PAHs and copper) in stormwater within the system and discharging from the two outfalls (USACE 2022b). Dilution modeling for copper, PAHs, and PCBs estimated that receiving water concentrations would be two to five orders of magnitude lower than the stormwater collected from the outfalls. A subsequent optimization study concluded that further efforts to treat stormwater by various means were not recommended if actions are planned to address the upslope sources of contamination (USACE 2022b).

Evidence of windblown transport of soil and sandblast grit has also been observed, thereby releasing and dispersing contaminated soil and sandblast grit into the air as particulate dust.

To the extent that soil and sandblast grit adhere to and are tracked by vehicles and equipment (e.g., tires), there is a potential for transport of contaminants along roadways and walkways within the AOPC and elsewhere at Bonneville Dam. However, this mechanism is likely minor because of the minimal vehicle traffic and control measures currently practiced by Bonneville Dam complex employees.

5.1.6 Exposure Pathways and Receptors

5.1.6.1 Human Health Exposure Pathways and Receptors

Multiple potential current and future receptor groups and exposure pathways were identified in the screening level HHRA (completed as part of the RI Report) and the BHHRA for the Sandblast Area AOPC (URS-USACE 2012, 2016). The potential receptor groups and exposure pathways are summarized below:

- Current/future outdoor maintenance workers (adults) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Current/future construction/excavation workers (adults) – Surface and subsurface soil from 0 to 10 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Hypothetical future fishing platform users (adults and children) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors) by adults and children

- Nursing infants – Maternal milk (ingestion) from mothers who are hypothetical future fishing platform users with soil exposures from 0 to 3 feet bgs

These potential receptors and exposure pathways were evaluated as described in Section 5.2.1.

5.1.6.2 Ecological Exposure Pathways and Receptors

Potentially complete ecological exposure pathways for the Sandblast Area AOPC were identified in the Level I/Level II ERA completed in 2012 (URS-USACE 2012) and refined in the Level III BERA (URS-USACE 2016). Exposure media that may provide a potentially complete exposure pathway to ecological receptors at the Sandblast Area AOPC are summarized below:

- Terrestrial plants
  - Soil – Root uptake of COPECs in surface (0 to 1 foot bgs) and shallow (0 to 3 feet bgs) soil
- Soil invertebrates
  - Soil – Direct contact (ingestion and dermal contact) of COPECs in surface (0 to 1 foot) and shallow (0 to 3 feet bgs) soil
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
- Birds (upland species)
  - Soil – Incidental ingestion of COPECs in surface (0 to 1 foot bgs) and shallow (0 to 3 feet bgs) soil
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
- Mammals (upland species)
  - Soil – Incidental ingestion of COPECs in surface (0 to 1 foot bgs) and shallow (0 to 3 feet bgs) soil
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil

5.2 Evaluation of Receptor Risks

Potential exposures to site soil were qualitatively evaluated in the screening level HHRA (URS-USACE 2012) and quantitatively evaluated in the BHHRA/BERA (URS-USACE 2016), the *Reevaluation of Baseline Risk Assessment Calculations* (USACE 2017a~~, 2023a~~), and the lead modeling update (Appendix D). This included an evaluation of current and reasonably foreseeable (as well as hypothetical future) exposures to chemicals in soil and estimates of ELCR and noncancer HI and PbB modeling for human receptors. In addition, site -specific PALs were calculated for the chemicals recommended for further evaluation (COCs).

Potential risks to ecological receptors were quantitatively evaluated in the Level I/Level II ERA (URS-USACE 2012) and the Level III BERA (URS-USACE 2016).

5.2.1 Human Health Risk Summary

The following sections provide a summary of the screening level HHRA, BHHRA, reevaluation of the BHHRA, and updated lead modeling (URS-USACE 2012, 2016; USACE 2017a, ~~2023a,~~ Appendix D).

5.2.1.1 Human Health Risk Approach and Risk Estimates

A screening level HHRA was performed as part of the RI Report (URS-USACE 2012), whereby detected concentrations of chemicals in soil were compared to agency-approved screening levels. The EPCs were calculated for each chemical in soil as the lesser of the 95% UCL and the maximum detected concentration. The chemicals with EPCs exceeding screening levels were identified as COPCs, and it was recommended that a site-specific BHHRA be prepared for the COPCs.

The subsequent BHHRA addressed the following exposure scenarios for current and future potential receptor groups (URS-USACE 2016):

- Current/future outdoor maintenance workers – Surface soil (0 to 3 feet bgs; via ingestion, dermal contact, and inhalation of dusts and vapors).
- Current/future construction/excavation workers – Surface and subsurface soil (0 to 10 feet bgs; via ingestion, dermal contact, and inhalation of dusts and vapors).
- Future hypothetical fishing platform users – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors) for adults and children of the four treaty tribes; the tribes were assumed to exercise their treaty rights to engage in fishing from Bradford Island, construct and use fishing platforms along the upland shoreline of Bradford Island, and camp in the interior of Bradford Island.
- Nursing infants – Maternal milk (via ingestion) for nursing infants of mothers who are hypothetical future fishing platform users or workers with soil exposures.

For the BHHRA (URS-USACE 2016), the soil COPCs for each receptor group were identified using agency-approved screening levels. Both RME and CTE were evaluated for receptor exposures to represent a range of upper-end and average exposures.

The BHHRA calculations for the RME scenario were reevaluated in response to comments received from the Yakama Nation and Oregon DEQ on the draft version of the FS regarding the tribal subsistence fisher scenario (USACE 2017a, 2017b~~, 2023a~~). In addition, the reevaluation calculations incorporated the revised toxicity values for benzo(a)pyrene that were released by EPA in 2017. The reevaluation calculations used the same surface soil dataset and COPCs as the BHHRA and addressed the following scenarios:

- Current/future outdoor maintenance workers – Surface soil (0 to 3 feet bgs; via ingestion, dermal contact, and inhalation of dusts and vapors).
- Future hypothetical fishing platform users – Surface soil (via ingestion, dermal contact, and inhalation of dusts and vapors) for adults and children using a revised exposure duration for adults and revised exposure time for both adults and children.
- Nursing infants – Maternal milk (via ingestion) for nursing infants of mothers who are hypothetical future fishing platform users with soil exposures.

Potential exposures to lead in site soil were initially assessed in the 2016 BHHRA but were reassessed in 2024 due to updates to the ALM and the IEUBK Model and use of a lower target PbB of 5 µg/dL. For this reassessment of lead exposures, the most current versions of the ALM (version date 14 June 2017) and IEUBK (Version 2.0 Build 1.72, May 2021) Model available from EPA were used.

Results of the most recent risk estimates (and lead modeling results) for each receptor group (and the source of the estimates) are summarized in Table 5-1.

Table 5-1. Human Health Updated Risk Estimate Results – Sandblast Area AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Receptor Type	ELCR	HI	Probability That Receptor Has PbB > 5 µg/dL[a]
Outdoor Maintenance Worker[b]	9~~3~~ × 10^{-6}	0.3	0.21%
Construction/Excavation Worker[c]	2 × 10^{-6}	1	0.21%
Hypothetical Fishing Platform User[b]	5~~7~~ × 10^{-5} (child/adult aggregate) 3~~8~~ × 10^{-7} (nursing infant)	0.5~~2~~ (child) 0.3~~1~~ (adult) 0.2~~8~~ (nursing infant)	0.72% (adult) 12% (child)

[a] Source: Appendix D; the ALM was used to evaluate PbB for adult workers, and results were used to represent outdoor maintenance workers and construction/excavation workers; the higher probability considering both the 0- to 1-foot-bgs and 0- to 3-foot-bgs intervals is presented.

[b] ELCR and HI source: USACE 2017a~~2023b~~.

[c] ELCR and HI source: URS-USACE 2016.

Bold = value exceeds a ~~HI of 1 or exceeds a~~ 5 percent probability of a PbB greater than 5 µg/dL.

5.2.1.2 Human Health Chemicals of Concern and Project Action Levels

The human health COCs for the EE/CA were identified based on consideration of the outdoor maintenance worker scenario, the construction/excavation worker scenario, and the hypothetical fishing platform user scenario. Based on the risk estimates presented above, no exposure scenarios have a cumulative ELCR estimate above the CERCLA risk management range of 10^{-4} to 10^{-6} (40 CFR 300.430[e][2][i][A][2]) or ~~. However, one exposure scenario (the hypothetical fishing platform user) has~~ a target organ specific HI above 1 ~~for child receptors, warranting identification of COCs. For the hypothetical fishing platform user, site-related chemicals posing an HQ above 0.1 were identified as final COCs~~. However~~In addition~~, since the probability of hypothetical fishing platform users (child) having a PbB above 5 µg/dL was above the EPA target of 5 percent, lead was considered a COC for that receptor.

One ~~Two~~ final COC~~s~~ (~~benz o[a]pyrene and~~ lead) was~~were~~ identified for the Sandblast Area AOPC. The associated ~~hazard estimates and the~~ PbB modeling results are presented in Table 5-2. However, the risks to hypothetical fishing platform users are not considered current and imminent site risks warranting an NTCRA (see Section 5.3); therefore, the COC does not advance as a PAL presented in Section 5.3.2.

Table 5-2. Human Health Chemical~~s~~ of Concern and Proposed Project Action Level~~s~~ – Sandblast Area AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

			Sandblast Area AOPC			
Receptor	Exposure Depth (feet bgs)	Soil COC	Chemical-specific EPC (mg/kg)	Chemical-specific HQ	Probability That Receptor Has PbB > 5 µg/~~dLa~~dL*	Proposed Human Health Soil PAL (mg/kg)
~~Hypothetical Fishing Platform User[a]~~	~~0 to 3~~	~~Benzo(a)pyrene~~	~~2.39~~	~~2 (child)~~	~~--~~	~~0.19[b]~~
Hypothetical Fishing Platform ~~Usera~~User*	0 to 3	Lead	300	--	12%	200

~~a~~ * From Table 2 of Appendix D.
~~b From Table 4 of USACE 2023b.~~

5.2.2 Ecological Risk Summary

The following sections provide a summary of the Level I/Level II ERA and Level III BERA performed for the Sandblast Area AOPC.

5.2.2.1 Ecological Risk Assessment Approach and Results

A Level I/Level II ERA for the Sandblast Area AOPC was completed to support the RI Report (URS-USACE 2012), and a Level III BERA was completed in 2016 (URS-USACE 2016). The primary objectives of the ERAs were to determine if site-related chemicals were present at concentrations that could have adverse effects to ecological receptors that may use the Upland OU. The ERAs were completed in accordance with Oregon DEQ and EPA guidance (Oregon DEQ 2001; EPA 1998).

Soil was evaluated for ~~potential risk~~risks to ecological receptors at the Sandblast Area AOPC. Potentially complete exposure pathways evaluated in the Level I/Level II ERA for the Sandblast Area AOPC included the following:

- Terrestrial plants – Root uptake of surface (0 to 1 foot bgs) and shallow soils (0 to 3 feet bgs)
- Soil Invertebrates – Direct contact with surface (0 to 1 foot bgs) and shallow soils (0 to 3 feet bgs)
- Birds and mammals – Incidental ingestion of surface (0 to 1 foot bgs) and shallow soils (0 to 3 feet bgs) and dietary intake of forage/prey.

COPECs retained for evaluation in the Level II ERA were identified using the following Oregon DEQ criteria:

- Analytes with less than 5 percent frequency of detection were excluded from further evaluation if the sample reporting limits were protective of ecological receptors.
- Inorganics analytes detected below background concentrations (site-specific or regional) using a statistical evaluation were excluded as COPECs.
- Analytes below 2012 SLVs either individually or cumulative for all media and routes of exposure were excluded as COPECs.
- Bioaccumulative analytes that were detected at least once (regardless of the frequency of detection) were retained as COPECs if the SLV was not based on potential for bioaccumulation.
- Analytes without 2012 SLVs were retained as COPECs.

EPCs used in the Level II ERA were the maximum detected concentrations for receptors with limited or no mobility (plants, invertebrates) and the lower of the 95% UCL calculated using EPAs ProUCL software and the maximum detected concentration for birds, mammals, and aquatic organisms (EPA 2011; URS-USACE 2012).

For the Level II ERA, EPCs for each combined media, receptor, and COPEC scenario were compared to media-specific 2012 SLVs protective of individual receptor groups to arrive at a toxicity ratio (URS-USACE 2012). In addition, potential cumulative effects for all COPECs in a given exposure media were estimated through a summation of the individual toxicity ratios.

COPECs in surface and shallow soils retained for further evaluation in the Level III BERA for the Sandblast Area AOPC included metals, tributyltin, organochlorine pesticides, HPAHs, SVOCs, and VOCs.

The Level III BERA was completed in 2016 and refined the risk evaluation for potential ecological receptors that may use the Sandblast Area AOPC (URS-USACE 2016). Receptors and exposure pathways evaluated in the BERA for the Sandblast Area AOPC included the following:

- Terrestrial plants and soil invertebrates – Root uptake and direct contact with surface and shallow soil
- Birds (Canada goose, American robin, American kestrel) – Incidental ingestion of surface and shallow soil, ingestion of forage or prey, and ingestion of surface water

- Upland mammals (vagrant shrew) – Incidental ingestion of surface and shallow soil, ingestion of prey, and ingestion of surface water
- Piscivorous mammals (American mink) – Incidental ingestion of surface soil, upland prey, and surface water

For ingestion of soils and food chain uptake into forage/prey, surface soils were defined as 0 to 1 foot bgs, and shallow soils were defined as 0 to 3 feet bgs. For the surface water ingestion pathway, it was assumed that the American robin, Canada goose, and vagrant shrew ingested water from puddles in the Upland OU whereas the American kestrel and mink were assumed to ingest water from the Columbia River. The mink was included in the BERA assuming that a small portion of its diet could include upland mammals.

Exposure and toxicity assumptions utilized in the BERA were as follows:

- EPCs – Soil EPCs were the lower of the 95% UCL and maximum detected concentrations. Upland OU surface water data were not collected but were modeled using the surface soil EPCs and soil-to-water equilibrium portioning equations. River water EPCs were the maximum detected concentrations.
- Bioaccumulation – Literature bioaccumulation factors and regression models were used to estimate uptake into forage and prey items.
- Dietary composition – It was assumed that each bird and mammal receptor consumed 100 percent of a single dietary item (plants, invertebrates, small mammals) with the exception of the mink, which was only assumed to consume 15 percent of an upland dietary item (small mammals).
- Toxicity values – Both low SLVs/NOAELs and high SLVs/LOAELs were utilized to provide a risk range. Uncertainty factors were applied to normalize endpoints where necessary.

The risk characterization included HQs computed for each receptor/COPEC using both the low SLVs/NOAELs and high SLV/LOAELs, cumulative risk His for groups of chemicals with similar modes of toxicity, and an uncertainty evaluation. The following decision criteria were utilized:

- Estimated exposures with low SLV/NOAEL HQs below 1 were considered to not pose adverse effects to ecological receptors because of the inherent conservatism built into the exposure and effects assessments.
- Estimated exposures with high SLV/LOAEL HQs greater than 1 indicate that the exposure exceeds a known effect level for a test organism and risk management may be warranted.
- Estimated exposures with low SLV/NOAEL HQs greater than 1 but high SLV/LOAEL HQs less than 1 were evaluated further as part of the uncertainty assessment to develop conclusions about the likelihood that a ~~potential risk~~risk or hazard was present.

COPECs that were determined to pose a ~~potential risk~~risk to ecological receptors at the conclusion of the BERA were identified as COECs and were recommended for further evaluation. The soil COECs for the Sandblast Area AOPC were as follows:

- Antimony – Vagrant shrew
- Chromium – American robin, vagrant shrew
- Lead – American robin, vagrant shrew
- Nickel – Terrestrial plants, American robin, vagrant shrew
- HPAHs – Terrestrial plants, vagrant shrew

5.2.2.2 Ecological Chemicals of Concern and Project Action Levels

Ecological PALs for the Sandblast Area AOPC were identified for each COEC/receptor group using the high 2012 SLVs for plants and invertebrates, the LOAEL-based RBCs for birds (robin) and mammals (shrew) developed in the BERA (URS-USACE 2016), and the site-specific background value (95% UPL).

The 2012 SLVs and RBCs for the receptor groups showing ~~potential risk~~risk to each COEC, the site-specific background values, and the ecological PALs are presented in Table 5-3. The ecological PAL is the lowest SLV or RBC unless that value is below the background value, in which case the background value is selected as the ecological PAL.

Table 5-3. Ecological Chemicals of Concerns and Proposed Project Action Levels – Sandblast Area AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Plant High SLV (mg/kg)	Invertebrate High SLV (mg/kg)	American Robin LOAEL RBC (mg/kg)	Vagrant Shrew LOAEL RBC (mg/kg)	Site-specific Background 95% UPL[a] (mg/kg)	Proposed Ecological Soil PAL~~*~~[b] (mg/kg)	Exposure Depth (feet bgs)
Antimony	--	--	--	2.84	0.176	2.84	0 to 3
Chromium	<bkg	<bkg	218	177	28.1	28.1	0 to 3
Lead	--	--	56	157	25.5	56	0 to 3
Nickel	190	--	138	<bkg	26.5	26.5	0 to 3
Total HPAHs	6	--	--	5.92	--	5.92	0 to 3

[a] Site-specific background concentrations were only used to establish screening level values for inorganic analytes in soil (URS-USACE 2012).

[b] Proposed ecological PALs are only developed for the receptor groups that showed potential for adverse effects in the BERA (URS-USACE 2016). The ecological PAL is the lowest LOAEL RBC or high SLV unless it is less than background. In which case, the site-specific background 95% UPL is shown.

~~* Proposed ecological PALs are only developed for the receptor groups that showed potential for adverse effects in the BERA (URS-USACE 2016). The ecological PAL is the lowest LOAEL RBC or high SLV unless it is less than background, in which case the site-specific background 95% UPL is shown.~~

Notes:

All values are shown in mg/kg.

-- = analyte was not identified as a COEC for this receptor or SLV/RBC not available
<bkg = below background

5.3 Removal Action Scope and Objectives

An NTCRA is being undertaken at the Sandblast Area AOPC to address current and imminent site risks due to COECs within soil and spent sandblast grit, surface soil and spent sandblast grit erosion, windblown transport of soil and spent sandblast grit, and offsite transport of contaminants adhered to onsite vehicles or personnel at ELA North and the SGSA (40 CFR 300.415).

Although not an NTCRA objective, the NTCRA is anticipated to also reduce site risks to future hypothetical fishing platform users.

RAOs, PALs, and estimated quantities of contaminated media are presented in the following subsections.

5.3.1 Removal Action Objectives

RAOs are specific goals for addressing risks and hazards associated with site-related contamination. RAOs can be accomplished by ensuring exposure pathways are not completed or by reducing concentrations of COCs at exposure points to below protective concentrations. RAOs define the extent to which sites require cleanup to meet the protectiveness objectives.

The RAOs developed for ELA North and the SGSA are as follows:

- RAO SA1 – Reduce potential contaminant migration: Reduce potential contributions of contaminated soil and spent sandblast grit at ELA North and the SGSA into the Columbia River through stormwater erosion, into the air through windblow transport, and via offsite transport through adherence to vehicles and equipment.

- RAO SA2 – Limit source exposure at the SGSA: Reduce or eliminate ingestion and direct contact by ecological receptors of spent sandblast grit at the SGSA.
- RAO SA3 – Prevent unacceptable exposure to contaminated soil at ELA North: Prevent ingestion and dermal contact by ecological receptors of COECs in excess of the PALs within soil (Table 5-4) at ELA North.

5.3.2 Project Action Levels

To achieve the RAOs listed above, the risk-based PALs for the Sandblast Area AOPC are established in Table 5-4. These PALs are considered in evaluating the overall effectiveness of removal process options and alternatives and are considered protective of the environment for the COECs identified at Sandblast Area AOPC.

Table 5-4. Sandblast Area AOPC Project Action Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Soil PAL (mg/kg)
Total HPAHs	5.92[a]
Antimony	2.84[a]
Chromium	28.1[~~a,~~b]
Lead	56[a]
Nickel	26.5[a,b]

[a] Based on unacceptable health risks to ecological receptors (e.g., plants, invertebrates, American robin, and vagrant shrew).
[b] Based on the site-specific background concentration level as defined by the 95% UPL.

Note:

Soil PALs are based on the proposed PALs in Table~~s~~ 5-3 only. The human health COCs presented in Section 5.2.1.2 do not present a current and imminent site risk warranting an NTCRA and therefore are not included in Table 5-4.

5.3.3 Media and Areas Requiring Removal Action

Based on the findings in Sections 5.1.4, 5.2, and 5.3.2, PAH and metals concentrations exceeding the PALs have been identified in soil and spent sandblast grit within the subarea boundaries of ELA North and the SGSA. Figures 5-1 and 5-2 show the locations of sample exceedances and proposed removal extents (corresponding to estimated quantities) at the Sandblast Area AOPC (URS-USACE 2012, 2016). If additional areas are identified during the removal action to contain spent sandblast grit and/or COECs in soil exceeding the PALs, then the spent sandblast grit and/or soil from the additional areas will also be removed during the NTCRA if practical.

5.3.4 Quantity of Contaminated Media

The estimated quantities of contaminated soil and sandblast grit exceeding PALs and considered during removal action alternative development and cost estimating are summarized in Table 5-5. These quantities were conservatively estimated based on the most current data inputs and assumptions available during development of this EE/CA. As additional data become available, these estimates may be further refined. The following data inputs and assumptions were used during quantity calculations:

- Data inputs:

- The project RAOs and PALs
- Ecological exposure scenarios and depths
- Relevant historical analytical data from the RI Report, BHHRA/BERA, and associated previous reports (URS-USACE 2012, 2016)
- Data graphically presented on figures using ArcGIS software; areas and volumes were calculated using ArcGIS tools
- Site photographs and aerial imagery from the RI Report, a project site visit on 8 November 2023, and other available sources (URS-USACE 2012)
- Landowner tolerance for future environmental liabilities and remedial and removal actions

- Assumptions:
  - The ELA North removal action will address the lateral extent of contaminated soil exceeding the PALs (source area) down to an estimated maximum depth of 3 feet bgs based on the previously presented RAOs, rationale, and data inputs.
  - The SGSA removal action will address the spent sandblast grit within the defined area boundaries down to the underlying asphalt pavement with an estimated average thickness of 0.5 foot based on the previously presented RAOs, rationale, and data inputs.
  - The removal areas were estimated based on the extent of soil contamination exceeding PALs and visible spent sandblast grit (source areas), as show on Figures 5-1 and 5-2.
  - If additional areas are identified during the removal action to contain waste debris and/or COECs in soil exceeding the PALs, then the waste debris and/or soil from the additional areas will also be removed during the NTCRA if practical.
  - The NTCRA is not the CERCLA final remedy, and if determined necessary, additional remedial actions~~,~~ would be addressed in the CERCLA final remedy.
  - Potential specific conflicts with onsite anthropogenic features, including utilities, will be mitigated during subsequent remedy planning and implementation. No paved roadways or buildings will be disturbed or compromised as a result of removal activities.
  - The excavated soil and spent sandblast grit are assumed to have a swell factor of 1.25 (25 percent increase). This factor was used to convert in situ bank volumes to ex situ loose volumes during loading and transportation.
  - The contaminated soil is assumed to be predominantly moist silty sand and gravel (SM/GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001). This in situ bulk density was used to convert volume estimates to mass (weight) estimates.
  - The spent sandblast grit is assumed to consist of spent green diamond abrasive grit with a dry bulk density ranging from 85 to 105 pounds per cubic foot (URS-USACE 2022e; Target Products Ltd. 2019). The spent sandblast grit with SGSA is assumed to be moist with a conservatively estimated in situ bulk density of 105 pounds per cubic foot (1.42 tons/BCY). This in situ bulk density was used to convert volume estimates to mass (weight) estimates.
  - Other site media, such as groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

Table 5-5. Estimated Removal Area Quantities for the Sandblast Area AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Item Description	Removal Area Quantity[a]
Lateral Extent of Source	
Area S1 – ELA North (soil)	15,588 square feet[b] (0.358 acres)
Area S2 – SGSA (sandblast grit)	3,016 square feet[b] (0.069 acres)
Total area	18,604 square feet[b] (0.427 acres)
Vertical Extent of Source	
Area S1 – ELA North (soil)	3 feet bgs
Area S2 – SGSA (spent sandblast grit)	0.5 foot bgs
Volume	
Area S1 – ELA North (soil)	1,732 BCY
Area S2 – SGSA (spent sandblast grit)	56 BCY
Estimated total bank volume (in situ)	1,788 BCY
Soil swell factor	1.25 (25%)
Area S1 – ELA North (soil)	2,165 LCY
Area S2 – SGSA (spent sandblast grit)	70 LCY
Estimated total loose soil volume (ex situ)	2,235 LCY
Soil Mass	
Estimated bulk soil density	1.49 tons/BCY[c]
Area S1 – ELA North (soil)	2,581 tons
Estimated soil mass	2,581 tons
Spent Sandblast Grit Mass	
Estimated bulk waste density	1.42 tons/BCY[d]
Area S2 – SGSA (spent sandblast grit)	80 tons
Estimated sandblast grit mass	80 tons

[a] Estimated extent or quantity of soil contamination exceeding PALs and visible spent sandblast grit as shown on Figures 5-1 and 5-2.

[b] For estimating purposes, assumes a source area based on the extents of spent sandblast grit and soil contamination determined by visual inspection and/or analytical sample data.

[c] Assumed value based on a predominantly moist silty sand (GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001).

[d] Assumed value based on predominantly moist spent green diamond abrasive grit with an estimated in situ (bank) bulk density of 105 pounds per cubic foot (1.49 tons/BCY) (URS-USACE 2022e; Target Products Ltd. 2019).

5.3.5 Removal Action Schedule

NTCRA field activities are planned to begin during ~~Summer 2026~~2025 and are expected to be completed within approximately 12 months. The required duration to perform removal action activities at the

Sandblast Area AOPC is estimated to be 4 weeks. Additional schedule details will be provided in a future NTCRA work plan.

5.4 Presumptive Remedy Considerations

Federal facilities, like the Bradford Island NPL Site, are encouraged to accelerate and streamline the cleanup of contaminated sites, including by the use of presumptive remedies (EPA 1994). As previously described in Sections 3.4 and 4.4, presumptive remedies are being considered in this EE/CA to focus the removal action development and screening process and target alternatives known to be effective, feasible, and cost-efficient (EPA 1997, 1999).

~~As discussed in Section 5.1.4, the impacted soil at the Sandblast Area AOPC poses a relatively low long-term threat. Generally, EPA expects that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable.~~ Based on CSM similarities, ~~Therefore,~~ the Sandblast Area AOPC was compared to EPA's evaluation and guidance for metals-in-soil sites presented in the following EPA guidance: *Presumptive Remedy for Metals-in-Soil Sites* (EPA 1999). This presumptive remedy is intended for use at sites where metals contamination in soils is a primary problem.

EPA has prescribed "containment,"~~,~~ such as engineering controls, as the presumptive remedy for metals-in-soil sites that pose a relatively low long-term threat similar to the Sandblast Area AOPC (EPA 1999). ~~This presumptive remedy is intended for use at sites where metals contamination in soils is a primary problem.~~

~~EPA conducted an analysis of potentially available technologies for metals-in-soil sites and found that use of this presumptive remedy streamlines the remedy selection for metals-in-soil sites, like the Sandblast Area AOPC, by narrowing the universe of alternatives considered on the basis of effectiveness, feasibility, or cost (EPA 1999).~~

Containment of metals-in-soil waste includes vertical or horizontal barriers, such as soil covers, caps, sheet piles, and slurry walls. These engineering controls ~~remedial technologies~~ can provide sustained isolation of contaminants and prevent mobilization of soluble compounds over long periods of time. ICs generally are used in conjunction with containment to further limit the potential for unintended access to the contaminated media.

To accelerate and streamline the cleanup ~~of the Landfill AOPC~~, this EE/CA incorporates the containment presumptive remedy for the Sandblast Area AOPC, thereby eliminating the need for further identification and screening of alternatives for the NTCRA beyond what is presented in the following removal alternative descriptions in Section 5.5 (EPA 1994, 1999).

5.5 Removal Action Alternatives

5.5.1 Alternative Descriptions

Removal action alternatives have been identified to achieve the RAOs and corresponding PALs. The No Action Alternative was included for comparative purposes per the NCP.

5.5.1.1 Alternative S0 – No Action

The no action alternative provides a baseline against which to compare the performance and effectiveness of the other alternatives (EPA 2018). With Alternative S0, no action would be conducted in the near-term to address impacted soil at ELA North or spent sandblast grit at the SGSA, and no controls would be implemented in the short-term to control or monitor potential receptor exposures to site COECs. Onsite contaminated soil and spent sandblast grit would remain in place, contamination will continue to migrate into the Columbia River, and ecological receptors will continue to be exposed to contamination until a long-term remedy is implemented for the AOPC. No NTCRA would be implemented to remove COEC sources or prevent potential future exposure. It is assumed that the current level of maintenance would be sustained. Alternative S0 will not achieve the RAOs (Section 5.3.1). This alternative has no ($0) capital, O&M, or periodic costs.

5.5.1.2 Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration

Alternative S1 primarily consists of (1) ~~complete~~ targeted excavation and removal of contaminated soil in excess of the PALs within ELA North down to the vertical extent of contamination or maximum depth of ecological receptor exposure (3 feet bgs), whichever is least; (2) backfilling of the excavation at ELA North; (3) ~~complete~~ removal of visible spent sandblast grit overlaying the asphalt pavement in the SGSA (0.5-foot-thick layer); (4) transporting and disposing of removed soil and spent sandblast grit at a permitted, offsite RCRA Subtitle C and/or D landfill(s); (5) installing a riprap revetment and vegetative buffer at ELA North; (6) asphalt paving the equipment storage areas at ELA North; and (7) general site restoration.

Alternative S1 would achieve all RAOs following completion of the removal action, which is expected within a duration of 4 to 8 weeks once work commences at the AOPC. The need for LUCs or O&M is not currently anticipated to control exposure to contaminants in soil and spent sandblast grit for this alternative because the impacted media would be removed from the site. If necessary, additional remedial actions, including LUCs and O&M, will be addressed in the CERCLA final remedy. Figures 5-1 and 5-2 and Appendix B, Sheet 9 show the proposed areas of contaminated soil and spent sandblast grit removal.

Alternative S1 involves first clearing and grubbing the surface of Area S1 in ELA North (Appendix B, Sheet 9 through 11 and Table 5-5) and then excavating to remove contaminated soil in excess of the PALs down to the vertical extent of soil contamination or maximum depth of ecological receptor exposure (3 feet bgs), whichever is least. The vertical extent of soil contamination is estimated to average between 3 and 5 feet bgs.

Additionally, if bedrock or groundwater is encountered during excavation, then the vertical extent of soil removal will be terminated. Removal will occur during seasonal low groundwater to achieve the greatest excavation depth without requiring additional excavation stabilization. If needed, temporary removal and relocation of any riprap along the shoreline will require careful coordination with USACE.

The lateral and vertical extents of soil removal at Area S1 will be continuously assessed during excavation using a combination of visual inspection and soil field screening. Field screening for PAHs and metals may include employing EIA soil test kits and handheld XRF analyzers. Once the extents of removal are thought to have been achieved, confirmation samples will be collected from the floor and walls of the open excavation and analyzed for site COECs (PAHs and metals) to confirm that all contaminated soil above PALs was removed. Confirmation sample results will be assessed on a point-by-point basis, and excavation will continue at any removal location that exceeds the PALs until follow-on confirmation samples can confirm that the extent of contamination exceeding the PALs has been successfully removed. The exception being where a maximum depth of potential exposure of 3 feet bgs or refusal at bedrock or groundwater is achieved, whichever is least.

Alternative S1 also includes ~~complete~~ removal of visible spent sandblast grit overlaying the asphalt pavement of Area S2 in SGSA (Appendix B, Sheet 9 through 11 and Table 5-5). The average thickness of the spent sandblast grit layer is estimated to be 0.5 foot. If the underlaying asphalt pavement is encountered, the vertical extent of removal will be terminated. The lateral and vertical extents of spent sandblast grit at Area S2 will be continuously assessed during removal using visual inspection.

At ELA North, excavation will be performed using traditional excavation and earthwork equipment. At the SGSA, removal will be performed using a combination of vacuum truck, traditional earthwork, and street sweeper equipment that will not damage the underlying asphalt pavement. A pre-construction survey and assessment of adjacent access roads would be completed prior to commencing onsite work. The paved portion of the current Landfill access road adjacent to NSA North (Figure 5-1) may require upgrades, including widening, rerouting, and structural improvement to the roadbed to effectively accommodate loaded end-dump trucks (e.g., addition of a gravel surface layer) and access to other AOPCs. The Landfill access road adjacent to ELA North is paved with weathered asphalt.

During excavation, contaminated soil, spent sandblast grit, and clean soil will be actively segregated based on field screening for offsite disposal or use as clean backfill (URS-USACE 2022c). Clean soil will be stacked into open stockpiles and ~~soil sampled~~tested to confirm acceptability for onsite reuse as backfill. Removed contaminated soil and spent sandblast grit will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or the CWM Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). During excavation and loading, contaminated soil and spent sandblast grit are to be managed separately and not commingled onsite or prior to delivery at an offsite landfill.

Waste characterization samples will be collected from removed soil and spent sandblast grit to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for TCLP metals and site COECs, including PAHs and metals. For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste disposal is subject to RCRA LDRs (40 CFR 268). In this case, the contaminated soil and spent sandblast grit would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit. Note that since 1994, sandblast grit generated at Bonneville Dam has generally been managed as a RCRA hazardous waste (URS-USACE 2022e).

Following excavation, the Area S1 excavation would be backfilled to the existing grade and any disturbed areas would be restored to their pre-removal action conditions (Appendix B, Sheet 9 and 11). Backfilling and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Clean backfill material should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c). The final backfilled grade will be contoured to the surrounding landscape. The volume of required clean backfill is estimated to be approximately 1,701 BCY (2,126 LCY; 2,534 tons), which will be imported from offsite. Backfill is not required at Area S2 as excavation below the asphalt pavement layer is not expected.

The shoreline slopes at ELA North (Area S1) will also be stabilized and armored with a riprap revetment up to or beyond the maximum Forebay elevation of 85.9 feet NAVD88 (approximately 8 feet above the average river elevation upstream of the dam) (USACE 2024b; NOAA 2023). Then the backfilled exposed slope area between the revetment and the slope crest (between 85.9 feet and 89.5 feet NAVD88) will be stabilized by installation of an approximately 10- to 12-foot-wide vegetation buffer. The upland portion of ELA North between the vegetation buffer and the existing Landfill access road will be paved with an asphalt pavement surface to aid in future equipment storage.

The vegetative buffer and any disturbed areas, including the staging and loading areas, will be stabilized and revegetated by reseeding with suitable native, perennial grass and herbaceous species in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Following seeding, a jute net will be placed over the areas that have been reseeded. The jute net should be placed loosely over the ground in the direction of flow and secured with ground staples and check slots. Construction monitoring and a post-construction survey would occur for this alternative.

Due to the existing asphalt pavement layer at the SGSA, no further site restoration should be required in Area S2.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept and prevent exposed material from migrating into the Columbia River (URS-USACE 2022c). Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once removal activities are complete, the interim site controls would be discontinued.

Alternative S1 has capital costs but ~~no O&M~~ no anticipated O&M or periodic costs.

5.5.1.3 Alternative S2 – Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/ Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, Institutional Controls, and Long-term Operation and Maintenance

Alternative S2 was developed based on EPA's presumptive remedy for metals-in-soil sites to provide containment of the contaminated soil exceeding the PALs within ELA North (Area S1) and targeted removal of the spent sandblast grit at the SGSA (Area S2). Per Sections 5.1.6 and 5.2, the primary potential complete exposure pathway at the Sandblast Area AOPC is direct exposure (ingestion, dermal contact, inhalation of dusts and vapors, and root uptake) to contaminated soil and spent sandblast grit by human and ecological receptors. Alternative S2 prevents direct contact by physically and administratively restricting receptors from accessing the contamination source. Additionally, potential stormwater erosion of contaminants into the Columbia River are mitigated by a shoreline vegetative buffer at ELA North.

Alternative S2 primarily consists of (1) complete removal of visible spent sandblast grit overlaying the asphalt pavement in the SGSA (0.5-foot-thick layer), (2) installing an engineered soil cover or asphalt cap over the entire source area at ELA North, (3) installing a riprap revetment with vegetative buffer along the river shoreline, (4) general site restoration, (5) establishing ICs that restrict specific land uses and activities that could damage the soil cover or asphalt cap and/or cause receptor exposure, and (6) implementing long-term O&M to maintain the integrity and protectiveness of the remedy.

Alternative S2 would achieve all RAOs following completion of removal action activities and the establishment of ICs. Removal action activities are expected to be complete within a duration of 12 to 16 weeks once work commences at the AOPC, but establishment of ICs is anticipated to take approximately 6 to 9 months. ICs and O&M would be required for the life of the remedy (greater than 30 years) to continue to control exposure to the covered contaminant source. Figure 5-3 shows the proposed areas of contaminated soil and spent sandblast grit removal.

First, Alternative S2 involves the complete removal of visible spent sandblast grit overlaying the asphalt pavement of Area S2 in SGSA. The average thickness of the spent sandblast grit layer is estimated to be 0.5 foot. If the underlaying asphalt pavement is encountered, the vertical extent of removal will be terminated. The lateral and vertical extents of spent sandblast grit at Area S2 will be continuously assessed during removal using visual inspection. At the SGSA, removal will be performed using a combination of vacuum truck, traditional earthwork, and street sweeper equipment that will not damage the underlying asphalt pavement. Removed spent sandblast grit will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or the CWM

Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). During excavation and loading, spent sandblast grit is to be managed separately and not commingled with soil onsite or prior to delivery at an offsite landfill.

Waste characterization samples will be collected from removed spent sandblast grit to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for TCLP metals and site COCs and COECs, including PAHs and metals. For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste disposal is subject to RCRA LDRs (40 CFR 268). In this case, the spent sandblast grit would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit. Note that since 1994, sandblast grit generated at Bonneville Dam has generally been managed as a RCRA hazardous waste (URS-USACE 2022e).

Alternative S2 also involves containment of the contaminated soil at ELA North (Area S1) using an asphalt cap and engineered soil cover system (Figure 5-3). ELA North will be cleared and grubbed, and the crest of the slope used for equipment storage (above approximately 89.5 feet NAVD88) will be graded to a level surface. Then the level surface between the slope crest to the existing paved Landfill access road will be capped with a 6-inch-thick, low-permeability asphalt (bituminous concrete) pavement cap to prevent exposure and provide an improved working surface for equipment storage. The asphalt cap would be composed of a 2-inch-thick hot mix asphalt surface course and 4-inch-thick hot mix asphalt base course. And if needed, a structural aggregate sub-base may be placed over the top of the natural subgrade prior to capping. The asphalt cap will be fused into the existing Landfill access road pavement.

After placement of the asphalt cap, a 3-foot-thick engineered soil cover will be placed over the shoreline slope between the waterline (77.8 feet NAVD88 average elevation) and the northern edge of the asphalt cap (approximately 89.5 feet NAVD88). The engineered soil cover will consist of a minimum of 2.5 feet of clean soil beneath a minimum of 0.5 foot of topsoil to allow for revegetation. An estimated 767 BCY (958 LCY) of clean soil and 153 BCY 192 LCY) of topsoil will need to be obtained from areas adjacent to the site or imported from offsite. Clean soil will be tested to confirm acceptability for onsite use in backfilling and soil cover construction. Backfilling and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). If needed, clean backfill should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c). If needed, temporary removal and relocation of any existing riprap along the shoreline will require careful coordination with USACE.

Following cap and cover construction, the shoreline slope, including the lower portion of the soil cover, will be stabilized and armored with a riprap revetment up to or beyond the maximum Forebay elevation of 85.9 feet NAVD88 (approximately 8 feet above the average river elevation upstream of the dam) (USACE 2024b; NOAA 2023).

Clearing, grubbing, and construction will be performed using traditional and specialized earthwork and construction equipment (e.g., standard and/or spider excavator or hot asphalt paver). The portion of the paved Landfill access road adjacent to ELA North may require upgrades, including widening, rerouting, and structural improvement to the roadbed, to effectively accommodate loaded end-dump trucks. A pre-construction survey and assessment of the Landfill access road would be completed prior to commencing onsite work.

After revetment construction, any remaining exposed areas of the engineered soil cover will be revegetated with suitable native, perennial grass and herbaceous species to provide a vegetative buffer and minimize erosion. All disturbed areas, including staging and loading area would be restored and revegetated by reseeding with suitable native scrub-shrub and herbaceous species in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Following reseeding, a stabilizing jute net would be loosely placed over the restored areas in the direction of flow and secured with ground staples and check slots. Larger native vegetation species may also be planted to aid in surface stabilization. Construction monitoring and a post-construction survey would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into the Columbia River (URS-USACE 2022c). Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once construction activities are complete, the interim site controls would be discontinued.

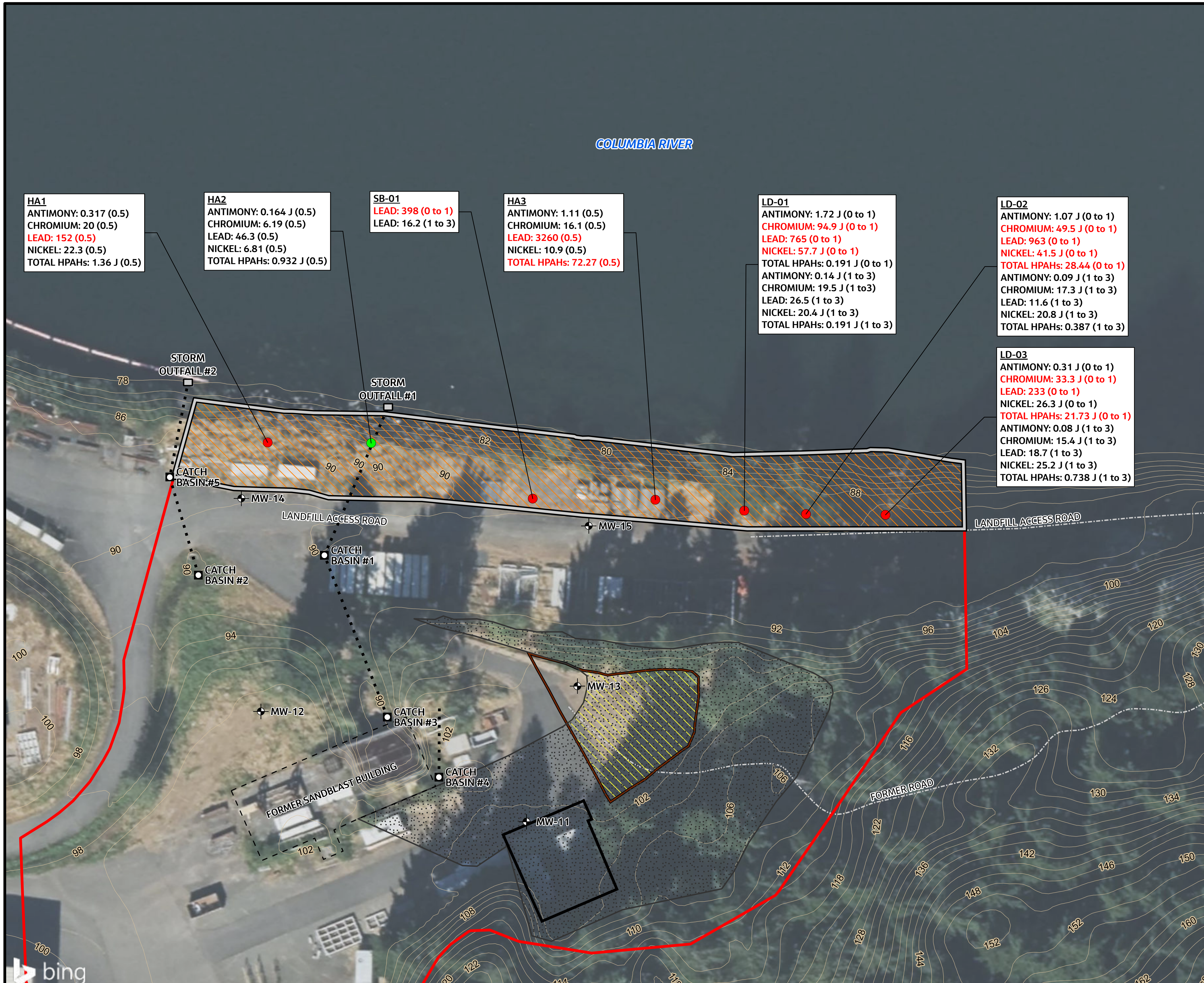
Lastly, administrative ICs, including signage, environmental deed restrictions or covenants, and access restrictions and control features, will be established at the Sandblast Area AOPC to accomplish the following:

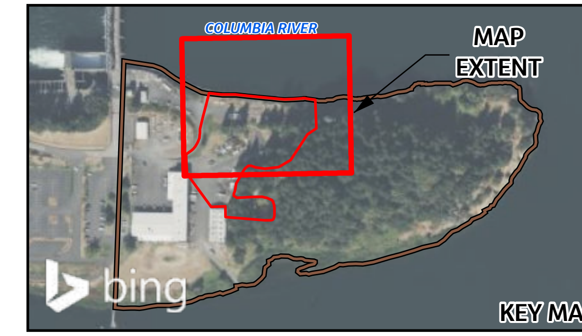
- Control potential exposure to the buried contaminated soil by current and future construction/ excavation workers and other potential receptors.
- Restrict future site construction and excavation.
- Ensure land usage is compatible with agreed upon acceptable land uses, controls, and remedial design assumptions.
- Limit any unauthorized activities that would compromise the cap and cover system (e.g., excavation, drilling, or mooring).
- Warn of potential site hazards from buried contaminated soil.
- Prevent impacted soil from being transported offsite.
- Educate site workers and the public about access restrictions and potential site dangers.

Warning signage and perimeter barriers such as gates will be installed at possible site access locations (e.g., landfill access road and on the revetment) to control access.

Additionally, an O&M program will be implemented to focus on verifying the continued protectiveness of the remedy and ensuring assumptions made during remedy selection remain valid. O&M will consist of semiannual site inspections of the asphalt cap, engineered soil cover, and signage; necessary maintenance of the cap and cover system; IC maintenance (such as sign maintenance and administrative reviews); and routine monitoring of site access and conditions.

Alternative S2 has capital costs, O&M, and periodic costs. ~~Five-year reviews will be required for the life of the remedy.~~





LEGEND

- SAMPLE DOES NOT EXCEED PAL
- SAMPLE EXCEEDS PAL

LD-03 — LOCATION NAME
ANTIMONY: 0.31 J (0 to 1) — SAMPLE DEPTH (feet BGS); DATA FLAG; RESULT (mg/kg); ANALYTE

- CATCH BASIN
- GROUNDWATER MONITORING LOCATION
- STORM OUTFALL
- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- UNDERGROUND STORM SEWER/OUTFALL (APPROXIMATE)
- SANDBLAST AREA AOPC (135844 SQUARE FEET)
- NORTHERN EQUIPMENT LAYDOWN AREA
- SANDBLAST GRIT STORAGE AREA
- SPENT SANDBLAST GRIT DISPOSAL AREA (APPROXIMATE)
- FORMER SANDBLAST BUILDING
- CURRENT HAZARDOUS MATERIALS STORAGE
- SOURCE AREA – AREA S1 (15588 SQUARE FEET)
- SOURCE AREA – AREA S2 (3016 SQUARE FEET)

COEC	SOIL PAL[a] (mg/kg)
TOTAL HPAHs	5.92
ANTIMONY	2.84
CHROMIUM	28.1
LEAD	56
NICKEL	26.5

[a] BASED ON UNACCEPTABLE HEALTH RISKS TO ECOLOGICAL RECEPTORS (E.G., PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND VAGRANT SHREW).

NOTES:
RED TEXT INDICATES ANALYTE RESULT EXCEEDS THE PAL
AOPC = AREA OF POTENTIAL CONCERN
BGS = BELOW GROUND SURFACE
COEC = CONTAMINANT OF ECOLOGICAL CONCERN
HPAH = HIGH-MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBON
J = THE REPORTED VALUE IS AN ESTIMATE
mg/kg = MILLIGRAMS PER KILOGRAM
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
PAL = PROJECT ACTION LEVELS
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0 50 100 Feet

FIGURE 5-1
SANDBLAST AREA AOPC ALTERNATIVE S1 - NORTHERN EQUIPMENT LAYDOWN AREA
UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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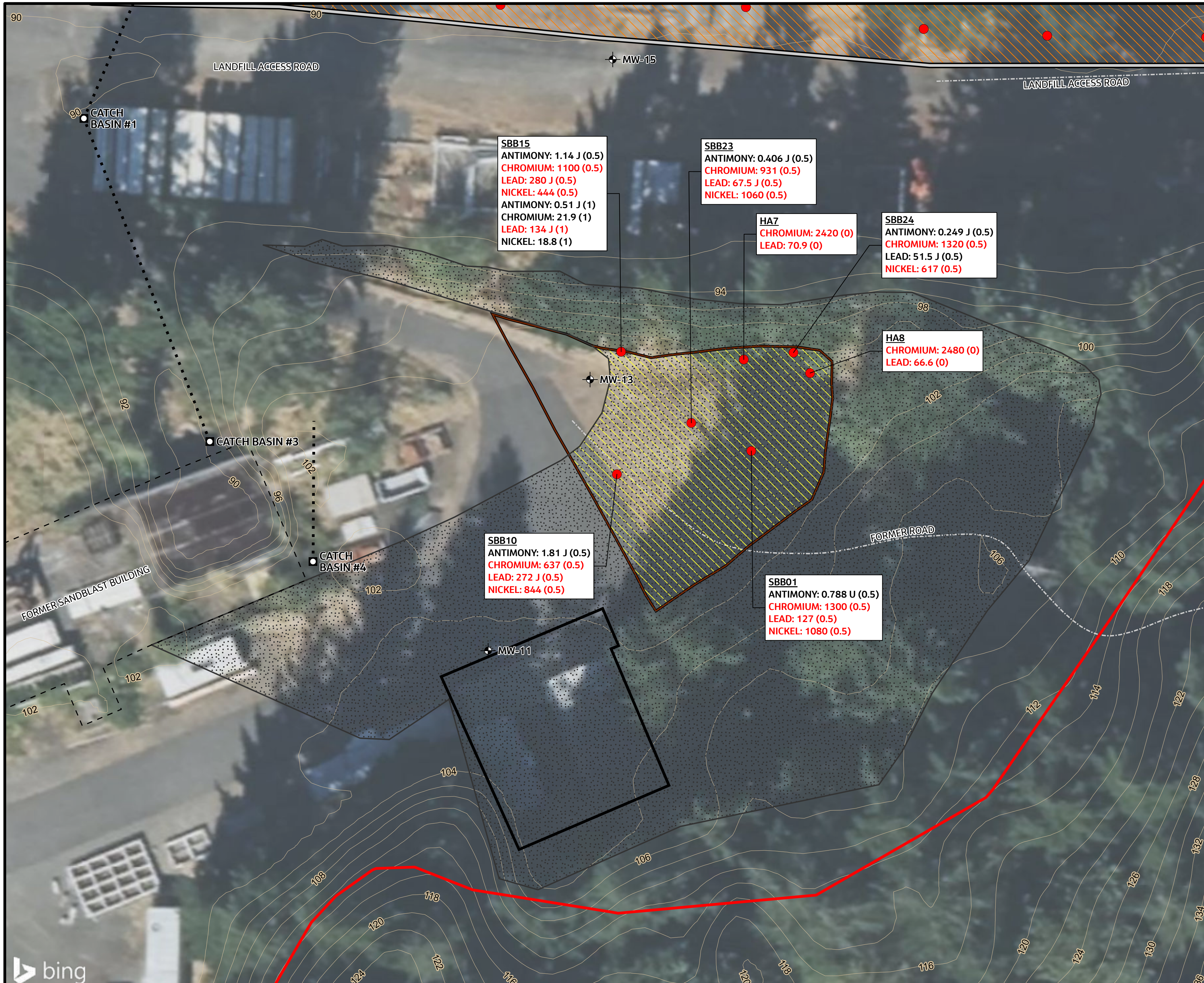

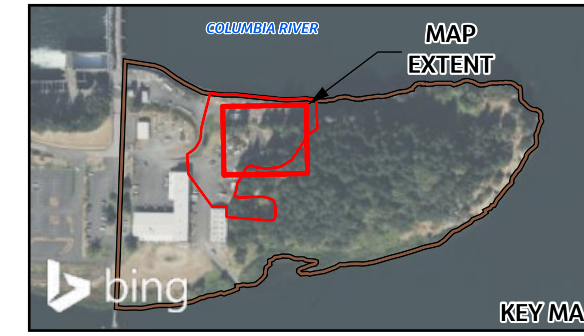

LEGEND

- SAMPLE EXCEEDS PAL
- ANTIMONY: 0.249 J (0.5) — SBB24: LOCATION NAME; SAMPLE DEPTH (feet BGS); DATA FLAG; RESULT (mg/kg); ANALYTE
- CATCH BASIN
- GROUNDWATER MONITORING LOCATION
- ROAD
- UNDERGROUND STORM SEWER/OUTFALL (APPROXIMATE)
- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- SANDBLAST AREA AOPC (135844 SQUARE FEET)
- NORTHERN EQUIPMENT LAYDOWN AREA
- SANDBLAST GRIT STORAGE AREA
- SPENT SANDBLAST GRIT DISPOSAL AREA (APPROXIMATE)
- FORMER SANDBLAST BUILDING
- CURRENT HAZARDOUS MATERIALS STORAGE
- SOURCE AREA – AREA S1 (15588 SQUARE FEET)
- SOURCE AREA – AREA S2 (3016 SQUARE FEET)

COEC	SOIL PAL[a] (mg/kg)
TOTAL HPAHs	5.92
ANTIMONY	2.84
CHROMIUM	28.1
LEAD	56
NICKEL	26.5

[a] BASED ON UNACCEPTABLE HEALTH RISKS TO ECOLOGICAL RECEPTORS (E.G., PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND VAGRANT SHREW).

NOTES:
RED TEXT INDICATES ANALYTE RESULT EXCEEDS THE PAL
AOPC = AREA OF POTENTIAL CONCERN
BGS = BELOW GROUND SURFACE
COEC = CONTAMINANT OF ECOLOGICAL CONCERN
HPAH = HIGH-MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBON
J = THE REPORTED VALUE IS AN ESTIMATE
mg/kg = MILLIGRAMS PER KILOGRAM
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
PAL = PROJECT ACTION LEVELS
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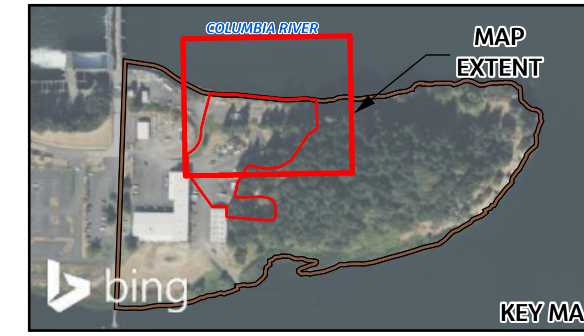
0 25 50 Feet

N

FIGURE 5-2
SANDBLAST AREA AOPC ALTERNATIVE S1 - SANDBLAST GRIT STORAGE AREA
UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON



LEGEND

- SAMPLE DOES NOT EXCEED PAL
- SAMPLE EXCEEDS PAL
- CATCH BASIN
- GROUNDWATER MONITORING LOCATION
- STORM OUTFALL
- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- UNDERGROUND STORM SEWER/OUTFALL (APPROXIMATE)
- SANDBLAST AREA AOPC (135844 SQUARE FEET)
- NORTHERN EQUIPMENT LAYDOWN AREA
- SANDBLAST GRIT STORAGE AREA
- SPENT SANDBLAST GRIT DISPOSAL AREA (APPROXIMATE)
- FORMER SANDBLAST BUILDING
- CURRENT HAZARDOUS MATERIALS STORAGE
- SOURCE AREA – AREA S1 (15588 SQUARE FEET)
- SOURCE AREA – AREA S2 (3016 SQUARE FEET)
- ASPHALT CAP AREA
- SOIL COVER AREA

COEC	SOIL PAL[a] (mg/kg)
TOTAL HPAHs	5.92
ANTIMONY	2.84
CHROMIUM	28.1
LEAD	56
NICKEL	26.5

[a] BASED ON UNACCEPTABLE HEALTH RISKS TO ECOLOGICAL RECEPTORS (E.G., PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND VAGRANT SHREW).

NOTES:
AOPC = AREA OF POTENTIAL CONCERN
BGS = BELOW GROUND SURFACE
COEC = CONTAMINANT OF ECOLOGICAL CONCERN
HPAH = HIGH-MOLECULAR WEIGHT POLYCYCLIC AROMATIC HYDROCARBON
J = THE REPORTED VALUE IS AN ESTIMATE
mg/kg = MILLIGRAMS PER KILOGRAM
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
PAL = PROJECT ACTION LEVELS
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0 50 100 Feet

N

FIGURE 5-3
SANDBLAST AREA AOPC ALTERNATIVE S2
UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

Pistol Range AOPC

6.1 Conceptual Site Model

As initially introduced in Section 3.1, the purpose of the CSM is to provide a fundamental understanding of the environmental setting based on information gathered from both historical and recent investigations. Therefore, the CSM for the Pistol Range AOPC is summarized in the following sections.

6.1.1 Site History

The Pistol Range AOPC was historically used by the U.S. Army for small arms practice beginning in the 1940s to 1950s, which ceased in the late 1960s or early 1970s. No other land use associated with the Pistol Range AOPC is known. The former small arms range once consisted of a 20- by 20-foot wooden firing shed, a secondary firing location, and a 30-foot-long, 7-foot-tall treated timber and earthen backstop (Figure 6-1). The firing shed is located approximately 80 feet southwest of the backstop. The firing shed fell into disrepair and was demolished by USACE in the 1990s; however, the resulting wooden debris pile was abandoned-in-place on the surface. When the Pistol Range AOPC was actively used, the ground surface was likely sparsely vegetated but has since been recolonized by surrounding herbaceous vegetation.

6.1.2 Physical Setting

The Pistol Range AOPC is located on the south side of the Upland OU approximately 75 feet southeast of the equipment building and north of the southern channel of the Columbia River (Figure 2-3). Based on historical aerial photographs, location of the firing shed and backstop, and location of past investigations, the Pistol Range AOPC is approximately 210 feet long, 35 to 50 feet wide, and encompasses an area of approximately 11,393 square feet (0.262 acre) (Figure 6-1). The AOPC is at an elevation of between 79 and 110 feet NAVD88, which on average is approximately 17 feet above the average elevation of the adjacent river lagoon (77.8 feet NAVD88) southeast of the AOPC. Access to the Pistol Range AOPC is provided by an unimproved access road that extends approximately 200 feet southeast from the existing service center building and equipment building (Figure 6-1).

The overall slope of the Pistol Range AOPC is to the southeast toward the southern channel of the Columbia River. The topography of the area consists of a series of excavated benches that step southward and down toward the Columbia River, resulting in a sequence of slopes and flat areas. The shoreline is very gently sloped into the adjacent lagoon. Currently, the ground surface is stable and is vegetated with a mix of scrub-shrub and herbaceous vegetation. An upland meadow community, similar to that found at the Landfill AOPC, currently covers the firing range. The hillside behind the backstop is moderately steep (15 to 30 degree slopes) and is densely vegetated with herbaceous vegetation and shrub/forest fringe communities. Along the southern portion of the firing range and south of the access road, a densely vegetated scrub/shrub community is present. No evidence of surface runoff, soil erosion, or sediment deposition has been observed, suggesting that erosion and transport of soil from the Pistol Range AOPC to the river is currently unlikely. When the Pistol Range AOPC was in use, the ground surface was likely less vegetated, and there may have been historical runoff to the Columbia River (e.g., the adjacent lagoon).

Soil at the Pistol Range AOPC predominantly consists of alluvium composed of gravelly silts and sands with intermittent gravel layers down to a depth of 14 to 40 feet bgs (URS-USACE 2012). Groundwater beneath the Upland OU is generally within the alluvium and is indicated to be largely perched above the fractured but less-permeable Eagle Creek Formation slide block. No groundwater monitoring wells have been installed at the Pistol Range AOPC, but groundwater was measured at approximately 10 to 10.9 feet bgs (80.3 to 14.2 feet NAVD88) in soil borings advanced in February 2009 (URS-USACE 2012). Groundwater is anticipated to generally flow toward the southeast with the surface topography under both wet season and dry season conditions. Generally, hydraulic conductivities are anticipated to be similar to those encountered at the Sandblast Area AOPC and other areas of Bradford Island.

6.1.3 Source of Contamination and Affected Media

As a result of historical use as a small arms practice range, surface and shallow soils at the Pistol Range AOPC are impacted with metals from firing range activities (Figure 6-1). Specifically, soil immediately adjacent to the firing shed and backstop are contaminated with lead.

The boundaries of the Pistol Range AOPC encompasses an area of approximately 11,393 square feet (Figure 6-1). However, the lateral extent of unacceptable lead concentrations in soil is isolated to two smaller areas of approximately 3,676 square feet surrounding the backstop (Area P1) and 1,419 square feet adjacent to the firing shed (Area P2). Based on soil sample data, the total source volume within the Pistol Range AOPC is estimated to be approximately 283 BCY with a depth of 1.5 feet bgs (URS-USACE 2012).

6.1.4 Nature and Extent of CERCLA Contaminants

Previous investigations collected and analyzed surface (0 to 0.5 foot bgs) and near surface (1.0 to 1.5 feet bgs) soil samples within and adjacent to the Pistol Range AOPC (URS-USACE 2012). In total, 63 soil samples were analyzed for lead with a subset (10) of the samples analyzed for antimony, copper, mercury, nickel, and zinc (Figure 6-1). Five samples were analyzed for arsenic.

During the RI, soil concentration data were compared to the project 2012 SLVs selected for human and ecological exposure scenarios as previously listed in Section 3.1.4 (URS-USACE 2012). With a few exceptions, lead, nickel, and zinc concentrations in soil exceeded their respective 2012 SLVs throughout the Pistol Range AOPC with maximum concentrations 1,110 mg/kg lead, 32 J mg/kg nickel, and 199 mg/kg zinc. The highest concentrations of lead were detected at and behind the backstop. Adjacent to the firing shed, lead, nickel, and zinc concentrations up to 758 mg/kg, 32 J mg/kg, and 199 mg/kg were detected. The highest concentrations of nickel and zinc were detected within 10 feet downrange from the firing shed. Estimated concentration values are flagged with a "J" qualifier.

Following the RI, the lateral extent of surface and near surface soil contamination exceeding the 2012 SLVs was estimated to be at least 210 feet long and 70 feet wide in total, although the area of exceedance appears to be more consistent with several isolated, noncontiguous areas (URS-USACE 2012). The lateral extent of metals contamination remains undefined to the northwest, northeast, and east of the Pistol Range AOPC, particularly behind and adjacent to the backstop. The vertical extent of soil contamination exceeding the 2012 SLVs was estimated to average approximately 1.5 feet bgs but does not exceed 3 feet bgs.

Additional summary of the nature and extent of contamination at the Pistol Range AOPC is provided in the RI Report (URS-USACE 2012).

6.1.5 Fate and Transport Characteristics

The potential mechanism for offsite transport of contaminants from the Pistol Range AOPC is stormwater erosion of contaminants from areas of exposed soil. The offsite transport of soil contaminants is commonly the result of exposed contaminated soils. Historical soil erosion from the AOPC may have occurred when the firing range was active and minimally vegetated. And although the site is currently stable, vegetated, and site observations confirm that stormwater erosion is minimal, erosion during extreme weather events could transport soil contaminants into the Columbia River. Two direct-push groundwater samples collected during the 2012 RI did not exceed the 2012 SLVs; therefore, leaching of lead or zinc to groundwater was not indicated (URS-USACE 2012).

6.1.6 Exposure Pathways and Receptors

6.1.6.1 Human Health Exposure Pathways and Receptors

Multiple potential current and future receptor groups and exposure pathways were identified in the screening level HHRA (completed as part of the RI Report) and the BHHRA for the Pistol Range AOPC (URS-USACE 2012, 2016). The potential receptor groups and exposure pathways are summarized below:

- Current/future outdoor maintenance workers (adults) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Current/future construction/excavation workers (adults) – Surface and subsurface soil from 0 to 10 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors)
- Hypothetical future fishing platform users (adults and children) – Surface soil from 0 to 3 feet bgs (ingestion, dermal contact, and inhalation of dusts and vapors) by adults and children

These potential human health receptors and exposure pathways were further evaluated in the BHHRA as described in Section 6.2.1.

6.1.6.2 Ecological Exposure Pathways and Receptors

Potentially complete ecological exposure pathways for the Pistol Range AOPC were identified in the Level I/Level II ERA completed in 2012 as part of the RI Report (URS-USACE 2012) and refined in the Level III BERA (URS-USACE 2016). Exposure media that may provide a potentially complete exposure pathway to ecological receptors at the Pistol Range AOPC are summarized below:

- Terrestrial plants
  - Soil – Root uptake of COPECs in surface soil (0 to 1.5 feet bgs)
- Soil invertebrates
  - Soil – Direct contact (ingestion or dermal contact) of COPECs in surface soil (0 to 1.5 feet bgs)
- Birds (upland species)
  - Soil – Incidental ingestion of COPECs in surface soil (0 to 1.5 feet bgs)
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
  - Surface water – Incidental ingestion of COPECs in surface water
- Mammals (upland species)
  - Soil – Incidental ingestion of COPECs in surface soil (0 to 1.5 feet bgs)
  - Food chain uptake – Ingestion of forage/prey species that may have bioaccumulated COPECs from soil
  - Surface water – Incidental ingestion of COPECs in surface water
- Aquatic biota (invertebrates, fish, and wildlife)
  - Sediment – Direct contact with COPECs in sediment by sediment-dwelling invertebrates
  - Groundwater – Ingestion or direct contact with COPECs in groundwater

6.2 Evaluation of Receptor Risks

Potential exposures to site soil were qualitatively evaluated in the screening level HHRA (URS-USACE 2012) and quantitatively evaluated in the BHHRA/BERA (URS-USACE 2016) and the lead modeling update (Appendix D). This included an evaluation of current and reasonably foreseeable (as well as hypothetical future) exposures to chemicals in soil and estimates of ELCR and noncancer HI and PbB modeling for human receptors. In addition, site-specific PALs were calculated for the chemicals recommended for further evaluation (COCs), if any.

Potential risks to ecological receptors were quantitatively evaluated in the Level I/Level II ERA (URS-USACE 2012) and the Level III BERA (URS-USACE 2016).

6.2.1 Human Health Risk Summary

The following sections provide a summary of the screening level HHRA, BHHRA, and updated lead modeling (URS-USACE 2012, 2016, Appendix D).

6.2.1.1 Human Health Risk Approach and Risk Estimates

A screening level HHRA was performed as part of the RI Report, whereby detected concentrations of chemicals in soil were compared to agency-approved screening levels (URS-USACE 2012). The EPCs were calculated for each chemical in soil as the lesser of the 95% UCL and the maximum detected concentration. No EPCs exceeded screening levels; therefore, no soil COPCs were identified.

For the BHHRA (URS-USACE 2016), the soil COPCs for each receptor group were identified using agency-approved screening levels. Lead was the only soil COPC identified for fishing platform users.

Potential exposures to lead in site soil were initially assessed in the 2016 BHHRA but were reassessed in 2024 due to updates to the ALM and the IEUBK Model and use of a lower target PbB of 5 µg/dL. For this reassessment of lead exposures, the most current versions of the ALM (version date 14 June 2017) and IEUBK (Version 2.0 Build 1.72, May 2021) Model available from EPA were used.

Results of the most recent lead modeling results for each receptor group (and the source of the estimates) are summarized in Table 6-1.

Table 6-1. Human Health Updated Risk Estimate Results – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Receptor Type	Probability That Receptor Has PbB > 5 µg/dL*
Outdoor Maintenance Worker	0.10%
Construction/Excavation Worker	0.10%
Hypothetical Fishing Platform User	0.29% (adult) 5.4 %(child)

* Source: Appendix D; the ALM was used to evaluate PbB for adult workers, and results were used to represent outdoor maintenance workers and construction/excavation workers; the higher probability considering both the 0- to 1-foot-bgs and 0- to 3-foot-bgs intervals is presented.

Bold = value exceeds a 5 percent probability of having a PbB greater than 5 µg/dL.

6.2.1.2 Human Health Chemicals of Concern and Project Action Levels

The human health COCs for the EE/CA were identified based on consideration of the outdoor maintenance worker scenario, the construction/excavation worker scenario, and the hypothetical fishing platform user scenario. Based on the lead modeling results presented above, the probability of hypothetical fishing platform users (child) having a PbB above 5 µg/dL was above the EPA target of 5 percent; therefore, lead was considered a COC for that receptor.

~~One COC (lead)~~Lead was identified as a COC for soil at the Pistol Range AOPC. The associated PbB modeling result is~~; therefore, a human health PAL was identified, as~~ presented in Table 6-2. However, the risks to hypothetical fishing platform users are not considered current and imminent site risks warranting an NTCRA (see Section 6.3);~~,~~ therefore, this COC does not advance as a PAL presented in Section 6.3.2.

Table 6-2. Human Health Chemicals of Concern and Proposed Project Action Levels – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

			Pistol Range AOPC		
Receptor	Exposure Depth (feet bgs)	Soil COC	Chemical-specific EPC (mg/kg)	Probability That Receptor Has PbB > 5 µg/dL	Proposed Human Health Soil PAL (mg/kg)
Hypothetical Fishing Platform User*	0 to 3	Lead	208	5.4% (child)	200

* From Table 2 of Appendix D.

6.2.2 Ecological Risk Summary

The following sections provide a summary of the Level I/Level II and Level III ERAs performed for the Pistol Range AOPC.

6.2.2.1 Ecological Risk Assessment Approach and Results

A Level I/Level II ERA was completed for the Pistol Range AOPC to support the Upland OU RI (URS-USACE 2012) and a Level III BERA was completed in 2016 (URS-USACE 2016). The primary objectives of the ERAs were to determine if site-related chemicals were present at concentrations that could have adverse effects to ecological receptors that may use the Upland OU. The ERAs were completed in accordance with Oregon DEQ and EPA guidance (Oregon DEQ 2001; EPA 1998).

Media evaluated for ~~potential risk~~risks to ecological receptors at the Pistol Range AOPC included soil, sediment, and surface water. Potentially complete exposure pathways evaluated in the Level I/Level II ERA for the Pistol Range AOPC included the following:

- Terrestrial plants – Root uptake of surface soil (0 to 1.5 feet bgs)
- Soil invertebrates – Direct contact (ingestion and dermal contact) with surface soil (0 to 1.5 feet bgs)
- Birds and mammals – Incidental ingestion of surface soil (0 to 1.5 feed bgs), dietary intake of forage/prey, and ingestion of surface water

COPECs retained for evaluation in the Level II ERA were identified using the following Oregon DEQ criteria:

- Analytes with less than 5 percent frequency of detection were excluded from further evaluation if the sample reporting limits were protective of ecological receptors.
- Inorganic analytes detected below background concentrations (site-specific or regional) using a statistical evaluation were excluded as COPECs.
- Analytes below 2012 SLVs either individually or cumulative for all media and routes of exposure were excluded as COPECs.

- Bioaccumulative analytes that were detected at least once (regardless of the frequency of detection) were retained as COPECs if the SLV was not based on potential for bioaccumulation.
- Analytes without 2012 SLVs were retained as COPECs.

EPCs used in the Level II ERA were the maximum detected concentrations for receptors with limited or no mobility (plants, invertebrates) and the lower of the 95% UCL calculated using EPA's ProUCL software and the maximum detected concentration for birds and mammals (EPA 2011; URS-USACE 2012).

For the Level II ERA, EPCs for each combined media, receptor, and COPEC scenario were compared to media-specific 2012 SLVs protective of individual receptor groups to arrive at a toxicity ratio (URS-USACE 2012). In addition, potential cumulative effects for all COPECs in a given exposure media were estimated through a summation of the individual toxicity ratios.

COPECs in surface soils retained for further evaluation in the BERA for the Pistol Range AOPC were limited to lead. COPECs in sediment did not pose a risk to sediment-dwelling invertebrates and were not carried forth to the BERA.

The Level III BERA was completed in 2016 and refined the risk evaluation for potential ecological receptors that may use the Pistol Range AOPC (URS-USACE 2016). Receptors and exposure pathways evaluated in the BERA for the Pistol Range AOPC included the following:

- Terrestrial plants and soil invertebrates – Root uptake with surface soil (0 to 1.5 feet bgs)
- Soil invertebrates – Direct contact (ingestion and dermal contact) with surface soil (0 to 1.5 feet bgs)
- Birds (Canada goose, American robin, American kestrel) – Incidental ingestion of surface soil (0 to 1.5 feet bgs), ingestion of forage or prey, and ingestion of surface water
- Upland mammals (vagrant shrew) – Incidental ingestion of surface soil (0 to 1.5 feet bgs), ingestion of prey, and ingestion of surface water
- Piscivorous mammals (American mink) – Incidental ingestion of surface soil (0 to 1.5 feet bgs), upland prey, and surface water

For ingestion of soils and food chain uptake into forage/prey, surface soils were defined as 0 to 1.5 feet bgs. For the water ingestion pathway, it was assumed that the American robin, Canada goose, and vagrant shrew ingested water from puddles in the Upland OU whereas the American kestrel and mink were assumed to ingest water from the Columbia River. The mink was included in the BERA assuming that a small portion of its diet could include upland mammals.

Exposure and toxicity assumptions utilized in the BERA were as follows:

- EPCs – Soil EPCs were the lower of the 95% UCL and maximum detected concentrations. Upland OU surface water data were not collected but were modeled using the surface soil EPC and soil-to-water equilibrium portioning equations. River water EPCs were the maximum detected concentrations.
- Bioaccumulation – Literature bioaccumulation factors and regression models were used to estimate uptake into forage and prey items.
- Dietary composition – It was assumed that each bird and mammal receptor consumed 100 percent of a single dietary item (plants, invertebrates, small mammals) with the exception of the mink, which was only assumed to consume 15 percent of an upland dietary item (small mammals).
- Toxicity Values – Both low SLVs/NOAELs and high SLVs/LOAELs were utilized to provide a risk range. Uncertainty factors were applied to normalize endpoints where necessary.

The risk characterization included HQs computed for each receptor/COPEC using both the low SLVs/NOAELs and high SLV/LOAELs, cumulative risk HIs for groups of chemicals with similar modes of toxicity, and an uncertainty evaluation. The following decision criteria were utilized:

- Estimated exposures with low SLV/NOAEL HQs below 1 were considered to not pose adverse effects to ecological receptors because of the inherent conservatism built into the exposure and effects assessments.
- Estimated exposures with high SLV/LOAEL HQs greater than 1 indicate that the exposure exceeds a known effect level for a test organism, and risk management may be warranted.
- Estimated exposures with low SLV/NOAEL HQs greater than 1 but high SLV/LOAEL HQs less than 1 were evaluated further as part of the uncertainty assessment to develop conclusions about the likelihood that a ~~potential risk~~risk or hazard was present.

COPECs that were determined to pose a ~~potential risk~~risk to ecological receptors at the conclusion of the BERA were identified as COECs and were recommended for further evaluation. The COECs for the Pistol Range AOPC were as follows:

- Soil: Lead – American robin

6.2.2.2 Ecological Chemicals of Concern and Project Action Levels

Ecological PALs for the Pistol Range AOPC were identified for each COEC/receptor group using the high 2012 SLVs for plants and invertebrates, the LOAEL-based RBCs for birds (robin) and mammals (shrew) developed in the BERA (URS-USACE 2016), and the site-specific background value (95% UPL). Lead was identified as a COEC.

The 2012 SLVs and RBCs for the receptor groups showing ~~potential risk~~risk to each COEC, the site-specific background values, and the ecological PALs are presented in Table 6-3. The ecological PAL is the lowest SLV or RBC unless that value is below the background value, in which case the background value is selected as the ecological PAL.

Table 6-3. Ecological Chemicals of Concern and Proposed Project Action Levels – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Plant High SLV (mg/kg)	Invertebrate High SLV (mg/kg)	American Robin LOAEL RBC (mg/kg)	Vagrant Shrew LOAEL RBC (mg/kg)	Site-specific Background 95% UPL (mg/kg)	Proposed Ecological Soil PAL* (mg/kg)	Exposure Depth (feet bgs)
Lead	--	--	78	--	25.5	78	0 to 1.5

* Proposed ecological PALs are only developed for the receptor groups that showed potential for adverse effects in the BERA. The ecological PAL is the lowest LOAEL RBC or high SLV unless it is less than background, in which case the site-specific background 95% UPL is shown.

Notes:

All values are shown in mg/kg.

-- = analyte was not identified as a COEC for this receptor or SLV/RBC not available
<bkg = below background

6.3 Removal Action Scope and Objectives

An NTCRA is being undertaken at the Pistol Range AOPC to address current and imminent site risks due to the COEC (lead) in soil and surface soil erosion (40 CFR 300.415).

Although not an NTCRA objective, the NTCRA is anticipated to also reduce site risks to future hypothetical fishing platform users.

RAOs, PALs, and estimated quantities of contaminated media are presented in the following subsections.

6.3.1 Removal Action Objectives

RAOs are specific goals for addressing risks and hazards associated with site-related contamination. RAOs can be accomplished by ensuring exposure pathways are not completed or by reducing concentrations of COECs at exposure points to below protective concentrations. RAOs define the extent to which sites require cleanup to meet the protectiveness objectives.

The RAOs developed for the Pistol Range AOPC are as follows:

- RAO PR1 – Reduce potential contaminant migration: Reduce potential contributions of lead in soil into the Columbia River through stormwater erosion.
- RAO PR2 – Prevent unacceptable ecological exposure to soil: Prevent ingestion and direct contact by ecological receptors of lead in excess of the PAL within soil (Table 6-4).

6.3.2 Project Action Levels

To achieve the RAOs listed above, the risk-based PAL for the Pistol Range AOPC is established in Table 6-4. The PAL is considered in evaluating the overall effectiveness of removal process options and alternatives and is considered protective of the environment for the COEC identified at the Pistol Range AOPC.

Table 6-4. Pistol Range AOPC Project Action Levels
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

COEC	Soil PAL (mg/kg)
Lead	78*

* Based on unacceptable health risks to ecological receptors (e.g., plants, invertebrates, American robin, and vagrant shrew).

Note:

Soil PALs are based on the proposed PALs in Table 6-3 only. The human health risk due to lead presented in Section 6.2.1.2 does not present a current and imminent site risk warranting an NTCRA and therefore is not included in Table 6-4.

6.3.3 Media and Areas Requiring Removal Action

Based on the findings in Sections 6.1.4, 6.2, and 6.3.2, lead concentrations exceeding the PAL have been identified in soil within two separate areas immediately downrange of the former Firing Shed (Firing Shed Area) and surrounding the backstop (Backstop Area) at the Pistol Range AOPC. Figure 6-1 shows the location of sample exceedances and proposed removal extents (corresponding to estimated quantities) at the Pistol Range AOPC (URS-USACE 2012, 2016). If additional areas are identified during the removal action to contain COECs in soil exceeding the PALs, then the soil from the additional areas will also be removed during the NTCRA if practical.

6.3.4 Quantity of Contaminated Media

The estimated quantity of contaminated soil exceeding PALs and considered during removal action alternative development and cost estimating is summarized in Table 6-5. These quantities were conservatively estimated based on the most current data inputs and assumptions available during development of this EE/CA. As additional data become available, these estimates may be further refined. The following data inputs and assumptions were used during quantity calculations:

- Data inputs:

  - The project RAOs and PALs
  - Ecological exposure scenarios and depths
  - Relevant historical analytical data from the RI Report, BHHRA/BERA, and associated previous reports (URS-USACE 2012, 2016)
  - Data graphically presented on figures using ArcGIS software; areas and volumes calculated using ArcGIS tools
  - Site photographs and aerial imagery from the RI Report, a project site visit on 8 November 2023, and other available sources (URS-USACE 2012)
  - Landowner tolerance for future environmental liabilities and remedial and removal actions
- Assumptions:
  - The Pistol Range AOPC removal action will address the lateral extent of contaminated soil exceeding PALs (source area) down to an estimated maximum depth of 3 feet bgs based on the previously presented RAOs, rationale, and data inputs.
  - The removal area was estimated based on the extent of soil contamination exceeding the PAL (source area) as shown on Figure 6-1.
  - If additional areas are identified during the removal action to contain waste debris and/or COECs in soil exceeding the PALs, then the waste debris and/or soil from the additional areas will also be removed during the NTCRA if practical.
  - The NTCRA is not the CERCLA final remedy, and if determined necessary, additional remedial actions~~,~~ would be addressed in the CERCLA final remedy.
  - Potential specific conflicts with onsite anthropogenic features, including utilities, will be mitigated during subsequent remedy planning and implementation. No paved roadways or buildings will be disturbed or compromised as a result of removal activities.
  - The excavated soil is assumed to have a swell factor of 1.25 (25 percent increase). This factor was used to convert in situ bank volumes to ex situ loose volumes during loading and transportation.
  - The contaminated soil is assumed to be predominantly moist silty sand and gravel (SM/GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001). This in situ bulk density was used to convert volume estimates to mass (weight) estimates.
  - Other site media, such as groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

Table 6-5 present the estimated quantity of contaminated soil considered during removal action alternative development and cost estimating.

Table 6-5. Estimated Removal Area Quantities for the Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Item Description	Removal Area Quantity[a]
Lateral Extent of Source	
Area P1 – Backstop Area	3,676 square feet[b] (0.084 acre)
Area P2 – Firing Shed Area	1.419 square feet[b] (0.033 acre)
Total area	5,095 square feet[b] (0.117 acre)
Vertical Extent of Source	
Area P1 – Backstop Area	3 feet bgs
Area P2 – Firing Shed Area	3 feet bgs
Volume	
Area P1 – Backstop Area	408 BCY
Area P2 – Firing Shed Area	158 BCY
Estimated total bank volume (in situ)	566 BCY
Soil swell factor	1.25 (25%)
Area P1 – Backstop Area	510 LCY
Area P2 – Firing Shed Area	198 LCY
Estimated total loose soil volume (ex situ)	708 LCY
Soil Mass	
Estimated bulk soil density	1.49 tons/BCY[c]
Area P1 – Backstop Area	608 tons
Area P2 – Firing Shed Area	236 tons
Estimated soil mass	844 tons

[a] Estimated extent or quantity of soil contamination exceeding PALs as shown on Figure 6-1.

[b] For estimating purposes, assumes a source area based on the extents of known soil contamination determined by analytical sample data.

[c] Assumed value based on a predominantly moist silty sand (GM) with an estimated in situ (bank) bulk density of 110 pounds per cubic foot (1.49 tons/BCY) (Peck, Hanson, and Thornburn 1974; NAVFAC 2008; Lindenburg 2001).

6.3.5 Removal Action Schedule

NTCRA field activities are planned to begin during ~~Summer 2026~~2025 and are expected to be completed within approximately 12 months. The required duration to perform removal action activities at the Pistol Range AOPC is estimated to be 2 weeks. Additional schedule details will be provided in a future NTCRA work plan.

6.4 Presumptive Remedy Considerations

Federal facilities, like the Bradford Island NPL Site, are encouraged to accelerate and streamline the cleanup of contaminated sites, including by the use of presumptive remedies (EPA 1994). As previously described in Sections 3.4, 4.4, and 5.4, presumptive remedies are being considered in this EE/CA to focus the removal action development and screening process and target alternatives known to be effective, feasible, and cost-efficient (EPA 1997, 1999).

~~As discussed in Section 6.1.4, the impacted soil at the Pistol Range AOPC poses a relatively low long-term threat. Generally, it is expected that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable.~~ Based on CSM similarities, ~~Therefore,~~ the Pistol Range AOPC was compared to EPA's evaluation and guidance for metals-in-soil sites presented in the following EPA guidance: *Presumptive Remedy for Metals-in-Soil Sites* (EPA 1999). This presumptive remedy is intended for use at sites where metals contamination in soils is a primary problem.

~~EPA has prescribed containment as the presumptive remedy for contaminated soil sites similar to the Pistol Range AOPC (EPA 1999). This presumptive remedy is intended for use at sites where metals contamination in soils is a primary problem.~~ EPA has prescribed "containment," such as engineering controls, as the presumptive remedy for metals-in-soil sites that pose a relatively low long-term threat similar to the Pistol Range AOPC (EPA 1999). Containment of metals-in-soil waste includes vertical or horizontal barriers, such as soil covers, caps, sheet piles, and slurry walls. These engineering controls can provide sustained isolation of contaminants and prevent mobilization of soluble compounds over long periods of time. ICs generally are used in conjunction with containment to further limit the potential for unintended access to the contaminated media.

~~EPA conducted an analysis of potentially available technologies for metals-in-soil sites and found that use of containment streamlines the remedy selection for metals-in-soil sites, like the Pistol Range AOPC, by narrowing the universe of alternatives on the basis of effectiveness, feasibility, or cost (EPA 1999). Containment of metals-in-soil waste includes vertical or horizontal barriers, such as soil covers, caps, sheet piles, and slurry walls. ICs generally are used in conjunction with containment to further limit the potential for unintended access to the contaminated media.~~

To accelerate and streamline the cleanup ~~of the Landfill AOPC~~, this EE/CA incorporates the containment presumptive remedy for the Pistol Range AOPC, thereby eliminating the need for further identification and screening of alternatives for the NTCRA beyond what is presented in the following removal alternative descriptions in Section 6.5 (EPA 1993c, 1994).

6.5 Removal Action Alternatives

6.5.1 Alternative Descriptions

A range of removal action alternatives has been identified to achieve the RAOs and corresponding PALs. The No Action Alternative was included for comparative purposes per the NCP.

6.5.1.1 Alternative P0 – No Action

The no action alternative provides a baseline against which to compare the performance and effectiveness of the other alternatives (EPA 2018). With Alternative P0, no action would be conducted in the near-term to address impacted soil at the Pistol Range AOPC, and no controls would be implemented in the short-term to control or monitor potential receptor exposures to site COECs. Onsite contaminated soil would remain in place, contamination will continue to migrate into the Columbia River, and ecological receptors will continue to be exposed to contamination until a long-term remedy is implemented for the AOPC. No NTCRA would be implemented to remove COEC sources or prevent potential future exposure. It is assumed that the current level of maintenance would be sustained. Alternative P0 will not achieve the RAOs (Section 6.3.1). This alternative has no ($0) capital, O&M, or periodic costs.

6.5.1.2 Alternative P1 – ~~Complete~~ Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

Alternative P1 primarily consists of (1) ~~complete~~ excavation and removal of contaminated soil in excess of the PAL within the Pistol Range AOPC to the vertical extent of contamination or maximum depth of 3 feet bgs, whichever is least; and (2) transporting and disposing of removed soil at a permitted, offsite RCRA Subtitle C and/or D landfill(s).

Alternative P1 would achieve all RAOs following completion of the removal action, which is expected within a duration of 2 to 4 weeks once work commences at the AOPC. The need for LUCs or O&M is not currently anticipated to control exposure to contaminants in soil for this alternative because the impacted soil would be removed from the site. If necessary, additional remedial actions, including LUCs and O&M, will be addressed in the CERCLA final remedy.~~No LUCs or O&M would be required to control exposure to contaminants in soil for this alternative because the impacted soil would be removed from the site.~~ Figure 6-1 and Appendix B, Sheet 12 show the proposed areas of contaminated soil removal.

Alternative P1 involves first removing the wooden remains of the former Firing Shed and backstop and clearing and grubbing the surface of Areas P1 and P2 at the Pistol Range AOPC. Within Areas P1 and P2, contaminated soil in excess of the PAL will be excavated down to the vertical extent of contamination or maximum depth of 3 feet bgs, whichever is least (Appendix B, Sheets 12 through 14 and Table 6-5). Although unlikely, if bedrock or groundwater is encountered during excavation, then the vertical extent of soil removal will be terminated. Removal will occur during seasonal low groundwater to achieve the greatest excavation depth without requiring additional excavation stabilization.

The lateral and vertical extents of soil removal at the Pistol Range AOPC will be continuously assessed during excavation using a combination of visual inspection and soil field screening. Field screening for the site COEC (lead only) may include employing handheld XRF analyzers and soil test kits. Once the extent of removal is thought to have been achieved, confirmation samples will be collected from the floor and walls of all open excavations and analyzed for lead to confirm that all contaminated soil above the PAL was removed. Confirmation sample results will be assessed on a point-by-point basis, and excavation will continue at any removal location that exceeds the PALs until follow-on confirmation samples can confirm that the extent of contamination exceeding the PALs has been successfully removed. The exception being where a maximum depth of potential exposure of 3 feet bgs or refusal at bedrock or groundwater is achieved, whichever is least.

Debris removal, clearing, grubbing, and excavation will be performed using traditional excavation and earthwork equipment. A pre-construction survey and assessment of adjacent access roads would be completed prior to commencing onsite work. The paved access road adjacent to the Pistol Range AOPC may require upgrades, including widening and structural improvement to the roadbed to effectively accommodate loaded end-dump trucks (e.g., addition of a gravel surface layer).

During excavation, waste debris, contaminated soil, and clean soil will be actively segregated based on field screening for offsite disposal or use as clean backfill (URS-USACE 2022c). Clean soil will be stacked into open stockpiles and ~~soil sampled~~tested to confirm acceptability for onsite reuse as backfill. Removed contaminated soil and wooden debris will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or the CWM Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). During excavation and loading, contaminated soil and any debris are to be managed separately and not commingled onsite or prior to delivery at an offsite landfill.

Waste characterization samples will be collected from removed soil to develop waste disposal profiles for transportation and disposal. Waste characterization samples will be analyzed for lead and TCLP metals. For disposal facility waste acceptance, waste characterization samples may also include, but are not limited to, the following analytical groups: TCLP RCRA metals, TCLP VOCs, TCLP SVOCs, TCLP pesticides and herbicides, PCBs, and asbestos due to facility history. Any hazardous waste soil disposal is subject to RCRA LDRs (40 CFR 268). In this case, the contaminated soil would be directly transported to the disposal facility for necessary offsite treatment and final disposal at the disposal facility. Prior to transport, the disposal facility would be notified that the hazardous waste is subject to LDRs for management in accordance with the terms of their disposal permit.

Following excavation and once RAOs have been achieved, all excavations would be backfilled to the existing grade, and any disturbed areas would be restored to their pre-removal action conditions (Appendix B, Sheets 12 and 14). Backfilling and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Clean backfill material should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c). The final backfilled grade will be contoured to the surrounding landscape. The volume of required clean backfill is estimated to be approximately 128 BCY (159 LCY; 190 tons), which may be obtained from clean soil adjacent to the site or imported from offsite. Potential adjacent areas of clean backfill are located north of the Pistol Range AOPC.

All disturbed areas, including the staging and loading area would be stabilized and revegetated by reseeding with suitable native scrub-shrub and herbaceous species in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Following seeding, a jute net should be placed over the areas that have been regraded. The jute net should be placed loosely over the ground in the direction of flow and secured with ground staples and check slots. Larger native vegetation species may also be planted to aid in site restoration. Construction monitoring and post-construction monitoring (i.e., a post-construction survey) would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the adjacent lagoon and the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into sensitive areas (URS-USACE 2022c). Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once removal activities are complete, the interim site controls would be discontinued.

Alternative P1 has capital costs but ~~no O&M~~ no anticipated O&M or periodic costs.

6.5.1.3 Alternative P2 – Engineered Soil Cover, Site Restoration, Institutional Controls, and Long-term Operation and Maintenance

Alternative P2 was developed based on EPA's presumptive remedy for metals-in-soil sites to provide containment of the contaminated soil exceeding the PALs within the Pistol Range AOPC (Areas P1 and P2). Per Sections 6.1.6 and 6.2, the primary potential complete exposure pathway at the Pistol Range AOPC is direct exposure (ingestion, dermal contact, inhalation of dusts and vapors, root uptake, and food chain uptake) to contaminated soil by human and ecological receptors. Alternative P2 prevents direct contact by physically and administratively restricting receptors from accessing the contamination source.

Alternative P2 primarily consists of (1) installing an engineered soil cover over the entire source area, (2) general site restoration, (3) establishing ICs that restrict specific land uses and activities that could damage the soil cover and/or cause receptor exposure, and (4) implement long-term O&M to maintain the integrity and protectiveness of the remedy.

Alternative P2 would achieve all RAOs following completion of removal action activities and the establishment of ICs. Removal action activities are expected to be complete within a duration of 2 to 4 weeks once work commences at the AOPC, but establishment of ICs is anticipated to take approximately 6 to 9 months. ICs and O&M would be required for the life of the remedy (greater than 30 years) to continue to control exposure to the covered contaminant source. Figure 6-2 shows the proposed areas of contaminated soil containment and application of ICs.

Alternative P2 involves first removing the wooden remains of the former Firing Shed and backstop and clearing and grubbing the surface of Areas P1 and P2 at the Pistol Range AOPC. Removed wooden debris will be loaded into 30-ton (25-LCY) total capacity end-dump trucks with pup trailers, driven approximately 110 miles east along Interstate 84, and disposed of at the Columbia Ridge Landfill (RCRA Subtitle D) and/or the CWM Arlington Landfill (RCRA Subtitle C) near Arlington, Oregon, as required (Waste Management 2024a, 2024b). Any wooden debris will be managed separately and not commingled with soil onsite or prior to delivery at an offsite landfill.

Once the former Firing Shed and backstop are removed, an engineered soil cover with a minimum total thickness of 3 feet will be constructed over Areas P1 and P2 to physically eliminate direct receptor exposure, reduce precipitation from percolating into the underlying contaminated soil, and prevent erosion of contaminated soil (Figure 6-2). The total soil cover thickness is based on the anticipated exposure depths for outdoor maintenance workers, hypothetical future fishing platform users, and ecological receptors (Section 6.1.6). The engineered soil cover will consist of a minimum of 2.5 feet of clean soil beneath a minimum of 0.5 foot of topsoil to allow for revegetation. An estimated 708 BCY (885 LCY) of clean soil and 142 BCY (277 LCY) of topsoil will need to be obtained from areas adjacent to the site or imported from offsite. Clean soil will be tested to confirm acceptability for onsite use in backfilling and soil cover construction. Backfilling and stabilization will be implemented according to the design details and specifications provided in Section 4 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). If needed, clean backfill should be placed at a minimum of 90 percent of the Modified Proctor Method, ASTM D 1557 (URS-USACE 2022c). After final grading, the engineered soil cover will be revegetated with suitable native, perennial grass and herbaceous species to minimize erosion. Following reseeding, a stabilizing jute net would be loosely placed over the restored areas in the direction of flow and secured with ground staples and check slots. Larger native vegetation species may also be planted to aid in surface stabilization.

All remaining disturbed areas, including staging and loading areas, would be restored by covering with 4 to 6 inches of topsoil; revegetating with suitable native, perennial scrub-shrub and herbaceous species; and stabilized in accordance with Section 4.4.3 of the *North Slope Regrade & Stabilization Geotechnical Design Report* (URS-USACE 2022c). Construction monitoring and a post-construction survey would occur for this alternative.

Interim site controls and BMPs would be implemented and maintained while work activities are underway, including sediment control fences, warning signage, and temporary construction fencing to secure the work areas. Standard sediment control BMP measures will be ~~considered~~applied to prevent transport of upland soils into the Columbia River. These measures may include temporary installation of sediment fences, decking, or other means installed downslope to intercept exposed material from migrating into the Columbia River (URS-USACE 2022c). All stockpiled soil will be contained on an impermeable ground liner and protected from adverse weather by a secured rain sheet. Routine site inspection, equipment maintenance, and interim site control maintenance would be performed as part of monitoring and maintenance activities. Once earthwork activities are complete, the interim site controls would be discontinued.

Lastly, administrative ICs, including signage, environmental deed restrictions or covenants, and access restrictions and control features, will be established at the Pistol Range AOPC to accomplish the following:

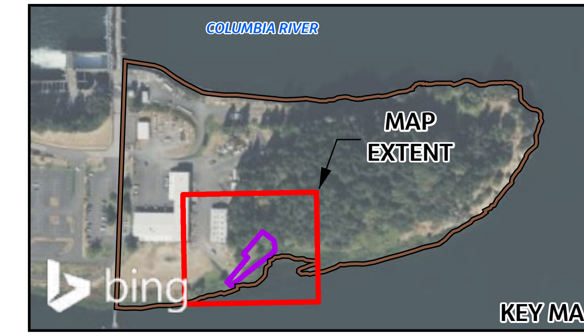
- Control potential exposure to the buried contaminated soil by current and future construction/excavation workers and other potential receptors.

- Restrict future site construction and excavation.
- Ensure land usage is compatible with agreed upon acceptable land uses, controls, and remedial design assumptions.
- Limit any unauthorized activities that would compromise the soil cover (e.g., excavation, drilling, or vehicular traffic).
- Warn of potential site hazards from buried contaminated soil.
- Prevent impacted soil from being transported offsite.
- Educate site workers and the public about access restrictions and potential site dangers.

Warning signage and perimeter barriers such as gates or bollards will be installed at possible site access locations (e.g., entrance of the Pistol Range AOPC) restricting motors vehicles onto the soil cover but still allowing foot traffic. Limited low impact vehicles may be allowed onsite for maintenance and inspections as necessary.

Additionally, an O&M program will be implemented to focus on verifying the continued protectiveness of the remedy and ensuring assumptions made during remedy selection remain valid. O&M will consist of semiannual site inspections of the engineered soil cover and signage, necessary maintenance of the soil cover, IC maintenance (such as sign maintenance and administrative reviews), and routine monitoring of site access and conditions.

Alternative P2 has capital costs, O&M, and periodic costs. ~~Five-year reviews will be required for the life of the remedy.~~



LEGEND

- SOIL CONCENTRATION DOES NOT EXCEED PAL
- SOIL CONCENTRATION EXCEEDS PAL

PFR71 — LOCATION NAME
32 (0 to 0.5) — SAMPLE DEPTH (feet BGS)
RESULT (mg/kg)

- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- ROAD
- TIMBER AND EARTHEN BACKSTOP
- PISTOL RANGE AOPC (11393 SQUARE FEET)
- FORMER FIRING SHED (APPROXIMATE)
- SOURCE AREA – AREA P1 (3675 SQUARE FEET)
- SOURCE AREA – AREA P2 (1419 SQUARE FEET)

COEC	SOIL PAL (mg/kg)
LEAD	78[a]

[a] BASED ON UNACCEPTABLE RISK TO THE AMERICAN ROBIN.

NOTES:

RED TEXT INDICATES ANALYTE RESULT EXCEEDS THE PAL

AOPC = AREA OF POTENTIAL CONCERN

BGS = BELOW GROUND SURFACE

COEC = CHEMICAL OF ECOLOGICAL CONCERN

mg/kg = MILLIGRAMS PER KILOGRAM

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

PAL = PROJECT ACTION LEVEL

0 40 80 Feet

N

FIGURE 6-1
PISTOL RANGE AOPC
ALTERNATIVE P1

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

LEGEND

- 2- FOOT ELEVATION CONTOUR (NAVD88) (USGS 2019)
- TIMBER AND EARTHEN BACKSTOP
- PISTOL RANGE AOPC (11393 SQUARE FEET)
- FORMER FIRING SHED (APPROXIMATE)
- SOURCE AREA – AREA P1 (3675 SQUARE FEET)
- SOURCE AREA – AREA P2 (1419 SQUARE FEET)
- SOIL COVER AREA

COC/COEC	SOIL PAL (mg/kg)
LEAD	78*

* BASED ON UNACCEPTABLE HEALTH RISKS TO ECOLOGICAL RECEPTORS (E.G., PLANTS, INVERTEBRATES, AMERICAN ROBIN, AND VAGRANT SHREW).

NOTES:

AOPC = AREA OF POTENTIAL CONCERN

BGS = BELOW GROUND SURFACE

COC = CONTAMINANT OF CONCERN (HUMAN HEALTH)

COEC = CONTAMINANT OF ECOLOGICAL CONCERN

mg/kg = MILLIGRAMS PER KILOGRAM

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

PAL = PROJECT ACTION LEVELS

0 40 80 Feet

FIGURE 6-2
PISTOL RANGE AOPC
ALTERNATIVE P2

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

Assessment of Removal Action Alternatives

All removal action alternatives, including the No Action Alternative, were developed for evaluation against the RAOs. The alternatives were initially evaluated individually based on effectiveness, implementability, and cost, and then the results were compared and qualitatively ranked to ascertain their relative merits in accordance with *Guidance on Conducting Non-Time-Critical Removal Action Under CERCLA* (EPA 1993a).

7.1 Individual Analysis

The removal action alternatives initially were evaluated individually regarding their overall effectiveness, implementability, and cost. The findings from the individual analyses are discussed in Tables 7-1 through 7-3.

7.1.1 Effectiveness

The *effectiveness* criterion addresses the expected results of the removal action alternatives and their ability to meet the RAO within the scope of the removal action (EPA 1988, 1993a). It includes the following subcategories that address both protectiveness and the ability to achieve the RAO.

- Protection of human health and the environment – Evaluates how the alternative achieves and maintains the protection of human health and the environment and achieves site-specific objectives both during and after implementation.
- Short-term effectiveness – Evaluates the effectiveness in protecting human health and the environment during implementation of an alternative before the RAO has been met. The duration of time until the RAO has been met also is factored into this criterion. Protection of the community and workers, environmental impacts, and time until the RAO is achieved are all considered.
- Long-term effectiveness and permanence – Evaluates the long-term effectiveness in maintaining protection of human health and environment after the RAO has been met. The magnitude of residual risk and adequacy and reliability of post-removal site controls are taken into consideration.
- Reduction of toxicity, mobility, or volume through treatment – Evaluates the anticipated performance of the specific treatment technologies and methods employed. CERCLA Section 121(b) includes a statutory preference for alternatives that permanently reduce the toxicity, mobility, or volume of contamination through treatment of contamination rather than removing and disposing of it offsite (42 U.S.C. 9621(b); 42 U.S.C. 9601(23); 42 U.S.C. 9601(24)). This statutory preference specifically applies to remedial actions, but EPA guidance states that the preference for treatment is also an appropriate goal for removal actions (EPA 1993a). When considering treatment, factors such as volume of materials destroyed or treated, the degree of expected reductions, the degree to which treatment is irreversible, and the type and quantity of remaining residuals are taken into consideration.

7.1.2 Implementability

The *implementability* criterion encompasses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation (EPA 1988, 1993a). It includes three subcategories that address both feasibility and the availability of resources:

- Technical feasibility – Evaluates the ability of the technology to implement the removal action. Factors to be considered include reliability of the technology, constructability, and operation, demonstrated performance and useful life, adaptability to environmental conditions, contribution to performance of long-term remedy effectiveness (42 U.S.C. 9604(a)(2)), implementation within the allotted schedule, and ease of undertaking cleanup actions if necessary.

- Administrative feasibility – Evaluates those activities needed to coordinate with other agencies, organizations, and interested parties. The need for permits, waivers, easements and/or rights-of-way, and adherence to applicable non-environmental laws are to be assessed. Statutory limits, impacts on adjoining property, the ability to impose LUCs, and concerns of other regulatory agencies should be considered.
- Availability of resources – Evaluates whether necessary resources are available to implement the scope and schedule of an alternative. The availability of equipment; personnel; services; materials; prospective technology; treatment, storage, and disposal capacity; funding; and other resources should be assessed.

7.1.3 Cost

The *cost* criterion encompasses the lifecycle costs of a project, including the projected implementation costs and the long-term O&M costs of the removal action (EPA 1988, 1993a; EPA and USACE 2000). It includes three subcategories that address overall cost of an alternative: capital costs, O&M costs, and periodic costs.

For the detailed cost analysis, the expenditures required to complete each alternative were estimated in terms of capital costs, including direct and indirect costs, to complete initial construction activities. Direct costs include the cost of construction, equipment, land and site development, pre-disposal treatment, transportation, and final disposal. Indirect costs include engineering expenses, startup and turndown costs, permit costs, and contingency allowances. O&M costs include the cost of O&M, annual monitoring and reporting costs, and auxiliary support costs. Periodic costs include the cost of conducting periodic 5-year reviews, if needed.

The alternatives were analyzed using TPV, which discounts all future costs, such as O&M and periodic costs, to the expected value at present (in 2024 base year dollars) (EPA and USACE 2000). TPV analysis allows the cost of the removal action to be compared based on a single figure representing the amount of money that, if invested in the base year (2024) and disbursed as needed, would be sufficient to cover all costs associated within the lifecycle of the removal action. The TPV cost calculations include an assumed discount rate of 2.5 percent, which is the United States 30-year “real” interest rate published by the U.S. Office of Management and Budget on 28 December 2023 for calendar year 2024 (OMB 2023).

The estimated costs are provided to an expected accuracy of -30 to +50 percent. The alternative cost estimates are in 2024 dollars, and the unit pricing is based on costs from similar projects, vendor quotes, or engineering estimates. Engineer’s cost estimates for each alternative are presented in Appendix C and summarized in Tables 7-1 through 7-3.

7.2 Comparative Analysis

The purpose of the comparative analysis is to identify the relative technical advantages and disadvantages of each alternative so that key tradeoffs affecting the selection of a removal action alternative can be identified. The findings of the individual analysis of the removal action alternatives are used to weigh and compare the alternatives relative to each another.

During the comparative analysis, the qualitative findings from the individual analyses were equated to a six-tiered, qualitative rating scale developed to weigh and compare the effectiveness, implementability, and cost of the alternatives. A rating of Very High, High, Moderate, Low, Very Low, and Unacceptable was assigned to each sub-criterion to provide relative indications of desirability, conformance, and acceptability. A rating of Very High is the most preferred acceptable outcome and a rating of Very Low is the least preferred acceptable outcome. An Unacceptable rating indicates that the minimum criterion conditions are not achieved. The sub-criterion ratings were then aggregated to determine an overall rating of effectiveness, implementability, and cost for each alternative. Ratings were assigned according to site knowledge, experience, and professional judgment and used as a means of weighing the trade-offs associated with each alternative.

The greatest rating does not necessarily indicate that an alternative is the best alternative. Comparison between removal alternatives should be assessed based both on the individual criteria and as a whole. Tables 7-4 through 7-6 summarize the comparative analysis of the removal alternatives, including the individual criteria and overall ratings of conformance/desirability.

Table 7-1. Individual Analysis of Removal Action Alternatives – Landfill AOPC

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative L0 – No Action	Alternative L1 – ~~Complete~~ Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration	Alternative L2 – Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M
Effectiveness	Protection of Human Health and the Environment	• Is the no action alternative. • Does not mitigate mass wasting and erosion of contaminated soil and waste debris into the Columbia River. • Does not protect ecological receptors from unacceptable exposure to COECs in soil and waste debris. • Does not achieve the RAO.	• Is a removal action alternative. • Mitigates mass wasting and erosion of contaminated soil and waste debris into the Columbia River via slope reduction, stabilization, and shoreline revetment. • Protects current ecological receptors from unacceptable exposure at the site by ~~completely~~ excavating the source of contamination and contaminated soil in excess of the PALs to the maximum depth of waste debris (15 feet bgs), bedrock, or groundwater, whichever is least • Achieves the RAOs.	• Is a removal action alternative based on EPA's containment presumptive remedy. • Mitigates mass wasting and erosion of contaminated soil and waste debris into the Columbia River via limited slope reduction, stabilization, and shoreline revetment. • Protects current ecological receptors from unacceptable exposure at the site by installing an engineered soil cover over the entire source area, establishing ICs, and implementing long-term O&M. • Achieves the RAOs.
	Short-term Effectiveness	• Does not provide short-term protectiveness of site workers, the community, or the environment during implementation of the alternative. • Does not create additional environmental impacts. • Does not reduce waste debris and COEC migration to surface water, groundwater, air, and transit surfaces through soil mass wasting, stormwater erosion, fugitive dust, and adherence to vehicles and equipment. • The time until the RAO is achieved is infinite.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Reduces worker protections by increasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by excavation, construction earthwork, and possible stormwater and airborne migration of contaminated soil/dust. • Application of appropriate engineering controls can reduce the ~~potential~~ risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 12 to 16 weeks once work commences at the AOPC.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Increases worker protections by decreasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by earthwork and possible stormwater and airborne migration of contaminated soil/dust. • Application of appropriate engineering controls can reduce the ~~potential~~ risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 6 to 9 months once construction is complete and ICs are established.
	Long-term Effectiveness and Permanence	• Does not provide long-term effectiveness, adequacy, and reliability in maintaining protection to human health and the environment. • Residual risk to human health and the environment remains unchanged.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining is minimal. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures is very high.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining is low. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures are high.
	Reduction of Toxicity, Mobility or Volume through Treatment	• Does not reduce the toxicity, mobility, or volume of contamination through treatment. • The type and quantity of remaining residuals are unchanged.	• Mitigates the transport of waste debris and contaminated soil into the environment, including the Columbia River, through removal and containment within an engineered and monitored RCRA Subtitle C or D landfill. • Reduces potential leaching of contaminants into the Columbia River that may negatively affect aquatic biota. • Highly reduces the quantity of remaining residuals. • Does not reduce the toxicity, mobility, or volume of contamination through treatment.	• Mitigates the transport of waste debris and contaminated soil into the environment, including the Columbia River, through onsite containment by a soil cover and slope reduction and stabilization. • Reduces potential leaching of contaminants into the Columbia River that may negatively affect aquatic biota. • Moderately reduces the quantity of remaining residuals. • Does not reduce the toxicity, mobility, or volume of contamination through treatment.

Table 7-1. Individual Analysis of Removal Action Alternatives – Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative L0 – No Action	Alternative L1 – ~~Complete~~Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration	Alternative L2 – Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M
Implementability	Technical Feasibility	• Does not require implementing technology, construction, or operation. • Does not contribute to the efficient performance of any long-term removal action of the contaminated soil onsite. • No construction, long-term O&M, or stewardship is required. • Implementation is expected to be complete once the Action Memorandum is finalized. • Implementation of the alternative will have no construction impacts on the local community. • Does not provide effectiveness and protectiveness; therefore, environmental conditions will have no change on the alternative. • LDRs will not apply because hazardous waste disposal is not necessary. • If necessary, additional removal action could be easily implemented.	• Removal and disposal are common construction methods with moderate constructability. • Does not require long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action onsite. • Implementation is expected to be complete in 12 to 16 weeks with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 875 trips) are expected to be very high due to the quantity of disposed source materials (equivalent to 18,570 LCY), imported backfill and topsoil (2,956 LCY), and imported riprap (365 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions will not impact the effectiveness and protectiveness of the alternative because the source of contamination has been removed. Therefore, the site would be highly adaptable to changing conditions. • With the exception of seasonal groundwater levels and bedrock depths, environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will apply to any offsite disposal of hazardous wastes, which may necessitate treatment to achieve the concentration levels required for disposal. Hazardous waste treatment technologies are well established and readily available. • If necessary, additional cleanup action could be very easily implemented.	• The necessary earthwork is a common construction method with moderate constructability. • Requires long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action onsite. • Implementation is expected to be complete in 6 to 9 months with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 349 trips) are expected to be low due to the quantity of disposed source materials (2,235 LCY); imported backfill, soil cover, and topsoil (6,114 LCY); and imported riprap (365 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions can impact the effectiveness and protectiveness of the alternative if the integrity of the soil cover is compromised by erosion, flooding, or other damage. Therefore, the site is moderately adaptable to changing conditions. • With the exception of seasonal groundwater levels and bedrock depths, environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will apply to any offsite disposal of hazardous wastes, which may necessitate treatment to achieve the concentration levels required for disposal of source materials removed as part of the slope reduction. Hazardous waste treatment technologies are well established and readily available. • If necessary, additional cleanup action could be easily implemented.
	Administrative Feasibility	• Does not require LUCs, including ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • Does not require any permits and/or waivers. • LDRs will not apply because hazardous waste disposal is not necessary. • Statutory limits do not apply. • Impacts on adjoining property will not occur.	• ~~Does not require~~ If the removal action is effective, LUCs, including ICs, are not anticipated to be necessary as part of the final remedy. • Does not limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • May require a SWPPP, other substantive permit-based requirements, and/or waivers. • LDRs may apply to the offsite disposal of hazardous wastes. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.	• Requires establishment of ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • May require a SWPPP, other substantive permit-based requirements, and/or waivers. • LDRs may apply to the offsite disposal of hazardous wastes. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.

Table 7-1. Individual Analysis of Removal Action Alternatives – Landfill AOPC

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative L0 – No Action	Alternative L1 – ~~Complete~~Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration	Alternative L2 – Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M
Implementability (cont'd)	Availability of Resources	• Does not require any equipment, materials, or technology. • May require specialized professionals and/or vendors, including lawyers, consultants, and engineers, which are reasonably available. • Does not require TSD capacity. • Funding is not required.	• Requires traditional construction equipment and materials, which are readily available. • The required technology is well understood and available for full-scale implementation. • Additional field screening, confirmation soil sampling, and waste characterization sampling will be required. Sampling technologies are well established, and sample laboratories are reasonably available. • Requires specialized professionals and/or vendors, including engineers, construction managers, environmental scientists, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, and interim site control maintenance. • Several permitted RCRA C and D landfills are available in Oregon and nearby states to accept removed wastes. • Offsite TSD capacity is sufficient. • Funding is adequate.	• Requires traditional construction equipment and common materials, which are readily available. • The required technology is well understood and available for full-scale implementation. • Additional confirmation soil sampling and waste characterization sampling will be required. Sampling technologies are well established, and sample laboratories are reasonably available. • Requires specialized professionals and/or vendors, including lawyers, engineers, construction managers, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, ICs, and O&M. • Several permitted RCRA C and D landfills are available in Oregon and nearby states to accept removed wastes. • Offsite TSD capacity is sufficient. • Funding is adequate.
Costs*	Estimated Total Cost	$0	$15,458,579	$5,972,024
	Capital Costs	$0	$15,458,579	$4,540,137
	O&M Costs	$0	$0	$1,201,864
	Periodic Costs	$0	$0	$230,023
	Estimated Total Cost Range (-30% to +50%)	$0	$10,821,005 – $23,187,868	$4,180,417 – $8,958,037
	TPV Cost	$0	$15,458,579	$5,412,534

*Includes excavating the Bulb Slope AOPC and replacing and stabilizing the asphalt access road along the top of the Bulb Slope as part of the Landfill AOPC removal action as described in Section 4. See Appendix C for additional cost details.

Notes:

SWPPP = Storm Water Pollution Prevention Plan
TSD = transport, storage, and disposal

Table 7-2. Individual Analysis of Removal Action Alternatives – Sandblast Area AOPC

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative S0 – No Action	Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration	Alternative S2 – Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M
Effectiveness	Protection of Human Health and the Environment	• Is the no action alternative. • Does not mitigate the erosion of contaminated soil and spent sandblast grit into the Columbia River, into the air through windblow transport, or the offsite transport through adherence to vehicles and equipment. • Does not protect ecological receptors from unacceptable exposure to COECs in soil and spent sandblast grit. • Does not achieve the RAO.	• Is a removal action alternative. • Mitigates the erosion of contaminated soil and spent sandblast grit into the Columbia River, into the air through windblow transport, and the offsite transport through adherence to vehicles and equipment at the ELA North and the SGSA subareas of the Sandblast Area AOPC by (1) removing the visible spent sandblast grit within the SGSA; (2) removing contaminated soil in excess of the PALs down to the vertical extent of contamination or maximum depth of receptor exposure (3 feet bgs), whichever is least; and (3) installing a shoreline vegetation buffer and asphalt storage surface at ELA North. • Protects current ecological receptors from unacceptable exposure to COECs in soil and spent sandblast grit through removal action. • Achieves the RAOs.	• Is a removal action alternative based on EPA's containment presumptive remedy. • Mitigates the erosion of contaminated soil and spent sandblast grit into the Columbia River, into the air through windblow transport, and the offsite transport through adherence to vehicles and equipment at the ELA North and the SGSA subareas of the Sandblast Area AOPC by (1) removing the visible spent sandblast grit within the SGSA, (2) installing an soil cover and asphalt cap over the entire source area at ELA North, (3) installing a riprap revetment with vegetative buffer along the river shoreline, (4) general site restoration, (5) establishing ICs, and (6) implementing of long-term O&M. • Protects current ecological receptors from unacceptable exposure to COECs in soil and spent sandblast grit through containment (covering and capping). • Achieves the RAOs.
	Short-term Effectiveness	• Does not provide short-term protectiveness of site workers, the community, or the environment during implementation of the alternative. • Does not create additional environmental impacts. • Does not reduce contaminated soil and spent sandblast grit migration to surface water, groundwater, air, and transit surfaces through soil mass wasting, stormwater erosion, fugitive dust, and adherence to vehicles and equipment. • The time until the RAO is achieved is infinite.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Reduces worker protections by increasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by excavation, construction earthwork, and possible migration of contaminated soil/dust and spent sandblast grit through stormwater erosion, fugitive dust, and adherence to vehicles and equipment. • Application of appropriate engineering controls can reduce the ~~potential~~ risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 4 to 8 weeks once work commences at the AOPC.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Increases worker protections by decreasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by earthwork and possible stormwater and airborne migration of contaminated soil/dust. • Application of appropriate engineering controls can reduce the ~~potential~~ risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 6 to 9 months once construction is complete and ICs are established.
	Long-term Effectiveness and Permanence	• Does not provide long-term effectiveness, adequacy, and reliability in maintaining protection to human health and the environment. • Residual risk to human health and the environment remains unchanged.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining in targeted areas is minimal. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures is very high.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining is low. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures are high.
	Reduction of Toxicity, Mobility or Volume through Treatment	• Does not reduce the toxicity, mobility, or volume of contamination through treatment. • The type and quantity of remaining residuals are unchanged.	• Reduces the transport of contaminated soil and spent sandblast grit into the environment, including the Columbia River, through removal and containment within an engineered and monitored RCRA Subtitle C or D landfill. • Does not reduce the toxicity, mobility, or volume of contamination through treatment.	• Reduces the transport of contaminated soil and spent sandblast grit into the environment, including the Columbia River, through removal and onsite containment by a soil cover, asphalt cap, vegetative buffer, and stabilization. • The type and quantity of remaining residuals are unchanged. • Does not reduce the toxicity, mobility, or volume of contamination through treatment.

Table 7-2. Individual Analysis of Removal Action Alternatives – Sandblast Area AOPC

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative S0 – No Action	Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration	Alternative S2 – Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M
Implementability	Technical Feasibility	• Does not require implementing technology, construction, or operation. • Does not contribute to the efficient performance of any long-term removal action of the contaminated soil onsite. • No construction, long-term O&M, or stewardship is required. • Implementation is expected to be complete once the Action Memorandum is finalized. • Implementation of the alternative will have no construction impacts on the local community. • Does not provide effectiveness and protectiveness; therefore, environmental conditions will have no change on the alternative. • LDRs will not apply because hazardous waste disposal is not necessary. • If necessary, additional removal action could be easily implemented.	• Removal and disposal are common construction methods with high constructability and minimal follow-on operation. • Does not require long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action of the contaminated soil and spent sandblast grit onsite. • Implementation is expected to be complete in 4 to 8 weeks with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 206 trips) are expected to be low due to the quantity of disposed source materials (2,235 LCY), imported backfill and topsoil (2,126 LCY), and imported riprap (778 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions will not impact the effectiveness and protectiveness of the alternative because the source of contamination has been removed. Therefore, the site would be highly adaptable to changing conditions. • With the exception of seasonal groundwater levels and bedrock depths, environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will apply to any offsite disposal of hazardous wastes, which may necessitate treatment to achieve the concentration levels required for disposal of spent sandblast grit and contaminated soil. Hazardous waste treatment technologies are well established and readily available. • If necessary, additional cleanup action could be very easily implemented.	• The necessary earthwork is a common construction method with moderate constructability. • Requires long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action onsite. • Implementation is expected to be complete in 6 to 9 months with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 80 trips) are expected to be very low due to the quantity of disposed source materials (70 LCY); imported backfill, soil cover, and topsoil (1,150 LCY); and imported riprap (778 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions can impact the effectiveness and protectiveness of the alternative if the integrity of the soil cover or asphalt cap is compromised by cracking, erosion, flooding, or other damage. Therefore, the site is moderately adaptable to changing conditions. • With the exception of bedrock depths and soil stability at the waterline, environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will apply to any offsite disposal of hazardous wastes, which may necessitate treatment to achieve the concentration levels required for disposal of spent sandblast grit. Hazardous waste treatment technologies are well established and readily available. • If necessary, additional cleanup action could be easily implemented.
	Administrative Feasibility	• Does not require LUCs, including ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • Does not require any permits and/or waivers. • LDRs will not apply because hazardous waste disposal is not necessary. • Statutory limits do not apply. • Impacts on adjoining property will not occur.	• If the removal action is effective, LUCs, including ICs, are not anticipated to be necessary as part of the final remedy. ~~Does not require LUCs, including ICs.~~ • Does not limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • May require a SWPPP, other substantive permit-based- requirements, and/or waivers. • LDRs may apply to the offsite disposal of hazardous wastes. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.	• Requires establishment of ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • May require a SWPPP, other substantive permit-based- requirements, and/or waivers. • LDRs may apply to the offsite disposal of hazardous wastes. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.

Table 7-2. Individual Analysis of Removal Action Alternatives – Sandblast Area AOPC

Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative S0 – No Action	Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration	Alternative S2 – Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M
Implementability (cont'd)	Availability of Resources	• Does not require any equipment, materials, or technology. • May require specialized professionals and/or vendors, including lawyers, consultants, and engineers, which are reasonably available. • Does not require TSD capacity. • Funding is not required.	• Requires traditional construction equipment and materials, which are readily available. • Removal, landfilling, and site restoration technology is well understood and available for full-scale implementation. • Additional field screening, confirmation soil sampling, and waste characterization sampling will be required. Sampling technologies are well established, and sample laboratories are reasonably available. • Requires specialized professionals and/or vendors, including engineers, construction managers, environmental scientists, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, and interim site control maintenance. • Several permitted RCRA C and D landfills are available in Oregon and nearby states to accept removed wastes. • Offsite TSD capacity is sufficient. • Funding is adequate.	• Requires traditional construction equipment and materials, which are readily available. • The required technology is well understood and available for full-scale implementation. • Additional visual inspection and waste characterization sampling will be required. Sampling technologies are well established, and sample laboratories are reasonably available. • Requires specialized professionals and/or vendors, including lawyers, engineers, construction managers, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, ICs, and O&M. • Several permitted RCRA C and D landfills are available in Oregon and nearby states to accept removed wastes. • Offsite TSD capacity is sufficient. • Funding is adequate.
Costs	Estimated Total Cost	$0	$2,610,926	$2,465,546
	Capital Costs	$0	$2,610,926	$1,480,058
	O&M Costs	$0	$0	$790,817
	Periodic Costs	$0	$0	$194,672
	Estimated Total Cost Range (-30% to +50%)	$0	$1,827,648 – $3,916,389	$1,725,882 – $3,698,319
	TPV Cost	$0	$2,610,926	$2,160,986

Table 7-3. Individual Analysis of Removal Action Alternatives – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative P0 – No Action	Alternative P1 – ~~Complete~~Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration	Alternative P2 – Engineered Soil Cover, Site Restoration, ICs, and Long-term O&M
Effectiveness	Protection of Human Health and the Environment	• Is the no action alternative. • Does not mitigate erosion of contaminated soil into the Columbia River. • Does not protect ecological receptors from unacceptable exposure to COECs in soil and waste debris. • Does not achieve the RAOs.	• Is a removal action alternative. • Mitigates erosion of contaminated soil into the Columbia River by (1) removing contaminated soil in excess of the PALs down to the vertical extent of contamination or maximum depth of 3 feet bgs, whichever is least; and (2) planting a vegetative cover. • Protects ecological receptors from unacceptable exposure to COECs in soil through removal action. • Achieves the RAOs.	• Is a removal action alternative based on EPA's containment presumptive remedy. • Mitigates erosion of contaminated soil into the Columbia River by (1) installing an engineered soil cover over the entire source area; (2) soil stabilization and general site restoration; (3) establishing ICs; and (4) implementing long-term O&M. • Protects ecological receptors from unacceptable exposure to COECs in soil through containment (soil cover). • Achieves the RAOs.
	Short-term Effectiveness	• Does not provide short-term protectiveness of site workers, the community, or the environment during implementation of the alternative. • Does not create additional environmental impacts. • Does not reduce waste debris and COEC migration to surface water, groundwater, air, and transit surfaces through soil mass wasting, stormwater erosion, fugitive dust, and adherence to vehicles and equipment. • The time until the RAOs are achieved is infinite.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Reduces worker protections by increasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by excavation, construction earthwork, and possible migration of contaminated soil/dust through stormwater erosion, fugitive dust, and adherence to vehicles and equipment. • Application of appropriate engineering controls can reduce the ~~potential risk~~risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 2 to 4 weeks once work commences at the AOPC.	• Provides short-term protectiveness of the community and environment during implementation by employing interim site controls and BMPs, including sediment control fences, warning signage, and temporary construction fencing. • Increases worker protections by decreasing the likelihood of site excavation worker exposure during implementation of the alternative. • Creates additional environmental impacts by earthwork and possible stormwater and airborne migration of contaminated soil/dust. • Application of appropriate engineering controls can reduce the ~~potential risk~~risks to workers and impacts to the environment. • Will achieve the RAOs within approximately 6 to 9 months once construction is complete and ICs are established.
	Long-term Effectiveness and Permanence	• Does not provide long-term effectiveness, adequacy, and reliability in maintaining protection to human health and the environment. • Residual risk to human health and the environment remains unchanged.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining is minimal. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures is very high.	• Maintains long-term protectiveness of site workers, the community, and environment after the RAOs are achieved. • The magnitude of residual risk remaining is low. • Provides adequate long-term measures for sustaining protectiveness. • Long-term reliability of the technology and control measures are high.
	Reduction of Toxicity, Mobility or Volume through Treatment	• Does not reduce the toxicity, mobility, or volume of contamination through treatment. • The type and quantity of remaining residuals are unchanged.	• Reduces the transport of COECs into the environment, including the Columbia River, through removal and containment within an engineered and monitored RCRA Subtitle C or D landfill. • Does not permanently reduce the toxicity, mobility, or volume of contamination through treatment.	• Reduces the transport of COECs into the environment, including the Columbia River, through onsite containment by a soil cover and stabilization. • The type and quantity of remaining residuals are unchanged. • Does not reduce the toxicity, mobility, or volume of contamination through treatment.

Table 7-3. Individual Analysis of Removal Action Alternatives – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative P0 – No Action	Alternative P1 – ~~Complete~~Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration	Alternative P2 – Engineered Soil Cover, Site Restoration, ICs, and Long-term O&M
Implementability	Technical Feasibility	• Does not require implementing technology, construction, or operation. • Does not contribute to the efficient performance of any long-term removal action of the contaminated soil onsite. • No construction, long-term O&M, or stewardship is required. • Implementation is expected to be complete once the Action Memorandum is finalized. • Implementation of the alternative will have no construction impacts on the local community. • Does not provide effectiveness and protectiveness; therefore, environmental conditions will have no change on the alternative. • LDRs will not apply because hazardous waste disposal is not necessary. • If necessary, additional removal action could be easily implemented.	• Removal and disposal are common construction methods with high constructability and minimal follow-on operation. • Does not require long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action of the contaminated soil onsite. • Implementation is expected to be complete in 2 to 4 weeks with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 49 trips) are expected to be very low due to the quantity of disposed source materials (equivalent 713 LCY) and imported backfill and topsoil (505 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions will not impact the effectiveness and protectiveness of the alternative because the source of contamination has been removed. Therefore, the site would be highly adaptable to changing conditions. • With the exception of seasonal groundwater levels and bedrock depths, environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will apply to any offsite disposal of hazardous wastes, which may necessitate treatment to achieve the concentration levels required for disposal. Hazardous waste treatment technologies are well established and readily available. • If necessary, additional cleanup action could be very easily implemented.	• The necessary earthwork is a common construction method with moderate constructability. • Requires long-term O&M and stewardship. • Is an established technology with a high level of reliability and minimal delays during implementation. • Performance of the technology and methods has been well demonstrated. • The technology will contribute to the efficient performance of any long-term removal action onsite. • Implementation is expected to be complete in 6 to 9 months with an indefinite useful life. • Potential impacts on the local community during construction operations from additional truck traffic (estimated 43 trips) are expected to be very low due to the quantity of disposed source materials (equivalent to 5 LCY), and imported backfill, soil cover, and topsoil (1,062 LCY). • The approximate driving distance from the AOPC to landfill disposal is approximately 110 miles. • Environmental conditions can impact the effectiveness and protectiveness of the alternative if the integrity of the soil cover is compromised by erosion, flooding, or other damage. Therefore, the site is moderately adaptable to changing conditions. • Environmental and geographic conditions will have little effect on the set-up and construction phases. • LDRs will not apply because hazardous waste disposal is not necessary. • If necessary, additional cleanup action could be easily implemented.
	Administrative Feasibility	• Does not require LUCs, including ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team (and potentially other interested parties. • Does not require any permits and/or waivers. • LDRs will not apply because hazardous waste disposal is not necessary. • Statutory limits do not apply. • Impacts on adjoining property will not occur.	• If the removal action is effective, LUCs, including ICs, are not anticipated to be necessary as part of the final remedy. ~~Does not require LUCs, including ICs.~~ • Does not limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • Does not require LUCs, including ICs. • May require a SWPPP, other substantive permit-based- requirements, and/or waivers. • LDRs may apply to the offsite disposal of hazardous wastes. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.	• Requires establishment of ICs. • May limit future land uses. • Requires coordination with the Bradford Island NPL Site Technical Coordination Team and potentially other interested parties. • Requires establishment of ICs. • May require a SWPPP, other substantive permit-based- requirements, and/or waivers. • LDRs will not apply because hazardous waste disposal is not necessary. • The alternative will not be EPA funded; therefore, no statutory limits apply. • Impacts on adjoining property will be minimal.

Table 7-3. Individual Analysis of Removal Action Alternatives – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion	Subcategories	Alternative P0 – No Action	Alternative P1 – ~~Complete~~Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration	Alternative P2 – Engineered Soil Cover, Site Restoration, ICs, and Long-term O&M
Implementability (cont'd)	Availability of Resources	• Does not require any equipment, materials, or technology. • May require specialized professionals and/or vendors, including lawyers, consultants, and engineers, which are reasonably available. • Does not require TSD capacity. • Funding is not required.	• Requires traditional construction equipment and materials, which are readily available. • Removal, landfilling, and site restoration technology is well understood and available for full-scale implementation. • Additional field screening, confirmation soil sampling, and waste characterization sampling will be required. Sampling technologies are well established, and sample laboratories are reasonably available. • Requires specialized professionals and/or vendors, including engineers, construction managers, environmental scientists, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, and interim site control maintenance. • Several permitted RCRA C and D landfills are available in Oregon and nearby states to accept removed wastes. • Offsite TSD capacity is sufficient. • Funding is adequate.	• Requires traditional construction equipment and common materials, which are readily available. • The required technology is well understood and available for full-scale implementation. • Additional confirmation soil sampling and waste characterization sampling will not be required. • May require specialized professionals and/or vendors, including lawyers, engineers, construction managers, consultants, and tradesman, which are reasonably available. • Requires personnel, equipment, and materials for installation of interim site controls and BMPs, routine site inspection, equipment maintenance, ICs, and O&M. • Several permitted RCRA D landfills are available to accept removed non-hazardous wooden debris in Oregon and nearby states. • Offsite TSD capacity is sufficient. • Funding is adequate.
Costs	Estimated Total Cost	$0	$1,061,803	$1,307,980
	Capital Costs	$0	$1,061,803	$684,500
	O&M Costs	$0	$0	$428,808
	Periodic Costs	$0	$0	$194,672
	Estimated Total Cost Range (-30% to +50%)	$0	$743,262 – $1,592,704	$915,586 – $1,961,969
	TPV Cost	$0	$1,061,803	$1,112,864

Table 7-4. Comparative Analysis of Removal Action Alternatives – Landfill AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion/Sub-criteria[a]	Alternative L0 – No Action	Alternative L1 – ~~Complete~~Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration	Alternative L2 – Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M
Effectiveness Rating[b]	Unacceptable	High	~~High~~Moderate
Protection of Human Health and the Environment	Unacceptable	Very High	~~Very High~~Moderate
Short-term Effectiveness	Unacceptable	Moderate	~~High~~Moderate
Long-term Effectiveness and Permanence	Unacceptable	Very High	~~High~~Moderate
Reduction of Toxicity, Mobility, or Volume through Treatment[c]	Unacceptable	Very Low	Very Low
Implementability Rating[b]	Unacceptable	Very High	High
Technical Feasibility	Unacceptable	High	High
Administrative Feasibility	Unacceptable	Very High	Moderate
Availability of Resources	Unacceptable	Very High	Very High
Cost[d]			
TPV Cost	$0	$15,458,579	$5,412,534
Estimated Total Cost Range (-30% to +50%)	$0	$10,821,005 – $23,187,868	$4,180,417 – $8,958,037
Overall Rating[e]	Unacceptable	High	High

[a] The sub-criterion ratings were aggregated to determine an overall rating of effectiveness, implementability, and cost for each alternative.

[b] Except Cost, a rating of Very High, High, Moderate, Low, Very Low, or Unacceptable was assigned to each sub-criterion to provide relative indications of desirability, conformance, and acceptability.

[c] CERCLA Section 121(b) includes a statutory preference for alternatives that permanently reduce the toxicity, mobility, or volume of contamination through treatment contamination rather than removing and disposing of it offsite (42 U.S.C. 9621(b); 42 U.S.C. 9601(23); 42 U.S.C. 9601(24)). This statutory preference specifically applies to remedial actions, but EPA guidance (EPA 1993a) states that the preference for treatment is also an appropriate goal for removal actions. As result, all removal action alternatives were assigned a very low rating.

[d] Includes excavating the Bulb Slope AOPC and replacing and stabilizing the asphalt access road along the top of the Bulb Slope as part of the Landfill AOPC removal action as described in Section 4.

[e] Effectiveness, implementability, and cost were equally considered to provide an overall rating.

Table 7-5. Comparative Analysis of Removal Action Alternatives – Sandblast Area AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion/Sub-criteria[a]	Alternative S0 – No Action	Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration	Alternative S2 – Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M
Effectiveness Rating[b]	Unacceptable	High	Moderate
Protection of Human Health and the Environment	Unacceptable	Very High	~~Very High~~Moderate
Short-term Effectiveness	Unacceptable	Moderate	Moderate
Long-term Effectiveness and Permanence	Unacceptable	Very High	High
Reduction of Toxicity, Mobility, or Volume through Treatment[c]	Unacceptable	Very Low	Very Low
Implementability Rating[b]	Unacceptable	Very High	High
Technical Feasibility	Unacceptable	Very High	High
Administrative Feasibility	Unacceptable	High	Moderate
Availability of Resources	Unacceptable	Very High	Very High
Cost			
TPV Cost	$0	$2,610,926	$2,160,986
Estimated Total Cost Range (-30% to +50%)	$0	$1,827,648 – $3,916,389	$1,725,882 – $3,698,319
Overall Rating[d]	Unacceptable	High	Moderate

[a] The sub-criterion ratings were aggregated to determine an overall rating of effectiveness, implementability, and cost for each alternative.

[b] Except Cost, a rating of Very High, High, Moderate, Low, Very Low, or Unacceptable was assigned to each sub-criterion to provide relative indications of desirability, conformance, and acceptability.

[c] CERCLA includes a statutory preference to permanently reduce the toxicity, mobility, or volume of contamination through treatment. A removal action is not the same as treatment; therefore, all removal action alternatives were assigned a very low rating.

[d] Effectiveness, implementability, and cost were equally considered to provide an overall rating.

Table 7-6. Comparative Analysis of Removal Action Alternatives – Pistol Range AOPC
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

Evaluation Criterion/Sub-criteria[a]	Alternative P0 – No Action	Alternative P1 – ~~Complete~~ Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration	Alternative P2 – Engineered Soil Cover, Site Restoration, ICs, and Long-term O&M
Effectiveness Rating[b]	Unacceptable	High	~~High~~Moderate
Protection of Human Health and the Environment	Unacceptable	Very High	~~Very High~~Moderate
Short-term Effectiveness	Unacceptable	Moderate	~~High~~Moderate
Long-term Effectiveness and Permanence	Unacceptable	Very High	High
Reduction of Toxicity, Mobility, or Volume through Treatment[c]	Unacceptable	Very Low	Very Low
Implementability Rating[b]	Unacceptable	Very High	High
Technical Feasibility	Unacceptable	Very High	High
Administrative Feasibility	Unacceptable	High	Moderate
Availability of Resources	Unacceptable	Very High	Very High
Cost			
TPV Cost	$0	$1,061,803	$1,112,864
Estimated Total Cost Range (-30% to +50%)	$0	$743,262 – $1,592,704	$915,586 – $1,961,969
Overall Rating[d]	Unacceptable	High	Moderate

[a] The sub-criterion ratings were aggregated to determine an overall rating of effectiveness, implementability, and cost for each alternative.

[b] Except Cost, a rating of Very High, High, Moderate, Low, Very Low, or Unacceptable was assigned to each sub-criterion to provide relative indications of desirability, conformance, and acceptability.

[c] CERCLA includes a statutory preference to permanently reduce the toxicity, mobility, or volume of contamination through treatment. A removal action is not the same as treatment; therefore, all removal action alternatives were assigned a very low rating.

[d] Effectiveness, implementability, and cost were equally considered to provide an overall rating.

Recommended Removal Action Alternatives

Alternatives L0, S0, and P0 (no action) do not prevent mass wasting, erosion, and migration of ~~contaminated soil,~~ contaminated waste debris, contaminated soil, and spent sandblast grit. As a result, these no action alternatives do not protect ecological receptors from unacceptable exposure to applicable waste debris~~,~~ and COECs, and do not meet their respective RAOs. Additionally, these no action alternatives are considered unacceptable regarding effectiveness, implementability, and cost.

~~In comparison, the remaining~~ Alternatives L1, ~~L2,~~ S1, ~~S2,~~ and P1~~, and P2~~ are each highly effective and very highly implementable overall, ~~protective of the environment~~ and ~~all~~ each provides a ~~a high to very high level~~greater level of human health and the environmental protectiveness, long-term effectiveness and permanence, technical feasibility, ~~, technical feasibility, and availability of necessary resources.~~ and administrative feasibility compared to the other alternatives. These alternatives also likely provide a significantly shorter duration to achieve the RAOs and greater protectiveness of the community and environment without the need to establish ICs and provide long-term stewardship in the future. Additionally, Alternatives L1, S1, and P1 are the most likely to not limit future land uses.

Comparatively, Alternatives L2, S2, and P2 are only moderately effective but are also highly implementable overall. These alternatives provide an equal or higher level of short-term effectiveness~~,~~; reduction of toxicity, mobility, or volume through treatment; and availability of resources compared to ~~Alternatives L1, S1, and P1 provide a greater level of short-term effectiveness and administrative feasibility than~~ Alternatives L1, S1, and P1~~the other alternatives~~. The advantages of Alternatives L2, S2, and P2 are primarily due to the ~~significantly shorter duration to achieve the RAOs and full~~ protectiveness of site workers and costs (except for cost of Alternative P2).~~the community and environment without the need to establish ICs and provide long-term stewardship in perpetuity. Additionally, Alternatives L1, S1, and P1 do not limit future land uses.~~

Excluding no action, Alternatives L2, S2, and P1 are the least costly alternatives~~compared to their corresponding sister alternatives (Alternatives L1, B2, S1, and P2)~~. Although very similar, any differences between Alternatives L1, L2, S1, S2, P1, and P2 are primarily due to the quantities of disposed and imported materials (e.g., soils and wastes), expected waste designation, and complexity of earthwork and construction required at each AOPC that affect the likelihood and duration of site excavation worker exposure, the amount of transportation, the level of interim site controls and BMPs, and the need to achieve LDRs and establish ICs, and perform long-term O&M and stewardship.

Based on the evaluation of the tradeoffs between the alternatives, the recommended removal alternatives for the Upland OU are as follows:

- Landfill AOPC: Alternative L1 – ~~Complete~~ Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration
- Sandblast Area AOPC (ELA North and SGSA): Alternative S1 – Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration
- Pistol Range AOPC: Alternative P1 – ~~Complete~~ Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

The NTCRA is not the CERCLA final remedy, and additional remedial actions, including LUCs and O&M, will be addressed in the CERCLA final remedy, if needed. Site media at the Landfill AOPC, Bulb Slope AOPC, Sandblast AOPC, Pistol Range AOPC, including subsurface soil, groundwater, surface water, and sediment, will continue to be assessed as part of supplemental remedial investigation of the Upland OU and River OU.

Federal Facility Agreement party Project Managers will have the opportunity to comment on the recommendation during the regulatory review period for this EE/CA. USACE will support EPA's Technical Coordination Team meetings in discussing the EE/CA. Following the regulatory review period under the Federal Facility Agreement, any separate review period under memoranda of understanding with interested Tribes, and a 30-day public comment period, in connection with restoration advisory board meetings, will be held to assess public acceptance of the recommended alternatives. Written responses to comments will be prepared after the close of the public comment period and will be included in the Administrative Record file. The basis for the selection of an appropriate removal action will be documented in an Action Memorandum.

SECTION 9

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Appendix A
Potentially Applicable or Relevant and Appropriate Requirements

Description	Citations or References	Requirement	Rationale	Associates to AOPC / Alternative: Landfill AOPC			Sandblast Area AOPC			Pistol Range AOPC		
				L0	L1*	L2*	S0	S1	S2	P0	P1	P2
Chemical-specific ARARs												
None				--	--	--	--	--	--	--	--	--
Location-specific ARARs												
Archaeological Resources Protection Act of 1979	• 16 USC 470ee(a)	Provides for the protection of archaeological resources on federal, state, and Tribal lands. Imposes conditions for excavation or removal of archaeological or historical materials.	Applicable if historical and archaeological resources may be irreparably harmed by implementation of the removal action activities.	--	◆	◆	--	◆	◆	--	◆	◆
Native American Graves Protection and Repatriation Act of 1990	• 43 CFR 10.5(b)	If a discovery is made, all nearby activity must stop.	Applicable if Native American funerary objects, sacred objects, or objects of patrimony are discovered at the site.	--	◆	◆	--	◆	◆	--	◆	◆
Endangered Species Act of 1973	• 16 USC 1538(a)(1)(b)	Prohibits take of endangered species.	Applicable if the removal action could negatively impact endangered species.	--	◆	◆	--	◆	◆	--	◆	◆
Bald and Golden Eagle Protection Act	• 16 USC 668	Makes it illegal to take any bald eagle or golden eagle, alive or dead, or any part, nest, or egg thereof of foregoing eagles.	It is possible that an inadvertent taking of such an eagle could occur during remedial activities (e.g., disturbing an active nest). Bald eagles are found throughout much of Oregon, Washington, and the Columbia River drainage basin. It is possible that such nests are in the area to be disturbed.	--	◆	◆	--	◆	◆	--	◆	◆
The Migratory Bird Treaty Act of 1918	• 16 USC 703(a)(a)	Makes it unlawful to take, kill, or possess any migratory bird or any part, nest, or eggs of any such bird.	Applicable to removal actions that could harm migratory birds using the Columbia River.	--	◆	◆	--	◆	◆	--	◆	◆
Action-specific ARARs												
Storage and Treatment of Hazardous Waste at a Transloading Facility	• 40 CFR Part 264, Subparts B, C, F, G, I, J, K, L, M, AA, BB, CC, and DD	Transloading is the process of transferring a shipment from one mode of transportation to another. These regulations provide standards for location, design, operation, and closure of units in which storage or treatment of hazardous waste may occur at a transloading facility. These regulations also provide requirements for use and management of containers, tank systems, surface impoundments, waste piles, and land treatment units one or more of which may be used for the storage and treatment of hazardous waste at a transloading facility.	The listed requirements of Part 264 are Applicable to the siting, design, operation, and closure of any containers, tank systems, surface impoundments, waste piles or land treatment areas used for the storage (over 90 days) and/or treatment of hazardous waste onsite prior to disposal offsite. The specific storage system and treatment methods that may be employed at the onsite transloading facility will be determined during remedial design. Historically, spent sandblast grit from Bradford Island has been managed as hazardous waste. Per Oregon rules, soils containing pesticide residue from onsite spills at the Landfill AOPC and Sandblast Area AOPC are considered a state-only hazardous waste.	--	◆	◆	--	◆	◆	--	◆	◆
Discharge of Dredge and Fill to Waters of the U.S. under the CWA	• CWA Section 404, 33 USC 1344 • 40 CFR Part 230 • CWA Section 404(b)(1) Guidelines	Indicates prohibitions on dredge and fill of waters of the U.S., including wetlands. The CWA regulations control the discharge of fill material into surface waters (including wetlands), and requirements on stormwater management and drained water treatment.	This is an action-specific ARAR if wetlands or waters of the U.S. are disturbed onsite by the action. Prohibits discharge of dredged or fill material into waters of the U.S. without a permit. Substantive requirements could be considered as an ARAR. Procedural and administrative requirements would not apply. Applicable due to riverbank restoration and any discharge of fill materials into the river or lagoon at the Landfill AOPC, Bulb Slope AOPC, Sandblast Area AOPC, and Pistol Range AOPC.	--	◆	◆	--	◆	◆	--	◆	◆

				Associates to AOPC / Alternative:								
				Landfill AOPC			Sandblast Area AOPC			Pistol Range AOPC		
Description	Citations or References	Requirement	Rationale	L0	L1*	L2*	S0	S1	S2	P0	P1	P2
Discharges from Removal and Fill Activities into Waters of the State	• ORS 196.825(5) • OAR 141-085-0680 • OAR 141-085- 0685 • OAR 141-085-0690 • OAR 141-085-0710 • OAR 141-085-0715	State substantive requirements for mitigation for the reasonably expected adverse effects of removal or fill in a project development in waters of the state.	Applicable compensatory mitigation standards and requirements for reasonably expected adverse effects, if any, from dredging, capping, placement of material for enhanced natural recovery, and riverbank remediation. The site includes Essential Fish Habitat and the specifically listed state regulations contain specific habitat mitigation standards not found in CWA Section 404 regulations for reasonably expected adverse effects of remedial action activities, which will be incorporated into compensatory mitigation plans developed during remedial design. Substantive requirements could be considered as an ARAR. Procedural and administrative requirements would not apply. Applicable due to potential increased stormwater erosion during construction and riverbank restoration at the Landfill AOPC, Bulb Slope AOPC, and Sandblast Area AOPC.	--	◆	◆	--	◆	◆	--	◆	◆
Protection of Wetlands	• CWA Section 404; 33 USC 1344 • Executive Order 11990	Requires minimization of destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. The executive order also provides that activities avoid construction in wetlands if a practicable alternative exists.	Applicable to the Landfill AOPC, Bulb Slope AOPC, and Sandblast Area AOPC because their riverbanks are classified as lake wetlands in the U.S. Fish and Wildlife Wetland Inventory. Applicable to the Landfill AOPC and Pistol Range AOPC because portions of the AOPCs are considered estuarine and marine wetland. Applicable to the Pistol Range AOPC because the adjacent lagoon is identified as a freshwater emergent wetland. Substantive requirements could be considered as an ARAR. Procedural and administrative requirements would not apply. Executive orders are not promulgated law but are to be considered.	--	◆	◆	--	◆	◆	--	◆	◆
Oil Storage (SPCC)	• 40 CFR 112.1 through 112.8, 112.20, and 112.21.	Regulates the onsite management of petroleum and non-petroleum fuels and oils.	This is only an ARAR if more than 1,320 gallons of fuel or oil is stored onsite during the action (40 CFR 112.1 (d)(2)(ii)).	--	◆	◆	--	◆	◆	--	◆	◆
Land Disposal Restrictions	• 40 CFR 268	Specifies treatment standards and technologies for specific hazardous wastes prior to land disposal. This is done by determining if the waste meets the treatment standards in 40 CFR 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11. Must comply with the special requirements of 40 CFR 268.9 in addition to any applicable requirements in 40 CFR Section 268.7. 40 CFR 268.9(a) requires identification of an EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 et seq.	This requirement is Applicable to characterizing and treating soil materials planned for offsite disposal. Any hazardous waste shipped offsite would be required to meet Land Disposal Restrictions treatment standards before disposal. Historically, spent sandblast grit from Bradford Island has been managed as hazardous waste.	--	◆	◆	--	◆	◆	--	◆	--
RCRA – Solid Waste	• 40 CFR 258 Subpart A	Establishes substantive requirements for the management of non-municipal, non-hazardous waste disposal units.	RCRA Solid Waste requirements may be relevant and appropriate to removal actions that result in upland disposal. Requirements for the management of solid waste landfills may be relevant and appropriate to upland disposal if considered in remedial alternatives.	--	◆	◆	--	◆	◆	--	◆	◆
Military Munitions Rule	• 40 CFR 266.203 through 266.206	Defines and regulates military munitions under RCRA Subtitle C regulations.	May be relevant and applicable if munitions items are discovered onsite, which this rule would then stand through its own force and authority. Based on historical use, there is the potential to discover munitions items at the Pistol Range AOPC and the Landfill AOPC. Identifies when military munitions become a solid waste, and, if these wastes are also hazardous under 40 CFR Part 266 or 40 CFR Part 261, the management standards that apply to these wastes. Unless otherwise specified in 40 CFR Part 266, all applicable requirements in 40 CFR Parts 260 through 270 apply to waste military munitions.	--	◆	◆	--	◆	◆	--	◆	◆

Notes:

ARARs may be waived under certain circumstances (CERCLA 121[d][4], 42 USC 9621[d][4]). The waiver criteria include the following: (1) the remedial (or removal) action is being conducted as an interim measure, (2) compliance with the ARAR would result in greater risk to health and the environment, (3) compliance with the ARAR is technically impractical, (4) equivalent standard of performance, (5) inconsistent application of state requirements, and (6) fund balancing (applicable to Superfund-funded sites only).

* Alternatives L1 and L2 include associated excavation activities at the Bulb Slope AOPC (See Sections 4.3 and 4.4).

-- = Not applicable

AOPC = area of potential concern
ARAR = applicable or relevant and appropriate requirement
B0 = Bulb Slope AOPC Alternative: No Action
B1 = Bulb Slope AOPC Alternative: Complete Removal of Contaminant Sources and Soil, Offsite Landfilling, Shoreline Revetment, Slope Stabilization, and Site Restoration
B2 = Bulb Slope AOPC Alternative: Concrete-Geotextile Seawall, Soil Cover, Slope Stabilization, Site Restoration, Institutional Controls, and Long-Term Operation and Maintenance
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = Code of Federal Regulations
CWA = Clean Water Act
EE/CA = Engineering Evaluation and Cost Analysis
EPA = U.S. Environmental Protection Agency
ESA = Equipment Storage Area
HAP = hazardous air pollutant
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
L0 = Landfill AOPC Alternative: No Action
L1 = Landfill AOPC Alternative: Complete Removal of Contaminated Sources and Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration
L2 = Landfill AOPC Alternative: Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, Institutional Controls, and Long-Term Operation and Maintenance
mg/kg = milligram(s) per kilogram
NPDES = National Pollutant Discharge Elimination System
OAR = Oregon Administrative Rule
Oregon DEQ = Oregon Department of Environmental Quality
ORS = Oregon Revised Statutes
P0 = Pistol Range AOPC Alternative: No Action
P1 = Pistol Range AOPC Alternative: Complete Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration
P2 = Pistol Range AOPC Alternative: Engineered Soil Cover, Site Restoration, Institutional Controls, and Long-Term Operation and Maintenance
RACM = regulated asbestos-containing material
RCRA = Resource Conservation and Recovery Act
S0 = Sandblast Area AOPC Alternative: No Action
S1 = Sandblast Area AOPC Alternative: Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration
S2 = Sandblast Area AOPC Alternative: Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, Institutional Controls, and Long-Term Operation and Maintenance
SDWA = Safe Drinking Water Act
SPCC = Spill Prevention Control and Countermeasure
TSCA = Toxic Substances Control Act
USACE = U.S. Army Corps of Engineers
USC = U.S. Code

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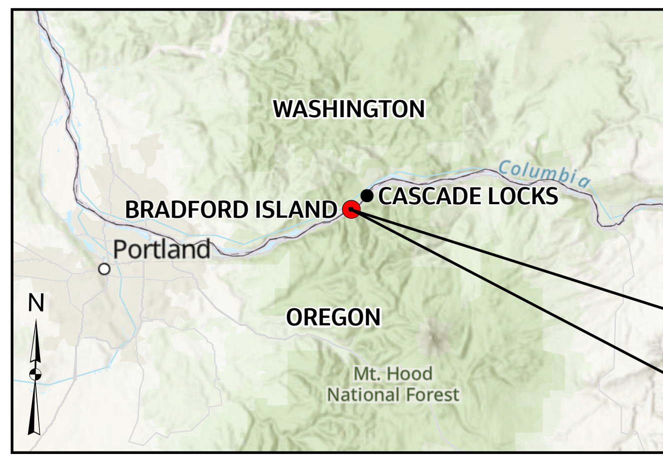
Appendix B
Conceptual Design Drawings

CONCEPTUAL DESIGN DRAWINGS

US Army Corps of Engineers

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT

Bradford Island NPL Site
Cascade Locks, Oregon



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SHEET 3 – LANDFILL AOPC ALTERNATIVE L1 POST-REMOVAL ACTION PLAN
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ACRONYMS

AOPC = AREA OF POTENTIAL CONCERN
ELA = EQUIPMENT LAYDOWN AREA
NAVD 88 = NORTH AMERICAN VERICAL DATUM OF 1988
PAL = PROJECT ACTION LEVEL
SGA = SANDBLAST GRIT STORAGE AREA
SQ FT = SQUARE FEET

LEGEND

UPLAND OPERABLE UNIT
BULB SLOPE AOPC
LANDFILL AOPC
PISTOL RANGE AOPC
SANDBLAST AREA AOPC

SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY, OREGON METRO, OREGON STATE PARKS, WA STATE PARKS GIS, ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, BUREAU OF LAND MANAGEMENT, EPA, NPS, USFWS, ESRI, USGS

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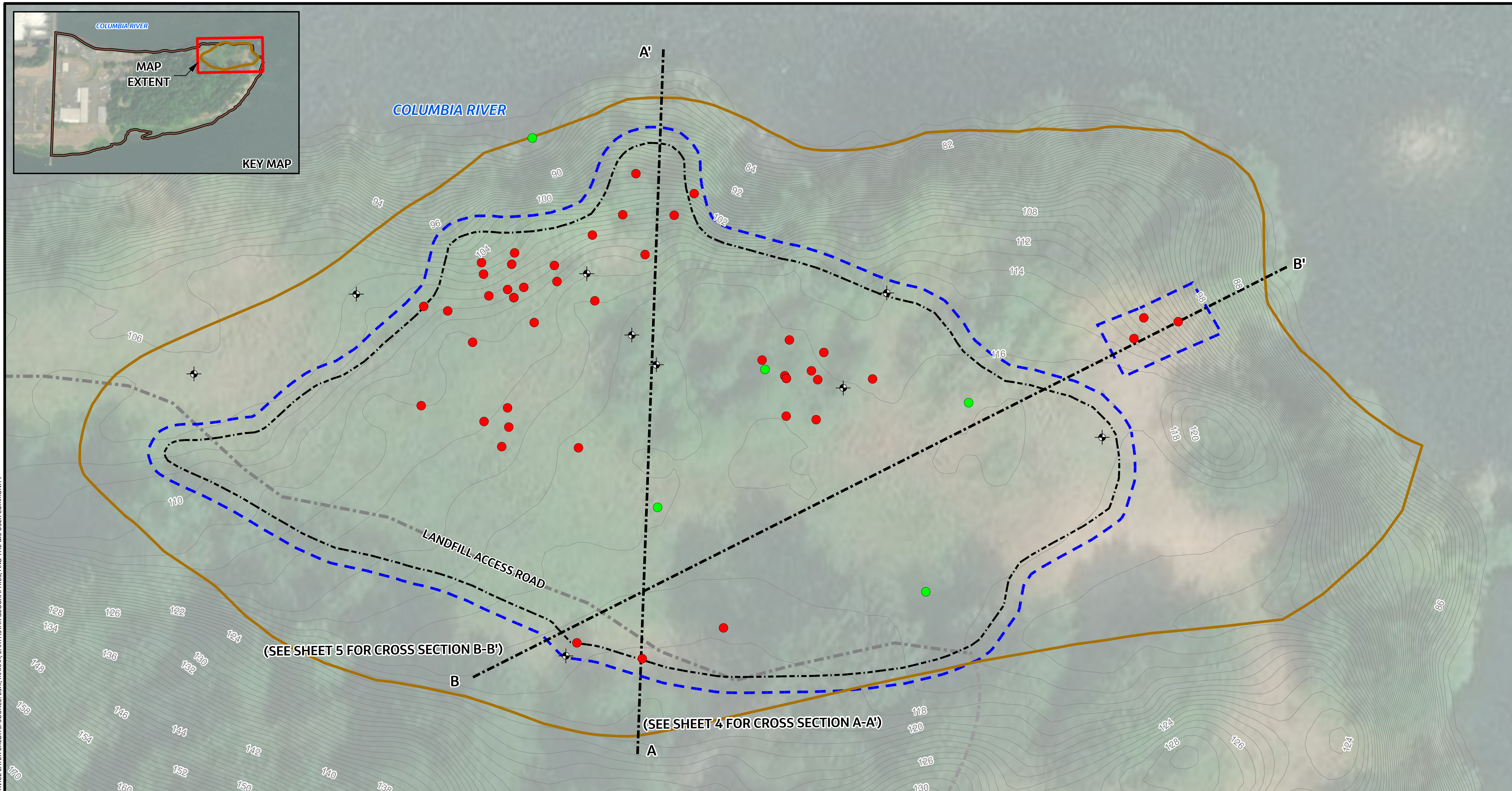

SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

LEGEND

- SOIL SAMPLE DOES NOT EXCEED PAL
- SOIL SAMPLE EXCEEDS PAL
- MONITORING WELL LOCATION
- LOCATION OF CROSS SECTION
- EXISTING GRADE (NAVD88) (USGS 2019)
- LANDFILL ACCESS ROAD
- UPLAND OPERABLE UNIT
- LANDFILL AOPC (59094 SQ FT)
- EXTENT OF LANDFILL DEBRIS (APPROXIMATE)
- APPROXIMATE EXCAVATION AREA (32074 SQ FT)

NOTES:

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0 30 60 Feet

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SHEET 2 OF 14
LANDFILL AOPC ALTERNATIVE L1
PRE-REMOVAL ACTION PLAN
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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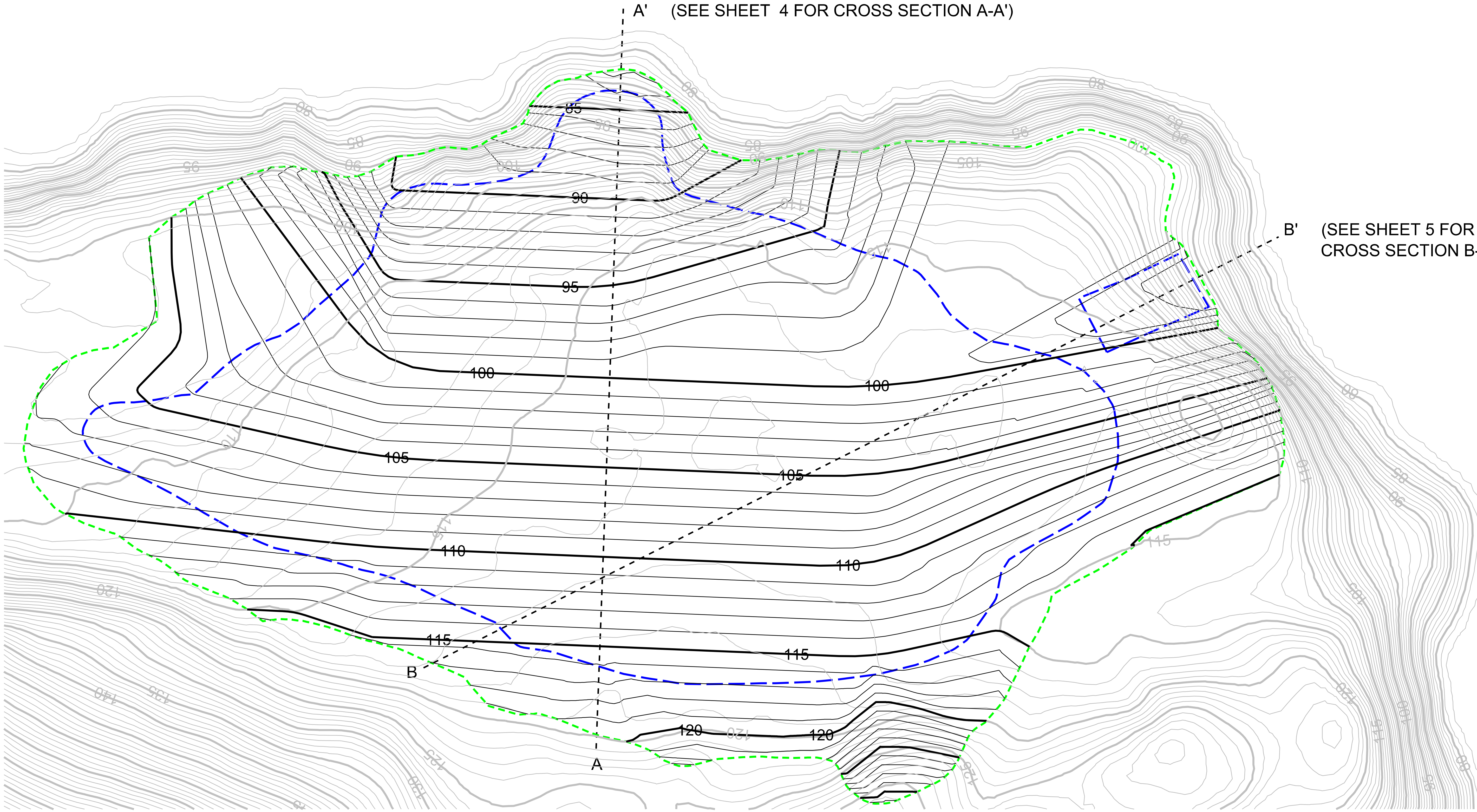
A' (SEE SHEET 4 FOR CROSS SECTION A-A')

B' (SEE SHEET 5 FOR CROSS SECTION B-B')



LEGEND

APPROXIMATE EXCAVATION AREA (32070 SQ FT)

APPROXIMATE GRADING AREA (53332 SQ FT)

EXISTING GRADE CONTOURS

FINAL GRADE CONTOURS

NOTES:

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0 30 60 Feet

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SHEET 3 OF 14

LANDFILL AOPC

ALTERNATIVE L1

POST-REMOVAL ACTION PLAN

CONCEPTUAL DESIGN DRAWINGS

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT

BRADFORD ISLAND NPL SITE

CASCADE LOCKS, OREGON

US Army Corps of Engineers

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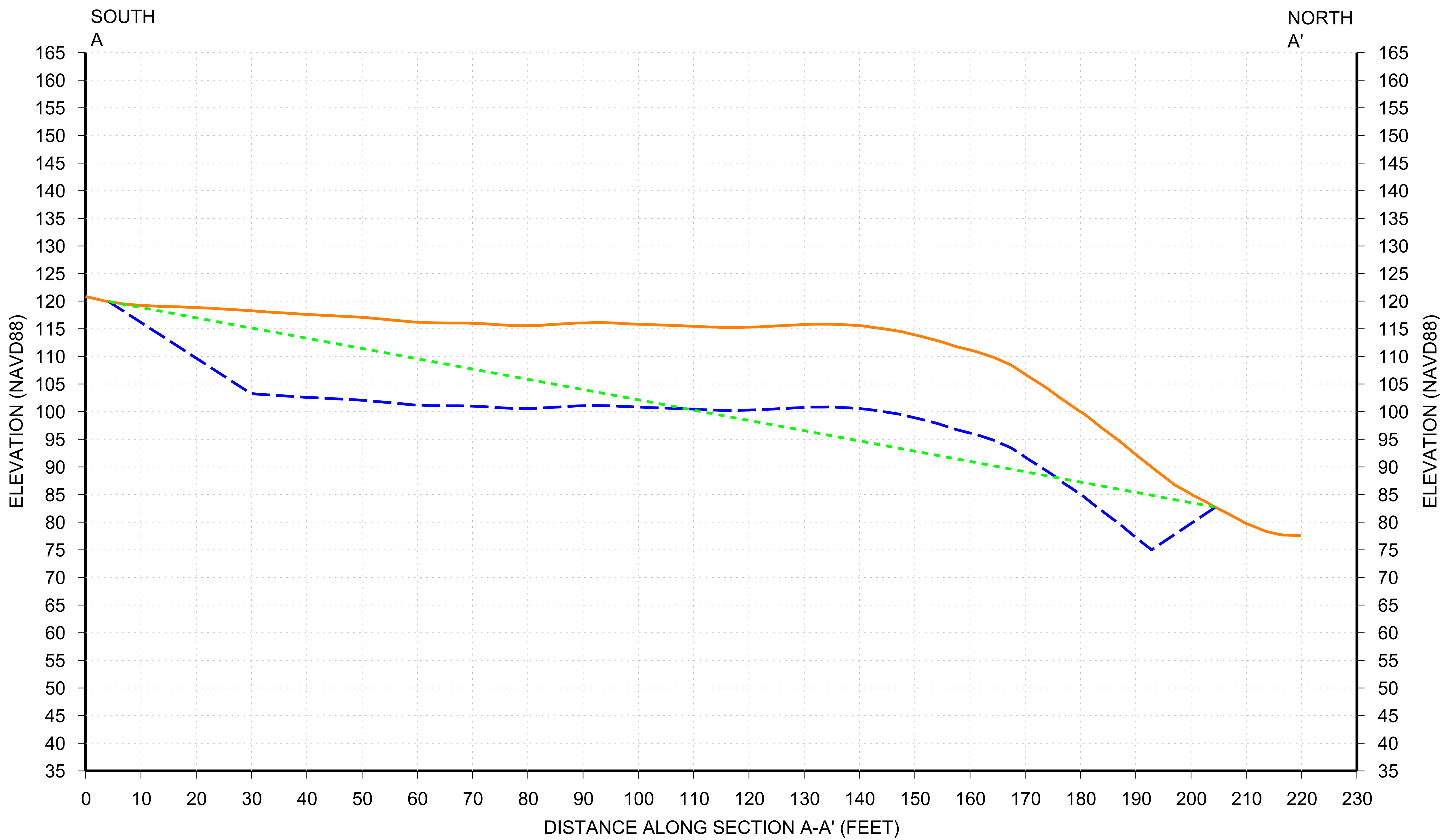

LEGEND
APPROXIMATE EXCAVATION AREA GRADE
APPROXIMATE FINAL GRADE
EXISTING GRADE SURFACE

NOTES:
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SHEET 4 OF 14
LANDFILL AOPC
ALTERNATIVE L1
POST-REMOVAL ACTION
CROSS SECTION A-A'
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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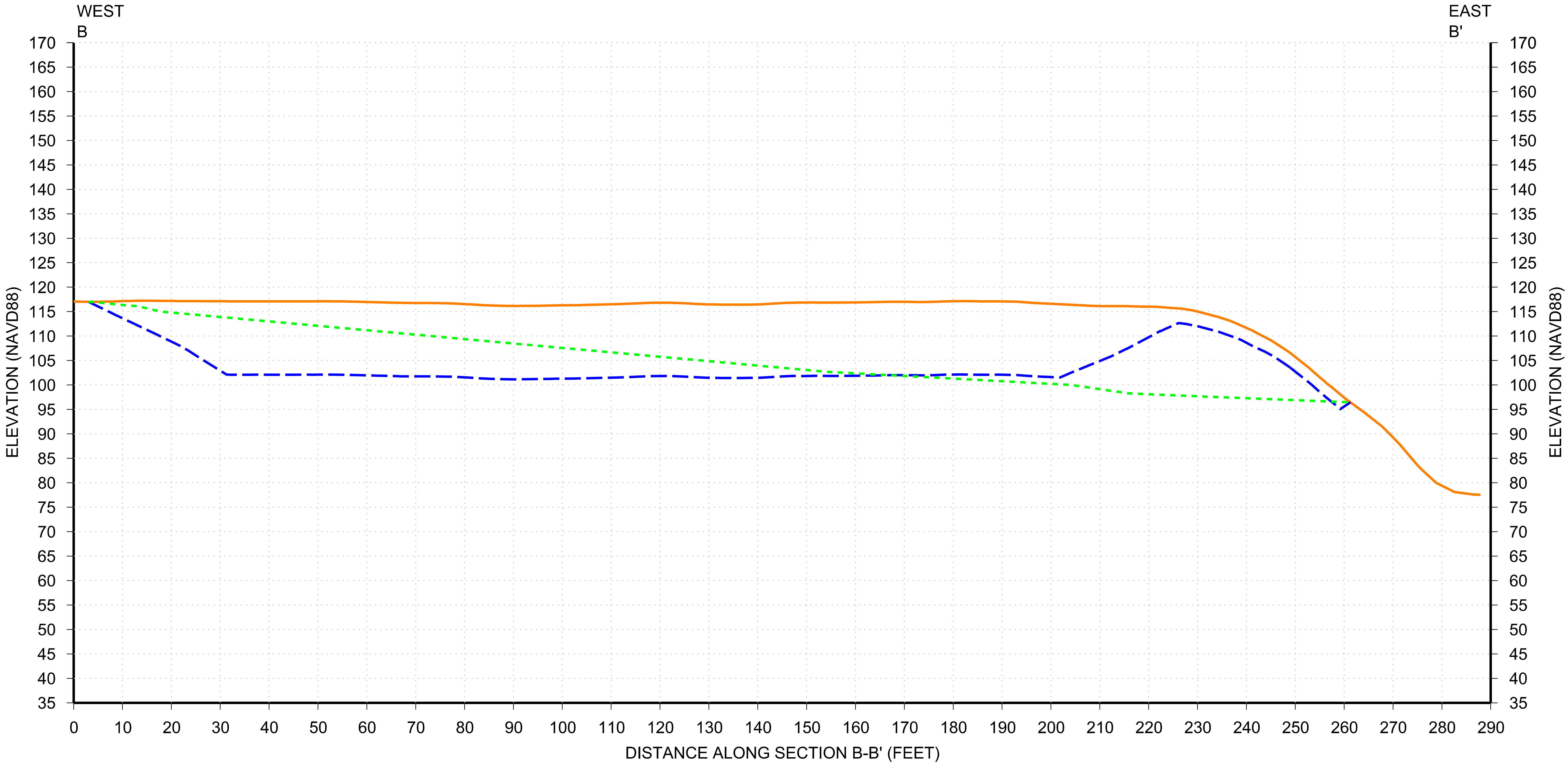

LEGEND
- APPROXIMATE EXCAVATION AREA GRADE
- APPROXIMATE FINAL GRADE
- EXISTING GRADE SURFACE

NOTES:
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SHEET 5 OF 14
LANDFILL AOPC
ALTERNATIVE L1
POST-REMOVAL ACTION
CROSS SECTION B-B'
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
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SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

LEGEND

- SOIL SAMPLE
- LOCATION OF CROSS SECTION
- EXISTING GRADE (NAVD88) (USGS 2019)
- LANDFILL ACCESS ROAD
- UPLAND OPERABLE UNIT
- BULB SLOPE AOPC (2350 SQ FT)
- APPROXIMATE EXCAVATION AREA (2350 SQ FT)

NOTES:

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0 20 40 Feet

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SHEET 6 OF 14

BULB SLOPE AOPC PRE-EXCAVATION PLAN

CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
CASCADE LOCKS, OREGON

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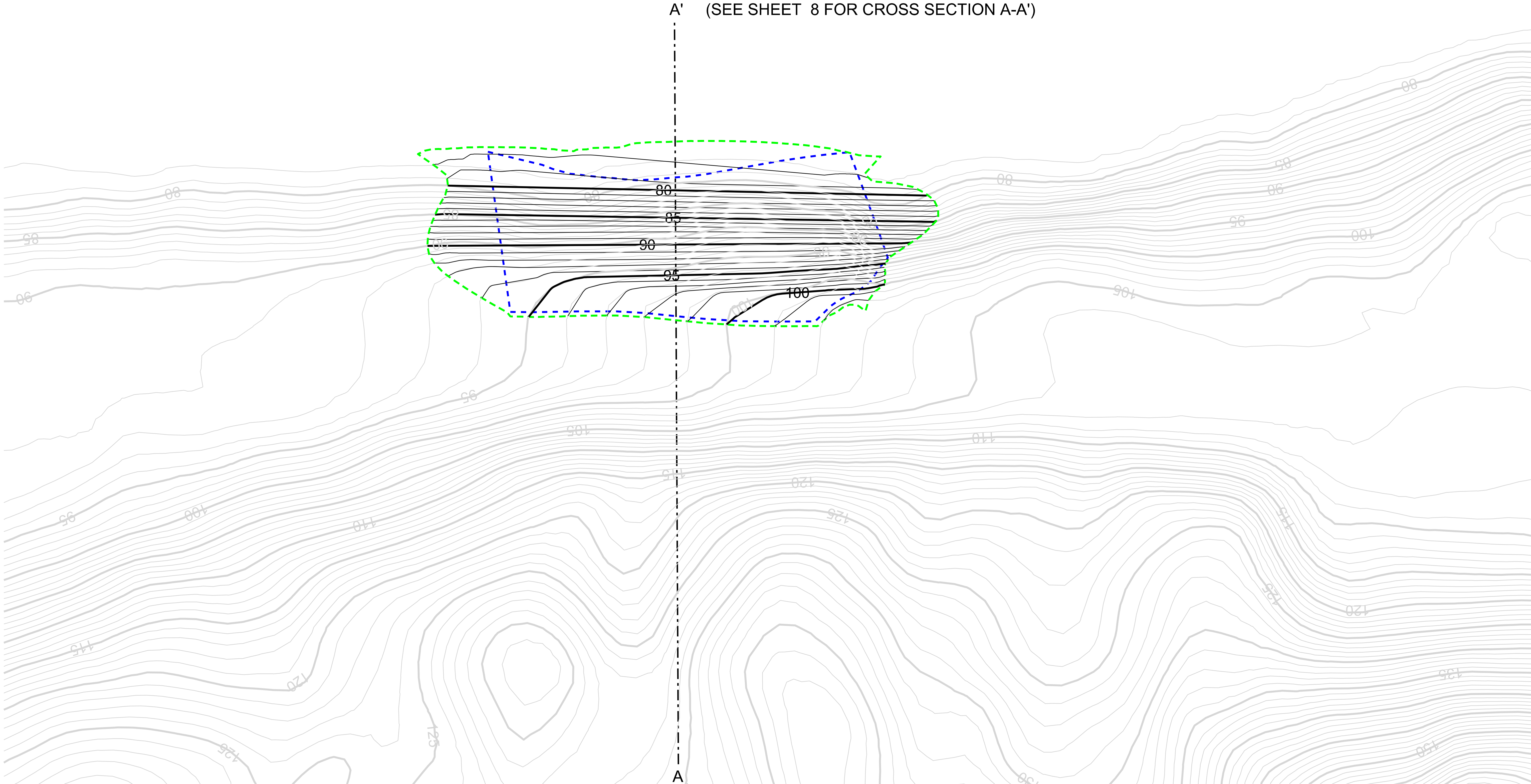

LEGEND

APPROXIMATE EXCAVATION AREA (2350 SQ FT)
APPROXIMATE GRADING AREA (3364 SQ FT)
EXISTING GRADE CONTOURS
FINAL GRADE CONTOURS

NOTES:
THIS DRAWING IS TO BE USED FOR CONCEPTUAL DESIGN PURPOSES ONLY.

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SHEET 7 OF 14
BULB SLOPE AOPC
POST-EXCAVATION PLAN
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
EVALUATION AND COST ANALYSIS REPORT
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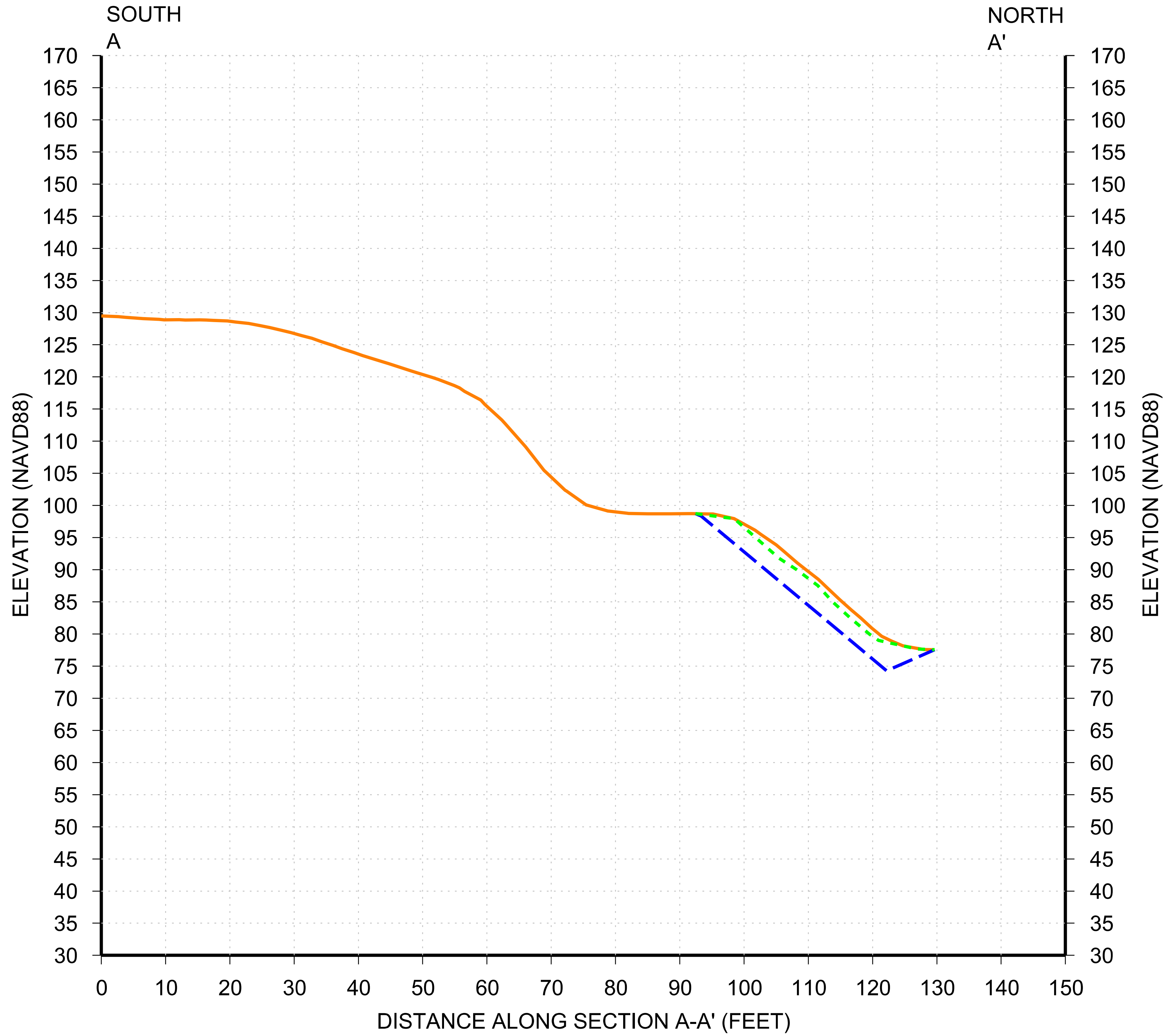

LEGEND

- APPROXIMATE EXCAVATION AREA GRADE
- APPROXIMATE FINAL GRADE
- EXISTING GRADE SURFACE

NOTES:
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SHEET 8 OF 14
BULB SLOPE AOPC
POST-EXCAVATION
CROSS SECTION A-A'

CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
EVALUATION AND COST ANALYSIS REPORT
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SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

LEGEND

- SAMPLE DOES NOT EXCEED PAL
- SAMPLE EXCEEDS PAL
- MONITORING WELL LOCATION
- LOCATION OF CROSS SECTION
- EXISTING GRADE (NAVD88) (USGS 2019)
- ROAD
- UPLAND OPERABLE UNIT
- SANDBLAST AREA AOPC (135844 SQ FT)
- NORTHERN EQUIPMENT LAYDOWN AREA
- SANDBLAST GRIT STORAGE AREA
- APPROXIMATE EXCAVATION AREA (18604 SQ FT)

NOTES:

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0 30 60 Feet

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SHEET 9 OF 14

SANDBLAST AREA AOPC ALTERNATIVE S1

PRE-REMOVAL ACTION PLAN

CONCEPTUAL DESIGN DRAWINGS

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT

BRADFORD ISLAND NPL SITE

CASCADE LOCKS, OREGON

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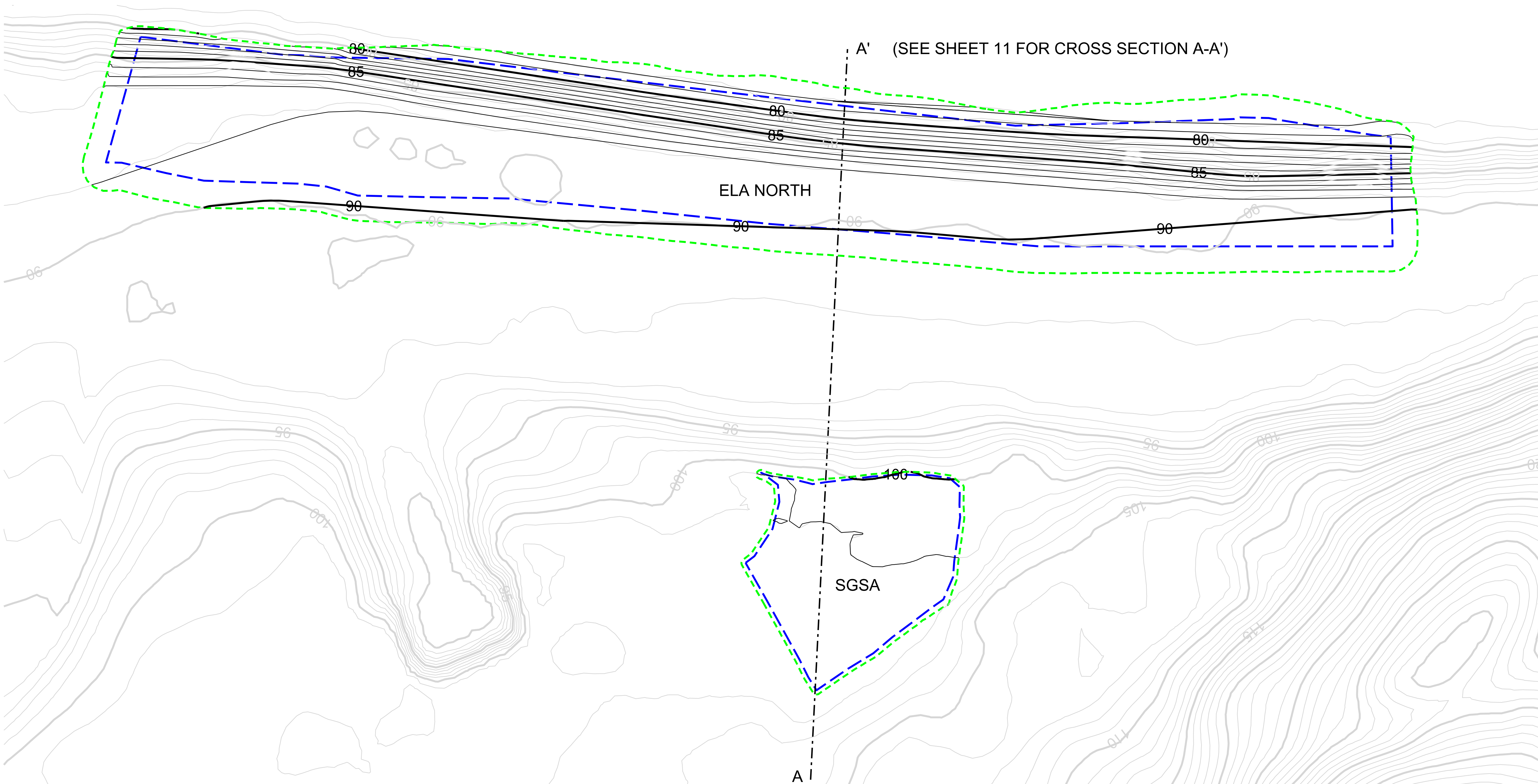

LEGEND

APPROXIMATE EXCAVATION AREA (18902 SQ FT)

APPROXIMATE GRADING AREA (24761 SQ FT)

EXISTING GRADE CONTOURS

FINAL GRADE CONTOURS

NOTES:
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0 30 60 Feet

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SHEET 10 OF 14
SANDBLAST AREA
ALTERNATIVE S1
POST-REMOVAL ACTION PLAN

CONCEPTUAL DESIGN DRAWINGS
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EVALUATION AND COST ANALYSIS REPORT
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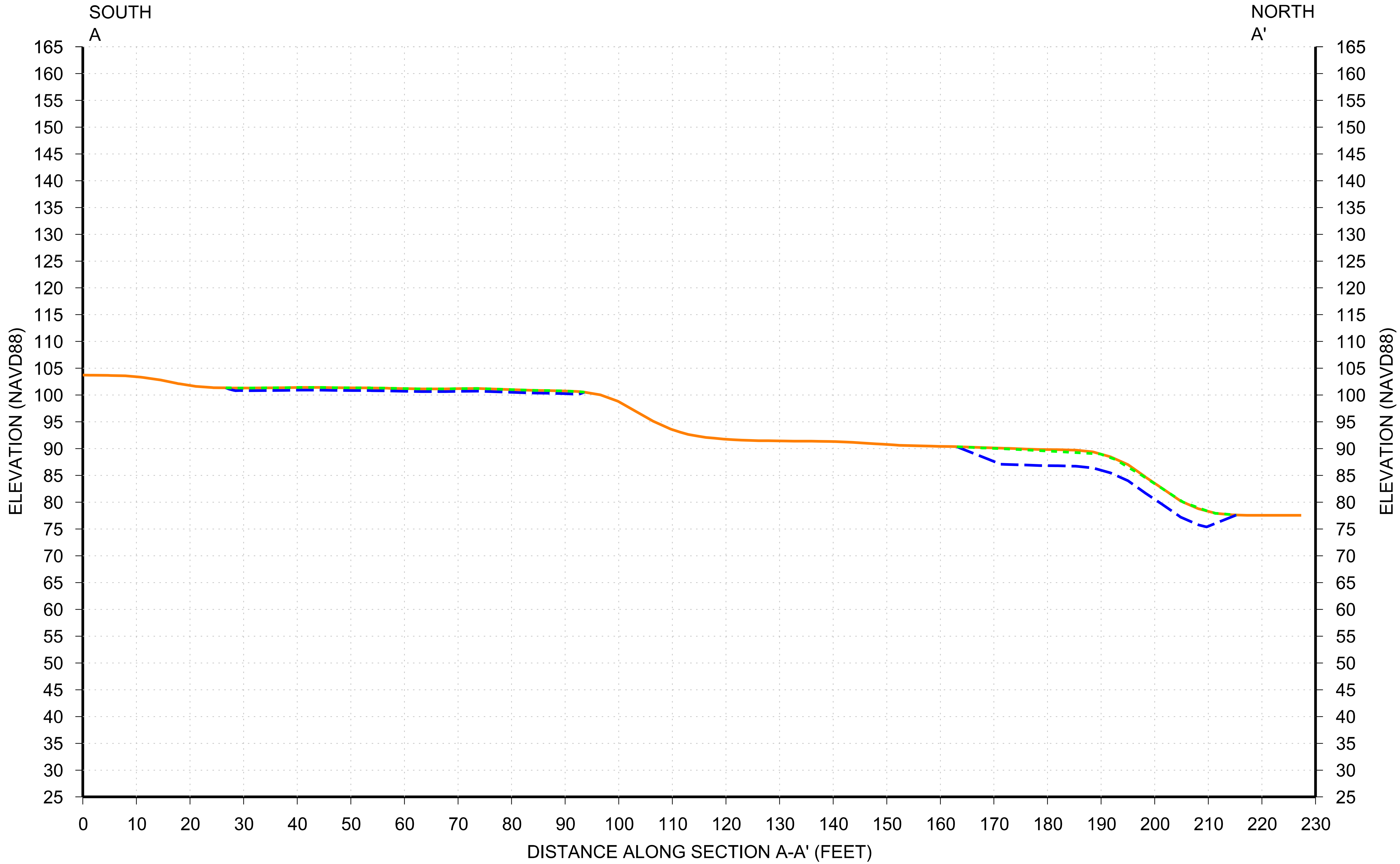

LEGEND
APPROXIMATE EXCAVATION AREA GRADE
APPROXIMATE FINAL GRADE
EXISTING GRADE SURFACE

NOTES:
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SHEET 11 OF 14
SANDBLAST AREA AOPC
ALTERNATIVE S1
POST-REMOVAL ACTION
CROSS SECTION A-A'
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
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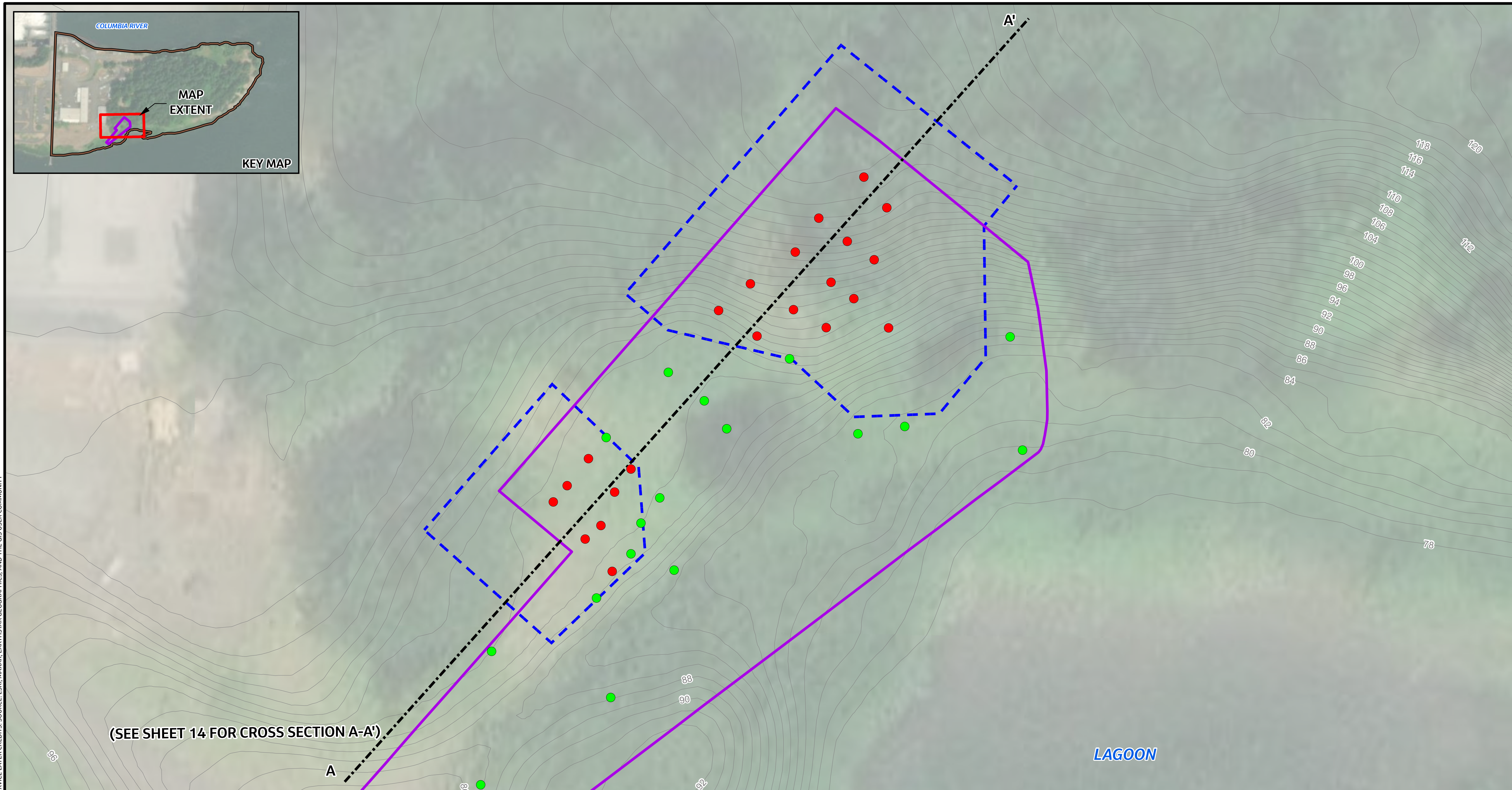

LEGEND

- SOIL SAMPLE DOES NOT EXCEED PAL
- SOIL SAMPLE EXCEEDS PAL
- LOCATION OF CROSS SECTION
- EXISTING GRADE (NAVD88) (USGS 2019)
- LANDFILL ACCESS ROAD
- UPLAND OPERABLE UNIT
- PISTOL RANGE AOPC (11393 SQ FT)
- APPROXIMATE EXCAVATION AREA (5095 SQ FT)

NOTES:

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SHEET 12 OF 14

PISTOL RANGE AOPC ALTERNATIVE P1

PRE-REMOVAL ACTION PLAN

CONCEPTUAL DESIGN DRAWINGS

UPLAND OPERABLE UNIT ENGINEERING EVALUATION AND COST ANALYSIS REPORT

BRADFORD ISLAND NPL SITE

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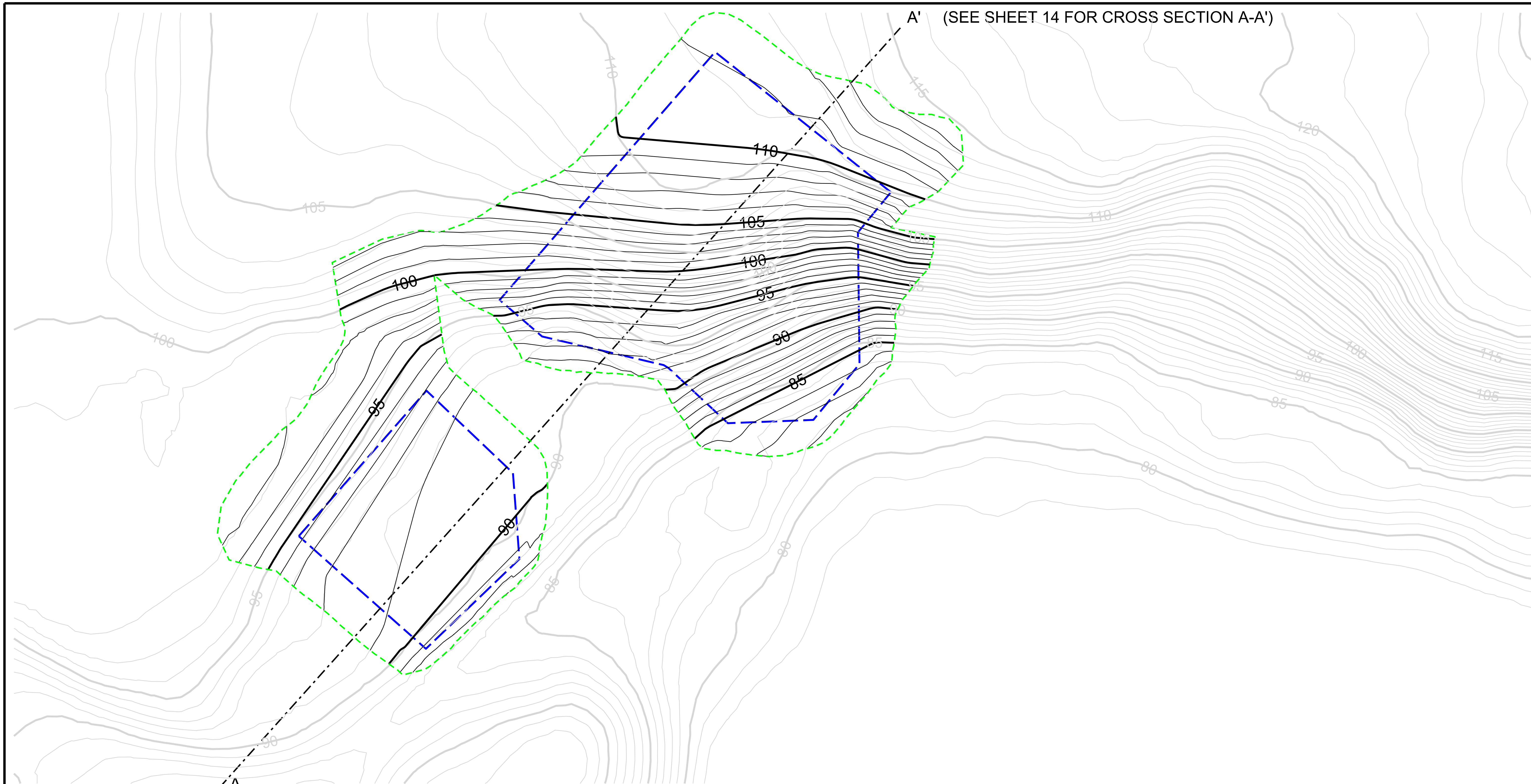

LEGEND

- APPROXIMATE EXCAVATION AREA (5094 SQ FT)
- APPROXIMATE GRADING AREA (7355 SQ FT)
- EXISTING GRADE CONTOURS
- FINAL GRADE CONTOURS

NOTES:
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SHEET 13 OF 14
PISTOL RANGE AOPC
ALTERNATIVE P1
POST-REMOVAL ACTION PLAN
CONCEPTUAL DESIGN DRAWINGS
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EVALUATION AND COST ANALYSIS REPORT
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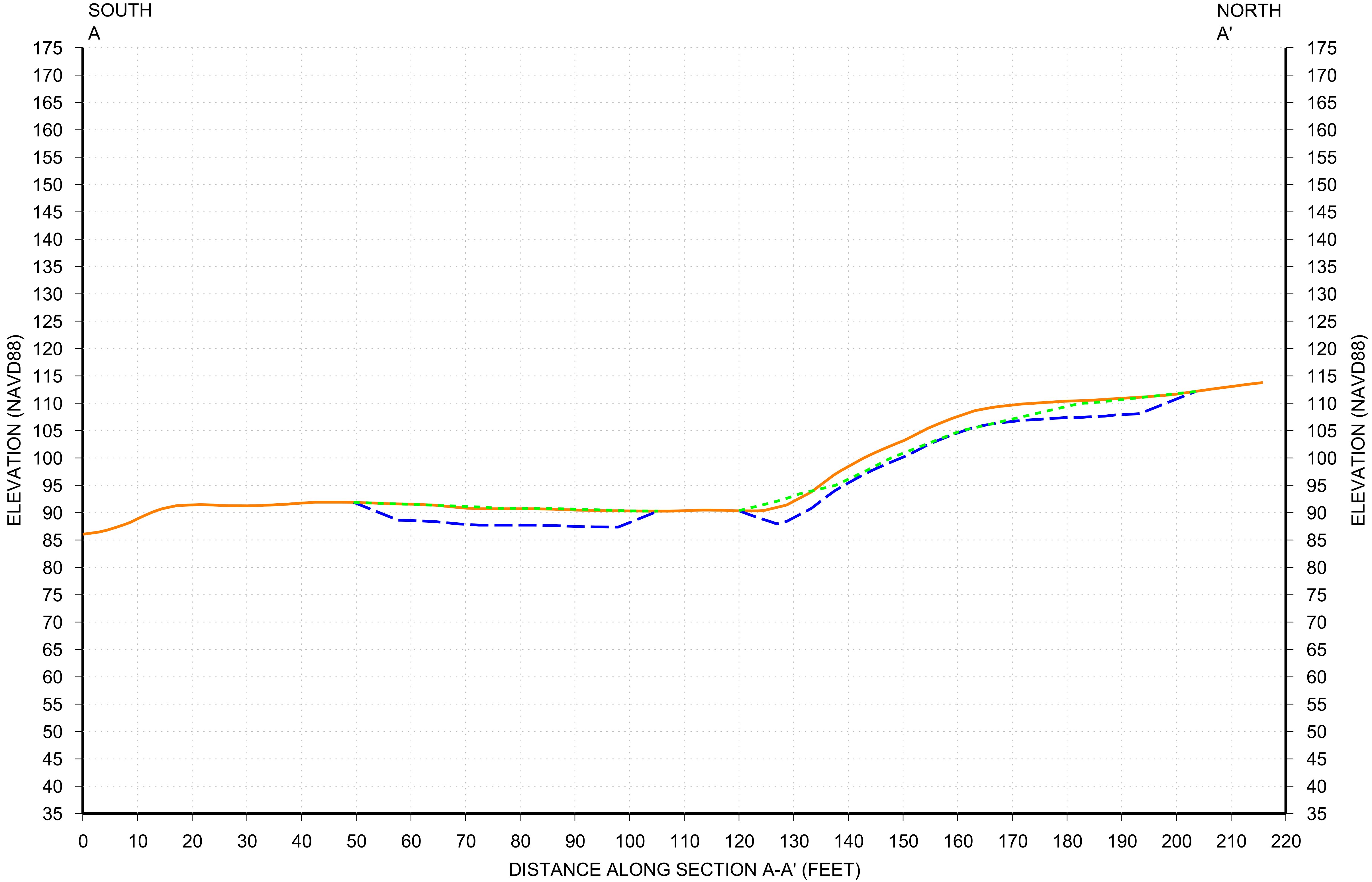

LEGEND
APPROXIMATE EXCAVATION AREA GRADE
APPROXIMATE FINAL GRADE
EXISTING GRADE SURFACE

NOTES:
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SHEET 14 OF 14
PISTOL RANGE AOPC
ALTERNATIVE P1
POST-REMOVAL ACTION
CROSS SECTION A-A'
CONCEPTUAL DESIGN DRAWINGS
UPLAND OPERABLE UNIT ENGINEERING
EVALUATION AND COST ANALYSIS REPORT
BRADFORD ISLAND NPL SITE
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Appendix C
Alternative Cost Estimates

Table C-1. Cost Estimate Summary

FINAL (January 2025)							
Bradford Island NPL Site, Cascades Locks, Oregon							
Cost Type	Landfill AOPC		Bulbslope AOPC Excavation	Sandblast AOPC (ELA North and SGSA)		Pistol Range AOPC	
	Alternative L1 Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration	Alternative L2 Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M	Excavation of Debris and Contaminated Soil, Slope and Roadway Stabilization, and Site Restoration	Alternative S1 Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration	Alternative S2 Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M	Alternative P1 Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration	Alternative P2 Engineered Soil Cover, Site Restoration, ICs, and Long term O&M
Total Estimated Present Worth Costs							
Capital Cost	$14,820,032	$3,901,590	$638,547	$2,610,926	$1,480,058	$1,061,803	$684,500
O&M Cost	$0	$1,201,864	$0	$0	$790,817	$0	$428,808
Periodic Cost	$0	$230,023	$0	$0	$194,672	$0	$194,672
Total Estimated Costs	*$14,820,032*	*$5,333,477*	*$638,547*	*$2,610,926*	*$2,465,546*	*$1,061,803*	*$1,307,980*
Total Present Value*	$14,820,032	$4,773,987	$638,547	$2,610,926	$2,160,986	$1,061,803	$1,112,864
Estimated Range of Costs							
From	From	From	From	From	From	From	From
-30%	$10,374,022	$3,733,434	$446,983	$1,827,648	$1,725,882	743,262	915,586
To	To	To	To	To	To	To	To
+50%	$22,230,047	$8,000,216	$957,821	$3,916,389	$3,698,319	$1,592,704	$1,961,969

* Total present values was calculated using a 30-year "real" discount rate of 2.5%. For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different “cost of capital” than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. *Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses*. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. EPA 540-R-00-002. July.

Table C-2. Alternative L1 Cost Estimate FINAL (January 2025)

Landfill AOPC

Alternative L1

Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Landfill AOPC Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
1010	Submittals	0.25	LS	$ 86,163	$ 21,541	Refer: Appendix C Table C-3; Bid Proposal Summary and Cost Detail Report for Alternative L1 (.pdf)
1020	Mobilization	0.25	EA	$ 39,345	$ 9,836	
1030	Overall Site Set-Up	0.25	EA	$ 80,906	$ 20,227	
1034	Overall Access Road Improvements	500	LF	$ 60.04	$ 30,020	
1040	Landfill: Erosion/Site Controls	1	LS	$ 19,841	$ 19,841	
1044	Landfill: Access Road Improvements	1,500	LF	$ 100.67	$ 151,005	
1046	Landfill: Well Abandonment	224	LF	$ 54.53	$ 12,215	
1050	Landfill: Clear & Grub	53,332	SF	$ 1.12	$ 59,732	
1054	Landfill: Exc & Stockpile Impacted Soil & Debris	17,555	BCY	$ 30.56	$ 536,481	
1058	Landfill: Confirmation Sampling	81	EA	$ 739.91	$ 59,933	
1060	Landfill: Regrade/Backfill Excavation	5,966	LCY	$ 50.30	$ 300,090	
1063	Landfill: Site Restoration - Riprap	365	CY	$ 188.10	$ 68,657	
1064	Landfill: Restoration	53,332	SF	$ 3.24	$ 172,796	
1070	Landfill: Waste Characterization	55	EA	$ 2,746	$ 151,017	
1074	Landfill: Loadout for T&D	22,135	TON	$ 16.27	$ 360,136	
1077	Landfill: T&D - Non-hazardous waste soil	9,251	TON	$ 189.21	$ 1,750,382	
1078	Landfill: T&D - Hazardous waste soil	11,306	TON	$ 512.95	$ 5,799,413	
1079	Landfill: T&D - Hazardous waste debris	1,578	TON	$ 580.02	$ 915,272	
1080	Overall Site Tear-down/Restoration	0.25	LS	$ 44,907	$ 11,227	
1084	Demobilization	0.25	LS	$ 39,345	$ 9,836	
1090	Project Support	4	MNTH	$ 129,537	$ 518,147	
				Subtotal	$ 10,977,801	
			Management Reserve	15%	$ 1,646,670	
			Engineering Management	20%	$ 2,195,560	
				Capital Project Cost Total	$ 14,820,032	

Table C-2. Alternative L1 Cost Estimate — FINAL (January 2025)

Landfill AOPC

Alternative L1

Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Landfill AOPC O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				O&M Project Cost Total	$ -	
		Annual O&M Cost Total		Years		

Landfill AOPC Periodic Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				Periodic Project Cost Total	$ -	

Landfill AOPC Project Cost Summary		Quantity	Unit	Unit Cost	Total	Notes
	Landfill AOPC Capital Cost	1	LS	$ 14,820,032	$ 14,820,032	
	Landfill AOPC O&M Cost		YR	$ -	$ -	
	Landfill AOPC Periodic Cost		EA	$ -	$ -	
				Landfill AOPC Project Total	$ 14,820,032	
			Project Cost Range	+50%	$ 22,230,047	
				-30%	$ 10,374,022	

Table C-2. Alternative L1 Cost Estimate FINAL (January 2025)

Landfill AOPC

Alternative L1

Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Present Value Analysis						
Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Landfill AOPC)	0	$14,820,032	$ 14,820,032	1.000	$ 14,820,032	
Annual O&M Cost	0		$ -	20.930	$ -	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	0		$ 0		$ -	
				Subtotal	$ 14,820,032	
			Total Present Value for Landfill AOPC	$ 14,820,032		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different “cost of capital” than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures: This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-3. Alternative L1 Cost Detail | FINAL (January 2025)

Landfill AOPC

Alternative L1 - Removal of Sources of Contamination and Contaminated Soil, Offsite Landfilling, Backfilling, Slope Reduction and Stabilization, Shoreline Revetment, and Site Restoration

Bradford Island EE/CA

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
1010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -		$ -	$ 16,700.96	$ 4,839.85	$ 86,163.24	$ 21,541
1020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00		$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
1030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40		$ -	$ 15,682.00	$ 4,544.56	$ 80,906.24	$ 20,227
1034	Overall Access Road Improvements	500	LF	$ 8,666.02	$ 6,361.67	$ -	$ 4,004.40	$ 2,047.36	$ -	$ 2,194.26		$ -	$ 23,273.71	$ 6,746.29	$ 60.04	$ 30,020
1040	Landfill: Erosion/Site Controls	1	LS	$ 4,807.88	$ 3,558.98	$ -	$ 5,009.00	$ 1,014.38	$ -	$ 992.84		$ -	$ 15,383.08	$ 4,457.93	$ 19,841.01	$ 19,841
1044	Landfill: Access Road Improvements	1,500	LF	$ 22,680.24	$ 16,484.17	$ 42,979.75	$ 12,337.00	$ 10,617.75	$ -	$ 11,973.21		$ -	$ 117,072.12	$ 33,932.88	$ 100.67	$ 151,005
1046	Landfill: Well Abandonment	224	LF	$ -	$ -	$ -	$ -	$ -	$ 9,470.00	$ -		$ -	$ 9,470.00	$ 2,744.72	$ 54.53	$ 12,215
1050	Landfill: Clear & Grub	53,332	SF	$ 16,827.58	$ 12,456.41	$ -	$ 157.50	$ 8,658.58	$ -	$ 8,141.84		$ -	$ 46,241.91	$ 13,489.93	$ 1.12	$ 59,732
1054	Landfill: Exc & Stockpile Impacted Soil & Debris	17,555	BCY	$ 128,165.40	$ 96,588.28	$ -	$ 1,012.50	$ 92,256.75	$ -	$ 97,898.40		$ -	$ 415,921.33	$ 120,559.47	$ 30.56	$ 536,481
1058	Landfill: Confirmation Sampling	81	EA	$ 9,803.32	$ 7,282.23	$ -	$ 112.50	$ 4,489.10	$ 20,250.00	$ 3,043.20	$ 1,486.40	$ -	$ 46,466.75	$ 13,465.96	$ 739.91	$ 59,933
1060	Landfill: Regrade/Backfill Excavation	5,966	LCY	$ 39,693.50	$ 29,983.87	$ 88,680.00	$ 315.00	$ 25,429.60	$ 23,900.00	$ 24,669.12		$ -	$ 232,671.09	$ 67,418.71	$ 50.30	$ 300,090
1063	Landfill: Site Restoration - Riprap	365	CY	$ 9,126.04	$ 6,124.57	$ 31,540.00	$ 90.00	$ 3,399.69	$ -	$ 2,951.31		$ -	$ 53,231.61	$ 15,424.89	$ 188.10	$ 68,657
1064	Landfill: Restoration	53,332	SF	$ 9,798.80	$ 7,062.84	$ -	$ 112.50	$ 2,413.05	$ 112,500.00	$ 2,094.80		$ -	$ 133,981.99	$ 38,813.69	$ 3.24	$ 172,796
1070	Landfill: Waste Characterization	55	EA	$ 20,010.69	$ 14,639.05	$ -	$ 202.50	$ 8,080.38	$ 66,000.00	$ 5,477.76	$ 2,675.52	$ -	$ 117,085.90	$ 33,930.90	$ 2,745.76	$ 151,017
1074	Landfill: Loadout for T&D	22,135	TON	$ 120,322.40	$ 89,802.18	$ -	$ 1,800.00	$ 36,964.80	$ -	$ 30,412.80		$ -	$ 279,302.18	$ 80,834.27	$ 16.27	$ 360,136
1077	Landfill: T&D - Non-hazardous waste soil	9,251	TON	$ -	$ -	$ -	$ -	$ -	$ 1,357,121.70	$ -		$ -	$ 1,357,121.70	$ 393,260.01	$ 189.21	$ 1,750,382
1078	Landfill: T&D - Hazardous waste soil	11,306	TON	$ -	$ -	$ -	$ -	$ -	$ 4,496,396.20	$ -		$ -	$ 4,496,396.20	$ 1,303,016.50	$ 512.95	$ 5,799,413
1079	Landfill: T&D - Hazardous waste debris	1,578	TON	$ -	$ -	$ -	$ -	$ -	$ 709,626.60	$ -		$ -	$ 709,626.60	$ 205,644.96	$ 580.02	$ 915,272
1080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,522.49	$ 44,907.48	$ 11,227
1084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00		$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
1090	Project Support	4	MNTH	$ 153,485.94	$ 110,509.65	$ -	$ 46,100.00	$ 40,022.48	$ 12,500.00	$ 38,150.31	$ 960.00	$ -	$ 401,728.38	$ 116,418.82	$ 129,536.80	$ 518,147
															Total	$ 10,977,801

Table C-4. Alternative L2 Cost Estimate FINAL (January 2025)
Landfill AOPC
Alternative L2
Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M
Bradford Island NPL Site, Cascades Locks, Oregon
Base Year: 2024
Class 4 Estimate: (+50%, -30%)

Landfill AOPC Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
1010	Submittals	0.25	LS	$ 87,857	$ 21,964	Refer: Appendix C Table C-5; Bid Proposal Summary and Cost Detail Report for Alternative L2 (.pdf)
1020	Mobilization	0.25	EA	$ 40,118	$ 10,030	
1030	Overall Site Set-Up	0.25	EA	$ 82,496	$ 20,624	
1034	Overall Access Road Improvements	500	LF	$ 61.22	$ 30,610	
1040	Landfill: Erosion/Site Controls	1	LS	$ 20,231	$ 20,231	
1044	Landfill: Access Road Improvements	1,500	LF	$ 102.47	$ 153,705	
1046	Landfill: Well Abandonment	224	LF	$ 55.60	$ 12,454	
1050	Landfill: Clear & Grub	53,332	SF	$ 1.14	$ 60,798	
1054	Landfill: Exc & Stockpile Impacted Soil & Debris	2,160	BCY	$ 44.01	$ 95,062	
1058	Landfill: Confirmation Sampling	6	EA	$ 1,599.27	$ 9,596	
1060	Landfill: Install a Riprap Revetment	365	CY	$ 216.75	$ 79,114	
1062	Landfill: Install Soil Cover	35,502	SF	$ 15.69	$ 557,026	
1064	Landfill: Regrade/Backfill Excavation	1,183	LCY	$ 82.43	$ 97,515	
1065	Landfill: General Site Restoration	53,332	SF	$ 4.06	$ 216,528	
1066	Landfill: Institutional Controls (ICs)	1	YEAR	$ 13,224	$ 13,224	
1068	Landfill: Long-Term O&M	1	YEAR	$ 33,385	$ 33,385	
1069	Landfill: Five (5) Year Review	6	EA	$ 20,426	$ 122,554	
1070	Landfill: Waste Characterization	5	EA	$ 3,103	$ 15,514	
1074	Landfill: Loadout for T&D	1,770	TON	$ 27.22	$ 48,179	
1077	Landfill: T&D - Non-hazardous waste soil	796	TON	$ 192.93	$ 153,572	
1078	Landfill: T&D - Hazardous waste soil	974	TON	$ 523.03	$ 509,431	
1079	Landfill: T&D - Hazardous waste debris	100	TON	$ 591.42	$ 59,142	
1080	Overall Site Tear-down/Restoration	0.25	LS	$ 45,790	$ 11,448	
1084	Demobilization	0.25	LS	$ 40,118	$ 10,030	
1090	Project Support	4	MNTH	$ 132,083	$ 528,331	
				Subtotal	$ 2,890,066	
			Management Reserve	15%	$ 433,510	
			Engineering Management	20%	$ 578,013	
				Capital Project Cost Total	$ 3,901,590	

Table C-4. Alternative L2 Cost Estimate

FINAL (January 2025)

Landfill AOPC

Alternative L2

Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Landfill AOPC O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
1068	Landfill: Long-Term O&M	30	YEAR	$ 33,385	$ 1,001,554	
				Subtotal	$ 1,001,554	
			Management Reserve	10%	$ 100,155	
			Engineering Management	10%	$ 100,155	
				O&M Project Cost Total	$ 1,201,864	
	Annual O&M Cost Total		1	Years	$ 40,062	

Landfill AOPC Periodic Cost		Quantity	Unit	Unit Cost	Total	Notes
1066	Landfill: Institutional Controls (ICs)	6	YEAR	$ 13,224	$ 79,344	
1069	Landfill: Five (5) Year Review	6	YEAR	$ 20,426	$ 122,554	
				Subtotal	$ 201,899	
			Management Reserve	10%	$ 20,190	
			Engineering Management	10%	$ 7,934	
				Periodic Project Cost Total	$ 230,023	
	Annual Periodic Cost Total		6	Years	$ 38,337	

Landfill AOPC Project Cost Summary		Quantity	Unit	Unit Cost	Total	Notes
	Landfill AOPC Capital Cost	1	LS	$ 3,901,590	$ 3,901,590	
	Landfill AOPC O&M Cost	30	YR	$ 40,062	$ 1,201,864	
	Landfill AOPC Periodic Cost	6	EA	$ 38,337	$ 230,023	
				Landfill AOPC Project Total	$ 5,333,477	
			Project Cost Range	+50%	$ 8,000,216	
				-30%	$ 3,733,434	

Table C-4. Alternative L2 Cost Estimate FINAL (January 2025)

Landfill AOPC

Alternative L2

Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Landfill AOPC)	0	$ 3,901,590	$ 3,901,590	1.00	$ 3,901,590	
Annual O&M Cost	1 to 30		$ 40,062	20.93	$ 838,512	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	5		$ 38,337	0.88	$ 33,884	
Periodic Cost	10		$ 38,337	0.78	$ 29,949	
Periodic Cost	15		$ 38,337	0.69	$ 26,471	
Periodic Cost	20		$ 38,337	0.61	$ 23,396	
Periodic Cost	25		$ 38,337	0.54	$ 20,679	
Periodic Cost	30		$ 38,337	0.48	$ 18,277	
				Subtotal	$ 4,773,987	
			Total Present Value for Landfill AOPC	$ 4,773,987		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different "cost of capital" than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures: This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-5. Alternative L2 Cost Detail FINAL (January 2025)

Landfill AOPC

Alternative L2 - Engineered Soil Cover, Limited Slope Reduction and Stabilization, Shoreline Revetment, ICs, and Long-term O&M

Bradford Island EE/CA

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
1010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -		$ -	$ 16,700.96	$ 5,263.21	$ 87,856.68	$ 21,964
1020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00		$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
1030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40		$ -	$ 15,682.00	$ 4,942.09	$ 82,496.36	$ 20,624
1034	Overall Access Road Improvements-ECM	500	LF	$ 8,666.02	$ 6,361.67	$ -	$ 4,004.40	$ 2,078.40	$ -	$ 2,163.22		$ -	$ 23,273.71	$ 7,336.29	$ 61.22	$ 30,610
1040	Landfill: Erosion/Site Controls	1	LS	$ 4,807.88	$ 3,558.98	$ -	$ 5,009.00	$ 1,014.38	$ -	$ 992.84		$ -	$ 15,383.08	$ 4,847.88	$ 20,230.96	$ 20,231
1044	Landfill: Access Road Improvements	1,500	LF	$ 22,680.24	$ 16,484.17	$ 42,979.75	$ 12,137.00	$ 10,617.75	$ -	$ 11,973.21		$ -	$ 116,872.12	$ 36,832.88	$ 102.47	$ 153,705
1046	Landfill: Well Abandonment	224	LF	$ -	$ -	$ -	$ -	$ -	$ 9,470.00	$ -		$ -	$ 9,470.00	$ 2,984.40	$ 55.60	$ 12,454
1050	Landfill: Clear & Grub	53,332	SF	$ 16,827.58	$ 12,456.41	$ -	$ 157.50	$ 8,658.58	$ -	$ 8,141.84		$ -	$ 46,241.91	$ 14,556.57	$ 1.14	$ 60,798
1054	Landfill: Exc & Stockpile Impacted Soil & Debris	2,160	BCY	$ 23,644.39	$ 17,952.63	$ -	$ 1,102.50	$ 14,494.05	$ -	$ 15,085.64		$ -	$ 72,279.21	$ 22,782.39	$ 44.01	$ 95,062
1058	Landfill: Confirmation Sampling	6	EA	$ 2,223.41	$ 1,626.58	$ -	$ 22.50	$ 738.17	$ 1,500.00	$ 768.29	$ 417.28	$ -	$ 7,296.23	$ 2,299.39	$ 1,599.27	$ 9,596
1060	Landfill: Install a Riprap Revetment	365	CY	$ 11,244.64	$ 7,797.58	$ 31,540.00	$ 540.00	$ 4,336.00	$ -	$ 4,697.32		$ -	$ 60,155.54	$ 18,958.21	$ 216.75	$ 79,114
1062	Landfill: Install Soil Cover	35,502	SF	$ 86,526.44	$ 61,436.63	$ 152,040.00	$ 4,095.00	$ 36,374.58	$ 43,600.00	$ 39,405.80		$ -	$ 423,478.45	$ 113,525.00	$ 15.69	$ 557,026
1064	Landfill: Regrade/Backfill Excavation	1,183	LCY	$ 11,682.88	$ 8,772.14	$ 35,490.00	$ 540.00	$ 5,167.14	$ 6,900.00	$ 5,597.74		$ -	$ 74,149.90	$ 23,364.79	$ 82.43	$ 97,515
1065	Landfill: General Site Restoration	53,332	SF	$ 19,915.28	$ 14,646.56	$ -	$ 900.00	$ 8,039.16	$ 112,500.00	$ 8,709.08		$ -	$ 164,710.08	$ 51,817.84	$ 4.06	$ 216,528
1066	Landfill: Institutional Controls (ICs)	1	Year	$ 2,143.68	$ 1,424.97	$ 5,560.00	$ 135.00	$ 379.96	$ -	$ 411.62	$ -	$ -	$ 10,055.23	$ 3,168.85	$ 13,224.08	$ 13,224
1068	Landfill: Long-Term O&M	1	Year	$ 8,251.58	$ 5,250.29	$ 5,700.00	$ 432.00	$ 1,992.61	$ 1,600.00	$ 2,158.66	$ -	$ -	$ 25,385.14	$ 7,999.98	$ 33,385.12	$ 33,385
1069	Landfill: Five (5) Year Review	6	EA	$ 54,369.96	$ 37,923.01	$ -	$ 894.00	$ -	$ -	$ -	$ -	$ -	$ 93,186.97	$ 29,367.35	$ 20,425.72	$ 122,554
1070	Landfill: Waste Characterization	5	EA	$ 2,223.41	$ 1,626.58	$ -	$ 22.50	$ 723.10	$ 6,000.00	$ 783.36	$ 417.28	$ -	$ 11,796.23	$ 3,717.52	$ 3,102.75	$ 15,514
1074	Landfill: Loadout for T&D	1,770	TON	$ 14,606.24	$ 9,928.84	$ -	$ 720.00	$ 5,464.13	$ -	$ 5,919.47		$ -	$ 36,638.68	$ 11,540.72	$ 27.22	$ 48,179
1077	Landfill: T&D - Non-hazardous waste soil	796	TON	$ -	$ -	$ -	$ -	$ -	$ 116,773.20	$ -		$ -	$ 116,773.20	$ 36,799.08	$ 192.93	$ 153,572
1078	Landfill: T&D - Hazardous waste soil	974	TON	$ -	$ -	$ -	$ -	$ -	$ 387,359.80	$ -		$ -	$ 387,359.80	$ 122,071.42	$ 523.03	$ 509,431
1079	Landfill: T&D - Hazardous waste debris	100	TON	$ -	$ -	$ -	$ -	$ -	$ 44,970.00	$ -		$ -	$ 44,970.00	$ 14,172.00	$ 591.42	$ 59,142
1080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,743.14	$ 45,790.08	$ 11,448
1084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00		$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
1090	Project Support	4	MNTH	$ 153,485.94	$ 110,509.65	$ -	$ 46,100.00	$ 40,022.48	$ 12,500.00	$ 38,150.31	$ 960.00	$ -	$ 401,728.38	$ 126,602.30	$ 132,082.67	$ 528,331
															Total	$ 2,890,066

Table C-6. Bulb Slope AOPC Excavation Cost Estimate | FINAL (January 2025)

Bulbslope AOPC Excavation

Excavation of Debris and Contaminated Soil, Slope and Roadway Stabilization, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bulbslope AOPC Excavation Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
2010	Submittals	0.25	LS	$ 86,163	$ 21,541	Refer: Appendix C Table C-7; Bid Proposal Summary and Cost Detail Report for Alternative B1 (.pdf)
2020	Mobilization	0.25	EA	$ 39,345	$ 9,836	
2030	Overall Site Set-Up	0.25	EA	$ 80,906	$ 20,227	
2034	Overall Access Road Improvements	350	LF	$ 60.04	$ 21,014	
2040	Bulb Slope: Erosion/Site Controls	1	LS	$ 11,535	$ 11,535	
2044	Bulb Slope: Access Road Improvements	350	LF	$ 112.06	$ 39,221	
2050	Bulb Slope: Clear & Grub	3,364	SF	$ 2.53	$ 8,511	
2054	Bulb Slope: Exc & Stockpile Impacted Soil & Debris	232	BCY	$ 182.65	$ 42,375	
2058	Bulb Slope: Confirmation Sampling	10	EA	$ 1,675	$ 16,750	
2060	Bulb Slope: Regrade/Backfill Excavation	395	LCY	$ 181.24	$ 71,590	
2063	Bulb Slope: Site Restoration - Riprap	131	CY	$ 217.41	$ 28,481	
2064	Bulb Slope: Restoration	3,364	SF	$ 7.55	$ 25,398	
2070	Bulb Slope: Waste Characterization	2	EA	$ 3,378	$ 6,756	
2074	Bulb Slope: Loadout for T&D	200	TON	$ 22.52	$ 4,504	
2077	Bulb Slope: T&D - Non-hazardous waste soil	139	TON	$ 189.21	$ 26,300	
2078	Bulb Slope: T&D - Hazardous waste soil	35	TON	$ 512.95	$ 17,953	
2079	Bulb Slope: T&D - Hazardous waste debris	26	TON	$ 580.02	$ 15,081	
2080	Overall Site Tear-down/Restoration	0.25	LS	$ 44,907	$ 11,227	
2084	Demobilization	0.25	LS	$ 39,345	$ 9,836	
2090	Project Support	0.5	MNTH	$ 129,724	$ 64,862	
				Subtotal	$ 472,998	
			Management Reserve	15%	$ 70,950	
			Engineering Management	20%	$ 94,600	
				Capital Project Cost Total	$ 638,547	

Table C-6. Bulb Slope AOPC Excavation Cost Estimate

FINAL (January 2025)

Bulbslope AOPC Excavation

Excavation of Debris and Contaminated Soil, Slope and Roadway Stabilization, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bulbslope AOPC Excavation O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				O&M Project Cost Total	$ -	
	Annual O&M Cost Total		0	Years		

Bulbslope AOPC Excavation Periodic Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				Periodic Cost Total	$ -	

Bulbslope AOPC Excavation Project Cost Summary		Quantity	Unit	Unit Cost	Total	Notes
	Bulbslope AOPC Excavation Capital Cost	1	LS	$ 638,547	$ 638,547	
	Bulbslope AOPC Excavation O&M Cost	0	YR	$ -	$ -	
	Bulbslope AOPC Excavation Periodic Cost	0	LS	$ -	$ -	
				Bulbslope AOPC Excavation Project Total	$ 638,547	
			Project Cost Range	+50%	$ 957,821	
				-30%	$ 446,983	

Table C-6. Bulb Slope AOPC Excavation Cost Estimate

FINAL (January 2025)

Bulbslope AOPC Excavation

Excavation of Debris and Contaminated Soil, Slope and Roadway Stabilization, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Bulbslope AOPC Excavation)	0	$ 638,547	$ 638,547	1.000	$ 638,547	
Annual O&M Cost	0		$ -	20.930	$ -	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	0		$ -	1.000	$ -	
Subtotal		$ 638,547			$ 638,547	
Total Present Value for Bulbslope AOPC Excavation				$ 638,547		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different "cost of capital" than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures:

This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-7. Bulb Slope AOPC Excavation Cost Detail — FINAL (January 2025)

Bulbslope AOPC Excavation

Excavation of Debris and Contaminated Soil, Slope and Roadway Stabilization, and Site Restoration

Bradford Island EE/CA

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
2010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -	$ -	$ -	$ 16,700.96	$ 4,839.85	$ 86,163.24	$ 21,541
2020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
2030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40	$ -	$ -	$ 15,682.00	$ 4,544.56	$ 80,906.24	$ 20,227
2034	Overall Access Road Improvements	350	LF	$ 6,066.21	$ 4,453.17	$ -	$ 2,803.70	$ 1,619.31	$ -	$ 1,349.82	$ -	$ -	$ 16,292.21	$ 4,721.79	$ 60.04	$ 21,014
2040	Bulb Slope: Erosion/Site Controls	1	LS	$ 2,403.94	$ 1,779.49	$ -	$ 3,756.60	$ 507.17	$ -	$ 496.44	$ -	$ -	$ 8,943.64	$ 2,591.82	$ 11,535.46	$ 11,535
2044	Bulb Slope: Access Road Improvements	350	LF	$ 6,545.88	$ 4,688.11	$ 10,263.50	$ 3,263.70	$ 2,668.64	$ -	$ 2,979.10	$ -	$ -	$ 30,408.93	$ 8,812.07	$ 112.06	$ 39,221
2050	Bulb Slope: Clear & Grub	3,364	SF	$ 2,403.94	$ 1,779.49	$ -	$ 22.50	$ 1,236.94	$ -	$ 1,163.12	$ -	$ -	$ 6,605.99	$ 1,904.93	$ 2.53	$ 8,511
2054	Bulb Slope: Exc & Stockpile Impacted Soil & Debris	232	BCY	$ 10,133.31	$ 7,693.97	$ -	$ 67.50	$ 7,712.04	$ -	$ 7,247.76	$ -	$ -	$ 32,854.58	$ 9,520.22	$ 182.65	$ 42,375
2058	Bulb Slope: Confirmation Sampling	10	EA	$ 3,921.33	$ 2,912.90	$ -	$ 45.00	$ 1,795.61	$ 2,500.00	$ 1,217.31	$ 594.56	$ -	$ 12,986.71	$ 3,763.49	$ 1,675.02	$ 16,750
2060	Bulb Slope: Regrade/Backfill Excavation	395	LCY	$ 13,459.60	$ 10,239.81	$ 6,060.00	$ 90.00	$ 9,904.44	$ 6,900.00	$ 8,852.16	$ -	$ -	$ 55,506.01	$ 16,083.79	$ 181.24	$ 71,590
2063	Bulb Slope: Site Restoration - Riprap	131	CY	$ 4,563.02	$ 3,062.30	$ 11,236.00	$ 45.00	$ 1,699.85	$ -	$ 1,475.65	$ -	$ -	$ 22,081.82	$ 188.10	$ 217.41	$ 28,481
2064	Bulb Slope: Restoration	3,364	SF	$ 3,905.88	$ 2,820.16	$ -	$ 45.00	$ 1,619.60	$ 9,900.00	$ 1,406.00	$ -	$ -	$ 19,696.64	$ 5,701.56	$ 7.55	$ 25,398
2070	Bulb Slope: Waste Characterization	2	EA	$ 1,111.72	$ 813.28	$ -	$ 11.25	$ 448.90	$ 2,400.00	$ 304.34	$ 148.64	$ -	$ 5,238.13	$ 1,517.99	$ 3,378.06	$ 6,756
2074	Bulb Slope: Loadout for T&D	200	TON	$ 1,504.03	$ 1,122.53	$ -	$ 22.50	$ 462.06	$ -	$ 380.16	$ -	$ -	$ 3,491.28	$ 1,012.72	$ 22.52	$ 4,504
2077	Bulb Slope: T&D - Non-hazardous waste soil	139	TON	$ -	$ -	$ -	$ -	$ -	$ 20,391.30	$ -	$ -	$ -	$ 20,391.30	$ 5,908.89	$ 189.21	$ 26,300
2078	Bulb Slope: T&D - Hazardous waste soil	35	TON	$ -	$ -	$ -	$ -	$ -	$ 13,919.50	$ -	$ -	$ -	$ 13,919.50	$ 4,033.75	$ 512.95	$ 17,953
2079	Bulb Slope: T&D - Hazardous waste debris	26	TON	$ -	$ -	$ -	$ -	$ -	$ 11,692.20	$ -	$ -	$ -	$ 11,692.20	$ 3,388.32	$ 580.02	$ 15,081
2080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,522.49	$ 44,907.48	$ 11,227
2084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
2090	Project Support	0.5	MNTH	$ 19,495.91	$ 14,037.01	$ -	$ 5,762.50	$ 5,047.28	$ 1,000.00	$ 4,826.00	$ 120.00	$ -	$ 50,288.70	$ 14,573.41	$ 129,724.22	$ 64,862
															Total	$ 472,998

Table C-8. Alternative S1 Cost Estimate

FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S1

Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Sandblast AOPC (ELA North and SGSA) Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
3010	Submittals	0.25	LS	$ 86,163	$ 21,541	Refer: Appendix C Table C-11; Bid Proposal Summary and Cost Detail Report for Alternative S1 (.pdf)
3020	Mobilization	0.25	EA	$ 39,345	$ 9,836	
3030	Overall Site Set-Up	0.25	EA	$ 80,906	$ 20,227	
3034	Overall Access Road Improvements	300	LF	$ 60.03	$ 18,009	
3040	Sandblast: Erosion/Site Controls	1	LS	$ 24,189	$ 24,189	
3044	Sandblast: Access Road Improvements	300	LF	$ 98.04	$ 29,412	
3050	Sandblast: Clear & Grub	24,761	SF	$ 1.03	$ 25,504	
3054	Sandblast: Exc & Stockpile Impacted Soil & Debris	1,788	BCY	$ 34.17	$ 61,096	
3058	Sandblast: Confirmation Sampling	50	EA	$ 728.22	$ 36,411	
3060	Sandblast: Regrade/Backfill Excavation	2,522	LCY	$ 64.62	$ 162,972	
3063	Sandblast: Site Restoration - Riprap	778	LCY	$ 173.95	$ 135,333	
3064	Sandblast: Restoration	36,761	SF	$ 5.40	$ 198,509	
3070	Sandblast: Waste Characterization	10	EA	$ 3,012	$ 30,120	
3074	Sandblast: Loadout for T&D	2,661	TON	$ 23.69	$ 63,039	
3078	Sandblast: T&D - Non-hazardous waste soil	1,290	TON	$ 189.21	$ 244,081	
3079	Sandblast: T&D - Hazardous waste soil	1,371	TON	$ 512.95	$ 703,254	
3080	Overall Site Tear-down/Restoration	0.25	LS	$ 44,907	$ 11,227	
3084	Demobilization	0.25	LS	$ 39,345	$ 9,836	
3090	Project Support	1	MNTH	$ 129,423	$ 129,423	
				Subtotal	$ 1,934,019	
			Management Reserve	15%	$ 290,103	
			Engineering Management	20%	$ 386,804	
				Capital Project Cost Total	$ 2,610,926	

Table C-8. Alternative S1 Cost Estimate — FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S1

Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Sandblast AOPC (ELA North and SGSA) Annual O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				O&M Project Cost Total	$ -	
	Annual O&M Cost Total	0		Years		

Sandblast AOPC (ELA North and SGSA) Periodic Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				Periodic Project Cost Total	$ -	

Sandblast AOPC (ELA North and SGSA) Project Cost Summary		Quantity	Unit	Unit Cost	Total	Notes
	Sandblast AOPC (ELA North and SGSA) Capital Cost	1	LS	$ 2,610,926	$ 2,610,926	
	Sandblast AOPC (ELA North and SGSA) Annual O&M Cost	2	YR	$ -	$ -	
	Sandblast AOPC (ELA North and SGSA) Periodic Cost	1	LS	$ -	$ -	
				Sandblast AOPC (ELA North and SGSA) Project Total	$ 2,610,926	
			Project Cost Range	+50%	$ 3,916,389	
				-30%	$ 1,827,648	

Table C-8. Alternative S1 Cost Estimate FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S1

Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Present Value Analysis						
Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Sandblast AOPC (ELA North and SGSA))	0	$ 2,610,926	$ 2,610,926	1.000	$ 2,610,926	
Annual O&M Cost			$ -		$ -	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost			$ -		$ -	
				Subtotal	$ 2,610,926	
Total Present Value for Sandblast AOPC (ELA North and SGSA)				$ 2,610,926		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different “cost of capital” than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures:

This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-9. Alternative S1 Cost Detail FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S1 - Targeted Removal of Contaminated Soil and Spent Sandblast Grit, Offsite Landfilling, Backfilling, Shoreline Revetment with Vegetative Buffer, Asphalt Pavement, and Site Restoration

Bradford Island EE/CA

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
3010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -	$ -	$ -	$ 16,700.96	$ 4,839.85	$ 86,163.24	$ 21,541
3020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
3030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40	$ -	$ -	$ 15,682.00	$ 4,544.56	$ 80,906.24	$ 20,227
3034	Overall Access Road Improvements	300	LF	$ 5,199.62	$ 3,816.99	$ -	$ 2,401.40	$ 1,387.98	$ -	$ 1,156.99	$ -	$ -	$ 13,962.98	$ 4,046.02	$ 60.03	$ 18,009
3040	Sandblast: Erosion/Site Controls	1	LS	$ 6,752.02	$ 4,965.83	$ -	$ 5,029.25	$ 1,014.38	$ -	$ 992.84	$ -	$ -	$ 18,754.32	$ 5,434.91	$ 24,189.23	$ 24,189
3044	Sandblast: Access Road Improvements	300	LF	$ 4,252.56	$ 3,090.79	$ 8,660.25	$ 2,563.90	$ 2,001.49	$ -	$ 2,234.33	$ -	$ -	$ 22,803.32	$ 6,608.68	$ 98.04	$ 29,412
3050	Sandblast: Clear & Grub	24,761	SF	$ 7,211.82	$ 5,338.46	$ -	$ 67.50	$ 3,710.82	$ -	$ 3,489.36	$ -	$ -	$ 19,817.96	$ 5,685.87	$ 1.03	$ 25,504
3054	Sandblast: Exc & Stockpile Impacted Soil & Debris	1,788	BCY	$ 14,240.60	$ 10,732.04	$ -	$ 112.50	$ 10,848.50	$ -	$ 11,434.80	$ -	$ -	$ 47,368.44	$ 13,727.52	$ 34.17	$ 61,096
3058	Sandblast: Confirmation Sampling	50	EA	$ 5,881.99	$ 4,369.33	$ -	$ 67.50	$ 2,693.46	$ 12,500.00	$ 1,825.92	$ 891.84	$ -	$ 28,230.04	$ 8,180.96	$ 728.22	$ 36,411
3060	Sandblast: Regrade/Backfill Excavation	2,522	LCY	$ 17,011.50	$ 12,850.22	$ 63,780.00	$ 135.00	$ 10,898.40	$ 11,100.00	$ 10,572.48	$ -	$ -	$ 126,347.60	$ 36,624.04	$ 64.62	$ 162,972
3063	Sandblast: Site Restoration - Riprap	778	CY	$ 15,970.57	$ 10,718.02	$ 66,968.00	$ 157.50	$ 5,949.46	$ -	$ 5,164.79	$ -	$ -	$ 104,928.34	$ 188.10	$ 173.95	$ 135,333
3064	Sandblast: Restoration	36,761	SF	$ 7,811.76	$ 5,640.29	$ -	$ 90.00	$ 3,240.35	$ 134,400.00	$ 2,810.85	$ -	$ -	$ 153,993.25	$ 44,516.15	$ 5.40	$ 198,509
3070	Sandblast: Waste Characterization	10	EA	$ 4,446.82	$ 3,253.14	$ -	$ 45.00	$ 1,795.64	$ 12,000.00	$ 1,217.28	$ 594.56	$ -	$ 23,352.44	$ 6,767.46	$ 3,011.99	$ 30,120
3074	Sandblast: Loadout for T&D	2,661	TON	$ 21,056.42	$ 15,715.39	$ -	$ 315.00	$ 6,468.84	$ -	$ 5,322.24	$ -	$ -	$ 48,877.89	$ 14,161.20	$ 23.69	$ 63,039
3078	Sandblast: T&D - Non-Hazardous waste soil	1,290	TON	$ -	$ -	$ -	$ -	$ -	$ 189,243.00	$ -	$ -	$ -	$ 189,243.00	$ 54,837.90	$ 189.21	$ 244,081
3079	Sandblast: T&D - Hazardous waste soil	1,371	TON	$ -	$ -	$ -	$ -	$ -	$ 545,246.70	$ -	$ -	$ -	$ 545,246.70	$ 158,007.75	$ 512.95	$ 703,254
3080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,522.49	$ 44,907.48	$ 11,227
3084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
3090	Project Support	1	MNTH	$ 38,371.50	$ 27,627.42	$ -	$ 11,525.00	$ 10,352.85	$ 2,500.00	$ 9,727.20	$ 240.00	$ -	$ 100,343.97	$ 29,079.17	$ 129,423.14	$ 129,423
															Total	$ 1,934,019

Table C-10. Alternative S2 Cost Estimate FINAL (January 2025)
Sandblast AOPC (ELA North and SGSA)
Alternative S2
Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and

Bradford Island NPL Site, Cascades Locks, Oregon
Base Year: 2024
Class 4 Estimate: (+50%, -30%)

Sandblast AOPC (ELA North and SGSA) Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
3010	Submittals	0.25	LS	$ 87,857	$ 21,964	Refer: Appendix C Table C-13; Bid Proposal Summary and Cost Detail Report for Alternative S2 (.pdf)
3020	Mobilization	0.25	EA	$ 40,118	$ 10,030	
3030	Overall Site Set-Up	0.25	EA	$ 82,496	$ 20,624	
3034	Overall Access Road Improvements	300	LF	$ 61.21	$ 18,363	
3040	Sandblast: Erosion/Site Controls	1	LS	$ 24,665	$ 24,665	
3044	Sandblast: Access Road Improvements	300	LF	$ 99.97	$ 29,991	
3050	Sandblast: Clear & Grub	24,761	SF	$ 1.05	$ 25,999	
3054	Sandblast: Exc & Stockpile Sandblast Grit	56	BCY	$ 188.80	$ 10,573	
3058	Sandblast: Confirmation Sampling	5	EA	$ 1,829.94	$ 9,150	
3060	Sandblast: Install Riprap Revetment	778	CY	$ 209.95	$ 163,341	
3062	Sandblast: Install Soil Cover	8,280	SF	$ 15.12	$ 125,194	
3064	Sandblast: ELA North Asphalt Cap	8,731	SF	$ 14.18	$ 123,806	
3065	Sandblast: General Site Restoration	36,761	SF	$ 4.13	$ 151,823	
3066	Sandblast: Institutional Controls (ICs)	1	YEAR	$ 6,612	$ 6,612	
3068	Sandblast: Long-Term O&M	1	YEAR	$ 21,967	$ 21,967	
3069	Sandblast: Five (5) Year Review	6	EA	$ 20,426	$ 122,554	
3070	Sandblast: Waste Characterization	2	EA	$ 4,673	$ 9,347	
3074	Sandblast: Loadout for T&D	80	TON	$ 63.14	$ 5,051	
3079	Sandblast: T&D - Hazardous waste soil	80	TON	$ 523.03	$ 41,842	
3080	Overall Site Tear-down/Restoration	0.25	LS	$ 45,790	$ 11,448	
3084	Demobilization	0.25	LS	$ 40,118	$ 10,030	
3090	Project Support	1	MNTH	$ 131,967	$ 131,967	
				Subtotal	$ 1,096,339	
			Management Reserve	15%	$ 164,451	
			Engineering Management	20%	$ 219,268	
				Capital Project Cost Total	$ 1,480,058	

Table C-10. Alternative S2 Cost Estimate FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S2

Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Sandblast AOPC (ELA North and SGSA) Annual O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
3068	Sandblast: Long-Term O&M	30	YEAR	$ 21,967	$ 659,014	
				Subtotal	$ 659,014	
			Management Reserve	10%	$ 65,901	
			Engineering Management	10%	$ 65,901	
				O&M Project Cost Total	$ 790,817	
		Annual O&M Cost Total	1	Years	$ 26,361	

Sandblast AOPC (ELA North and SGSA) Periodic Cost		Quantity	Unit	Unit Cost	Total	Notes
3066	Sandblast: Institutional Controls (ICs)	6	YEAR	$ 6,612	$ 39,672	
3069	Sandblast: Five (5) Year Review	6	YEAR	$ 20,426	$ 122,554	
				Subtotal	$ 162,226	
			Management Reserve	10%	$ 16,223	
			Engineering Management	10%	$ 16,223	
				Periodic Project Cost Total	$ 194,672	
		Annual Periodic Cost Total	1	Years	$ 32,445	

Sandblast AOPC (ELA North and SGSA) Project Cost Summary		Quantity	Unit	Unit Cost	Total	Notes
	Sandblast AOPC (ELA North and SGSA) Capital Cost	1	LS	$ 1,480,058	$ 1,480,058	
	Sandblast AOPC (ELA North and SGSA) Annual O&M Cost	30	YR	$ 26,361	$ 790,817	
	Sandblast AOPC (ELA North and SGSA) Periodic Cost	6	YR	$ 32,445	$ 194,672	
				Sandblast AOPC (ELA North and SGSA) Project Total	$ 2,465,546	
			Project Cost Range	+50%	$ 3,698,319	
				-30%	$ 1,725,882	

Table C-10. Alternative S2 Cost Estimate FINAL (January 2025)
Sandblast AOPC (ELA North and SGSA)
Alternative S2
Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and

Bradford Island NPL Site, Cascades Locks, Oregon
Base Year: 2024
Class 4 Estimate: (+50%, -30%)

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Sandblast AOPC (ELA North and SGSA))	0	$ 1,480,058	$ 1,480,058	1.000	$ 1,480,058	
Annual O&M Cost	1 to 30		$ 26,361	20.93	$ 551,734	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	5		$ 32,445	0.88	$ 28,677	
Periodic Cost	10		$ 32,445	0.78	$ 25,346	
Periodic Cost	15		$ 32,445	0.69	$ 22,402	
Periodic Cost	20		$ 32,445	0.61	$ 19,800	
Periodic Cost	25		$ 32,445	0.54	$ 17,501	
Periodic Cost	30		$ 32,445	0.48	$ 15,468	
				Subtotal	$ 2,160,986	
Total Present Value for Sandblast AOPC (ELA North and SGSA)				$ 2,160,986		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different "cost of capital" than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures:

This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-11. Alternative S2 Cost Detail FINAL (January 2025)

Sandblast AOPC (ELA North and SGSA)

Alternative S2- Targeted Removal of Spent Sandblast Grit, Engineered Soil Cover/Asphalt Cap, Shoreline Revetment with Vegetative Buffer, Site Restoration, ICs, and Long-term O&M

Bradford Island EE/CA

Base Year: 2024

Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
3010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -	$ -	$ -	$ 16,700.96	$ 5,263.21	$ 87,856.68	$ 21,964
3020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
3030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40	$ -	$ -	$ 15,682.00	$ 4,942.09	$ 82,496.36	$ 20,624
3034	Overall Access Road Improvements-ECM	300	LF	$ 5,199.62	$ 3,816.99	$ -	$ 2,401.40	$ 1,221.59	$ -	$ 1,323.38	$ -	$ -	$ 13,962.98	$ 4,400.02	$ 61.21	$ 18,363
3040	Sandblast: Erosion/Site Controls	1	LS	$ 6,752.02	$ 4,965.83	$ -	$ 5,029.25	$ 1,014.38	$ -	$ 992.84	$ -	$ -	$ 18,754.32	$ 5,910.32	$ 24,664.64	$ 24,665
3044	Sandblast: Access Road Improvements	300	LF	$ 4,252.56	$ 3,090.79	$ 8,660.25	$ 2,563.90	$ 2,033.19	$ -	$ 2,202.63	$ -	$ -	$ 22,803.32	$ 7,187.68	$ 99.97	$ 29,991
3050	Sandblast: Clear & Grub	24,761	SF	$ 7,211.82	$ 5,338.46	$ -	$ 67.50	$ 3,710.82	$ -	$ 3,489.36	$ -	$ -	$ 19,817.96	$ 6,181.09	$ 1.05	$ 25,999
3054	Sandblast: Exc & Stockpile Sandblast Grit	56	BCY	$ 2,281.51	$ 1,531.14	$ -	$ 112.50	$ 1,014.79	$ 2,000.00	$ 1,099.35	$ -	$ -	$ 8,039.29	$ 2,533.51	$ 188.80	$ 10,573
3058	Sandblast: Confirmation Sampling	5	EA	$ 1,693.76	$ 1,208.32	$ -	$ 90.00	$ 723.10	$ 2,250.00	$ 783.36	$ 208.64	$ -	$ 6,957.18	$ 2,192.52	$ 1,829.94	$ 9,150
3060	Sandblast: Install Riprap Revetment	778	CY	$ 22,489.28	$ 15,595.18	$ 66,968.00	$ 1,080.00	$ 8,671.99	$ -	$ 9,394.65	$ -	$ -	$ 124,199.10	$ 186.36	$ 209.95	$ 163,341
3062	Sandblast: Install Soil Cover	8,280	SF	$ 18,037.14	$ 13,466.22	$ 35,460.00	$ 135.00	$ 8,394.13	$ 10,600.00	$ 9,093.65	$ -	$ -	$ 95,186.14	$ 16.08	$ 15.12	$ 125,194
3064	Sandblast: ELA North Asphalt Cap	8,731	SF	$ 4,549.38	$ 3,057.32	$ -	$ 225.00	$ 1,610.50	$ 82,944.50	$ 1,744.70	$ -	$ -	$ 94,131.40	$ 16.08	$ 14.18	$ 123,806
3065	Sandblast: General Site Restoration	36,761	SF	$ 12,447.05	$ 9,154.11	$ -	$ 562.50	$ 5,420.00	$ 82,000.00	$ 5,871.65	$ -	$ -	$ 115,455.31	$ 36,367.62	$ 4.13	$ 151,823
3066	Sandblast: Institutional Controls (ICs)	1	Year	$ 1,071.84	$ 712.47	$ 2,780.00	$ 67.50	$ 189.98	$ -	$ 205.81	$ -	$ -	$ 5,027.60	$ 13,248.93	$ 6,612.02	$ 6,612
3068	Sandblast: Long-Term O&M	1	Year	$ 5,157.24	$ 3,281.43	$ 3,800.00	$ 270.00	$ 1,245.38	$ 1,600.00	$ 1,349.16	$ -	$ -	$ 16,703.21	$ 33,447.85	$ 21,967.13	$ 21,967
3069	Sandblast: Five (5) Year Review	6	EA	$ 54,369.96	$ 37,923.01	$ -	$ 894.00	$ -	$ -	$ -	$ -	$ -	$ 93,186.97	$ 20,464.10	$ 20,425.72	$ 122,554
3070	Sandblast: Waste Characterization	2	EA	$ 1,693.76	$ 1,208.32	$ -	$ 90.00	$ 723.10	$ 2,400.00	$ 783.36	$ 208.64	$ -	$ 7,107.18	$ 2,239.80	$ 4,673.49	$ 9,347
3074	Sandblast: Loadout for T&D	80	TON	$ 1,504.03	$ 1,122.53	$ -	$ 22.50	$ 572.14	$ -	$ 619.82	$ -	$ -	$ 3,841.02	$ 1,210.18	$ 63.14	$ 5,051
3079	Sandblast: T&D - Hazardous waste soil	80	TON	$ -	$ -	$ -	$ -	$ -	$ 31,816.00	$ -	$ -	$ -	$ 31,816.00	$ 10,026.40	$ 523.03	$ 41,842
3080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,743.14	$ 45,790.08	$ 11,448
3084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
3090	Project Support	1	MNTH	$ 38,371.50	$ 27,627.42	$ -	$ 11,525.00	$ 10,352.85	$ 2,500.00	$ 9,727.20	$ 240.00	$ -	$ 100,343.97	$ 31,622.81	$ 131,966.78	$ 131,967
															Total	$ 1,096,339

Table C-12. Alternative P1 Cost Estimate FINAL (January 2025)
Pistol Range AOPC
Alternative P1
Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon
Base Year: 2021
Class 4 Estimate: (+50%, -30%)

Pistol Range AOPC Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
4010	Submittals	0.25	LS	$ 86,163	$ 21,541	Refer: Appendix C Table C-15; Bid Proposal Summary and Cost Detail Report for Alternative P1 (.pdf)
4020	Mobilization	0.25	EA	$ 39,345	$ 9,836	
4030	Overall Site Set-Up	0.25	EA	$ 80,906	$ 20,227	
4034	Overall Access Road Improvements	200	LF	$ 60.04	$ 12,008	
4040	Pistol Range: Erosion/Site Controls	1	LS	$ 19,841	$ 19,841	
4044	Pistol Range: Access Road Improvements	200	LF	$ 98.52	$ 19,704	
4050	Pistol Range: Clear & Grub	7,355	SF	$ 1.16	$ 8,532	
4054	Pistol Range: Exc & Stockpile Impacted Soil & Debris	817	BCY	$ 49.36	$ 40,327	
4058	Pistol Range: Confirmation Sampling	18	EA	$ 879.67	$ 15,834	
4060	Pistol Range: Regrade/Backfill Excavation	505	LCY	$ 98.08	$ 49,530	
4064	Pistol Range: Restoration	7,355	SF	$ 1.94	$ 14,269	
4070	Pistol Range: Waste Characterization	5	EA	$ 3,417	$ 17,084	
4074	Pistol Range: Loadout for T&D	850	TON	$ 21.19	$ 18,012	
4078	Pistol Range: T&D - Hazardous waste soil	844	TON	$ 512.95	$ 432,930	
4079	Pistol Range: T&D - Non-hazardous waste debris	6	TON	$ 189.21	$ 1,135	
4080	Overall Site Tear-down/Restoration	0.25	LS	$ 44,907	$ 11,227	
4084	Demobilization	0.25	LS	$ 39,345	$ 9,836	
4090	Project Support	0.5	MNTH	$ 129,297	$ 64,649	
				Subtotal	$ 786,521	
			Management Reserve	15%	$ 117,978	
			Engineering Management	20%	$ 157,304	
				Capital Project Cost Total	$ 1,061,803	

Table C-12. Alternative P1 Cost Estimate

FINAL (January 2025)

Pistol Range AOPC

Alternative P1

Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2021

Class 4 Estimate: (+50%, -30%)

Pistol Range AOPC Annual O&M Cost		Quantity	Unit	Unit Cost	Total	Notes
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				O&M Project Cost Total	$ -	
		Annual O&M Cost Total	0	Years		
Pistol Range AOPC Periodic Cost		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
					$ -	
				Subtotal	$ -	
			Management Reserve	10%	$ -	
			Engineering Management	10%	$ -	
				Periodic Cost Total	$ -	
Pistol Range AOPC Project Cost Summary		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
	Pistol Range AOPC Capital Cost	1	LS	$ 1,061,803	$ 1,061,803	
	Pistol Range AOPC Annual O&M Cost	0	YR	$ -	$ -	
	Pistol Range AOPC Periodic Cost	0	LS	$ -	$ -	
				Pistol Range AOPC Project Total	$ 1,061,803	
			Project Cost Range	+50%	$ 1,592,704	
				-30%	$ 743,262	

Table C-12. Alternative P1 Cost Estimate FINAL (January 2025)
Pistol Range AOPC
Alternative P1
Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

Bradford Island NPL Site, Cascades Locks, Oregon
Base Year: 2021
Class 4 Estimate: (+50%, -30%)

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Pistol Range AOPC)	0	$ 1,061,803	$ 1,061,803	1.000	$ 1,061,803	
Annual O&M Cost	0		$ -	20.930	$ -	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	0		$ -	1.000	$ -	
				Subtotal	$ 1,061,803	
Total Present Value for Pistol Range AOPC				$ 1,061,803		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different “cost of capital” than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures:

This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-13. Alternative P1 Cost Detail FINAL (January 2025)
Pistol Range AOPC
Alternative P1 - Removal of Contaminated Soil, Offsite Landfilling, Backfilling, and Site Restoration

Bradford Island EE/CA
Base Year: 2024
Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
4010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -	$ -	$ -	$ 16,700.96	$ 4,839.85	$ 86,163.24	$ 21,541
4020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
4030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40	$ -	$ -	$ 15,682.00	$ 4,544.56	$ 80,906.24	$ 20,227
4034	Overall Access Road Improvements	200	LF	$ 3,466.40	$ 2,544.66	$ -	$ 1,603.00	$ 925.33	$ -	$ 771.32	$ -	$ -	$ 9,310.71	$ 2,697.29	$ 60.04	$ 12,008
4040	Pistol Range: Erosion/Site Controls	1	LS	$ 4,807.88	$ 3,558.98	$ -	$ 5,009.00	$ 1,014.38	$ -	$ 992.84	$ -	$ -	$ 15,383.08	$ 4,457.93	$ 19,841.01	$ 19,841
4044	Pistol Range: Access Road Improvements	200	LF	$ 2,835.03	$ 2,060.54	$ 5,853.75	$ 1,703.00	$ 1,334.32	$ -	$ 1,489.55	$ -	$ -	$ 15,276.19	$ 4,427.81	$ 98.52	$ 19,704
4050	Pistol Range: Clear & Grub	7,355	SF	$ 2,403.94	$ 1,779.49	$ -	$ 22.50	$ 1,236.94	$ -	$ 1,163.12	$ -	$ -	$ 6,605.99	$ 1,925.81	$ 1.16	$ 8,532
4054	Pistol Ran: Exc & Stockpile Impacted Soil & Debris	817	BCY	$ 10,133.31	$ 7,693.97	$ -	$ 67.50	$ 6,551.30	$ -	$ 6,818.68	$ -	$ -	$ 31,264.76	$ 9,062.36	$ 49.36	$ 40,327
4058	Pistol Range: Confirmation Sampling	18	EA	$ 2,941.01	$ 2,184.68	$ -	$ 33.75	$ 1,346.72	$ 4,500.00	$ 912.98	$ 357.28	$ -	$ 12,276.42	$ 3,557.64	$ 879.67	$ 15,834
4060	Pistol Range: Regrade/Backfill Excavation	505	LCY	$ 6,729.80	$ 5,119.92	$ 15,150.00	$ 45.00	$ 3,650.15	$ 4,200.00	$ 3,506.81	$ -	$ -	$ 38,401.68	$ 11,128.72	$ 98.08	$ 49,530
4064	Pistol Range: Restoration	7,355	SF	$ 1,959.76	$ 1,412.57	$ 2,280.00	$ 22.50	$ 482.61	$ 4,500.00	$ 418.96	$ -	$ -	$ 11,076.40	$ 3,192.30	$ 1.94	$ 14,269
4070	Pistol Range: Waste Characterization	5	EA	$ 2,779.26	$ 2,033.21	$ -	$ 28.13	$ 1,111.02	$ 6,000.00	$ 772.06	$ 521.60	$ -	$ 13,245.28	$ 3,838.42	$ 3,416.74	$ 17,084
4074	Pistol Range: Loadout for T&D	850	TON	$ 6,016.12	$ 4,490.10	$ -	$ 90.00	$ 1,953.95	$ -	$ 1,414.93	$ -	$ -	$ 13,965.10	$ 4,046.40	$ 21.19	$ 18,012
4078	Pistol Range: T&D - Hazardous waste soil	844	TON	$ -	$ -	$ -	$ -	$ -	$ 335,658.80	$ -	$ -	$ -	$ 335,658.80	$ 97,271.00	$ 512.95	$ 432,930
4079	Pistol Range: T&D - Non-hazardous waste debris	6	TON	$ -	$ -	$ -	$ -	$ -	$ 880.20	$ -	$ -	$ -	$ 880.20	$ 255.06	$ 189.21	$ 1,135
4080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,522.49	$ 44,907.48	$ 11,227
4084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,210.03	$ 39,344.84	$ 9,836
4090	Project Support	0.5	MNTH	$ 19,186.44	$ 13,814.18	$ -	$ 5,762.50	$ 5,176.42	$ 1,200.00	$ 4,863.61	$ 120.00	$ -	$ 50,123.15	$ 14,525.44	$ 129,297.18	$ 64,649
															Total	$ 786,521

Table C-14. Alternative P2 Cost Estimate — FINAL (January 2025)

Pistol Range AOPC

Alternative P2

Engineered Soil Cover, Site Restoration, ICs, and Long term O&M

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2021

Class 4 Estimate: (+50%, -30%)

Pistol Range AOPC Capital Cost		Quantity	Unit	Unit Cost	Total	Notes
4010	Submittals	0.25	LS	$ 87,857	$ 21,964	Refer: Appendix C Table C-16; Bid Proposal Summary and Cost Detail Report for Alternative P2 (.pdf)
4020	Mobilization	0.25	EA	$ 40,118	$ 10,030	
4030	Overall Site Set-Up	0.25	EA	$ 82,496	$ 20,624	
4034	Overall Access Road Improvements	200	LF	$ 61.22	$ 12,244	
4040	Pistol Range: Erosion/Site Controls	1	LS	$ 20,231	$ 20,231	
4044	Pistol Range: Access Road Improvements	200	LF	$ 100.45	$ 20,090	
4050	Pistol Range: Clear & Grub	7,355	SF	$ 1.18	$ 8,679	
4054	Pistol Ran: Exc & Stockpile Impacted Debris	42	CY	$ 260.78	$ 10,953	
4062	Pistol Range: Install Soil Cover	7,647	SF	$ 17.72	$ 135,505	
4065	Pistol Range: General Site Restoration	7,355	SF	$ 2.18	$ 16,034	
4066	Pistol Range: Institutional Controls (ICs)	1	YEAR	$ 6,612	$ 6,612	
4068	Pistol Range: Long-Term O&M	1	YEAR	$ 11,911	$ 11,911	
4069	Pistol Range: Five (5) Year Review	6	EA	$ 20,426	$ 122,554	
4074	Pistol Range: Loadout for T&D	6	TON	$ 175.45	$ 1,053	
4079	Pistol Range: T&D - Non-hazardous waste debris	6	TON	$ 192.93	$ 1,158	
4080	Overall Site Tear-down/Restoration	0.25	LS	$ 45,790	$ 11,448	
4084	Demobilization	0.25	LS	$ 40,118	$ 10,030	
4090	Project Support	0.5	MNTH	$ 131,838	$ 65,919	
				Subtotal	$ 507,037	
			Management Reserve	15%	$ 76,056	
			Engineering Management	20%	$ 101,407	
				Capital Project Cost Total	$ 684,500	

Table C-14. Alternative P2 Cost Estimate						FINAL (January 2025)
Pistol Range AOPC						
Alternative P2						
Engineered Soil Cover, Site Restoration, ICs, and Long term O&M						
Bradford Island NPL Site, Cascades Locks, Oregon						
Base Year: 2021						
Class 4 Estimate: (+50%, -30%)						
Pistol Range AOPC Annual O&M Cost		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
4068	Pistol Range: Long-Term O&M	30	YEAR	$ 11,911	$ 357,340	
				Subtotal	$ 357,340	
			Management Reserve	10%	$ 35,734	
			Engineering Management	10%	$ 35,734	
				O&M Project Cost Total	$ 428,808	
		Annual O&M Cost Total	1	Years	$ 14,294	
Pistol Range AOPC Periodic Cost		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
4066	Pistol Range: Institutional Controls (ICs)	6	YEAR	$ 6,612	$ 39,672	
4069	Pistol Range: Five (5) Year Review	6	EA	$ 20,426	$ 122,554	
				Subtotal	$ 162,226	
			Management Reserve	10%	$ 16,223	
			Engineering Management	10%	$ 16,223	
				Periodic Cost Total	$ 194,672	
		Annual Periodic Cost Total	1	Years	$ 32,445	
Pistol Range AOPC Project Cost Summary		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
	Pistol Range AOPC Capital Cost	1	LS	$ 684,500	$ 684,500	
	Pistol Range AOPC Annual O&M Cost	30	YR	$ 14,294	$ 428,808	
	Pistol Range AOPC Periodic Cost	6	EA	$ 32,445	$ 194,672	
				Pistol Range AOPC Project Total	$ 1,307,980	
			Project Cost Range	+50%	$ 1,961,969	
				-30%	$ 915,586	

Table C-14. Alternative P2 Cost Estimate — FINAL (January 2025)

Pistol Range AOPC

Alternative P2

Engineered Soil Cover, Site Restoration, ICs, and Long term O&M

Bradford Island NPL Site, Cascades Locks, Oregon

Base Year: 2021

Class 4 Estimate: (+50%, -30%)

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor[a] 2.50%	Present Value	Notes
Capital Cost (Pistol Range AOPC)	0	$ 684,500	$ 684,500	1.000	$ 684,500	
Annual O&M Cost	1 to 30		$ 14,294	20.93	$ 299,169	Discount factor based on a 30-year real discount rate without inflation factored. See notes below.
Periodic Cost	5		$ 32,445	0.88	$ 28,677	
Periodic Cost	10		$ 32,445	0.78	$ 25,346	
Periodic Cost	15		$ 32,445	0.69	$ 22,402	
Periodic Cost	20		$ 32,445	0.61	$ 19,800	
Periodic Cost	25		$ 32,445	0.54	$ 17,501	
Periodic Cost	30		$ 32,445	0.48	$ 15,468	
				Subtotal	$ 1,112,864	
Total Present Value for Pistol Range AOPC				$ 1,112,864		

[a] For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94. This rate represents the 30-year "real" discount rate that approximates the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of expected inflation. Because the Federal government has a different “cost of capital” than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Sources: (1) Office of Management and Budget. 2023. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Appendix C of OMB Circular A-94 revised December 28, 2023., (2) U.S. Environmental Protection Agency. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

N/A*: There is no corresponding cost during this year.

Disclosures:

This version is a draft and is not a final issue estimate.

These AACE Classification Class 4 cost estimates are assumed to represent the actual total installed cost within the range of -30 percent to +50 percent (% based on AACE) of the cost indicated. It would appear prudent that internal budget allowances account for the highest cost indicated by this range as well as other site specific allowances. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

This is not an offer for construction and/or project execution.

Table C-15. Alternative P2 Cost Detail FINAL (January 2025)
Pistol Range AOPC
Alternative P2 - Engineered Soil Cover, Site Restoration, ICs, and Long term O&M

Bradford Island EE/CA
Base Year: 2024
Class 4 Estimate: (+50%, -30%)

Bid Item	Description	Quantity	Units	Labor	Burden	Perm Mtrl	Const Mtrl	Eqp Oper Exp	Subcontractor	Co Equip	Services	Travel	Direct Total	Markup	Unit Price	Total
4010	Submittals	0.25	LS	$ 4,878.31	$ 3,402.65	$ -	$ -	$ -	$ 8,420.00	$ -	$ -	$ -	$ 16,700.96	$ 5,263.21	$ 87,856.68	$ 21,964
4020	Mobilization	0.25	EA	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
4030	Overall Site Set-Up	0.25	EA	$ 2,428.99	$ 1,839.24	$ 4,163.00	$ 3,886.51	$ 1,261.86	$ 750.00	$ 1,352.40	$ -	$ -	$ 15,682.00	$ 4,942.09	$ 82,496.36	$ 20,624
4034	Overall Access Road Improvements-ECM	200	LF	$ 3,466.40	$ 2,544.66	$ -	$ 1,603.00	$ 814.40	$ -	$ 882.25	$ -	$ -	$ 9,310.71	$ 2,933.29	$ 61.22	$ 12,244
4040	Pistol Range: Erosion/Site Controls	1	LS	$ 4,807.88	$ 3,558.98	$ -	$ 5,009.00	$ 1,014.38	$ -	$ 992.84	$ -	$ -	$ 15,383.08	$ 4,847.88	$ 20,230.96	$ 20,231
4044	Pistol Range: Access Road Improvements	200	LF	$ 2,835.03	$ 2,060.54	$ 5,853.75	$ 1,703.00	$ 1,355.46	$ -	$ 1,468.41	$ -	$ -	$ 15,276.19	$ 4,813.81	$ 100.45	$ 20,090
4050	Pistol Range: Clear & Grub	7,355	SF	$ 2,403.94	$ 1,779.49	$ -	$ 22.50	$ 1,236.94	$ -	$ 1,163.12	$ -	$ -	$ 6,605.99	$ 2,072.91	$ 1.18	$ 8,679
4054	Pistol Ran: Exc & Stockpile Impacted Debris	42	BCY	$ 2,725.69	$ 1,898.06	$ -	$ 135.00	$ 1,713.31	$ -	$ 1,856.09	$ -	$ -	$ 8,328.15	$ 2,624.61	$ 260.78	$ 10,953
4062	Pistol Range: Install Soil Cover	7,647	SF	$ 21,043.33	$ 15,710.61	$ 32,745.00	$ 945.00	$ 9,793.16	$ 12,200.00	$ 10,609.25	$ -	$ -	$ 103,046.35	$ 32,458.49	$ 17.72	$ 135,505
4065	Pistol Range: General Site Restoration	7,355	SF	$ 2,281.51	$ 1,531.14	$ 2,280.00	$ 112.50	$ 711.50	$ 4,500.00	$ 770.80	$ -	$ -	$ 12,187.45	$ 3,846.45	$ 2.18	$ 16,034
4066	Pistol Range: Institutional Controls (ICs)	1	Year	$ 1,071.84	$ 712.47	$ 2,780.00	$ 67.50	$ 189.98	$ -	$ 205.81	$ -	$ -	$ 5,027.60	$ 13,248.93	$ 6,612.02	$ 6,612
4068	Pistol Range: Long-Term O&M	1	Year	$ 2,578.62	$ 1,640.73	$ 1,900.00	$ 135.00	$ 577.30	$ 1,600.00	$ 625.40	$ -	$ -	$ 9,057.05	$ 33,447.85	$ 11,911.32	$ 11,911
4069	Pistol Range: Five (5) Year Review	6	EA	$ 54,369.96	$ 37,923.01	$ -	$ 894.00	$ -	$ -	$ -	$ -	$ -	$ 93,186.97	$ 20,464.10	$ 20,425.72	$ 122,554
4074	Pistol Range: Loadout for T&D	6	TON	$ 319.94	$ 253.04	$ -	$ 16.88	$ 101.07	$ -	$ 109.49	$ -	$ -	$ 800.42	$ 252.28	$ 175.45	$ 1,053
4079	Pistol Range: T&D - Non-hazardous waste debris	6	TON	$ -	$ -	$ -	$ -	$ -	$ 880.20	$ -	$ -	$ -	$ 880.20	$ 277.38	$ 192.93	$ 1,158
4080	Overall Site Tear-down/Restoration	0.25	LS	$ 1,828.49	$ 1,386.79	$ -	$ 198.75	$ 571.76	$ 3,250.00	$ 343.59	$ 1,125.00	$ -	$ 8,704.38	$ 2,743.14	$ 45,790.08	$ 11,448
4084	Demobilization	0.25	LS	$ 796.16	$ 605.98	$ -	$ 5,004.50	$ 643.54	$ -	$ 576.00	$ -	$ -	$ 7,626.18	$ 2,403.34	$ 40,118.08	$ 10,030
4090	Project Support	0.5	MNTH	$ 19,186.44	$ 13,814.18	$ -	$ 5,762.50	$ 5,176.42	$ 1,200.00	$ 4,863.61	$ 120.00	$ -	$ 50,123.15	$ 15,796.02	$ 131,838.34	$ 65,919
															Total	$ 507,037

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.2	2.2	2.2	2.3	2.5	2.5

Analyses of projects with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Projects with durations longer than 30 years may use the 30-year interest rate.

Appendix D
Human Health Lead Exposure Reevaluation Technical Memorandum

TECHNICAL MEMORANDUM

Reevaluation of Human Health Lead Exposures from the Baseline Human Health and Ecological Risk Assessment, Upland Operable Unit, Bradford Island, Cascade Locks, Oregon

PREPARED FOR:	U.S. Army Corps of Engineers, Kansas City District
PREPARED BY:	Jacobs
DATE:	24~~2~~ January~~October~~ 2025~~4~~

Potential exposures to lead in site soil and sediments in the Upland Operable Unit were assessed in the Baseline Human Health and Ecological Risk Assessment (BHHRA) at Bradford Island (URS-USACE 2016). However, since the final 2016 BHHRA, the U.S. Environmental Protection Agency (EPA) has updated the Adult Lead Methodology (ALM) version and the Integrated Exposure Uptake Biokinetic (IEUBK) Model version used in the 2016 BHHRA. While numerous changes and updates have occurred to both models, the most notable change shared by both models is the change to the target blood lead concentration (PbB). The target PbB for both lead models was reduced from 10 micrograms per deciliter (µg/dL) to 5 µg/dL. Detailed summaries of the changes to both models, including the EPA Office of Solid Waste and Emergency Response (OSWER) and EPA Office of Land and Emergency Management (OLEM) directives that drove the changes, are available on the EPA Lead at Superfund Sites web page (EPA 2025~~4~~).

For this reevaluation of lead exposures at the Upland Operable Unit sites, the most current versions of the ALM (version date 14 June 2017) and IEUBK (Version 2.0 Build 1.72, May 2021) Model available from EPA were used (EPA 2014).

Soil and Sediment Exposure Point Concentrations

Potential exposures to lead in soil and sediment at the areas of potential concern (AOPCs) in the Upland Operable Unit were evaluated in Appendices B2 and B3 of the 2016 BHHRA. The same exposure point concentrations (EPCs) used in the 2016 BHHRA for each AOPC were used for this lead reevaluation.

Human Receptors and Exposure Scenarios

Four AOPCs were assessed for potential lead exposures: The Landfill, Sandblast Area, Pistol Range, and Bulb Slope AOPCs. Soil data were available for all four AOPCs, and sediment data were also available for the Pistol Range AOPC.

The human receptors for the lead models are adult workers and future hypothetical fishing platform users (adult and child). Consistent with the 2016 BHHRA, worker exposures to lead were evaluated using all default exposure assumptions incorporated in the ALM. Hypothetical adult fishing platform user exposures to lead were evaluated using all default exposure assumptions incorporated in the ALM, with the exception of the assumed exposure frequency (EF); rather than the default, 365 days/year was used to account for daily exposure. In addition, consistent with the 2016 BHHRA, hypothetical child fishing platform user exposures to lead were evaluated using all default exposure assumptions incorporated in the IEUBK Model.

Two additional exposure scenarios were included in this reevaluation that were not included in the 2016 BHHRA: workers in the Pistol Range AOPC and workers in the Bulb Slope AOPC. These two scenarios were not included in the 2016 BHHRA since the lead EPCs were less than the industrial screening level available at the time (800 milligrams per kilogram [mg/kg]). However, to provide a comprehensive evaluation, these two exposure scenarios were included in this reassessment. For these two scenarios, the EPCs are the mean detected lead concentrations presented in Table 5.6 (Pistol Range AOPC) and Table 5.7 (Bulb Slope AOPC) of the 201~~6~~2 Remedial Investigation Report ~~BHHRA~~ (URS-USACE 2012). The calculated lead EPCs for the Pistol Range and Bulb Slope AOPCs are included as Tables 1-1a ~~B-2.0a~~ and 1-1b~~B-2.0b~~, respectively, of Attachment 1.

Risk Estimate Results

The updated lead modeling for worker receptors at the four AOPCs is presented in Attachment 1 and summarized in Table 1. For all AOPCs, lead exposures were concluded to be acceptable (less than 5 percent of the assessed population is predicted to have a PbB exceeding the target of 5 µg/dL).

Table 1. Predicted Blood Lead Concentration in Fetuses of Adult Workers
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

AOPC	Medium	EPC (mg/kg)	Probability[a]	Probability Exceeds 5%[b]
Landfill	Unsieved soil (0 to 1 foot bgs)	211	0.10%	No
	Unsieved soil (0 to 3 feet bgs)	342	0.28%	No
Sandblast Area	Soil, sieved < 250 µm (0 to 1 foot bgs)	300	0.21%	No
	Soil, sieved < 250 µm (0 to 3 feet bgs)	202	0.09%	No
Pistol Range	Unsieved soil (0 to 1.5 feet bgs)	208	0.10%	No
Bulb Slope	Unsieved soil (0 to 1 foot bgs)	222	0.11%	No

[a]Probability that the receptor would have a PbB exceeding the 5 µg/dL level of concern.

[b]EPA's target is to limit the risk to a typical fetus of an adult exposed at a site to no more than a 5% chance of exceeding the PbB of concern (EPA 1994, 2003).

Notes:

µm = micrometer(s)
bgs = below ground surface

The updated lead modeling for hypothetical fishing platform users (adult and child) is presented in Attachment 2 and summarized in Table 2. For adult hypothetical platform users at all AOPCs, lead exposures were concluded to be acceptable (less than 5 percent of the assessed population is predicted to have a PbB exceeding the target of 5 µg/dL). However, for child hypothetical platform users at all AOPCs, lead exposures were concluded to be unacceptable (more than 5 percent of the evaluated population is predicted to have a PbB exceeding the target of 5 µg/dL), with the exception of sediment at the Pistol Range AOPC.

Preliminary Remediation Goal for Lead

The EPA's target is for less than 5 percent of the assessed population to have a PbB exceeding 5 µg/dL. Based on the results of the lead reassessment, potential lead exposures by adult workers and hypothetical adult fishing platform users at all four Upland AOPCs do not exceed EPA's target.

However, hypothetical child fishing platform users at all four Upland Operable Unit AOPCs exceed EPA's target for lead based on potential soil exposures (sediment exposures at the Pistol Range AOPC do not exceed EPA's target). Therefore, a soil project action level (PAL) for this receptor group was identified. All default values incorporated in the IEUBK Model were used to calculate the PAL for lead. The calculated PAL for lead in soil (0 to 3~~1~~ fee~~oo~~t bgs) is 200 mg/kg, as shown in Attachment 3. Because the same exposure scenario and exposure factor values were assumed to apply to all four AOPCs, the lead PAL is the same for soil (0 to 3~~1~~ fee~~oo~~t bgs) at all four AOPCs.

Table 2. Fishing Platform Receptors – Predicted Blood Lead Concentration in Children and Fetuses of Adults
Upland Operable Unit Engineering Evaluation and Cost Analysis Report, Bradford Island NPL Site, Cascade Locks, Oregon

AOPC	Medium	EPC (mg/kg)	Receptor	Probability[a]	Probability Exceeds 5%[b]
Landfill	Unsieved soil (0 to 1 foot bgs)	211	Fetus of Adult	0.30%	No
			Child	5.6%	Yes
	Unsieved soil (0 to 3 feet bgs)	342	Fetus of Adult	1.0%	No
			Child	16%	Yes
Sandblast Area	Soil, sieved < 250 µm (0 to 1 foot bgs)	300	Fetus of Adult	0.72%	No
			Child	12%	Yes
	Soil, sieved < 250 µm (0 to 3 foot bgs)	202	Fetus of Adult	0.27%	No
			Child	5.1%	Yes
Pistol Range	Unsieved soil (0 to 1.5 feet bgs)	208	Fetus of Adult	0.29%	No
			Child	5.4%	Yes
Pistol Range	Unsieved sediment	27.1	Fetus of Adult	0.02%	No
			Child	0.16%	No
Bulb Slope	Unsieved soil (0 to 1 foot bgs)	222	Fetus of Adult	0.34%	No
			Child	6.3%	Yes

[a] Probability that the receptor would have a PbB exceeding 5 µg/dL.
[b] EPA's target is to limit the risk to a typical child or fetus of an adult exposed at a site to no more than a 5% chance of exceeding the PbB of concern (EPA 1994, 2003).

References

U.S. Environmental Protection Agency (EPA). 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities Washington, D.C.: Office of Emergency and Remedial Response. OSWER Directive #9355.4-12. July.

EPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001, OSWER Directive #9285.7-54. January.

EPA. 2017. Adult Lead Methodology (ALM) Spreadsheet. Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas. U.S. EPA Technical Review Workgroup for Lead. Version date 14 June 2017.

EPA. 20254. Lead at Superfund Sites: Software and User's' Manuals. https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals#update.

URS Corporation–U.S. Army Corps of Engineers (URS-USACE). 2012. *Upland and River Operable Units, Remedial Investigation Report, Bradford Island, Cascade Locks, Oregon*. June.

URS-USACE. 2016. *Baseline Human Health and Ecological Risk Assessment, Upland Operable Unit, Bradford Island, Cascade Locks, Oregon*. Final. April.

Attachment 1

Attachment 1 USEPA Adult Lead Methodology (ALM)
Index of Tables

Table 1-1a
2002 Pistol Range Preliminary Assessment/Site Investigation Soil Analytical Results

Site ID	Sample ID	Sample Date	Depth (feet bgs)	Lead (mg/kg)
PFR01	021119PFR01SS	11/19/2002	0.0 to 0.5	185
PFR01	021119PFR02SS	11/19/2002	1.0 to 1.5	37
PFR03	021119PFR03SS	11/19/2002	0.0 to 0.5	758
PFR04	021119PFR04SS	11/19/2002	0.0 to 0.5	84
PFR04	021119PFR05SS	11/19/2002	1.0 to 1.5	30
PFR06	021119PFR06SS	11/19/2002	0.0 to 0.5	124
PFR06	021119PFR07SS	11/19/2002	1.0 to 1.5	160
PFR08	021119PFR08SS	11/19/2002	0.0 to 0.5	269
PFR08	021119PFR09SS	11/19/2002	1.0 to 1.5	48
PFR10	021119PFR10SS	11/19/2002	0.0 to 0.5	78
PFR12	021119PFR12SS	11/19/2002	0.0 to 0.5	81
PFR12	021119PFR13SS	11/19/2002	1.0 to 1.5	42
PFR14	021119PFR14SS	11/19/2002	0.0 to 0.5	98
PFR14	021119PFR15SS	11/19/2002	1.0 to 1.5	16
PFR16	021119PFR16SS	11/19/2002	0.0 to 0.5	52
PFR17*	021119PFR17SS	11/19/2002	0.0 to 0.5	36.5
PFR17	021119PFR19SS	11/19/2002	1.0 to 1.5	11
PFR20*	021119PFR20SS	11/19/2002	0.0 to 0.5	78
PFR22	021119PFR22SS	11/19/2002	0.0 to 0.5	39
PFR22	021119PFR23SS	11/19/2002	1.0 to 1.5	18
PFR24	021119PFR24SS	11/19/2002	0.0 to 0.5	60
PFR25	021119PFR25SS	11/19/2002	0.0 to 0.5	56
PFR25	021119PFR26SS	11/19/2002	1.0 to 1.5	24
PFR27*	021119PFR27SS	11/19/2002	0.0 to 0.5	45
PFR29	021119PFR29SS	11/19/2002	0.0 to 0.5	95
PFR29	021119PFR30SS	11/19/2002	1.0 to 1.5	57
PFR31	021119PFR31SS	11/19/2002	0.0 to 0.5	93
PFR32	021119PFR32SS	11/19/2002	0.0 to 0.5	59
PFR32	021119PFR33SS	11/19/2002	1.0 to 1.5	25
PFR34	021119PFR34SS	11/19/2002	0.0 to 0.5	156
PFR35	021119PFR35SS	11/19/2002	0.0 to 0.5	176
PFR35	021119PFR37SS	11/19/2002	1.0 to 1.5	21
PFR38	021119PFR38SS	11/19/2002	0.0 to 0.5	171
PFR39	021119PFR39SS	11/19/2002	0.0 to 0.5	527
PFR39	021119PFR40SS	11/19/2002	1.0 to 1.5	573
PFR41	021119PFR41SS	11/19/2002	0.0 to 0.5	733
PFR42	021119PFR42SS	11/19/2002	0.0 to 0.5	266
PFR42	021119PFR43SS	11/19/2002	1.0 to 1.5	43
PFR44	021121PFR44SS	11/21/2002	0.0 to 0.5	756
PFR45	021121PFR45SS	11/21/2002	0.0 to 0.5	761
PFR45	021121PFR46SS	11/21/2002	1.0 to 1.5	694
PFR47	021121PFR47SS	11/21/2002	0.0 to 0.5	543
PFR48	021121PFR48SS	11/21/2002	0.0 to 0.5	915
PFR48	021121PFR49SS	11/21/2002	1.0 to 1.5	835
PFR50	021121PFR50SS	11/21/2002	0.0 to 0.5	817
PFR50	021121PFR51SS	11/21/2002	1.0 to 1.5	1110
PFR52*	021121PFR52SS	11/21/2002	0.0 to 0.5	60.5
PFR52	021121PFR54SS	11/21/2002	1.0 to 1.5	61
PFR55	021121PFR55SS	11/21/2002	0.0 to 0.5	46
PFR56	021121PFR56SS	11/21/2002	0.0 to 0.5	391
PFR56	021121PFR57SS	11/21/2002	1.0 to 1.5	410
PFR58	021121PFR58SS	11/21/2002	0.0 to 0.5	31
PFR59	021121PFR59SS	11/21/2002	0.0 to 0.5	19

Table 1-1a

2002 Pistol Range Preliminary Assessment/Site Investigation Soil Analytical Results

Site ID	Sample ID	Sample Date	Depth (feet bgs)	Lead (mg/kg)
PFR60	021121PFR60SS	11/21/2002	0.0 to 0.5	22
PFR60	021121PFR61SS	11/21/2002	1.0 to 1.5	28
PFR62	021121PFR62SS	11/21/2002	0.0 to 0.5	30
PFR63	021121PFR63SS	11/21/2002	0.0 to 0.5	15
PFR63	021121PFR64SS	11/21/2002	1.0 to 1.5	10
PFR65*	021121PFR65SS	11/21/2002	0.0 to 0.5	7.5
PFR67*	021121PFR67SS	11/21/2002	0.0 to 0.5	29.5
PFR69*	021121PFR69SS	11/21/2002	0.0 to 0.5	32
PFR71*	021121PFR71SS	11/21/2002	0.0 to 0.5	26
PFR73	021121PFR73SS	11/21/2002	0.0 to 0.5	45
			Mean Detect Pb =	208

* The data displayed are the result of averaging primary and field duplicate results at this sampling location as described in Section 5.1 of the RI Report (URS-USACE 2012).

Notes:

bold = analyte detected above MDL.

bgs = below ground surface
MDL = method detection limit
mg/kg = milligram(s) per kilogram

Table 1-1b
2002 Bulb Slope Reconnaissance Investigation Soil Analytical Results

Site ID	Sample ID	Sample Date	Depth (feet bgs)	Lead (mg/kg)
AREA A04	021120BSA04SS	11/20/2002	0.17 to 0.33	234
AREA A05	021120BSA05SS	11/20/2002	0.17 to 0.33	202
AREA B06	021120BSB06SS	11/20/2002	0.17 to 0.33	444
AREA B07	021120BSB07SS	11/20/2002	0.17 to 0.33	170
AREA C01	021120BSC01SS	11/20/2002	0.08 to 0.25	67
AREA C02*	021120BSC02SS	11/20/2002	0.17 to 0.33	47.5
AREA C08	021120BSC08SS	11/20/2002	0.17 to 0.33	142
AREA C09	021120BSC09SS	11/20/2002	0.17 to 0.33	25
PILE #3 BANK #1	020419P3B1SD	4/19/2002	0	196
PILE #3 BANK #2	020419P3B2SD	4/19/2002	0	247
PILE #3 BANK #3	020419P3B3SD	4/19/2002	0	289
PILE #3 BANK #4	020419P3B4SD	4/19/2002	0	597
			Mean Detect Pb =	222

* The data displayed are the result of averaging primary and field duplicate results at this sampling location as described in Section 5.1 of the RI Report (URS-USACE 2012).

Notes:

bold = analyte detected above MDL.

bgs = below ground surface
MDL = method detection limit
mg/kg = milligram(s) per kilogram

Table 1-2a. Landfill AOPC
Soil – Unsieved (0 to 1 foot bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	211
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.9
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.1
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.10%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 1-2b. Landfill AOPC
Soil – Unsieved (0 to 3 feet bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	342
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.1
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.6
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.28%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 1-3a. Sandblast AOPC
Soil – Sieved < 250 µm (0 to 1 foot bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	300
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.0
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.4
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.21%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 1-3b. Sandblast AOPC
Soil – Sieved < 250 µm (0 to 3 feet bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	202
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.9
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.1
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.09%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 1-4. Pistol Range AOPC
Soil – Unsieved (0 to 1.5 feet bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	208
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.9
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.1
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.10%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 1-5. Bulb Slope AOPC
Soil – Unsieved (0 to 1 foot bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	222
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.9
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.2
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.11%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Attachment 2

Attachment 2 — ALM and IEUBK: Hypothetical Fishing Platform Users

Index of Tables

Calculations of Project Action Levels (PALs)

Table 2-1. Landfill AOPC
Soil – 0 to 1 foot bgs

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	211
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.1
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.6
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.30%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-2. Landfill AOPC
Soil – 0 to 3 foot bgs

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	342
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.4
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	3.4
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	1.0%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-3. Sandblast Area AOPC
Soil – Sieved < 250 µm (0 to 1 foot bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	300
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.3
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	3.1
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.72%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-4. Sandblast Area AOPC
Soil – Sieved < 250 µm (0 to 3 foot bgs)

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	202
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.1
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.6
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.27%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-5a. Pistol Range AOPC
Soil – 0 to 1.5 feet bgs

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	208
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.1
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.6
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.29%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-5b. Pistol Range AOPC
Sediment

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	27.1
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.7
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	1.6
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.02%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 2-6. Bulb Slope AOPC
Soil – 0 to 1 foot bgs

Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009–2014
PbS	Soil lead concentration	µg/g or ppm	222
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	365
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.1
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.7
PbB_t	Target PbB level of concern (e.g., 2 to 8 µg/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.34%

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

LEAD MODEL FOR WINDOWS Version 2.0

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate.

While IEUBK Model output is generally written with three digits to the right of the decimal point, the true precision of the output is strongly influenced by least precise input values.

==
Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 157.700 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	211.000	157.700
12-24	211.000	157.700
24-36	211.000	157.700
36-48	211.000	157.700
48-60	211.000	157.700
60-72	211.000	157.700
72-84	211.000	157.700

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

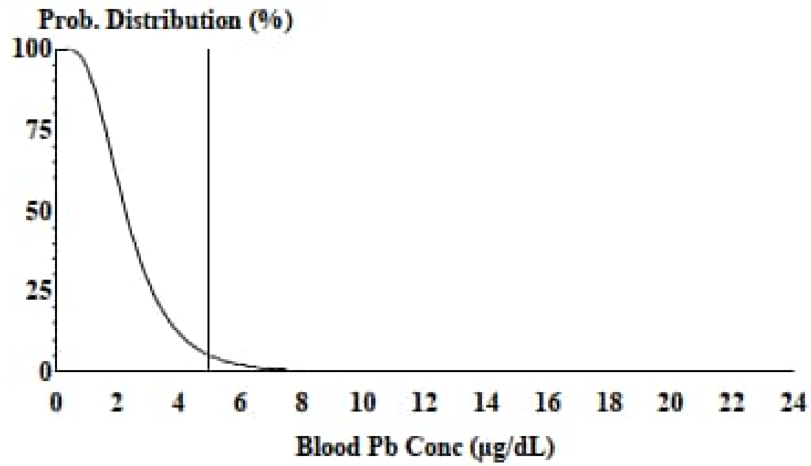
Maternal Blood Concentration: 0.540 g Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.245	0.000	0.168
12-24	0.057	2.358	0.000	0.181
24-36	0.075	2.488	0.000	0.219
36-48	0.093	2.588	0.000	0.234
48-60	0.102	2.722	0.000	0.248
60-72	0.111	2.934	0.000	0.262
72-84	0.118	2.896	0.000	0.276

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	4.388	5.835	3.1
12-24	4.804	7.401	3.1
24-36	3.488	6.270	2.5
36-48	3.303	6.217	2.2
48-60	3.525	6.596	2.1
60-72	2.754	6.061	1.9
72-84	2.918	6.208	1.8

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.371
GSD = 1.600
% Above = 5.620

Age Range = 12 to 72 months

Run Mode = Research
Comment = Landfill Unseived Soil

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate. While IEUBK Model output is generally written with three digits to the right of the decimal point, the true precision of the output is strongly influenced by least precise input values.

LEAD MODEL FOR WINDOWS Version 2.0

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate.

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==

Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake(µg/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 249.400 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (µg Pb/g)	House Dust (µg Pb/g)
6-12	342.000	249.400
12-24	342.000	249.400
24-36	342.000	249.400
36-48	342.000	249.400
48-60	342.000	249.400
60-72	342.000	249.400
72-84	342.000	249.400

****** Alternate Intake ******

Month	Alternate (µg Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

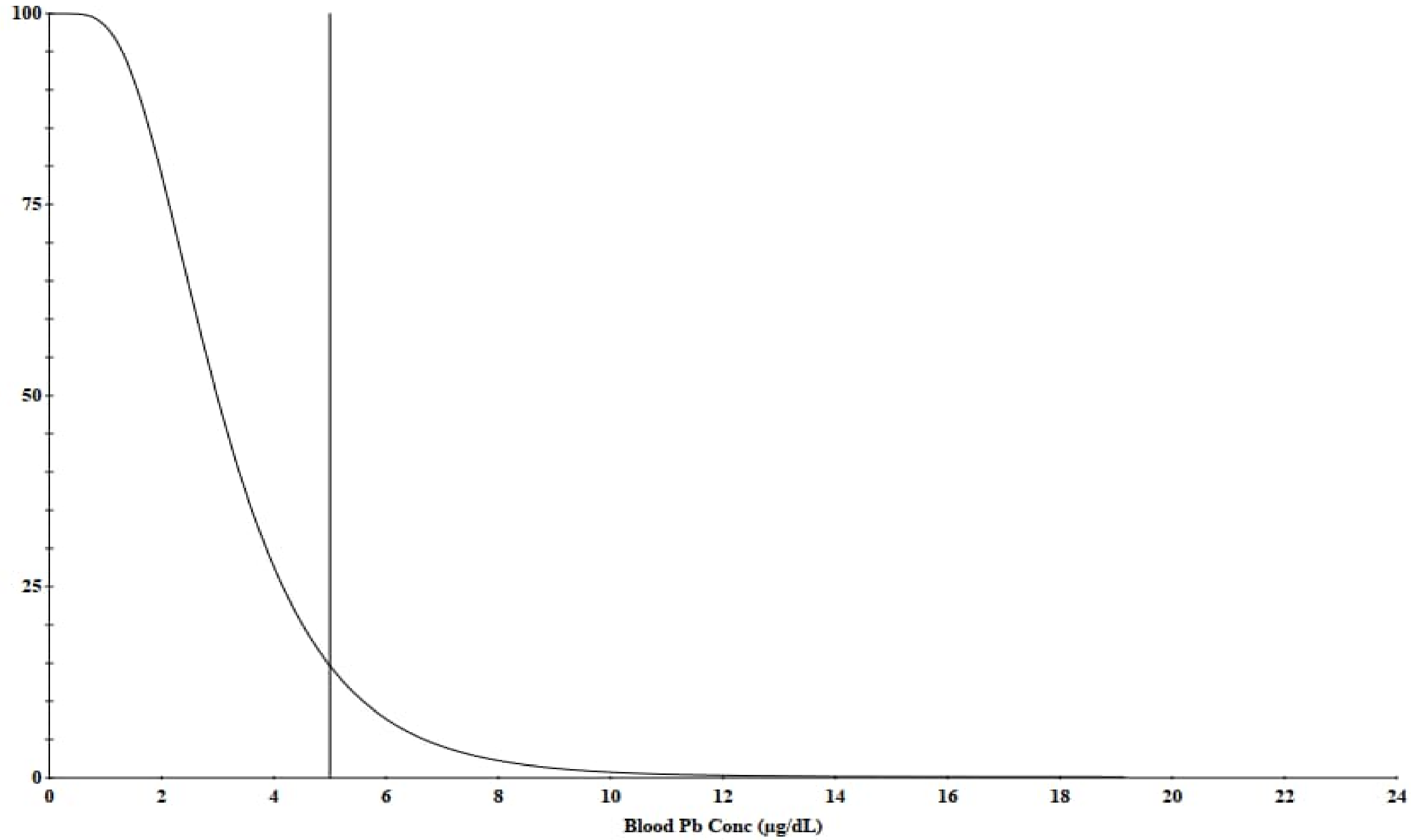
Maternal Blood Concentration: 0.600 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
6-12	0.034	1.211	0.000	0.164
12-24	0.057	2.303	0.000	0.177
24-36	0.075	2.451	0.000	0.216
36-48	0.093	2.556	0.000	0.231
48-60	0.102	2.691	0.000	0.245
60-72	0.111	2.911	0.000	0.260
72-84	0.118	2.874	0.000	0.274

Month	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
6-12	6.835	8.243	4.4
12-24	7.516	10.053	4.2
24-36	5.505	8.248	3.3
36-48	5.228	8.108	2.9
48-60	5.584	8.622	2.8
60-72	4.377	7.660	2.5
72-84	4.639	7.905	2.3

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 3.132
GSD = 1.600
% Above = 15.985

Age Range = 12 to 72 months

Run Mode = Research
Comment = Landfill Unseived Soil (0-3)

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LEAD MODEL FOR WINDOWS Version 2.0

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==

Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 220.000 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	300.000	220.000
12-24	300.000	220.000
24-36	300.000	220.000
36-48	300.000	220.000
48-60	300.000	220.000
60-72	300.000	220.000
72-84	300.000	220.000

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.540 g Pb/dL

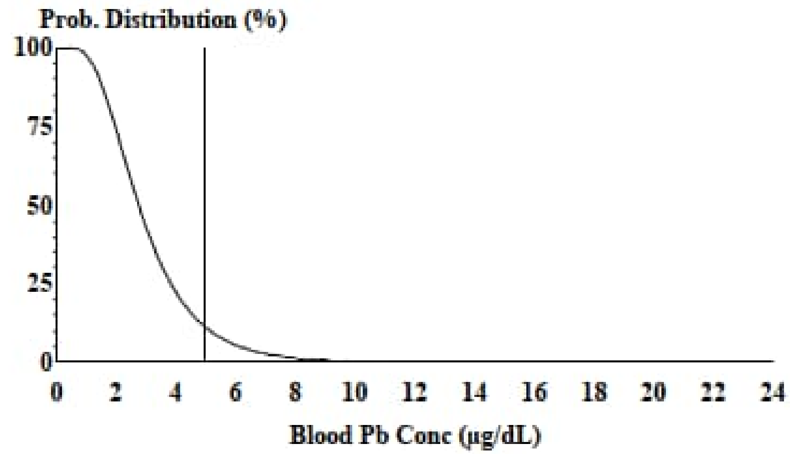
****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.221	0.000	0.165
12-24	0.057	2.320	0.000	0.179
24-36	0.075	2.463	0.000	0.217
36-48	0.093	2.566	0.000	0.232
48-60	0.102	2.701	0.000	0.246
60-72	0.111	2.919	0.000	0.261
72-84	0.118	2.881	0.000	0.275

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	6.065	7.485	4.0
12-24	6.660	9.216	3.9
24-36	4.865	7.620	3.0
36-48	4.616	7.507	2.6
48-60	4.928	7.978	2.6
60-72	3.860	7.150	2.3
72-84	4.090	7.364	2.1

Sandblast Area AOPC
Soil – Sieved < 250 µm (0 to 1 foot bgs)

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.891
GSD = 1.600
% Above = 12.192

Age Range = 12 to 72 months

Run Mode = Research
Comment = Sandblast Area Sieved Soil

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==
Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake(µg/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 151.400 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (µg Pb/g)	House Dust (µg Pb/g)
6-12	202.000	151.400
12-24	202.000	151.400
24-36	202.000	151.400
36-48	202.000	151.400
48-60	202.000	151.400
60-72	202.000	151.400
72-84	202.000	151.400

****** Alternate Intake ******

Month	Alternate (µg Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

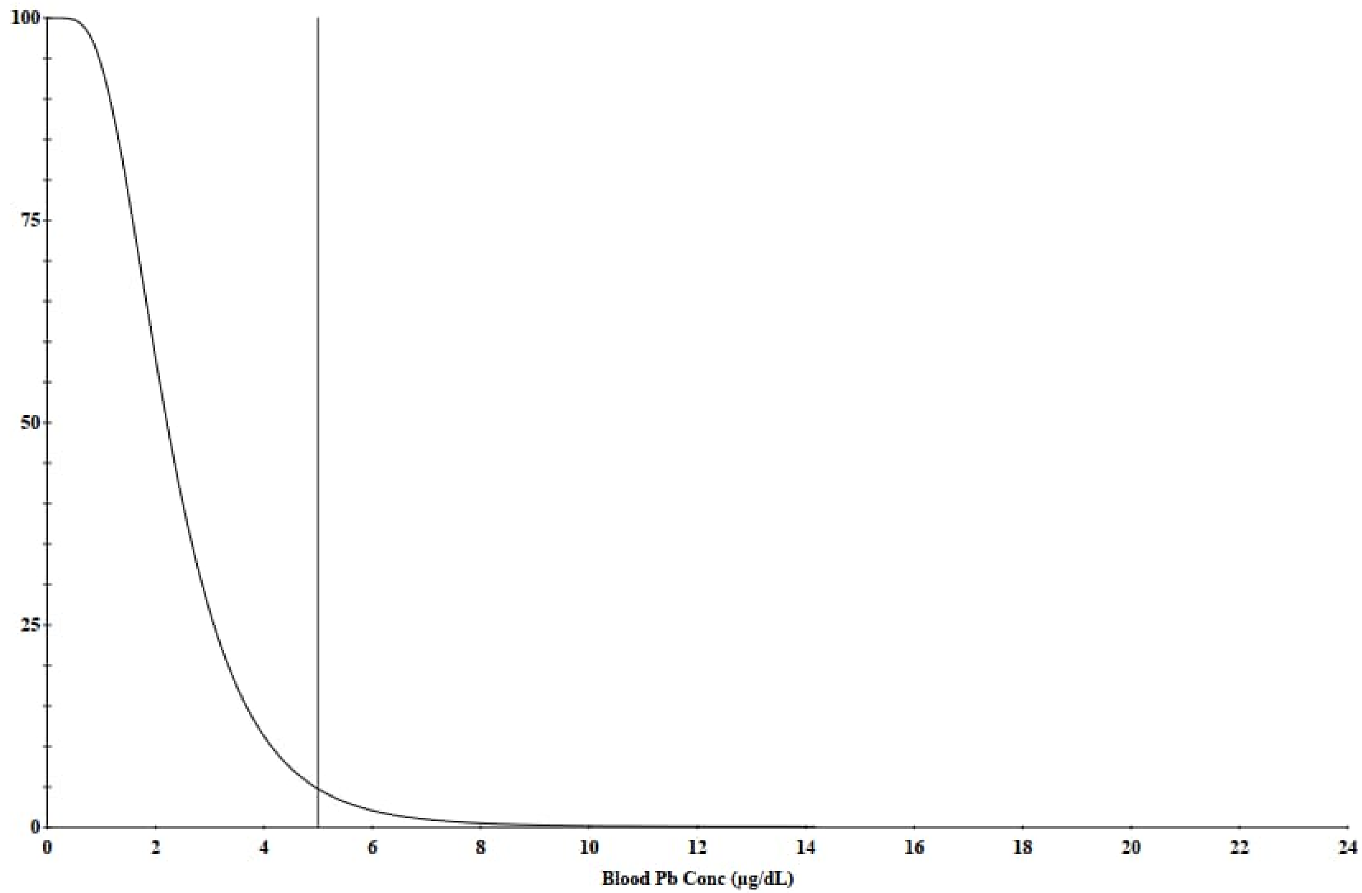
Maternal Blood Concentration: 0.600 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
6-12	0.034	1.247	0.000	0.169
12-24	0.057	2.362	0.000	0.182
24-36	0.075	2.491	0.000	0.219
36-48	0.093	2.590	0.000	0.234
48-60	0.102	2.724	0.000	0.248
60-72	0.111	2.936	0.000	0.262
72-84	0.118	2.897	0.000	0.276

Month	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
6-12	4.214	5.664	3.0
12-24	4.613	7.214	3.0
24-36	3.347	6.132	2.4
36-48	3.169	6.086	2.1
48-60	3.381	6.455	2.1
60-72	2.641	5.951	1.9
72-84	2.799	6.090	1.7

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.318
GSD = 1.600
% Above = 5.093

Age Range = 12 to 72 months

Run Mode = Research
Comment = Sandblast Area Siev Soil (0-3)

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==
Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 155.600 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	208.000	155.600
12-24	208.000	155.600
24-36	208.000	155.600
36-48	208.000	155.600
48-60	208.000	155.600
60-72	208.000	155.600
72-84	208.000	155.600

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

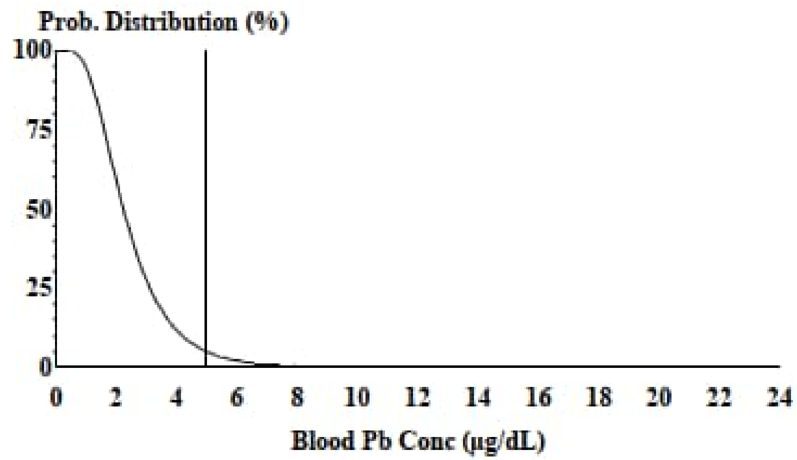
Maternal Blood Concentration: 0.540 g Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.246	0.000	0.169
12-24	0.057	2.359	0.000	0.182
24-36	0.075	2.489	0.000	0.219
36-48	0.093	2.588	0.000	0.234
48-60	0.102	2.722	0.000	0.248
60-72	0.111	2.935	0.000	0.262
72-84	0.118	2.896	0.000	0.276

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	4.330	5.778	3.1
12-24	4.740	7.338	3.1
24-36	3.441	6.224	2.5
36-48	3.259	6.174	2.2
48-60	3.477	6.549	2.1
60-72	2.716	6.024	1.9
72-84	2.878	6.169	1.8

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.353
GSD = 1.600
% Above = 5.441

Age Range = 12 to 72 months

Run Mode = Research
Comment = Pistol Range Unseived Soil

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==
Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 28.970 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	27.100	28.970
12-24	27.100	28.970
24-36	27.100	28.970
36-48	27.100	28.970
48-60	27.100	28.970
60-72	27.100	28.970
72-84	27.100	28.970

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

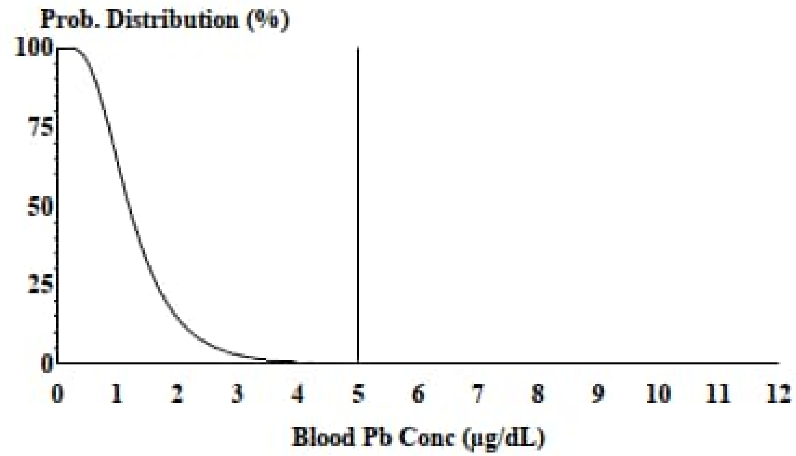
Maternal Blood Concentration: 0.540 g Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.298	0.000	0.176
12-24	0.057	2.442	0.000	0.188
24-36	0.075	2.542	0.000	0.224
36-48	0.093	2.633	0.000	0.238
48-60	0.102	2.766	0.000	0.252
60-72	0.111	2.967	0.000	0.265
72-84	0.118	2.927	0.000	0.279

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	0.708	2.215	1.2
12-24	0.770	3.457	1.4
24-36	0.552	3.393	1.3
36-48	0.520	3.484	1.2
48-60	0.554	3.674	1.2
60-72	0.431	3.774	1.2
72-84	0.457	3.781	1.1

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl	**Age Range = 12 to 72 months**
Geo Mean = 1.253	
GSD = 1.600	**Run Mode = Research**
% Above = 0.162	**Comment = Pistol Range Unseived Sediment**

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==
Model Version: 2.0 Build1
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 165.400 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	222.000	165.400
12-24	222.000	165.400
24-36	222.000	165.400
36-48	222.000	165.400
48-60	222.000	165.400
60-72	222.000	165.400
72-84	222.000	165.400

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

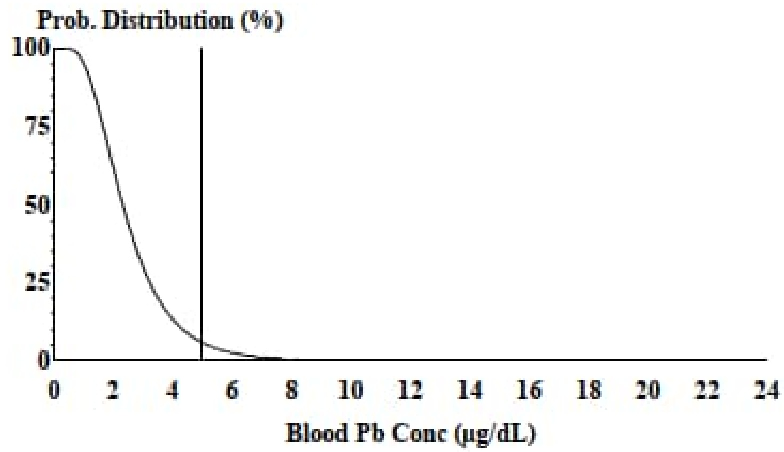
Maternal Blood Concentration: 0.540 g Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.242	0.000	0.168
12-24	0.057	2.353	0.000	0.181
24-36	0.075	2.485	0.000	0.219
36-48	0.093	2.585	0.000	0.234
48-60	0.102	2.719	0.000	0.247
60-72	0.111	2.932	0.000	0.262
72-84	0.118	2.894	0.000	0.276

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	4.598	6.042	3.2
12-24	5.037	7.628	3.2
24-36	3.659	6.439	2.5
36-48	3.467	6.378	2.2
48-60	3.699	6.768	2.2
60-72	2.891	6.196	2.0
72-84	3.063	6.351	1.8

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.436
GSD = 1.600
% Above = 6.301

Age Range = 12 to 72 months

Run Mode = Research
Comment = Bulb Slope Unseived Soil

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate. While IEUBK Model output is generally written with three digits to the right of the decimal point, the true precision of the output is strongly influenced by least precise input values.

Attachment 3

Table 3-1
Project Action Level (PAL) for Soil (0 to 3 feet bgs)
Hypothetical Child Fishing Platform User
Upland Operable Unit, Bradford Island, Cascade Locks, Oregon

LEAD MODEL FOR WINDOWS Version 2.0

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate.

While IEUBK Model output is generally written with three digits to the right of the decimal point, the true precision of the output is strongly influenced by least precise input values.

==
Model Version: 2.0 Build1
Date: 06/20/2024, 07:47
Site Name: Fishing Platform
Operable Unit: Upland Operable Unit, Bradford Island, Cascade Locks, Oregon
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Month	Time Outdoors (hours)	Ventilation Rate (m/day)	Lung Absorption (%)	Outdoor Air Pb Conc. (g Pb/m)
6-12	1.000	3.216	32.000	0.100
12-24	2.000	4.970	32.000	0.100
24-36	3.000	6.086	32.000	0.100
36-48	4.000	6.954	32.000	0.100
48-60	4.000	7.682	32.000	0.100
60-72	4.000	8.318	32.000	0.100
72-84	4.000	8.887	32.000	0.100

****** Diet ******

Month	Diet Intake (g/day)
6-12	2.660
12-24	5.030
24-36	5.210
36-48	5.380
48-60	5.640
60-72	6.040
72-84	5.950

Table 3-1
Project Action Level (PAL) for Soil (0 to 3 feet bgs)
Hypothetical Child Fishing Platform User
Upland Operable Unit, Bradford Island, Cascade Locks, Oregon

****** Drinking Water ******

Water Consumption:

Month	Water (L/day)
6-12	0.400
12-24	0.430
24-36	0.510
36-48	0.540
48-60	0.570
60-72	0.600
72-84	0.630

Drinking Water Concentration: 0.900 g Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 150.000 g/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Month	Soil (g Pb/g)	House Dust (g Pb/g)
6-12	200.000	150.000
12-24	200.000	150.000
24-36	200.000	150.000
36-48	200.000	150.000
48-60	200.000	150.000
60-72	200.000	150.000
72-84	200.000	150.000

****** Alternate Intake ******

Month	Alternate (g Pb/day)
6-12	0.000
12-24	0.000
24-36	0.000
36-48	0.000
48-60	0.000
60-72	0.000
72-84	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.540 g Pb/dL

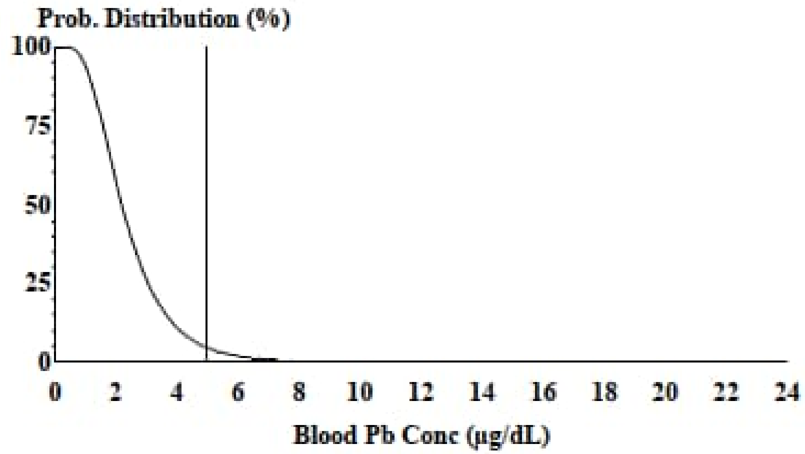
****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Month	Air (g/day)	Diet (g/day)	Alternate (g/day)	Water (g/day)
6-12	0.034	1.248	0.000	0.169
12-24	0.057	2.363	0.000	0.182
24-36	0.075	2.491	0.000	0.219
36-48	0.093	2.590	0.000	0.234
48-60	0.102	2.724	0.000	0.248
60-72	0.111	2.936	0.000	0.263
72-84	0.118	2.897	0.000	0.276

Month	Soil+Dust (g/day)	Total (g/day)	Blood (g/dL)
6-12	4.176	5.626	3.0
12-24	4.570	7.172	3.0
24-36	3.316	6.102	2.4
36-48	3.139	6.056	2.1
48-60	3.350	6.424	2.1
60-72	2.616	5.926	1.9
72-84	2.772	6.064	1.7

Figure 3-1
Project Action Level (PAL) for Soil (0 to 3 feet bgs)
Hypothetical Child Fishing Platform User
Upland Operable Unit, Bradford Island, Cascade Locks, Oregon

IEUBK Distribution Probability Percent



Cutoff = 5.000 µg/dl
Geo Mean = 2.306
GSD = 1.600
% Above = 4.979

Age Range = 12 to 72 months

Run Mode = Research
Comment = Bradford Fishing Platform PRG

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