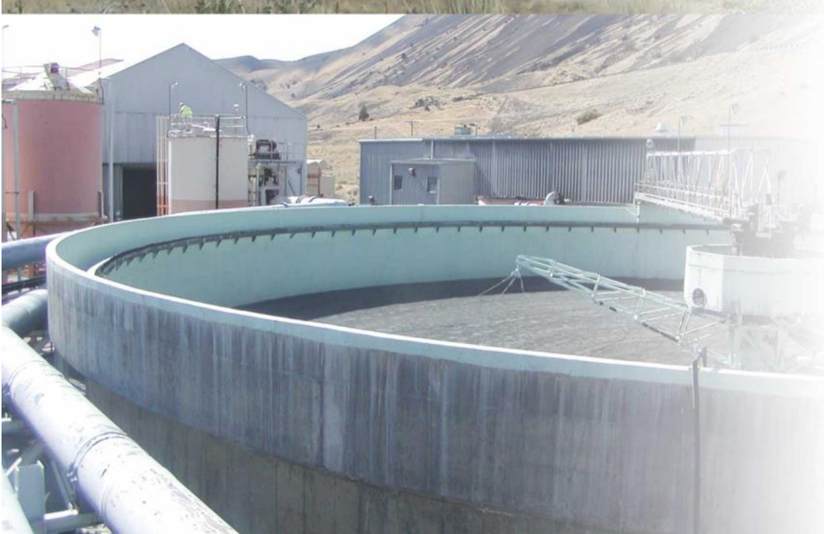

FINAL DRAFT REMEDIAL INVESTIGATION REPORT

VOLUME 1: INTRODUCTION AND PROJECT FRAMEWORK

Columbia Gorge Aluminum Smelter Site

Revision 0
Goldendale, WA
Facility Site ID #95415874

Agreed Order DE 10483

June 14, 2022

On behalf of:

Lockheed Martin Corporation
6801 Rockledge Drive
Bethesda MD 20817

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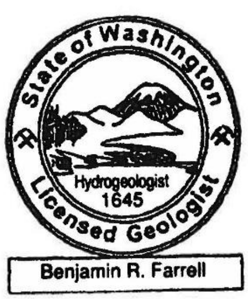

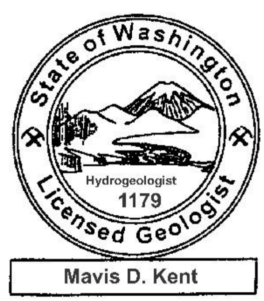

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Acronyms

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
AST	Aboveground Storage Tank
BAL	Basalt Aquifer – Lower Zone
BAP	Benzo(a)pyrene
BAU	Basalt Aquifer – Upper Zone
BMEC	Blue Mountain Environmental Consulting, Inc.
BOD	Biologic Oxygen Demand
BPA	Bonneville Power Administration
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CAP	Cleanup Action Plan
CLARC	Ecology Cleanup Level and Risk Calculation database
COD	Chemical Oxygen Demand
COPCs	Chemicals of Potential Concern
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CSL	Cleanup Screening Level
DI	Deionized
DQO	Data Quality Objective
Ecology	Washington Department of Ecology
EELF	East End Landfill
EHW	Extremely Hazardous Waste
EPA	U.S. Environmental Protection Agency
ESI	East Surface Impoundment
FERC	Federal Energy Regulatory Commission
FS	Feasibility Study
FSP	Field Sampling Plan
ft	Feet
ft bgs	Feet below ground surface
ft msl	Feet mean sea level
GIS	Geographic Information System
GWAOC	Groundwater in the Uppermost Aquifer
HEAF	High Efficiency Air Filtration
HEAST	Health Effects Assessment Summary Table
HMW	High molecular weight
IRIS	Integrated Risk Information System database

KPUD	Klickitat County Public Utility District
L/kg	Liter per kilogram
LMW	Low molecular weight
Lockheed Martin	Lockheed Martin Corporation
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
MTCA	Model Toxics Control Act
NCEA	National Center for Environmental Assessment
ND	Not Detected
NE	Not Established
NESI	North of the East Surface Impoundment
NPDES	National Pollutant Discharge Elimination System
NSC	NSC Smelter, LLC
OMM	Operations, Maintenance and Monitoring
PAAOC	Plant Area – Area of Concern
PA/SI	Preliminary Assessment/Site Inspection
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCLs	Preliminary Cleanup Levels
PGG	Plateau Geoscience Group, LLC
PHS	Priority Habitats and Species
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QMP	Quality Management Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RSL	Regional Screening Level
SCUM II	Sediment Cleanup User's Manual
SCO	Sediment Cleanup Objective
SMS	Sediment Management Standards
SPL	Spent Pot Liner
SPLP	Synthetic Precipitation Leaching Procedure
SWMU	Solid Waste Management Unit
TEE	Terrestrial Ecological Evaluation
Tetra Tech	Tetra Tech, Inc.
TFAS	Treaty Fishing Access Site

TPH	Total Petroleum Hydrocarbons
TPH-Dx	Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx	Total Petroleum Hydrocarbons – Gasoline-extended range
TTEC	Total Toxicity Equivalent Concentration
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
UA	Unconsolidated Aquifer
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UTL	Upper Threshold Limit
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WAD	Weak Acid Dissociable
WDFW	Washington Department of Fish and Wildlife
WELF	West End Landfill
WESP	Wet Electrostatic Precipitator
WPA	Work Plan Addendum
WSI	West Surface Impoundment
Yakama Nation	Confederated Tribes and Bands of the Yakama Nation

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs)
(Agreed Order No. DE 10483)

Solid Waste Management Units (SWMUs)

NPDES Ponds (SWMU #1)
East Surface Impoundment (ESI) (SWMU #2)
Intermittent Sludge Disposal Ponds (SWMU #3)
West Surface Impoundment (SWMU #4)
Line A Secondary Scrubber Recycle Station (SWMU #5)
Line B, C, D Secondary Scrubber Recycle Stations (SWMU #6)
Decommissioned Air Pollution Control Equipment (SWMU #7)
Tertiary Treatment Plant (SWMU #8)
Paste Plant Recycle Water System (SWMU #9)
North Pot Liner Soaking Station (SWMU #10)
South Pot Liner Soaking Station (SWMU #11)
East SPL Storage Area (SWMU #12)
West SPL Storage Area (SWMU #13)
North SPL Storage Containment Building (SWMU #14)
South SPL Storage Building (SWMU #15)
SPL Handling Containment Building (SWMU #16)
East End Landfill (SWMU #17)
West End Landfill (SWMU #18)
Plant Construction Landfill (SWMU #19)
Drum Storage Area (SWMU #20)
Construction Rubble Storage Area (SWMU #21)
Wood Pallet Storage Area (SWMU #22)
Reduction Cell Skirt Storage Area (SWMU #23)
Carbon Waste Roll-off Area (SWMU #24)
Solid Waste Collection Bin and Dumpsters (SWMU #25)
HEAF Filter Roll-Off Bin (SWMU #26)
Tire and Wheel Storage Area (SWMU #27)
90-Day Drum Storage Area (SWMU #28)
Caustic Spill (SWMU #29)

Paste Plant Spill (SWMU #30)

Smelter Sign Area (SWMU #31)

Stormwater Pond (SWMU #32) - Stormwater lines addressed with other line types as part of Plant Area AOC

Areas of Concern (AOCs)

Columbia River Sediments

Groundwater in the Uppermost Aquifer at the Facility

Wetlands

Rectifier Yard

Plant Area

Additional Investigation Areas

Eastern Reconnaissance Area

East Surface Impoundment Fence-Line Area

West SPL Storage Area Ditch

Section 1
Introduction

This section provides an introduction and overview of the project including project objectives, scope, involved parties, and report organization. This Remedial Investigation (RI) Report has been prepared to address the requirements of the 2014 Agreed Order No. DE 10483 issued by Washington State Department of Ecology (Ecology) and dated May 1, 2014.

The Agreed Order required two phases of RI Work Plan preparation (Phase 1 and Phase 2) that were prepared as two separate volumes. The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) summarized available information and data regarding 32 Solid Waste Management Units (SWMUs) and 5 Areas of Concern (AOCs) identified in the Agreed Order, screened each SWMU and AOC to determine if they require further investigation, and identified data gaps and data needs for each SWMU and AOC. The Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) defined the specific investigation and evaluation activities for each SWMU and AOC that required further investigation to characterize the nature and extent of contamination. Ecology formally approved the Final RI Phase 1 and Phase 2 Work Plans in correspondence dated August 14, 2015 (Ecology 2015d). A supplemental Work Plan for the Plant Area AOC (PGG 2017) and a Bioassay Sampling and Analysis Plan (Tetra Tech 2018a) were also submitted to and approved by Ecology to address data needs identified during the course of the field investigation.

The initial RI field program was implemented from September 2015 through August 2018. A Draft RI Report was submitted to Ecology on January 24, 2019 (Tetra Tech et al. 2019a). Ecology provided comments, including Yakama Nation Comments, on the Draft RI Report on June 26, 2019 (Ecology and Yakama Nation 2019). The Draft RI Report Comments (Ecology and Yakama Nation 2019) stated that additional characterization work was required to adequately define the nature and extent of contamination at the Site, and that the preparation of a Work Plan Addendum (WPA) would be required to address data gaps identified in the comments submitted on June 26, 2019.

The Draft WPA was submitted for Ecology and Yakama Nation review on November 18, 2019 (Tetra Tech et al. 2019b). Ecology and Yakama Nation submitted comments on the Draft WPA on March 20, 2020 (Ecology and Yakama Nation 2020a) and comment responses were submitted to

Ecology on May 13, 2020 (Tetra Tech et al. 2020a). The Final WPA was submitted for Ecology and Yakama Nation review on July 24, 2020 and comments were received on August 26, 2020 (Ecology and Yakama Nation 2020b). The Final WPA, Revision 1 was submitted to Ecology on September 18, 2020 (Tetra Tech et al. 2020b).

The WPA field program was implemented in two phases: a fall 2020 mobilization and a spring 2021 mobilization. The identified data needs for the RI and WPA are summarized in Section 3.0.

1.1 AGREED ORDER AND INVOLVED PARTIES

Ecology is the lead regulatory agency for the work to be conducted under the 2014 Agreed Order (Ecology 2014). NSC Smelter, LLC (NSC), the current property owner, and Lockheed Martin Corporation (Lockheed Martin), a past owner, are the named parties required to undertake actions under the terms and conditions of the Agreed Order. A team of consultants including Tetra Tech, Inc. (Tetra Tech), Blue Mountain Environmental Consultants, Inc. (BMEC), and Plateau Geoscience Group, LLC (PGG) are working for the parties named in the Agreed Order in support of the RI work effort. The Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) are an interested party because the site is located in a treaty-defined usual and accustomed fishing area and adjacent to the upland North Shore Treaty Fishing Access Site (TFAS) (Ecology 2014).

1.2 SCOPE AND OBJECTIVES

The overall objective of the Agreed Order for all parties is to provide for remedial action where there has been a release or threatened release of hazardous substances (Ecology 2014). The objective of the Remedial Investigation/Feasibility Study (RI/FS) under the Washington State Model Toxics Control Act (MTCA) is to collect, develop, and evaluate sufficient information regarding a site to select cleanup actions consistent with MTCA requirements. The objective of the FS report is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the site.

This Final Draft RI Report fully summarizes the site characterization findings and defines the nature and extent of contamination and was completed consistent with the requirements of MTCA [Washington Administrative Code (WAC) 173-340-350] and the Ecology-approved Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b) as well as the Final WPA (Tetra Tech et al. 2020b).

1.3 REPORT ORGANIZATION

This Final Draft RI Report has been subdivided into five volumes for ease of presentation and review. This organization varies from the organization of the four Volume Draft RI Report with the creation of an additional volume to summarize results for the former footprint of the main plant. In addition to this Volume 1, Introduction and Project Framework, the RI Report is comprised of the following volumes:

- **Volume 2, Solid Waste Management Unit (SWMU) Results and Summary** presents the results for the 32 SWMUs and three additional investigation areas at the site.
- **Volume 3, Rectifier Yard and Plant Area AOC Results and Summary** presents the results for the for main footprint of the former plant and includes summarization of RI results for the Rectifier Yard and Plant Area AOCs. This section also includes relevant data from SWMUs and underground conveyance lines within the footprint of the former plant courtyards and south plant area.
- **Volume 4, Areas of Concern Results and Summary** presents the RI results for the three other AOCs specified in the Agreed Order including: the Columbia River Sediments AOC, the Groundwater in Uppermost Aquifer AOC, and the Wetlands AOC.
- **Volume 5, Appendices,** includes all Appendices for the RI report including: Appendix A, Introduction and Project Framework Supporting Documentation; Appendix B, SWMU Field Logs; Appendix C, Columbia River Sediments AOC; Appendix D, Groundwater in the Uppermost Aquifer AOC; Appendix E, Wetlands AOC; Appendix F, Rectifier Yard AOC; Appendix G, Plant Area AOC; Appendix H, Analytical Results; and Appendix I Data Validation Reports.

This Volume 1 has been organized into the following major sections:

Section 1.0 **Introduction –** Provides a summary of the project objective, scope, involved parties, and report organization.

Section 2.0 **Background –** Summarizes basic background information about the site including facility description and history, and environmental setting.

Section 3.0 **Identified Data Needs –** Briefly summarizes the SWMUs and AOCs at the site along with identified data needs for each SWMU and AOC from the Ecology-approved Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b) and Final WPA (Tetra Tech et al. 2020b).

Section 4.0 **Site Conceptual Model –** Summarizes the conceptual site model including current and future land use, potential sources and release mechanisms, transport pathways, exposure media and routes, and human and ecological receptors. This conceptual model has been updated based on the current findings of the WPA.

Section 5.0 **Regulatory Framework –** Summarizes the regulatory framework relevant to the RI including: permitting and regulatory history overview, chemicals of potential concern (COPCs), and screening levels for potentially contaminated media at the site including soil, groundwater, surface water sediment.

Section 6.0 **Data Quality Summary –** Provides an overview the analytical data quality for the RI including all sampled media (i.e., soil, groundwater, surface and stormwater, sediment, and bioassays).

Section 7.0 **References –** Lists the cited references for the complete RI Report.

1.4 DRAFT RI REPORT COMMENTS AND RESPONSES

Ecology and Yakama Nation past comments on the Draft RI Report (Ecology and Yakama Nation 2019) were reviewed and used to develop the scope of work for the WPA. An initial response to RI comments regarding WPA data needs was provided to Ecology during August 2019 (Lockheed Martin and NSC 2019); however, the responses did not address all the RI comments. The RI comments related to the data needs were addressed through the comment, revision, and WPA finalization process as well as by the additional WPA data that have been collected and summarized in this report. All comments on the Draft RI Report have been addressed in this Revised Draft RI Report. Complete and updated responses to the Draft RI Report are provided in Volume 5, Appendix A-1. The responses include a summary that explains how and where in the report, the comments are addressed.

The Revised RI Report was submitted to Ecology on November 30, 2021. Ecology submitted comments on the Revised RI Report on March 31, 2022 (Ecology 2022). A draft response to comments (Lockheed Martin and NSC 2022) was submitted to Ecology on April 15, 2022. An updated version of the responses is also included in Appendix A-1.

Section 2
Site Background

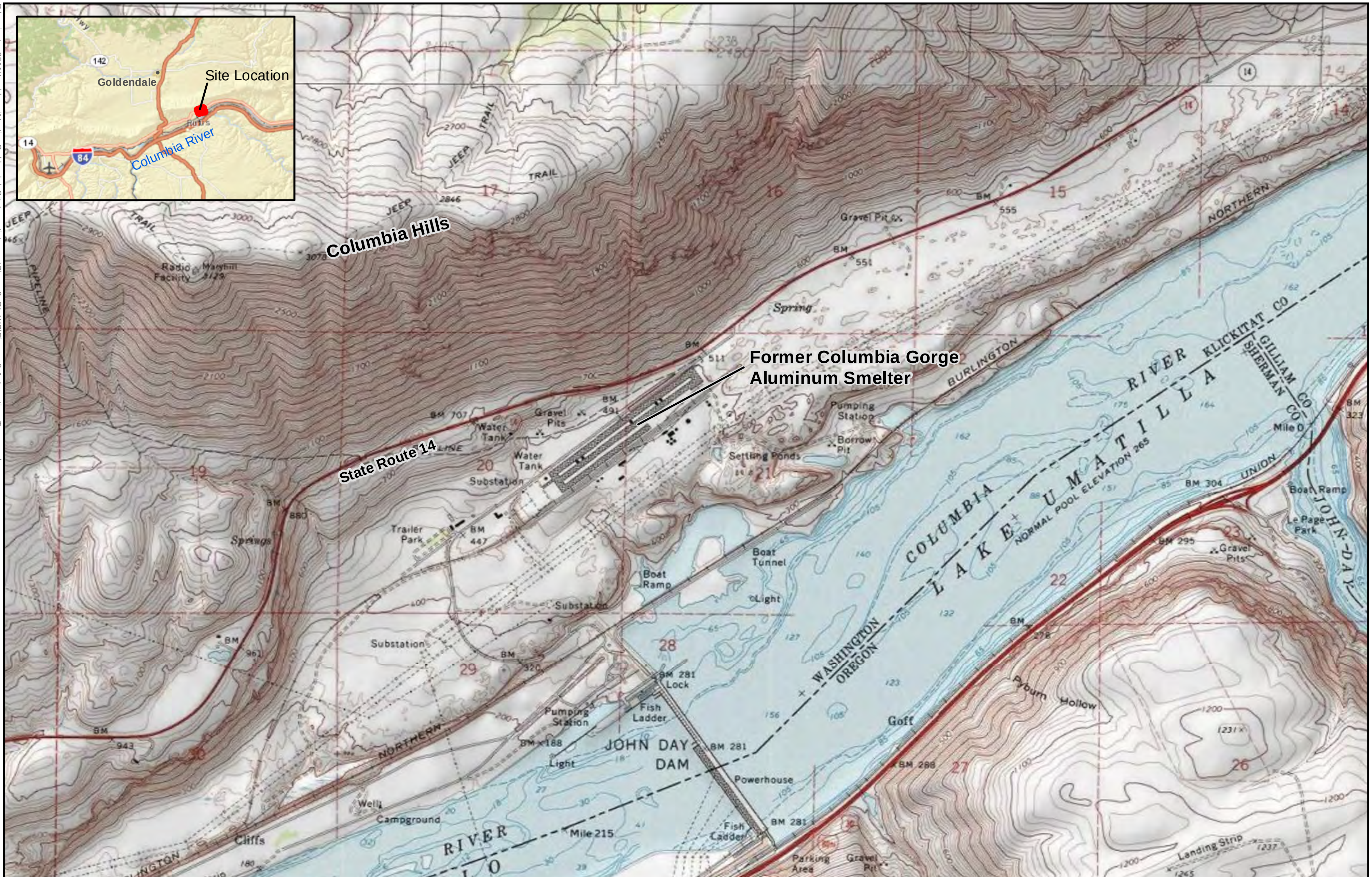
This section summarizes basic background information regarding the facility including facility description, and environmental setting as previously presented in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a).

2.1 FACILITY DESCRIPTION

The former Columbia Gorge Aluminum Smelter (site) is located at 85 John Day Dam Road, Goldendale, Washington. It incorporates an area of approximately 350 acres that formerly represented the active smelter operation within a 7,000-acre parcel of land currently under the same ownership. The site is located adjacent to the Columbia River approximately 9 miles southeast of the City of Goldendale in Klickitat County, and within portions of Sections 20 and 21 in T3N, R17E, Willamette Meridian (Figure 2-1).

The smelter was operated nearly continuously as a primary aluminum smelter from its completion of construction in the early 1970s until 2003 when aluminum smelter operations were permanently suspended. The current owner (NSC) plans to redevelop the subject property for commercial and industrial purposes. Demolition of buildings directly associated with the smelter operations, including the reduction cell lines, began in 2011 and was completed in spring 2013. Remaining buildings and structures include the former administration building R&D laboratory building; paste plant building; the south, north, and east spent pot liner (SPL) storage buildings; and a few small shop and storage structures.

Ecology identified 32 SWMUs and four AOCs in the Agreed Order based upon the findings of the Preliminary Assessment/Site Inspection (PA/SI) (Ecology 1989), Resource Conservation and Recovery Act (RCRA) Part B Permit Applications (Goldendale Aluminum Company 1997, ENSR 1991, Parametrix 2004a), historical environment reports and data in Ecology site files, and knowledge of past operations. On October 20, 2014, NSC and Lockheed Martin identified a fifth AOC that incorporates the plant general area. An additional area of investigation was also included in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) to address a ditch on the south side of



Topographic Map Data Source: USGS 24k Topographic Quadrangles, 1973.

N W E S

0 0.25 0.5 1
Miles

Figure 2-1
Project Location Topographic Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

the West SPL Storage Area. The Work Plan Addendum also included investigation of East Surface Impoundment Fence Line Area and Eastern Reconnaissance Area to address comments on the Draft RI Report.

2.2 ENVIRONMENTAL SETTING

This section describes the environmental setting for the facility including location, topography, climate, geology and hydrogeology, surface water, wetlands, and ecology.

2.2.1 Topography

The former smelter is located on a topographic bench about 450 to 540 feet (ft) in elevation, approximately 0.5 miles from the Columbia River (see Figure 2-1). South of the site, the bench generally terminates in a line of cliffs above the Columbia River. The Columbia River surface water elevation is about 268 feet mean sea level (ft msl) in the Lake Umatilla pool upstream of the John Day Dam in the site vicinity. North of the site, the Columbia Hills form a steep ridge with about 2,500 ft of relief with a talus slope extending down slope onto the site. Three natural seasonal drainages are present to the south of the former smelter and north of the Columbia River. One of these drainages was modified during initial plant construction into a series of settling ponds called the National Pollutant Discharge Elimination System (NPDES) Ponds A through D (Figure 2-2). The two western intermittent drainages originally extended north to near the base of the Columbia Hills but were filled in as part of plant construction (refer to Figure 2-2).

2.2.2 Climate

The site is located in the eastern portion of the Columbia River gorge in a semi-arid region. Average annual rainfall is about 9 to 12 inches per year with the driest periods occurring during summer through early Fall. The site is characterized by hot, and dry conditions in the summer (average daytime high temperature of 90º F in July) and relatively cold conditions in the winter (average daytime high temperatures of 40º F in December) (The Weather Channel 2014). Locally, most of the precipitation in the area occurs November through February. The wettest months are December and January with an average rainfall of about 2.5 inches per month.

R:\projects_2011\LockheedMartin_GoldendaleSite\Investig\maps\2019_Reporting\Figure_1-1_Site_Features.mxd

Legend

Wetlands

N W E S

0 500 1,000 2,000

Feet

Imagery Data Sources: USDA NAIP 1-m Imagery, 2006.

Figure 2-2
Primary Site and Vicinity Features Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

2.2.3 Area Geology and Hydrogeology

The site is located on the Columbia River Plateau where the bedrock is composed of the Miocene Columbia River Basalt Group. Specifically, the lower to middle Miocene Grande Ronde Basalt Formation underlies the topographic bench in the former smelter vicinity. The Grande Ronde Basalts are generally fine-grained and petrographically non-distinctive (Bela 1982). Individual flows range in thickness up to 160 ft but are generally between 50 and 80 ft (Bela 1982). The Grande Ronde Basalts are estimated to be greater than 1,500 ft thick along the lower John Day River (Bela 1982).

The Columbia Hills geologic structure, located north of the site, consists of a series of east-west trending anticlines and synclines that are cut by or overlie north-dipping thrust faults (Bela 1982, USGS 2014). A second series of northwest/southeast trending high-angle faults (with associated folds) divide the east west trending folds and faults into a series of segments (Bela 1982, USGS 2014). There is suspected Quaternary movement along some of the northwest/southeast trending fault sections (USGS 2014). An east-west trending thrust fault is present near the base of the Columbia Hills to the north of the site based upon a repeated section within the Grande Ronde Basalt (Bela 1982).

Two generally northwest-southeast trending faults have been previously mapped in the site vicinity, one named Goldendale strike-slip fault and the other a combination strike-slip and normal fault, intersect the thrust fault in the site vicinity [Klickitat County Public Utility District (KPUD) 2014]. The Goldendale fault is inferred to be located west of the West Surface Impoundment (WSI), and about 1 mile downstream of John Day Dam. The second fault passes under the former location of the aluminum plant with the fault trace appearing to coincide with the western gulley that leads from the western end of the Boat Basin up to the western end of the former plant area. According to the John Day Pool pumped storage pre-application document (KPUD 2014), it is unlikely that the faults in the immediate site vicinity are active or have the potential to produce earthquakes.

The bench area represents an erosional feature formed by erosional scour during the Pleistocene Missoula Floods. Unconsolidated deposits in the site vicinity consist of glacial fluvial sediments, alluvium, colluvium shed from the ridge to the north, potential localized aeolian deposits, and man-made fill associated with highway construction, dam construction, and smelter construction and operations. These unconsolidated deposits are present as either a discrete stratigraphic unit ranging from a few feet to about 60-ft thick in localized areas within flood-scoured depressions on the basalt bench surface.

Conceptually, the aquifer system represents an unconsolidated alluvial/colluvial aquifer underlain by a series of basalt bedrock aquifer zones that represent the more permeable zones within the basalts and typically correspond to flow tops. RI characterization of the site hydrogeology is presented in detail in Volume 4, Section 2.0, Groundwater in Uppermost Aquifer AOC.

2.2.4 Site Hydrogeologic Conceptual Model

Site geology consists of unconsolidated deposits including colluvium, alluvium, and fill material that are underlain by two to three basalt flows that are part of the Grand Ronde Basalt Formation, Sentinel Springs Member, Basalt of Museum (informally designated sub-member) that represents the topmost stratigraphic portion of the formation. In general, there is a lack of sedimentary interbeds within the basalt flows at the Site. Within the basalt sequence, groundwater predominantly occurs in flow-top breccias and connected fractures. The hydrogeologic conceptual model is presented in detail in Volume 4 of this RI Report, and is briefly summarized in this introductory volume for convenience.

Conceptually, the aquifer system represents an unconsolidated alluvial/colluvial aquifer underlain by a series of basalt bedrock aquifer zones that represent the more permeable zones within the basalts and typically correspond to flow tops/flow top breccias.

Three suspected strike-slip fault zones were identified during the RI that likely affect groundwater flow at the Site (Figure 2-3). The fault system and site geology are based on initial mapping by Bela (1982). Also, included in Figure 2-3 are monitoring wells completed in the Basalt Aquifer Lower (BAL) zone and other monitoring wells in the vicinity of the faults because of their relevance to the groundwater-to-surface water migration pathway. The strike-slip fault zones occur at the following locations: 1) the western intermittent drainage that extends up the gulley at the western end of the Boat Basin, 2) along the alignment of the stormwater pond/Spring 01/Wetland K, and 3) the eastern end of the Former Plant Area. The fault areas coincide with topographic valley trends and are oriented generally parallel to groundwater flow direction (toward the Columbia River). Within the Basalt Aquifer Upper (BAU) zone, groundwater flow converges on the fault zones. It appears that

Legend

Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

BAU_1 - Shallower Water-bearing Zone

BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

BAL_1 - Shallower Water-bearing Zone

BAL_2 - Deeper Water-bearing Zone

BAL_3 - Deepest Water-bearing Zone

Spring

SWMU Investigation Areas

Thrust Fault

Strike Slip Fault

Fault Displacement and Location Uncertain

N W E S

0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 2-3
Fault Locations and
Selected Monitoring Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

groundwater migrates along these fault/fracture systems both horizontally and vertically. Based on continuous cores drilled during the RI, evidence of tectonic fracturing was found including shatter breccias, potential slickensides, and gouge zones were noted between about 45 and 160 feet below ground surface (ft bgs) with an estimated 10 to 20 ft of vertical displacement. Conceptually, the thrust fault located north of the Site may limit groundwater migration from the upgradient deeper basalt aquifer system across the fault zone.

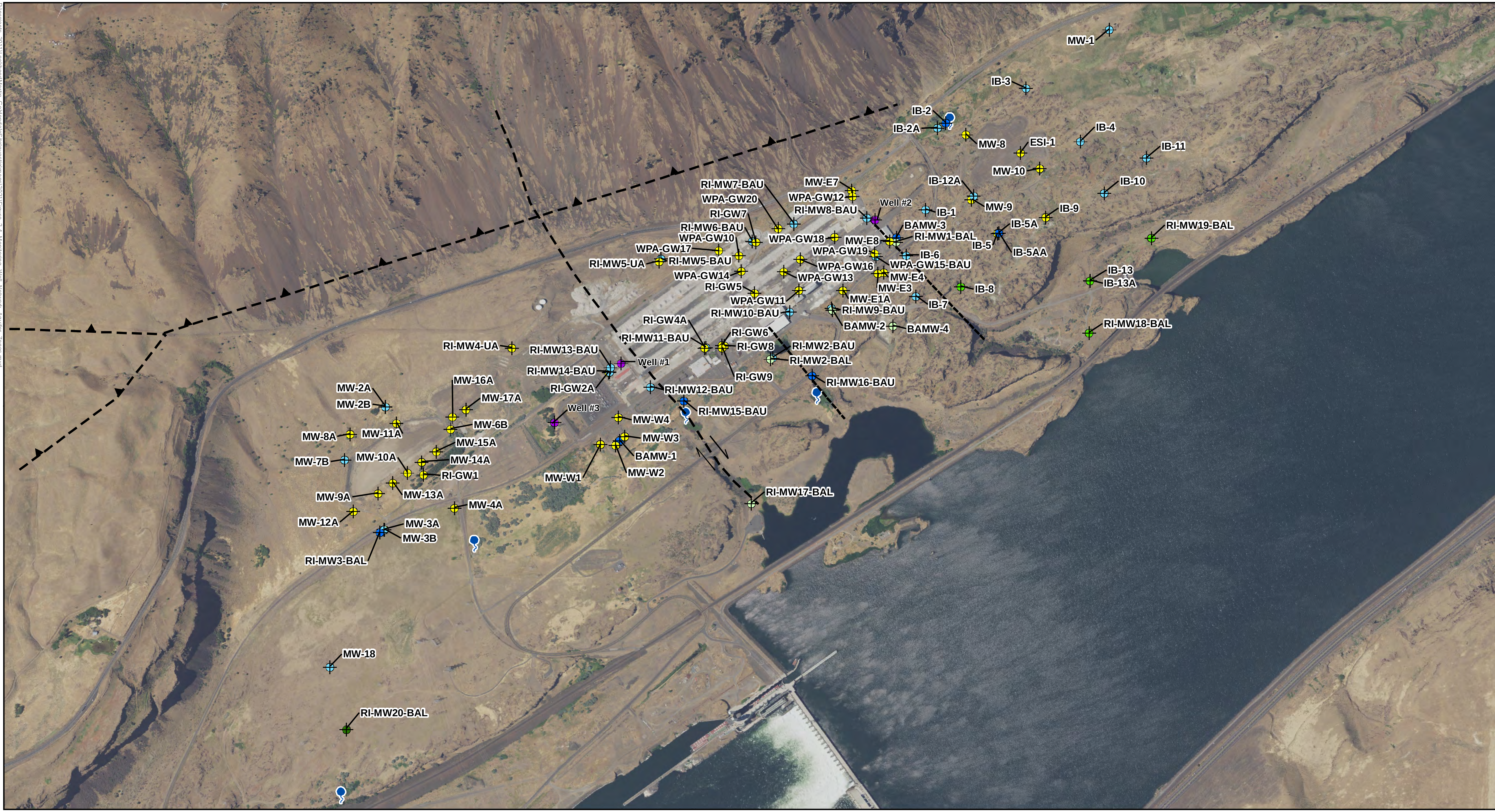
The various aquifer zones present at the Site are described and defined as follows:

- **Unconsolidated Aquifer (UA) Zone.** Based on the occurrence of unconsolidated water-bearing deposits including fill material (absent in some areas).
- **Basalt Aquifer Upper (BAU) Zone**. Two water-bearing zones (BAU_1 and BAU_2) within the upper basalt aquifer system at an elevation significantly higher than the Columbia River.
- **Basalt Aquifer Lower (BAL) Zone**. Two to three water-bearing zones (BAL_1, BAL_2, and BAL_3) within the lower basalt aquifer system. The BAL_1 water bearing zone occurs near the elevation of the Lake Umatilla Pool. The BAL_2 water-bearing zone occurs at an elevation about 40 ft below the Lake Umatilla Pool. The BAL_3 water-bearing zone occurs near the elevation of the Columbia River below John Day Dam (about 100 ft lower than the Lake Umatilla Pool).

There are 94 monitoring wells at the Site that were included in the RI and WPA field programs. Well locations are shown by aquifer zone in Figure 2-4.

A series of RI cross-sections, water-level elevation maps for each aquifer zone, and selected well and surface water intake pond hydrographs that are relevant to the potential groundwater-to-surface water flow path are included in Volume 4. The cross-section figures have been modified from the Draft RI cross-sections to show the fluoride and sulfate concentrations for wells and springs.

Groundwater flow is conceptualized toward the Columbia River (generally to the southwest-southeast) for all three aquifer zones (refer to Volume 4). There is an east-southeast water-level elevation gradient observed in the BAL zone. A steep water-level elevation gradient is observed in all three aquifer zones between the Former Plant Area and the Columbia River (i.e., UA zone = 0.053 foot/foot near the West Surface Impoundment, BAU zone = 0.202 foot/foot along fault zone at the east end of the former plant, BAL_1 zone = 0.060 feet per foot). The BAL_2 zone that responds to water-level fluctuation in the Lake Umatilla Pool is characterized by a flatter horizontal gradient



<u>Legend</u>

- Production Well
- Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

- BAL_1 - Shallower Water-bearing Zone
- BAL_2 - Deeper Water-bearing Zone
- BAL_3 - Deepest Water-bearing Zone

- Spring
- Thrust Fault
- Strike Slip Fault
- Fault Displacement and Location Uncertain

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-4
Monitoring Well Network
by Aquifer Zone

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

of 0.001 foot/foot. The horizontal gradient in the BAL_3 zone has not been characterized as only one well has been installed in this zone. Based on review of the water-level elevations for RI-MW20-BAL and gauging data for the John Day Dam Spillway, it appears that water-level elevations in this well are within about one foot of the Columbia River. Note that the river elevation varies significantly on each side of the dam. Further information regarding the horizontal gradient and vertical gradients is summarized in the Final Draft RI Report (refer to Volume 4, Section 2.3.2, and Volume 5, Appendix D-13, Table D-13-14 for vertical gradients).

Downward vertical gradients are present between aquifer zones. The vertical gradient between the BAU and BAL zones is large, which is indicative of a general lack of hydraulic connection between these zones. The UA and BAU zones are interconnected, while the BAL zone has limited connection to the BAU and UA zones with a greater potential for interconnection in areas with faulting or where topographic relief has resulted in a thinner zone of impermeable flow interior between the BAU and BAL aquifer zones. Confined aquifer conditions were generally observed during drilling in the basalt aquifer zones.

The degree of interconnection within a given basalt water-bearing zone flow breccias and associated fracture system is variable across the Site and the range of hydraulic conductivities for basalt water-bearing zones is also variable. The hydraulic conductivity of basalt flow interiors is low and migration of contaminants through flow interiors to the lower BAL zone appears to be limited to areas with faulting or where the thickness of the flow interior has been reduced based on topographic relief.

Figure 2-5 shows relevant site features and associated flow paths. The figure includes the following features:

- Drainage lines and other constructed features (e.g., groundwater collection lines, stormwater lines, industrial and monitoring lines, scrubber effluent lines, stormwater pond, and NPDES Ponds).
- Springs and wetlands.
- Natural drainage features.
- Selected relevant SWMU investigation areas.

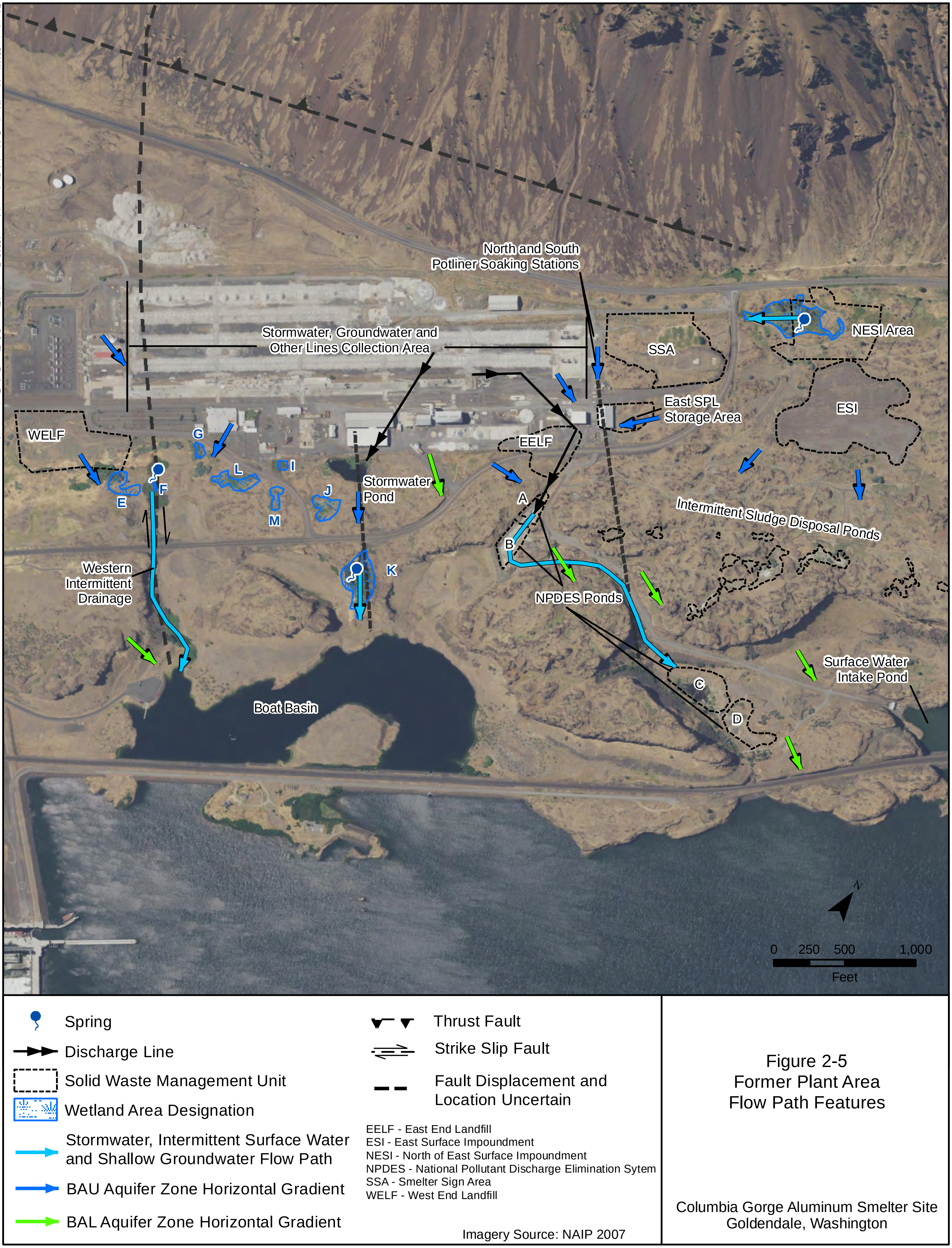


Figure 2-5
Former Plant Area
Flow Path Features

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

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- Stormwater, spring water, and shallow groundwater flow paths shown in blue.
- BAU and BAL Aquifer zone horizontal gradients shown by color-coded arrows. The gradient arrows are based on the first baseline round of groundwater sampling during the RI (Q1) and the RI water-level elevation maps for Q1 that are included in Volume 4 of this Final Draft RI report.

Five man-made features influence groundwater flow and contaminant transport in the plant area, including: 1) the groundwater conveyance lines, 2) the scrubber effluent lines, 3) industrial and monitoring lines, 4) stormwater lines, and 5) the stormwater pond (Figure 2-5). There is a flat and mounded area in the groundwater elevations for the UA and BAU aquifer zones that coincides with the footprint of the Former Plant Area and the French-drain shallow groundwater collection system that routes shallow groundwater to the stormwater pond (refer to Figure 2-5 and Volume 4). The scrubber effluent lines appear to route shallow groundwater to the head of the former NPDES Pond A (SWMU 1). The unlined stormwater pond is interconnected with and appears to locally recharge the BAU aquifer zone based on multiple lines of evidence including the results of the pond-drawdown test, water quality results, and water geochemistry. Water from the stormwater pond appears to represent a significant recharge source for Wetland K and Spring 01.

Groundwater migration to the Columbia River is most likely localized along fracture/fault zones that coincide with topographic lows. Migration of contaminants to the BAL zone, and subsequently to the Columbia River is most likely where: 1) sources of contamination are/were at a lower elevation than a portion of the impermeable flow interior between the BAU and the BAL zones due to topographic relief at the Site (e.g., NPDES ponds), and 2) areas where the basalt bedrock is fractured or faulted to provide a migration pathway to the deeper zones.

In some areas, water discharging from a spring (e.g., Spring 01 and Wetland F spring) or discharge pipe (head of Pond A) flows downstream within a gulley and subsequently seeps back into the ground where it may continue to migrate toward the Columbia River within unconsolidated deposits or fractures. A limited portion of this water may migrate through the basalts in fractured or faulted areas to reach the BAL zone.

Alluvial terraces are present near the Boat Basin along the shoreline of the Columbia River and extending uphill from the mouths of gullies. These sedimentary deposits represent Missoula Flood Deposits, based on the occurrence of granitic clasts and the high abundance of sand. These deposits are commonly 5- to 10-ft thick and up to a maximum of about 20-ft thick and are generally absent from the topographic bench where the main plant is situated. Due to the thin nature of the unconsolidated deposits and based on RI well drilling observations, it does not appear that this perched zone is well developed along the shoreline of the Columbia River. In these areas, infiltrating wetland water may locally infiltrate into the basalt and potentially migrate to the lower BAL-aquifer zone. However, this scenario is unlikely given the thickness of the impermeable basalt flow interior (greater than 50 ft) between the BAU- and the BAL-aquifer zones. Wetland water could also potentially infiltrate at areas where the basalt flow interiors may be more permeable due to faulting.

The BAL_1 and BAL_2 zones do not appear to have widespread groundwater discharge to the Columbia River based on hydrographs of shoreline monitoring wells versus the Columbia River and the absence of groundwater during drilling of the BAL_1 stratigraphic interval at two of three shoreline well locations (refer to Volume 4 hydrographs). The hydraulic relationship between the Columbia River and the BAL_3 zone was not characterized as only one well (RI-MW20-BAL) has been installed in this zone and a long-term water-level elevation study was not planned in this area of the Site because of the large distance (over 1 mile) from the likely source areas (WSI and West SPL Storage Area) to the Columbia River and the significant depth of the BAL3 zone (about 300 ft bgs in the suspected source area).

From the perspective of potential migration to surface water, fluoride represents the most wide-spread chemical with concentrations exceeding the Maximum Contaminant Level (MCL) of 4 milligrams per Liter (mg/L) across the Site and in all three aquifer zones. Fluoride concentrations are below 4 mg/L MCL in all wells near the Columbia River. Sulfate concentrations exceed the Secondary MCL of 250 mg/L primarily in the eastern and western portion of the Site and in all three aquifer zones. Sulfate concentrations slightly exceed the sulfate screening level of 250 mg/L in a few well locations near the Columbia River.

2.2.5 Surface Water

The Columbia River is the major water body in the site vicinity (refer to Figure 2-1). Near the site, the Columbia River represents a reservoir (Lake Umatilla) with water-levels and flows controlled by a nearby dam (John Day Dam). Also, the John Day River flows from the eastern interior of Oregon into the Columbia River about one mile upstream of the former smelter.

The John Day Dam spans the Columbia River and is equipped with fish passages that are used by various runs of salmon and steelhead, including some that are threatened. The reach of the Columbia River in the site vicinity was suspected to be a depositional area due to the presence of the John Day Dam downstream of the site and the confluence of the John Day River on the Oregon shoreline southeast of the site. However, sediment deposition is considered relatively low throughout the John Day Reservoir system based on a U.S. Geological Survey (USGS) [USGS open-file report (2004-1014)]. The limited amount of sediment observed throughout this reservoir is presumably because there were several dams that already existed upstream of the John Day Dam prior to its construction. This finding is supported by the fact that no maintenance dredging has been required on the upstream side of the John Day Dam since construction based on recent communication with the U.S. Army Corps of Engineers (USACE) (Tetra Tech, personal communication, October 25, 2018).

The site is located in a treaty-defined usual and accustomed fishing area of the Yakama Nation. The upland North Shore TFAS is located adjacent to the Columbia River immediately upstream of the John Day Dam (Ecology 2014). Enrolled Yakama Nation tribal members exercise treaty reserved fishing rights for ceremonial, subsistence, and commercial purposes from numerous traditional platforms on the Washington shore of the Columbia River within a mile of the site (Ecology 2014).

A public boat launch area and Boat Basin are located about 0.5 miles from the former smelter and upstream from the John Day Dam. The North Shore TFAS is an upland area located immediately west of the boat launch and Boat Basin, and is operated and maintained under the jurisdiction of the Yakama Nation and the United States (Ecology 2014). All of these features are on land owned by the U.S. Army Corps of Engineers (refer to Figures 2-1 and 2-2).

Use designations for the reach of Columbia River in the site vicinity under the Washington State Surface Water Regulations (WAC 173-201A-602, Table 602) include: 1) aquatic life uses of spawning and rearing; 2) primary recreation use; 3) water supply uses including domestic, industrial, agricultural, and stock water; and 4) miscellaneous uses including wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics.

There are three natural drainages that lead from the southern margin of the former smelter. The easternmost drainage contains the NPDES ponds (SWMU 1), and two drainages farther west drain into the Boat Basin. The two westernmost drainages correspond with wetland areas of the facility (refer to Figure 2-2).

2.2.6 Wetlands

Wetlands have been delineated and studied in the site vicinity and consist primarily of Category III and IV palustrine emergent and/or palustrine scrub/shrub wetlands (PGG 2013a,b; Tetra Tech 2011b). Fourteen wetland areas have been mapped at the site, and most of these wetlands have been disturbed by grazing, and historical grading activities (PGG 2013a,b; Tetra Tech 2011b). Category III and Category IV wetlands represent wetlands with a moderate to low level functions that generally have been disturbed in some ways and are often smaller, less diverse, and/or more isolated from other natural resources than other higher functional category wetlands.

An additional wetland area appears to be present south of the site in an area mapped on the Washington Department Fish and Wildlife Priority Habitat and Species map as a forested/shrub wetland (Figure 2-6) and down slope from a spring discovered during the initial RI field program and sampled during the WPA. Most wetlands at the site have been sampled as part of the RI and WPA sampling programs.

2.2.7 Area Ecology

The subject property is part of Eastern Washington shrub-steppe community that includes sagebrush, bunch grass, and rabbit brush. The habitat near the site is commonly referred to as "scablands" that includes sagebrush and grasses between areas of exposed bedrock with a hummocky topography. The basalt also forms cliffs in areas along the Columbia River and steep talus slopes north of the site along the base of the Columbia Hills (refer to Figure 2-1). In wetter areas, such as near depression wetlands at the site or where the water table is relatively shallow, tree species include oak, pine, hackberry, willow, and Russian olive.

The area provides habitat for numerous bird species such as sparrows, chukar, quail, turkeys, crows, and raptors including the red-tailed hawk, and golden eagle. Ponds and wetland areas provide habitat for ducks, geese, and other water birds. Mammals may include mice and other rodents, rabbits, raccoons, skunks, foxes, coyotes, and deer. A few reptile species including rattlesnakes are present in the site vicinity.

Legend

Wetland Area Designation

Spring

Species

Prairie Falcon Breeding

Habitat

Aquatic Habitat

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Talus Slopes

Waterfowl Concentration

Cliffs/Bluffs

Oak Forest

Oak/Pine Mixed Forest

There are 7 records of Golden Eagle Breeding Area within the Township, and 1 record of Little Brown Bat Communal Roost within the Township.

N W E S

0 500 1,000 2,000

Feet

Figure 2-6
Priority Habitat and Species

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

State or federally designated threatened and endangered species are listed to occur in the site vicinity, and in the nearby Columbia River. Listed species include the western gray squirrel (state listing as threatened) as well as various federally listed threatened fish including particular bull trout, steelhead, Chinook salmon, and chum salmon runs. The Snake River sockeye salmon is federally listed as endangered.

At the September 30th, 2019 meeting, Ecology provided supplemental information regarding Priority Habitats and Species (PHS) in the Site vicinity. PHS information is used primarily by cities and counties when implementing and updating land use plans and development regulations under the Growth Management Act and Shoreline Management Act. It is also used by local governments and landowners for wildlife conservation purposes to protect habitat.

Washington Department of Fish and Wildlife maintains a listing https://wdfw.wa.gov/species-habitats/at-risk/phs/list and geographic information system (GIS) application http://apps.wdfw.wa.gov/phsontheweb/ of PHS that are defined as follows:

- Priority Species include State Endangered, Threatened, Sensitive and Candidate Species, vulnerable animal aggregations (e.g., bat colonies), and vulnerable species of recreational, commercial, or tribal importance.
- Priority Habitats represent habitat types or elements with unique or significant value to many species. A Priority Habitat may consist of a unique vegetation type (e.g., shrub-steppe) dominant plant species (e.g., juniper savannah), or a specific habitat feature (e.g., cliffs).

Figure 2-6 shows the PHS areas mapped in the Site vicinity.

Based on the review of the PHS maps and associated database records, the following species records were identified:

- **Golden Eagle Breeding**. The Golden Eagle represents a State Candidate Species with seven records shown in the Township.
- **Prairie Falcon Breeding.** The Prairie Falcon is not included in the Washington State species listings and appear to represent a vulnerable animal aggregation. One record was found that corresponded to the cliff/bluff areas north of site.
- **Little Brown Bat Communal Roost.** The Little Brown Bat is not included in the Washington State species listings and appears to represent a vulnerable animal aggregation. One record was found in the Township.

The following Priority Habitats were identified in the Site vicinity:

- **Boat Basin and Wetland K**. These areas were listed in the map application and associated database based on waterfowl concentrations (i.e., database designation of "regular" concentration).

- **Cliffs and Bluffs.** These features were listed in the map application and associated database as a habitat feature.

- **Oak or Oak-Pine Mixed Forest.** These features were listed in the map application and associated database as terrestrial habitat features.

- **Talus Slopes.** These features were listed in the map application and associated database as a habitat feature.

- **Freshwater Forested/Shrub Wetland.** The wetland area adjacent to the recently discovered spring southwest of the Site near the former Cliffs town site is mapped as a freshwater forested/shrub wetland with aquatic habitat.

- **Freshwater Emergent Wetland.** A small portion of Wetland D (i.e., part of former Duck Pond location) is mapped as a Freshwater Emergent Wetland.

- **NPDES Pond A.** Mapped as an aquatic habitat.

2.3 CURRENT LAND USE

Demolition of buildings directly associated with the former Columbia Gorge Aluminum Smelter operations, including the reduction cell lines, was completed in spring 2013. Remaining buildings and structures include the former administration building R&D laboratory building, paste plant building, the north, south and east SPL storage buildings, and a few small shop and storage structures.

A description about the former plant operation and history is summarized in detail in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). The main features of the former plant and surrounding area are shown on Figure 2-2. The only development near the project site is the John Day Hydroelectric Dam, located on the Columbia River approximately 0.5 miles to the southwest (refer to Figure 2-1). Land use surrounding the site has been limited to livestock grazing, including primarily cattle in the sagebrush/grassland habitat.

The current owner (NSC) is planning to sell its land (and other assets) for commercial and industrial purposes. There are no current/active facility operations; however, portions of the former plant area have been periodically leased for commercial/industrial purposes (e.g., turbine disassembly and recycling) and the subject site is periodically accessed to perform routine environmental monitoring, including groundwater sampling and stormwater discharge monitoring. In addition, ongoing environmental investigation is being conducted in accordance with the 2014 Agreed Order.

Access to the site is restricted, with the vast majority of the site fenced and locked. Some areas to the east and west of the main plant [e.g., Wetland K and the eastern portion of the Intermittent Sludge Disposal Ponds (SWMU 3)] are located outside the existing perimeter fencing. The current owners employ a full-time site manager, whose duties include site security inspections.

2.4 SURROUNDING LAND USE

The site is located in a treaty-defined usual and accustomed fishing area of the Confederated Tribes and Bands of the Yakama Nation. The upland North Shore TFAS is located adjacent to the Columbia River immediately upstream of the John Day Dam (Ecology 2014). Enrolled Yakama tribal members exercise treaty reserved fishing rights for ceremonial, subsistence, and commercial purposes from numerous traditional platforms on the Washington shore of the Columbia River within a mile of the site (Ecology 2014).

A public day-use park (Railroad Island Park) that includes a boat launch is located immediately upstream of the John Day Dam, and about 0.5 miles from the former smelter. This land is owned by the U.S. Army Corps of Engineers.

As previously discussed in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a), the largest water rights in the vicinity were associated with aluminum smelter operation. The rights originally included both groundwater and surface water. The surface water right was for commercial and industrial purposes and has been reportedly transferred to KPUD; the water use designation has been changed from industrial to municipal and the place of use has been expanded to various locations in Klickitat County. The groundwater right designated use was for commercial, industrial, and domestic purposes. This water right has been transferred to KPUD, with a change in use to Municipal Use (Tetra Tech et al. 2015a).

2.5 PROPOSED JOHN DAY POOL PUMPED STORAGE HYDROGEOLOGIC PROJECT

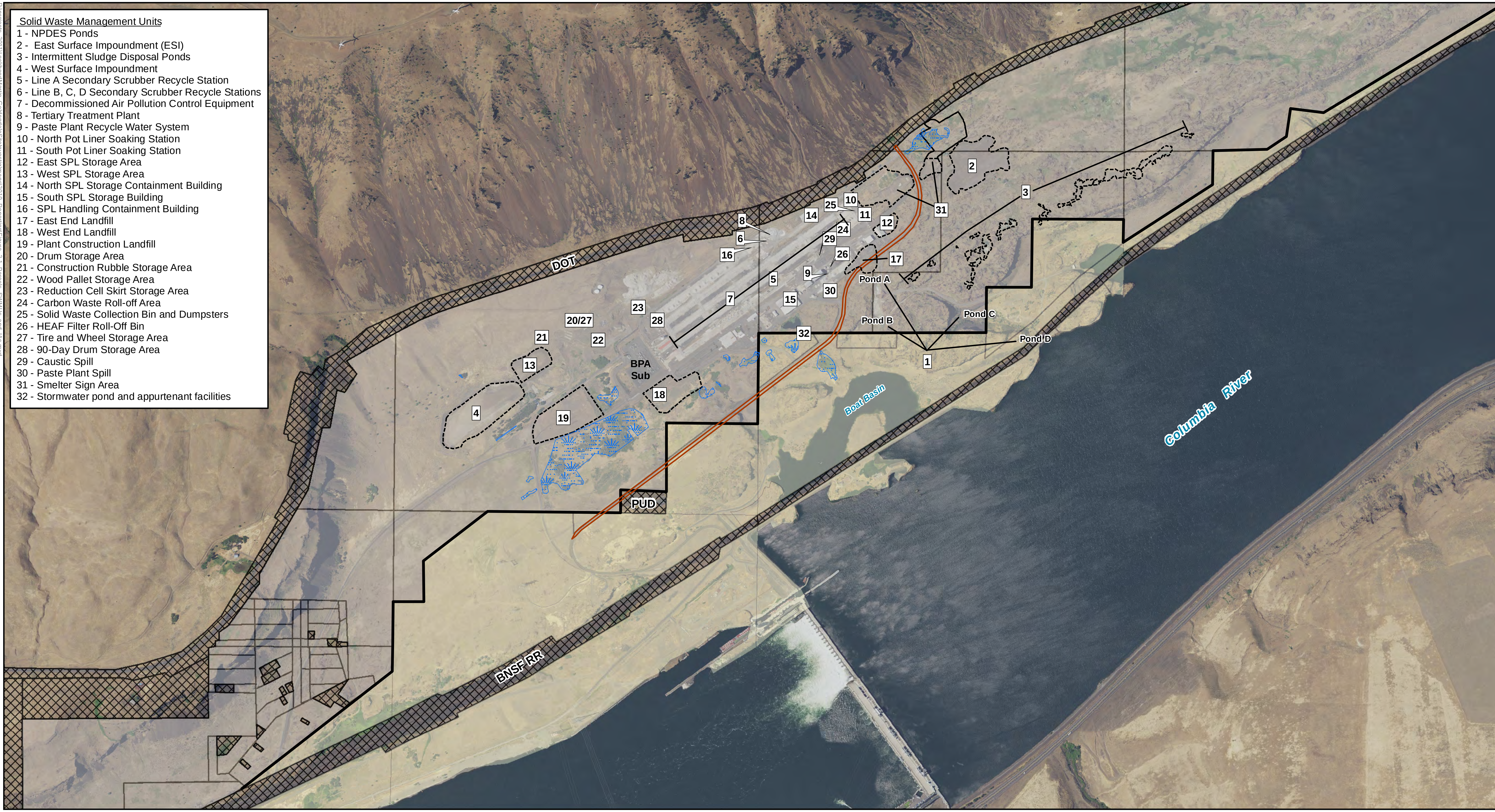
In March 2018, the Federal Energy Regulatory Commission (FERC) granted a preliminary permit for the John Day Pool Pumped Storage Hydroelectric Project. Conceptually, the proposed hydroelectric project represents a closed-loop pumped storage Hydropower facility that includes two 65-acre ponds (reservoirs), one on the site of the former smelter and one at the top of the adjacent cliff (about 2,000 ft in elevation rise) located about a mile to north. The pump-storage system is estimated to provide about 1,200 megawatts of capacity. Power from the proposed storage hydroelectric project would be routed to the existing Bonneville Power Administration substation that was formerly associated with smelter, which then ties into nearby transmission lines.

Some of the pumped storage facilities (including the lower reservoir, power plant, water supply lines, and transmission lines) have previously been proposed in the areas of SWMUs and AOCs being investigated as part of the RI. Based on review of recent planning documents for the pumped storage project (ERM West 2021), the WSI (SWMU 4), which has already been closed under RCRA, will be removed. The West SPL Storage Area (SWMU 13), which was closed under Washington State Solid Waste Regulations, is planned to remain in place. Construction of the lower reservoir could also potentially significantly affect groundwater recharge and flow. Monitoring wells present in the construction footprint are planned to be decommissioned and replaced as necessary and appropriate.

Two major potential investors in the proposed John Day Pool Pumped Storage Hydroelectric Project currently include National Grid and Rye Development, and although FERC granted a preliminary permit for the project in March 2018 the final approval (if granted) is likely several years away.

2.6 PROPERTY OWNERSHIP AND ZONING

The Site occupies land owned primarily by NSC with areas south of the main plant owned by the USACE. Figure 2-7 shows land ownership in the Site vicinity. As shown in Figure 2-7, a portion of a few SWMU areas are located outside of the NSC-owned property. These SWMU areas include the NPDES Ponds C and D (SWMU 1), as well as a small portion of the Intermittent Sludge Disposal Ponds (SWMU 3). Wetland K, which was investigated during the RI and WPA as part of the Wetlands AOC, is located outside of the NSC-owned land on the north side of the Boat Basin (refer to Figure 2-7) on land owned by the USACE.



Legend

NSC Smelter LLC Parcels

USACE

Other Ownership

Klickitat County Road Right-of-Way (John Day Dam Road)

Property Boundary

1 Solid Waste Management Unit

SWMU Investigation Areas

Wetlands

N W E S

0 500 1,000 2,000 Feet

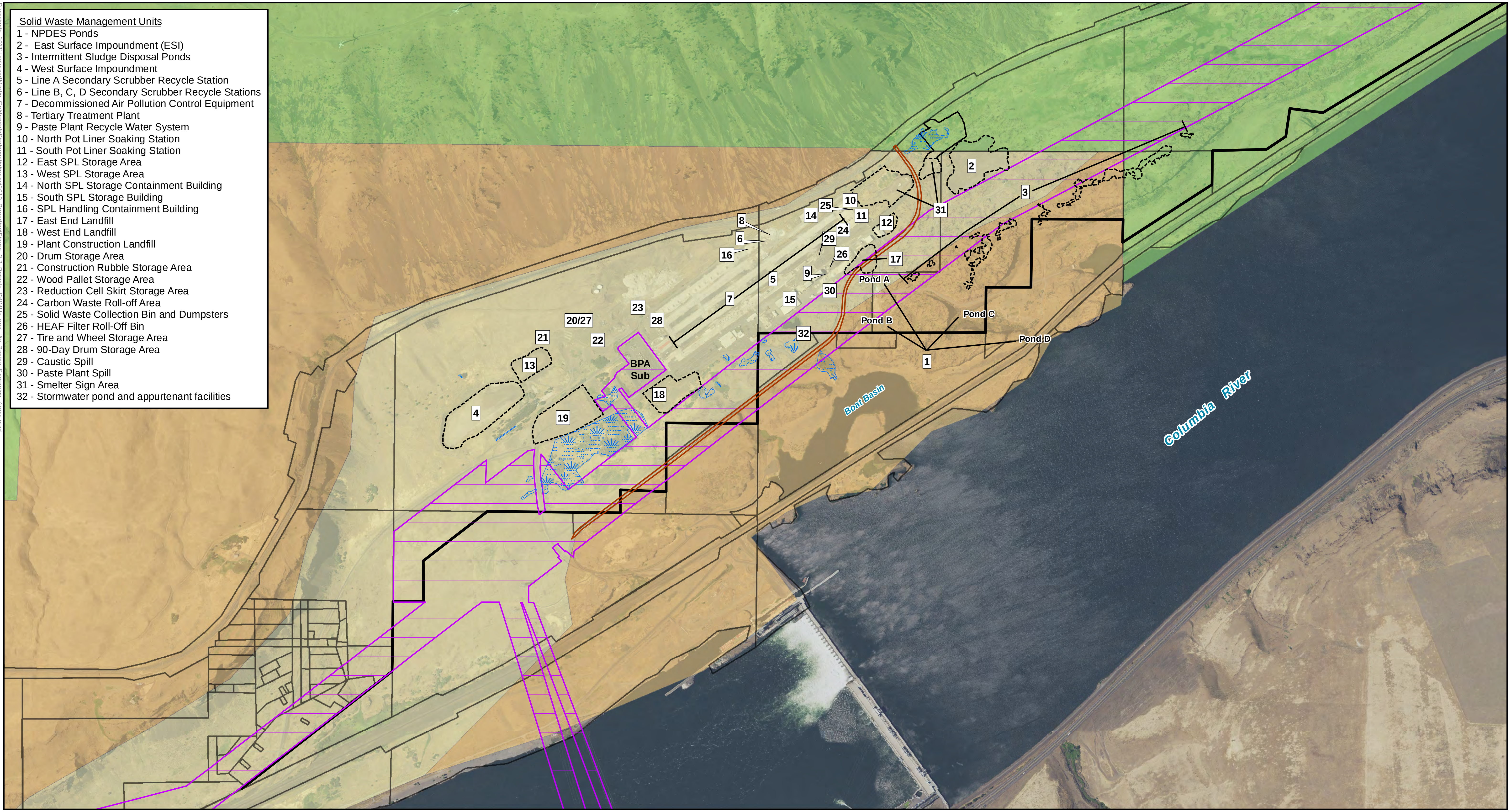
Imagery Source: NAIP 2017

Figure 2-7
Parcel Ownership and
Solid Waste Managment Units
and Investigation Areas

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Figure 2-8 shows the zoning and land use in the Site vicinity. The majority of the Site falls within an area zoned as Industrial Park. The SWMUs and most of the investigation areas were part of past industrial operations. An area zoned as Extensive Agriculture is present in the eastern portion of the Site and includes the North of the East Surface Impoundment (NESI) subarea of the Smelter Sign Area (SWMU 31), and a portion of the closed and capped East Surface Impoundment (ESI; SWMU 2), which was closed under RCRA. An area zoned as Open Space is present south of main plant area and includes portions of NPDES Ponds C and D (SWMU 1), the Intermittent Sludge Disposal Ponds (SWMU 3), and Wetland K. The location of the Bonneville Power Administration (BPA) transmission line corridor right-of-way is also shown on Figure 2-8 because the BPA right-of-way areas are subject to property access and land use restrictions and are not shown on the Klickitat County Zoning Map.

Ecology and Yakama Nation Comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) state that screening levels should be applied consistent with the property use based on current Klickitat County zoning information. Ecology and the Yakama Nation's position is that soil screening levels appropriate for industrial use can only be used for screening in areas zoned for industrial use and where a restrictive covenant is able to be recorded, and screening levels appropriate for unrestricted land use should be applied for all other areas (i.e., zoned for Open Space and Extensive Agriculture). Soil data for areas of the site that are zoned as Open Space and Extensive Agriculture will be screened against MTCA Method A and B soil screening levels for unrestricted land use, soil screening levels for protection of groundwater, and terrestrial ecological soil screening levels for plants, soil biota, and protection of wildlife as summarized in Section 5.0. The responsible parties have agreed to this approach for the purposes of screening during the RI. Potential changes to zoning and cleanup levels will be revisited as appropriate during the FS stage of the project.



Legend

- Parcel Boundaries
- Klickitat County Road Right-of-Way (John Day Dam Road)
- Property Boundary
- 1 Solid Waste Management Unit
- SWMU Investigation Areas
- Wetlands
- BPA Right-of-Way (Restricted Access and Use Area)

Klickitat County Zoning

- Extensive Agriculture
- Industrial Park
- Open Space

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-8
Parcel Zoning and Land Use
Solid Waste Management Units
and Investigation Areas

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Section 3
Identified Data Needs

This section provides a summary of the RI data needs and objectives for SWMUs and AOCs, as detailed in the Ecology-approved Final RI Phase 1 and 2 Work Plans (Tetra Tech et al. 2015a,b) and Final Work Plan Addendum (Tetra Tech et al. 2020b).

3.1 SWMU, AOC, AND ADDITIONAL INVESTIGATION AREAS SUMMARY

The list of SWMUs and AOCs to be evaluated in the original RI are summarized in the May 2014 Agreed Order (Ecology 2014). The Agreed Order includes 32 SWMUs and 4 AOCs. A fifth AOC (the Plant Area AOC) was identified by the project team during work plan preparation and included additional areas of the former plant that may have released COPCs. An additional area of investigation was identified to include the southern surface drainage ditch near the West SPL Storage Area (SWMU 13). The locations of the SWMUs listed in the Agreed Order as shown in Figure 2-1.

A detailed description of SWMUs and AOCs, including a summary operational history and past investigations is provided in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). Brief background summaries are included for individual SWMUs and AOCs in Volumes 2, 3, and 4 of this RI Report.

3.2 DATA NEEDS SUMMARY

This section summarizes the identified RI data gaps and data needs for the site SWMUs and AOCs as previously described in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a).

3.2.1 RI Work Plan Data Needs

This section summarizes data needs identified in the RI Work Plans and addressed by the RI Field Program.

3.2.1.1 SWMU Data Needs

A summary of RI data needs and investigation objectives for the 32 SWMUs is provided in Table 3-1 [as previously summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a)].

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #1 NPDES Ponds	Independent soil removal action completed to MTCA Method B residential soil screening levels for PAHs in 2010 (ARCADIS 2011). Potential for re-contamination of soil at Pond A from runoff will be addressed as part of the data needs for the stormwater pond and appurtenant facilities SWMU (SWMU 32) and Plant Area AOC. Groundwater data needs for this area of the site are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Determination of current soil concentrations at mouth of pipe that discharges to Pond A. Characterization of current groundwater conditions and extent of groundwater contamination in this area (see Groundwater in the Uppermost Aquifer AOC).
SWMU #2 East Surface Impoundment (ESI)	The unit was closed under RCRA and an Engineered cap was installed in 1987. A long-term OMM program is ongoing that includes groundwater monitoring. Groundwater chemical concentrations for some constituents have been detected above established screening levels. Groundwater data needs in this area of the site (e.g., current conditions and extent of groundwater contamination) are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Characterization of current groundwater conditions and downgradient extent of groundwater contamination (see Groundwater in the Uppermost Aquifer AOC).
SWMU #3 Intermittent Sludge Disposal Ponds	Independent soil removal action was completed to MTCA Method A Industrial Soil screening levels for PAHs in 2007 (URS 2008b). The appropriateness of industrial cleanup levels for this SWMU based on future land use considerations should be confirmed. No groundwater data needs have been identified.	No further investigation is proposed.
SWMU #4 West Surface Impoundment	The impoundment was closed under RCRA and an engineered cap was installed in 2005. A long-term OMM program is ongoing that includes groundwater monitoring. Groundwater chemical concentrations for some constituents have been detected above established screening levels. Groundwater data needs are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Characterization of current groundwater conditions and downgradient extent of groundwater contamination (see Groundwater in the Uppermost Aquifer AOC).
SWMU #5 Line A Secondary Scrubber Recycle Station	No environmental investigations have been conducted. Characterization of chemical concentrations in surface and subsurface soil represents a data gap and data need. Limited characterization of current shallow groundwater conditions represents a data need that is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Determination if a release has occurred from the unit. Characterization of COPC concentrations in surface and subsurface soil and shallow groundwater.
SWMU #6 Line B, C, D Secondary Scrubber Recycle Stations	No environmental investigations have been conducted. Characterization of chemical concentrations in surface and subsurface soil represents a data gap and data need. Limited characterization of current shallow groundwater conditions at this unit and the nearby Tertiary Treatment Plant (SWMU 8) represents a data need that is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Determination if a release has occurred from the unit. Characterization of COPC concentrations in surface and subsurface soil and shallow groundwater.
SWMU #7 Decommissioned Air Pollution Control Equipment	SWMU represents 20 roof-top units associated with Production Buildings A and B that were removed in the late 1990s. Surface soil samples were collected in the courtyards near the Wet Electrostatic Precipitator (WESP) units during an initial investigation of the Production Area in 2010 (PGG 2010). This soil sampling effort did not specifically target the individual WESP units and other potential sources are present at the Courtyards. Soil chemical conditions in the Courtyards and Production Area will be addressed as part of the Plant Area AOC.	No SWMU-specific investigation is planned. COPC chemical concentrations in soils will be characterized as part of the Plant Area AOC.

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #8 Tertiary Treatment Plant	No environmental investigations have been conducted. Characterization of COPC concentrations in surface and subsurface soil represents a data gap and data need. Limited characterization of current shallow groundwater conditions at this unit and the nearby Line B, C, D Secondary Scrubber Recycle System (SWMU 6) represents a data need that is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Determination if a release has occurred from this unit. Characterization of COPC concentrations in surface and subsurface soil and shallow groundwater.
SWMU #9 Paste Plant Recycle Water System	Spills from this unit were documented in 1990 and the system was upgraded. No environmental investigation of the recycle sump (briquette cooling sump), settling tanks, or other appurtenant facilities has been performed. Inspection of the Recycle Water System Sump and facilities that are part of Paste Plant Recycle Water System with targeted sludge and soil sampling to characterize current PAH concentrations. Shallow groundwater characterization in the sump vicinity is addressed under the Groundwater in the Uppermost Aquifer AOC.	Determination of COPC concentrations in surface and subsurface soils and sump sludge.
SWMU #10 North Pot Liner Soaking Station	Soil and groundwater at the North and South Pot Liner Soaking Stations were investigated as part of an independent RI/FS in 2008 (URS 2008e). PAH soil contamination was found above MTCA Method C screening levels. A soil removal action was recommended as the preferred remedial alternative. Characterization of the full extent of soil contamination represents a data need but could also be performed during the remedial action. No groundwater investigation needs have been identified other than additional sampling of the existing shallow well in the site vicinity as addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Confirmation of the extent of soil contamination associated with this SWMU.
SWMU #11 South Pot Liner Soaking Station	Refer to SWMU 10 because the North and South Pot Liner Soaking Stations are located in close proximity and previously investigated together.	Refer to SWMU 10.
SWMU #12 East SPL Storage Area	This SWMU was investigated as part of an independent RI/FS during 2008 (URS 2008c). PAHs were found in site soils above MTCA Method C screening levels and selenium was detected above MTCA terrestrial ecological screening level values. A soil removal action was recommended as the preferred remedial alternative. Characterization of the full extent of soil contamination represents a data need but could also be performed during the remedial action. Groundwater data need for this SWMU is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Confirmation of the extent of soil contamination associated with this SWMU.
SWMU #13 West SPL Storage Area	The West SPL Storage Area was closed in 1988 under the solid waste regulations (WAC 173-304) and still contains SPL. An engineered cap was constructed in 1988. The site was under a long-term OMM program that ceased when the responsible party went bankrupt. Groundwater monitoring was performed from 1990 to 2008 and groundwater chemical concentrations above screening levels have been detected. Characterization of current groundwater conditions has been conducted as part of the Groundwater in the Uppermost Aquifer AOC.	Confirmation of the extent of groundwater contamination (see Groundwater in the Uppermost Aquifer AOC).

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 3 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #14 North SPL Storage Containment Building	This unit was cleaned closed under RCRA during July 2009 (CH2M Hill 2009). Soil sampling program was limited to cyanide and fluoride for a small number of samples. It is also unclear if the soil screening levels used for closure are protective of groundwater. Data gaps and data needs include: Determination of a fluoride and cyanide-containing waste and soil screening level that is protective of groundwater consistent with MTCA requirements and will be addressed as part of the Groundwater in the Uppermost Aquifer AOC. • Current chemical concentrations of PAHs and selected metals in soil. • Collection of subsurface soil samples beneath the liner. • Investigation of shallow groundwater is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Supplemental characterization of COPC concentrations in soil. Development of soil screening levels protective of groundwater consistent with MTCA requirements. Characterization of shallow groundwater COPC concentrations.
SWMU #15 South SPL Storage Building	This unit was cleaned closed under RCRA during 1996 (Golder 1996a). Closure soil sampling program was limited to cyanide and fluoride for a small number of samples. It is also unclear if the soil screening levels used for closure are protective of groundwater. Data gaps and data needs include: • Determination of a fluoride and cyanide-containing waste and soil screening level that is protective of groundwater consistent with MTCA requirements and will be addressed as part of the Groundwater in the Uppermost Aquifer AOC. • Current chemical concentrations of PAHs and selected metals in soil. • Verification of the presence and condition of the liner with potential soil sampling beneath the liner depending on the results of verification activities. Investigation of shallow groundwater is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Supplemental characterization of COPC concentrations in soil. Development of soil screening levels protective of groundwater consistent with MTCA requirements.
SWMU #16 SPL Handling Containment Building	This unit was cleaned closed under RCRA during 2011 (PGG 2011). Closure soil sampling program included additional chemical analyses (PAHs, metals, and PCBs) and collection of several more soil samples than during closure of the other SPL units. Contaminated soils were removed based on the detected PAH concentrations in soil above MTCA Method B screening levels. No data needs for soil have been identified. No SWMU-specific groundwater data needs have been identified.	No investigation activities are proposed.

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 4 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #17 East End Landfill	The EELF was investigated in 1991 and again 2008 as part of an independent RI/FS (URS 2008a). Elevated concentrations of PAHs were detected above MTCA Method C screening levels in landfill materials and in the underlying soils. Remedial excavation and disposal was identified as the preferred remedial alternative at the site. Additional investigation (Tetra Tech 2011a) was planned in this area because some documentation was found that indicated potential SPL disposal in this area and additional potential sources were identified. Additional landfill material and soil characterization and refinement of contaminated material volumes represent data needs for this SWMU. Groundwater data needs in this area of the site (e.g., current conditions, occurrence of groundwater, interaction with groundwater drainage/collection lines, extent of groundwater contamination) are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Supplemental characterization of the nature and extent of landfill materials and soil contamination. Refinement of estimates of waste and contaminated soil volumes. Characterization of groundwater occurrence and conditions and interaction with groundwater drainage/collection lines.
SWMU #18 West End Landfill	An independent soil and groundwater RI/FS was performed in 2008 (URS 2008f, 2010). Maximum concentrations of PAHs, oil-range petroleum hydrocarbons, and a few metals (arsenic, cadmium, selenium) exceeded MTCA Method A screening levels for industrial use in the landfill wastes. Low levels of arsenic, cadmium, chromium, lead, and cyanide were detected in groundwater above MTCA groundwater screening levels. However, it's unclear if the detected groundwater concentrations were representative of groundwater conditions or attributable to the WELF. An engineered cap was the recommended remedial alternative and a cap was designed (Tetra Tech 2010, 2012). No additional data needs have been identified for the soils and wastes. Groundwater data needs for this area of the site (e.g., current conditions and extent of groundwater contamination) are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	No data needs have been identified for landfill wastes or soils. Characterization of current groundwater conditions and extent of groundwater contamination in this area (see Groundwater in the Uppermost Aquifer AOC).
SWMU #19 Plant Construction Landfill	No environmental investigations have been performed. A geotechnical investigation (Fujitani Hilts & Associates 2001) suggest that the construction rubble is primarily basalt cobbles and gravel (likely from initial plant blasting and grading activities). Characterization of COPC in site surface and subsurface soils represents a data need. Verification and inspection of the existing piezometer has been identified as a data need. Current groundwater conditions are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Characterization of COPC concentrations in soil.
SWMU #20 Drum Storage Area	This SWMU was characterized as part of an independent site investigation during 2008 (URS 2008d). Results show the presence of PAHs in soil above MTCA Method B and below MTCA Method C Industrial screening levels. The appropriateness of industrial cleanup levels for this SWMU based on future land use considerations should be confirmed. No data gaps or data needs have been identified.	No environmental investigation activities are proposed.

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 5 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #21 Construction Rubble Storage Area	No investigation of the Construction Rubble Area (SWMU 21) that is located west of the Drum Storage Area has been performed. This SWMU also includes recently generated debris from plant demolition. The concrete construction rubble stockpiles remaining at the site have been investigated (PGG 2012c, 2014b). Results show the presence of PAHs above Method B screening levels and below Method C screening levels. Fluoride and cyanide concentrations were below Method B screening levels, but it is unclear if these concentrations are protective of groundwater. Characterization of chemical concentrations of soil in Construction Rubble Area west of the Drum Storage area represents a data gap and data need. Further evaluation of potential reuse of the crushed concrete material stored onsite represents a data evaluation need for the overall project. Additional RI-related data gaps and data needs have not been identified for the crushed concrete. The Rebar Storage Area near the Rectifier Yard will be addressed as part of the Rectifier Yard AOC.	Characterization of chemical concentrations in soil for the Construction Rubble Area located west of the Drum Storage Area (SWMU 21). Further investigation of crushed concrete from site demolition activities does not represent an RI-related data need and is not proposed. Potential site reuse of the crushed concrete will be further evaluated during the FS.
SWMU #22 Wood Pallet Storage Area	The Wood Pallet Storage Area was inspected in 2012 (PGG 2012a) and a burn pile was found that contained materials other than wood. Environmental sampling has not been conducted at this area. Waste profiling with potential sampling of the underlying soils represents a data need for this SWMU. No SWMU-specific groundwater data needs have been identified	Characterization of COPC chemical concentrations in waste and underlying soil.
SWMU #23 Reduction Cell Skirt Storage Area	The Reduction Cell Skirt Storage Area located northwest of the Production Building D was reportedly cleaned up at the time of closure, but soil sample results have not been documented. Characterization of surface and subsurface COPC concentrations in soil represents a data gap and data need for this SWMU. No SWMU-specific groundwater data needs have been identified.	Characterization of COPC chemical concentrations in surface and subsurface soil.
SWMU #24 Carbon Waste Roll-off Area	The specific locations of the carbon waste roll-off boxes associated with the production lines are unclear and likely changed over the period of plant operations. These areas likely included the courtyards adjacent to and/or between the Production Buildings. Characterization data for soil have been collected from the Courtyards (PGG 2010) and show PAH concentrations above MTCA Method C screening levels in some areas. Further characterization of carbon manufacturing, handling, and storage facilities represents a data need that is addressed as part of the Plant Area AOC.	No SWMU-specific investigation is planned. Characterization of the nature and extent of soil contamination for the courtyards and other carbon handling areas near the Production Buildings is an objective for the Plant Area AOC.
SWMU #25 Solid Waste Collection Bin and Dumpsters	The exact locations of the solid waste collection bins and dumpsters in the former production area are unclear and likely changed during the period of plant operations. Soil chemical concentrations in the courtyards and other areas of the former plant represents a data gap and data need that is addressed as part of the Plant Area AOC.	No SWMU-specific environmental investigation is proposed. Data needs for soil characterization in this area will be addressed as part of Plant Area AOC.

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 6 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #26 HEAF Filter Roll-Off Bin	No environmental investigations have been performed. The likelihood of release is low based on the period and nature of this storage operation. The specific location of this roll-off bin near the Paste Plant is unclear.	No environmental investigation activities are proposed.
SWMU #27 Tire and Wheel Storage Area	This SWMU was reportedly cleaned up following a 1994 brush fire that consumed the existing tires and wheels stored in this area. This SWMU is co-located with Drum Storage Area (SWMU 20). Soils in the vicinity of this SWMU were investigated as part of the 2008 Drum Storage Area RI performed by Lockheed Martin (URS 2008d). No data gaps or additional data needs are identified for this SWMU; however, the appropriateness for the use of industrial cleanup levels in site soils based on future land use considerations should be confirmed.	Refer to Drum Storage Area (SWMU 20).
SWMU #28 90-Day Drum Storage Area	No environmental investigations have been performed. The likelihood of release is low based on construction, relatively recent period of operations, and the record keeping and inspection program that was implemented. No data needs have been identified.	No environmental investigation activities are proposed.
SWMU #29 Caustic Spill	The area was inspected (Ecology 1990d,e) and some soils were reportedly excavated due to high pH in response to this NaOH spill that occurred in 1990. Characterization of COPC concentrations in soil and groundwater was not performed. Subsurface soil chemical characterization for site COPC represents a data need for this SWMU. Limited groundwater sampling of the spill area represents a data need that is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Characterization of COPC concentrations in subsurface soil in the spill area. Determination of whether a release to groundwater has occurred.
SWMU #30 Paste Plant Spill	Environmental investigation of the Paste Plant Spill occurred in 1991 (Technico Environmental Services 1991a,c). PAH concentrations in soil exceeded MTCA Method C industrial screening levels in the area near the fence line south of the Paste Plant. A soil removal action was performed, and confirmation sample results showed additional contaminated soils remaining. Additional areas of waste disposal and potential sources of contamination (e.g., East End Landfill) were identified. Subsurface soil sampling beneath concrete and asphalt in the area of the Paste Plant Spill to characterize PAH concentrations. Current concentrations of site COPC in soil and shallow groundwater represent a data gap and data need for this SWMU. Groundwater characterization needs are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Supplemental characterization of the nature and extent of soil and shallow groundwater contamination in the spill area.
SWMU #31 Smelter Sign Area	Evidence of SPL and other aluminum reduction was discovered and reported to Ecology in 2011. Work plans for site characterization were prepared in 2011 (Tetra Tech 2011b,c). Data needs and data gaps include waste characterization as well as characterization of COPC concentrations in surface and subsurface soils. Characterization of shallow groundwater COPC chemical concentrations and water-level elevations in the NESI subarea near the wetlands represents a data gap and data need that are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Nature and extent of waste and soil contamination in the Smelter Sign Area.

Table 3-1
Solid Waste Management Units – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 7 of 7)

SWMU Designation	Cleanup Status and Data Needs Summary	Investigation Objectives
SWMU #32 Stormwater pond and appurtenant facilities	Sediments in the stormwater pond were investigated in 1991 (Technico Environmental Services 1991b) and contained PAHs above the state Extremely Hazardous Waste (EHW) designation criteria of one percent. Stormwater catch basins have been sampled and were found to consistently contain PAHs above MTCA Method C screening levels for soil. Accessible lines and catch basins at the time have been cleaned (PGG 2012b). A series of groundwater collection lines have been documented that drain into the stormwater pond (Columbia Gorge Aluminum 2011). Data gaps and data needs include the following: • Characterization of current chemical concentrations of PAHs and other site COPC in stormwater detention pond sediments. Characterization of the vertical and horizontal extent of contamination. • Estimation of the volume of contaminated sediments and the anticipated waste designations. • Verification of the groundwater collection system layout and construction. • Hydrologic evaluation of the groundwater collection system and its effect on shallow groundwater occurrence and flow beneath the production area. • Verification that stormwater lines and catch basins have been cleaned to the maximum extent practicable now that plant demolition activities have been completed and site access has become easier. • Characterization of shallow groundwater COPC chemical concentrations and water-level elevations near the stormwater pond and in the main production area represents a data gap and data need that are addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Supplemental characterization of the nature and extent of contamination in the stormwater pond sediment. Hydrologic characterization of the groundwater collection system and its effect on shallow groundwater occurrence and flow.
Other Potential Source (Northwestern Area) – Research and Development Laboratory Septic Drain Field	This area was investigated in 2012 (PGG 2013a). Elevated concentrations of PAHs, metals (e.g., arsenic, cadmium), and low levels of a few VOCs were detected primarily in septic tank sludge for the newer septic system. The tank sludge was removed and appropriately disposed of offsite, and the septic system was decommissioned. Shallow groundwater sampling was not performed and it's unclear if contaminants could have impacted shallow groundwater. No characterization needs for soil have been identified. Limited groundwater sampling of the drain field represents a data need that is addressed as part of the Groundwater in the Uppermost Aquifer AOC.	Determination of whether a release to groundwater has occurred (see Groundwater in the Uppermost Aquifer AOC).
Other Potential Source (Western Area) – Upper Fluoride Area	This area was investigated in 2012 (PGG 2013a). No evidence of a release or waste handling/disposal was found. No data gaps or data needs have been identified.	No environmental investigation activities are proposed.
Other Potential Source (Northwestern Area) – Southern Surface Drainage Ditch near West SPL Storage Area (SWMU 13)	This investigation area was added based on Ecology (2015b) comments on the Phase 1 Work Plan. The WSI slurry lines were historically located in the ditch adjacent to the WSI. There is potential for the sludge lines to have released contaminants to the unlined ditch. This ditch was modified, repaired, and lined in 1996 and 1997 (CH2MHill 1996, 1997). Inspection of the ditch and potential soil sampling represents a data need for this area.	Verification of the lined portion of the ditch, determination of whether a release to ditch soils has occurred, determination of the amount of soil in the potentially impacted area of the ditch.

Notes:

AOC	Area of Concern	NESI	North of the East Surface Impoundment	SPL	Spent Pot Liner
COPC	Chemical of Potential Concern	OMM	Operations, Maintenance and Monitoring	SWMU	Solid Waste Management Unit
EELF	East End Landfill	PAH	Polycyclic Aromatic Hydrocarbon	VOC	Volatile Organic Compound
EHW	Extremely Hazardous Waste	RCRA	Resource Conservation and Recovery Act	WELF	West End Landfill
MTCA	Washington State Model Toxics Control Art	RI/FS	Remedial Investigation/Feasibility Study		

These include the majority of SWMUs identified in the Agreed Order that were not previously closed under RCRA (or other regulatory programs) and are characterized by a distinct historical operational footprint.

Consistent with the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a), a few SWMUs were determined to have no RI field investigation data needs, including the following:

- Prior Ecology-approved unit closure including SWMU 2 [East Surface Impoundment (ESI)], SWMU 4 [West Surface Impoundment (WSI)], and SWMU 13 (West SPL Storage Area).
- Prior site investigations including SWMU 18 [West End Landfill (WELF)], and SWMU 20 (Drum Storage Area) that showed adequate past characterization data.
- Review of background information indicating a low potential for releases including SWMU 27 (Tire and Wheel Storage Area), and SWMU 28 (90-Day Drum Storage Area).
- Lack of clear operational footprint including SWMU 7 (Decommissioned Air Pollution Control Equipment), SWMU 24 (Carbon Waste Roll-Off Area), SWMU 25 (Solid Waste Collection Bin and Dumpsters), and SWMU 26 [High Efficiency Air Filtration (HEAF) Filter Roll-Off Bin]. The areas of these SWMUs have been addressed as part of the Plant Area AOC field investigation.

Note that some of the SWMUs listed above (e.g., SWMU 18, West End Landfill) will be carried forward to the FS even though there was no RI-specific data collection. For all SWMUs, groundwater characterization data needs have been addressed as part of the Groundwater in the Uppermost Aquifer AOC.

3.2.1.2 AOC Data Needs

A summary of RI data needs and objectives for the five AOCs (i.e., Columbia River Sediments, Groundwater in the Uppermost Aquifer, Wetlands, Rectifier Yard, and Plant Area) is provided in Table 3-2 [as previously summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a)]. All of the AOCs had identified RI field investigation data needs and were sampled as part of the RI field program.

Table 3-2
Areas of Concern – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 4)

Areas of Concern	Investigation Area(s)	Data Gaps and Data Needs Summary	Investigation Objectives
Columbia River Sediments	Columbia River, Boat Basin, and Intermittent Drainages.	Current information and/or data regarding sediment transport in Boat Basin and the reach of the Columbia River near the site (e.g., depositional rate, areas of re suspension, degree of connection and circulation, and potential dredging areas).	Characterize physical processes and properties that may affect sediment quality concentrations and potential remedial alternatives analysis.
		Chemical characterization of surface (0-6 inch) sediment in the Boat Basin and Columbia River to determine current conditions for site COPC. Because anticipated land and water use is assumed to remain the same, subsurface sediments will remain covered with no exposure to potential receptors. Ecology and Yakama Nation (Ecology 2015b,c) comments on the Draft Phase 1 and Phase 2 Work Plans included consideration for sampling of deeper intervals.	Characterize current sediment quality in surface sediments to evaluate potential exposure.
		Chemical characterization of sediment and surface water in the two intermittent streams draining into the Boat Basin to determine current conditions for site COPC.	Characterize potential contaminant transport to the Boat Basin and Columbia River.
		Further characterization and evaluation of background sediment concentrations for site COPC to determine current conditions.	Characterize naturally occurring background concentrations and potential contribution from other upstream sources.
		Ecology and Yakama Nation Comments (Ecology 2015b) on the Draft Phase 1 Work Plan include consideration of human health evaluation for Columbia River sediments.	The focus of this investigation is on the collection of new chemical and physical sediment data to establish current baseline sediment quality conditions and to identify associated potential ecological and human health risks.
Groundwater in the Uppermost Aquifer	Site-Wide	Confirm and update the site hydrogeologic conceptual site model to reflect current conditions. Additional site-wide investigation is needed. Detailed hydrostratigraphic characterization of the unconsolidated aquifer (UA), upper basalt aquifer (BAU), and lower basalt aquifer (BAL), including occurrence of groundwater, lithology, and continuity of permeable zones within the basalt. Evaluation of aquifer characteristics for the UA, BAU, and BAL aquifer zones including groundwater flow directions, horizontal and vertical gradients, hydraulic conductivity, and aquifer interconnection within the underlying basalt aquifer system. Characterization of current groundwater quality for site COPC, geochemistry, and background concentrations for the UA, BAU, and BAL aquifer zones. Better definition and refinement regarding the lateral extent of contamination for various aquifer zones to evaluate the groundwater to surface water pathway. Characterization of seasonal variability in groundwater quality.	Better understand groundwater occurrence, flow, seasonal variability, and contaminant distribution to evaluate potential transport and exposure pathways.
		Development of soil screening levels protective of groundwater for fluoride and cyanide consistent with the requirements of MTCA. Development of an appropriate groundwater screening level for sulfate.	Establish necessary soil screening levels to adequately assess the potential for ongoing releases to groundwater. Better evaluate potential human health risks from exposure to sulfate in groundwater.
		Verification of the physical condition of the monitoring wells and ancillary equipment (e.g., pumps). Evaluation of the construction details for existing wells to determine which wells are appropriate from a construction standpoint for inclusion in the RI sampling program. Verification of well elevation and location information. These data needs should be addressed before completion of the Phase 2 Work Plan. Identification of monitoring wells that may serve as potential pathways for contaminant migration that may require physical modification or decommissioning as appropriate.	Determine and ensure that representative groundwater RI data will be collected. Eliminate potential well-related groundwater transport pathways.

Table 3-2
Areas of Concern – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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Areas of Concern	Investigation Area(s)	Data Gaps and Data Needs Summary	Investigation Objectives
Groundwater in the Uppermost Aquifer (Continued)	Production Area	Characterization in the production area to determine hydrogeology and water quality concentrations. Further characterization at the east end of the plant in the area of the filled drainage channel and associated NPDES drainage. There is a general lack of groundwater characterization in these areas.	Characterize nature and extent of groundwater contamination and hydrogeologic conditions.
	SWMU-Specific	Evaluation of potential releases to groundwater for SWMUs and other source areas that have not been characterized.	
Wetlands	Wetlands west and south of the former smelter and excluding NPDES Ponds	Soil quality data wetlands sufficient to evaluate impacts from site operations via air deposition. Sufficient background soil samples for evaluating potential contamination in wetland sediment. Further evaluation of COPC list for wetlands soil characterization and characterization of background concentrations.	Characterize nature and extent of soil/sediment contamination in the wetlands related to former smelter emissions.
Rectifier Yard	Rectifier Yard and Rectifier Building	Collection of soil samples where feasible in areas that were previously inaccessible. Additional characterization of surface and near surface samples for a more comprehensive suite of site COPC. This effort will include resampling of: 1) selected previous transformer sampling locations and with chemical analyses of metals and petroleum hydrocarbons; 2) selected previous oil pipeline sampling locations with chemical analyses for metals and PCBs; 3) sample transformer substations not previously sampled in areas where PCBs were detected in soil and 4) selected previous aboveground storage tank (AST) sampling locations with chemical analyses of metals, fluoride, cyanide, PAHs and petroleum hydrocarbons. Further evaluation of the vertical and horizontal extent of petroleum hydrocarbon contamination in soil near the oil conveyance lines and at the interior transformer substations. Further evaluation of the horizontal and vertical extent of PAH soil contamination at the transformers and oil conveyance lines. Verification that all oil conveyance lines have been removed. Characterization of subsurface soils beneath Rectifier Building A- and B-series transformer locations, and beneath the Rectifier Building foundation with the chemical sampling program to include metals, PAHs, PCBs and petroleum hydrocarbons. Characterization of soil concentrations at the oil house to include chemical analyses of metals, PAHs, PCBs and petroleum hydrocarbons for selected samples. Characterization of surface soils in the northern portion of the Rectifier Yard used for storage of demolition debris (rebar) with the chemical sampling program to include metals, fluoride, cyanide, PAHs, PCBs, and petroleum hydrocarbons. Additional evaluation of Transformer Substation T5B to determine if additional soil removal is warranted.	Characterization of the nature and extent of soil contamination. Evaluation of potential for releases from site features to subsurface soil and shallow groundwater (groundwater investigation is addressed as part of the Groundwater in the Uppermost Aquifer AOC).

Table 3-2
Areas of Concern – Data Needs and Investigation Objectives Summary
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Areas of Concern	Investigation Area(s)	Data Gaps and Data Needs Summary	Investigation Objectives
Plant Area	Potential Sources in the Plant Area AOC that are not included as existing SWMUs and AOCs	The Plant Area AOC has been subdivided into three main categories of features: 1) Carbon Handling, Storage, and Manufacturing. 2) Bath Handling and Storage, and 3) Cast House, Production Buildings, and Ancillary Features. SWMUs 7, 24, 25, and 26 will also be addressed under the Plant Area AOC because of their indeterminate locations. Data gaps and data needs include the following: **Carbon Manufacturing, Handling and Storage Features.** Characterization of surface and subsurface soil chemical concentrations at the identified carbon handling, storage, and manufacturing potential source areas. Inspection and evaluation of the construction of the subsurface portion of the Coke and Pitch Unloading Structure. Sampling of the groundwater collection sump if this structure is still present and accessible. **Bath Handling and Storage Features.** Characterization of surface and subsurface soil chemical concentrations at the newly identified bath storage and handling features. With the exception of the Bath Storage Building (that also represents the East SPL Storage Area, SWMU 12) environmental investigations have not been performed at these locations. Particularly for bath handling and storage features, development of a fluoride soil screening level under MTCA that is protective of groundwater for drinking water use represents a RI data evaluation need. **Cast House and Production Buildings Foundation Footprint**. Characterization of chemical concentrations in soils within the footprint of the Cast House and Production Buildings represents a data gap and data need for the RI. In particular, subsurface soils associated with low lying structures beneath building foundations where waste, effluent, or direct contact cooling water may have accumulated should be characterized (e.g., sumps, subsurface ducts, under-floor trenches, DC casting pits). Specific data gaps and data needs include the following: • **Casting Pits.** Further information regarding the casting pit(s) design and construction represents a data gap and data need to determine the potential for these subsurface structures to affect groundwater occurrence and flow. Characterization of shallow groundwater in the vicinity of the Casting Pits represents a data gap and data need. • **Courtyards.** Supplemental characterization of soils to better define the extent of contamination and for additional COPC represents a RI data gap and data need. Confirmation of current post-demolition chemical concentrations for surface and near surface soils also represent an RI data gap and need for the Courtyards. Determination of the extent of PAH contamination above MTCA Method C formula values represents a FS data need. • **Industrial Sump.** The Industrial sump is part of both the industrial wastewater and stormwater conveyance system. Stormwater is pumped from the stormwater pond to the Industrial Sump with gravity drainage from the sump to the Columbia River. Characterization of chemical concentrations in subsurface soil and shallow groundwater in the vicinity of the Industrial Sump represents an RI data gap and data need. Characterization of chemical concentrations in sump sludge/sediments, and estimation of sludge/sediment volumes in the Industrial Sump represent remediation data needs.	Characterization of the nature and extent of soil contamination. Evaluation of potential for releases from site features to subsurface soil and shallow groundwater. Evaluation of potential contaminant transport pathways. Characterization of potential hydrologic interaction between subsurface features and shallow groundwater.

Table 3-2
Areas of Concern – Data Needs and Investigation Objectives Summary
Remedial Investigation Work Plans
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Areas of Concern	Investigation Area(s)	Data Gaps and Data Needs Summary	Investigation Objectives
Plant Area (Continued)	Potential Sources in the Plant Area AOC that are not included as existing SWMUs and AOCs	• **Industrial Lines.** Verification that the lines and associated catch basins have been cleaned to maximum extent practicable now that site demolition activities (that previously limited access to the lines) have been completed. Further cleaning of the lines should be performed as appropriate. • **Discharge Line to NPDES Pond A.** Determination of current concentrations of COPC in the discharge line water represents a RI data gap and data need. Chemical characterization of soil/sediment at the discharge point near Pond A represents a data gap and data need to evaluate the potential for re-contamination of NPDES Pond A soil. • **Hydrologic Characterization of Electrostatic Precipitation Lines/Groundwater Collection Line**. Hydrologic evaluation of the groundwater collection system including estimation of the relative contribution of groundwater and electrostatic precipitation line water conveyed by the piping systems to NPDES Pond A. Evaluation of the effects of the electrostatic precipitation lines and groundwater collection system on shallow groundwater occurrence, flow, and groundwater contaminant concentrations represents a RI data gap and data need that will be addressed as part of the Groundwater in the Uppermost Aquifer AOC. • **Fuel Handling and Storage Areas.** Characterization of current COPC concentrations in surface and subsurface soils in UST and AST areas represents a RI data gap and data need. • **Shops, Maintenance, and Repair Areas.** Characterization of COPC concentrations in surface and subsurface soil represents a RI data gap and data need. Additional characterization of subsurface soil and shallow groundwater represents a data gap and data need for the Equipment Wash Station, Oil Change Pit, and Friction Weld Press Pit. • **Ancillary Features.** Data gaps and data needs include characterization of COPC concentrations in surface and subsurface soils. Characterization of groundwater occurrence, chemical concentrations, and flow in the Production Area represents an RI data need that will be addressed under the Groundwater in the Uppermost Aquifer AOC.	

Notes:
AOC Area of Concern

3.2.1.3 WPA Data Needs

The objective of the WPA field investigation is to address data gaps and investigation tasks required to adequately define the nature and extent of contamination for completion of the RI work effort and support the evaluation of cleanup alternatives as detailed in the June 26, 2019 RI comment letter (Ecology and Yakama Nation 2019). On June 26, 2019, Ecology and the Yakama Nation provided review comments for the January 24, 2019 Draft RI Report for the Columbia Gorge Aluminum Smelter Site and the Interim Action Work Plan for the ESI Fence Line Area (Ecology and Yakama Nation 2019). Ecology comments required preparation and submittal of a WPA to address the following data gaps:

- Additional information is needed in specific areas to understand potential interaction between impacted groundwater at the Site and the Columbia River,
- The extent of soils exceeding applicable screening levels is not fully defined, including in areas not zoned for industrial land use,
- The sources of on-going contaminant loading to the stormwater pond and recontamination of the former NPDES ponds are not fully understood,
- Systematic field reconnaissance is needed to confirm that all areas impacted by truck-hauled waste dumping have been identified,
- Soils exceeding screening levels for petroleum hydrocarbons for protection of groundwater were identified in a number of areas that do not appear to have representative/corresponding groundwater data for these pollutants,
- Given current land-use zoning on and adjacent to impacted areas of the Site, it appears that a site-specific terrestrial ecological evaluation (TEE) is required under (WAC) 173-340-7491(2)(a)(i). In addition, an evaluation of screening levels for the protection of human health is needed to ensure that treaty-protected tribal uses do not result in unacceptable risks. Additional characterization data may be necessary to support these elements, and
- Recommendations on additional data needed to support an evaluation of cleanup alternatives should be developed for each Solid Waste Management Unit and Area of Concern. These recommendations should be addressed in the WPA.

On August 6, 2019, Ecology met with Lockheed Martin and NSC representatives at the Site to discuss the Draft RI Report comments and relevant topics. Lockheed Martin and NSC provided formal response to Ecology and Yakama comments pertinent to the development of the WPA on August 28, 2019 (Lockheed Martin and NSC 2019). On September 30, 2019, a meeting with Ecology and Yakama was held at Ecology's Headquarters in Lacey, Washington to discuss comments and topics relevant to development of the WPA, including 1) zoning and land use, 2) truck haul waste dumping and site reconnaissance, 3) groundwater to surface water pathway, 4) groundwater characterization, 5) plant area and stormwater conveyance lines, and 6) extent of soil contamination.

Specific data needs addressing primary topics and existing data gaps in support of the WPA are summarized by SWMUs and AOCs in Table 3-3. In addition to SWMUs and AOCs, the data needs for other investigation areas, including the ditch near the West SPL Storage Area, the ESI Fence Line Area, and Eastern Area Site Reconnaissance are included in Table 3-3. Investigation work elements and associated Data Quality Objectives (DQOs) are summarized in the Final WPA, Revision 1 (Tetra Tech et al. 2020b). All data collected during each phase of the WPA investigation has been validated by a third-party data validator and data qualifiers were assigned as appropriate. All data have been deemed acceptable for use on the project based on the project DQOs; no data have been rejected. Figure 2-2 provides an overview of site features, including many of those referenced in this section.

The WPA included a decision-tree field investigation approach for the Plant Area AOC with a goal of making next-step decisions in the field during one mobilization. The decision tree (Figure 3-1) incorporates an iterative approach to define the horizontal and vertical extent of contamination in soil and shallow groundwater. The approach incorporated initial borings with subsequent sampling locations based upon data results from the previous round(s) of sampling, until the extent of soil contamination was determined. During the WPA field investigation, some of the SWMUs and additional investigation areas [i.e., the Intermittent Sludge Disposal Ponds (SWMU 3), NPDES Ponds A and B (SWMU 1), the ESI Fence Line Area, and the West SPL Storage Area Ditch] were also iteratively investigated during the Fall 2020 and Spring 2021 WPA field mobilizations to better define the extent of surface and near surface soil contamination.

Table 3-3
Work Plan Addendum Data Needs Summary by SWMU and AOC
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 3)

Work Plan Addendum Investigation Area(s)	Ecology and Yakama Nation Draft RI Comment Topics Relating to Work Plan Addendum	Project Team Identified Work Plan Addendum Data Needs
Solid Waste Management Units (SWMUs)		
SWMU 1 NPDES Ponds	– Extent of soil contamination. – Plant Area and Stormwater Conveyance Lines. – Zoning and Land Use. – Site-Specific and Site-Wide TEE.	• Determine extent of soil contamination in NPDES Ponds A, B, C, and D • Determine if SWMU 17 (East End Landfill) is a potential source of PAH soil contamination. • Chemical characterization of discharge at head of NPDES Pond A (see Plant Area AOC). • Confirm previous results of RI-bypass line investigation. • Site-wide and site-specific TEE with further assessment of TEE screening levels.
SWMU 3 Intermittent Sludge Disposal Ponds	– Zoning and Land Use. – Truck Haul Waste Dumping and Site Reconnaissance. – Extent of soil contamination. – Site-Specific and Site-Wide TEE.	• Evaluation of historical remedial action soil confirmation results to help determine potential of extent of soil contamination • Field reconnaissance to verify absence of additional aluminum smelter-related wastes and stained soils. • Confirmation soil characterization outside of excavation limits to determine extent of contamination • Site-wide and site-specific TEE with further assessment of TEE screening levels
SWMUs 10 and 11 North and South Pot Liner Soaking Stations	– Extent of Soil Contamination. – Soil screening levels for groundwater protection.	• Better characterize vertical and horizontal extent of contamination based on revised soil screening levels for groundwater protection • Verify absence of perched UA zone in this area.
SWMU 31 Smelter Sign Area	– Zoning and Land Use. – Truck Haul Waste Dumping and Site Reconnaissance. – Extent of soil contamination. – Site-Specific and Site-Wide TEE.	• Determine extent of surface soil contamination at both the Smelter Sign and NESI sub-areas. • Field reconnaissance and sampling along transects immediately east of the NESI area to verify no evidence of waste dumping (as consistent with previous site reconnaissance findings) and evaluate potential wind-related impacts. • Site-wide and site-specific TEE with further assessment of TEE screening levels.
SWMU 32 Stormwater Pond and Appurtenant Facilities	– Plant Area and Stormwater Conveyance Lines.	Refer to Plant Area AOC

Table 3-3
Work Plan Addendum Data Needs Summary by SWMU and AOC
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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Work Plan Addendum Investigation Area(s)	Ecology and Yakama Nation Draft RI Comment Topics Relating to Work Plan Addendum	Project Team Identified Work Plan Addendum Data Needs
Areas of Concern (AOCs)		
Groundwater in the Uppermost Aquifer (GWAOC)	– Groundwater to Surface Water Pathway. – Groundwater Characterization.	• Characterize spring water quality (including newly discovered spring in western area, NESI area wetland spring, Wetland D spring, Wetland K spring, and Wetland F spring). • Characterize shallow groundwater chemical concentrations at the Western Intermittent Drainage near the Boat Basin and between Wetland K and the Boat Basin. • Single round of sampling of Unconsolidated Aquifer (UA) and Basalt Aquifer Upper (BAU) zone wells in the Former Plant Area Footprint to assess current conditions and better document TPH distribution in groundwater. • Risk evaluation for fluoride and sulfate groundwater and surface water screening levels protective of ecological receptors. • Groundwater flux and hydrogeologic water balance assessment to evaluate the amount of discharge to the Columbia River. • Additional boring and shallow monitoring wells to address subsurface soil hotspot areas in PAAOC and assess potential shallow groundwater impacts for TPH and other chemicals of potential concern.
Wetlands	– Zoning and Land Use. – Groundwater to Surface Water Pathway. – Extent of Soil Contamination. – Site-Wide TEE.	• Further characterize extent of soil contamination in Wetlands D and K. • Confirm that MTCA unrestricted land use screening levels are protective of tribal treaty-protected land uses for Wetland K (off property areas zoned as open-space). • Estimation of recharge/discharge for Wetland K. • Characterize site-wide spring water quality (including newly discovered spring in western area, NESI area wetland spring, Wetland D spring, Wetland K spring, and Wetland F spring). • Characterize extent of water quality exceedances within Wetland K. • Determine the presence or absence of shallow perched groundwater at Wetland K and in the Western Intermittent Drainage near the Boat Basin. Characterize shallow groundwater chemical concentrations. • Site-wide and site-specific TEE with further assessment of TEE screening levels.
Plant Area (PAAOC)	– Groundwater to Surface Water Pathway. – Groundwater Characterization. – Soil Sources of Groundwater Contamination. – Extent of Soil Contamination. – Site-Wide TEE (applies to all soil investigation areas, PAAOC not excluded).	**Extent of Contamination** • Additional test pits, borings, and shallow monitoring wells to address subsurface soil hotspot areas in PAAOC and assess potential shallow groundwater impacts for TPH or other chemicals. • Assess potential impacts to soil and shallow groundwater in newly identified investigation areas. • Further characterize extent of fluoride, sulfate, PAHs, and TPH contamination in soil at select Courtyard Segment hotspot areas. • Site-wide and site-specific TEE with further assessment of TEE screening levels. • Single round of groundwater sampling of existing BAU and UA wells in Former Plant Area Footprint to assess current conditions and better document groundwater TPH concentrations. • Vertical Extent of Contaminated Soil at transformer substations and other operational features in Courtyard Segments. • Characterize vertical and horizontal extent of fluoride and sulfate in the Crucible Cleaning Room Area. • Determine the vertical and horizontal extent of carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and petroleum hydrocarbons in soil at the Soil Boring SB-VS01 location in Courtyard Segment A5. • Evaluate potential impact of contaminated sediment and groundwater in the Coke and Pitch Unloading Sump on shallow groundwater immediately downgradient from the sump.

Table 3-3
Work Plan Addendum Data Needs Summary by SWMU and AOC
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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Work Plan Addendum Investigation Area(s)	Ecology and Yakama Nation Draft RI Comment Topics Relating to Work Plan Addendum	Project Team Identified Work Plan Addendum Data Needs
Areas of Concern (AOCs) (Continued)		
Plant Area (PAAOC) (Continued)	− Plant Area and Stormwater Conveyance Lines.	• Determine vertical and horizontal extent of cPAHs and petroleum hydrocarbons in soil at the Former Above-ground Storage Tank (AST) Near the East SPL Storage Area and the potential impact on underlying shallow groundwater. • Determine the vertical extent of fluoride in soil at the Friction Weld Building and evaluate the potential impact on underlying shallow groundwater. • Determine the vertical and horizontal extent of fluoride and sulfate in soil at the Soil Boring SB-SE08 location in Courtyard Segment A4 and evaluate the potential impact on underlying shallow groundwater. • Determine the horizontal extent of sulfate in soil at the Soil Boring SB-SE18 location in Courtyard Segment C5 and evaluate potential impact on underlying shallow groundwater. • Characterize groundwater occurrence and chemical concentrations in the vicinity of the Soil Boring SE-SB17 investigation area through installation and sampling of new UA zone and BAU zone wells. **Stormwater and Other Lines Evaluation** • Determination of source of discharge to NPDES Pond A. • Sampling of discharge pipe at head of NPDES Pond A. • Further characterization of the interconnection of stormwater/groundwater/process water lines under the Plant Area. • Characterize sediment quality in the Industrial Sump that is part of the NPDES-permitted system. • Characterization of contaminant loading from various line types and line segments. Determine relative contribution of contaminated groundwater inflow versus site runoff.
Additional Areas of Investigation		
Ditch near West SPL Storage Area	− Extent of soil contamination. − Site-Wide TEE.	• Determine extent of soil contamination in associated with ditch. • Site-wide and site-specific TEE with further assessment of TEE screening levels.
East Surface Impoundment (ESI) Fence Line Area	− Zoning and Land Use. − Truck Haul Waste Dumping and Site Reconnaissance. − Waste-listing determination for existing soil stockpile removal. − Site-Wide TEE.	• Additional site reconnaissance and characterization to verify the lateral and vertical extent of contamination in ESI Fence Line Area. • Ecology concurrence for disposal of existing soil/waste stockpile. • Site-wide and site-specific TEE with further assessment of TEE screening levels.
Eastern Area Site Reconnaissance	− Zoning and Land Use. − Truck Haul Waste Dumping and Site Reconnaissance. − Site-Wide TEE.	• Site reconnaissance including inspection and documentation using grid in eastern portion of the Site to verify absence of aluminum smelter-related waste and stained soils. • Verification sampling of surface and subsurface conditions at select locations based on site reconnaissance observations. • Site-wide and site-specific TEE with further assessment of TEE screening levels.

Notes:
AOC = Area of Concern
BMEC = Blue Mountain Environmental Consulting
ESI = East Surface Impoundment
GWAOC = Groundwater Area of Concern
MTCA = Model Toxics Control Act
NESI = North of the East Surface Impoundment
NPDES = National Pollutant Discharge Elimination System
NSC = NSC Smelter LLC
PAAOC = Plant Area – Area of Concern
PAH = Polynuclear Aromatic Hydrocarbon
RI = Remedial Investigation
SPL = Spent Pot Liner
SWMU = Solid Waste Management Unit
TEE = Terrestrial Ecological Evaluation
TPH = Total Petroleum Hydrocarbons

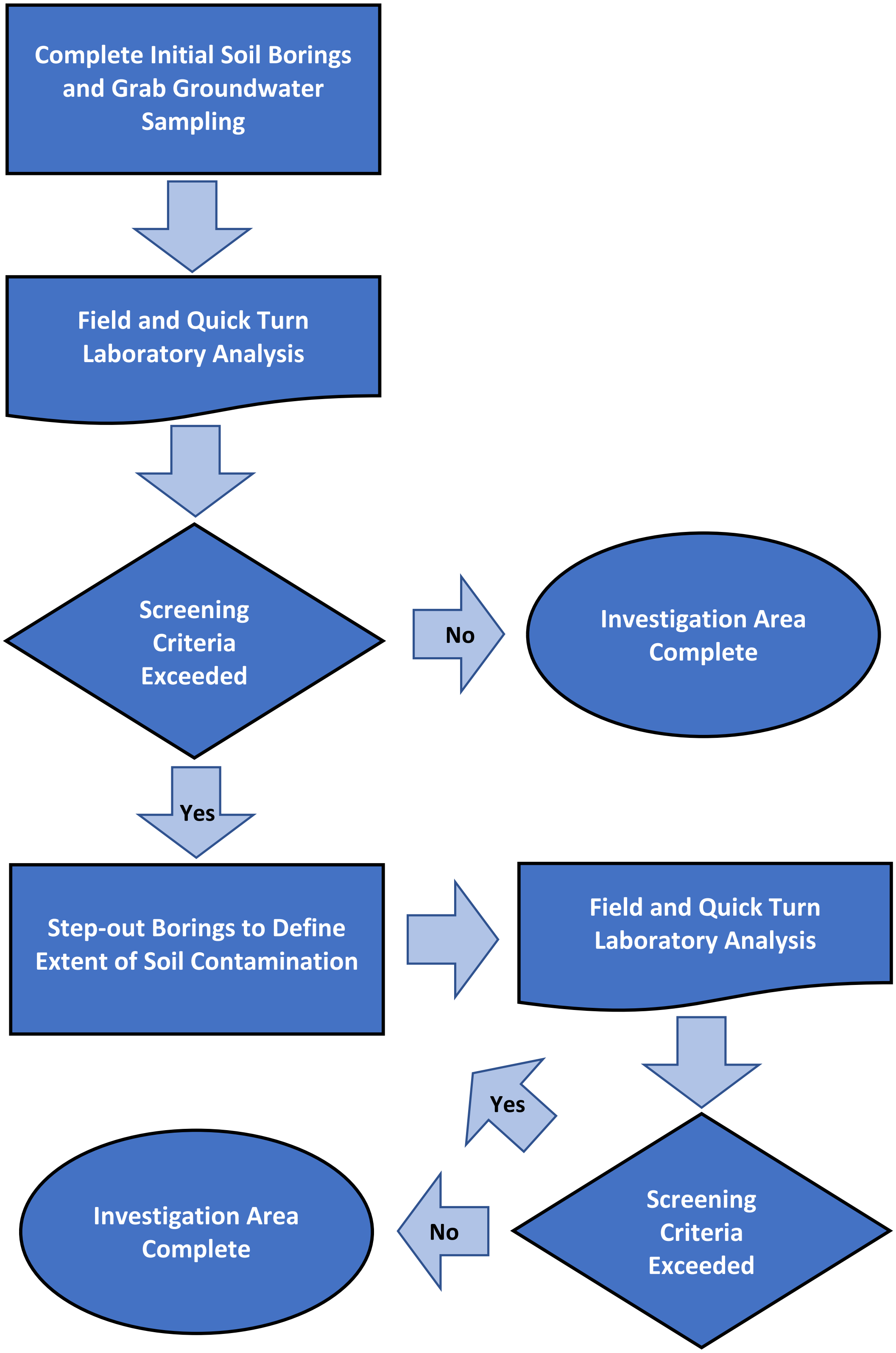


Figure 3-1
Decision Tree for Identifying Soil Sources of Contamination to Groundwater in Investigation Areas
Columbia Gorge Aluminum Smelter Site,
Goldendale, Washington
TETRA TECH, INC.

Section 4
Site Conceptual Model

This section summarizes the site conceptual model for the Columbia Gorge Aluminum Smelter site. A general description of the site is provided in Section 2.0, and a brief summary and description of the SWMUs and AOCs is included Section 3.0. A detailed description of the operational history and past environmental data collected at the facility is summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a).

This section incorporates, and updates information previously summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a), as well as new information from completion of the RI work effort. The RI results for individual SWMUs and AOCs is provided in Volumes 2 and 3, respectively. Additional detailed information regarding the hydrogeologic site conceptual model is provided in Section 2.2.4 and in Volume 4, Section 2 of this report.

4.1 POTENTIAL SOURCES AND RELEASE MECHANISMS

Potential contaminant sources are related to the former operation of the primary aluminum smelter from its completion of construction in the early 1970s until 2003 when aluminum smelter operations were permanently suspended. A summary of the aluminum plant processes and primary sources, as well as associated contaminants and release mechanisms is provided below.

4.1.1 Site Industrial Processes and Primary Sources

At the former aluminum reduction facility, aluminum was produced by the reduction of aluminum oxide, in vertical stud Soderberg cells using a Hall-Heroult reduction process. The aluminum oxide (alumina) was received by railcar and stored on-site in large silos. From these silos, it was transferred via conveyor belts through dry fluoride scrubbers. The aluminum oxide absorbs fluoride during this process and is then considered to be enriched aluminum ore and stored in enriched ore silos (PGG 2014a).

The enriched ore was then transported to the reduction cells in specially designed wheeled vehicles. Petroleum coke and coal tar pitch were processed in the carbon plant and used as a carbon source for anodes in the reduction cells. The enriched aluminum ore was dissolved in molten cryolite (sodium hexafluoroaluminate) in a flux process such that during the reduction process, carbon from the anodes bound to and removed oxygen, producing carbon dioxide and (essentially) pure aluminum. The molten aluminum collected in the bottom of the reduction cells was siphoned from the cells, to be shipped off-site in hot crucibles or transported to the on-site cast house where it was de-gassed, alloyed, and cast into various forms. The castings produced at the site were sent to other locations for forging, rolling, or extrusion.

During aluminum casting, the molten aluminum was fluxed to remove dissolved gasses and particulate matter. Gases generated during reduction and flux processes were collected using skirts over the process chambers. These gases contained particulates, carbon dioxide, sulfur dioxide, hydrogen fluoride, and organics such as polycyclic aromatic hydrocarbons (PAHs) and some metals. These waste gases were cleaned using various treatment systems over the years, each subsequent system improving on the other. Initially, wastewater from the gas cleaning systems was treated via sequential settling in Ponds A, B, C, and D, and then discharged under permit to the Columbia River (refer to Figure 2-2).

Solids that built up in the ponds was periodically dredged and disposed of in an unlined natural depression east of the aluminum production area. This depression later became a wastewater evaporation pond and was named the East Surface Impoundment. During this same period in the 1970s, some of the solids/sludges from the NPDES ponds were periodically pumped to a series of shallow depressions to the east that became known as the East Surface Deposits Area. In 1978, these treatment processes were replaced by a dry scrubber and baghouse to remove particulates and fluoride gas, with a secondary wet scrubber process to remove sulfur dioxide. Water from this process was also discharged to the East Surface Impoundment. By 1985, the wastewater was all diverted into a West Surface Impoundment (PGG 2014a) (refer to Figure 2-2).

Secondary gases (those escaping into work areas) were collected via the building ventilation system and cleaned via water scrubbing. Initially, the wastewater from this secondary scrubbing system was sequentially discharged through Ponds A, B, C, and D. In 1983, this secondary gas treatment system was replaced by a recirculating clarifier, with a tertiary treatment system to remove fluoride. Solids resulting from the clarifier and tertiary treatment system processes were disposed in the West Surface Impoundment (refer to Figure 2-2).

Smelter process wastes were placed in containers at their point of generation and shipped off-site immediately, or the containers were collected in a central storage area and then shipped off-site within 90 days. The only on-site stored waste materials were the brick and carbon portions of SPLs, which are the bottoms of the reduction cells. From 1971 until 1988, the brick and carbon wastes were stored on concrete slabs. In 1988, these storage areas were enclosed. By 1995, all of the SPL wastes were shipped to an approved waste facility and all newly generated wastes were shipped to the same facility (PGG 2014a). Non-hazardous construction/demolition debris, facility trash, wood waste, alumina, carbon waste, and vegetation material were disposed in landfill areas located adjacent to the west and east ends of smelter plant. These landfills were operated and closed in the 1980's and have been covered by earthen materials. The aluminum smelter operations were permanently suspended in 2003.

The landfill historically operated at the site include the East End Landfill (SWMU 17) and the West End Landfill (SWMU 18). The EELF operated from 1971 to 1982 and the West End Landfill operated from 1982 to 1987. Both were informally closed with a soil cover. The West SPL Storage Area (SWMU 13) was closed with a constructed cap during 1989 under WAC 173-304 solid waste requirements (CH2MHill 1988a,b). Ongoing groundwater monitoring was conducted at that site related to the closure of the unit from 1990 to 2008. The responsible party for the West SPL Storage Area filed for bankruptcy during 2010.

4.1.2 Site Contaminants and Release Mechanisms

As described later in Section 5.2, COPCs at the site include the typical suite of chemicals associated with aluminum reduction facilities. These include cyanide, fluoride, sulfate, and PAHs. In addition to the aluminum smelting process, various equipment and building maintenance activities were conducted. These required petroleum products including oil and grease, and solvents. Polychlorinated biphenyls (PCBs) were also historically used in oils in some of the capacitors and transformers at the site.

Cyanide, fluoride, and sulfate are related to operation and use of the pot liners at the site. Fluoride is present in the cryolite bath material. PAHs and sulfur were present in the coke and pitch used in the manufacturing of briquettes used to line the pots. Cyanide is produced in trace amounts within the pots during smelting operations. The historic use of PCBs is limited to specific areas within the former reduction facility footprint. PAH particulates from the aluminum processing cells became entrained in gaseous emissions and removed by the scrubber air pollution control system (in particular the wet air scrubber system), which then generated a PAH-containing wastewater stream and sludge. The particulates also contained fluoride and sulfur.

The potential mechanisms for contaminant releases at the site were primarily associated with ore handling and the smelting process(es), including spills and leaks, storm and wastewater collection and discharge, and waste disposal. Discharges to the air and to the Columbia River have been conducted under permits from the appropriate state and federal agencies. From 2003 to the present, various demolition and material removal processes have been completed.

Based on the findings of the RI, underground utility lines including the groundwater collection lines, stormwater lines, scrubber effluent lines, and the industrial and monitoring lines have affected migration of contaminants in the subsurface within the plant area footprint. The groundwater collection lines were designed to collect groundwater from the upslope (north side) of the plant area footprint and convey it to the stormwater pond. The stormwater pond is unlined and recharges the basalt aquifer system. The scrubber effluent lines originally contained waste materials, and line surveys show various breaks in the lines. In the north-central portion of the plant footprint, the industrial and monitoring lines connect to the large clarifier east of the Tertiary Treatment Plant (SWMU 8) and extend through Passage Number 3 and line video surveys showed various breaks in the line. Shallow groundwater enters the line system during seasonally high water-levels and discharges to the head of NPDES Pond A through the scrubber effluent line.

4.1.3 Potential Non-Site Related Sources

In addition to potential upgradient sources to the Columbia River, which could contribute to sediment contamination, other potential non-site related sources of contamination have been identified with respect to the Columbia River Sediments AOC.

A review of historical aerial photographs from the 1960’s to early 1970’s show significant disturbance and stockpiled construction materials in the vicinity of the Boat Basin. The Boat Basin represents a man-made feature that was constructed during the final phase of dam construction. Other potential sources of contamination were identified in PA/SI of the John Day Dam (USACE 1994) including a burn pile on Railroad Island and service roads that were reportedly sprayed with oils.

Other ongoing uses of the Boat Basin include vehicle access and parking, vessel launch and storage, and railroad operations. The Burlington Northern railroad extends along the northern (Washington) side of the Boat Basin and Columbia River. The associated railroad track is constructed using creosote-treated railroad ties that represent a commonly known source of PAH contamination. For example, a PAH Chemical Action Plan, prepared by Washington State Departments of Ecology and Health cite railroad ties as a major source for PAH contamination, and recommends mapping railroad tracks to see if they are close to sensitive environments, such as nearshore areas (Ecology 2012b). These historical and ongoing operations could have potentially contributed to sediment contamination in the Boat Basin and adjacent Columbia River.

4.2 EXPOSURE MEDIA AND MIGRATION PATHWAYS

This section summarizes the exposure media and migration pathways at the site based on the RI findings to provide context for the RI-decision-making. Potentially impacted environmental media resulting from past plant operations subsequent demolition activities as well as spills and incidental releases include the following:

- Surface and subsurface soil within and surrounding the site and within downgradient swales which may have received stormwater, aeolian deposition, or direct disposal of wastes from the site.
- Storm and wastewater in collection ponds and wet areas that have may have received runoff, as well as permitted and un-permitted discharges.
- Surface water, including seeps, springs, wetlands, and the Columbia River that may have potentially received stormwater, aeolian deposition or groundwater discharges.
- Groundwater that may have been impacted through leaching of contaminated soils and wastes, underground line leakage, burial of smelter wastes, and spills.
- Sediment in water collection systems and ponds, wet areas, wetlands and the Columbia River that may have potentially received runoff, permitted discharges, groundwater discharges, and aeolian deposition from the site.

The above represents the potential exposure media for both human and ecological receptors of potential concern. Vegetation adjacent or downwind from the site may also represent a secondary exposure potential. A summary of COPC is included in Section 5.2, with an associated summary of potential screening levels for soils, surface water, groundwater, and freshwater sediments provided in Section 5.3.

The primary contaminant transport mechanisms associated with the subject site include the following:

- **Infiltration and Leaching**. Infiltration of rainwater and stormwater runoff, as well as from ponded and wetland areas resulting in potential leaching of chemicals to subsurface soils and shallow groundwater.
- **Volatilization**. Volatile organic compounds (VOCs) are not an issue at the site. Although volatilization can be a mechanism for migration of free cyanide, it is not expected to be a major transport pathway at this site based on site data, which shows cyanide primarily occurring in a metal cyanide form when present.
- **Surface Water/Stormwater Runoff**. There are three natural drainages that lead from the southern margin of the former smelter. The easternmost drainage contains the NPDES ponds, and two drainages farther west drain into the Boat Basin. The two westernmost drainages correspond with wetland areas of the facility and contain springs. Surface water flow and runoff in all three drainages is intermittent and surface water runoff/discharge does not appear to represent a significant transport pathway to the Columbia River based on field observations during the RI and WPA. Refer to Volume 2, Section 1 for a summary of the NPDES Ponds Drainage, Volume 4, Section 2.0, for a summary of the water balance in the drainages, and Volume 4, Section 3, for a summary of the spring discharges at the site.
- **Stormwater and Wastewater Discharge**. Direct discharge of stormwater and/or historical wastewater (direct discharge to the Columbia River have been conducted under permits from the appropriate state and federal agencies) Permitted discharges represent a potential past, current, and future pathway of contaminant migration to surface water.
- **Groundwater Flow**. Transport of dissolved constituents through vertical and horizontal groundwater flow. Details regarding groundwater occurrence, including flow and chemical characteristics are summarized in the Groundwater in the Uppermost Aquifer AOC discussion in Volume 4, Section 2.0. Based on the findings of the RI, the amount of groundwater discharge to Columbia River surface water and sediment appears limited. Refer to Volume 4, Section 2.0 for a summary of lines of evidence including groundwater and surface water hydrograph analysis (lag and dampening analysis), and water balance analysis of flow paths between the site and the Columbia River.
- **Underground Line and Groundwater Interactions**. In the former plant area, shallow groundwater enters the groundwater and stormwater collection system and comingles at manhole MH4L5, which eventually drains to the stormwater pond [refer to the Volume 3 of this report as well as the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) for a more detailed description]. Shallow groundwater also enters into the industrial and monitoring lines and scrubber effluent lines during high water period in areas where these lines have been damaged. The southern, east-west trending, scrubber effluent line currently discharges shallow groundwater to the head of the NPDES Ponds drainage. Runoff in the former NPDES drainage (former settling pond) drainage may currently recharge the basalt aquifer zone during periods of high precipitation in the fall and winter.

Permitted stormwater discharge to the NPDES ponds may also have historically recharged the basalt aquifer system (specifically the BAU and BAL Zones, the UA zone is not present in this area.) Note that a soil removal action was implemented, and a stormwater bypass system was constructed during 2010 to help address runoff in the NPDES drainage. Refer to the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) for further details.

At the stormwater pond, it appears that the pond locally recharges the BAU zone as well as a nearby spring at Wetland K (Spring 01). This spring is recharged by the BAU zone. Refer to Volumes 2, 3 and 4 for the RI findings regarding stormwater and groundwater interactions. Volume 4, Section 3, Wetlands AOC, summarizes the results for the springs at the site and summarizes the aquifer zones that recharge specific springs.

- **Columbia River Sediment Suspension and Deposition**. Sediment suspension and deposition through river flow and recirculation.
- **Aeolian Transport.** Wind-driven soil particle movement (re-suspension and deposition).
- **Direct and Indirect Atmospheric Inputs**. Includes potential fugitive emissions from historical plant operations.
- **Wildfire Transport.** This mechanism was identified by the Yakama Nation for inclusion because the general area is prone to wildfires. Wildfires can potentially generate contaminants from the burning of facility-related source materials (as well as other non-facility-related materials), and cause aeolian transport, as well as indirectly contribute to increased erosion and runoff in the area of the fire. This mechanism represents a potential consideration for remedy implementation.

4.3 CHEMICALS OF POTENTIAL CONCERN

COPCs for the site include the typical suite of chemicals associated with aluminum reduction facilities. These include cyanide, fluoride, sulfate, and PAHs. In addition, PCBs, some metals (e.g., arsenic, cadmium, nickel, and lead), VOCs related to fuels and solvents, and total petroleum hydrocarbons (TPH) represent COPC for some areas and media at the site.

Cyanide, fluoride, and sulfate are related to smelter operations and used pot liners at the site. Fluoride is present in the cryolite bath material, in spent pot liners, and air pollution control byproducts. PAHs and sulfate are present in the coke and pitch for the manufacture of briquettes used to line the pots. Cyanide is produced in trace amounts within the SPLs during the aluminum reduction process. PCBs were historically used in oils in the capacitors and transformers at the site.

PAH particulates from the aluminum processing cells became entrained in gaseous emissions and removed by the scrubber air pollution control system (in particular the wet air scrubber system), which then generated a PAH-containing wastewater stream and sludges.

4.4 CHEMICAL FATE AND TRANSPORT

This section briefly summarizes fate and transport properties for some of the main chemicals of potential concern at the site.

4.4.1 Fluoride

In general, fluoride is more soluble in alkaline soils than in acidic soils (with lower Kd values for alkaline soils). Site soils appear to be neutral to slightly alkaline and the groundwater pH at the site typically ranges between about 6.5 to 8.0 pH units. Fluoride-containing wastes present at the site include cryolite as the dominant form, which was used in the electrolytic refining process, and SPL (K088 waste). Cryolite (Na_3AlF_6) is slightly soluble in water, with literature values indicating a solubility of 420 mg/L (228 mg/L fluoride). The principal minerals present in the SPL include cryolite, fluorite (CaF_2), and sodium fluoride (NaF). Fluorite has very low solubility, while sodium fluoride is extremely soluble in water. The fluoride ion will sorb or participate in exchange reactions on clays, alumina, and iron oxides. Based on geologic logging and chemistry data collected during the RI, colluvial soils at the site are frequently clay-rich and iron-rich given their derivation from the Columbia River Basalts. Derivation of soil screening levels for protection of groundwater for fluoride include a discussion of the literature ranges of partitioning coefficients (Kd) and are summarize in Section 5.2 of this Volume as well as in Volume 5, Appendix A-5.

4.4.2 Sulfate

Sulfates commonly occur naturally as the mineral gypsum, epsomite, and barite. High concentrations of naturally occurring sulfates have been reported for groundwater within the Columbia River Basalt Group, although elevated sulfate concentrations were not detected in the RI background well data set. Sulfate ion is the second most abundant ion in seawater and freshwater.

Sulfate and sulfuric acid products are used in the production of fertilizers, chemicals, dyes, glass, paper, soaps, textiles, fungicides, and insecticides. They are also used in mining, wood pulp, metal and plating industries and industrial operations of smelters, pulp and paper mills, textile mills, and tanneries. Sodium, potassium and magnesium sulfates are all highly soluble in water, while calcium and barium sulfates, and many heavy metal sulfates are less soluble. Atmospheric sulfur dioxide formed by combustion of fossil fuels and various metallurgical processes may contribute to the sulfate content of surface waters as well as acid rain (World Health Organization 2004, Encyclopedia of Toxicology 2014).

Sulfate is part of the biologically mediated sulfur cycle in which the sulfate ion is biologically reduced to sulfide through a multi-step process. This bacterially-driven cycle is important to the biodegradation of petroleum hydrocarbons under anaerobic conditions, where sulfate acts as the terminal electron acceptor for the microbial metabolism of petroleum hydrocarbons (Encyclopedia of Ecology 2008).

4.4.3 Cyanide

Cyanide concentrations at the site are generally low in wastes, soil, and groundwater at the site and the collected RI data suggests that the cyanides occur primarily in a metal-complexed form.

Cyanide occurs as a groundwater contaminant at various industrial sites including aluminum production plant manufactured-gas plants, electroplating facilities and ore-heap-leaching facilities. Cyanide can exist in aqueous solution as free cyanide (HCN or CN^-), or in metal cyanide complexes with metals such as cadmium, cobalt, copper, iron, nickel, and others (Gosh et al. 1999a,b; Meussen et al. 1999). The toxicity of cyanide is primarily associated with free cyanide. In its free form, cyanide is both volatile (as the HCN form) and biodegradable.

Metal-cyanide complexes, especially strong complexes with cobalt and iron, are much less toxic than free cyanide and weak-acid-dissociable (WAD) complexes formed with metals such as copper, zinc, and nickel. Metal cyanide complexes typically dominate aqueous speciation of cyanide in groundwater systems with iron cyanide complexes often most abundant. Cyanide tends to be relatively mobile and persistent in groundwater systems. Metal cyanide complexes are stable in conditions of no light and at neutral to high pH. Metal cyanide complexes may break down to free cyanide or WAD cyanide complexes with metals like copper, zinc and nickel under conditions of low pH or in the presence of UV light that can photolyze strong metal cyanide bonds. Under conditions of neutral pH, iron-cyanide complexes show little adsorption onto iron oxides but may have greater absorption on aluminum oxides or Kaolin clay.

4.4.4 Metals

Various metals (As, Al, Cd, Cr, Cu, Ni, Pb, Se, and Zn) have been detected in smelter wastes, soils, and or groundwater above natural background concentrations and screening levels in at least a few locations.

The most important factors controlling metal fate and transport are solubility, redox behavior, aqueous speciation, and sorption behavior, all of which are functions of the ambient geochemical environment. For metals, volatilization and photolysis are of limited importance. Biotransformation processes can be important for some metals (e.g., Cu, As, and Pb) under certain environmental conditions. All metals are, to variable extents, subject to cation-exchange reactions with minerals present in the environment. This does not include anionic metal species, such as oxyanions of metals in certain oxidations states. The extent to which cation-exchange occurs is dependent on the mineral species present and on pH, as well as on the characteristics of the individual metals.

The mobility of metals within environmental matrices depends upon numerous factors such as the relative stabilities of individual valence states (which are element-specific), oxygen content, pH and Eh conditions, and the presence of available complexing agent.

In general, metals have a high adsorptive affinity for inorganic mineral surfaces and organic matter. Adsorption, for most metals, is highly pH-dependent, with desorption generally more favored at low pH and sorption mechanisms dominating at higher pH conditions for cationic metals. However, the types of clays and their surface charges in relation to soil pH values, dictate whether sorption or desorption will occur. Additionally, chemical speciation determines the relative degree of adsorption among different species of a particular metal. Based on the data available for site soils, sorption is most probably a significant fate process for metals. The aerobic conditions in the surface water and shallow groundwater are likely to promote the precipitation of ferromanganese oxides and oxyhydroxides (probably nucleating on sand and soil grains) to which other metals will readily adsorb. A brief discussion of the important controls on fate and transport of the metals of potential concern at the site follows in the subsequent paragraphs.

4.4.4.1 Arsenic

Arsenic occurs predominantly in the As(+3) and As(+5) valence states and, although certain conditions may promote the formation of arsenious (H_3As0_3) or arsenic (H_3As0_4) acid, the oxidation state of arsenic is the factor that seems to control arsenic solubilization. The inorganic state is dominant even though arsenic is involved in biological cycling that can form soluble organic complexes. Studies have shown that arsenic is both methylated and demethylated during biological cycling, and that the processes seem to more or less cancel each other out.

The redox chemistry of arsenic is highly analogous to that of iron and manganese, and arsenic tends to be closely associated with these two elements in aqueous systems. Under aerobic conditions, As(+5) is the predominant species. Pentavalent arsenic is highly insoluble and tends to be strongly adsorbed on ferromanganese precipitates, i.e., As(+5) follows the oxidized species of iron (Fe(+3)) and manganese (Mn(+4)). Thus, in oxidated water, arsenic is primarily associated with particulate phases. Under reducing conditions arsenic is reduced to As(+3), which is soluble in anoxic waters. It should be noted that arsenic may also form complexes with anthropogenically introduced organic compounds that may affect the geochemical behavior of arsenic. The anionic arsenate and arsenite ions, when present, may behave in a manner similar to the phosphate anion in aqueous systems.

Arsenic is adsorbed principally onto clays, aluminum hydroxides, ferromanganese oxides, and organic compounds. In general, pentavalent arsenic has a greater adsorptive affinity than trivalent arsenic. For arsenic, adsorption is most important in aerobic, acidic fresh water with adsorption decreasing above pH 9 for As(+3) and above pH 7 for As(+5). Arsenic is not appreciably bioaccumulated in aquatic organisms.

At the site, soil and groundwater background concentrations exceed screening levels. In groundwater, concentrations of total and field-filtered (dissolved) arsenic are similarly elevated, which suggests that arsenic is most likely dissolved in the groundwater.

4.4.4.2 Aluminum

The chemistry of aluminum in surface water is complex because of the following properties: 1) it is more soluble in acidic solutions and in basic solutions than in neutral solutions, 2) specific ions such as chloride, fluoride, nitrate, phosphate and sulfate form soluble complexes with aluminum, 3) it can form strong complexes with fulvic and humic acids, 3) hydroxide ions can bond with aluminum ions to form soluble and insoluble compounds (EPA 2018). Factors such as pH, temperature and the presence of complexing ions influence the fate and transport of aluminum. At neutral pH, aluminum is nearly insoluble, but its solubility increases exponentially as it reaches either acidic (pH<6) or basic (pH>8) conditions. The neutral groundwater pH at the site suggests that aluminum is in an insoluble form. This is generally supported by the groundwater data that shows significantly lower concentrations in the total fraction than the dissolved (field-filtered) fraction. The presence of elevated concentrations of fluoride and sulfate in subsurface suggests the potential for formation of various complexes.

4.4.4.3 Cadmium

Cadmium can exist in soluble organic complexes or as an ionic species in water. Cadmium ions in solution are always present in the +2 valence state in aqueous environmental matrices. Cadmium may also be associated with the particulate phase. Cadmium is principally adsorbed by clays, organics, carbonates, and aluminum and iron oxides, with adsorption generally increasing as the pH increases (Appelo and Postma 2005). Cadmium is not appreciably bioaccumulated in aquatic organisms.

4.4.4.4 Chromium

Chromium is an essential micronutrient that, at elevated levels, can have toxic effects. In aqueous systems chromium can theoretically occur in two oxidation states: Cr(+3) and Cr(+6). In many ways, the hydrogeochemical behavior of chromium is the opposite of iron, manganese, arsenic and antimony. The oxidized state of chromium, Cr(+6), is relatively soluble, forming complex anions in aqueous solution. The most important of these are chromate (CrO_4^{-2}) and hydrochromate ($HCrO_4^{-}$). However, Cr(+6) species are not stable aqueous complexes under virtually all naturally occurring redox conditions. Hexavalent chromium is stable at Eh approaching and above the limit of atmospheric oxidation. In virtually all-natural waters trivalent chromium is the stable and predominant aqueous form of chromium. In its trivalent form, chromium rapidly precipitates as insoluble oxides or hydroxides or adsorbs onto clays or oxides of other metals. Chromium is not appreciably bioconcentrated in aquatic organisms.

4.4.4.5 Copper

Copper is an essential nutrient that, at elevated levels, can have toxic effects. Copper(+2) is the most prevalent form of copper in aqueous systems as most of the stable cuprous (+1) forms in waters are highly insoluble. Copper may also exist in water as the hydrated divalent cupric ion. However, in general, most copper in aqueous solution is in a complex form with organic or inorganic ligands and these are expected to be the predominant dissolved aqueous species of copper. Copper is sorbed by clays, mineral surfaces, organics, carbonate, and iron and manganese oxide precipitates. In general, copper complexed with naturally occurring organic acids are more easily adsorbed by clays and free mineral surfaces than the hydrated cations. Copper adsorption is highly pH dependent, and the presence of other anionic species can increase copper adsorption. Copper is not appreciably bioconcentrated in aquatic organisms, since its toxicity to aquatic vegetation and fish limits the extent to which bioaccumulation can occur.

4.4.4.6 Lead

Lead(+2) is the most common stable ionic aqueous species with hydroxyl, carbonate, sulfide and sulfate anions acting as solubility controls. Under aerobic conditions, $PbSO_4$ and to a lesser extent $PbCO_3$, control lead solubility, whereas, under anaerobic conditions, PbS concentrations mediate aqueous lead solubility. Lead may also exist in soluble organic complexes (i.e., humic and fulvic acids) in aqueous matrices. Lead adsorbs principally to clays, hydrous iron and manganese oxides, mineral surfaces, and organic compounds. Lead adsorption is very pH-dependent, with low pH conditions favoring desorption. Lead is not appreciably bioaccumulated in aquatic organisms.

4.4.4.7 Nickel

Nickel almost always occurs as Ni(+2) in aquatic environments. Although in general, groundwater Eh-pH conditions seem to favor the presence of dissolved nickel, in aqueous matrices nickel may be primarily associated with the particulate phases because of its strong adsorptive affinity. Nickel sorbs to hydrous iron, manganese oxides, clay minerals, and organic material. Nickel is not appreciably bioaccumulated in aquatic organisms.

4.4.4.8 Selenium

Selenium is an essential nutrient, but can be toxic when only slightly above necessary levels. The geochemical behavior of selenium is similar to that of sulfur, and selenium occurs in both cationic (mostly +4) and anionic (-2) states. More rarely, selenium can occur in the native (0) state. However, this occurs only under anoxic conditions which may be present in deep soil strata, deep groundwater and/or marshland soil/sediment exhibiting high biologic oxygen demand (BOD) and chemical oxygen demand (COD) values. Selenium is not appreciably bioaccumulated in aquatic organisms and can cause deformities in vertebrates (SSSA 1989).

4.4.4.9 Zinc

In most natural waters, zinc occurs as the hydrated divalent (+2) cation. In organically polluted waters, complexing with organic compounds may be an important process. The solubility of zinc is strongly dependent on pH, with low pH favoring increased solubility. Soils and groundwater pH at the site are generally neutral to slightly alkaline. Zinc has a strong affinity for adsorption to hydrous metal oxides, clays and organic matter. Adsorption of zinc is strongly favored at higher (>7) pH values and it is not appreciably bioaccumulated in aquatic organisms.

4.4.5 Diesel-Range and Residual-Range Petroleum Hydrocarbons

Diesel-range and residual-range petroleum hydrocarbons have been detected above screening levels in both soil and groundwater at the site. Gasoline-range petroleum hydrocarbons have been detected at the site, but primarily at low concentrations below screening levels.

The main investigation area with elevated concentrations of petroleum hydrocarbon is at the Compressor Building UST site (part of the Plant Area AOC). At this site, diesel-range petroleum hydrocarbons are the main fuel-related contaminant found in soil and groundwater. Petroleum product has not been found, but there is a smear zone present at the top of the water table at this location.

Diesel-range petroleum hydrocarbons are soluble and mobile in soil and groundwater. Petroleum hydrocarbon transport can be complicated by the potential presence of a product phase on top of the water table as well as potential for vapor migration. However, at this site, there is no free petroleum product present of the water table and volatile organic compounds such as benzene, toluene, ethyl benzene and xylenes, have been detected only at very low concentrations below screening levels in soil and groundwater, which suggests a low potential for vapor transport and migration. A smear zone (potential residual saturation zone) is present at the Former Compressor Building.

As a class, petroleum hydrocarbons are biodegradable with the lighter and more soluble blends biodegraded more rapidly and to lower residual levels than the heavier less soluble members. Heavier petroleum hydrocarbon blends (residual range petroleum hydrocarbons have only limited solubility in water, adsorb strongly to soil, and biodegrade at rates much slower than lighter-end petroleum hydrocarbons (Kerr Environmental Research Laboratory 2004).

4.4.6 Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are among the most widespread chemicals of concern at the site and are present at elevated concentrations in soils and wastes at the site. PAHs are persistent and generally immobile in soil matrices under normal environmental conditions. This is primarily due to their low aqueous solubility and resistance to photolytic, oxidative and hydrolytic degradation, and their high affinity for adsorption to organic matter and soil particles. However, in the presence of highly mobile organic compounds (i.e., VOCs, phenolic compounds, ethers and/or nitrobenzene) which can act as co-solvents, the mobility of PAHs in soils and/or aqueous matrices can be greatly enhanced which would facilitate the transport of PAHs to groundwater. These highly mobile organic compounds acting as co-solvents can also greatly enhance the transport of PAHs within groundwater and/or surface water. However, other highly mobile organic compounds such as VOCs do not represent COPCs at this site.

PAHs can be degraded by microbial populations; however, this is generally a slow process in the environment. Among PAHs, naphthalene is relatively mobile in the environment due to its lower adsorptive affinity and higher aqueous solubility in comparison to most PAHs. The carcinogenic PAHs tend to be high molecular weight compounds that are less mobile in the environment and more likely to bind to soil particles. Some of the PAHs may exhibit substantial bioaccumulation (i.e., phenanthrene); however, this is usually a transitory effect (i.e., depuration typically occurs within several weeks or months) since most organisms have the ability to metabolize these compounds.

4.5 ECOLOGICAL AND HUMAN RECEPTORS

Potential exposure to chemicals (i.e., toxicity) and/or physical stresses (e.g., destruction of habitat and disturbance) represent the primary effects to potential ecological and human receptors at the site. A discussion regarding potential ecological and human receptors, including preliminary conceptual exposure models is provided in the following sections.

4.5.1 Ecological Receptors and Terrestrial Ecological Evaluation

Ecological receptors likely to be exposed at a site are dependent on the available habitat and level of physical disturbance present. Of the 7,000 acres associated with the subject property, 350 acres had been developed with buildings, structures, roads, or waste retention areas related to aluminum production at the site. Many of the former structures were demolished between 2010 and 2013. Most of the 350 acres have been significantly physically altered, and for the most part, no longer provide suitable ecological habitat. However, adjacent to the site there are grassy hillsides intermixed with talus slopes and patches of forest, sagebrush/bunchgrass scablands, cliffs, bluffs, wetlands, the storm drain pond, and the Columbia River.

4.5.1.1 Area Ecology Summary

The site is situated in the Columbia River gorge, which is located within the Columbia River Basin and considered to be part of the Intermountain Semi-desert ecoregion (PGG 2014a). The primary regional vegetation type is sagebrush steppe. Common native upland habitats are dominated by bunchgrass, rabbitbrush, and sagebrush. Trees are uncommon, except adjacent to water sources such as wetlands, ponds, streams, and rivers. In these wetter areas, common tree species include oak, pine, willow, and Russian olive. In areas suitable for agriculture the native vegetation has been replaced with grain (in wetter areas) or other row crops (including grapes) that may require irrigation (PGG 2014a). Regionally representative terrestrial fauna and water dependent species (including those relying on significant habitat of the Columbia River) are summarized in Table 4-1.

The Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species database lists priority habitats in the Site vicinity as summarized in Table 4-1. In addition, the adjacent Columbia River provides federally designated critical habitat for Chinook salmon, steelhead, and bull trout. Threatened or endangered species, including those identified to be present near or to pass through the Columbia River adjacent to the site, are also summarized in Table 4-1. The state-threatened western gray squirrel identified in Table 4-1 would most likely be present in oak forests not immediately adjacent to the subject property (PGG 2014a). A Priority Habitat Map is presented as Figure 2-6 in Section 2.

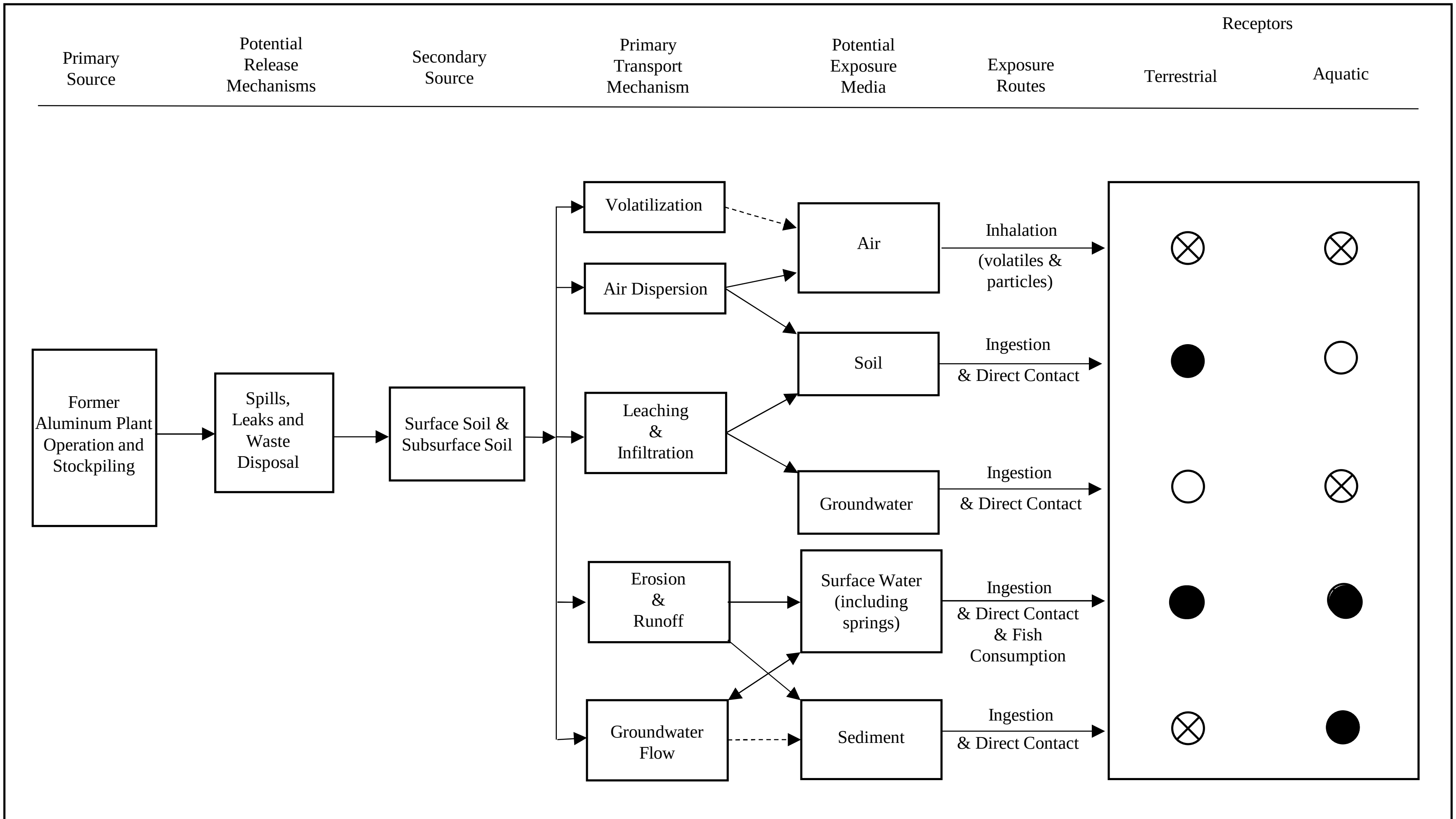
4.5.1.2 Conceptual Ecological Exposure Model

A preliminary conceptual ecological exposure model is presented in Figure 4-1. This conceptual model includes the primary sources of contamination, mechanisms of release and transport, and impacted media as described in the previous sections. Direct contact and ingestion of contaminated soil and surface water (including springs) are the main potentially complete and significant exposure routes for terrestrial receptors. For aquatic receptors, the main potentially complete and significant

Table 4-1
Ecological Summary Information
Columbia Gorge Aluminum Smelter Site,
Goldendale, Washington

Regional		Local	
Potential Representative Terrestrial Fauna	**Columbia River Water Dependent Species**	**Priority Habitats in Site Vicinity [a]**	**Threatened and Endangered Species**
• Numerous terrestrial invertebrate species • A few snake and lizard species including rattlesnake • Song and perching birds such as sparrows; scavengers such as crows, ravens, and vultures; and raptors such as owls, hawks, and eagles • Small-sized mammals such as deer mice; medium-sized mammals such as raccoons, skunks, opossum, and rabbits; and large-sized mammals such as coyote and deer	• Waterfowl • Aquatic invertebrates • Benthic invertebrates • A few frog, salamander, and turtle species • Numerous fish species	• Oak and oak/pine forests • Talus slopes • Cliffs and bluffs • Palustrine wetlands In addition, the adjacent Columbia River provides federally designated critical habitat for Chinook salmon, steelhead, and bull trout	**State Threatened** • Western gray squirrel **Federally Threatened** • Middle Columbia River bull trout • Middle Columbia River steelhead • Snake River fall, spring, and summer Chinook • Columbia River chum salmon • Upper Columbia River bull trout • Snake River bull trout • Snake River basin steelhead • Upper Columbia River steelhead • Columbia River coho salmon **Federally Endangered** • Upper Columbia River spring Chinook salmon • Snake River sockeye salmon

a Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species database.



Legend

- ● Complete Exposure
- ⊗ Potentially Complete but Insignificant/indirect exposure
- ○ Incomplete Exposure
- ——— Complete Pathway or Medium
- - - - - - Incomplete or Insignificant Pathway or Medium

Figure 4-1
Conceptual Ecological Exposure Model

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

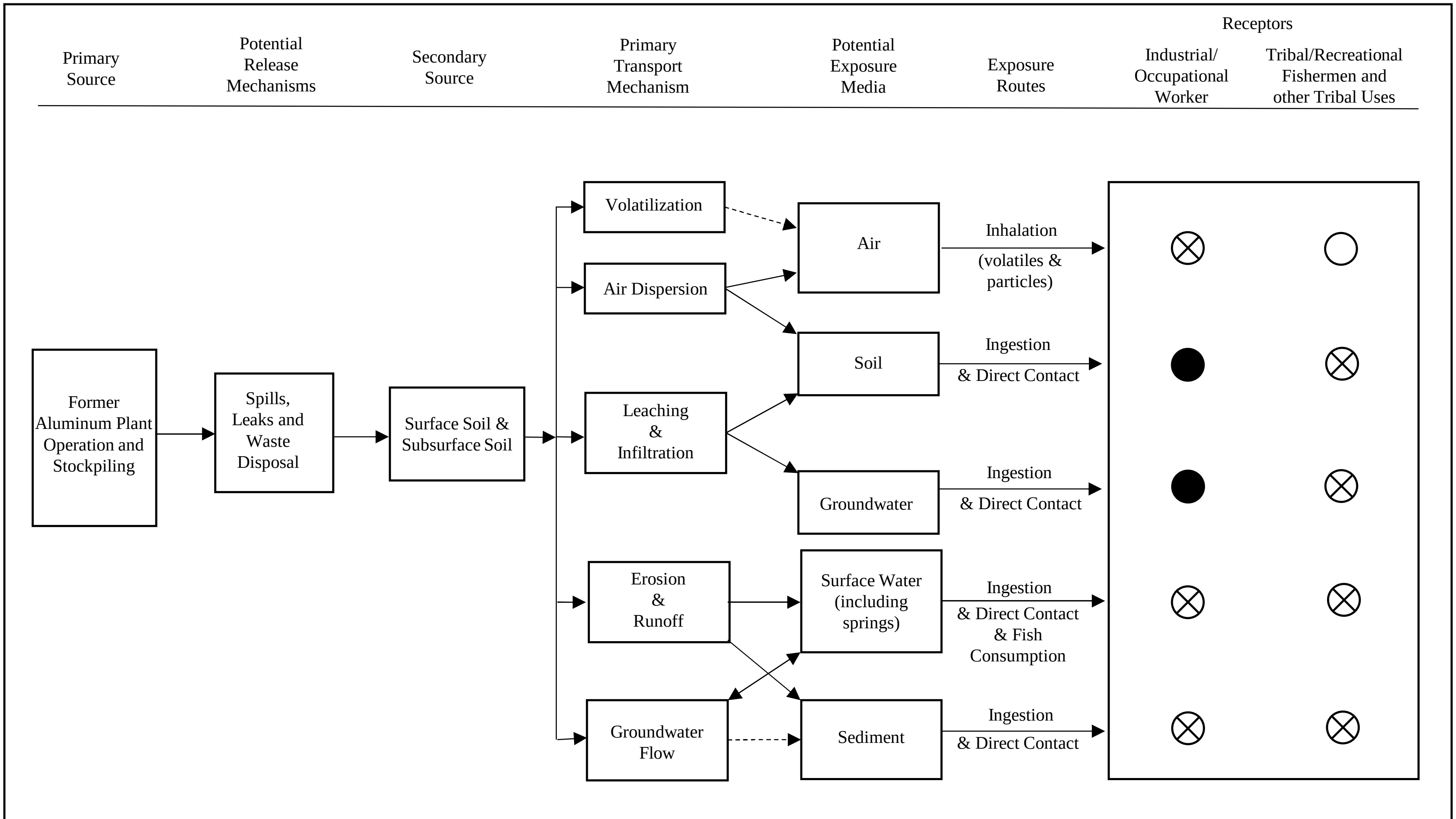
exposure route are ingestion and contact with contaminated sediment/sediment pore water, and surface water.

4.5.2 Human Receptors

A preliminary conceptual human exposure model is presented in Figure 4-2. The project site is zoned industrial, and a significant portion of the buildings have been demolished. Future site use is anticipated to remain industrial. In an industrial situation such as this, the likely human receptors are those who work at the site, such as occupational workers. When demolition and re-development are occurring, construction and excavation workers are likely to be present. Under the existing and future industrial use of the site, the human receptors of concern include current demolition workers, current and future occupational workers, future construction/excavation workers, and potential trespassers (PGG 2014a) as well as workers performing periodic environmental monitoring and sampling, and ongoing site investigation and cleanup action activities at the site are considered part of this group. Based on water rights, groundwater represents potential future drinking water source. For the Yakama Nation, the groundwater exposure pathway is considered as potentially complete, but with low exposure potential (PGG 2014a).

Grazing cattle have been observed in outlying open areas of the site (both east and west of the former plant area). Cattle could be exposed to site contaminants through ingestion of grass and water and direct contact. Chemicals could bioaccumulate and expose humans that consume cattle food products. However, this pathway is thought to have a low exposure potential.

In addition to the above, recreational and tribal-related uses along the Columbia River adjacent to the site are included for potential human exposure pathway consideration. The site is located in a treaty-defined usual and accustomed area of the Confederated Tribes and Bands of the Yakama Nation. Use designations for the reach of the Columbia River include: 1) aquatic life uses of spawning and rearing; 2) primary recreation use; 3) water supply uses including domestic, industrial, agricultural, and stock water; and 4) miscellaneous uses including wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics. Based on the above, both tribal and recreational fishermen are considered to represent potential human receptors.



Legend

- ● Complete Exposure
- ⊗ Potentially Complete but Insignificant/indirect exposure
- ○ Incomplete Exposure
- ——— Complete Pathway or Medium
- - - - - Incomplete or Insignificant Pathway or Medium

Note:
This exposure model does not include potential municipal water use considerations for surface water and groundwater exposure media.

Figure 4-2
Conceptual Human Health Exposure Model

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Section 5
Regulatory Framework

This section summarizes the regulatory framework for the RI/FS. Additional details regarding regulatory history are provided in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a).

5.1 PERMIT AND REGULATORY OVERVIEW

This section summarizes key environmental permitting and orders pertaining to the site.

5.1.1 RCRA Permit

A significant part of the RCRA permit history of the facility relates to the listing, delisting, and subsequent relisting of SPL as a RCRA listed (K088) hazardous waste. SPL was initially listed as a RCRA hazardous waste by the U.S. Environmental Protection Agency (EPA) in July 1980 because of its cyanide content but was then delisted on January 16, 1981 resulting from a Congressional mandate that excluded mineral processing wastes. On September 13, 1988, EPA again listed SPL as a hazardous waste. Ecology has responded to the delisting and listing process by modifying the authorized state regulations (Washington State Dangerous Waste Regulations, WAC 173-303) to reflect the RCRA listing status of SPL. The RCRA permit history for the facility reflects these changes in regulation. Several of the SWMUs at the site represent former SPL storage and handling areas [i.e., North Pot Liner Soaking Station (SWMU 10), South Pot Liner Soaking Stations (SWMU 11), East SPL Storage Area (SWMU 12), West SPL Storage Area (SWMU 13), North SPL Storage Containment Building (SWMU 14), South SPL Storage Building (SWMU 15), and SPL Handling Containment Building (SWMU 16)].

In addition to the SPL, the wastewater sludges disposed of in surface impoundments [East Surface Impoundment (SWMU 2) and West Surface Impoundment (SWMU 4)] were found to have received state-only dangerous wastes based on bioassay criteria in place at that time and regulated under the RCRA Permit (Ecology 2014; Parametrix 2004a). Sludges were also disposed of elsewhere on the site including the NPDES Ponds (SWMU 1) and the Intermittent Sludge Disposal Ponds (SWMU 3).

There are also various historical landfills at the site including the East End Landfill (SWMU 17) and the West End Landfill (SWMU 18). The EELF operated from 1971 to 1982 and the West End Landfill operated from 1982 to 1987. Both were informally closed with a soil cover. The West SPL Storage Area (SWMU 13) was closed with a designed and constructed cap during 1989 under WAC 173-304 solid waste requirements (CH2MHill 1988a,b). Ongoing groundwater monitoring was conducted at that site related to the closure of the unit from 1990 to 2008. The responsible party for the West SPL Storage Area filed for bankruptcy during 2010.

Various additional SWMUs have also been identified at the site as part of RCRA permitting process and are included in this RI.

The extremely hazardous waste state designation for wastes containing PAHs at concentrations greater than one percent [WAC 173-303-100(6)] will be applicable or relevant for future investigation and remediation activities that may generate PAH-containing wastes.

5.1.2 MTCA Agreed Order

Investigation and potential cleanup of the Ecology-identified SWMUs and AOCs will be conducted under the requirements of the Agreed Order, which was issued pursuant to MTCA (WAC 173-340). Investigation and cleanup of the SWMUs and AOCs will be conducted consistent with MTCA requirements. The Agreed Order requires preparation of a remedial investigation work plan, performance of an RI/FS, and development of a Draft Cleanup Action Plan (CAP) for the former Columbia Gorge Aluminum Smelter site. Preparation of the Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b) and the Final WPA (Tetra Tech et al. 2020b) were conducted consistent with MTCA RI/FS requirements (WAC 173-340-350) and the MTCA Agreed Order.

5.1.3 Wastewater Discharge Permitting

Wastewater discharges at the site have been permitted since the initial construction of the facility in the early 1970's. Waste streams from the facility's air pollution control scrubber systems were discharged under a NPDES permit into Ponds A and B and the discharge from these ponds was historically combined with the plant's other industrial discharges (e.g., cooling water, stormwater run-off, groundwater collection and treated sewage) as well as the secondary smelter scrubber effluent stream at a point down stream of Pond B. These combined discharges historically flowed down an associated drainage channel into gravel-lined Ponds C and D, followed by a permitted discharge through a diffuser into Lake Umatilla reservoir (refer to Figure 2-2).

The permit conditions have been modified several times during the long period of operation of the smelter to reflect changes in the wastewater discharge regulations, smelter operations, air pollution controls, and associated wastewater treatment.

During the most recent period of active smelter industrial operations, a water treatment plant was operated to remove fluoride and suspended solids from the blowdown of two secondary scrubber recirculated water streams and two primary emission control system SO_2 scrubbers. The NPDES Permit (No. WA 000054-0), effective June 1, 2002, was issued to allow the discharge of treated scrubber water to the Columbia River. Industrial wastewater and stormwater effluent limits and/or monitoring were included in the permit for aluminum, total suspended solids, fluoride, oil and grease, benzo(a)pyrene, antimony, nickel, arsenic, pH, temperature, and flow. This permit was later re-issued on April 1, 2008, modified on March 30, 2012 (Ecology 2012a). The modified permit remained in effect at the time of the RI field investigation activities.

In 2010, Lockheed Martin cleaned up the NPDES ponds and associated discharges as part of an independent cleanup action (ARCADIS 2011). A bypass pipeline was constructed in May 2010 to route stormwater around the former ponds. Currently, there are no active industrial wastewater discharges to the Columbia River as the plant ceased operations during 2003. Stormwater and collected groundwater from the facility continues to discharge to the Columbia River through the stormwater system (Ecology 2015a).

Investigation of the NPDES Ponds (SWMU 1) was included under both the RI and WPA field programs and results for the NPDES Ponds are summarized in Volume 2, Section 1 of the Final Draft RI Report.

5.1.4 Water Rights and Use

Surface water and groundwater in the site vicinity has been primarily used for commercial, industrial, irrigation, and domestic purposes. The Department of Ecology's Water Resources Program maintains for the State of Washington various documents and records related to existing or requested water rights and water claims.

The largest water rights in the vicinity were associated with aluminum smelter operation. The rights originally included both groundwater and surface water. The surface water right was for commercial and industrial purposes. The water right has been transferred to KPUD; the water use designation recently has been changed from industrial to municipal and the place of use has been expanded to various locations in Klickitat County. The original groundwater right is for three wells and the designated use was for either commercial, industrial, and domestic purposes. This water right has been transferred to KPUD, with a change in use to Municipal Use.

There are also a few records of domestic, irrigation, and stock watering water rights (groundwater and surface water springs) in the site vicinity located west and northwest of the smelter. The U.S. Army Corps of Engineers has groundwater rights for heat exchange/cooling water and domestic use associated with operations of the John Day Dam located south of the site.

5.2 SCREENING LEVELS

This section summarizes a range of screening levels appropriate for the RI. These levels have been used as a basis of comparison to: 1) characterize the nature and extent of contamination at the site, and 2) help determine if specific SWMUs and AOCs need to be further evaluated in the FS to determine the appropriate cleanup actions. For soil and groundwater media, the primary screening levels identified for use in the RI/FS are MTCA Method A, B, and C Cleanup Levels (Chapter 173-340 WAC). A brief summary description of Method A, B, and C Cleanup Levels follows:

- Method A provides tables of cleanup levels that are protective of human health for the 25 to 30 most common hazardous substances for soil and groundwater and including petroleum hydrocarbons. Method A is designed for cleanups that are relatively straightforward or involve only a few hazardous substances. Use of Method A may be appropriate for some specific-SWMUs at the site, specifically for some petroleum-related releases. Note that Method A soil tables include consideration of protection of groundwater and the Method A groundwater table includes consideration of ARARs such as MCLs (where protective). Method A table values are intended to be "off the shelf' values to use for simple sites.

- Method B represents the universal method under MTCA with cleanup levels acceptable for unrestricted (all) land uses and consistent with state and federal requirements. Human health levels for individual carcinogens cannot exceed one-in-a-million and cumulative site cancer-risk levels may not exceed 1 in 100,000. Levels of non-carcinogens cannot exceed the point at which a substance may cause illness in humans (that is the hazard quotient must be less than 1).

- Method C is a conditional method that is commonly used to set soil cleanup levels at qualifying industrial sites and for groundwater in some specific circumstances. Method C based on less stringent exposure assumptions and higher lifetime cancer risk thresholds than Method B. All practical methods of treatment must be used, and institutional controls must be implemented and maintained as part of site cleanup actions in which Method C cleanup levels are adopted.

  Method A differs from Methods B and C, which are based on the calculated risk from standard exposure scenarios and do not consider ARARs or other exposure pathways, and a separate analysis of ARARs and other exposure pathways must be considered in establishing cleanup levels under Methods B and C.

Note that the screening levels presented in this section do not represent established site cleanup levels, but rather will be used for site screening in the RI. Site cleanup levels will be formally proposed in the FS report as well as in the draft CAP. Cleanup levels will be evaluated based on the remedial investigation results consistent with MTCA requirements.

The screening levels in this RI report have been used to help identify sites to be carried forward into the FS. In some instances, the rationale for preliminary selection of cleanup levels (e.g., use of MTCA Method C soil cleanup levels for some SWMUs) is presented to provide context for the evaluation and selection of alternatives to be presented in the FS.

There have been updates to various screening levels during and since preparation of the Draft RI Report in January 2019 (Tetra Tech et al. 2019a). The screening levels potentially applicable for various media are summarized for clarity and updated as appropriate. Tables 5-1, 5-2, 5-3, and 5-4 summarize current soil screening levels, groundwater screening levels, surface water screening levels, and sediment screening levels, respectively.

The Ecology Toxics Cleanup Program Cleanup and Risk Calculation (CLARC) Table was updated in May 2019 (Ecology 2019a) and February 2021 (Ecology 2021b) subsequent to the completion and submittal of the Draft RI Report (Tetra Tech et al. 2019a) to Ecology on January 24, 2019. The CLARC update includes incorporation of new cancer and non-cancer toxicity values for benzo(a)pyrene that were published by the EPA during January 2017 in EPA’s Integrated Risk Information System (IRIS) database. The CLARC update also affected how other carcinogenic PAHs are evaluated using the Total Toxicity Equivalent Concentration (TTEC) approach under MTCA. Ecology (2019b) guidance further summarizes these changes to PAH and benzo(a)pyrene MTCA default screening levels. These modified MTCA default values have been generally adopted for screening purposes in this RI Report with a few exceptions noted for specific media.

Standard MTCA Method A, B, and C formula values have been adopted from the CLARC Data Summary Tables accessed online during June 2021 (February 2021 CLARC Update) that includes available soil screening levels protective of groundwater. In cases where formula values for both non-cancer and carcinogenic risks were provided, the lower of the two formula value cleanup levels (usually carcinogenic) was included.

5.2.1 Soil

MTCA Methods A, B, C, MTCA soil screening levels for protections of groundwater, and MTCA terrestrial ecologic soil screening levels have been adopted for screening purposes in this RI report. Soil screening levels for site COPC are summarized in Table 5-1.

5.2.1.1 MTCA Method A, B, and C

MTCA Method A, B, and C soil cleanup levels have been included in Table 5-1 for screening comparison purposes in the RI. Method A Cleanup Levels for both Unrestricted Land Use and Industrial properties are included. Note that for some chemicals, the Method A soil cleanup level is based on protection of groundwater.

MTCA Method C Industrial Cleanup Levels are appropriate for cleanup of soils at the site and have been used for screening in the soil data summary tables for individual SWMUs and AOCs (refer to Volumes 2, 3, and 4). Ecology previous comments on the Phase 1 RI Work Plan (Ecology 2015a) state that industrial cleanup levels are appropriate for the site in areas owned by NSC Smelter LLC and zoned as industrial (Ecology and Yakama Nation 2019, 2020a).

The MTCA regulation (WAC 173-340-745) specifies that Method C soil cleanup levels may only be established where the parties conducting the cleanup action can demonstrate the following:

- The site must meet the definition of an industrial property [WAC 173-340-745(a)(i)]. Land use has historically been industrial at the smelter site; much of the area including the former production area is zoned as industrial (see Figure 2-8), and future land use is planned to be industrial. Access to the property is restricted. Much of the former plant area is covered by paving and building foundations.

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 3)

Chemicals of Potential Concern	MTCA Screening Levels											Range of Background Concentrations	Laboratory Reporting Limit / Method Detection Limit
	Method A				Protection of Groundwater		Protection of Surface Water		Site-Specific TEE [d,e]				
	Unrestricted Land Use	Industrial	Method B	Method C	Vadose Zone	Saturated Zone	Vadose Zone	Saturated Zone	Ecological Indicator-Plants	Ecological Indicator-Soil Biota	Ecological Indicator-Wildlife		
Aluminum Smelting (mg/kg)													
Cyanide	NA	NA	50	2,200	140.4/1.9 [i]	0.1	1.0	0.041	NE	NE	5	NE	2.0 / 0.51
Fluoride	NA	NA	4,800	210,000	615/147.6 [j]	140	NE	NE	NE	NE	NE	14.11 [h]	8.0 / 2.41
Sulfate	NA	NA	NE	NE	2,150 [m]	2,150 [m]	NE	NE	NE	NE	NE	NE	20.0 / 7.75
Polynuclear Aromatic Hydrocarbons (PAHs) (mg/kg)													
1-Methylnaphthalene	NL [a]	NL [a]	34	4,500	0.082	0.0042	NE	NE	NE	NL	NL	NE	0.005 / 0.00063
2-Methylnaphthalene	NL [a]	NL [a]	320	14,000	1.7	0.088	NE	NE	NE	NL	NL	NE	0.005/ 0.000205
Acenaphthene	NA	NA	4,800	210,000	98	5	3.1	0.16	NL	NL	NL	NE	0.005 / 0.0006
Acenaphthylene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005 / 0.0005
Anthracene	NA	NA	NE	NE	2,300	110	47	2.4	NE	NL	NL	NE	0.005 / 0.0006
Benzo(a)anthracene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00076
Benzo(a)pyrene	0.1 [b]	2.0 [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00084
Benzo(b)fluoranthene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00059
Benzo(g,h,i)perylene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005 / 0.0005
Benzo(k)fluoranthene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00060
Chrysene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 /0.0015
Dibenzo(a,h)anthracene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00072
Fluoranthene	NA	NA	3,200	140,000	630	32	5.9	0.3	NE	NL	NL	NE	0.005 / 0.0014
Fluorene	NA	NA	3,200	140,000	100	5.1	1.6	0.08	NE	NL	NL	NE	0.005/ 0.0005
Indeno(1,2,3-cd)pyrene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00060
Naphthalene	5.0 [a]	5.0 [a]	1.6	70	4.5	240	NE	NE	NE	NL	NL	NE	0.005 / 0.00162
Phenanthrene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005/ 0.00163
Pyrene	NA	NA	2,400	110,000	650	33	11.0	0.55	NE	NL	NL	NE	0.005/ 0.00097
Total TTEC cPAH (calc)	0.1 [b]	2.0 [b]	0.19 [b]	130 [b]	3.9 [b]	0.19	0.00031	0.000016	NE	NE	NE	NE	0.005 / 0.00084
Total LMW PAH	NA	NA	NE	NE	NE	NE	NE	NE	NE	29	100	NE	0.005 / 0.0005
Total HMW PAH	NA	NA	NE	NE	NE	NE	NE	NE	NE	18	1.1	NE	0.005 / 0.00084
Polychlorinated Biphenyls (PCBs) (mg/kg)													
Total PCBs	1.0	10.0	0.5	66	NE	0.14	NE	0.0000022	40	NE	0.65	NE	0.02 / 0.0074
Aroclors													
1016	NA	NA	5.6	250	NE	0.12	NE	0.00032	NE	NE	NE	NE	0.02 / 0.0074
1221	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0042
1232	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0049
1242	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0035
1248	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0029
1254	NA	NA	0.5	66	0.71	0.035	0.0017	0.000084	40	NE	NE	NE	0.02 / 0.0037
1260	NA	NA	0.5	66	NE	0.036	NE	NE	NE	NE	NE	NE	0.02 / 0.0074

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 3)

Chemicals of Potential Concern	MTCA Screening Levels											Range of Background Concentrations	Laboratory Reporting Limit / Method Detection Limit
	Method A				Protection of Groundwater		Protection of Surface Water		Site-Specific TEE [d,e]				
	Unrestricted Land Use	Industrial	Method B	Method C	Vadose Zone	Saturated Zone	Vadose Zone	Saturated Zone	Ecological Indicator-Plants	Ecological Indicator-Soil Biota	Ecological Indicator-Wildlife		
Metals (mg/kg)													
Aluminum	NA	NA	80,000	3,500,000	480,000	24,000	NE	NE	50	NE	NE	12,692 [h] / 28,299 [g]	15.0 / 3.3
Arsenic	20 [m]	20 [m]	0.67	88	2.9	0.15	2.9	0.15	10	60	132	1.9 [h] / 7.61 [g]	0.5 / 0.1
Cadmium	2 [f]	2 [f]	80	3,500	0.69	0.035	0.099	0.055	4	20	14	0.07 [h] / 0.81 [g]	0.4 / 0.07
Chromium [l]	2,000	2,000	120,000	5,300,000	490,000	24,000	1,500	74	42	42	67	12.37 [h] / 31.88 [g]	0.5 / 0.06
Copper	NA	NA	3,200	140,000	280	14	4.9	0.25	100	50	217	28.4 [g]	1.0 / 0.22
Lead	250	1,000	NE	NE	3,000	150	500	25	50	500	118	5.19 [h] / 13.1 [g]	0.5 / 0.05
Mercury	2 [f]	2 [f]	24	NE	2.10	0.10	0.013	0.00063	0.3	0.1	5.5	0.0015 [h] / 0.04 [g]	0.03 / 0.009
Nickel [c]	NA	NA	880	70,000	130	6.5	68	3.4	30	200	980	24.54 [g]	0.5 / 0.19
Selenium	NA	NA	400	18,000	5.2	0.26	0.52	0.026	1	70	0.3	0.29 [h]	1.5 / 0.28
Zinc	NA	NA	24,000	1,100,000	6,000	300	120	6.2	86	200	360	80.91 [g]	5.5 / 1.61
Total Petroleum Hydrocarbons (TPHs) (mg/kg)													
TPH-Gx (gasoline-extended range)	100 [n] 30	100 [n] 30	NE	NE	NA	NA	NA	NA	120	120	1,000	NA	5.0 / 2.30
TPH-Dx (diesel and heavy-oil ranges)	2,000	2,000	NE	NE	NA	NA	NA	NA	1,600	260	2,000	NA	50 / 12.3
Volatile Organic Compounds (VOCs) (mg/kg)													
Fuel-Related													
Benzene	0.03	0.03	18	2,400	0.027	0.0017	0.0024	0.00015	NE	NE	0.255	NA	0.030 / 0.0038
Toluene	7.0	7.0	6,400	280,000	4.5	0.27	0.4	0.024	200	NE	5.45	NA	0.15 / 0.0135
Ethyl benzene	6.0	6.0	8,000	350,000	5.9	0.34	0.24	0.014	NE	NE	5.16	NA	0.040/0.0091
Xylenes	9.0	9.0	16,000	700,000	14	0.83	NE	NE	NE	NE	10.0	NA	0.2 / 0.0149
Solvents													
Tetrachloroethene (PCE)	0.05 [f]	0.05 [f]	480 [j]	21,000 [j]	0.05	0/0028	0.024	0.0013	NE	NE	9.92	NA	0.002/ 0.0004
Trichloroethene (TCE)	0.03 [f]	0.03 [f]	12	1,800	0.025	0.0015	0.0019	0.00011	NE	NE	12.4	NA	0.002 / 0.0003
1,1,1-Trichloroethane (1,1,1-TCA)	2.0[f]	2 [f]	160,000	7,000,000	1.5	0.084	74	4.2	NE	NE	29.8	NA	0.002 / 0.0003
1,2,-Dichloroethane (1,2-DCA)	NE	NE	11	1,400	0.023	0.0016	0.043	0.0029	NE	NE	21.2	NA	0.001 / 0.0002
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	NE	160	7,000	0.078	0.0052	NE	NE	NE	NE	30.2	NA	0.003 / 0.0006
Vinyl chloride	NE	NE	0.67	88	0.0017	0.000089	0.00012	0.0000061	NE	NE	6.46	NA	0.002/ 0.0003

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 3 of 3)

Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate the February 2021 CLARC Update (Ecology 2021b).

a Method A level includes sum of 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene.
b MTCA cleanup levels for carcinogenic PAHs are based on toxicity equivalency factor summation approach specified in WAC 173-340-708(8) and Table 708-2 of MTCA.
c CLARC value for nickel refinery dusts adopted for human-health screening purposes. Soil screening values for protection of groundwater based on soluble salt-physical properties.
d Ecological indicator soil concentration for plants, soil biota, and wildlife exposure categories (Table 749-3, WAC 173-340-7493, MTCA).
e Additional ecological indicator soil screening values provided by Ecology and based on Ecology Implementation Memorandum # 19 for TPH and EPA ecological soil screening level guidance for low molecular-weight (LMW) and high molecular-weight (HMW) PAHs (EPA 2007a). For PAHs, total LMW and HMW PAH concentrations will be used for screening purposes. Individual PAH levels are provided for completeness.
f Method A soil level is designed to be protective of groundwater drinking water use.
g Natural background based on Ecology (1994) soil natural background concentration study. Value represents 90^{th} percentile of eastern Washington data set.
h Site-specific background value from PGG (2013a) site investigation.
i Cyanide soil screening levels for protection of groundwater based on free cyanide form, literature distribution coefficient, MTCA Method B groundwater formula value/MCL, and fixed parameter three phase partitioning mode.
j Fluoride soil screening level for protection of groundwater based on MCL and empirical demonstration consistent with WAC 173-340-747.
k Sulfate screening level for protection of groundwater based on literature distribution coefficient, Secondary MCL, and fixed parameter there-phase partitioning model.
l Chromium screening levels are based on chromium (III) as the dominant form.
m Method A Cleanup Level for arsenic based on protection of groundwater adjusted for soil natural background.
n Method A Cleanup Level of 100 mg/kg if benzene is not detected and the sum of BTEX is less than 1 percent). Otherwise, the MTCA Method A Cleanup Level is 30 mg/kg.

mg/kg = Milligrams per kilogram
µg/kg = Micrograms per kilogram
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
CLARC = Cleanup Level and Risk Calculations Summary Tables and guidance accessed online during April 2018.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbons
HMW = High Molecular-Weight
LMW = Low Molecular-Weight
MTCA = Model Toxics Control Act
MCL = Maximum Contaminant Level
NA = Not applicable
NE = Not established in look-up Tables.
NL = Not listed. Screening level for specific chemical is not listed but is accounted for by summation process. Refer to footnotes.
NPDES = National Pollutant Discharge Elimination System
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TEE = Terrestrial Ecological Evaluation
Total TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds

- The cleanup action(s) provide for appropriate institutional controls including placement of restrictive covenants on the property where industrial soil cleanup levels are applied [WAC 173-340-745(a)(ii)]. For all SWMUs and AOCs where MTCA Method C Cleanup Levels are planned to be implemented, appropriate institutional controls will be included in the evaluation of remedial alternatives in the FS.

- Hazardous substances remaining at the property after remedial action would not pose a threat to human health or the environment [WAC 173-340-745(a)(iii)]. For areas that are zoned industrial and under the ownership of NSC, industrial land use represents the reasonable maximum exposure at the Columbia Gorge Aluminum Smelter site. For other areas, exposure scenarios and screening levels based on unrestricted land use have been adopted. In this RI, soil concentrations are also compared to soil screening levels protective of groundwater (consistent with WAC 173-340-747) and soil levels protective of terrestrial ecological receptors (consistent with WAC 173-340-7490) as appropriate to address these potentially complete pathways.

For TPH-impacted sites (Compressor Building Former UST, refer to Volume 3, Section 2.4.4), MTCA Method A Cleanup Levels for Industrial Land Use are appropriate for soil at this industrial site.

5.2.1.2 Human Health

Ecology and Yakama Nation comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) indicated a data need to confirm that MTCA Soil Cleanup Levels for Unrestricted Land Use (MTCA Method A and B) are protective of Treaty-Protected Tribal Uses. It appears likely that MTCA soil cleanup level for unrestricted land use are protective based on their residential exposure assumptions (e.g., exposure frequency, average body weight, soil ingestion rate and risk levels). Based on Yakama Nation comments on the Draft WPA, it appears that “data of sufficient quality to determine protectiveness based on Unrestricted Land Use would likely be sufficient to determine protectiveness relative to Treaty-Protected Tribal uses.”

5.2.1.3 Protection of Groundwater

Soil screening levels protective of groundwater from CLARC have been included where available as calculated with the fixed parameter three-phase partitioning model [as described in WAC 173-340-747(4) and based on MTCA Equation 747-1]. For three aluminum smelter-related chemicals lacking CLARC values (i.e., fluoride, cyanide, and sulfate), soil screening levels were determined consistent with MTCA. For sulfate and cyanide, the fixed parameter three-phase partitioning model was used in conjunction with MTCA and MCL groundwater screening levels, and literature distribution coefficient (Kd) values as input values. For fluoride, an empirical demonstration has been used to establish soil screening levels protective of groundwater consistent with WAC 173-340-747(9). Refer to Section 5.2.6 for further discussion. Refer to Volume V, Appendix A-5 for supporting documentation including referenced citations regarding soil screening levels protective of groundwater.

The screening level for carcinogenic PAH compounds is based on the calculated TTEC value, which represents the equivalent benzo(a)pyrene concentration using methods in WAC 173-340-708(8) and Table 708-2 of MTCA.

5.2.1.4 Protection of Surface Water

Recent Ecology (2021c) guidance include soil screening levels for protection of surface water. The Draft RI Report included evaluation of soil screening levels for protection of groundwater based on the fixed parameter three-phase partitioning model, but did not include use of surface water screening levels as the target cleanup level.

Based on Ecology's comments on the Revised RI Report (Ecology 2022), Ecology has agreed to the use of soil screening level for protection of groundwater, rather than the soil screening levels based on surface water protection. The soil screening levels in CLARC for the protection of surface water, in part, are based on consumption of fish from those waters. At this site, the documented pathway/connection between groundwater and surface water occurs at springs. The predominately seasonal springs are present as surface water for a short distance and are not in surface connection with fish-bearing waters. Therefore, these springs do not provide habitat capable of supporting fish that could be consumed by humans. While these seasonal, localized spring environments may provide habitat for other aquatic life, applicable freshwater criteria have either not been established or are higher than criteria for protection of other pathways. In this case, Ecology believes that soil screening levels for protection of human health by consumption of groundwater will be protective of the other exposure pathways posed by the springs. Areas of soil that exceed these screening levels will be recommended for inclusion in the FS for further evaluation.

5.2.1.5 Terrestrial Ecological Evaluation

MTCA (WAC 1173-340-7490) defines procedures for determining whether a release of hazardous substances to soil may pose a threat to terrestrial ecologic receptors. The procedures are not intended to evaluate potential threats to ecological receptors in sediments or surface water. The regulation includes procedures for both a simplified terrestrial ecological evaluation and site-specific terrestrial ecologic evaluation.

Ecology and Yakama Nation comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) requested additional TEE. In the Draft RI Report (Tetra Tech et al. 2019a), SWMUs and AOCs were evaluated individually for either a simplified (most SWMUs) or the site-specific TEE that was conducted for the Wetlands AOC. The simplified TEE evaluation included comparison of soil screening levels for industrial or commercial sites (refer to MTCA Table 749-2) and protection of wildlife (refer to MTCA Table 749-3). In addition, some SWMUs and AOCs were initially excluded from TEE based on their lack of available habitat (e.g., the PAAOC) or on the basis that a remedial action had already been completed (e.g., the West Surface Impoundment).

Supplemental ecological information was provided by Ecology that shows the location of PHS areas in the Site vicinity (refer to Section 2.2.7 and Figure 2-6). Ecology comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) state that a site-specific TEE is necessary for the overall site and that MTCA Table 749-3 Indicator Concentrations for three receptor categories (soil, biota, plants) should be used in this screening consistent with Ecology (2017b) guidance. Ecology's position is that soils in areas which are both owned by NSC and zoned for industrial use may be screened using only the wildlife values for TEE. All other areas of the Site should be screened using appropriate values for all three eco-risk receptor categories.

In addition to the screening levels included by rule in MTCA Table 749-3, screening levels for additional chemicals have been provided by Ecology. These recommended screening levels are based on best available science. For PAHs, The PAH values in the Ecology-supplied table are based on EPA (2007a) guidance "Ecological Soil Screening Levels for PAHs, Interim Final". Table 5-1 summarizes these TEE screening values with associated laboratory reporting limits and method detection limits.

5.2.2 Groundwater

Table 5-2 summarizes groundwater screening levels considered for use in support of this RI report. Based on review of water rights and groundwater use, it appears that MTCA Method A and Method B groundwater cleanup levels are appropriate. Groundwater at this site is considered to represent a potential source of drinking water as that represents its highest beneficial use consistent with MTCA requirements and given the recent change of groundwater rights for the former plant production wells to municipal use. However, Method C industrial groundwater cleanup levels are also provided in Table 3-3 for general comparison purposes.

For screening purposes, groundwater results have been primarily compared against groundwater protection standards. Spring water results are considered to represent discharging groundwater consistent with Ecology (2022) comments on the Revised RI Report because of their seasonal nature and lack of fish habitat. See Volume 4 for a complete summary of groundwater and spring results.

For a few chemicals (i.e., fluoride, free cyanide), groundwater federal primary MCLs, which also represent Washington State Primary MCLs in WAC 246-290-310 were also included as appropriate groundwater screening levels. In the case of sulfate, the secondary MCL of 250 mg/L was used for screening purposes because no risk-based concentration or reference dose was found.

5.2.2.1 Fluoride

For fluoride, the MCL is 4.0 mg/L and the MTCA Method B formula value is 0.96 mg/L. Based on review, most aluminum smelter groundwater cleanups in Washington have adopted the MCL for fluoride as the site groundwater cleanup level. The fluoride cleanup level is calculated with the standard MTCA equations and using the Integrated Risk Information System (IRIS) reference dose of 6.00E-2 mg/kg-day. Note that the MTCA Method B formula value of 0.96 mg/L is similar to the Federal Department of Health and Human Services optimal fluoridation level for community drinking water systems of 0.7 mg/L, which was set to promote public health benefits of fluoride for preventing tooth decay while minimizing the chance for dental fluorosis (tooth mottling). EPA has set a secondary MCL for fluoride of 2.0 mg/L, based on tooth discoloration that they deem as a cosmetic effect (as opposed to a human health effect).

Table 5-2
Groundwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Chemicals of Potential Concern	MTCA Screening Levels			Natural Background	WA MCL	Laboratory Reporting Limit / Method Detection Limit
	Method A	Method B	Method C			
Aluminum Smelting (mg/L)						
Cyanide (Free)	NE	0.01	0.022	NE	0.2	0.005 / 0.0015
Fluoride	NE	0.96	2.1	0.72	4.0	0.20 / 0.030
Sulfate	NE	NE	NE	32	250 (also federal secondary)	1.20 / 0.260
Polynuclear Aromatic Hydrocarbons (PAHs) (µg/L)						
Acenaphthene	NA	960	2,100	NE	NE	0.020 / 0.0013
Acenaphthylene	NA	NE	NE	NE	NE	0.020 / 0.0011
Anthracene	NA	4,800	11,000	NE	NE	0.020 / 0.00082
Benzo(g,h,i)perylene	NA	NE	NE	NE	NE	0.0020 / 0.00086
Fluoranthene	NA	640	1,400	NE	NE	0.020 / 0.00082
Fluorene	NA	640	1,400	NE	NE	0.020 / 0.0011
1-Methylnaphthalene	NL [a]	1.5	15	NE	NE	0.020/ 0.0013
2-Methylnaphthalene	NL [a]	32	70	NE	NE	0.020 / 0.0013
Naphthalene	160 [a]	160	350	NE	NE	0.020/ 0.0014
Phenanthrene	NA	NE	NE	NE	NE	0.020 / 0.0011
Pyrene	NA	480	1,100	NE	NE	0.020 / 0.0010
Carcinogenic PAHs (µg/L)						
Total Toxicity Equivalent Concentration (TTEC)	0.1	0.2 [d]	0.2 [d]	NE	0.2	0.020 / 0.0011
Benzo(a)pyrene	0.1 [b]	0.023	0.88	NE	0.2	0.020 / 0.0011
Benz(a)anthracene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.000097
Benzo(b)fluoranthene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00083
Benzo(k)fluoranthene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00094
Chrysene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00076
Dibenz(a,h)anthracene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.0013
Indeno(1,2,3-cd)pyrene	NL [b]	NL [b]	NL [b]	NE	NE	0.05020 / 0.00089
Polychlorinated Biphenyls (PCBs) (µg/L)						
Total PCBs	0.1	0.044	0.44	ND	0.5	0.621/0.022
1016	NA	1.1	2.5	ND	NE	0.621/0.022
1221	NA	NE	NE	ND	NE	0.621/0.022
1232	NA	NE	NE	ND	NE	0.621/0.022
1242	NA	NE	NE	ND	NE	0.621/0.022
1248	NA	NE	NE	ND	NE	0.621/0.022
1254	NA	0.044	0.44	ND	NE	0.621/0.022
1260	NA	0.044	0.44	ND	NE	0.621/0.022
Metals (mg/L)						
Aluminum	NE	16	35	1.14	NE	0.1 / 0.0126
Arsenic	0.005	0.000058	0.00058	0.0069	0.01	0.001 / 0.0002
Cadmium	0.005	0.008	0.018	NE	0.005	0.0004 / 0.0001
Chromium (total)	0.05	24 (Cr III)	53 (Cr III)	0.03	0.1	0.0004 / 0.0002
Copper	NE	0.64	1.4	NE	1.3	0.002 / 0.0006
Iron	NA	11	25	13	0.3 (Secondary MCL)	0.5/0.18
Lead	0.015	NE	NE	0.00046	0.015	0.0008 / 0.0002
Mercury	0.002	NE	NE	NE	0.002	0.0003 / 0.0002
Nickel [c]	NA	0.000096	0.00096	0.0065	0.1	0.0003 / 0.0001
Selenium	NA	0.08	0.18	NE	0.050	0.0008 / 0.0020
Silver	NA	0.08	0.18	NE	NE	0.0004 / 0.0005
Zinc	NA	4.8	11	NE	NE	0.007 / 0.0019

Table 5-2
Groundwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Chemicals of Potential Concern	MTCA Screening Levels			Natural Background	WA MCL	Laboratory Reporting Limit / Method Detection Limit
	Method A	Method B	Method C			
Total Petroleum Hydrocarbons (TPH) (mg/L)						
TPH-Gx (gasoline-extended range)	1.0 (no benzene) 0.80 (benzene present)	NE	NE	NE	NE	0.250 / 0.10
TPH-Dx (diesel and heavy-oil ranges)	0.5	NE	NE	NE	NE	0.110 / 0.065
Volatile Organic Compounds (VOCs) (µg/L)						
Fuel-Related						
Benzene	5.0	0.8	8.0	NE	5.0	0.20 / 0.03
Toluene	1,000	640	1,400	NE	1,000	0.20 / 0.05
Ethyl benzene	700	800	1,800	NE	700	0.20 / 0.05
Xylenes	1,000	1,600	3,500	NE	10,000	0.50 / 0.115
Solvent-Related						
Tetrachloroethene (PCE)	5.0	21	110	NE	5.0	0.50 / 0.084
Trichloroethene (TCE)	5.0	0.54	8.8	NE	5.0	0.20 / 0.066
1,1,1-Trichloroethane (1,1,1-TCA)	200	16,000	35,000	NE	200	0.20 / 0.025
1,2,-Dichloroethane (1,2-DCA)	5.0	0.48	4.8	NE	5.0	0.20 / 0.043
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	16	35	NE	70	0.20 / 0.055
Vinyl chloride	0.2	0.029	0.29	NE	2.0	0.02 / 0.013

Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate February 2021 CLARC Update (Ecology 2021b).

Based on the conceptual model of the site presented in this Final Draft RI Report, Ecology (2022) comments state that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs. The springs represent a special case since they are largely seasonal and do not provide fish habitat. Accordingly, spring data have been compared with groundwater screening levels.

a Method A level includes sum of 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene.

b MTCA cleanup levels for carcinogenic PAHs are based on toxicity equivalency factor summation approach specified in WAC 173-340-708(8) and Table 708-2 of MTCA.

c CLARC Method B and C values for nickel refinery dusts or nickel soluble salts depending on available values.

d MTCA Method B and C Cleanup Levels for carcinogenic PAHs represent the MCL consistent with Ecology (2021b) February 2021 CLARC modification.

mg/L = Milligrams per Liter
µg/L = Micrograms per Liter
CLARC = Cleanup Level and Risk Calculations Summary Tables accessed online during April 2018.
MCL = Maximum Contaminant Level
MTCA = Model Toxics Control Act
ND = Chemical was not detected
NE = Not established in look-up Tables
NL = Not listed. Screening level for specific chemical is not listed but is accounted for by summation process. Refer to footnotes.
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds
WA = Washington
Xylenes = Represents the total of m-, o-, and p-xylene isomers.

5.2.2.2 Cyanide

For cyanide (as free cyanide), the MCL is 0.2 mg/L and the MTCA Method B formula value is 0.010 mg/L. Both of the screening levels are based on free cyanide, and not metal-complexed cyanides. The RI groundwater results show that all forms of cyanide are infrequently detected in groundwater. Where cyanide is detected, it appears to predominately occur in the metal-complexed form. Total cyanide concentrations significantly exceed free cyanide concentrations in all wells with positive cyanide detections. Based on review of the RI groundwater data set, it does not appear that cyanide represents a significant risk-driver for groundwater based on its infrequency of detection and metal-complexed form at the site.

5.2.2.3 Sulfate

For sulfate, the only screening level found is the Secondary MCL of 250 mg/L, which is deemed non-mandatory by EPA, because Secondary MCL are established for "nuisance" chemicals on aesthetic qualities as opposed to human health effects. According to EPA, contaminants are not considered to present a risk to human health at the Secondary MCL. However, Ecology has explained that the Secondary MCL for sulfate represents a likely Applicable or Relevant and Appropriate Requirement for the project. Washington State drinking water regulations (WAC 246-290-310) include a Secondary MCL for sulfate of 250 mg/L and drinking water system purveyors must monitor for and comply with this secondary standard.

A preliminary review of the EPA IRIS, EPA Health Effects Assessment Summary Table (HEAST), and the National Center for Environmental Assessment (NCEA) databases do not show available reference doses for sulfate. The secondary MCL for sulfate of 250 mg/L will be retained for screening comparisons in the RI/FS. Based on further literature review, sulfate concentrations greater than 500 mg/L, show adverse effects on livestock (cattle calves) (NDSU 2021; UK 2008; Fort Keogh Livestock and Range Research Laboratory 2021) and it is assumed that other similarly sized herbivores such as deer would be similarly affected. For this reason, the 500 mg/L screening level will also be used for screening purposes for the groundwater and spring data sets.

5.2.3 Sediment

Table 5-3 summarizes sediment screening levels considered for use in support of this RI report. The Washington Sediment Management Standards represent the main regulations for conducting sediment cleanups in the State of Washington (WAC 173-204). The Washington State Sediment Management Standards (SMS) rule was adopted in 1991 and revised in 1995 and 2013. The Ecology sediment cleanup user's manual (SCUM II) (Ecology 2017a, 2019c) was used as the source of the screening levels in this RI Report. The goal of the SMS is to reduce and ultimately eliminate adverse effects on biological resources and threats to human health from surface sediment contamination. The SMS, in conjunction with MTCA, governs the process of how sediment sites are identified, investigated, cleaned up, and monitored in Washington State.

The SMS includes numerical chemical and narrative screening levels that are designed to protect the functions and integrity of the benthic community. These include chemical and biological criteria that represent levels predicted to have no adverse non-bioaccumulative effects on the benthic community [the Sediment Cleanup Objective (SCO)], and higher levels [the Cleanup Screening Level (CSL)] that predict minor adverse effects on the benthic community.

In 2013, Ecology finalized updates to the SMS, Chapter 173-204 WAC. In support of those SMS updates, revisions to the Sediment Cleanup User's Manual (termed SCUM II) were finalized in 2015. Included in SCUM II were SCO and cleanup screening levels for the protection of the benthic community in freshwater and marine sediments. The SCUM II guidance also includes the assessment approach for risks to human health for bioaccumulative chemicals. For the human health assessments, the SCUM II guidance includes two options, a simple streamlined approach using sediment data or a more detailed site-specific approach using site-specific sediment and tissue data. The SCUM II guidance included risk-based calculations for concentrations in sediment, using default assumptions, for human exposure pathways for direct contact included as a resource in the SCUM II guidance. The guidance notes that for the simple streamlined approach, the use of background sediment concentrations instead of site-specific consumption calculated values is appropriate since the risk-based concentrations are frequently below background, resulting in Sediment Cleanup Objectives and Cleanup Screening Level values defaulting to background or practical quantitation limits.

Table 5-3
Sediment Freshwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington
(Concentrations in mg/kg dry weight unless otherwise indicated)

Chemical	Washington SMS Freshwater		Reference Station Concentrations		Laboratory Reporting Limit / Method Detection Limit
	Sediment Cleanup Objective	Cleanup Screening Level	Maximum	90/90 UTL	
Aluminum Smelter (mg/kg)					
Total Cyanide	NE	NE	ND	NC	2.0 / 0.51
Fluoride	NE	NE	7.8	7.7	8.0 / 2.41
Sulfate	NE	NE	290	278	20 / 7.75
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)					
1-Methylnaphthalene	NA	NA	28	NC	5.0 / 0.63
2-Methylnaphthalene	NA	NA	30	NC	5.0 / 2.05
Acenaphthene	NA	NA	24	NC	5.0 / 0.60
Acenaphthylene	NA	NA	28	NC	5.0 / 0.50
Anthracene	NA	NA	29	NC	5.0 / 0.60
Benz[a]anthracene	NA	NA	83	NC	5.0 / 0.76
Benzo(a)pyrene	NA	NA	140	41	5.0 / 0.84
Benzo(b)fluoranthene	NA	NA	150	NC	5.0 / 0.59
Benzo(ghi)perylene	NA	NA	190	NC	5.0 / 0.50
Benzo(k)fluoranthene	NA	NA	43	NC	5.0 / 0.60
Chrysene	NA	NA	120	NC	5.0 / 1.50
Dibenzo(a,h)anthracene	NA	NA	26	NC	5.0 / 0.72
Fluoranthene	NA	NA	210	NC	5.0 / 1.40
Fluorene	NA	NA	27	NC	5.0 / 0.50
Indeno(1,2,3-cd)pyrene	NA	NA	150	NC	5.0 / 0.60
Naphthalene	NA	NA	100	NC	5.0 / 1.62
Phenanthrene	NA	NA	100	NC	5.0 / 1.63
Pyrene	NA	NA	260	NC	5.0 / 0.97
Total cPAH BaPeq (calc)	NA	NA	185	57	5.0 / 0.97
Total PAHs	17,000	30,000	1,516	NC	5.0 / 0.84
Polychlorinated Biphenyls (PCBs) (mg/kg)					
Total Aroclors	0.110	2.5	ND	NC	0.02 / 0.0074
Metals (mg/kg)					
Aluminum	NA	NA	21,000	NC	15.0 / 3.3
Arsenic	14	120	20	18	0.5 / 0.1
Cadmium	2.1	5.4	1.5	1.3	0.4 / 0.07
Chromium	72	88	32	NC	0.5 / 0.06
Copper	400	1,200	54	NC	1.0 / 0.22
Lead	360	>1,300	35.8	128	0.5 / 0.05
Mercury (inorganic)	0.66	0.8	0.18	1.06	0.03 / 0.009
Nickel	26	110	22.7	48.6	0.5 / 0.19
Selenium	11	>20	NE	NE	1.5 / 0.28
Zinc	3,200	>4,200	121	459	5.5 / 1.61
Bulk Petroleum Hydrocarbons (mg/kg)					
TPH-Diesel	340	510	ND	NC	50 / 12.3
TPH-Residual	3,600	4,400	61	NC	50 / 17.5

Notes:
The list of chemicals is limited to chemicals of potential concern for freshwater sediment. There are no SMS Standards for individual PAHs. Volatile Organic Compounds (VOCs) do not represent chemicals of potential concern for sediments.

mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
BaPeq = Benzo(a)pyrene equivalent
cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
NA = Not Applicable
NC = Not Calculated
ND = Not Detected
NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
SMS = Washington State Sediment Management Standard
TPH = Total Petroleum Hydrocarbon
UTL = Upper Threshold Limit

A revision of the SCUM II was made in 2017 (Ecology 2017a) with a draft of a second revision put out for comment in 2019 (Ecology 2019c). The 2019 revision of SCUM II included updates to the default assumptions for the risk-based calculations that resulted in changes to the guidance values for the human health direct exposure pathways included. The 2019 revision for the SCUM II guidance also has added text noting the risk-based concentrations for bio-accumulative chemicals are to be established if complete exposure pathways have been identified in the RI and that if exposure pathways are incomplete, then the benthic criteria should be compared to background concentrations and practical quantitation limits, which is the approach adopted in this report.

Numeric sediment screening levels for protection of human health are not listed on Table 5-3 because the SMS and associated SCUM II guidance (Ecology 2017a, 2019c) do not include specific numeric criteria. Risk-based sediment concentrations protective of human health have been initially evaluated and addressed using the "sediment only" approach in the SCUM II guidance. During the initial phase of the RI, sediment concentration data from the site investigation area were compared against the SMS screening levels, and collected site-specific background concentrations (termed reference concentrations) to determine if further investigation or evaluation was warranted. Based on the initial test results, a supplemental investigation including bioassay testing (Tetra Tech 2018a) was required by Ecology.

Ecology comments on the Draft RI Report, the Draft WPA, and the Revised RI Report state that the SMS criteria are applicable for use in areas that are inundated with water for periods of more than 6 consecutive weeks. Note that only a limited portion of the wetlands at the Site as well as the stormwater pond and the upper portion of the NPDES pond drainage meet this inundation criterion. Both the stormwater pond and the seasonal contaminated water discharge of the SE line at the head of the NPDES Ponds drainage will be addressed in the FS and the remedial action will likely eliminate or substantially reduce the period of inundation in the ponds to less than 6 consecutive weeks. Ponding has been observed seasonally in NPDES Ponds A and B, which are on NSC-owned lands, and have not been observed in Ponds C and D that are on USACE-owned lands.

Also, in general, it should be noted that for the main site COPCs in soil and sediment (e.g., fluoride, PAHs, and a few metals), Sediment Cleanup Objectives and Cleanup Screening Levels are either not established or are typically higher than corresponding soil screening levels for terrestrial ecologic screening, unrestricted land use, and/or groundwater protection.

Table 5-3 summarizes current freshwater sediment screening criteria. Table 5-3 also includes maximum and 90 Upper Threshold Limit (UTL) reference station concentrations which have been updated to include carcinogenic PAHs.

5.2.4 Surface Water

Table 5-4 summarizes surface water screening levels considered for use in support of this RI report. The draft RI Report summarized chemical-specific screening levels for surface water including: MTCA Method B Surface Water Cleanup Levels, Washington State (WAC 340-201A) and Federal Ambient Water Criteria (acute and chronic freshwater values). The MTCA Method B formula values incorporate human health water quality criteria in the National Toxics Rule (40 CFR 131.36) and the Clean Water Act 304 (a) human criteria for water and organisms.

Ecology and Yakama Nation comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) state that the surface water screening levels should be updated to include recent changes to the State human health water quality criteria promulgated in 2015 and 2016 changes in federal water quality criteria. Several surface water quality criteria have changed during the course of the RI field effort and Draft RI Report (Tetra Tech et al. 2019a) preparation, including updates in EPA's National Water Quality Criteria [304 (a)] in 2015 and 2016, Ecology Water Quality Standards (WAC 173-201A) in 2016, and EPA's 2016 "Revision of Certain Federal Water Quality Criteria Applicable in Washington." Changes of the water quality criteria in Washington are summarized in Ecology (2019a), EPA (2016), and Ecology (2021b).

Table 5-3 summarizes updated and current surface water screening criteria as summarized in the May 2019 update of CLARC for both human health and ecologic exposures along with project laboratory reporting limits and method detection limits. Based on Ecology (2019b, 2021a) guidance, Ecology plans to adopt the EPA 40 CFR 131.45 water quality criteria for benzo(a)pyrene as the MTCA Method B Cleanup Level. Note that some of these surface water screening criteria [e.g., benzo(a)pyrene] are orders of magnitude below the method detection limit and reporting limits.

Note that EPA hardness dependent water quality criteria for dissolved metals (As, Cd, Cr, Pb, Hg, Ni, Se, and Zn) have been adjusted according to the EPA (2021) calculation procedure based on RI hardness data for the Wetland K Spring (Spring 01). The water quality criteria for aluminum was also adjusted based on RI data for the Wetland K Spring (Spring 01) consistent with EPA (2018) guidance and associated calculator spreadsheet. Calculation of the ambient water quality criteria

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 3)

	MTCA Human Health		Human Health			Aquatic Life				
			Freshwater							
Chemical	Method B	Method C	WAC 173-201A (Washington State Surface Water Criteria)	40 CFR 131.45 Water Quality Criteria	Clean Water Act Section 304 National Recommended Water Quality Criteria – Water + Organisms	National Recommended Water Quality Criteria – Freshwater Acute (CMC)	National Recommended Water Quality Criteria – Freshwater Chronic (CCC)	Drinking Water WA MCL	Other Screening Levels to Be Considered	Laboratory Reporting Limit/Method Detection Limit
Aluminum Smelting (mg/L)										
Cyanide (Free)	1.6	4.1	0.019	0.009	0.004	0.022	0.0052	0.2	NE	0.005 / 0.0015
Fluoride	NE	NE	NE	NE	NE	NE	NE	4.0	2.0[d]	0.20 / 0.030
Sulfate	NE	NE	NE	NE	NE	NE	NE	250[f]	500[e]	1.20 / 0.260
Polynuclear Aromatic Hydrocarbons (PAHs) (µg/L)										
Acenaphthene	640	1,600	110	30	70	NE	NE	NE	NE	0.020 / 0.0013
Acenaphthylene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Anthracene	26,000	65,000	3,100	100	300	NE	NE	NE	NE	0.020 / 0.00082
Benzo(g,h,i)perylene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.0020 / 0.00086
Fluoranthene	90	230	16	6	20	NE	NE	NE	NE	0.020 / 0.00082
Fluorene	3,500	8,600	420	10	50	NE	NE	NE	NE	0.020 / 0.0011
1-Methylnaphthalene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020/ 0.0013
2-Methylnaphthalene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0013
Naphthalene	4,900	12,000	NE	NE	NE	NE	NE	NE	NE	0.020/ 0.0014
Phenanthrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Pyrene	2,600	6,500	310	8	20	NE	NE	NE	NE	0.020 / 0.0010
Carcinogenic PAHs (µg/L)										
Total Toxicity Equivalent Concentration (TTEC)	0.035/0.000016[b]	5.4/0.000016 [b]	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Benzo(a)pyrene	0.035/0.000016 [b]	5.4/0.000016 [b]	0.0014	0.000016	0.00012	NE	NE	0.2	NE	0.020 / 0.0011
Benzo(a)anthracene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.020 / 0.000097
Benzo(b)fluoranthene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.020 / 0.00083
Benzo(k)fluoranthene	NE	NE	0.014	0.0016	0.012	NE	NE	NE	NE	0.020 / 0.00094
Chrysene	NE	NE	1.4	0.016	0.12	NE	NE	NE	NE	0.020 / 0.00076
Dibenz(a,h)anthracene	NE	NE	0.0014	0.000016	0.00012	NE	NE	NE	NE	0.020 / 0.0013
Indeno(1,2,3-cd)pyrene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.05020 / 0.00089
Polychlorinated Biphenyls (PCBs) (µg/L)										
Total PCBs	0.0001	0.0026	0.00017	0.000007	0.000064	2	0.014	0.5	NE	0.621/0.022
Aroclors (µg/L)										
1016	0.0058	0.015	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1221	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1232	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1242	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1248	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1254	0.0017	0.0026	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1260	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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	MTCA Human Health		Human Health			Aquatic Life				
			Freshwater							
Chemical	Method B	Method C	WAC 173-201A (Washington State Surface Water Criteria)	40 CFR 131.45 Water Quality Criteria	Clean Water Act Section 304 National Recommended Water Quality Criteria – Water + Organisms	National Recommended Water Quality Criteria – Freshwater Acute (CMC)	National Recommended Water Quality Criteria – Freshwater Chronic (CCC)	Drinking Water WA MCL	Other Screening Levels to Be Considered	Laboratory Reporting Limit/Method Detection Limit
Metals (mg/L)										
Aluminum [a]	NE	NE	NE	NE	NE	1.3[c]	0.480[c]	NE	NE	0.1 / 0.0126
Arsenic	0.000098	0.0025	0.001	0.000018	0.000018	0.34	0.15	0.010	NE	0.001 / 0.0002
Cadmium [a]	NE	NE	NE	NE	NE	0.0026[h]	0.0010[h]	0.05	NE	0.0004 / 0.0001
Chromium (III)	240	610	NE	NE	NE	0.79[h]	0.010[h]	0.1	NE	0.0004 / 0.0002
Copper [a]	2.9	7.2	1.3	NE	1.3	NE[i]	NE[i]	13	NE	0.002 / 0.0006
Lead [a]	NE	NE	NE	NE	NE	0.10[h]	0.0039[h]	0.015	NE	0.0008 / 0.0002
Mercury	NE	NE	NE	NE	NE	0.0014	0.00077	0.002	NE	0.0003 / 0.0002
Nickel (soluble salts)[a]	1.1	2.8	0.15	0.08	0.06	0.66[h]	0.073[h]	0.1	NE	0.003 / 0.0001
Selenium	2.7	6.8	0.12	0.06	0.17	NE	NE	0.050	NE	0.008 / 0.0020
Zinc[a]	17	41	2.3	1	7.4	0.12[h]	0.01[h]	NE	NE	0.007 / 0.0019
Total Petroleum Hydrocarbons (TPHs) (mg/L)										
TPH-Gx (gasoline-extended range)	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.250 / 0.10
TPH-Dx (diesel and heavy-oil ranges)	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.110 / 0.065
Volatile Organic Compounds (VOCs) (µg/L)										
Fuel-Related										
Benzene	23	570	0.44	NE	0.58	NE	NE	5	NE	0.20 / 0.03
Toluene	19,000	48,000	180	72	57	NE	NE	1,000	NE	0.20 / 0.05
Ethyl benzene	6,900	17,000	200	29	68	NE	NE	700	NE	0.20 / 0.05
Xylenes	NE	NE	NE	NE	NE	NE	NE	10,000	NE	0.50 / 0.115
Solvent-Related										
Tetrachloroethene (PCE)	100	1,300	4.9	2.4	10	NE	NE	5	NE	0.50 / 0.084
Trichloroethene (TCE)	13	290	0.38	0.3	0.6	NE	NE	5	NE	0.20 / 0.066
1,1,1-Trichloroethane (1,1,1-TCA)	930,000	2,300,000	47,000	20,000	10,000	NE	NE	200	NE	0.20 / 0.025
1,2-Dichloroethane (1,2-DCA)	59	1,500	9.3	8.9	9.9	NE	NE	5	NE	0.20 / 0.043
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	NE	NE	NE	NE	NE	NE	70	NE	0.20 / 0.055
Vinyl chloride	3.7	92	0.02	NE	0.022	NE	NE	2	NE	0.02 / 0.013

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate February 2021 CLARC Update (Ecology 2021b).

a Hardness and/or pH dependent criteria.

b Ecology has proposed to adopt the EPA 40 CFR 131.45 criteria as the MTCA Method B and C Surface Water Cleanup Level (Ecology 2019b, 2021a) pending ongoing litigation between the State of Washington and EPA for surface waters that provide fish habitat. Based on the conceptual model of the site presented in this Final Draft RI Report, Ecology (2022) comments state that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs. The springs represent a special case since they are largely seasonal and do not provide fish habitat.

c Aluminum criteria calculated using EPA (2018) guidance and associated calculator spreadsheet. Values used to determine the screening levels included: dissolved organic carbon of 1.0 mg/L, pH of 7.19, and total hardness of 150 mg/L. Hardness and pH based on the Wetland K Spring 01 RI data set. Dissolved organic carbon based on the typical range for groundwater. Aluminum ambient water quality criteria are based on total recoverable fraction.

d Fluoride value represents the Federal EPA Secondary MCL as well as screening level protective of livestock (cattle) (NDSU Extension 2021, UK Cooperative Extension 2008).

e Sulfate value represents screening level protective of livestock (cattle) (NDSU Extension 2021, UK Cooperative Extension 2008).

f Criteria represents Federal EPA Secondary MCL.

g Criteria based of dissolved (field-filtered) fraction that will be used for comparison.

h Hardness dependent criteria that has been adjusted using a hardness value of 150 mg/L from the RI Wetland K Spring 01 data set. The ambient water criteria values were adjusted using the equation and conversion factors on the EPA (2021) National Recommended Water Quality Criteria-Aquatic Life Criteria Table, Appendix B.

i Calculation of ambient water quality criteria value for copper requires use of Biologic Ligand Model and sampling and analysis for development of appropriate input parameters has not been performed. For this reason, the Washington 173-201A freshwater chronic aquatic copper value will be used for screening purposes for this exposure pathway.

mg/L = Milligrams per Liter
µg/L = Micrograms per Liter
CCC = Criterion Continuous Concentration
CFR = Code of Federal Regulations
Cleanup Level and Risk Calculations Summary Tables accessed online during August 2019 (May 2019 CLARC Update)
CMC = Criterion Maximum Concentration
MTCA = Model Toxics Control Act
NE = Not established in look-up Tables
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds
WAC = Washington Administrative Code

value for copper requires use of the Biologic Ligand Model (EPA 2007b) and sampling and analysis for development of appropriate input parameters has not been performed. For this reason, the Washington 173-201A freshwater chronic aquatic copper value will be used for screening purposes for this exposure pathway.

EPA has revisited the 40 CFR 131.45 criteria and withdrew most of these water quality criteria effective on June 12, 2020. However, the State of Washington filed a lawsuit in June 2019 that challenges EPA's decision (Ecology 2021a). Ecology's policy indicates that "Ecology site managers will request PLPs to develop the most stringent surface water Preliminary Cleanup Levels (PCLs) for MTCA site investigation purposes, including application of EPA's 40 CFR 131.45 water quality criteria (including the withdrawn criteria)."

The principal issue related to default surface cleanup levels in the CLARC tables is associated with carcinogenic PAH compounds represented as equivalent Benzo[a]pyrene (BAP). Interim Policy 730, addresses issues related to litigation between Washington and the Federal Government over water quality standards for protection of human health associated with carcinogenic PAH compounds that are of particular concern. The Ecology guidance document "Polycyclic Aromatic Hydrocarbons and Benzo[a]pyrene: Changes to MTCA Default Cleanup Levels for 2017 (revised January 2020)", provides default cleanup values that are not site-specific. This guidance document identifies that the lowest of the Applicable or Relevant and Appropriate Requirements (ARAR) criteria for surface water is the applicable cleanup level, citing 40 CFR 131.45, at a value of 1.6×10^{-5} micrograms per Liter (µg/L) for BAP. Ecology has approved a method detection limit of 1.1×10^{-2} µg/L and a method reporting limit of 1.0×10^{-1} µg/L for BAP in the Final Work Plan Addendum, Columbia Gorge Smelter Site (Revision 1) dated September 18, 2020. The RI laboratories have been able to achieve a method detection limit of 1.1×10^{-3} µg/L and a method reporting limit of 2.0×10^{-2} µg/L, which are orders of magnitude higher than the default ARAR value of 1.6×10^{-5} µg/L.

In comments on the Revised RI Report (Ecology 2022), Ecology stated that if there's a completed pathway to a fish-bearing surface water for carcinogenic PAHs, then values established under 40 CFR 131.45 40 CFR 131.45 (currently in litigation) should be used, but adjusted upward to an appropriate practical quantitation limit consistent with MTCA requirements (WAC 173-340-7006[d]). Ecology noted that the springs represent a special case since they are seasonal and do not provide fish habitat. Based on the current understanding of the site presented in this Final Draft RI Report, Ecology has stated that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs.

Other constituents, including metals, metalloids, fluoride and sulfate, will utilize the groundwater screening levels for the springs to assess advancing them to the FS for evaluation. For fluoride, the Primary MCL of 4.0 mg/L will be adopted for screening purposes consistent with other aluminum smelter cleanups in Washington State. The MTCA Method B groundwater formula value of 0.96 mg/L will also be used in the RI/FS for screening purposes. In addition, based on literature review, a water quality screening level of 2.0 mg/L is deemed safe for livestock (cattle) (NDSU 2021; UK 2008; Fort Keogh Livestock and Range Research Laboratory 2021) and this value also represents the EPA Secondary MCL for fluoride. For these reasons, the fluoride screening level of 2.0 mg/L may also be used as appropriate for surface water screening.

5.2.5 Background Concentrations

This section summarizes how the evaluation and calculation approach for determination of background concentrations, soil screening levels for protection of groundwater, terrestrial ecological evaluation, and chemical lacking MTCA CLARC screening levels were determined for use in the RI report. In some cases (e.g., arsenic), soil and groundwater background concentrations are consistently higher than screening levels. In these cases, the screening levels have been adjusted to background concentrations consistent with MTCA requirements.

5.2.5.1 Soil

Two sets of background concentrations for metals and other inorganic chemicals are included for background screening level comparisons: Ecology (1994) soil natural background study and site-specific background concentrations based on data collected prior to the RI (PGG 2013a) (refer to Table 5-1). The Ecology (1994) background study values represent the 90th percentile of the eastern Washington data. The PGG (2013a) report includes results from 21 surface soil samples from unimpacted areas in the site vicinity. The calculated background concentrations represent the 90th percentile of the data set. The Ecology (1994) background values were typically used in background comparison, except for chemicals (e.g., selenium and fluoride) that were not evaluated in the Ecology background study. Supporting documentation regarding soil background concentrations are provided in Volume 5, Appendix A-2.

5.2.5.2 Groundwater

Determination of natural background concentrations in groundwater was needed as part of the RI to distinguish site-related concentrations from naturally occurring background concentrations. For the purposes of defining background concentrations under MTCA (WAC 173-340-709), the data set is assumed to be lognormally distributed unless it can be demonstrated that another distribution is appropriate. For lognormally distributed data sets, background is defined under MTCA as the upper 90^{th} percentile or 4 times the true 50^{th} percentile, whichever is lower.

Table 5-2 summarizes groundwater background concentrations for selected metals that exceeded groundwater screening levels in one or more wells (As, Al, Cr, Fe, Ni, and Pb) as well as fluoride and sulfate. The data set includes eight upgradient background well locations (three screened in the BAU and five screened in the UA aquifer zones) and four quarters of results for total (unfiltered) metals. For metals, both total and dissolved background concentrations were calculated to compare the data distributions, which were similar.

A statistical evaluation was performed using all eight background wells in accordance MTCA guidance. The full data set was considered appropriate for evaluation in part because of evidence of local interconnection of the UA and BAU aquifer zones. Aquifer-zone-specific background concentrations (i.e., separate background concentrations for the UA zone and BAU zone) were also calculated and evaluated, but in a few cases, there weren't enough positive detections for statistical evaluation. For these reasons and for simplicity, the full background well data set has been selected to calculate the site groundwater background concentrations for the RI.

ProUCL was used to evaluate the goodness of fit of the data distribution. In most cases, the 90^{th} percentile lognormal value was selected consistent with MTCA requirements. In some cases, the data sets did not match normal, lognormal, and gamma data distributions, so non-parametric statistics were also used. The ProUCL output files and summary table are available in Volume 5, Appendix A-3.

For those chemicals that were not detected in the eight background well data set during any of the four sampling rounds, the background concentration is listed in Table 5-2 as ND (Not Detected). Background concentrations were not calculated for those metals and other chemicals that did not exceed groundwater screening levels in any of the monitoring wells during the first (baseline) sampling round and the background concentration is listed as NE (Not Established).

Note that calculated background concentration for arsenic exceeded MTCA Method B groundwater formula values.

5.2.5.3 Sediment

Background reference stations and background concentrations have been evaluated consistent with Ecology (2017a) SCUM II guidance. Refer to the Ecology-approved Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) and the Final Columbia River Sediment AOC Bioassay Sampling and Analysis Plan (Tetra Tech 2018a) for further details regarding the reference station locations. A 90/90 UTL (i.e., the 90 percent UCL on the 90^{th} percentile) as well as the maximum concentrations were used for screening purposes consistent with SCUM II guidance. The calculated 90/90 UTL values are summarized in Table 5-3 and the ProUCL data files are included in Volume 5, Appendix A-4.

Refer to the Columbia River Sediments AOC (Volume 4, Section 1.0) for a detailed presentation of the results.

5.2.6 Soil Screening Levels for Protection of Groundwater

This section summarizes soil screening levels for protection of groundwater for use in this RI report. Two procedures were used to determine these screening levels:

- Soil screening levels protective of groundwater from the Ecology CLARC website have been included where available as calculated with the fixed parameter three-phase partitioning model [as described in WAC 173-340-747(4) and based on MTCA Equation 747-1].
- For three main aluminum smelter-related chemicals lacking CLARC soil screening levels protective of groundwater (i.e., fluoride, cyanide, and sulfate), soil screening levels for protection of groundwater were determined consistent with MTCA. Cyanide and sulfate protective screening levels were determined using the three-phase partitioning model with MTCA groundwater screening levels and literature distribution coefficient (Kd) values as input values. An alternate empirical method was used for determination of fluoride screening levels and is described in Section 5.4.2.1. These derived soil screening levels are summarized on Table 5-1.

Supporting documentation regarding calculation of soil screening levels protective of groundwater is included in Volume 5, Appendix A-5. Evaluation of this pathway is of particular relevance for groundwater COPCs that are widespread in site soils and wastes, represent groundwater COPC, and lack published CLARC values for this pathway. For example, fluoride is characterized by human health-based soil screening levels ranging between 4,800 mg/kg (MTCA Method B formula value) and 210,000 mg/kg (MTCA Method C formula value), while the groundwater protection levels range between 0.96 mg/L (MTCA Method B groundwater formula value) and 4.0 mg/L (MCL). While fluoride generally does not exceed the human-health based screening levels in soil and waste, it is widespread in soils and wastes in historical operational areas associated with the former plant. Fluoride also exceeds the MTCA Method B groundwater formula value at several wells and in all three aquifer zones.

Further details regarding the fluoride, cyanide, and sulfate soil screening levels for protection of groundwater are provided below.

5.2.6.1 Fluoride

The range of fluoride Kd values found based on sorption studies are generally low [commonly 0.2 to less than 20 liter per kilogram (L/kg)] and are not considered representative of site conditions. For this reason, an empirical approach consistent with MTCA was used to determine fluoride soil screening levels for protection of groundwater. Volume 5, Appendix A-5 summarizes the empirical approach for fluoride in detail.

In general, fluoride is more soluble in alkaline soils than in acidic soils (with lower Kd values for alkaline soils). Site soils appear to be neutral to slightly alkaline and the groundwater pH at the site typically ranges between about 6.5 to 8.0 pH units. Fluoride-containing wastes present at the site include cryolite, which was used in the electrolytic refining process, and SPL (K088 waste). Cryolite (Na_3AlF_6) is slightly soluble in water, with literature values indicating a solubility of 420 mg/L (228 mg/L fluoride). The principal minerals present in the SPL include cryolite, fluorite (CaF_2), and sodium fluoride (NaF). Fluorite has very low solubility, while sodium fluoride is extremely soluble in water. The fluoride ion will sorb or participate in exchange reactions on clays, alumina, and iron oxides.

A site-specific Kd was evaluated using the standard DI-leachable fluoride and Synthetic Precipitation Leaching Procedure (SPLP) fluoride results for waste samples collected at the East End Landfill (EELF), Smelter Sign Area, and the NESI consistent with the Final RI Phase 2 Work Plan. The SPLP results suggest that fluoride is weakly adsorbed and soluble in site wastes. However, SPLP results were only collected for waste samples, and the collected waste samples are not representative of site soils.

For this reason, an empirical approach was used to develop soil screening levels protective of groundwater for fluoride. The empirical approach was made consistent with MTCA requirements [WAC 173-340-747(9)]. The empirical approach was developed through evaluation of two lines of evidence: 1) correlation of shallow groundwater and waste concentrations in an area where aluminum smelter wastes are in contact with shallow groundwater (NESI area), and 2) consideration of fluoride soil screening levels protective of groundwater for other Washington aluminum smelter sites. Refer to Volume 5, Appendix A-5 for supporting analyses and data.

Smelter waste fluoride results for the NESI area were compared to groundwater results for a nearby monitoring well (IB-2A) and NESI wetland surface water to develop a correlation and interpolate the soil screening level that is protective of groundwater. In this area, smelter wastes are in direct contact with shallow groundwater, and for this reason the approach was deemed to provide the most representative results. The fluoride soil screening level for protection of groundwater derived using this approach is 615 mg/kg using the MCL of 4.0 mg/L and a screening level of 147.6 mg/kg using the MTCA Method B groundwater formula value of 0.96 mg/L. Note that the RI fluoride soil and waste results were analyzed by EPA Method 300 that includes a deionized (DI) water-leach extraction to determine fluoride concentrations. In effect, the fluoride waste and soil results represent water-soluble fluoride making for a representative comparison with site groundwater data.

Fluoride levels for other Washington sites are summarized as follows to provide some context for decision making:

- **Longview**. Fluoride soil screening level protective of groundwater of 3,100 mg/kg based on 2006 lysimeter data and 2007 SPLP data that determined an average Kd of 39 L/kg (Ecology 2018a). The fluoride MCL of 4.0 mg/L was used as the groundwater protection standard.

- **Kaiser Mead**. Fluoride soil screening level protective of groundwater of 2,884 mg/kg specified in the 2002 Record of Decision (Ecology 2002). The fluoride MCL of 4.0 mg/L was used as groundwater protection standard. Using the 3-phase partitioning model and MCL to reproduce this remediation level, the inferred Kd is 35 L/kg.

- **Intalco Ferndale** (Anchor Environmental 2006). Fluoride soil screening level protective of groundwater of 5,947 mg/kg based on porewater study and compliance remedial goal of 100 mg/L fluoride at the conditional point of compliance (i.e., site seeps). Determined an average Kd of 26.5 L/kg.

The derived site-specific fluoride soil screening levels for protection of groundwater of 615 mg/kg (based on the 4.0 mg/L MCL) and 147.6 mg/kg (based on MTCA Method B) (refer to Table 5-1 and Volume 5, Appendix A-5) are significantly lower than those used at other aluminum smelter MTCA cleanups. Remediation levels, cleanup levels, and point of compliance for soil and groundwater will be re-visited in the FS.

5.2.6.2 Cyanide

The Kd value used in the calculation was 9.9 L/kg, which is the same value used in the EPA Regional Screening Level User's Guide (EPA 2017). Use of this Kd value and the MTCA Method B groundwater formula value of 9.6 µg/L in the MTCA 3-phase partition equation results in a cyanide soil screening level of 1.9 mg/kg. Use of the MCL (0.200 mg/L) yields a cyanide screening level of 40 mg/kg. Both of these values have been used for screening purposes in the results summaries for individual SWMUs and AOCs.

Note that cyanide screening levels and Kd values are based on free cyanide, rather than total cyanide, and very little free cyanide has been found in the soil or groundwater at the site. This suggests that much of the cyanide is in a metal-complexed form (e.g., iron cyanide) that is less soluble. This supports adoption of the Kd literature value for cyanide of 9.9 L/kg and represents a common and accepted value used for EPA risk assessments.

5.2.6.3 Sulfate

Only limited risk assessment or partition coefficient (Kd) information was found during review for sulfate. Use of a Kd value of 0.23 L/kg from a British Environment Agency laboratory sorption study (Environmental Agency 2005) and the 250 mg/L MCL in the MTCA 3-phase partitioning model calculation yields a soil screening level for protection of groundwater of 2,150 mg/kg.

Sulfur in the aluminum smelter industry is most commonly associated with the coke used to produce anodes and may become concentrated in the air emissions [primarily as sulfur dioxide (SO_2)] during smelting (IAC 2008). The highest sulfate concentrations in groundwater at the site are generally associated with the ESI and the WSI, where air pollution control scrubber sludges were disposed, rather than the main plant area.

5.2.7 Terrestrial Ecological Evaluation

WAC 173-340-7490 defines procedures for characterizing potential impacts from releases to the terrestrial environment and establishing cleanup standard for protection of terrestrial plants and animals. The regulation specifies in the event of a release of a hazardous substance to the soil at a site that one of the following actions will be taken: 1) an exclusion from further terrestrial ecological evaluation will be documented using the criteria in WAC 173-340-7491, 2) a simplified terrestrial ecological evaluation will be performed consistent with WAC 173-340-7492, and 3) a site-specific terrestrial ecological evaluation will be performed consistent with WAC 173-340-7493. The regulation also states that terrestrial ecological procedures are not intended specifically for wetlands and that procedures for wetland evaluations will be determined on a case-by-case basis [WAC 173-340-7490(1)(c)].

Several of the SWMUs and AOCs were originally proposed for exclusion from terrestrial ecological evaluation because the site represents an industrial site where MTCA Method C soil cleanup levels and institutional controls will be implemented. Building, paved road, pavement or other physical barriers are and will be present that will prevent wildlife from being exposed to soil contamination consistent with WAC 173-340-7491(b). Also, a few of the sites [i.e., the ESI (SWMU 2), WSI (SWMU 4), and West SPL Storage Area (SWMU 13)] already have a protective cap in place and others have been previously remediated through soil removal that has reduced potential risks to terrestrial ecological receptors. A site-specific terrestrial ecological evaluation (rather than a site-specific wetland/aquatic evaluation) was included for wetland areas of the site because the Category III and IV wetlands at the site represent small, disturbed, wetlands of low to moderate function that are not substantially used by aquatic receptors.

Ecology comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) state that a site-specific TEE is necessary for the overall site (even for those areas with no available habitat). In addition to the screening levels included by rule in MTCA Table 749-3, screening levels for additional chemicals have been provided by Ecology. These recommended screening levels are based on best available science according to Ecology. Ecology has indicated for three receptor categories (soil biota, plants, and protection of wildlife) should be used in this screening. Ecology's position is that soils in areas which are both owned by NSC and zoned for industrial use may be screened using only the wildlife values for TEE. All other areas of the Site should be screened using appropriate values for all three eco-risk receptor categories. This approach will be adopted for the purposes of screening during the RI. Further evaluation of terrestrial ecologic screening levels may be performed as appropriate during the FS phase of the project.

5.2.8 Site Chemicals of Potential Concern Lacking MTCA Screening Levels-Sulfate

This section summarizes site COPC lacking MTCA Screening Levels as presented on the MTCA CLARC website. The most widespread smelter-related chemical that has been detected in soil, waste, and groundwater that is lacking MTCA formula values is sulfate.

The Washington State MTCA has a methodology for developing cleanup levels lacking reference dose information. WAC 173-340-708 (7) specifies use of reference dose/reference concentrations established in the following EPA databases in order of priority IRIS, HEAST, and the National Center for Environmental Assessment. If no values are available in these databases and the department determines that development of a reference dose/reference concentration is necessary, then the value will be established on a case-by-case basis using EPA 1993 risk assessment reference dose guidance, and Ecology consultation (as appropriate) with the science advisory board, the Department of Health, EPA, and other qualified persons.

Based on review of the Washington Department of Ecology CLARC website and the EPA Regional Screening Levels (RSLs), there are no risk-based screening levels included for sulfate in any media (soil, groundwater, or surface water). The only screening level found is the secondary MCL of 250 mg/L, which is based on taste rather than toxicity. Also, the World Health Organization (2004) did not identify a level of sulfate in drinking water that is likely to cause adverse human health effects based on a literature review.

The secondary MCL of 250 mg/L for sulfate has been selected for RI screening purposes at the site for convenience. The secondary MCL was also used to calculate the soil screening level for sulfate that is protective of groundwater. A MTCA Method C Industrial screening level for human health protection has not been developed for sulfate because no reliable reference dose was found based on scientific literature review. Based on further literature review, sulfate concentrations greater than

500 mg/L, show adverse effects on livestock (cattle calves) (NDSU 2021; UK 2008; Fort Keogh Livestock and Range Research Laboratory 2021) and it is assumed that other similarly sized herbivores such as deer would be similarly affected. For this reason, the 500 mg/L screening level will also be used for screening purposes for the groundwater and groundwater-springs data sets.

Section 6
Data Quality Assessment

Analytical laboratory and field-related data quality assurance and control plans prepared in support of the RI work effort included a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) that were both incorporated as part of the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). The FSP and QAPP describe the Quality Assurance/Quality Control (QA/QC) procedures that were used by the project field team, including subcontractors, as well as the certified analytical laboratories used in support of the RI work effort. Project performance and acceptance criteria established for the RI work effort is expressed in terms of accuracy, precision, representativeness, comparability, and completeness. A set of default quality control limits, including analytical method detection and reporting limits, as well as the associated precision, accuracy, and completeness criteria for the RI work effort are summarized in Section 6 of the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) and in the Final WPA (Tetra Tech et al. 2020b).

In addition to the FSP and QAPP, a supplemental project Quality Management Plan (QMP) was prepared that specifies the quality management approach, procedures, and documentation requirements to help ensure the successful implementation of the field program, and effective collection of RI data designed to meet established data quality and project objectives (Tetra Tech 2015).

The RI work effort was completed by environmental consulting firms representing both responsible parties, including Tetra Tech on behalf of Lockheed Martin and BMEC and PGG on behalf of NSC. BMEC and PGG specifically conducted the investigation of the Plant Area AOC and SWMUs 14, 15, 21, 22, 23, 30, and stormwater and industrial lines aspect of SWMU 32. All remaining SWMUs, AOCs, and additional investigation areas were investigated specifically by Tetra Tech, including a portion of SWMU 32 (the stormwater pond and surrounding area), which was a shared investigation with BMEC. All laboratory analyses and associated third-party data validation were completed in accordance with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) and Final WPA (Tetra Tech et al. 2020b).

Certified analytical laboratory support for the initial RI work effort was provided by Test America of Tacoma, Washington for Tetra Tech and Onsite Environmental, Inc. of Redmond, Washington for BMEC. Third-party data validation for the initial RI work effort was performed by Laboratory Data Consultants, Inc. of Carlsbad, California for Tetra Tech and EcoChem, Inc. of Seattle, Washington for BMEC. For the WPA work effort, a single laboratory and third-party data validator were selected for ongoing work (ALS of Kelso, Washington, and Laboratory Data Consultants, Inc. of Carlsbad, California, respectively). All of the RI data have been validated based on project DQOs and the data qualified as appropriate; none of the RI and WPA results were rejected.

Complete analytical results for the RI are presented in Volume 5, Appendix H (including H-1 and H-2 for Tetra Tech initial RI and WPA data sets, and H-3 and H-4 for BMEC initial RI and WPA data sets, respectively). Similarly, data validation reporting for all environmental samples collected in support of the RI work effort is provided in Volume 5, Appendix I (including I-1 and I-2 for Tetra Tech initial RI and WPA data sets and I-3 and I-4 for BMEC initial RI and WPA data sets, respectively). Data quality associated with individual SWMUs and AOCs is discussed in the summary of RI results provided in Volume 2, Volume 3, and Volume 4, respectively.

6.1 DATABASE AND UNIT CONVERSIONS

Ecology comments on the Draft RI Report and the WPA indicated a need for use of consistent reporting units for screening level summary tables, and sample results summary tables. The RI report and project data base has been updated to incorporate reporting units consistent with those units shown in the screening level tables (Tables 5-1 through 5-4) of this Volume.

6.2 RI DATA

In the Draft RI Report, several of the RI data summary tables incorporated inconsistent reporting units depending on which laboratory performed the chemical analyses. While the screening levels were converted in the text of the Draft RI Report to match the reporting units for as appropriate, comparison of data between areas became challenging. This problem was most widespread for the PAH soil data set. In this Final Draft RI Report, all RI results have been summarized in the same units as shown in Table 5-1 through 5-4 of this volume. This process was performed by converting the results within the project database. The laboratory reports and electronic data deliverables remain in the units as originally reported by the laboratory.

6.3 WPA DATA

The WPA data were analyzed by a single laboratory (ALS), which used consistent reporting units for all results. In this Final Draft RI Report, all WPA results have been summarized in the same units as shown in Table 5-1 through 5-4 of this volume. Results for a few analyte groups, have been converted within the project database to match the rest of the data set for a few analytical groups (PAHs in soil, free cyanide in water, TPH-Dx in water, metals in water). The laboratory reports and electronic data deliverables remain in the units as originally reported by the laboratory.

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